



Prepared in consultation with the Secretaries of Agriculture and Defense and in cooperation with the Upper San Pedro Partnership in response to Public Law 108-136, Section 321

## Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona—2011 Report to Congress



U.S. Department of the Interior  
U.S. Geological Survey



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## Contents

Executive summary .....	v
Preface .....	vi
Quantitative requirements .....	1
1. The quantity of the overdraft of the regional aquifer reduced during 2010 .....	1
2. Whether the reduction in the deficit met the goal specified for the reporting period .....	5
3. Water use management and conservation measures undertaken by each water-use controlling member of the Partnership.....	6
4. Extent of contribution of management and conservation measures to the reduction of the overdraft .....	9
Summary and conclusions of the quantitative requirements of the 2011 321 reporting .....	9
Legislative accomplishments.....	11
References Cited.....	16

## Figures

<b>Figure 1.</b> Effect of management-measure yields (planned yields and estimates of actual yields) on annual aquifer storage change (calculated as the difference between projected annual aquifer-storage depletions if no management measures are taken and management-measure yields).....	2
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## Tables

<b>Table ES1.</b> Water recharged to and withdrawn/discharged from the regional aquifer underlying the Sierra Vista Subwatershed in 2010 .....	vi
<b>Table 1.</b> Water recharged to and withdrawn/discharged from the regional aquifer underlying the Sierra Vista Subwatershed in 2010.....	3
<b>Table 2a.</b> Revisions to base groundwater budget, Sierra Vista Subwatershed of the Upper San Pedro basin, 2002 to 2010 .....	4
<b>Table 2b.</b> Annual aquifer storage overdraft (deficit) for the Sierra Vista Subwatershed .....	5
<b>Table 3.</b> Original and revised 2010 water budget deficit/surplus goals and actual water budget deficit or surplus ..	6
<b>Table 4.</b> Planned and estimated actual yields for 2010 of Partnership member measures to reduce aquifer overdraft and of increased recharge from urbanization .....	7

## Executive summary

Section 321 of the Defense Authorization Act of 2004, Public Law 108-136, requires each annual 321 report to address five requirements, of which four are quantitative. The responses to the four quantitative requirements of the Act for the calendar-year 2010 reporting period follow:

1. The quantity of the annual overdraft of the regional aquifer was reduced 1,500 acre-ft during the reporting period, 2010, compared to the previous reporting period, 2009;
2. The reduction in (1) met the goal specified for the reporting period;
3. The water-use management and conservation measures undertaken by each water-use controlling member of the Partnership during the reporting period are shown in table 4 by jurisdiction;
4. The extent of the contribution of such measures to the reduction of the overdraft was 9,000 acre-ft.

Groundwater depletion in the Sierra Vista Subwatershed continues albeit at a rate slower than in 2002. Although the annual overdraft of the aquifer has been greatly reduced from the 13,500 acre-ft originally anticipated for 2010 (fig. 1; utilizes 2010 census data) to 4,600 acre-ft today, groundwater continues to be removed from storage. Since 2002 (the beginning of 321 monitoring), about 65,200 acre-ft has been removed from storage in addition to the hundreds of thousands of acre-ft that previously were removed from storage since groundwater pumping commenced in the first half of the 20<sup>th</sup> century (D.R. Pool, unpub. data, 2011). Until the aquifer begins to accrete storage (the annual water budget balance becomes greater than 0) there will be no reduction in the cumulative deficit, and until additional management measures are undertaken, it is unlikely that there will be further progress made toward this goal.

**Table ES1.** Water recharged to and withdrawn/discharged from the regional aquifer underlying the Sierra Vista Subwatershed in 2010

[Water-budget volumes are in acre-ft; inflows are assigned positive numbers, outflows are assigned negative numbers; all values are estimates based upon the best available data and computational methods; values rounded to nearest 100 acre-ft]

Component	Estimated volume
Natural aspects of system	1,900
Pumping	-15,000
Active management measures	4,200
Passive recharge resulting from human activities	4,300
<b>Total aquifer storage change</b>	<b>-4,600</b>

## Preface

The Defense Authorization Act of 2004, Public Law 108-136, Section 321, stipulates the way in which Section 7 of the Endangered Species Act applies to the Fort Huachuca, Arizona, military reservation. Section 321 of this Act further directs the Secretary of the Interior to prepare reports to Congress on steps to be taken to reduce the overdraft and restore the sustainable yield of groundwater in the Sierra Vista Subwatershed:

The Secretary of [the] Interior shall prepare, in consultation with the Secretary of Agriculture and the Secretary of Defense and in cooperation with the other members of the Partnership, a report on water use management and conservation measures that have been implemented and are needed to restore and maintain the sustainable yield of the regional aquifer by and after September 30, 2011. The Secretary of the Interior shall submit the report to Congress not later than December 31, 2004. . . . Not later than October 31, 2005, and each October 31 thereafter through 2011, the Secretary of the Interior shall submit, on behalf of the Partnership, to Congress a report on the progress of the Partnership during the preceding fiscal year toward achieving and maintaining the sustainable yield of the regional aquifer by and after September 30, 2011.

Pursuant to this requirement, an initial Section 321 report, submitted to Congress in 2005, established goals to achieve sustainability and indicated the various water management measures planned by Partnership members to meet the targeted reductions in aquifer use (Department of the Interior, 2005).

The report that follows is an annual progress report, the sixth in a series of such reports to be prepared through 2011. The report utilizes the best information available at this time including data from Partnership research studies of the Sierra Vista Subwatershed, data collected by the monitoring program which has been tailored to Section 321 information needs, and the most recent population data from the 2010 U.S. Census. The authorship of this report is attributed collectively to the Upper San Pedro Partnership, a consortium of Federal and State agencies, local jurisdictions, and non-governmental organizations. Information for this report was supplied by several agencies including the Arizona Department of Water Resources, the U.S. Geological Survey, the Agricultural Research Service, the Bureau of Land Management, the Bureau of Reclamation, and other Upper San Pedro Partnership members.

Additional discussion of indicators of sustainability found in previous Section 321 reports was not possible this year due to the lack of federal funds to support publication of the 2011 report. The current, abbreviated report would not have been possible without the financial support of The Nature Conservancy, and without the continued interest, discussions, and technical support of the member organizations of the Upper San Pedro Partnership.

## Conversion Factors

### Inch/Pound to SI

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
Acre	4,047	square meter (m <sup>2</sup> )
Volume		
gallon (gal)	0.003785	cubic meter (m <sup>3</sup> )
acre-foot (acre-ft)	325851	gallon (gal)
acre-foot (acre-ft)	1,233	cubic meter (m <sup>3</sup> )
Flow rate		
acre-foot per year (acre-ft/yr)	1,233	cubic meter per year (m <sup>3</sup> /yr)
cubic foot per second (cfs)	448.812	gallon per minute (gpm)
gallon per minute (gpm)	1.6141	acre foot per year (acre-ft/yr)
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second (m <sup>3</sup> /s)
gallon per day (gal/d)	0.003785	cubic meter per day (m <sup>3</sup> /d)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:  $^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:  $^{\circ}\text{C}=(^{\circ}\text{F}-32)/1.8$

Vertical coordinate information is referenced to the insert datum name (and abbreviation) here for instance, "North American Vertical Datum of 1988 (NAVD 88)."

Horizontal coordinate information is referenced to the insert datum name (and abbreviation) here for instance, "North American Datum of 1983 (NAD 83)."

Altitude, as used in this report, refers to distance above the vertical datum.

# Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona—2011 Report to Congress

This report is submitted to Congress by the Secretary of the Interior, in consultation with the Secretary of Agriculture and Secretary of Defense and in cooperation with the other members of the Upper San Pedro Partnership.

Section 321 of the Defense Authorization Act of 2004, Public Law 108-136, requires each annual 321 report to include the following:

1. The quantity of the overdraft of the regional aquifer reduced during the reporting period;
2. Whether the reduction in (1) met the goal specified for the reporting period;
3. The water-use management and conservation measures undertaken by each water-use controlling member of the Partnership during the reporting period;
4. The extent of the contribution of such measures to the reduction of the overdraft;
5. The legislative accomplishments made during the reporting period in removing legal impediments that hinder the mitigation of water use by Partnership members.

The first four quantitative requirements are addressed in order, below (Quantitative requirements). The fifth reporting requirement (Legislative accomplishments) is addressed after a summary discussion of items one through four.

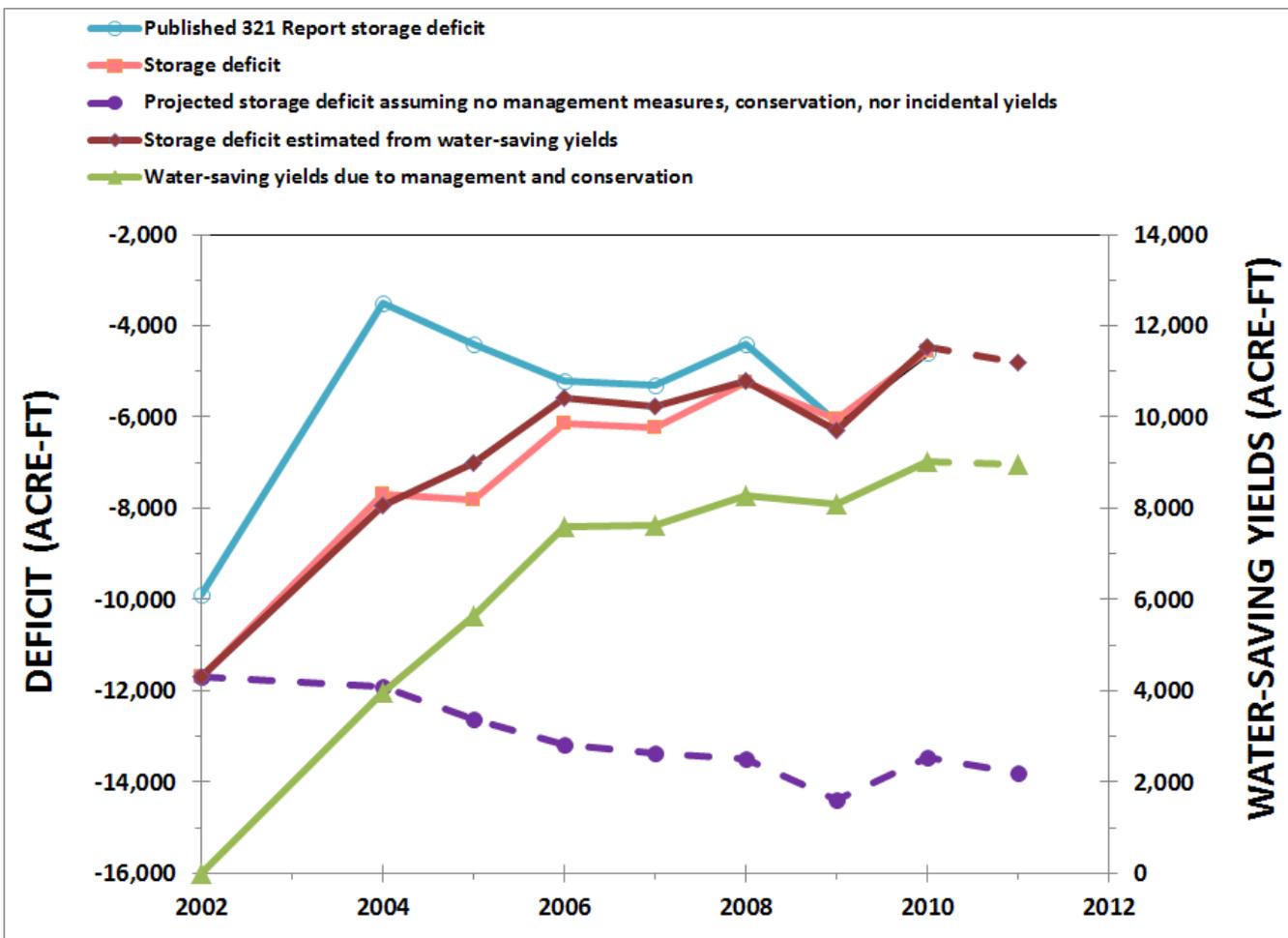
The fiscal year prior to the due date of this report to Congress (fiscal year 2011)—specified in Section 321 as the reporting period—was still underway during the preparation of this report and therefore was not a useable reporting period. As with previous Section 321 reports, the previous calendar year (2010) was used instead.

## Quantitative requirements

### 1. The quantity of the overdraft of the regional aquifer reduced during 2010

The value of the annual Subwatershed deficit (or overdraft) calculated using the water-budget method decreased from 6,100 acre-ft in 2009 to 4,600 acre-ft in 2010. In 2010, therefore, the annual overdraft decreased by 1,500 acre-ft (fig. 1 and table 1). This value includes accounting for all revisions that have been made to base water budget values since the beginning of 321 Reporting (table 2a). All annual aquifer storage deficits can only be compared after a similar accounting; these data are provided in table 2b. The decrease in the 2010 annual overdraft, in part, is a result of updated U.S. Census data that lower the estimated Subwatershed population from 2009 to 2010 by more than 5,000 persons.

Figure 1. Effect of management-measure yields (planned yields and estimates of actual yields) on annual aquifer-storage change (calculated as the difference between projected annual aquifer-storage depletions if no management measures are taken and the water-saving yields attributed to management measures and conservation). In other words, in terms of water-saving yields, the purple line plus the green line equals the maroon line. The actual storage deficit calculated for each year (column 6 in table 2b) is shown for comparison, as are the deficits originally published (column 2 in table 2b). All other deficit values shown for all years include all updates to the base groundwater budget that have occurred since the beginning of 321 reporting



**Table 1. Water recharged to and withdrawn/discharged from the regional aquifer underlying the Sierra Vista Subwatershed in 2010**

[Water-budget volumes are in acre-ft; inflows are assigned positive numbers, outflows are assigned negative numbers; all values are estimates based upon the best available data and computational methods; all totals rounded to nearest 100 acre-ft.]

Component	Estimated volume	Description
Natural aspects of system		
Natural recharge <sup>1</sup>	15,000	Inflow largely from percolating waters on and around mountains and through ephemeral-stream channels
Groundwater inflow <sup>1</sup>	3,000	Subsurface inflow from Mexico
Groundwater outflow <sup>1</sup>	-440	Subsurface outflow at USGS San Pedro River near Tombstone streamflow-gaging station (09471550)
Stream base flow <sup>2</sup>	-4,890	Groundwater discharge to the river that flows out of the Subwatershed
Evaporation and plant transpiration <sup>3</sup>	-10,800	Groundwater consumed in the riparian system exclusive of evapotranspiration supplied by near-riparian recharge from precipitation or flood runoff
Sub-total	1,900	Natural aspects of system
Pumping		
Pumping, water companies and public supply– gross	-9,467	Groundwater extractions by water companies and municipalities (excluding golf courses)
Pumping, rural/exempt well – gross	-4,228	Groundwater extractions by private wells
Pumping, industrial (turf, sand and gravel, stock tanks, golf courses) – gross	-1,143	Groundwater extractions for industrial uses (including golf courses)
Pumping, irrigation – net <sup>4</sup>	-126	Groundwater extractions for agricultural use
Sub-total	-15,000	Pumping
Active management measures		
Reduction of riparian evapotranspiration	645	Management of invasive mesquite
Municipal effluent recharge <sup>5,6</sup>	3,091	
Detention basin recharge <sup>7</sup>	447	
Sub-total	4,200	Active management measures
Passive recharge resulting from human activities		
Incidental recharge <sup>8</sup>	2,049	
Urban-enhanced recharge <sup>9</sup>	2,300	
Sub-total	4,300	Passive recharge due to human activities
Total aquifer storage change <sup>10</sup>	<b>-4,600</b>	Additions or reductions in stored aquifer water

<sup>1</sup> Flow volume estimated by the Arizona Department of Water Resources (2005).

<sup>2</sup> Base flow discharge at USGS San Pedro River near Tombstone streamflow-gaging station (09471550) estimated from entire period of record (Kennedy and Gungle, 2010).

<sup>3</sup> Evapotranspiration value is the average of the high and low estimates of Scott and others (2006).

<sup>4</sup> Pumping for irrigation is consumptive use only. Area considered is the groundwater basin portion of the Sierra Vista Subwatershed only. The area within the boundaries of the Sierra Vista Subwatershed includes more agricultural lands—

primarily located in the head waters of the Babocomari River—than the area within the groundwater basin portion of the Subwatershed.

<sup>5</sup> Municipal effluent recharge is water returned to the aquifer through recharge facilities as reported by the City of Sierra Vista (Mike Hemesath, Director, Department of Public Works, City of Sierra Vista, written commun., March 31, 2011), Fort Huachuca (Tom Runyon, Hydrologist, Fort Huachuca, written commun., April 8, 2011), City of Tombstone (Carla Molina, Tombstone Public Works, oral commun., July 11, 2011), and City of Bisbee (Steve Pauken, City Manager, City of Bisbee, written commun., July 15, 2011). City of Bisbee recharge calculations are for July 1, 2010 to June 30, 2011.

<sup>6</sup> Includes 350 acre-ft of incidental recharge through the constructed wetlands above the recharge ponds at the Sierra Vista Waste Water Reclamation facility (Mike Hemesath, Director, Department of Public Works, City of Sierra Vista, written commun., March 31, 2011).

<sup>7</sup> Recharge of stormwater within basins installed to mitigate flood peaks in urban ephemeral-stream channels.

<sup>8</sup> Incidental recharge is an estimate of water returned to the aquifer from septic tanks and turf watering.

<sup>9</sup> Urbanization in semiarid climates can increase recharge by concentrating rainfall runoff in ephemeral-stream channels (Kennedy, 2007; Lohse and others, 2010). Estimate provided by the Agricultural Research Service. Recharge caused by urbanization only partially mitigates the increased pumping that accompanies increased urbanization.

<sup>10</sup> Subtotals and total are equal to sum of individual terms rounded to nearest 100 acre-ft; sum of subtotals can differ from sum of all individual terms rounded to nearest 100 acre-ft due to rounding error.

**Table 2a.** Revisions to base groundwater budget, Sierra Vista Subwatershed of the Upper San Pedro basin, 2002–10. Negative values indicate an increase in the aquifer storage deficit (overdraft). Calendar year 2003 water-budget data were not analyzed in the 321 Report series.

[Volumes are in acre-ft]

Water budget year	Base groundwater-budget element revised in given year	Volume before revision (original)	Volume after revision (improved)	Resulting change in water-budget balance	Cumulative change in water-budget balance <sup>1</sup>
2002	none			0	0
2003	none	NA	NA	NA	NA
2004	Urban enhanced recharge	0	3,100	3,100	3,100
	[treated effluent incidental recharge] <sup>1</sup>	[0]	[700]	[700]	3,800
2005	Urban enhanced recharge	3,100	2,300	-800	3,000
2006	Exempt well pumping	-5,030	-4,390	640	3,640
	Evapotranspiration	-7,700	-10,800	-3,100	540
2007	none			0	540
2008	[treated effluent incidental recharge] <sup>1</sup>	[700]	[800]	[100]	640
2009	Base flow discharge	-3,250	-4,890	-1,640	-1000
	[treated effluent incidental recharge] <sup>1</sup>	[800]	[0]	[-800]	-1,800
2010	none			0	-1,800

**Table 2b.** Annual aquifer storage deficit (overdraft) for the Sierra Vista Subwatershed. For each year of 321 reporting, the overdraft is presented as published in the annual 321 Reports (column 2), as calculated using only water-budget elements originally used in the 2002 water budget (column 3), and after taking all revisions to base water-budget elements (as of the writing of this report) into account (column 6). The differences in the value of the overdraft as originally published compared to the value calculated using 2002 base budget elements only (column 4), and as compared to the value calculated accounting for all revisions to the base water-budget elements, as found in the 2010 water budget (column 5), are also presented. Note that the water-budget year is not the same as the year of the 321 Report, and that calendar year 2003 water-budget data were not analyzed in the 321 Report series.

[Deficits are in acre-ft]

Water-budget year	Deficits published in 321 Reports	Deficits if no base revisions to 2002 water budget <sup>1</sup>	Published deficits relative to 2002 water-budget components	Published deficits relative to 2010 water-budget components	Corrected deficits using current base budget revisions <sup>1</sup>
2002	-9,900	-9,900	0	1,800	-11,700
2003	NA	NA	NA	NA	NA
2004	-3,500	-5,900	2,400	4,200	-7,700
2005	-4,400	-6,000	1,600	3,400	-7,800
2006	-5,200	-4,340	-860	940	-6,140
2007	-5,300	-4,440	-860	940	-6,240
2008	-4,400	-3,440	-760	1040	-5,240
2009	-6,100	-4,300	-1,800	0	-6,100
2010	-4,600	-2,800	-1,800	0	-4,600

<sup>1</sup>From 2004 to 2008 there was on average 700 acre-ft of leakage per year (800 acre-ft in 2008) from the Sierra Vista Waste Water Reclamation Facility (Mike Hemesath, Director, City of Sierra Vista Department of Public Works, written commun., April 9, 2010; Hemesath, unpub. data, 2010). This is considered recharge and before now has not been included in the published annual 321 Report water budgets. This volume is a management measure that went into effect after 2002, and thus is not considered to be one of the base water-budget revisions; this is indicated by brackets in table 2a. In order to have the most accurate water budget possible, however, this volume is included in the water-budget accounting for years 2004, 2005, 2006, 2007, and 2008. Beginning in 2009, it is estimated that 350 acre-ft of leakage (recharge) now occurs annually at the facility, and this is included in the water budget found in the current report (table 1). The deficit if no base revisions are made to the 2002 water budget (table 2b, column 3) must include this additional 700 acre-ft for years 2004–07 and 800 acre-ft for 2008 to be correct as it is a previously missing management measure from those years, not a permanent base revision to a water-budget element. The corrected deficit using base water-budget element revisions (table 2b, column 6) must also include this additional volume to be correct. The deficits published in the annual 321 reports (table 2b, column 2), however, are just that, what was actually published, and so do not include this correction.

## 2. Whether the reduction in the deficit met the goal specified for the reporting period

The water-budget goal for 2010 presented in table 4 of the 2004 321 Report (Department of the Interior, 2005) was for the Partnership to have erased the annual water-budget deficit and to have accreted 1,300 acre-ft of storage by the end of 2010. Because of the revisions to the water budget noted in (1) and presented in tables 2a and 2b, however, the annual goals have changed since 2004. The revised and current annual water-budget goal anticipates a deficit of -500 acre-ft in 2010. The annual deficit in 2010 was -4,600 acre-ft (table 1), short of the goal by 4,100 acre-ft.

The projected change in the annual deficit from 2009 to 2010 was for an improvement (reduction of the deficit or increase in the surplus) of 600 acre-ft (table 3). As indicated in (1), above, the quantity of the annual overdraft of the regional aquifer was improved (deficit reduced) during 2010 by about 1,500 acre-ft, from an annual deficit of -6,100 acre-ft in 2009 to an annual deficit of -4,600 acre-ft in 2010. Therefore, the “reduction in the deficit” from 2009 to 2010 exceeded the deficit-reduction goal specified for the reporting period by 900 acre-ft.

**Table 3.** Original and revised 2010 water-budget deficit/surplus goals and actual water-budget deficit or surplus. Values include all revisions to base groundwater budget as of 2010. Positive numbers indicate an increase or surplus, negative numbers a decrease or deficit. The annual water budget balance fell short of the revised goal for 2010 by 4,100 acre-ft, although the annual increase in the water budget balance from 2009 to 2010 exceeded the annual improvement goal by 900 acre-ft.

[in acre-ft; all values rounded to nearest 100 acre-ft]

Annual water-budget balance			Annual improvement in water-budget balance	
Original goal for 2010 (from 2004 321 Report)	Revised 2010 goal (due to base water-budget revisions)	Actual 2010 value	Annual improvement goal, 2009–10 (2004 321 Report)	Actual improvement, 2009–10
1,300	-500	-4,600	600	1,500

### 3. Water use management and conservation measures undertaken by each water-use controlling member of the Partnership

The water-use management and conservation measures undertaken by each water-use controlling Partnership member in 2010 are detailed in table 4. The actual yields from the measures undertaken in 2010 (11,500 acre-ft) are about 300 acre-ft more than the 2010 planned yields as projected in last year’s report (11,200 acre-ft). The Partnership has chosen to include urban enhanced recharge as a separately categorized conservation yield in table 4. Because it was included in the base water budget (tables 1 and 2a) as a component of passive recharge from human activities, it must be subtracted from the total yield in table 4 to avoid double counting. Therefore, the actual water savings from conservation yields in 2010 is 9,200 acre-ft rather than 11,500 acre-ft (see fig 1).

**Table 4.** Planned and estimated actual yields for 2010 and planned yields for 2011 of Partnership member measures to reduce aquifer overdraft and of increased recharge from urbanization.

[Yields are in acre-ft; numbers compiled March—July, 2011, based on data provided by respective jurisdictions or in conjunction with USGS; conservation yields in each year are relative to a zero yield in the baseline year of 2002; recharge yields are total values and are relative to a baseline of zero acre-ft; totals rounded to nearest 100 acre-ft]

		2010 Yield	2010 Yield	2011 Yield
Description	Measure type	Planned	Actual	Planned
<b>Fort Huachuca</b>				
Conservation measures <sup>1,2</sup>	Conservation	[800]	[768]	[800]
Effluent recharge <sup>3</sup>	Recharge	200	194	200
Stormwater detention basins <sup>4</sup>	Recharge	50	172	50
<b>Cochise County</b>				
Conservation measures <sup>5</sup>	Conservation	120	120	120
Stormwater detention basins	Recharge	30	30	30
<b>Sierra Vista</b>				
Conservation measures <sup>1,2</sup>	Conservation	1,750	1,750	1,800
Improved golf course efficiency	Conservation	15	15	15
Effluent recharge <sup>6</sup>	Recharge	3,000	2,666	3,000
Stormwater detention basins <sup>7</sup>	Recharge	300	185	300
<b>Bisbee</b>				
Conservation measures	Conservation	50	50	60
Reduced groundwater pumping through effluent reuse	Conservation	485	83	485
Effluent recharge <sup>8</sup>	Recharge	5	351	15
<b>Huachuca City</b>				
Conservation measures <sup>2</sup>	Conservation	50	91	50
<b>Tombstone</b>				
Conservation measures <sup>2</sup>	Conservation	10	10	20
Effluent recharge <sup>9</sup>	Recharge	100	74	100
<b>Bureau of Land Management</b>				
Mesquite reduction <sup>10</sup>	Conservation	640	645	654
<b>Urban enhanced ephemeral-stream channel stormwater recharge</b>				
Increase in stormwater recharge in ephemeral-stream channels caused by urbanization <sup>11</sup>	Recharge	2,300	2,300	2,300
<b>Incidental yields</b>				
Retirement of agricultural pumping <sup>12</sup>	Conservation	2,070	2,070	2,070
<b>Total yields</b>				
Total yield <sup>13</sup>		11,200	11,500	11,300

<sup>1</sup>Fort Huachuca is wholly contained within the boundaries of the City of Sierra Vista, and Fort Huachuca's conservation yields (in brackets) are included in the Sierra Vista yields included in table 3. The Planned and Actual Total Yields found at the bottom of this table do not include the values from the Fort Huachuca Conservation Measures line. Fort Huachuca's yields were double counted in 321 reports before 2009.

<sup>2</sup> Yield relative to 2002 baseline of zero. Conservation efforts started earlier than 2002 that continue to provide yields do not contribute to a reported yield because they are already incorporated in the baseline actual water-use figures. Yield calculated as the difference between pumping reported by the agency for 2010 and the pumping that would have occurred using the 2002 gallons-per-capita-per-day rate for the associated population estimated for 2010 using 2010 U.S. Census data.

<sup>3</sup> Because Fort Huachuca was already recharging 239 acre-ft of effluent in 2002, only the increase in recharge since 2002 is credited here.

<sup>4</sup> Recharge from stormwater detention basins on Fort Huachuca (Tom Runyon, Hydrologist, Fort Huachuca, written commun., April 8, 2011). Report estimates based partially on monitoring data and therefore yield is subject to 2010 rainfall.

<sup>5</sup> Conservation yield attributable to Cochise County could not be calculated owing to the large number of small unmetered wells. The reported yield of 120 acre-ft is attributable to toilet-replacement rebates and assumed savings from code changes. Cochise County undertook various code changes that should have yielded water savings, but that cannot be quantified owing to lack of available metered water-use data including hot water on demand, gray water plumbing, high-efficiency commercial laundry facilities, ban on artificial water features, humidity sensors on outdoor irrigation, turf restrictions, and limits on evaporative coolers.

<sup>6</sup> Mike Hemesath, Director, Department of Public Works, City of Sierra Vista, written commun., March 31, 2011. Recharge values are based on metered inflows to infiltration basins minus estimated evaporative loss.

<sup>7</sup> Recharge of stormwater in 2010 in the City of Sierra Vista's stormwater detention basins. Values based on a Sierra Vista calculation derived from a Partnership sponsored study of runoff and recharge (Stantec Consulting and GeoSystems Analysis Inc., 2006). This technique was developed to provide a consistent method to calculate yields from Fort Huachuca, Sierra Vista, and Cochise County basins.

<sup>8</sup> Steve Pauken, City Manager, City of Bisbee, written commun., July 15, 2011. Recharge from effluent released into Greenbush Draw from July 1, 2010 to June 30, 2011; 95% of total effluent discharged is assumed to recharge the groundwater system.

<sup>9</sup> Carla Molina, Tombstone Public Works, personal commun., July 11, 2011. Recharge from effluent produced by residents of Tombstone that is released into Walnut Gulch; 95% of total effluent discharged is assumed to recharge the groundwater system.

<sup>10</sup> Water-use savings through management of invasive mesquite and tamarisk using various treatments. Mesquite and tamarisk reduction reduces water use by replacing mesquite with more shallowly rooted plants. Yield estimated using an Agricultural Research Service model of riparian transpiration in the San Pedro Riparian National Conservation Area. Water conservation is greatest initially following treatment and decreases over time.

<sup>11</sup> Urbanization in semiarid climates can increase recharge by concentrating rainfall runoff in ephemeral-stream channels (Kennedy, 2007; Lohse and others, 2010). Estimates provided by the Agricultural Research Service; credit not claimed by any particular Partnership member. These preliminary estimates will be refined through ongoing research and monitoring programs. Increased water use due to urbanization likely exceeds increased recharge. All urban-enhanced recharge estimates represent quantities expected in an average year—no current monitoring can provide year-specific values.

<sup>12</sup> Yield did not result from any specific Partnership member actions.

<sup>13</sup> Total yields rounded to nearest 100 acre-ft. Yields based on the best current data and assumptions. Yield values differ in places from prior Section 321 reports owing both to changes in implemented and planned projects and to reanalysis of yields using improved methods.

Note that the water budget shown in table 1 is calculated using combined estimated total pumping with management-measure yields, but excluding explicit conservation measures: the estimated reduction in gross pumping volume due to conservation measures is implicit in any reductions in groundwater pumping included in table 1. Because the estimated effects of conservation measures are often rough estimates, the totals in table 4 have a large margin of error.

#### **4. Extent of contribution of management and conservation measures to the reduction of the overdraft**

Had neither management nor conservation measures been employed, the deficit projected for 2010 would have been about 13,500 acre-ft (this takes into account all revisions to the water budget as well as an adjustment for the difference between the projected and actual population). The storage deficit calculated for 2010 accounting for management and conservation measures is about 4,500 acre-ft. The contribution of management and conservation measures to the reduction of the overdraft in 2010, therefore, equaled about 9,000 acre-ft (fig. 1). The deficit calculated for 2010 using the water-budget method and including all revisions to the base groundwater budget is about 4,600 acre-ft (table 1).

#### **Summary and conclusions of the quantitative requirements of the 2011 321 reporting**

Section 321 of the Defense Authorization Act of 2004, Public Law 108-136, requires each annual 321 report to address five requests, four of which are quantitative and have been discussed above. Item 5, Legislative accomplishments and impediments, is discussed further below. Responses to the four quantitative requirements of the Act follow:

1. The quantity of the annual overdraft of the regional aquifer was reduced 1,500 acre-ft during the reporting period, 2010, compared to the previous reporting period, 2009;
2. The reduction in (1) met the goal specified for the reporting period;
3. The water-use management and conservation measures undertaken by each water-use controlling member of the Partnership during the reporting period are shown in table 4 by jurisdiction;
4. The extent of the contribution of such measures to the reduction of the overdraft was 9,000 acre-ft.

This year, the State of Arizona population estimates which this report uses to estimate Subwatershed population are based on the U.S. Census data for 2010. These data are considered more accurate than the State of Arizona estimates used in recent 321 Reports. The Subwatershed population estimate for 2010 is 77,273 compared to 82,460, the population estimate for 2009 based on Arizona Department of Commerce (2010) estimates. This is a reduction in Subwatershed population estimation of more than 5,000 persons from 2009 to 2010, and a reduction of more than 9,100 persons from the projected 2010 population from the initial 321 Report in 2004. Because three of the water-budget items are calculated directly from population values (rural/exempt well pumping, sand and gravel pumping, and incidental recharge), the reduction in estimated population has resulted in a net effect of about a 550 acre-ft reduction in the water-budget balance from 2009 to 2010. Though this reduction in the annual deficit from 2009 to 2010 is not attributable to the work of the Partnership, the 2010 annual deficit nevertheless better reflects the Partnership efforts over the course of 321 reporting.

On the other hand, there were a number of temporary improvements to the water budget in 2010 that are unlikely to continue into 2011. Over half of the 263 acre-ft improvement in irrigation pumping from

2009 to 2010 is due to the temporary cessation of irrigation for a single field near Hereford (irrigation there is once again under way in 2011). The 580 acre-ft decrease in water-purveyor and public-supply pumping, the over 200 acre-ft increase in detention basin recharge, and the remaining reduction in irrigation pumping from 2009 to 2010 were due, in part, to the unusually dry summer of 2009 followed by the wetter-than-average summer of 2010. It is anticipated that a portion of this more than 1,000 acre-ft of combined improvements to the annual water-budget balance will not be reflected in the 2011 balance.

Groundwater depletion in the Sierra Vista Subwatershed continues albeit at a rate slower than in 2002. Although the annual overdraft of the aquifer has been greatly reduced from the 13,500 acre-ft originally anticipated for 2010 (fig. 1; utilizes 2010 census data) to 4,600 acre-ft today, groundwater continues to be removed from storage. Since 2002 (the beginning of 321 monitoring), about 65,200 acre-ft has been removed from storage in addition to the hundreds of thousands of acre-ft that previously were removed from storage since groundwater pumping commenced in the first half of the 20<sup>th</sup> century (D.R. Pool, unpub. data, 2011). Until the aquifer begins to accrete storage (the annual water budget balance becomes greater than 0) there will be no reduction in the cumulative deficit, and until additional management measures are undertaken, it is unlikely that there will be further progress made toward this goal.

## Legislative accomplishments

Consistent with the requirements of Section 321, the initial report included a list of potential legal barriers to the implementation of certain management measures. Section 321(d)(2)(C) further requires that annual reports include a discussion of what progress has been made in addressing these legal impediments. To meet this reporting requirement, the following list restates the legal impediments discussed in the initial Section 321 report and includes the current status of proposals to address these barriers. Recognizing that changes in applicable legal standards have broad-based policy effects that are beyond the scope of this report, this discussion of legal impediments carries no explicit or implicit recommendation or endorsement for any legislative action by any Partnership member or Federal, State, local, or other entity.

**Water-Management Measures and Legal Impediments** had originally been identified in three major categories: *Conservation Measures*, *Recharge/Reuse Measures*, and *Augmentation/Importation Measures*. Within each major category, specific issues have been determined to be important to meeting the stated goal of sustainability. Individual member entities have worked on those issues under their jurisdiction during the past seven years. Additionally, the Partnership has tracked legislation as it has been introduced in the Arizona Legislature along with any final action or inaction taken. Last year, the Partnership added an additional major category: *Statutory/Adjudication Issues*. This new category lists items of concern that, if resolved, could result in a dramatic change in the Partnership's ability to reach sustainability while at the same time recognizing their political challenges.

### General Report on Major Actions:

#### Augmentation/Recharge:

In 2009 Congress passed Public Law 111-11 that authorized the Bureau of Reclamation to conduct a feasibility study of water augmentation alternatives in the Sierra Vista Subwatershed. The goal of the study is to develop an augmentation alternative that is politically, legally and financially feasible. The first year of the study was initiated on several key activities, including a water-budget analysis, economic analysis, recharge evaluation, and evaluation of the preferred alternative. Congress appropriated \$289,000 for FY10 covering 45% of the first year's costs. A Memorandum of Understanding between Reclamation, BLM, Fort Huachuca, State of Arizona, City of Sierra Vista and The Nature Conservancy for the matching 55% has been executed. No Congressional funding was authorized for FY11 and funding for FY12 is still being worked on. Due to poor economic conditions, local cost sharing is questionable for future years; therefore, budget constraints will affect the work and the schedule.

#### Non-Federal Funding Opportunities:

Member agencies of the USPP began development of a series of conceptual proposals for possible funding by a major private foundation, during 2009. Groundwater modeling to assess the effectiveness of recharge locations has been funded but outside of the USPP. No further progress toward this outside funding was achieved in 2010.

## **Upper San Pedro Water District Election:**

After failing to be adopted during the 2010 election, this proposal is under discussion for possible inclusion on the 2012 ballot. At this time, it is not clear if it will be put on the ballot.

## **Legislative Actions:**

The passage and signing of HB2661 established a Water Resources Development Commission to project water needs in each county for the next 25, 50 and 100 years. The purposes of the commission are to identify the following: 1) available sources of water; 2) potential sources to meet future needs and evaluation of environmental considerations of using those sources; 3) legal and technical issues associated with developing future supplies and recommendations for dealing with legal issues; 4) methods to finance the acquisition of future supplies; and 5) recommendations regarding the need for further studies and evaluations. The Director of ADWR has appointed the Commission consisting of no more than 15 members, one of whom is a member of the USPP. A report must be submitted to the Legislature and Governor by October 1, 2011.

## **Budget cuts and their impact on the mission of the Arizona Department of Water Resources:**

During previous legislative sessions, ADWR's budget was significantly reduced. The end result is a decrease in manpower and funding. These cuts have had a negative impact on the efforts of the USPP, including loss of funding for projects. The number of people who previously supported water-resource planning and development efforts in rural Arizona has been reduced by three people. The former manager of the rural water-planning effort has been reassigned to hydrology and has been given the responsibility to support water-resource planning and development efforts in northern Arizona, which includes eight watershed partnerships and three Indian Water Rights Settlement negotiations. The responsibility of supporting the USPP and two other watershed partnerships in southern Arizona has been assigned to an individual with the responsibility for also completing the Water Atlas.

The passage of SB 1359 was intended to help offset the cuts in funding and minimize the need for further reductions in staff, by protecting and making available for use by ADWR revenue derived from various fees charged by ADWR. The revenue collected from the various fees is to be deposited in a newly established Water Resources Fund to carry out any statutory purpose. The revenue may not be appropriated or transferred by the Legislature to fund the general obligations of the state. These fees were anticipated to provide approximately \$2 million in annual funding to ADWR. In January 2011, the agency projected a shortfall of about \$500,000 in the original projection of \$2 million. ADWR was able to obtain the additional \$500,000 through a grant, which prevented further layoffs from occurring.

## **Report on Actions Taken on Specific Impediments:**

### **Conservation Measures:**

#### ***Code Changes:***

- Limited authority exists for local (city, county) action with respect to modifying human behavior subsequent to final building inspection or for actions not related to development (i.e., water-wasting ordinances).

- Although there have been no additional authorities requested or granted to local governments, many of the municipalities and Cochise County continue to work with developers in the voluntary mitigation of water use in new residential and commercial subdivisions.
- Current state law does not provide any effective mechanisms for local/regional water management authority, or local ability to create funding mechanisms outside of Active Management Areas (AMAs).
  - During the 2007 legislative session, a bill was passed and signed by the governor authorizing the establishment of the Upper San Pedro Water District subject to the approval of the voters of the Sierra Vista Subwatershed. At the November 2, 2010 general election, voters were asked to approve the formation of the district and elect seven members from within the subwatershed boundaries. If formation of the district had been approved, the issue of funding would have still remained to be resolved. Subwatershed voters, however, rejected the ballot measure with 11,596 in favor and 12,213 opposed to the district formation. It can still be included on the ballot again in 2012, but at this time it is not clear if this will occur.
- Under current state law regarding ADWR determination of “water inadequacy” (ADWR’s “water adequacy certificate”), only availability for human uses, not ecological uses, are considered.
  - No legislative change addressing this issue was requested or passed during the 2011 session.
- No Arizona agency has the authority to restrict new wells or require the metering of existing or new wells outside of designated active management areas and irrigation non-expansion areas, regardless of the groundwater availability in the area.
  - No legislative change addressing this issue was requested or passed during the 2011 session.

***Zoning:***

- Current law limits counties from applying subdivision standards (with respect to water-resource management) to lot splits of five or fewer (ARS 11-806/11-809).
  - No legislative change addressing this issue was requested or passed during the 2011 session.

***Easements:***

- Current state law regarding the establishment of “irrigation non-expansion areas (INAs)” applies to entire basins or sub basins and cannot be applied to a subwatershed such as the Sierra Vista Subwatershed (ARS 45-432).

- No legislative change addressing this issue was requested or passed during the 2011 session.
- Current tax policy provides incentives for water-consuming uses but not for water-conservation uses on undeveloped lands (ARS 42-15004).
  - No legislative change addressing this issue was requested or passed during the 2011 session.

***Technology Incentives:***

- Currently, there are no matching funds from state sources for conservation projects outside of the riparian zone to help address water-management issues.
  - Although no state funds became available during FY11 due to budget deficits, USPP has continued working with a private foundation on a series of potential projects and studies that would help address this impediment.

**Recharge/Reuse Measures:**

***Effluent Recharge/Reuse:***

- Currently, there are no matching funds from state sources for conservation projects outside of the riparian zone to help address water-management issues. Additionally, sufficient funding is not available for communities to meet EPA/ADEQ's high water-quality standards for effluent to be recharged through shallow basins.
  - Although no state funds became available during FY11 due to budget deficits, the USPP Technical Committee has been working to identify suitable recharge locations.

***Stormwater Recharge:***

- Currently Arizona limits the disposition and (or) use options for State trust lands. Such options could help permit construction of optimally located recharge facilities.
  - Although no state funds became available during FY11 due to budget deficits, the USPP Technical Committee has been working to identify suitable recharge locations. The Arizona State Land Department will cooperate with the effort under its statutory guidelines.

**Augmentation/Importation Measures:**

- Currently Arizona limits the disposition and (or) use options for State trust lands. Such options could help permit construction of optimally located recharge facilities.
  - Although no state funds became available during FY11 due to budget deficits, the USPP Technical Committee has been working to identify suitable recharge locations. The Arizona State Land Department will cooperate with the effort under its statutory guidelines.
- Current state law generally prohibits interbasin transfer of groundwater, and intrabasin transfer of groundwater between subbasins may be subject to the payment of ‘damages.’
  - Each year the legislature passes a one-year session law that allows for interbasin transfers under emergency drought conditions.

### **Statutory/Adjudication Issues:**

- The Arizona Corporation Commission (ACC), Arizona’s public utilities commission, is limited in its ability to consider area-wide conservation pricing for the private and individually owned water providers who serve a major portion of the area’s population.
- Under Arizona law, appropriable surface water, including the subflow of a river or stream, and groundwater are regulated separately when, hydrologically, there is no line that separates the two water sources.
- The outcome of the Gila River Adjudication, which has been ongoing for over 30 years, may render some projects unfeasible. Arizona’s definitions regarding surface water, groundwater, and the potential connections between them are subject to the judicial proceedings in the Gila River Adjudication.
- At the present time, Native American Central Arizona Project (CAP) entitlements cannot be leased for exportation and used outside of the Central Arizona Water Conservation District service area except by exchange. Any change to this would require modification of existing Indian water contracts as well as state law and the CAP Master Repayment Contract. However, it does not require a change in the settlement legislation. In addition, Tucson CAP subcontractors have a first right of refusal to any Tucson area Indian water being leased for more than 25 years.

See Appendix D from the 2010 report for details of legal impediments and legislative accomplishments from the 2009 and earlier 321 Reports.

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# Appendix A – Precipitation in the Sierra Vista Subwatershed

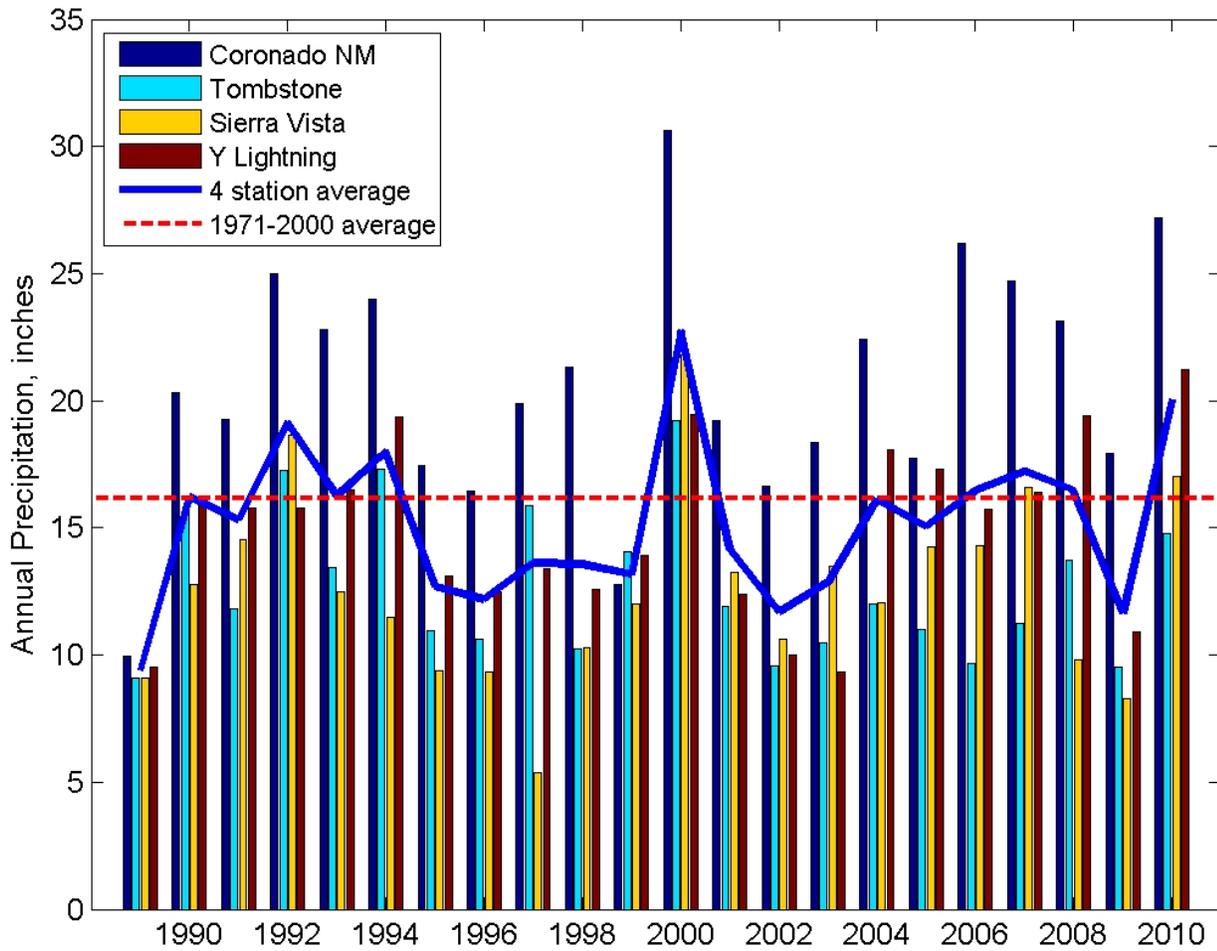


Figure A1. Four-station precipitation average, thirty-year mean, and individual precipitation station values for the Sierra Vista subwatershed of the Upper San Pedro Basin, 1990–2010.

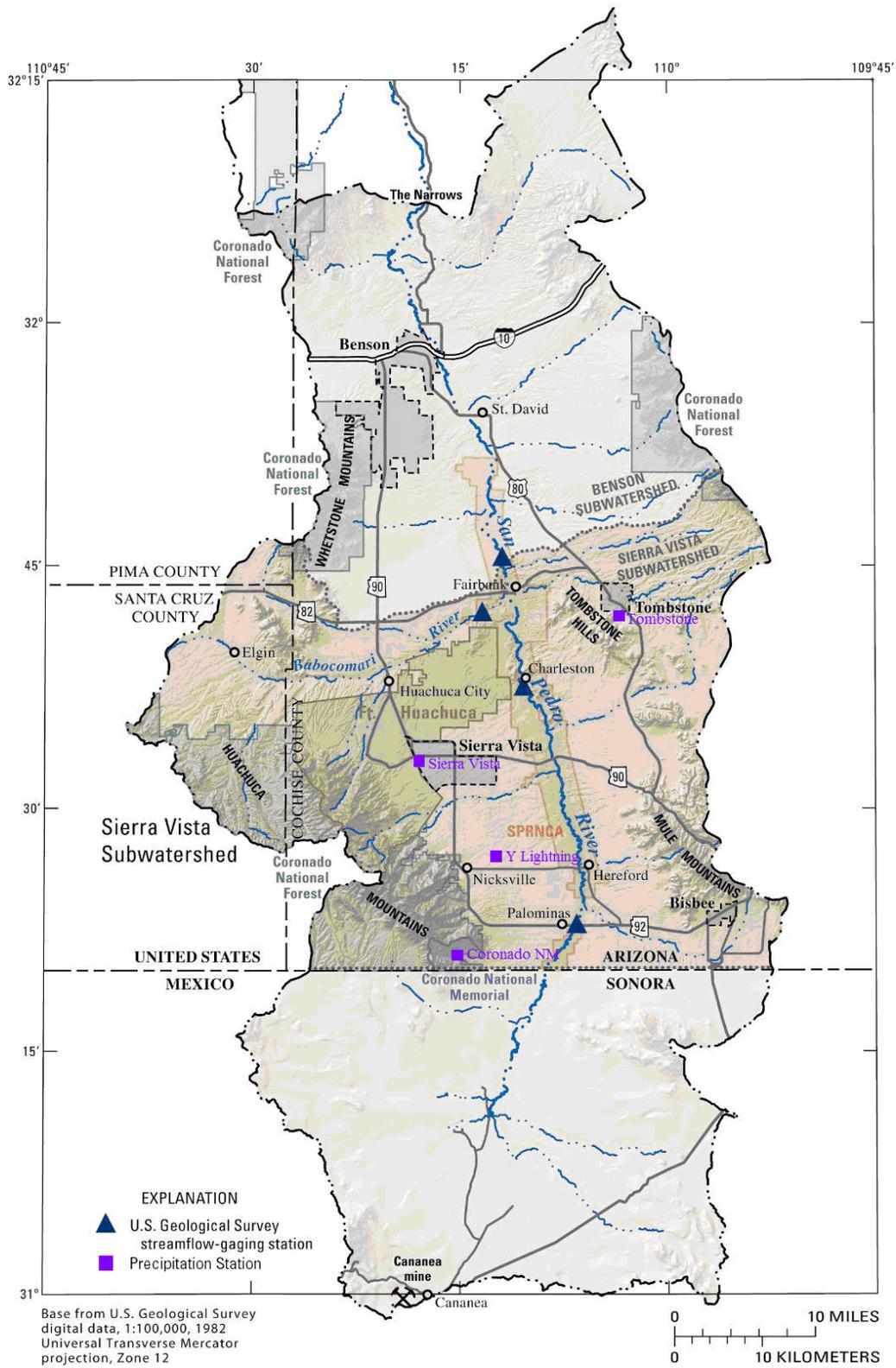


Figure A2. Location map for four precipitation stations referenced in fig. E1

## Precipitation Totals 2010

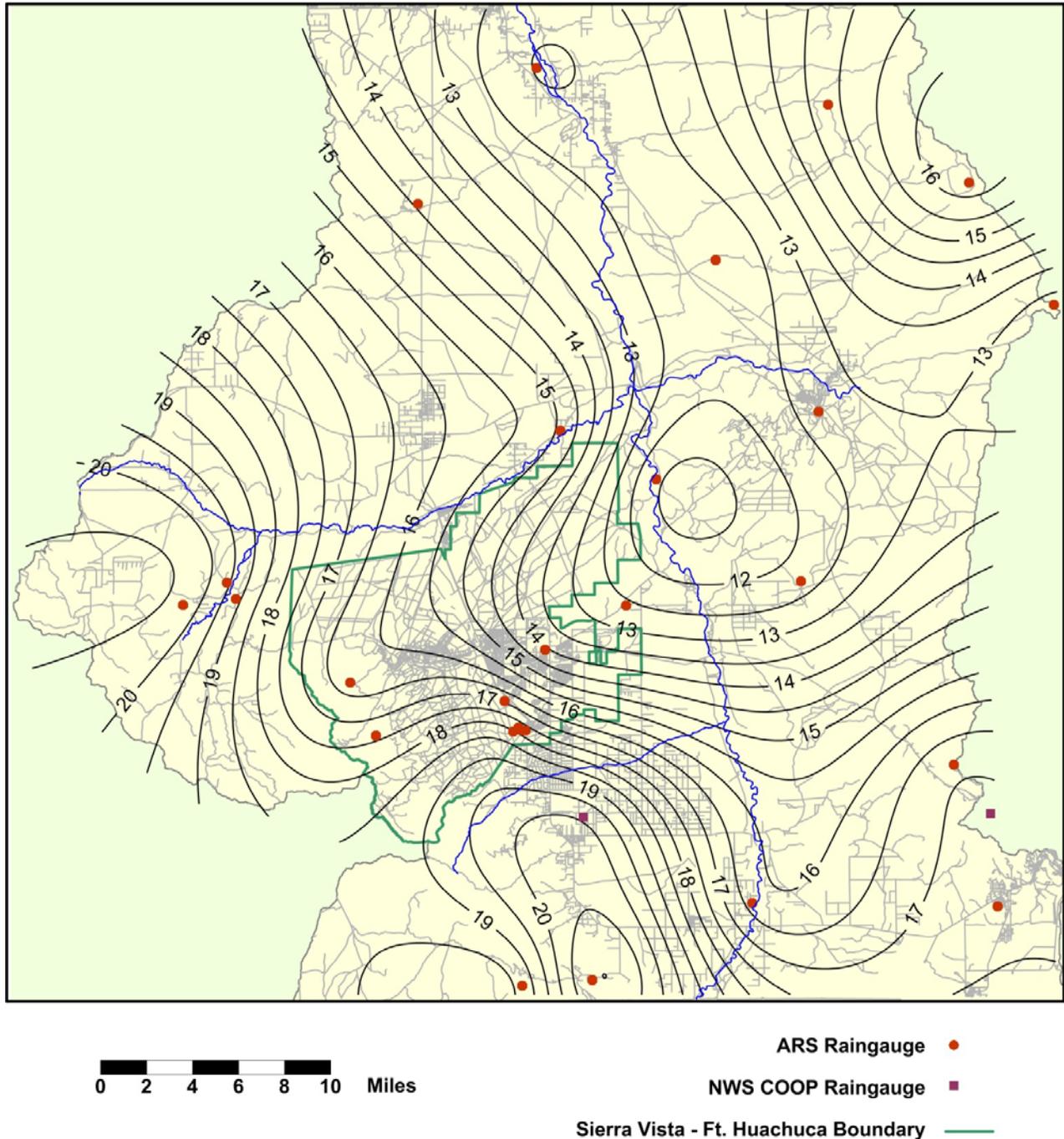


Figure A3. Subwatershed precipitation contour map, based on Agricultural Research Service (ARS) and National Weather Service cooperative raingauge network data. The interpolated basin floor precipitation calculated for the Subwatershed in 2010 based on these data was 15.64 inches (see 2009 and 2010 321 Reports for previous years' averages). Based on the 4-station average shown in figure A1, estimated precipitation for the Subwatershed in 2010 was higher, 20.04 inches. This is because of the greater weighting of the near-mountain Coronado National Memorial precipitation station in the 4-station average.

# Appendix B – Public Law 108-136 (Section 321)

## SEC. 321. COOPERATIVE WATER USE MANAGEMENT RELATED TO FORT HUACHUCA, ARIZONA, AND SIERRA VISTA SUBWATERSHED.

### (a) LIMITATION ON FEDERAL RESPONSIBILITY FOR CIVILIAN WATER CONSUMPTION IMPACTS.—

(1) LIMITATION.—For purposes of section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1536), concerning any present and future Federal agency action at Fort Huachuca, Arizona, water consumption by State, local, and private entities off of the installation that is not a direct or indirect effect of the agency action or an effect of other activities that are interrelated or interdependent with that agency action, shall not be considered in determining whether such agency action is likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

(2) VOLUNTARY REGIONAL CONSERVATION EFFORTS.—Nothing in this subsection shall prohibit Federal agencies operating at Fort Huachuca from voluntarily undertaking efforts to mitigate water consumption.

(3) DEFINITION OF WATER CONSUMPTION.—In this subsection, the term “water consumption” means all water use off of the installation from any source.

(4) EFFECTIVE DATE.—This subsection applies only to Federal agency actions regarding which the Federal agency involved determines that consultation, or reinitiation of consultation, under section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1536) is required with regard to an agency action at Fort Huachuca on or after the date of the enactment of this Act.

(b) RECOGNITION OF UPPER SAN PEDRO PARTNERSHIP.—Congress hereby recognizes the Upper San Pedro Partnership, Arizona, a partnership of Fort Huachuca, Arizona, other Federal, State, and local governmental and nongovernmental entities, and its efforts to establish a collaborative water use management program in the Sierra Vista Subwatershed, Arizona, to achieve the sustainable yield of the regional aquifer, so as to protect the Upper San Pedro River, Arizona, and the San Pedro Riparian National Conservation Area, Arizona.

### (c) REPORT ON WATER USE MANAGEMENT AND CONSERVATION OF REGIONAL AQUIFER.—

(1) IN GENERAL.—The Secretary of [the] Interior shall prepare, in consultation with the Secretary of Agriculture and the Secretary of Defense and in cooperation with the other members of the Partnership, a report on the water use management and conservation measures that have been implemented and are needed to restore and maintain the sustainable yield of the regional aquifer by and after September 30, 2011. The Secretary of the Interior shall submit the report to Congress not later than December 31, 2004.

(2) PURPOSE.—The purpose of the report is to set forth measurable annual goals for the reduction of the overdrafts of the groundwater of the regional aquifer, to identify specific water use management and conservation measures to facilitate the achievement of such goals, and to identify impediments in current Federal, State, and local laws that hinder efforts on the part of the Partnership to mitigate water usage in order to restore and maintain the sustainable yield of the regional aquifer by and after September 30, 2011.

(3) REPORT ELEMENTS.—The report shall use data from existing and ongoing studies and include the following elements:

(A) The net quantity of water withdrawn from and recharged to the regional aquifer in the one-year period preceding the date of the submission of the report.

(B) The quantity of the overdraft of the regional aquifer to be reduced by the end of each of fiscal years 2005 through 2011 to achieve sustainable yield.

(C) With respect to the reduction of overdraft for each fiscal year as specified under subparagraph (B), an allocation of responsibility for the achievement of such reduction among the water-use controlling members of the Partnership who have the authority to implement measures to achieve such reduction.

(D) The water use management and conservation measures to be undertaken by each water-use controlling member of the Partnership to contribute to the reduction of the overdraft for each fiscal year as specified under subparagraph (B), and to meet the responsibility of each such member for each such reduction as allocated under subparagraph (C), including—

- (i) a description of each measure;
- (ii) the cost of each measure;
- (iii) a schedule for the implementation of each measure;
- (iv) a projection by fiscal year of the amount of the contribution of each measure to the reduction of the overdraft; and
- (v) a list of existing laws that impede full implementation of any measure.

(E) The monitoring and verification activities to be undertaken by the Partnership to measure the reduction of the overdraft for each fiscal year and the contribution of each member of the Partnership to the reduction of the overdraft.

(d) ANNUAL REPORT ON PROGRESS TOWARD SUSTAINABLE YIELD.—

(1) IN GENERAL.—Not later than October 31, 2005, and each October 31 thereafter through 2011, the Secretary of the Interior shall submit, on behalf of the Partnership, to Congress a report on the progress of the Partnership during the preceding fiscal year toward achieving and maintaining the sustainable yield of the regional aquifer by and after September 30, 2011.

(2) REPORT ELEMENTS.—Each report shall include the following:

(A) The quantity of the overdraft of the regional aquifer reduced during the reporting period, and whether such reduction met the goal specified for such fiscal year under subsection (c)(3)(B).

(B) The water use management and conservation measures undertaken by each water-use controlling member of the Partnership in the fiscal year covered by such report, including the extent of the contribution of such measures to the reduction of the overdraft for such fiscal year.

(C) The legislative accomplishments made during the fiscal year covered by such report in removing legal impediments that hinder the mitigation of water use by members of the Partnership.

(e) VERIFICATION INFORMATION.—Information used to verify overdraft reductions of the regional aquifer shall include at a minimum the following:

(1) The annual report of the Arizona Corporation Commission on annual groundwater pumpage of the private water companies in the Sierra Vista Subwatershed.

(2) The San Pedro base flow monitoring record of the Charleston flow gauge of the United States Geological Survey.

(3) Current surveys of the groundwater levels in area wells as reported by the Arizona Department of Water Resources and by Federal agencies.

(f) SENSE OF CONGRESS.—It is the sense of Congress that any future appropriations to the Partnership should take into account whether the Partnership has met its annual goals for overdraft reduction.

(g) DEFINITIONS.—In this section:

(1) The term “Partnership” means the Upper San Pedro Partnership, Arizona.

(2) The term “regional aquifer” means the Sierra Vista Subwatershed regional aquifer, Arizona.

(3) The term “water-use controlling member” has the meaning given that term by the Partnership.

# Appendix C – Agency Representation in the Upper San Pedro Partnership

## Local Agencies

Bisbee  
Cochise County  
Huachuca City  
Sierra Vista  
Tombstone

## Arizona State Agencies

Arizona Natural Resource Conservation Districts State Association  
Department of Water Resources  
Department of Environmental Quality  
State Land Department

## Federal Agencies

Bureau of Land Management  
Bureau of Reclamation Fort Huachuca  
National Park Service  
USDA Agricultural Research Service  
U.S. Fish and Wildlife Service  
U.S. Forest Service  
U.S. Geological Survey

## Non-Governmental Agencies

ABCDW LLC  
Audubon Arizona  
Hereford Natural Resources Conservation District  
The Nature Conservancy