Arizona Department of Water Resources
Hydrology Division

Prescott Active Management Area
2000-2001 Hydrologic Monitoring Report

May 21, 2001

by

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Table of Contents

List of Figures

List of Tables

Introduction

On January 12, 1999 the Director of the Arizona Department of Water Resources (ADWR) issued a final determination that the Prescott Active Management Area (AMA) was no longer at "safe-yield" (ADWR, 1999). Safe-yield is the water management goal for the Prescott AMA which attempts to maintain a long-term balance between the amount of water withdrawn and the amount water recharged to the aquifer system. The determination that the Prescott AMA was no-longer in a state of safe-yield was based on the careful evaluation of a large body of hydrogeologic data that had been collected since the 1940's, and particularly based on the evaluation of data collected during the previous 3 to 4 year period (since 1995).

Several types of data were collected and evaluated by the ADWR during the safe-yield determination process. The data included water level data measured in index wells located throughout the AMA and stream discharge data obtained from permanent USGS stream gage locations, and from periodic stream discharge measurements made by ADWR personnel. The observation of generally declining water levels in the majority of wells measured, and decreased groundwater discharge from springs and streams was a clear indication to the ADWR that safe-yield conditions did not exist in the AMA.

Additionally, groundwater recharge data and groundwater pumpage data were collected and assembled into water budgets that indicated declining groundwater storage conditions in the AMA. These indications were corroborated by reasonably simulating historical groundwater conditions and trends using ADWR's Prescott AMA regional groundwater flow model which utilized the assembled historic water budget information as model inputs (Corkhill and Mason, 1995).

Although the ADWR was confident in its decision that the Prescott AMA was no longer in a safe-yield condition, it hired Dr. William Woessner, a professor of hydrogeology at the University of Montana and co-author of an authoritative college textbook on groundwater modeling, to examine and comment on the ADWR model and an alternative model that was also being reviewed at that time. Dr. Woessner provided conclusions and recommendations concerning the models and hydrologic monitoring activities in the AMA (Woessner, 1998).

The major conclusion Dr.Woessner reached concerning the ADWR model was that it provided an overall more reasonable representation of the hydrogeology and associated water balance in the AMA than the alternative model. Dr. Woessner recommended that the ADWR model should be used as an active management tool that should be updated with new drilling, pumping and well log data, and re-calibrated annually. This recommendation was consistent with ADWR's plans, and the model update, including the addition of new geologic data and water use data (through the year 1998) has recently been completed. The update activities have been documented and will be released in a new update report in the near future. The ADWR plans to use the updated model to simulate future groundwater conditions in the AMA which are based on future water use assumptions that will be developed in cooperation with the major water providers in the AMA.

Other recommendations made by Dr Woessner include:

- Six to eight wells in each sub-basin (12 to 16 total) should be instrumented with pressure transducer systems to record daily water levels over the long term.

- Daily discharge measurements should be established at Del Rio Springs [the Del Rio gage had actually been reestablished only a short time before Dr. Woessner’s report], and at the Agua Fria River near Humboldt.

- Measurements of discharge of major stream basins draining the mountain areas should be conducted.

This report provides an update on the progress that has been made to implement Dr. Woessner’s recommendations, and also discusses other proposed monitoring activities in the Prescott AMA. Additionally, the report presents hydrologic monitoring data and related information that has been compiled by the ADWR for the Prescott AMA during the period from January, 2000 through April, 2001. This year’s report includes water level measurement data collected at 119 well sites, and provides compilations of surface water, precipitation and pumpage data.

Groundwater Data and Conditions 2000-2001

The measurement of water levels is an important data collection activity that provides information about changing groundwater storage conditions in the regional aquifer system. In general, rising water levels are indicators of increasing groundwater storage conditions, while declining water levels are indicators of decreasing groundwater storage. Groundwater conditions in the AMA's regional aquifer system were assessed by measuring the depth to water at 119 well sites located throughout the AMA. The 2001 water level measurements were made between 03/05/2001 and 04/17/2001. The water level measurements were made by staff from the ADWR Field Services-Basic Data Section. The depths to water, water level changes, and water level elevations are summarized in Table 1.

Decreasing groundwater storage trends were observed at the majority of the 92 wells that were measured in both 2000 and 2001 (Figure 1). A statistical analysis of the water level data indicates 82 of the 92 wells (89 percent) that were measured in both 2000 and 2001 showed water level declines that ranged from –0.1 to –21.0 feet (Table 2). The mean decline was –3.7 feet and the median decline was –2.25 feet.

Increasing groundwater storage trends were observed in 9 of the 92 wells (10 percent) that were measured in both 2000 and 2001. Water level increases ranged from +0.1 to +15.0 feet (Table 2). The mean increase was +4.0 feet and the median increase was +1.1 feet. One well (1 percent) showed no change in water level between 2000 and 2001.

Water level declines were observed in most parts of the AMA. Declines ranged from less than -1 foot to over -8 feet in 25 wells that penetrate the Upper Alluvial Unit (UAU) and Lower Volcanic Unit (LVU) aquifers located in the northwestern portion of the Little Chino sub-basin near the Town of Chino Valley and Del Rio Springs (Townships 16 and 17 North, Range 2 West). Declines ranged from less than -1 foot to over -18 feet in 17 wells that penetrate the UAU, LVU and bedrock in the Williamson Valley area (Township 15 North, Ranges 2 and 3 West). Declines ranged from -1 to -4 feet in 20 wells that penetrate the UAU, LVU and bedrock in the Lonesome Valley and Indian Hills-Coyote Springs areas of the Little Chino sub-basin (Townships 15 and 16 North, Ranges 1 East and 1 West).

Water level declines ranged from -17 to -21 feet in 5 wells that are completed in the LVU in the northwest portion of the Upper Agua Fria sub-basin in the Prescott Valley area (Township 14 North, Range 1 West). Water level declines ranged from less than -1 foot to –7 feet in 12 wells located in other parts of the Upper Agua Fria sub-basin (Townships 13 and 14 North, Ranges 1 East and 1 West).

Water level increases ranging from less than +1 foot to +15 feet were observed in 4 wells that penetrate the UAU and undifferentiated volcanic rocks in the Upper Agua Fria sub-basin near Dewey and Humboldt (Township 13 and 14 North, Range 1 East). The water level increased +10 feet in one well located at the City of Prescott recharge facility in the southern portion of the Lonesome Valley area. Water levels were observed to increase from less than +1 foot to greater than +2 feet in 2 wells located 2 to 3 miles north of the Williamson Valley area.

Figure 1. Water level changes in the Prescott AMA 2000 to 2001

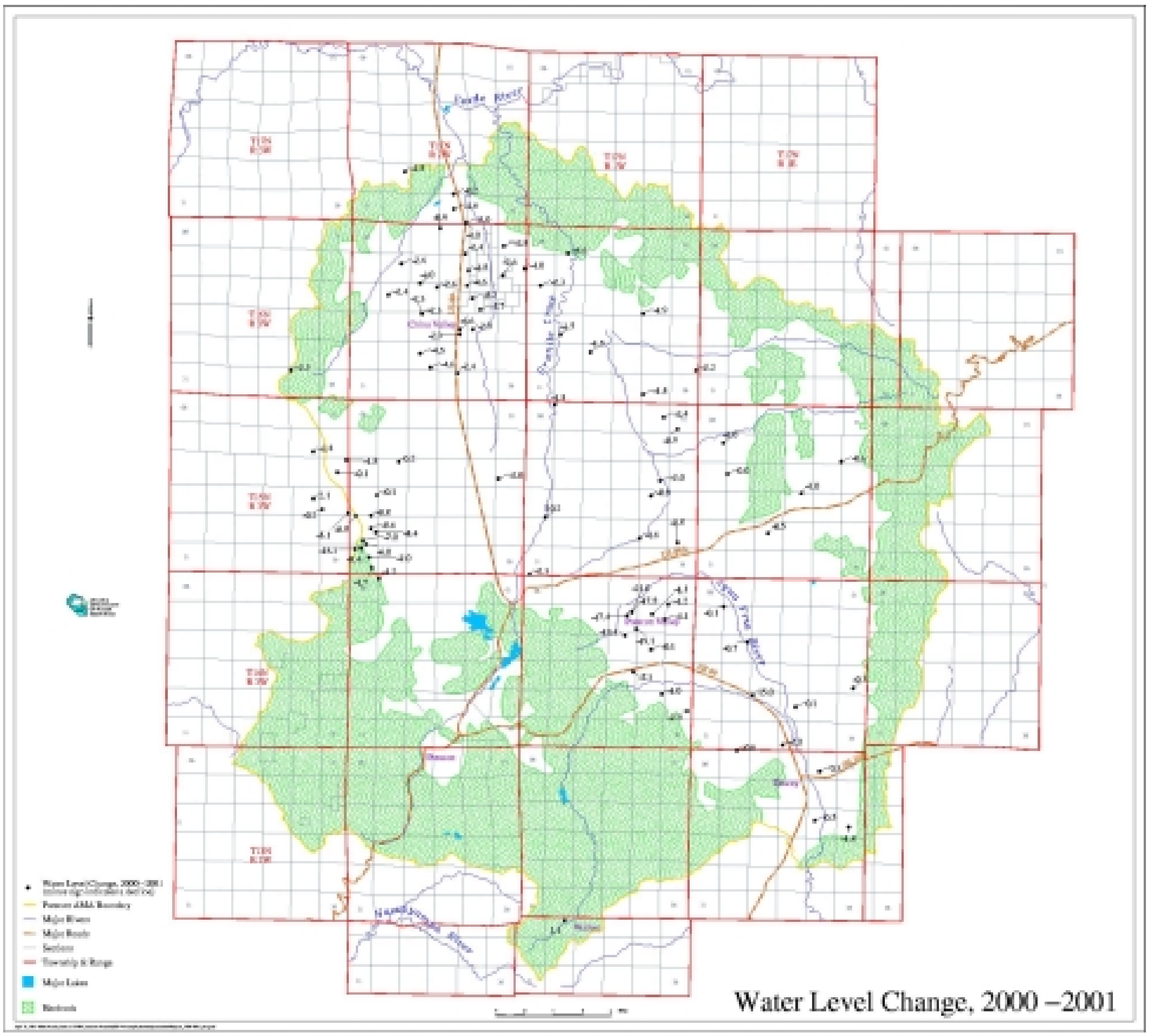


Table 1. Prescott water level data

(Water level measurements rounded to nearest 0.1 foot)

WELL_SITE_ID	CADASTRAL LOCATION	MEAS_DATE	1994 DTW	1999 DTW	2000 DTW	2001 DTW	2001 WL ELEV	94-01 CHG	99-01 CHG	00-01 CHG
343153112122901	A-13-01 01DCA	04/17/01		207.6		208.1	4531		-0.5	
343157112135401	A-13-01 02CAD	03/06/01	86.4	82.9	83.7	83.4	4519	3.0	-0.5	0.3
343233112164901	A-13-01 05ABB	03/05/01			152	152.6	4667			-0.6
343050112130901	A-13-01 12CCC	04/04/01	69.8	71.0		72.0	4498	-2.2	-1.0	
343017112124301	A-13-01 13CAA	03/05/01	110.3	130.8	134.3	136.1	4513	-25.8	-5.3	-1.8
343028112135701	A-13-01 14BDC1	03/05/01	28.7		30.5	30.0	4470	-1.4		0.5
343028112135702	A-13-01 14BDC2	03/05/01			39.6	33.4	4466			6.2
343652112172101	A-14-01 08BBB	03/08/01	197.6	200.6	199.3	199.4	4682	-1.8	-1.2	-0.1
343529112162201	A-14-01 17AAD	03/05/01	113.3	115.9	116.3	117	4662	-3.7	-1.1	-0.7
343428112123701	A-14-01 24DCB	03/05/01	306.3		301.2	301.5	4626	4.8		-0.3
343353112144101	A-14-01 27ACC	03/05/01	48.3	43.8	42.9	42.8	4617	5.5	1.0	0.1
343415112161401	A-14-01 28BBB	03/05/01	52.1	63.6	63.1	48.1	4666	4.0	15.5	15
343333112160201	A-14-01 28CDC	03/06/01		173.6		161.9	4562		11.7	
343337112152901	A-14-01 28DAC2	03/06/01				92.1	4573			
343244112150901	A-14-01 34CCA	03/05/01	66.7	73.9	75.5	77.5	4572	-10.8	-3.6	-2.0
344148112172701	A-15-01 07ADA	03/15/01	458.7	463.7	465.5	467.5	4542	-8.8	-3.8	-2.0
344157112150701	A-15-01 10BBB2	04/17/01				92.4	5242			
344117112130901	A-15-01 11DDD	03/09/01	212.7	216.6	217.2	217.8	5264	-5.1	-1.2	-0.6
344052112171701	A-15-01 17BCC	03/15/01	313.8	314.2	314.1	314.1	4664	-0.3	0.1	0.0
344029112143501	A-15-01 22ABB	03/09/01	57.9	60.2	60.9	61.9	5218	-4.0	-1.7	-1.0
343906112154701	A-15-01 28ACC	03/06/01	312.9	313.2	313.9	314.4	4757	-1.5	-1.2	-0.5
343832112172301	A-15-01 31AAA	03/06/01				338.1	4661			
342722112225901	B-12H01 20ACD	03/14/01		69.9	68.7	67.6	6342		2.3	1.1
343655112192201	B-14-01 01CCC	03/06/01		336.4	336.3	337.5	4687		-1.1	-1.2
343634112205201	B-14-01 10ACA	03/06/01	477.8	583.6	603.2	620.6	4379	-142.8	-37.0	-17.4
343641112204202	B-14-01 10ADB1 PZ1	03/06/01		566.3	585.5	603.3	4411		-37.0	-17.8
343640112204201	B-14-01 10ADB2	03/06/01			590.1	611.1	4403			-21.0
343610112203201	B-14-01 10DDA	03/06/01	522.2	639.3	654.4	673.5	4408	-151.3	-34.2	-19.1
343637112195701	B-14-01 11ACB	03/06/01	341.3	342	340.8	341.9	4701	-0.6	0.1	-1.1
343628112193001	B-14-01 11DAA	03/06/01	328.7	328.5	327.5	328.6	4714	0.1	-0.1	-1.1
343540112195701	B-14-01 14ACC	03/06/01	371.1	371.8	370.9	371.0	4740	0.1	0.8	-0.1
343558112205601	B-14-01 15ABB	03/06/01			686.8	706.2	4405			-19.4
343453112203401	B-14-01 22ADA	03/06/01	325.9		326.6	333.9	4850	-8.0		-7.3
343343112183801	B-14-01 25DAC	03/05/01	45.4	57.2	56.6	59.5	4873	-14.1	-2.3	-2.9
343413112193401	B-14-01 26AAA	03/05/01	209.3	212.0	212.5	213.5	4906	-4.2	-1.5	-1.0
343734112295501	B-14-02 05BBC	03/19/01		175.3	175.5	176.7	5128		-1.4	-1.2
344208112191201	B-15-01 01CDC	03/15/01	366.8	370.3	371.9	372.8	4540	-6.0	-2.5	-0.9
344233112193801	B-15-01 02ADC	03/15/01	323.1	327.0	328.3	330.7	4549	-7.6	-3.7	-2.4
344253112233601	B-15-01 05BBB2	03/19/01	279.1	284.1	287.8	289.3	4538	-10.2	-5.2	-1.5
344136112205601	B-15-01 10DBB	03/15/01				307.5	4250			
344038112194401	B-15-01 14DBD	03/09/01	323.5	328.8	330.7	332.6	4537	-9.1	-3.8	-1.9
343930112235301	B-15-01 19DCD1	03/14/01	220.8	225.3	236.6	226.4	4683	-5.6	-1.1	10.2

Table 1. Prescott water level data (Water level measurements rounded to nearest 0.1 foot)										
WELL_SITE_ID	CADASTRAL LOCATION	MEAS_DATE	1994 DTW	1999 DTW	2000 DTW	2001 DTW	2001 WL ELEV	94-01 CHG	99-01 CHG	00-01 CHG
343930112235601	B-15-01 19DCD2	03/14/01		370.5		374.6	4535		-4.1	
344011112200901	B-15-01 23BAD	03/15/01	328.7	336.3	339.3	340.2	4541	-11.5	-3.9	-0.9
343847112190401	B-15-01 25CDB	03/15/01	292.8	296.0	296.3	297.1	4629	-4.3	-1.1	-0.8
343854112202701	B-15-01 26CBC1	02/18/01		399.2	398.3	399.9	4555		-0.7	-1.6
343836112195501	B-15-01 26DCC	02/20/01				447.7	4542			
343746112242601	B-15-01 31CCD	03/19/01		341.7	341.8	344.1	4663		-2.4	-2.3
343820112195701	B-15-01 35ABD	03/09/01				379.5	4581			
344038112253701	B-15-02 13CCB	03/16/01	363.7	365.1	365.5	367.5	4587	-3.8	-2.4	-2
344106112291501	B-15-02 17ABA	03/16/01	297.2	295.5	294.9	294.7	4761	2.5	0.8	0.2
344005112300201	B-15-02 19ADA	03/16/01		334.4	334.4	334.5	4805		-0.1	-0.1
343928112301401	B-15-02 19DDC	03/19/01		308.1	308.7	309.5	4900		-1.4	-0.8
343905112301401	B-15-02 30ADC	03/16/01		119.5	123.1	128.7	5041		-9.2	-5.6
343927112304701	B-15-02 30BAB	03/19/01		159.0	158.9	164.7	5036		-5.7	-5.8
343843112303101	B-15-02 30CDA	04/04/01		156.6	159.7	166.7	5051		-10.1	-7.0
343858112300301	B-15-02 30DAA	03/19/01		144.7	148.8	154.2	5045		-9.5	-5.4
343836112302401	B-15-02 30DCB	04/04/01		148.5	151.9	157.9	5042		-9.4	-6.0
343813112301702	B-15-02 31ACD3	03/19/01		208.2	213.9	220.9	5029		-12.7	-7.0
343829112303501	B-15-02 31BAD1	03/14/01		210.8	216.6	222.0	5034		-11.2	-5.4
343827112304801	B-15-02 31BBD	04/10/01		166.3	169.6	187.9	5092		-21.6	-18.3
343754112301101	B-15-02 31DDB	03/19/01		208.3	209.2	210.9	5324		-2.6	-1.7
344241112312201	B-15-03 01DCD	04/04/01	102.0	95.1		94.0	4916	8.0	1.1	
344122112322201	B-15-03 11DDB	03/16/01		64.5	66.6	69.0	4991		-4.5	-2.4
344108112311001	B-15-03 13AAA	03/16/01		206.8	204	205.8	4876		1.0	-1.8
344147112313201	B-15-03 13ACC	03/16/01		217.4	217.1	217.2	4882		0.2	-0.1
344110112322201	B-15-03 14AAB	03/20/01				51.5	4998			
344059112325401	B-15-03 14BAD	03/20/01				44.8	4995			
344022112323501	B-15-03 14CDD	03/20/01				3.7	5026			
344038112321101	B-15-03 14DAD	03/20/01				49.7	5025			
344029112321501	B-15-03 14DDA	03/20/01				14.0	5036			
344006112321601	B-15-03 23ACA	03/20/01				26.4	5043			
343957112322001	B-15-03 23ADC	03/16/01		54.7	54.7	52.6	5032		2.1	2.1
343938112320101	B-15-03 24CCB	03/16/01		84.0	84.9	85.1	5034		-1.1	-0.2
343932112310401	B-15-03 24DDD	03/16/01		140.4	144.1	149.2	5040		-8.8	-5.1
344210112330901	B-15-03S02CCB	03/14/01				15.7	4974			
344727112231201	B-16-01 05CDD	03/15/01	174.9	180.9	180.5	184.1	4532	-9.2	-3.2	-3.6
344628112174901	B-16-01 07CDD	03/12/01	158.4	163.9	165.6	167.9	4537	-9.5	-4	-2.3
344540112202601	B-16-01 14CCC	03/15/01	284.7	290.3	291.8	293.7	4539	-9	-3.4	-1.9
344501112232601	B-16-01 20CAC	03/15/01		222.2	220.1	223.6	4556		-1.4	-3.5
344459112232601	B-16-01 20CBD1	03/15/01	45.2	44.4		49.3	4727	-4.1	-4.9	
344358112182901	B-16-01 25DDA	03/15/01	409.3	414.6	415.9	418.1	4542	-8.8	-3.5	-2.2
344429112222001	B-16-01 28BCA	03/15/01	267.3	272.7	274.7	276.2	4530	-8.9	-3.5	-1.5
344314112202401	B-16-01 35CBC	03/15/01	305.8	310.5	311.9	313.4	4528	-7.6	-2.9	-1.5

Table 1. Prescott water level data

(Water level measurements rounded to nearest 0.1 foot)

WELL_SITE_ID	CADASTRAL LOCATION	MEAS_DATE	1994 DTW	1999 DTW	2000 DTW	2001 DTW	2001 WL ELEV	94-01 CHG	99-01 CHG	00-01 CHG
344738112253301	B-16-02 01CBD	03/14/01	57.2	63.6	64.7	67.2	4522	-10	-3.6	-2.5
344809112275201	B-16-02 03BBB1	03/13/01	51.5	55.7	56.7	57.6	4481	-6.1	-1.9	-0.9
344723112265701	B-16-02 03DDC4	03/13/01	37.6	46.7	50.0	52.4	4537	-14.8	-5.7	-2.4
344704112291601	B-16-02 08ACA	03/13/01	106.4	105.0	107.0	109.4	4505	-3	-4.4	-2.4
344629112283401	B-16-02 09CDC	03/13/01	166.8	175.8	176.7	179.7	4508	-12.9	-3.9	-3.0
344653112264901	B-16-02 11CBB1	03/13/01	53.2	55.9	56.6	58.4	4551	-5.3	-2.5	-1.8
342658112244601	B-16-02 12ADD	03/12/01	110.2	115.6	117.1	118.1	4529	-7.9	-2.5	-1.0
344645112253401	B-16-02 12CBD	03/12/01		76.9	78.4	81.0	4518		-4.1	-2.6
344603112264001	B-16-02 14BCC	03/13/01	154.9	136.9	145.8	151.0	4508	3.9	-14.1	-5.2
344540112264501	B-16-02 14CCC	03/14/01		173.1		179.3	4500		-6.2	
344543112262201	B-16-02 14CDA	04/04/01	163.7	152.5	163.4	171.1	4502	-7.4	-18.6	-7.7
344626112265101	B-16-02 15AAA	03/13/01	93.5	103.9	106.2	110.8	4533	-17.3	-6.9	-4.6
344622112275701	B-16-02 16AAD	03/12/01		155.3	157.8	160.4	4514		-5.1	-2.6
344607112294301	B-16-02 17BDC	03/13/01	166.2	175.5	176.0	178.4	4521	-12.2	-2.9	-2.4
344534112282901	B-16-02 21BAA1	03/12/01	216.8	223.9	226.4	228.7	4509	-11.9	-4.8	-2.3
344535112283001	B-16-02 21BAA2	03/12/01	218.6	225.6	228.1	230.4	4510	-11.8	-4.8	-2.3
344507112270101	B-16-02 22DBA	03/13/01	192.4	201.8	201.0	207.6	4518	-15.2	-5.8	-6.6
344458112270601	B-16-02 22DBD	03/13/01		212.2	214.6	217.5	4515		-5.3	-2.9
344507112263801	B-16-02 23CBA	03/12/01		167.6	169.2	172	4508		-4.4	-2.8
344422112283201	B-16-02 28BDD	03/13/01	287.0	301.9	304.5	309.0	4511	-22.0	-7.1	-4.5
344357112280901	B-16-02 28DDC	03/16/01	288.1	295.7	296.4	301.0	4528	-12.9	-5.3	-4.6
344347112271001	B-16-02 34ABA2	03/14/01	265.1	272.4	274.2	276.6	4523	-11.5	-4.2	-2.4
344304112254701	B-16-02 35DDD	03/16/01	297.0	302.5		306.5	4528	-9.5	-4.0	
344348112331401	B-16-03 35BBB	03/16/01		115.0	115.5	117.8	5082		-2.8	-2.3
345048112292201	B-17-02 20ABD	03/13/01				177.2	4289			
345030112282301	B-17-02 21ACC	04/17/01				112.2	4367			
345056112271601	B-17-02 22ABB	03/21/01				23.7	4351			
344950112291101	B-17-02 29ADC	03/13/01		230.6		232.4	4372		-0.2	-1.8
344928112294601	B-17-02 29CAC	03/13/01		456.0		457.6	4292		-1.6	
344846112271401	B-17-02N34ACC	03/13/01	10.7	12.9	11.1	12.7	4497	-2	0.2	-1.6
344819112265701	B-17-02N34DDD1	03/12/01	4.6		10.7	12.7	4500	-8.1		-2.0
344819112265601	B-17-02N34DDD3	03/12/01	30.1	35.2	34.9	35.9	4479	-5.8	-0.7	-1.0
344821112301701	B-17-02S31ABA	03/13/01		498.8		501.0	4369		-2.2	
344820112272701	B-17-02S34ABB	03/12/01				1.5	4514			
344917112273101	B-17-02W27DCC	03/12/01	9.2	11.6	12.2	12.4	4457	-3.2	-0.8	-0.2

Table 2. Statistical summary of water level change data in the Prescott AMA (1995 to 2001)

Period of Change →	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Number of wells showing increases in water levels	1	4	10	7	21	9
Sum of increase (feet)	+0.6	+18.0	+33.0	+39.5	+22.7	+35.7
Minimum increase (feet)	+0.6	+2.0	+0.1	+0.1	+0.1	+0.1
Maximum increase (feet)	+0.6	+7.0	+9.2	+16.3	+4.8	+15.0
Mean of increases (feet)*	+0.6	+4.5	+3.3	+5.6	+0.9	+4.0
Median of increases (feet)**	+0.6	+4.5	+1.5	+4.4	+1.2	+1.1
Number of wells showing declines in water levels	15	10	34	35	63	82
Sum of declines (feet)	-54.3	-23.0	-71.4	-51.5	-188.2	-300.1
Minimum declines (feet)	-0.5	-1.0	-0.2	-0.1	-0.1	-0.1
Maximum declines (feet)	-13.4	-6.0	-12.6	-7.5	-19.6	-21.0
Mean of declines (feet)*	-3.6	-2.3	-2.1	-1.5	-3.0	-3.7
Median of declines (feet)**	-2.2	-1.5	-2.1	-1.2	-1.6	-2.25
Number of wells showing no change in water levels	0	3	0	1	3	1

* The mean of increases or declines is the arithmetic average of each group of measurements (that is, the average change in water level for wells with measured increases in water level or the average change in water level for wells with measured decreases in water level). For example, the sum of all measured water level increases in the 9 wells that showed increases between 2000 and 2001 was +35.7 feet. The mean of increases, +4.0 feet, was calculated by dividing the sum of increases (+35.7 feet) by the number of measurements that showed increases (9).

** The median of increases or declines is a statistical measure of the central value of each group of measurements. Half of the measurements in each group are less than the median, and half of the measurements in each group are greater than the median. For example, the median measured increase of +1.1 feet was measured in the 5th ranked well of the 9 total wells that showed increases between 2000 and 2001.

Surface Water Data 2000-2001

Surface water discharge data provide important information concerning the amount of flow in rivers and streams. Many of the discharge measurements are direct indicators of the volume of groundwater that is discharged from the regional aquifer system to springs and river channels. Surface water data are also used to estimate the volume of water that is recharged to the aquifer system from streambed infiltration. Surface water data were obtained for the period January 1, 2000 to April 13, 2001 from 7 United States Geological Survey (USGS) stream gages that are located in or near the Prescott AMA. The surface water data are tabulated in Table 3. Daily discharge hydrographs for these gages are assembled in Appendix A.

Comparisons of recent (January 1, 2000 to April 13, 2001) discharge data were made to long-term annual mean discharge data and to median daily discharge data for the USGS gages with comparatively long periods of record. Comparisons were made for the gage on the Verde River near Paulden (09503700 – period of record 1963 to present), and for the gage on the Agua Fria River near Mayer (09512500 – period of 1940 to present).

The recent annual mean discharge at the USGS gage on the Verde River near Paulden (09503700) was 17,614 acre-feet per year, or about 56 percent of the long-term mean of 31,420 acre-feet per year (from 1963 to 2000) (USGS,2001). The recent median daily discharge was 23 cubic feet per second (cfs), or 92 percent of the long-term median daily discharge of 25 cfs (USGS, 2001). The median daily discharge at the Paulden gage is generally indicative of the typical baseflow of the Verde River at that location. The baseflow is primarily sustained by a series of springs that discharge groundwater to the channel of the Verde River and to the channel of lower Granite Creek a few miles upstream from the gage.

The recent annual mean discharge at the USGS gage on the Agua Fria River near Mayer (09512500) was 9,269 acre-feet per year, or about 55 percent of the long-term mean of 16,724 acre-feet per year (USGS, 2001). The recent median daily discharge was about 3.5 cfs, or about 157 percent of the long-term median daily discharge of 2.2 cfs (USGS, 2001). Baseflow conditions begin on the Agua Fria River near Humboldt. However, some reaches of the river between Humboldt and the Mayer gage are dry during average to dry years (Wilson, 1988).

Table 3. Summary of provisional USGS stream gage data for selected gages in and near the Prescott AMA (01/01/2000 - 04/14/2001)

Gage Description	Gage Number	Period of Record	Mean Daily Discharge (cfs) 01/01/00 to 04/13/01	Median Daily Discharge (cfs) 01/01/00 to 04/13/01	Minimum Daily Discharge (cfs) 01/01/00 to 04/13/01	Maximum Daily Discharge (cfs) 01/01/00 to 04/13/01	Total Discharge (AF) 01/01/00 to 04/13/01	Annualized Discharge (AF/yr) 01/01/00 to 04/13/01
Del Rio Springs near Chino Valley	09502900	1996-2001	1.86	2.00	1.30	3.10	1,724	1,346
Granite Creek near Prescott	09503000	1932-1947 1994-2001	6.14	1.20	0.01	190.0	5,675	4,434
Granite Creek at Prescott	09502960	1994-2001	5.29	0.38	0.00	191.0	4,893	3,823
Granite Creek below Watson Lake	09503300	1999-2001	0.80	0.03	0.00	62.00	735	574
Verde River near Paulden	09503700	1963-2001	24.38	23.00	19.0	170.0	22,546	17,614
Agua Fria River near Humboldt	09512450	2000-2001	3.79	2.20	0.53	573.0	3,459	2,702
Agua Fria River near Mayer	09512500	1940-2001	12.86	3.45	0.09	900.0	11,864	9,269

Stream gage data and graphics downloaded from USGS website: http://water.usgs.gov/az/nwis/

Precipitation Data 2000

Monthly precipitation data are used to assess variations in climatic conditions. Comparisons between recent and long-term precipitation data are useful and aid in the interpretation of water level and surface water data. Precipitation data are also used in the evaluation and quantification of groundwater recharge.

Monthly total precipitation data for the year 2000 were collected for the Prescott (026796) and Chino Valley (021654) precipitation stations. The provisional precipitation data are summarized in Tables 4 and 5. The data indicate the total precipitation at Prescott in 2000 was about 82 percent of the long-term average. The data indicate that the total precipitation at Chino Valley was equal to the long-term average.

Table 4. Monthly total precipitation in calendar year 2000 Prescott, Arizona (inches)

Month ->	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2000	.26	1.20a	2.13	0.24	0.00	1.48	1.06	3.71	0.00	5.18	0.51r	0.05z	15.82
Long-term Mean 1898-2000	1.78	1.86	1.77	0.95	0.50	0.41	2.94	3.32	1.74	1.06	1.27	1.68	19.26

(period of record 1898 to present)

Table 5. Monthly total precipitation in calendar year 2000 Chino Valley, Arizona (inches)

Month->	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2000	0.08b	1.14c	1.32c	0.10b	0.00	0.61b	0.47e	2.55h	0.21	4.42n	0.90t	0.00z	11.80
Long-term Mean 1948-2000	0.97	0.94	0.98	0.57	0.39	0.35	1.94	2.09	1.29	0.84	0.64	0.93	11.79

(period of record 1948 to present)

(some months during 2000 were missing one or more days of data, therefore monthly and annual total data are considered provisional)
a=1 day missing, b=2 days missing, c=3 days missing,.. etc.., z=26 or more days missing

Precipitation data downloaded from the National Climate Data Center websites:
http://www.ncdc.noaa.gov/ol/climate/online/
http://www.wrcc.sage.edu/summary/climsaz.html

Groundwater Pumpage 2000

Groundwater pumpage represents the single largest component of outflow from the aquifer system in the Prescott AMA. Groundwater pumpage data provides important information that is used to assess the ever-growing demand on the aquifer system. Groundwater pumpage data are used to compile hydrologic water budgets, and supply well-specific pumpage inputs to groundwater flow models.

Annual groundwater pumpage totals are metered for each non-exempt well in the AMA, and are reported by the well owners to the ADWR. These data are tabulated in Table 6 for the period 1990 to 2000. The 2000 non-exempt well pumpage total in the Prescott AMA was 17,291 acre-feet (Table 6). The 2000 non-exempt pumpage was about 11 percent greater than the average annual non-exempt pumpage of 15,502 acre-feet during the 1990's (Table 6).

Table 6. Reported non-exempt well pumpage in the Prescott AMA (1990 - 2000)

(Acre – Feet)

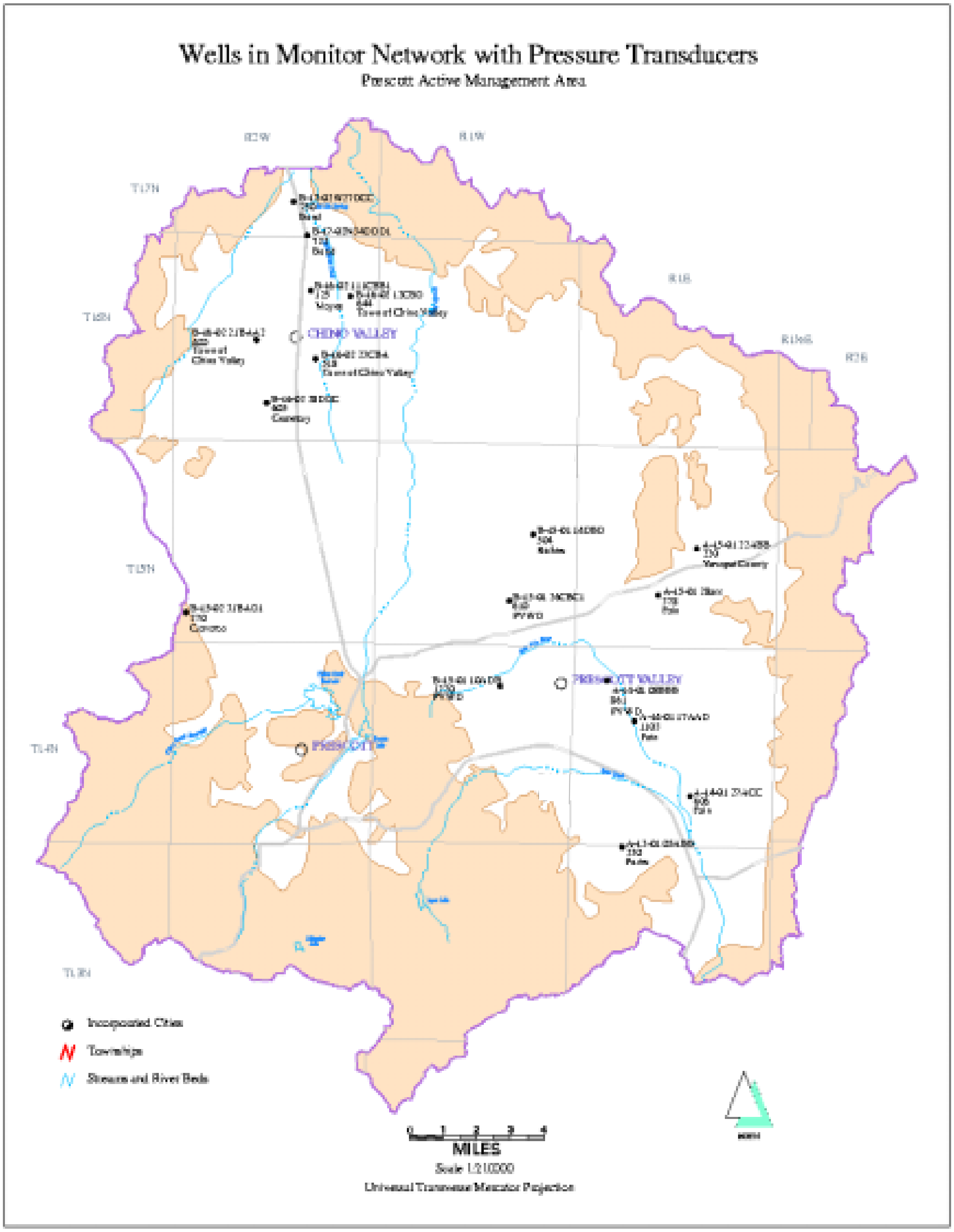
Year	Pumpage
1990	16,088
1991	13,780
1992	12,007
1993	15,279
1994	15,426
1995	15,011
1996	17,635
1997	17,132
1998	15,229
1999	15,642
2000	17,291
1990-2000 Total	170,520
1990-2000 Average	15,502

Pressure Transducer Data and Installations

This section provides an update on the installation of pressure transducers in wells in the Prescott AMA groundwater monitoring network. A characteristic hydrograph from one of the pressure transducer wells located near Del Rio Springs is shown in Figure 2. Some of the value and utility of pressure transducer data can be seen in its capacity to show seasonal water level trends, and how these trends may correlate to other important hydrologic phenomenon such as the variation in discharge from Del Rio Springs (Figure 2).

Figure 2. Comparison of depth to water in B(17-2) 27dcc and Del Rio Springs mean daily discharge (Oct. 29, 1999 - Nov. 21, 2000)

Figure 3. Wells in monitor network with pressure transducers



Monitor Well Selection Process

The following main criteria were considered for selecting wells to be added to the Prescott AMA monitoring network: owner cooperation, unused and unequipped status, location, driller's log availability, period of record, well depth and completion interval. Well locations were selected either for their strategic location for regional groundwater monitoring, and/or because they were located in areas of current or potential future hydrologic concern.

Most of the selected wells had driller's logs that ranged from poor to good quality. In general, deeper wells that penetrated volcanic deposits, and/or bedrock were selected. It is possible that additional wells may be added to the pressure transducer monitoring network in the future. Table 6 lists the wells that have been installed with pressure transducer equipment. Figure 3 shows the locations of wells with pressure transducer installations.

Method of Installation and Work Completed

The method of transducer installation varied from site to site depending upon the well diameter and depth. In all cases a .75" PVC sounding tube was installed along with the pressure transducer. In small-diameter wells (less than 6") the pressure transducer, stainless steel cable, and airline were taped to the bottom piece of PVC tubing. For added stability, the airline and stainless steel cable were also tie-wrapped to the PVC sounding tube at 10 foot intervals. In larger-diameter wells the pressure transducer was generally not taped to the bottom piece of PVC tubing, but instead was hung freely by the stainless steel cable.

All transducer installations were completed by teams of 2 to 4 staff (Figure 4) who lowered and connected the PVC tubing and transducer equipment into the well by hand (a specially constructed metal slip was used to support the PVC tubing while connections were being made). The practical depth that such installations could be accomplished by hand was in the 350 to 450 foot range. Due to the great set depth at the Fat Chance well, B(15-1) 10ADB1, the transducer installation was contracted to a pump company. Approximately 50 feet of extra airline and stainless steel support cable were included with each pressure transducer installation. The extra airline and cable will be required when water levels decline in the wells (which is anticipated) and it becomes necessary to lower the transducers to greater depths.

Once the pressure transducer and sounding tube were installed in a well, a surface hanger was set on the top of the well casing to support the data logger (Figure 5). The data loggers were set to record a pressure reading every 15 minutes. The frequency of pressure readings will likely be decreased as more experience is gained and more data is collected which will indicate optimal time intervals between pressure measurements. Initially the data loggers will be down loaded every 3 months to assure proper operation of the equipment.

The pressure transducer wells are secured using locking stainless steel shelters (Figure 6). The shelters are bolted to cement pads, and are designed to withstand the typical range of weather conditions and are resistant to vandalism. As of May , 2001, 17 sites have been instrumented with pressure transducers.

Figure 4. ADWR field crew installs pressure transducer in Chino Valley well

Figure 5. Surface hanger supports data logger

Figure 6. Typical shelter design

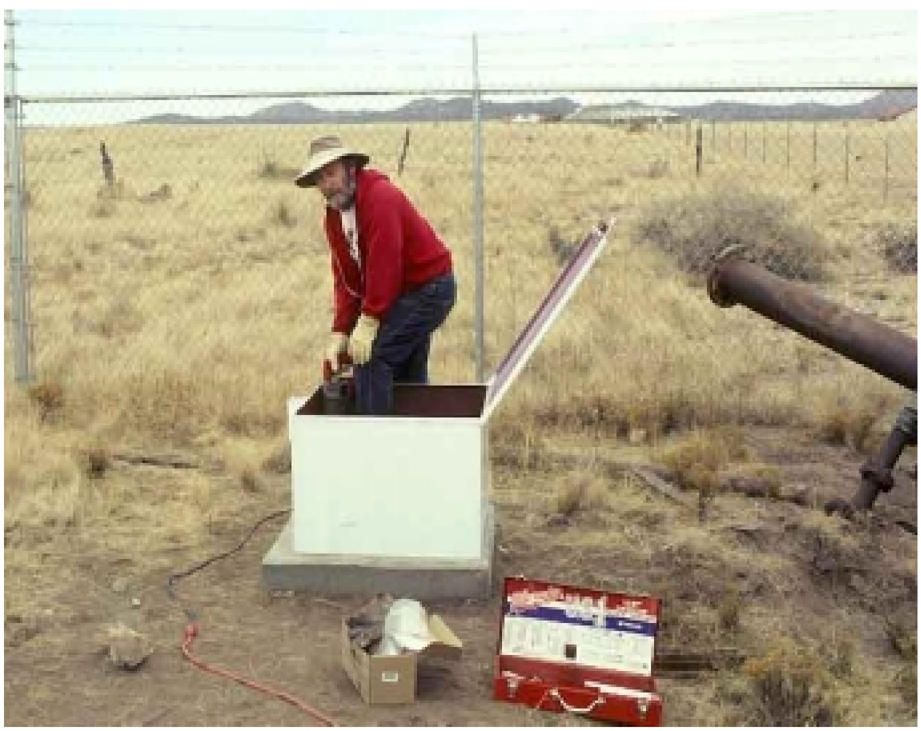


Table 7. Summary of well construction and hydrogeologic data for wells in Prescott AMA monitoring network installed with pressure transducers

Local ID	Well Registry Number	Owner	Depth	Casing	Perfs	Hydrogeologic Units	1st Year of Record GWSI (WLS)	WL Change 1994-2001	WL Change 2000-2001
A-13-01 5abb	502012	Porter	230	6" PVC 1-230'	170-230	UAU	1988	NA	-0.63
A-14-01 8bbb	536623	PVWD	861	6.62" Steel	675-861	UAU / Volcanics Schist	1994	-1.83	-.13
A-14-01 17aad	613025	Fain	1103	16" Steel	100-640	UAU/ Volcanics Granite	1979	-3.65	-0.66
A-14-01 27acc	613024	Fain	606	12" Steel		UAU / Volcanics Conglomerate	1967	+5.48	+0.10
A-15-01 28acc	613034	Fain	372	5" Steel		UAU	1979	-1.52	-0.53
A-15-01 22abb	519873	Yavapai County	220	6" Steel 0-218'	50-73' 112-135' 195-218'	UAU / Schist	1994	-3.98	-1.02
B-15-01 10adb1	519687	PVWD	1255	16" Steel PVC 0-940	910-940	UAU / Volcanics Conglomerate	1988	NA	NA
B-14-01 26aaa	612018	Lynx Ranch	328	12" Steel 0-30'		UAU / Granite	1978	-4.2	-1
B-15-01 14dbd	523925	Richter	504	7" Steel PVC 0-284'	284-504'	UAU / LVU	1994	-9.13	-1.95
B-15-01 26cbc1	541372	PVWD	610	7" Steel 0-594'	400-594'	UAU / LVU	1994	NA	-1.63
B-15-02 31bad1	638196	Cravatzo	270	4.5" Steel 0-270'	240-270'	UAU / LVU	1980	NA	-5.40
B-16-02 11cbb1	602559	Mayes	125	48" Concrete		UAU	1938	-5.25	-1.81
B-16-02 12cbd	606300	Town of Chino Valley	610	8" Steel		UAU / LVU	1941	NA	-2.6
B-16-02 21baa2	604725	Town of Chino Valley	400	20" Steel 0-260'	260-400	UAU / LVU	1981	-11.9	-2.3
B-16-02 23cba	800688	Town of Chino Valley	518	14" Steel 0-216'	216-518	UAU / LVU	1948	NA	-2.75
B-16-02 28ddc	628072	Cemetery	605	16" Steel	40-605	UAU / LVU	1958	-12.92	4.62
B-17-02N34ddd1	608242	Bond	722	10" Steel 0-263'	263-722	UAU / LVU	1943	-8.1	-2.02
B-17-02W27dcc	609768	Bond	755	Steel 18" 0-280' 12" 280-710' 6" 710-750'		UAU / LVU	1962	-3.2	-0.17

Table 8. Summary of (as-built) information for wells installed with pressure transducers

Local ID	Owner	Site Name	Depth	Transducer (PSI)	Cable Length	Depth Set	Shelter Type	Anchor Method
A-13-01 5abb	Porter	Closure	230	15	200	175	Big	Bolt down
A-13-01 8bbb	PVWD	Williams	861	15	260	220	Small	Weld
A-14-01 17aad	Fain	Fain North	1103	15	175	155	Big	Pour concrete
A-14-01 27acc	Fain	Fain South	606	30	125	80	Big	Pour concrete
A-15-01 28acc	Fain	Coyote	378	15	375	333	Small	Bolt down
A-15-01 22abb	State Land Dept.	Indian Hills	220	15	200	90	Small	Pour concrete
B-15-01 10adb	PVWD	Fat Chance	1220	75	900	800	Big	Pour concrete
B-15-01 14dbd	Richter	Richter South	504	15	390	353	Big	Pour concrete
B-15-01 26cbc1	PVWD	Viewpoint	610	30	500	454	Big	Pour concrete
B-15-02 31bad1	Cravatzo	Smilin' Jack	270	15	270	255	None	Not Applicable
B-16-02 11cbb1	Mayes		125	15	120	85	Existing	Weld
B-16-02 12cbd	Town of Chino Valley	Old Home Manor	644	30	175	150	Big	Pour Concrete
B-16-02 21baa2	Town of Chino Valley	Geiler	400	30	325	302	Big	Pour concrete
B-16-02 23cba	Town of Chino Valley	Magee	518	30	300	250	Big	Bolt down
B-16-02 28ddc	Cemetery	Cemetery	605	30	425		Big	Bolt down
B-17-02N34ddd1	Bond	Echols	722	30	150		Small	Weld
B-17-02W27dcc	Bond	007	755	15	125		Big	Bolt down

Stream Gage Installations

Five new USGS stream gages have been established in the Prescott AMA since 1994. One gage was established in 1999 on Granite Creek below Watson Lake by the USGS and the ADWR (095033000). This gage was established to quantify previously unmeasured spills from the reservoir (Figure 7). The quantification of these previously unmeasured spills is important because they periodically provide significant recharge to the regional aquifer system in the AMA. Two other gages were established on Granite Creek (09503000 and 09502960) upstream of Watson Lake in 1994. These gages were established by the USGS and the Yavapai-Prescott Indian Tribe to help quantify the volume and source(s) of flow on Granite Creek above Watson Lake.

Two other stream gages have recently been established by the USGS and the ADWR in the Prescott AMA. The Del Rio Springs gage (09502900) was established in 1996 to help quantify the volume of groundwater discharged to the channel of Little Chino Creek from Del Rio Springs. A gage was also established in 2000 on the Agua Fria River near Humboldt (09512450). This gage was established to quantify the volume of groundwater discharged to the channel of the Agua Fria River near Humboldt, and to quantify the volume of surface flow leaving the Prescott AMA from run-off events.

Figure 7. New USGS stream gage (095033000) located on Granite Creek below Watson Lake

Monitor Well Drilling

Another monitoring activity that was initiated during 2000 was the acquisition of leases to three sites located on State Trust lands where deep monitor wells will be drilled. The well sites are located in data deficient areas of the regional aquifer system where the aquifer thickness and hydrologic characteristics are comparatively unknown. Once drilled, these wells will be instrumented with pressure transducer systems and be added to the ADWR monitoring network. At least one well will be drilled during 2001, with the possibility of a second well being drilled if funding is available.

Gravimetric Aquifer Storage Monitoring and Land Subsidence Monitoring

Additional monitoring activities that may be implemented sometime in the future are the establishment of land subsidence and aquifer storage monitoring networks in the AMA that will rely on survey grade Global Positioning Service (GPS) measurements and precision microgravity measurements. These types of networks have recently been established in the Phoenix, Pinal and Tucson AMAs, and it is believed that this type of monitoring would also be effective and beneficial in the Prescott AMA.

The aquifer storage monitoring using microgravity techniques is particularly important because it provides another method for estimating changes in aquifer storage that is independent of other types of data and methods. Indications of changing aquifer storage conditions that are provided from water level measurements, water budgets and groundwater modeling can be supported and corroborated with the gravity data.

References

ADWR, 1999, Arizona Department of Water Resources Report on the Final Decision and Order That the Prescott Active Management Area is No Longer at Safe-Yield, 31 p.

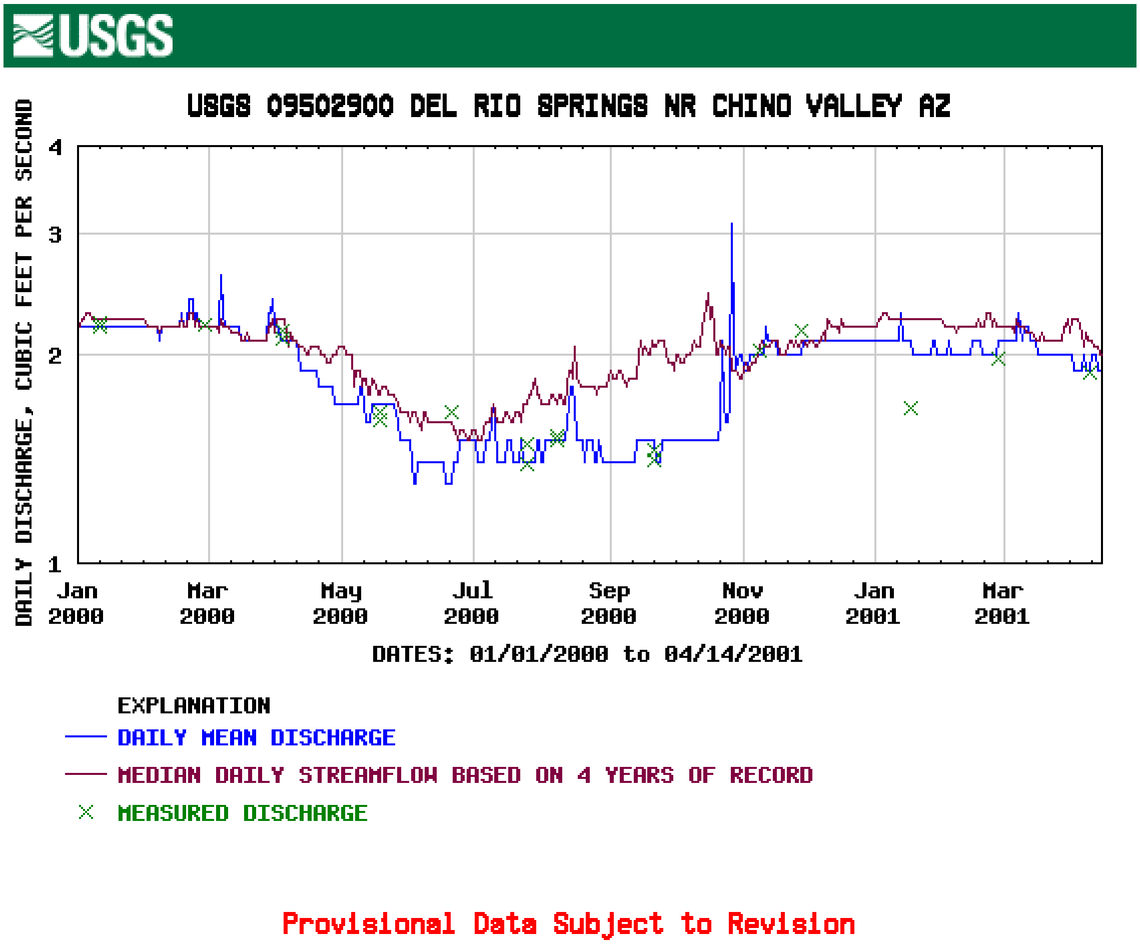
Corkhill, E.F., and Mason, D.M., 1995, Arizona Department of Water Resources Hydrogeology and Simulation of Groundwater Flow Prescott Active Management Area Yavapai County, Arizona, Modeling Report No. 9, 143 p.

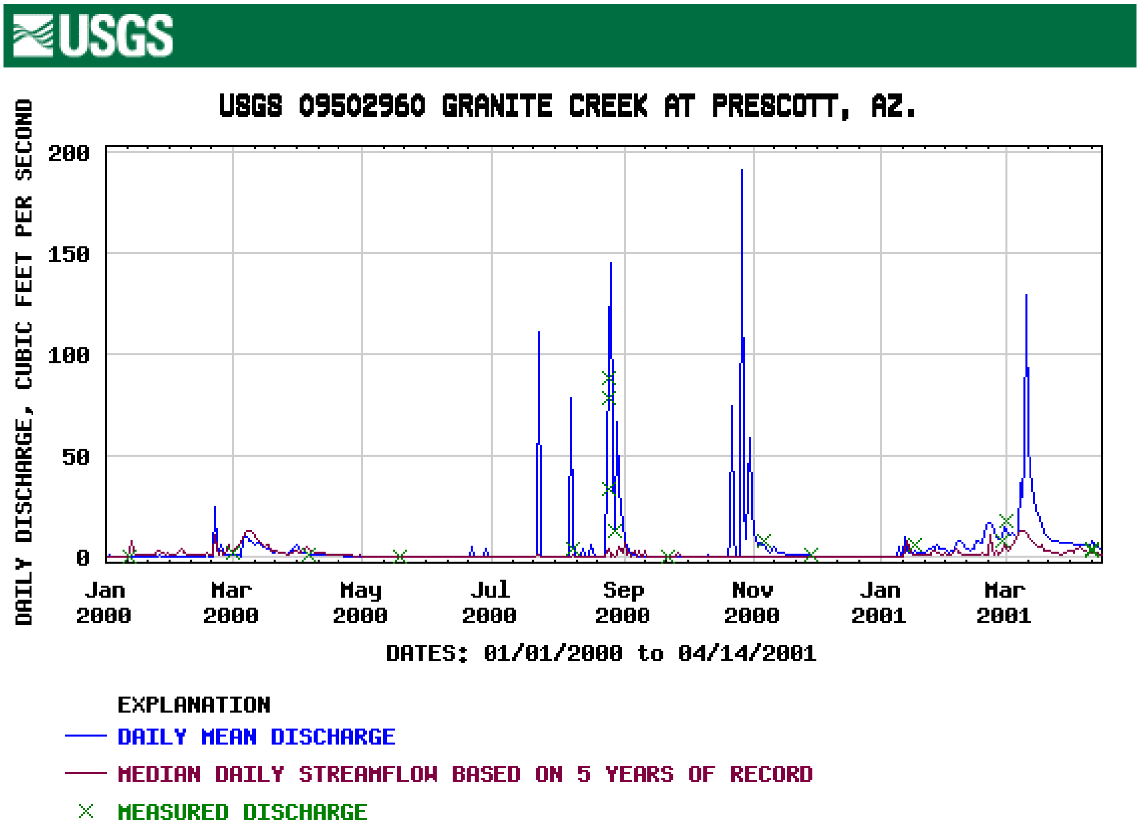
USGS, 2001, Water Resources Data Arizona Water Year 2000, Water-Data Report AZ-00-1, 390 p.

Wilson, R.P., 1988, Arizona Department of Water Resources Bulletin 5, Water Resources of the Northern Part of the Agua Fria area, Yavapai County, Arizona, 109 p.

Woessner, W.W., 1998, Evaluation of Two Groundwater Models of the Prescott Active Management Area ADWR Model (1995) and Southwest Ground-water Consultants, Inc. Model (1998), 2 Vols.

Appendix A - Daily discharge hydrographs for selected USGS streamgages


USGS
USGS 09502900 DEL RIO SPRINGS NR CHINO VALLEY AZ
DAILY DISCHARGE, CUBIC FEET PER SECOND
4
3
2
1
Jan 2000
Mar 2000
May 2000
Jul 2000
Sep 2000
Nov 2000
Jan 2001
Mar 2001
DATES: 01/01/2000 to 04/14/2001
EXPLANATION
DAILY MEAN DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 4 YEARS OF RECORD
MEASURED DISCHARGE
Provisional Data Subject to Revision



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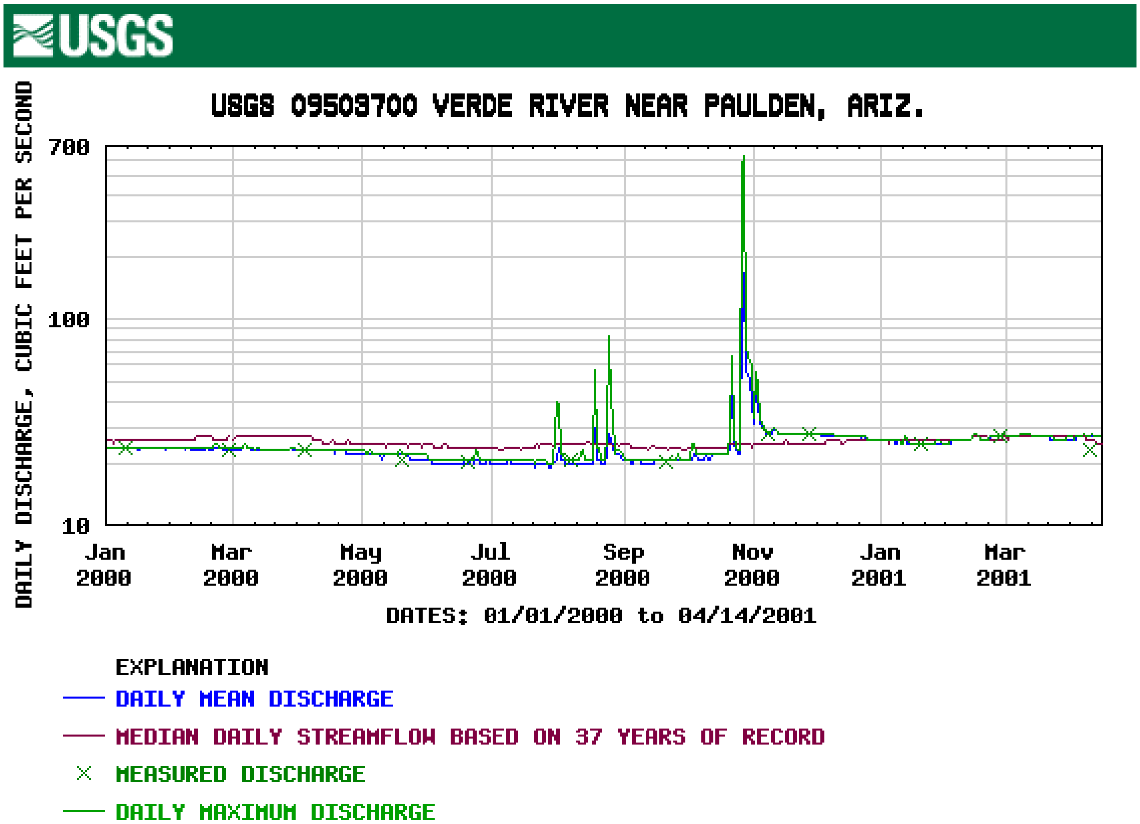

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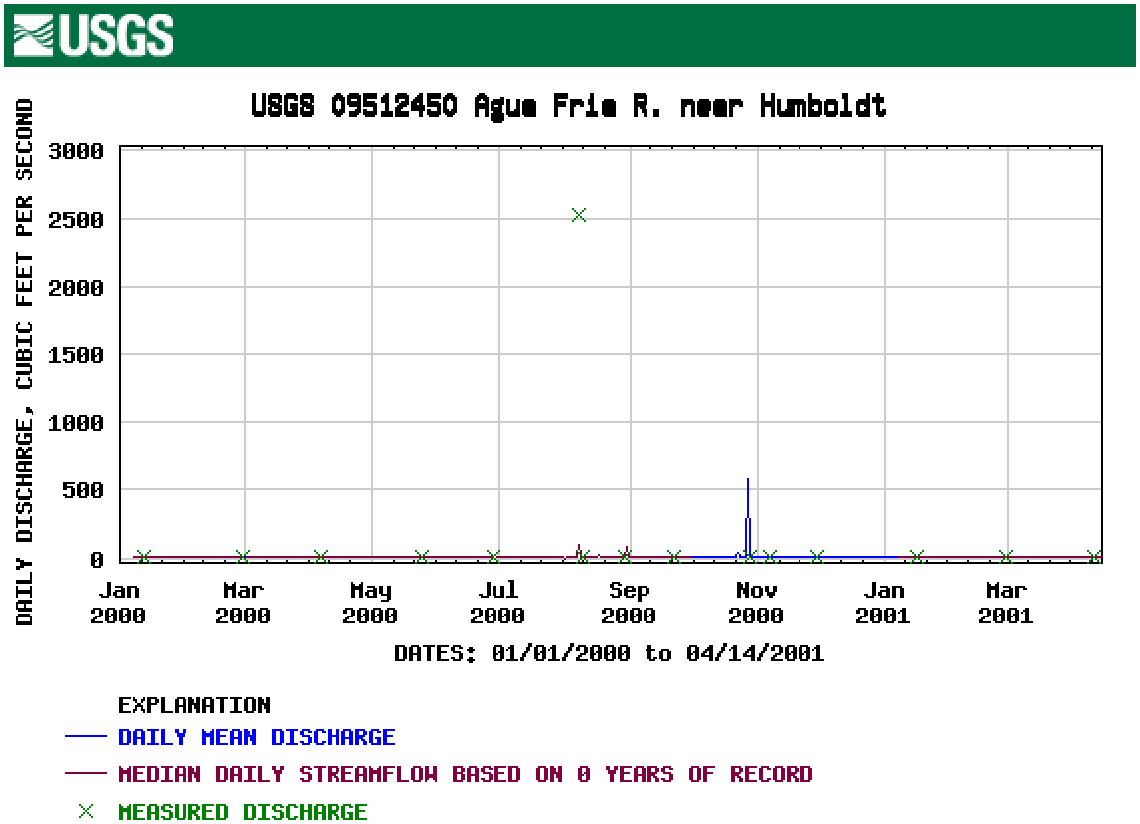
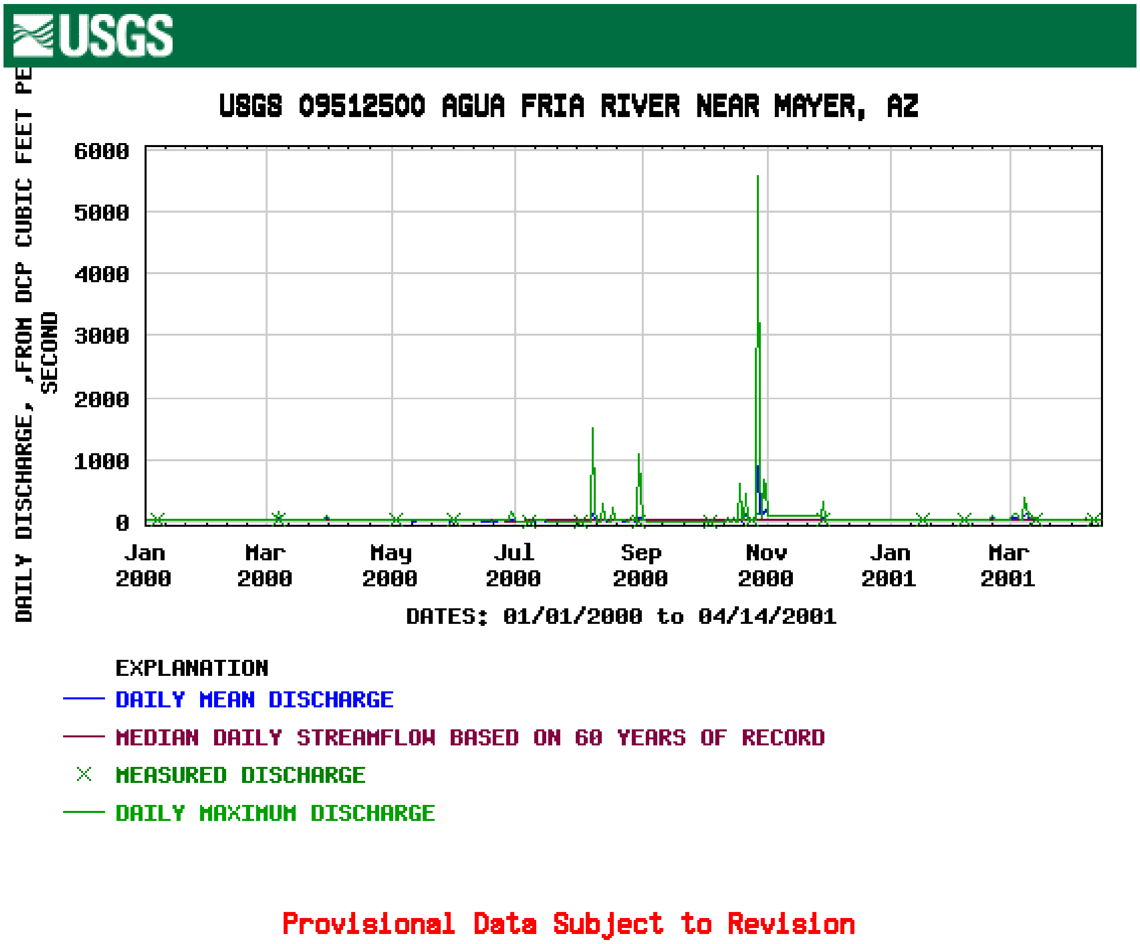
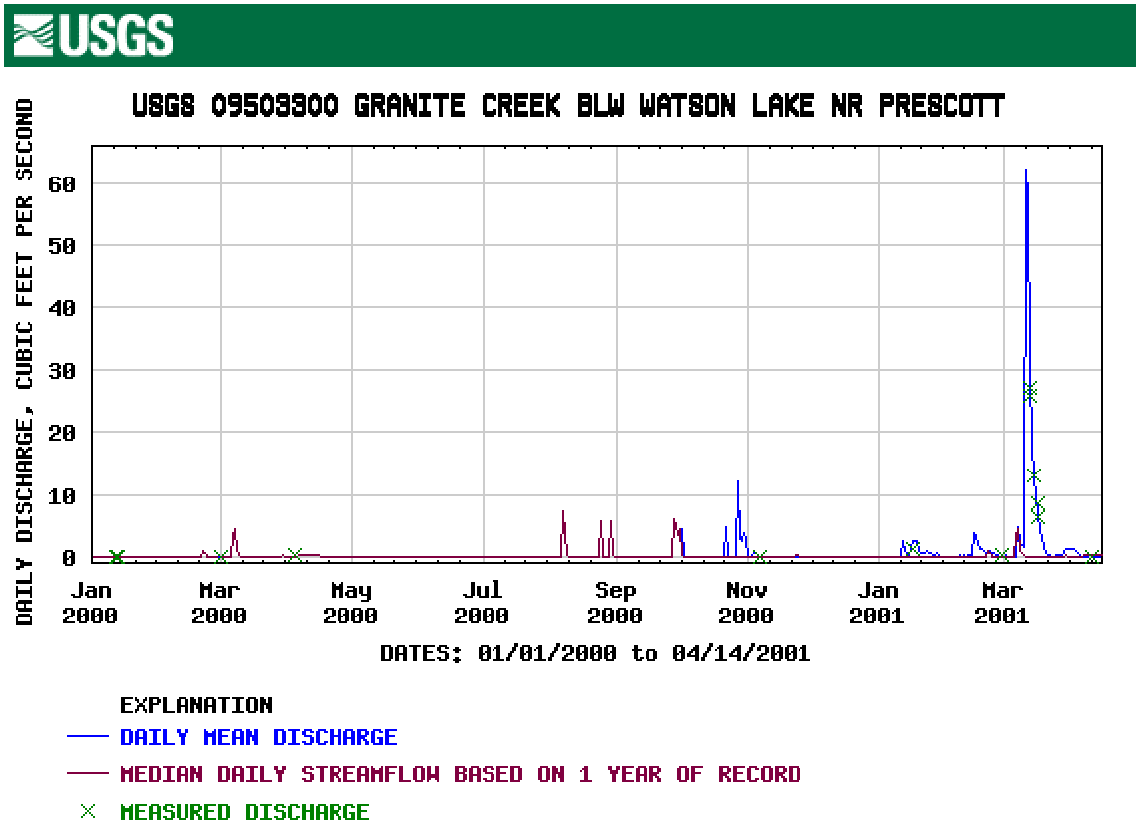
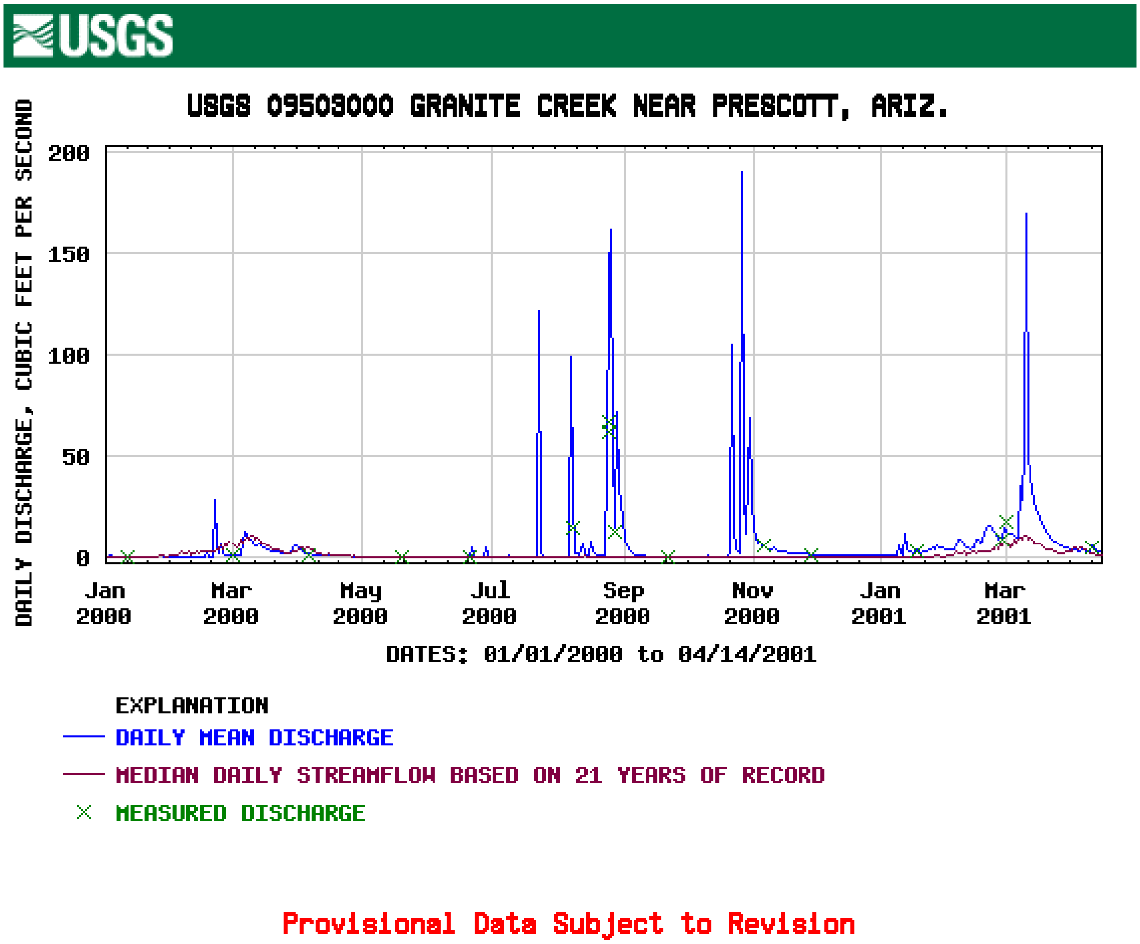


Provisional Data Subject to Revision


USGS
USGS 09512500 AGUA FRIA RIVER NEAR MAYER, AZ
DAILY DISCHARGE, ,FROM DCP CUBIC FEET PE SECOND
6000
5000
4000
3000
2000
1000
0
Jan 2000
Mar 2000
May 2000
Jul 2000
Sep 2000
Nov 2000
Jan 2001
Mar 2001
DATES: 01/01/2000 to 04/14/2001
EXPLANATION
DAILY MEAN DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 60 YEARS OF RECORD
MEASURED DISCHARGE
DAILY MAXIMUM DISCHARGE
Provisional Data Subject to Revision



Provisional Data Subject to Revision


USGS
USGS 09503000 GRANITE CREEK NEAR PRESCOTT, ARIZ.
DAILY DISCHARGE, CUBIC FEET PER SECOND
200
150
100
50
0
Jan 2000
Mar 2000
May 2000
Jul 2000
Sep 2000
Nov 2000
Jan 2001
Mar 2001
DATES: 01/01/2000 to 04/14/2001
EXPLANATION
DAILY MEAN DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 21 YEARS OF RECORD
MEASURED DISCHARGE
Provisional Data Subject to Revision