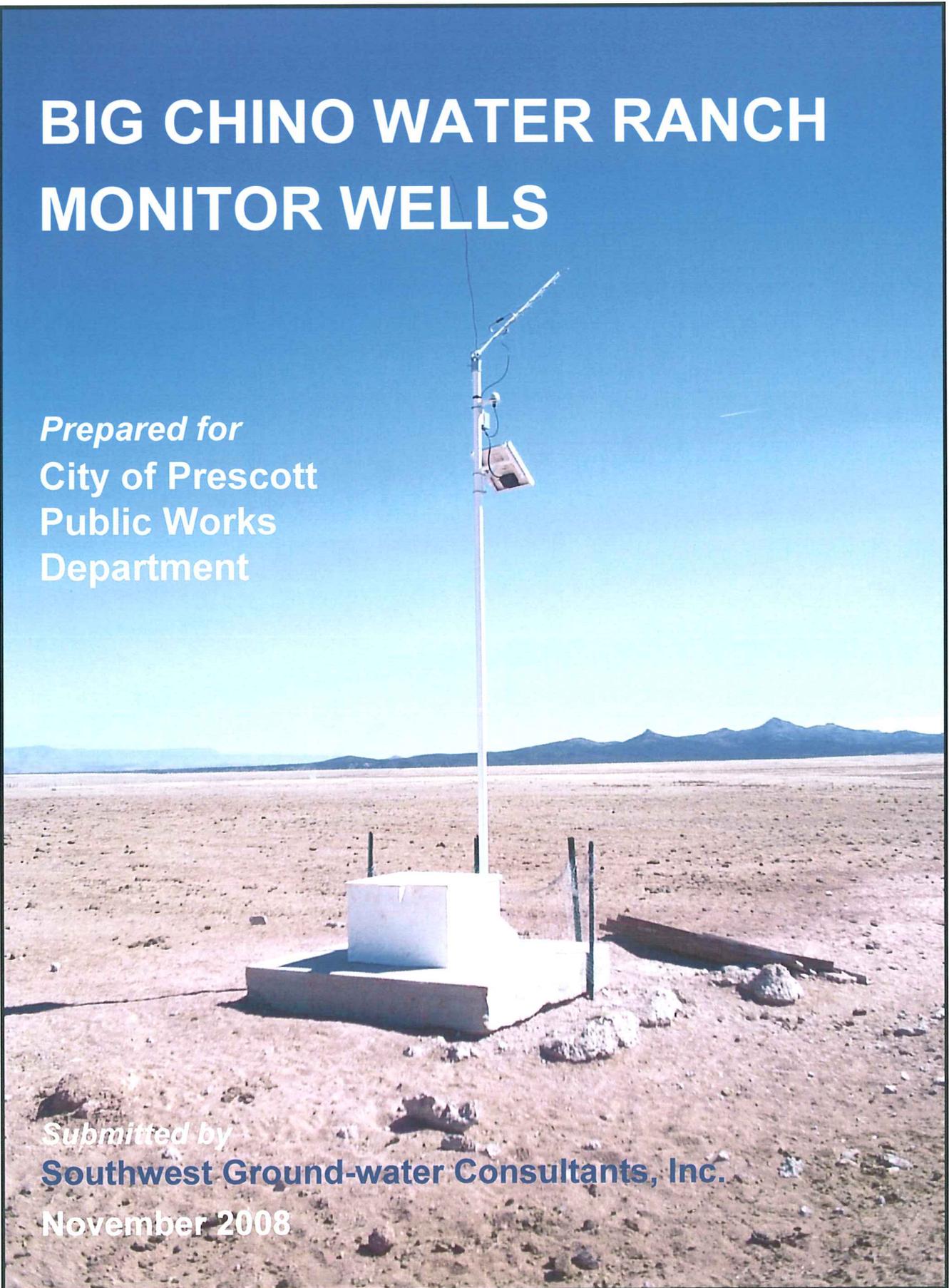


BIG CHINO WATER RANCH MONITOR WELLS

Prepared for
City of Prescott
Public Works
Department

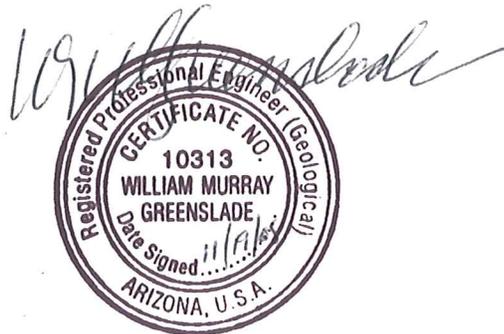
Submitted by
Southwest Ground-water Consultants, Inc.
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REPORT
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MONITOR WELLS

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Expires: 12/31/2008

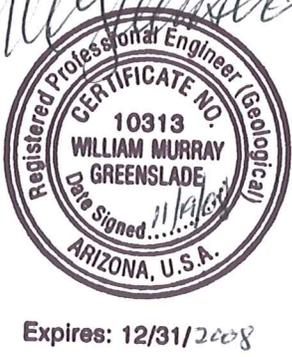
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Expires: 12/31/2008



1.0 EXECUTIVE SUMMARY

The Big Chino Water Ranch (BCWR) ground-water level monitoring program consists of seven (7) monitor wells six (6) of which are in place. Two (2) of the monitor wells are existing irrigation wells, three (3) new monitor wells have been installed under this program and one is planned for future installation. All of the monitor wells are or will be incorporated into the Arizona Department of Water Resources (ADWR) and/or U. S. Geological Survey (USGS) monitoring networks.

BCWR monitor well location and construction data are summarized on Table 1. Location of the wells is shown on Figure 1. Well construction diagrams, except for existing well WMW-1 for which construction data are not available, are presented on Figures 2 through 7. Lithologic logs and geophysical logs of monitor wells installed by the City are presented in Appendix I. The ADWR Well Drillers Report for existing well WMW-1 is given in Appendix II.



2.0 INTRODUCTION

2.1 BACKGROUND

The City of Prescott is committed to monitoring potential changes to the ground-water conditions in the area of the BCWR due to the City's development of the ground-water resources beneath the BCWR. In 2004 the City initiated a process of stakeholder involvement in identifying possible impacts on ground and surface water resources on and outside of the Big Chino Water Ranch property. As part of this process, a Peer Review Group was established to specifically assist in the development a ground-water monitoring program. Based on this process, a proposed ground-water monitoring program was presented in "Ground-water Monitoring Plan, Big Chino Water Ranch", dated December 7, 2005.

In 2004 the City commissioned the development of the BCWR numerical ground-water flow model of the Upper Big Chino sub-subbasin, including the area of the proposed BCWR well field. The City's ground-water monitoring program is designed to monitor changes in ground-water levels over time and to support re-calibration of the BCWR ground-water flow model, as needed.

2.2 HYDROGEOLOGY

The BCWR is located in the Upper Big Chino sub-subbasin of the Big Chino Subbasin in north-central Arizona near the boundary of the Transition Zone and the Colorado Plateau Physiographic provinces. The Big Chino Subbasin is an elongated asymmetrical graben bounded on the east-northeast by the Big Chino fault. Maximum depth of the graben is approximately 2,500 ft and occurs adjacent to the fault in the middle of the basin. The Big Chino Valley is mantled by erosional remnants of Quaternary and Tertiary gravels. Beneath the gravels is an



alluvial sequence of clays, clayey silts, sands and conglomerates of thicknesses ranging from less than 10 feet around the edges of the valley to greater than 2,000 ft in the center. An extensive playa deposit composed of fine-grained silts and clay-like sediments is located in the middle of the basin. Either within or beneath (or both) the alluvium is a volcanic rock (basalt and latite) interval of variable thickness (<30 to 200 ft) and extent. Between 300 and 400 ft of Paleozoic carbonates (dolomite and limestone) underlie the basin-fill alluvium/volcanic sequence over much of the subbasin. On the upthrown side of a fault bounding the Upper Big Chino sub-basin on the west, the carbonates appears to have been removed by erosion.

2.3 PURPOSE

The purpose of the BCWR ground-water monitoring program is to measure ground-water conditions prior to the start of the City of Prescott's ground-water withdrawals on the Big Chino Water Ranch property and to assess changes in conditions over time. The ground-water system in the Big Chino Valley is complex and the impacts due to pumpage on the BCWR will vary considerably both in time and space. Specifically the BCWR monitoring program is designed to:

1. **Measure water level change in the area of the BCWR well field.** This relates to ensuring that the well field will operate in an efficient manner. This will also assist in re-calibration of the BCWR ground-water flow model, if needed, based on future measured water levels.
2. **Measure water level change downgradient from the BCWR.** Impacts on water users outside of the Upper Big Chino sub-subbasin will occur only if water levels and gradients at the southern end of the Upper Big Chino sub-subbasin (which corresponds to the BCWR numerical model southern boundary) are reduced. Data on water level change over time in this area will also assist in re-calibration of the BCWR ground-water flow model, if needed.

The BCWR monitoring program was initiated in December 2005. Location, permitting and construction of the monitor wells occurred between December 2005 and May 2007.



3.0 MONITOR WELLS

The Big Chino Water Ranch (BCWR) ground-water level monitoring program consists of seven (7) monitor wells six (6) of which are in place. Two (2) of the wells are existing, three (3) have been installed under this program and one is planned for future installation. All of the installed wells are or will be incorporated into the Arizona Department of Water Resources (ADWR) and/or U. S. Geological Survey (USGS) monitoring networks.

The monitoring program is divided into three main groups of wells based on their general purpose and location: wells in the well field, wells on the southern border of the ground-water model area and wells outside the upper Big Chino sub-subbasin. Monitor well designations reflect their purpose/location, as follows:

Purpose/Location	Designation	Well Number
Well field	Well field Monitor Well (WMW)	WMW-1, WMW-2, WMW-3
Southern Model Boundary	Boundary Monitor Well (BMW)	BMW-1, BMW-2, BMW-3
Big Chino Sub-Basin	Big Chino Monitor Well (BCMw)	BCMw-1

Drill Tech, Inc. of Chino Valley, Arizona was contracted by the City to drill and construct the monitor wells. WMW-2 was completed using the Versa-Drill V-2000NG drill rig and the direct air rotary drilling method. WMW-3 and BCMW-1 were completed using a Schramm T685WS Rotodrill rig and the direct air rotary drilling method. BMW-3 was started with the Schramm drill rig and completed with a Portadrill TLS drill rig. BMW-3 was completed using the direct air rotary drilling method. However, a failed attempt was made to drill the well deeper using direct mud rotary.

Each of the installed and proposed monitor wells are described below. Key monitor well information is summarized on Table 1. Locations of all BCWR monitor wells are shown on Figure 1.



3.1 BCWR WELL FIELD MONITOR WELLS (WMW)

Three (3) monitor well locations on the BCWR were identified based on the following criteria.

- spatial distribution over the ranch
- water level change in the major producing units (upper alluvium and basalt)
- non-pumping wells

Most of the wells on the BCWR are irrigation pumping wells. For this reason, two (2) of the three (3) well field monitor wells are new wells, as discussed below. New monitor wells also have the advantage of being designed and constructed to monitor water levels in target aquifer units.

3.1.1 Well Field Monitor Well (WMW) - 1

Registration Number – 55-624116

Location – B(20-4)19CBA

Aquifer Unit Monitored: Upper Alluvium and Basalt

WMW-1 utilizes an existing BCWR non-pumping irrigation well, Pump Number 7. This well was drilled in 1959 to a reported total depth of 635 feet below land surface. The reported depth to ground water when drilled was 43 feet below ground surface (bgs). The measured the depth to water on July 10, 2008 was 72.04 feet bgs (NWISWeb 2008). The reported yield of this well is 1,400 gallons per minute (gpm), however the well is no longer equipped and this yield could not be confirmed. There are no data on the perforated interval in this well. According to the driller's log, aquifer materials penetrated in this well include approximately 605 feet of alluvium (predominated by gravels) and approximately 30 feet of volcanic materials (basalt?). The well is



cased with 16” diameter steel casing. The ADWR Drillers Report is given in Appendix II.

WMW-1 is located near the northern edge of the BCWR and is approximately 2.3 miles northwest of Well Pump Number 8, a sometimes active irrigation well. This well is currently equipped with a continuous water level recording device and is on the USGS real-time network via a satellite transmitter.

3.1.2 Well Field Monitor Well (WMW) – 2

Registration Number: – 55-210660

Location – B(20-4)33CBD

Aquifer Unit Monitored: Upper Alluvium

WMW-2 is located in the central portion of the BCWR, approximately 200 feet north of Pump Number 3, an inactive irrigation well. An as-built diagram is provided on Figure 2. Total casing depth is 419 ft bgs. The well is slotted from 99-159 and 319-399 ft bgs. WMW-2 monitors water levels in the upper alluvium. Depth to water in WMW-2 on January 24, 2008 was 43.22 ft bgs.

WMW-2 will be included in the ADWR well network. Water level will be measured semi-annually.

3.1.3 Well Field Monitor Well (WMW) – 3

Registration Number: 55-210659

Location – B(19-4)9DAA

Aquifer Unit Monitored: Basalt

WMW-3 is located near the southern end of the BCWR, approximately 1,000 feet southeast from Pump Number 12, an active irrigation well. An as-built diagram for WMW-3 is presented on Figure 3. Total casing depth is 655 ft bgs with a slotted interval of 615-655 ft bgs. WMW-3



monitors the water level in the upper 60 ft of the basalt. Depth to water in WMW-3 on January 24, 2008 was 21.59 ft bgs.

WMW-3 will be included in the ADWR network. Water level will be measured semi-annually.

3.2 BOUNDARY MONITOR WELLS (BMW)

The boundary between the Upper Big Chino and the Middle Big Chino sub-subbasins is approximately coincident with the southern general head boundary (GHB) of the BCWR ground-water model. Changes in flow across this boundary could potentially have an impact on uses in the Middle and Lower Big Chino sub-basins and, ultimately, on flow in the Verde River Springs. Three (3) boundary monitor wells were proposed to monitor changes in water levels downgradient from the BCWR well field. Two (2) of the wells have been installed. The deep carbonate well (BMW-2) was not be completed, as discussed below.

3.2.1 Boundary Monitor Well (BMW) - 1

ADWR Registration No. 55-200027

Location: B(18-4)11ACA

Aquifer Unit Monitored: Upper Alluvium

BMW-1 will monitor water levels in the upper alluvium unit. BMW-1, previously named BH-1 was one of the exploration borings drilled as part of the earlier CV/CF Ranch hydrology investigation. At the request of the landowner the exploration boring was converted to a livestock well. Permission was subsequently obtained from the owner to use it a monitoring well.

BMW-1 penetrates the upper alluvium to a depth of 490 ft bgs. Clay is encountered from land



surface to 300 ft bgs. From 300 ft bgs to 420 ft bgs the material is clayey sand. A well graded sand with some clay was penetrated between 421 ft bgs to 490 ft bgs. Granite was encountered from 491 to 507 ft bgs, where the hole was terminated.

Four (4) inch diameter PVC casing is installed from land surface to 490 ft bgs. The casing is slotted from 290 to 490 ft bgs. The annulus is sealed with cement grout from 0-20 ft bgs. Depth to water was measured at 315.60 ft bgs on March 13, 2007. An as-built diagram is provided on Figure 4. BMW-1 will monitored semi-annually.

3.2.2 Boundary Monitor Well (BMW) - 2
ADWR Registration No.: Not yet drilled
Location: B(19-4)35AAB
Aquifer Unit Monitored: Carbonates

Installation of proposed BMW-2 was attempted at the current location of BMW-3, but could not be completed to the target depth. Borehole stability problems prevented the drilling contractor from completing the well as planned. This well is proposed for future installation. Estimated depth to the top of the carbonates is approximately 1,600 ft bgs. The carbonates are estimated to be approximately 400 feet thick, giving a total well depth of about 2,000 ft bgs. The proposed well design is presented on Figure 5.

On completion it is proposed to install a transducer and data recorder on BMW-2.



3.2.3 Boundary Monitor Well (BMW) - 3

ADWR Registration No.: 55-905773

Location: B(18-4)01ACA

Aquifer Unit Monitored: Playa/Playa Fringe/Alluvium

An as-built diagram of BMW-3 is presented on Figure 6. As noted above, it was originally intended to construct BMW-2 at this location; however, the drilling contractor was unable to complete BMW-2 as designed. To salvage as much invested value as possible it was decided to complete the well as BMW-3.

Total casing depth is 1,000 ft bgs. BMW-3 is cased with LACES and is slotted from 499 to 999 ft bgs. The well monitors the water level in the playa fringe unit. Depth to water in BMW-3 on June 15, 2008 was 155 ft bgs.

BMW-3 is included in the ADWR network and has a continuous water level recorder.

3.3 WELLS OUTSIDE THE UPPER BIG CHINO SUB-SUBBASIN

There are areas within the Big Chino subbasin that lack good water level and aquifer data. One such area is downgradient from the BCWR model southern boundary where ground-water flow from the upper Big Chino sub-subbasin meets ground-water flow from the Williamson Valley sub-subbasin. Water level contours suggest relatively high transmissivity in this area; however, water level and aquifer data are limited. During the stakeholder process the Salt River Project proposed a monitoring well in this area (e-mail from Kornrumph dated January 5, 2005). The location of this well (BCMW-1) is shown on Figure 1.



3.3.1 Big Chino Monitor Well (BCMw) - 1

ADWR Registration No.: 55-211839

Location: B(18-4)25AAA

Aquifer Unit Monitored: Alluvium

A borehole was drilled to total depth of 737 ft bgs. Alluvium was penetrated from land surface to 695 ft bgs where the borehole encountered granite to the total well depth of 737 ft bgs. An as-built diagram for BCMw-1 is presented on Figure 7. Total casing depth is 680 ft bgs. BCMw-1 is slotted from 300 to 620 ft bgs. The well monitors the water level in the alluvium. Depth to water on June 15, 2008 was 261.2 ft bgs.

BCMw-1 is equipped with a continuous water level recording device that is maintained by ADWR.



Table 1, Summary of Monitor Well Data

Monitoring Area	Well ID	DWR No.	Status*	Cadastral Location	Total Depth (ft-bgs)	Casing Depth (ft-bgs)	Screen Interval (ft-bgs)	Monitored Units	Monitoring Frequency
Wellfield	WMW-1	55-624116	Existing	B(20-4)19CBA	635	605	NR	Alluvium/Basalt	Continuous
	WMW-2	55-210660	New	B(20-4)33CBD	420	419	99-159, 319-399	Upper Alluvium	Semi-Annual
	WMW-3	55-210659	New	B(19-4)19CCC	670	655	615-655	Basalt	Semi-Annual
Model Boundary	BMW-1	55-200027	Existing	B(18-4)11BDA	507	489	289-489	Alluvium	Semi-Annual
	BMW-2		Proposed	B(19-4)35AAB	2,000	2,000	1,600-2,000	Carbonates	Proposed continuous
	BMW-3	55-905773	New	B(18-4)01ACA	1,410	1,000	499-999	Playa Fringe/Alluvium	Continuous
Middle Big Chino	BCMw-1	55-211839	New	B(18-4)25AAA	690	680	300-680	Alluvium	Continuous

NR - Not Reported

* New, installed under this program

