# Mimbres Basin Hydrological Characterization Report
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**by**
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*Mimbres River at River Ranch, Summer Solstice 2012*

## Abstract

The Mimbres basin is a closed basin that occupies parts of Southwest New Mexico and Northwestern Chihuahua, Mexico. The lowest part of the basin was an ancient lake during the first days of men. In 1900 there was still a very high water table in the vicinity of Deming New Mexico. At present, fossil fuel powered pumps are depleting the groundwater to grow crops in the desert. So far, the water table has dropped 20 to 80 feet near Deming over an area of 200 square miles, and it has dropped 20 to 120 feet east of Columbus over an area of 80 square miles.

## Statement of Purpose

The purpose of this report is to describe and attempt to understand how a closed basin functions in the desert southwest. It is also for the author to learn about his home drainage basin that is being dewatered for mining and agriculture in the desert. This has become one focus of an intense political battle for water resources, with the free flowing Gila River in the balance.

## Geographical Introduction

The Mimbres Basin has a drainage area of 5,140 square miles. It is located primarily in Grant and Luna counties in Southwest New Mexico, and in northern Chihuahua in Mexico. There is about 450 square miles of the watershed in Doña Ana county, and a tiny sliver in Sierra County in New Mexico as well. Within the US, the basin is aligned north-south and is 95 miles from the headwaters to the border and averages 45 miles wide.

Mimbres is the name of the Native American tribe that used to live on the banks of the Mimbres river. It also is the Spanish name for Desert Willow, *Chilopsis linearis,* a native flowering shrub that grows in desert washes in the region.

## Physiography

The Mimbres basin is part of a larger international closed basin system called the Guzmán Basin (also called Los Muertos). This is a large endorheic (closed) basin that occupies the northwestern portion of Chihuahua in Mexico and extends into Luna and Grant Counties in Southwest New Mexico. The main rivers that flow into the basin in Mexico are the Casas Grandes River, which empties into Lake Guzmán, the Santa Maria River, which empties into Lake Santa Maria, the Carmen River, which drains from the Sierra Madre Occidental. In New Mexico there is the Mimbres River and its tributary, San Vicente Arroyo, which drain to the Mimbres basin. The Mimbres basin has a very low and indistinct southern rim that would keep its surface waters (if present) isolated from the Guzmán basin in the present climate.

Trout in the south-flowing Mimbres River in New Mexico have the same genetics as the trout that live in Old Mexico in streams that drain into the Guzmán basin. This proves that the surface waters were once connected during a wetter climate. Historical accounts tell of the area around Deming as still being a region with a very shallow water table that sometimes flooded large areas during a good rain year. Due to groundwater pumping, this does not happen anymore.

The north end of the Mimbres basin is bounded by mountains at the southern terminus of the North American Cordillera. The is the transition zone between the Colorado Plateau and the basin and range provinces to the south. The dominant feature is a monocline, the erosion of which has resulted in the exposure of a complete sequence of rocks from the Precambrian to Tertiary.

The Silver City Range, the Black Range and the Mimbres Mountains are the main source areas for precipitation. Reeds Peak in the Black range is the high point at 10,011 feet. The rim of the basin gradually decreases in elevation as it goes south. The rim also becomes lower relative to the basin floor along the way. Basin relief to length in the transverse direction goes from 144 feet per mile near the northern end of the basin to 5 feet per mile and less in the southern part of the basin. The low point of the basin is near the international boundary at an elevation of 3770 feet.

The major water-yielding unit in the Mimbres basin is the bolson-fill aquifer. It ranges in thickness from 0 to 3,700 feet. Recharge occurs from infiltration where ephemeral streams come out of the mountain front and disappear in the porous alluvium of the valley fill.

## Climate

This is a semiarid land at the north end of the basin, transitioning to an arid land at the low point of the basin. In Fort Bayard near Silver City, 135 years of record show an average precipitation of 15.47 inches at an elevation of 6142 feet. This is indicative of the upper watershed source area.

The precipitation in this region comes in two wet seasons. The bulk of the annual precipitation falls as torrential rains in July, August, and September. This is the monsoon season with its localized convective thundershowers one to ten miles across. Locals say about the monsoons that "A 20% chance of rain means 100% chance of rain in the area, and an 80% chance it won't rain on your ranch." Small tributaries can have large flows if they are at the epicenter of a big thundershower. The other wet season is winter, punctuated by the occasional very large scale storm system with the ability to saturate the entire watershed and dramatically increase stream flow regionally. In recent years, the winter storms are less frequent and intense, are less likely to have snow than rain, and they tend to occur later in the water year.

Average precipitation ranges from over 24 inches in the headwaters mountains to the north, down to less than 9 inches in the south. Annual rainfall variability increases as local annual rainfall decreases. One recent year the poor border town of Palomas, Mexico got barely any rain at all.

In Fort Bayard, 52 years of temperature records show an average annual high of 96.11 °F and an average annual low of 7.47 °F. The mean monthly temperature in Ft Bayard ranges from 37 - 41 °F in January to 72 - 81 °F in July. In Deming the range is 41 - 81 °F.

The spring winds in the region can be particularly violent in Deming New Mexico, where there are 288 sunny days per year. Silver City advertizes 295 sunny days per year, and Mimbres 291. If there are less sunny days in Deming than Silver City it is because of the dust storms that require people to drive with their lights on during windy days, a testament to poor land management.

## Land and Water Use

The vast majority of the area in the Mimbres Basin has been grazed by cattle ever since the Apaches were exterminated by the cavalry after the end of the Civil War. Vegetation type conversion from native grasslands to shrub land and non-native annuals has subsequently occurred over very large areas due to the grazing behavior of cattle. This a significant factor in water yield, evapotranspiration rates, and groundwater recharge. Hoof compaction and denudation of vegetation has increased the surface runoff coefficient in places, and destabilized banks resulting in many new arroyos.

A hundred years of fire suppression has altered forest stands. Once-open forest stands have changed to fire-prone thickets. Areas that withstood frequent grassfires under the ancient trees are now experiencing stand-replacement fires, with high sediment post-fire floods. The region entered the Anthropocene when Geronimo surrendered.

Once the river had the capability to occasionally flow all the way to Deming. Now it dries out in a desertified landscape. The Mimbres once had vast floodplain wetlands, but now it is totally altered by man. Irrigated agriculture in the Mimbres Valley has several points of diversion from the river, and there are many small apple orchards and a few vineyards. Most of the ephemeral tributaries are either gullied, or over-wide sand washes. Scores of dirt cattle tanks in the tributaries capture any runoff events in the upper watershed and cause it to be evaporated instead of soaking through an alluvial fan to reach the river. This has a huge effect on the ecology of the riparian system.

In the upper reaches of the river south of where Highway 35 crosses a low divide in the structural trench shared by both drainages and enters the Sapillo drainage, the Mimbres is deeply incised in places. People have built homes on the abandoned floodplain and now are invested in protecting their infrastructure from the river they have encroached upon. Where it goes under the Highway 152 bridge, the river has incised quite a bit, loosing floodplain, and therefore both groundwater recharge-capability and storage capacity in

the upper watershed. This is because the river had long ago has been straightened and shoved to the side of its valley for agriculture.

The poor river has also been manipulated by the State Highway department, the county road department, and local landowners' roads. Hundreds of miles of roads have added a new drainage pattern to the historic natural one, drying out some watercourses, and overloading others with water and sediment. Poorly drained county roads have caused quite a few gullies. A fine example is Royal John Mine Road off Highway 61.

A new power plant just north of Deming on U.S. Highway 180 was recently built by Duke Energy. Completed in the summer of 2002, this $250 million natural gas-fired plant supplies enough energy to light, heat and cool about 570,000 households. The energy is sold to the grid and destined for places like Arizona, Texas and California. This plant is now using Deming's wastewater for evaporative cooling. In 2005, the City of Deming municipal well fields pumped 4,542 acre-feet of water out of the ground. Assuming 50% is used for outside irrigation, and 50% goes to the sewer, this power plant is exporting 2271 acre-feet of water per year from the basin in the form of steam.

The Santa Rita copper mine has large groundwater wells along Whitewater Creek. This water is pumped to tailings ponds south of Hurley. This holding, combined with the nearby Tyrone mine (just on the other side of the continental divide) is by far the most valuable natural resource in the state, and is presently owned by Freeport Mac Moran. The pumping from 12 well fields has lowered the water table along San Vicente Arroyo, reducing the probability of surface flow.

Towns are growing. Municipal well pumping is discussed in the water balance section. Sprawl is gobbling up the country with "Monument to Myself" trophy homes as well as crappy trailers, and everything in-between. Each ranchette has its own water well. The use from this is hard to estimate yet relatively small in comparison to municipalities, mines, and agribusiness.

## General Geological Summary

The Mimbres River flows in the Mimbres Trench, a fault graben bounded by faults on both sides in the Mimbres Valley. Basin fill is generally 500 feet or less on the west side of the valley, and up to 1400 feet deep on the east side. The Mangas Trench is the home of the San Vicente Arroyo, where basin fill is 2000 feet deep and more over an area 10 miles wide and 50 miles long. The deepest fill is up to 4000 feet deep in the vicinity of Deming.

Prior work was done by R.T. Hanson with the USGS in 1994 analyzing the bolson fill aquifer and the groundwater. In 2011, Allan Cuddy et al with the New Mexico Office of the State Engineer developed a three dimensional groundwater flow model as a tool for management and administration of water rights.

## Hydrogeological Interpretation of Geological Framework

Mountain front runoff from the northern and higher elevation rim of the basin is recharging the aquifer. Downstream from Faywood, losses from the stream to the aquifer occur by infiltration through unsaturated sediments. Natural infiltration is thought to take place everywhere groundwater is less than 40-50 feet from the surface, and so is evapotranspiration. Due to the fault graben history of the watershed, the basin fill downstream from Faywood is so deep and porous that it has a lot of storage for water. The flux is small due to the dry climate, therefore the residency times are large.

## Surface Water

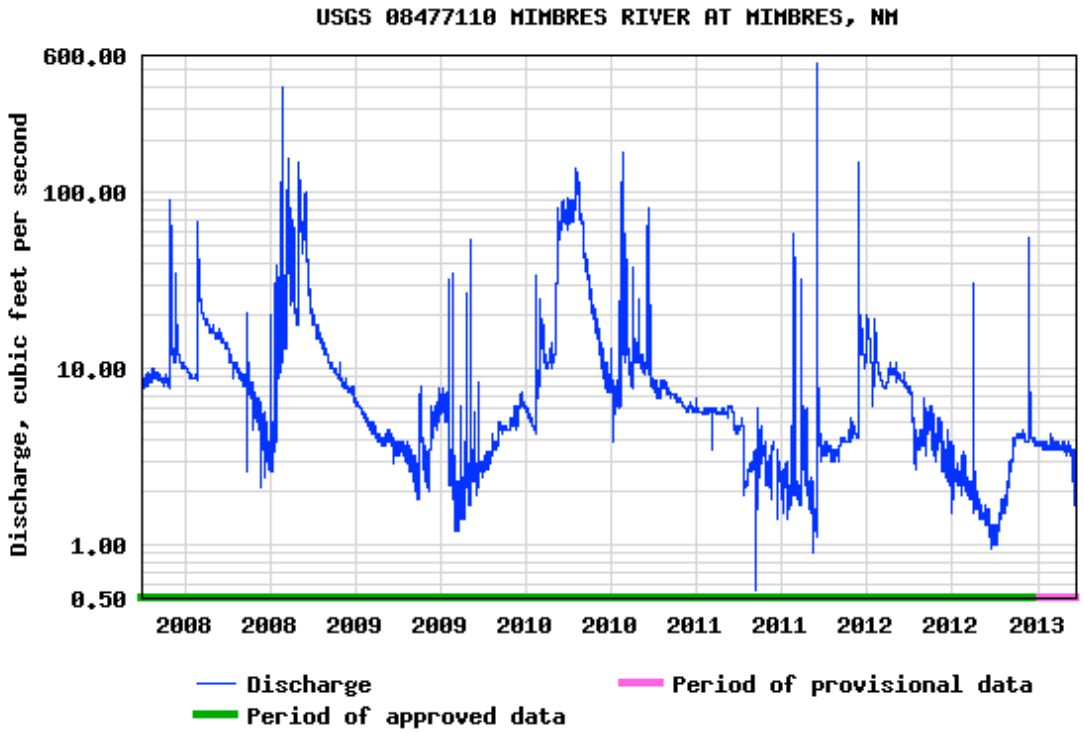
There are two main streams that flow in the Mimbres basin that each have stretches of perennial flow: The Mimbres River drains the Mimbres Mountains, the western Black Range and the eastern part of the Pinos Altos Range. San Vicente Arroyo drains the Silver City Range. Both of these water courses trend southward from near the northern rim of the basin and merge their dry paths slightly to the west of the center of the basin.

### Mimbres River

The Mimbres is a classic desert river with a ephemeral upper tributaries, and an ephemeral upper reach.. There is a perennial reach in the mid elevations that dries up in the desert sands usually just east of City of Rocks State Park. The river soaks into the sand and flows downward through a vadose zone until it reaches the water table.

In a really good water year that includes an unusually large and severe winter storm system, the Mimbres swells in its banks and advances down its ancient route all the way past Deming to spread out to dry in Florida Lake. This is in the flats north and east of the Florida Mountains, a rugged desert range that juts out of the middle of the basin near its sink. In a fantastic year the river would irrigate the desert lowlands all the way to another broad and unnamed sink near the Mexican border. The last time this happened was in 1905-1906. Climate change and continuous lowering of the groundwater table has decreased the probability of the Mimbres flowing far enough to do this anymore.

There is a USGS stream gauge on the Mimbres River in Mimbres, NM. Available data on the USGS website begins in 2007 and continues to this day. Average stream flow is 14.4 cubic feet per second. Below is a screen capture showing all the presently available stream flow data:




***Stream Flow of Mimbres River*** ***Source: USGS website***

San Vicente Arroyo

Draining the area presently known as Silver City, New Mexico, the San Vicente Arroyo drains about 28 square miles of country by the time it gets through town. Its watershed lies north to northwest of town. The area was originally called San Vicente de La Ciénega, and was the site of a desert marsh, or cíenega (cien aguas). This was drained to build Silver City during its mining heyday, which started in 1870. Woodcutting and the grazing of 1500 cattle near and around the city quickly denuded the watershed of ground cover.

By 1895, Main Street also served as a modest drainage some two or three feet lower than the ground on either side of the street. "On July 21, 1895 torrential rains fell which the denuded watershed was unable to absorb. The exceptionally large runoff created a monstrous ditch, the bottom of which was 35 feet below the street level of the previous afternoon." (Columbus, 1980, page 148) Subsequent floods in August 1903 scraped the ditch down to bedrock 55 feet below the old street level, and the excavation extended 15 miles downstream.

*The "Big Ditch" Photo courtesy of the Silver City museum, John Harlan collection*

The present day San Vicente Arroyo maintains a base flow of about 30 gallons per minute for a three mile reach from "ground-water discharge, return seepage from yard watering, and probably line losses from the city water system" (Trauger, 1972, page 51) After that about 1.4 cubic feet per second is added by the sewage treatment plant, and the base flow of this fluid is maintained for about a mile downstream.

## Groundwater

There are two fabulous hot springs in the Mimbres basin. The Mimbres Hot Springs Ranch (private) is on Hot Creek off Royal John Mine Road and produces approximately 30 gallons per minute, and Faywood Hot Springs (open to the public) off Highway 61, which has a lesser flow and is pumped to maintain the pools. There are also several warm springs in the area.

The groundwater recharge coming from the confluence of the San Vicente Arroyo and the Mimbres River leaves the alignment of the Mimbres river and heads south at a point that the river bends to the east. Perhaps this is an ancient path of the river with higher permeability. (see potentiometric surface map from Hansen in the appendix)
This has been annotated with a flow net.

## Water Quality

Water quality is very good in the northern part of the basin, and stays good until well south of Deming, where the quality changes. In Palomas, Mexico, the well water is too

salty to be good to drink. The Village of Palomas operates a desalinization plant and offers free drinking water to all the homeowners. This water is distributed in 5 gallon plastic carboys.

## Water Demand

As the population of the region grows, so does the demand for water for human uses. New Mexico has a long held agreement to supply water to Texas via the Rio Grande. State administrators are looking to exploit more water resources.

## Basin Water Balance

The Mimbres basin is a closed basin with a very small amount of leakage to the Mesilla Basin to the East. Before exploitation of water resources began, the basin was in balance. At present, the water table is dropping as more groundwater is being pumped to the surface and evapotranspired than is being replaced by natural recharge. This has accelerated evapotranspiration, which transports the groundwater into the atmosphere, which has an 8 day residency time before precipitation, approximately 75% of which falls on the sea. Therefore, groundwater pumping in the Mimbres basin is transferring water to the ocean and raising sea level. So far, the human race has managed to lower the groundwater by 120 feet in a large area south of Deming.

Estimated precipitation falling on the Mimbres River sub watershed above the Faywood Gage:

| Precip | width, mi | Length, mi | acre feet/year |
|---|---|---|---|
| 24 | 3 | 20 | 76,800 |
| 22 | 4 | 23 | 107,947 |
| 18 | 3 | 40 | 115,200 |
| 14 | 15 | 15 | 168,000 |
| | | TOTAL | 467,947 |

A bedrock constriction near the Faywood gage forces most of the groundwater to flow in the Mimbres River, so this is an ideal place to take measurements. The Mimbres gauge averages 14.4 cfs, or 10,425 acre-feet/year. This is approximately 1/45th of the average basin-wide precipitation for this sub-watershed. A similar approach could be used to calculate the contribution from San Vicente Arroyo (which also has a gage.

Estimates have been made for the annual basin recharge contributed by the ephemeral washes in the basin to compute a total annual recharge rate. For the entire Mimbres Basin there is an average annual recharge of 31,000 acre feet per year, and this is 1% of the average basin-wide precipitation. (Hansen)

Calculation of Annual Water Deficit

In the first table below the annual pumping from all the known large users was compiled from two sources and is tabulated in acre-feet per year. This was done for the only two recent years that data was available for all of these users, and then averaged. In the second table below is calculated the annual water deficit of 29,000 acre feet per year. This does not include all of the small users, so the actual deficit may be higher.

| | Acre Feet of Water Pumped out of the Groundwater Aquifer by Use | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Farming | | | Municipalities | | | | Total | Total | Total |
| Year | Irrigation | Bayard | Deming | Columbus | Santa Clara | Silver City | Tyrone | Municipal | Mine | Pumping |
| 1995 | 42,441 | 371 | 163 | 4,061 | 283 | 2,505 | 1,829 | 9,212 | 13,004 | 64,657 |
| 2000 | 33,617 | 357 | 213 | 4,102 | 245 | 2,020 | 1,438 | 8,375 | 13,708 | 55,700 |
| | | | | | | | | | Average = | 60,179 |

| | |
|---|---|
| Annual Recharge (af/y) | 31000 |
| Annual Pumping | -60179 |
| Annual Storage Change | -29179 |

**Summary or Conclusions**

Over-pumping of groundwater is lowering the water table. Climate models indicate that rainfall will decrease and temperatures will rise in the next decades. If the pumping were to decrease to less than the recharge, the water table would rise. How could this be done? Cities could raise their water rates to promote conservation, and promote water reuse practices such as rainwater collection and greywater recycling onto the landscape. Yet since cities only account for 15% of the total pumping, the overall effect from this to the water table would not be enough to reverse the downward trend.

Perhaps more efficient mining practices could be employed than the ones presently in use which uses large ponds of water subject to evaporation. Farming and irrigation is by far the largest user, and the component of farming that produces cattle feed uses the most water to produce the lowest return value. Curtailing this single activity would probably be enough to reverse the trend and allow the water table to rise slowly over time.

**Footnote**

The Arizona Water Settlement Act, signed into law by George Bush provides $66-128 million dollars for projects which create a supply of water and put it to beneficial use in the four southwest New Mexico counties of Grant, Luna, Catron and Hidalgo. There has been a very controversial decision making process that has gone on for 9 years so far to determine what this project shall be. As of March 2013, what is known as the Deming Proposal seems to be the preferred alternative by the Interstate Stream Commission. This project is a large diversion on the Gila River and a pipeline over the continental divide. Although economic and legal analyses support less expensive and more sustainable alternatives to construction of a large diversion on this wild and scenic river, the ISC is moving forward with this project amid rapidly growing public opposition.

Fossil fuel powered groundwater depletion wells are used to irrigate cattle feed in the desert. Save the Gila from this madness!

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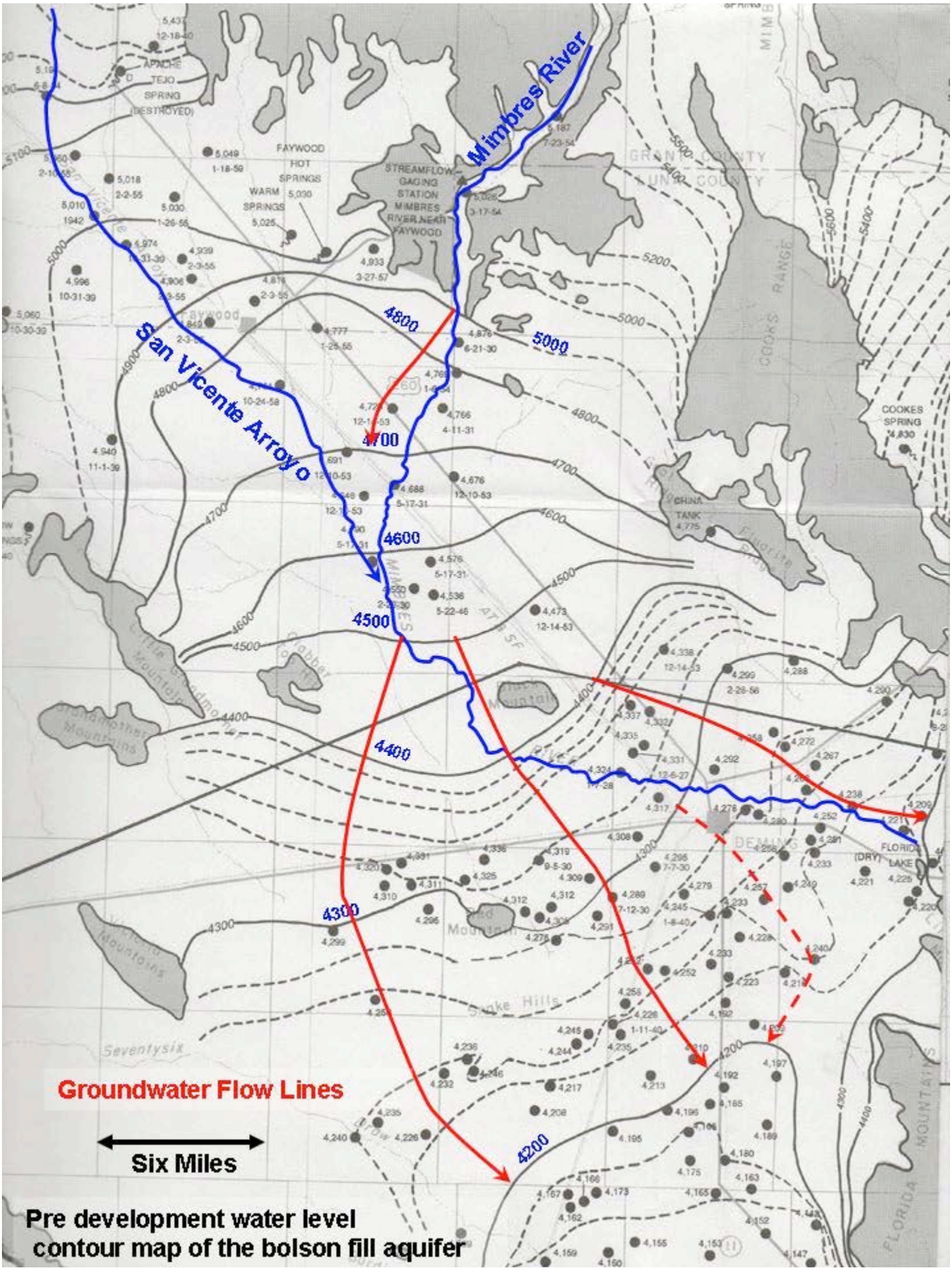
Mimbres River
San Vicente Arroyo
4800
5000
4700
4600
4500
4400
4300
4200
Groundwater Flow Lines
Six Miles
Pre development water level
contour map of the bolson fill aquifer

# Mimbres BASIN
## Mountains, streams and valley fill