APPENDIX G:
FORT HUACHUCA RELATED POPULATION ADJUSTED FOR DOUBLE COUNTING

		survey	# of people	Correction	Correction	Intermediate	Corrected	comments
		page #/para		Factor	Amount	Value	Value	
Military On Post (OP) Permanent Party	`		1772				1772	Sep 05 Pop Report
Students On Post			2252				2252	Sep 05 Pop Report
Family Members (FM) OP							2887	Sep 05 Pop Report
Military off post			1683				1683	Sep 05 Pop Report
FM off post							2624	Sep 05 Pop Report
Government Civilians (GC)			2901		1021		1880	Govt civilians minus military family members (MFM) and 2 worker homes
	2 worker homes	12/7.2.2		18.80%	545	2356		minus worker's family members in the heading below
	Mil FM OP	13/7.2.4		10.50%	303	2053		minus number counted as military family members
	Mil FM off post	14/7.2.4		6.60%	173	1880		minus number counted as military family members
GC Family Members		16/14	1880	1.61		3027	3027	calculates family members not already accounted for
		16/14						
Contractors*			4798			1861	2937	Contractors on and off post, minus MFM already counted and 2 worker homes
	2 worker homes	12/7.2.2		21.20%	1017			reduce number of households
	Mil FM on post	13/7.2.4		12.70%	609	4189		reduce contractor and household number for MFM
	Second Jobs	12/7.2.1		4.90%	235	3954		reduce for second job on post, likely to be a contractor
					1861			total households already counted above this line
Contractors FM				1.61	2937		4729	calculates family members not already accounted for
2 worker household adjustment		16/14		0.61	1562		953	adds 0.61 household members for 2 worker homes
Military Retirees			3687			3189	498	
	GC employees	13/7.2.3		18.80%	693			reduces for employees already counted above
	Contractors	13/7.2.3		40.70%	1501			reduces for employees already counted above

	GC household	13/7.2.3		14.00%	516			reduces for family members already counted above
	Contractor HH	13/7.2.3		13.00%	479			reduces for family members already counted above
Retiree family members				1			498	assumes 1 family member for each retiree
Survivors	296			1.50			444	assumes 0.5 family members per survivor
Total personnel							26184	
Less 3% living outside SV subwatershed							786	
Net in SV subwatershed							**25398**	

APPENDIX H:
LIST OF FORT HUACHUCA WATER CONSERVATION AND RECHARGE PROJECTS

Appendix H - List of Fort Huachuca Water Conservation and Recharge Projects

	2005 (baseline)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Actual	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan
Water Conservation											
Water Conservation Business Grants[1]			3	4	5	5	5	5	5	5	5
Front Load Washers[2]											
AAFES Laundry (25 washers)				0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Evap. Cooler Replacement[3]											
MCA Demolition of Evap Cooled Bldgs											2.51
Waterless urinals [4]		11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Waterwise Audits[5]		0.5	0.5	1	1.5	2	2.5	2.5	2.5	2.5	2.5
Athletic Field Artificial Turf[6]											
Bujalski				10.23	10.23	10.23	10.23	10.23	10.23	10.23	10.23
Geronimo								6.88	6.88	6.88	6.88
Williams									3.95	3.95	3.95
Foster										3.86	3.86
CDC Complex (4 fields)											11.24
Warrior Field (results in closure of Brock, Pauly, and Smiley Fields)					18.61	18.61	18.61	18.61	18.61	18.61	18.61
MFH Water Savings[7]		0.0	0	22.43	22.43	22.43	22.43	22.43	22.43	22.43	22.43
2006 MFH Toilet Replacement[8]			0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
Loss Reduction											
Chilled Water System Leak Repair				3.36	3.36	3.36	3.36	3.36	3.36	3.36	3.36
Replace Production Well Booster Pump Packing Glands				12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Total Water Conservation		**12.0**	**15.7**	**66.5**	**86.6**	**87.1**	**87.6**	**94.5**	**98.4**	**102.3**	**116.0**
Groundwater Pumping (acre-ft)	1403	1391.0	1387.3	1336.5	1316.4	1315.9	1315.4	1308.6	1304.6	1300.7	1287.0
Enhanced SW Recharge[9]											
East Range SW Basin (FH4)		105	105	105	105	105	105	105	105	105	105
Graveyard Gulch (FH8)		13	13	13	13	13	13	13	13	13	13
FH-7, Soldier Creek				184	184	184	184	184	184	184	184
Hatfield Basin, Phase I (FH2)		0	0	18	18	18	18	18	18	18	18
Hatfield Basin, Phase II (FH2a)					23	23	23	23	23	23	23
Hatfield Basin, Phase III (FH2b)						12	12	12	12	12	12
FH-5 and FH-6, Soldier Creek				229	229	229	229	229	229	229	229

Appendix H - List of Fort Huachuca Water Conservation and Recharge Projects

	2005 (baseline)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Actual	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan	BA Plan
Phase IV East Range (FH9)									13	13	13
Phase V East Range (FH10)								42	42	42	42
Total SW Recharge		**118**	**118**	**549**	**572**	**584**	**584**	**626**	**639**	**639**	**639**
Rooftop/runoff capture											
EPG Warehouse			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Barnes Field House (BFH)				1	1	1	1	1	1	1	1
Hospital					0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Rooftop Capture			**0.6**	**1.6**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
EFFLUENT BALANCE INFORMATION											
Effluent Available[10]											
Sewer Return Flows (58% of pumping)		807	805	775	764	763	763	759	757	754	746
Divert fire hydrant testing water to sewer			25	25	25	25	25	25	25	25	25
Divert reservoir flushing to sewer			7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25
Total Effluent		806.8	836.9	807.4	795.8	795.5	795.2	791.2	788.9	786.7	778.7
Effluent Reuse[11]											
Golf Course		245	245	245	245	245	245	245	245	245	245
Chaffee		44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8	44.8
Total Reuse		289.8	289.8	289.8	289.8	289.8	289.8	289.8	289.8	289.8	289.8
Effluent Recharge[12]											
East Range Basins	426	517	547	518	506	506	505	501	499	497	489
Huachuca City Effluent						200	200	200	200	200	200
Total Effluent Recharge	426	504.3	533.7	505.0	493.6	688.4	688.2	684.3	682.0	679.8	672.1
NET ON-POST GROUNDWATER DEMAND		**756**	**722**	**268**	**236**	**24**	**24**	**-21**	**-35**	**-37**	**-43**

NOTES:

1. Water savings are estimated based on initial grant applications submitted in 2006. Savings from this program are conservatively expected to accrue by 1 acre-feet/year.
2. AAFES contract laundry facility currently uses top-loading washers. When the current contract expires in 2008, AAFES will require front-loading washers.
3. Evaporative cooler demand was estimated using a spreadsheet developed by Bruce Johnson, P.E. that utilizes monthly atmospheric data. Assumptions in estimating cooler water demand included cooler operation for 8 hours per day, 5 times per week, and 120 days per year for a total of 4800 hours per year with an average cooler bleed rate of 0.1 gallons per hour.
4. Yields assume that all flush urinals will be replaced by 2006. Estimates based on average 40,000 gal/year/urinal. savings as reported by urinal manufacturer. 94 urinals planned for replacement in 2006.
5. Waterwise audits were initiated in January 2004. Estimated future savings were based on water audits conducted through June 2005.
6. Turf water demand based on UA Cooperative Extension "Cochise County Lawn Watering Guide".
7. Savings are based on a projected build-out of 1425 housing units in 2009. Savings will occur through use of low water use fixtures, a/c units, and turf reduction.
8. Pressure assist toilets will be installed in 65 homes in Pershing Plaza West I and 30 homes in Signal Village 3 for a total of 170 toilets. It is assumed savings will be 0.5 gallons per flush X 5 flushes per person/day. Based on historic data, occupancy is expected to be 3.11 persons/household or 264 residents so savings will be 240,00 gallons/year or 0.74 acre-feet/year.
9. Stormwater recharge projection data from Table 4-23 of *Cochise County Flood Control/Urban Runoff Recharge Plan, April 2006*
10. Sewer return flows predicted to be 58% of groundwater pumped.
11. Effluent demand based on UA Cooperative Extension "Cochise County Lawn Watering Guide" asssuming 17.2 acres of warm season turf.
12. Effluent recharge at Fort Huachuca reduced by 2.5% to account for evaporative losses. Huachuca City effluent not increased for projected population growth.

APPENDIX I:
ECONOMIC IMPACT FORECAST REPORT – 2006 AND ECONOMIC AND DEMOGRAPHIC ANALYSIS BY THE CENTER FOR ECONOMIC RESEARCH

EIFS REPORT

PROJECT NAME

Fort Huachuca Run 1

STUDY AREA

04003 Cochise, AZ

FORECAST INPUT

Change In Local Expenditures	$372,000,000
Change In Civilian Employment	2901
Average Income of Affected Civilian	$65,323
Percent Expected to Relocate	100
Change In Military Employment	5680
Average Income of Affected Military	$28,352
Percent of Militart Living On-post	69

FORECAST OUTPUT

Employment Multiplier	2.29	
Income Multiplier	2.29	
Sales Volume - Direct	$416,994,500	
Sales Volume - Induced	$537,922,900	
Sales Volume - Total	$954,917,400	49.16%
Income - Direct	$396,726,800	
Income - Induced)	$118,557,200	
Income - Total(place of work)	$515,283,900	26.44%
Employment - Direct	11062	
Employment - Induced	3201	
Employment - Total	14264	30.09%
Local Population	21367	
Local Off-base Population	11608	18.59%

RTV SUMMARY

	Sales Volume	Income	Employment	Population
Positive RTV	10.85 %	10.3 %	4.86 %	3.84 %
Negative RTV	-9.58 %	-7.1 %	-4.4 %	-1.13 %

Economic and Demographic Analysis in Support of the U.S. Fish and Wildlife Service Biological Opinion Regarding the Impact of Fort Huachuca

December 2006

Prepared by:

Robert Carreira
Director, Center for Economic Research
Cochise College
901 N. Colombo Avenue
Sierra Vista, Arizona 85635-2317

About the Cochise College Center for Economic Research

The Center for Economic Research (CER), founded in 1995, is an auxiliary department of Cochise College dedicated to analyzing and interpreting economic data for Cochise County and

providing economic information and forecasts to assist leaders in making informed decisions on business and public policy issues. The CER produces four economic review and forecast publications annually: *Sierra Vista Economic Focus*, *Douglas Perspective*, *Benson Prospectus*, and *Bisbee Outlook*. These publications are released each year in conjunction with economic focus luncheons held in those cities.

Throughout the year, the CER analyzes and interprets economic data for Cochise County and provides economic information and forecasts to assist leaders in making informed decisions on business and public policy issues. The CER responds to a wide range of data requests from citizens and business and community leaders throughout Cochise County and across the state and region. The CER also prepares weekly press releases providing insight into economic issues affecting Cochise County. The CER's quarterly newsletter, *The Indicator*, provides updates on the local economy and CER activities. The CER's website (www.cochise.edu/cer) provides updated economic news, information, analysis, and forecasts.

The CER is a State Data Center affiliate and a member of the Association for University Business and Economic Research.

Economic and Demographic Analysis in Support of the U.S. Fish and Wildlife Service Biological Opinion Regarding the Impact of Fort Huachuca

This report provides the results of economic and demographic analysis conducted by the Cochise College Center for Economic Research (CER). This analysis was conducted in support of the U.S. Fish and Wildlife Service (FWS) biological opinion regarding the impact of Fort Huachuca on the groundwater deficit in the Sierra Vista sub-watershed and the flow rate of the San Pedro River. This study also provides population projections for the years 2006 through 2016 for Cochise County and the Sierra Vista sub-watershed (Appendix A).

The Groundwater Deficit and Recent Residential and Commercial Development

The CER examined the relationship between the groundwater deficit in the Sierra Vista sub-watershed and recent residential and commercial development in the area. According to the Center for Biological Diversity (CBD) and the Maricopa Audubon Society (MAS), "the [annual] groundwater deficit has increased from 5,144 acre-feet estimate in the 2002 Biological Opinion to more recent estimates of between 8,400 acre-feet and 12,050 acre-feet" in 2005 (Civil No. 05-261-TUC-CKJ). Since an acre-foot is equal to 325,851 gallons, this means the annual deficit increased between 1.06 and 2.25 billion gallons between 2002 and 2005. According to the U.S. Geological Survey (USGS) (2004), per capita water use in Cochise County for all sources of water use other than irrigation and mining (i.e., public supply, domestic self supply, industrial, and thermoelectric power, combined) averaged 160 gallons per person, per day. Thus, such an increase in the groundwater deficit, if it were solely the result of residential and commercial development, would necessitate an increase in the population of the Sierra Vista sub-watershed between 18,167 and 38,533 people between 2002 and 2005.

According to estimates by the U.S. Census Bureau (2005), the population of all of Cochise County increased by only 6,098 people between 2002 and 2005. According to CER estimates, which are based on U.S. Census Bureau data, the population of the Sierra Vista sub-watershed increased by only 3,709 people (see Appendix B for methodology). A population increase nearly five times this large would have been necessary to increase the deficit to the *minimum* of the range suggested by the most recent estimates, if the deficit were caused exclusively by residential and commercial development.

According to the Arizona Department of Economic Security (DES), which has historically overestimated the population of Cochise County, the countywide population increased by 7,845 people between 2002 and 2005 (DES, 2006a). According to CER estimates based on the DES population estimates for all of Cochise County, the population of the Sierra Vista sub-watershed increased by only 4,752 people during this period. A population increase nearly four times this large would have been necessary to increase the groundwater deficit to the minimum of the range suggested by the most recent estimates.

It is important to note that approximately 27.9 percent of the land area of the Sierra Vista sub-watershed is located south of the U.S.-Mexico border in Sonora, Mexico. Agriculture is a primary economic activity in Sonora (Consejo para la Promoción Económica de Sonora, 2005). The state of Sonora is home to "63,000 rural producers, in over 710,000 hectares of land proper for cultivation, from which 93% are irrigated." The Mexican side of the sub-watershed also includes the Mexican city of Cananea, with a population of 32,074, as of 2000, according to the Instituto Nacional de Estadística Geografía e Informática (INEGI) (as cited in Sprouse, 2005, p. 13).

Census Bureau and DES Population Estimates

There is a significant discrepancy between Census Bureau and DES population estimates for Cochise County. While DES bases its annual population estimates on the population reported by the Census Bureau in the most recent decennial census (2000), the intercensal estimates produced by the Census Bureau and DES differ.

For 2005, DES (2006a) estimated the population of Cochise County at 131,790. However, according to U.S. Census Bureau (2005) estimates, Cochise County's population in 2005 was only 126,106. According to DES, the county's population between 2000 and 2005 grew by 14,035 (11.9 percent); according to the U.S. Census Bureau, it grew by only 8,351 (7.1 percent).

It is the opinion of the CER that the Census Bureau estimates have an accuracy advantage over the DES estimates. DES (n.d.) prepares its estimates using a composite methodology, which estimates the populations of specific age groups based on such data as birth records, school enrollments, driver's licenses issued, Medicare enrollment, and other factors. DES also uses a housing unit methodology, which considers changes in the housing stock. Something missing from the DES estimates, however, but included in the Census Bureau estimates, is migration patterns. This is important, especially since Cochise County is home to Fort Huachuca. Since military personnel experience frequent moves, there is a high degree of both in- and out-migration, which might undermine the DES methods.

Regarding the housing unit methodology used by DES (n.d.), this method fails to account for changes in the overstock of homes (i.e., homes that are unoccupied). In recent years, as home prices have increased, many homes for sale have remained on the market longer than in previous years. Moreover, in recent years, closings on new homes in Cochise County have failed to keep pace with new home permits issued (Bright Future Business Consulting, 2006). For example, in 2004, closings on new homes were equal to 63 percent of the total number of permits issued in that year; in 2005, this fell to only 55 percent; and in the first 5 months of 2006, it further dropped to only 32 percent. Much of this has been the result of speculative construction and investment home buying, which result in a larger number of unoccupied homes.

These changes in the housing market may impact the DES housing unit methodology. To evaluate DES population estimates, the CER compared the Census 2000 data to the DES estimates for that year (which were released prior to the census data) (as cited in CER, 2000). DES had estimated Cochise County's 2000 population at 126,300. When the census data were

released, it was revealed the county's population was only 117,755. Thus, DES had overestimated the county's population by 7.3 percent in 2000, which was the cumulative result of 10 years of population estimates. The current DES (2006) estimate of Cochise County's population for the year 2005 (5 years following the most recent census data) is 4.5 percent above the U.S. Census Bureau (2005) estimates.

According to the Census Bureau (2006a), there were 48,571 households in Cochise County in 2005. This was up from 43,893 in 2000, for an increase of 4,678 households, or 10.7 percent. But there were only 31,739 *family households* in 2005, up from 30,786 in 2000. This is an increase of only 953 family households, or 3.1 percent. The average household size in 2005 was 2.48, down from 2.55 in 2000. The average family size was 3.11, up from 3.07. Perhaps most significant is that the number of *non-family households* in Cochise County increased from 13,107 in 2000 to 16,832 in 2005, a jump of 28.4 percent. These changes in household characteristics, specifically the declining household size and the increase in non-family households, might explain some of the variation between the DES (2006a) and Census Bureau (2005) population estimates. In its housing unit methodology, DES assumes the household size to be the same as it was in 2000. This would lead to an overestimation of the population, if the household size had declined, as indicated by the Census Bureau.

Based on the historic inaccuracy of DES population estimates, which have overestimated the population of Cochise County, it is recommended that the Census Bureau's estimates be used. Population estimates and projections, using both DES and Census Bureau data, are contained in Appendix A of this report.

The Relationship between Fort Huachuca and Population Growth in Sierra Vista

To better understand the relationship between Fort Huachuca and population growth in Sierra Vista, it is instructive to view Sierra Vista's population growth in relation to that throughout the State of Arizona. According to DES (2006a), between 2000 and 2005 Sierra Vista's population grew at a rate significantly below the statewide average. From 2000 to 2005, Arizona's population grew by 17.8 percent, while Sierra Vista's population grew by only 15.7 percent. Between 2000 and 2005, Sierra Vista was ranked as the 35th fastest-growing incorporated place of 88 places statewide. Here, DES estimates are used to allow for comparisons of sub-county areas in Arizona; such comparisons are not possible using Census Bureau data, which provide intercensal estimates only for areas with populations of 65,000 and above.

A comparison of population growth rates of Arizona cities similar in size to Sierra Vista as of Census 2000 (37,775 ± 15 percent) (as cited in DES, 2006a) reveals that, of the four other Arizona cities of similar size (Avondale, Lake Havasu City, Prescott, and Bullhead City), all but one (Bullhead City) grew at a faster rate than Sierra Vista (see Table 1). This indicates population growth in Sierra Vista is not a unique phenomenon associated with the presence of Fort Huachuca, but rather a reflection of a statewide trend in population growth. According to the U.S. Census Bureau (2006b), Arizona was the second-fastest growing state in the nation from 2004 to 2005, behind only Nevada.

Table 1: Comparison of Population Growth Rates of Arizona Incorporated Places of Similar Size, 2000-2005

	2005 Population	*2000 Population*	*Population Growth (%)*
Avondale	66,110	35,883	84.2%
Lake Havasu City	53,435	41,938	27.4%
Prescott	40,770	33,938	20.1%
Sierra Vista	43,690	37,775	15.7%
Bullhead City	38,210	33,769	13.2%

Source: U.S. Census Bureau, Arizona Department of Economic Security, and Cochise College Center for Economic Research

Fort Huachuca's Responsibility for Population Growth

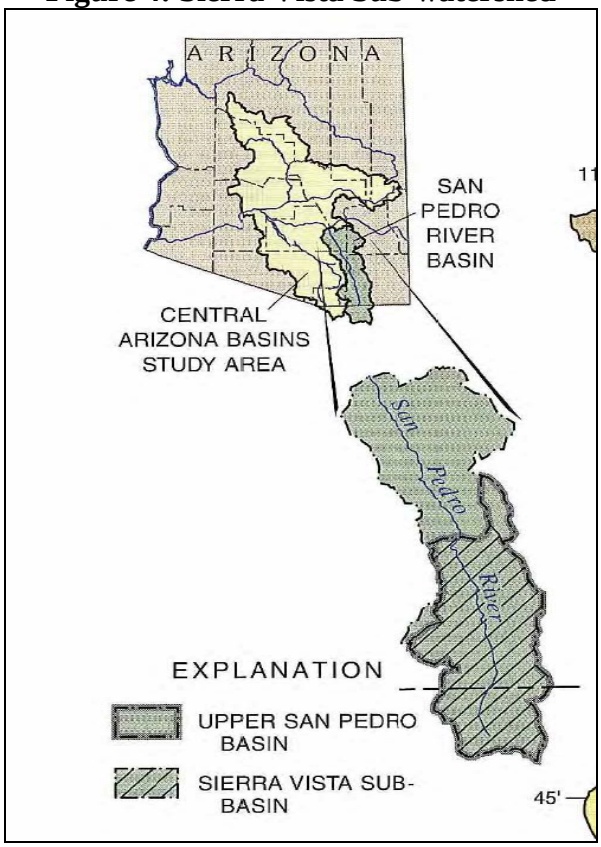
The CER evaluated the conclusion of the 2002 biological opinion that Fort Huachuca was responsible for 54 percent of the population of the Sierra Vista sub-watershed, or 34,993 residents. It is the opinion of the CER that this conclusion is inaccurate. One reason, as discussed above, is that a significant portion of the Sierra Vista sub-watershed lies south of the U.S.-Mexico border; approximately 27.9 percent of the land area of the sub-watershed is located in Mexico (see Figure 4). This includes the Mexican city of Cananea, with a population of 32,074, as of 2000, according to INEGI (as cited in Sprouse, 2005, p. 13).

Of the approximately 72.1 percent of the land area of the Sierra Vista sub-watershed located on the U.S. side, the population as of Census 2000 was approximately 70,036 (see Table 2). This is based on inclusion of the entire population of zip codes 85603, 85613, 85615, 85616, 85635, 85638, and 85650. This includes the areas of Bisbee, Bisbee Junction, Copper Queen, Lowell, South Bisbee, Sunset Acres, Tintown, Warren, Winwood, Fort Huachuca, Sierra Vista, Hereford, Miracle Valley, Nicksville, Palominas, Parker Lake, Huachuca City, Whetstone, Fry, Tombstone, and other surrounding unincorporated areas. The population of all of Cochise County in 2000 was 117,755 according to the U.S. Census Bureau (2000). Thus, the percentage of the countywide population residing in the Sierra Vista sub-watershed in 2000 was approximately 59.48. This was little changed from 1990, when 59.27 percent of the total county population (57,859 of 97,624 people) resided in the same area.

To estimate the population of the U.S. side of the Sierra Vista sub-watershed for 2005, the CER applied Holt's method of exponential data smoothing to track the trend in the proportion of the countywide population residing in the sub-watershed from 1990 to 2000, and to project that trend into the future. The CER then applied the estimated proportion of the county population for 2005 residing in the sub-watershed to the population estimates for Cochise County for 2005, as prepared by the U.S. Census Bureau (2006a). Based on this methodology (for a detailed

discussion, see Appendix B), the estimated population of the U.S. side of the Sierra Vista sub-watershed as of 2005 was 75,140 (or 59.585 percent of the total countywide population). For Fort Huachuca to be responsible for 54 percent of the population of the U.S. side of Sierra Vista sub-watershed, the fort would need to be responsible for a population of 40,576. It is the CER's estimate that, in 2005, Fort Huachuca was responsible for a population of 18,543 (see Appendix C for methodology). This accounts for 24.7 percent of the estimated population of the Sierra Sub-watershed, less than half the previous estimate of 54 percent.

Figure 4: Sierra Vista Sub-watershed



Source: Arizona Department of Environmental Quality

Table 2: Sierra Vista Sub-watershed (U.S. Side), Population as of Census 2000

Zip Code	*Area*	*Population*
85603	Bisbee, Bisbee Junction, Copper Queen, Lowell, South Bisbee, Sunset Acres, Tintown, Warren, Winwood	8,583
85613	Fort Huachuca, Sierra Vista	8,339
85615	Hereford, Miracle Valley, Nicksville, Palominas, Parker Lake	6,537
85616	Huachuca City, Whetstone	4,949
85635	Fry, Sierra Vista	28,936
85638	Tombstone	2,020
85650	Sierra Vista	10,672
TOTAL		70,036

Source: U.S. Census Bureau, 2000

With specific regard to the previous estimate of 54 percent of the population attributable to Fort Huachuca, a review of the FWS 2002 biological opinion indicates this estimate was produced using economic multipliers to tie induced employment to increased population. While the use of multipliers is appropriate for calculating the economic impact of spending by military bases, its application to estimate population growth is tenuous at best. Increased jobs do not necessarily translate into increased population. Rather, the first effect of an increase in jobs is to lower the unemployment rate. For example, in Sierra Vista in 2000, the unemployment rate was 4.1 percent (U.S. Census Bureau, 2000). The unemployment rate in Douglas, Arizona – the second largest city in Cochise County, located approximately 50 miles southeast of Sierra Vista – was 10.7 percent. Although Douglas' unemployment rate reached double-digits in 2000, the population of that city continued to grow (U.S. Census Bureau, 2000; DES, 2006a). If it is presumed that Sierra Vista could sustain a rate of unemployment equal to that of Douglas in 2000, while still experiencing population growth, and applying this rate to the 2005 civilian labor force of 17,548 in Sierra Vista as estimated by DES (2006d), this translates into 1,772 unemployed people. According to DES estimates, there were only 516 unemployed people in Sierra Vista in 2005. The difference, which is equal to 1,256 people, should be subtracted from any increased population estimated to result from economic activity at the fort, since the first effect of increased economic activity is to lower unemployment, not to increase population. According to DES estimates, Sierra Vista had the lowest unemployment rate in Cochise County in 2005, lending further support to this conclusion.

An example of the inappropriateness of using economic multipliers to estimate population growth was recently demonstrated by the CBD (2005). In a press release, the CBD asserted that, between August 2002 and June 2005, "Fort Huachuca and DoD have added and/or committed locally at least 2,851 new people and....[u]sing multipliers, this equates to 11,917 new people." But according to Census Bureau estimates, the population of all of Cochise County increased by only 6,098 people from 2002 to 2005. According to CER estimates, the population of the Sierra Vista sub-watershed increased by only 3,709 residents; thus, using economic multipliers to estimate population growth, the CBD assigned responsibility to Fort Huachuca for a number of new residents in the Sierra Vista sub-watershed that is more than three times the entire number of new residents in the sub-watershed, and nearly twice that of the entire population increase in all of Cochise County.

Another problem in attempting to use economic multipliers to project population growth is the issue of multiple counting. While spending by Fort Huachuca, both by the installation itself and by individuals receiving wages and salaries from the fort, increases the number of jobs in the local area; many of these jobs are created on Fort Huachuca or are taken by family members of active duty military personnel. These had already been counted in the fort's noonday population, plus the number of family members residing off-post, plus the number of off-post contractors, all of which had already been counted in the 2002 biological opinion, prior to considering induced employment.

To illustrate, as of Census 2000 the population of Fort Huachuca (zip code 85613) was 8,339. Of these, 3,773 were active duty military members. Thus, there were 4,566 Fort Huachuca residents not on active duty (i.e. military family members). Of these, 1,333 were in the civilian labor force. Thus, 29.2 percent of family members of active duty military personnel stationed at Fort Huachuca and residing on-post were in the civilian labor force in 2000. Applying this figure to the 5,511 total family members of military personnel stationed at Fort Huachuca in 2005 (Fort Huachuca, 2006), residing both on- and off-post, provides an estimate of 1,609 military family members who are either employed or actively seeking work. This number must also be subtracted from any estimates of increased population tied to employment projections produced using economic multipliers.

The number of personnel employed on Fort Huachuca must also be considered. In 2005, according to data published by Fort Huachuca (2006), there were 4,517 non-DoD civilians employed on Fort Huachuca. This category was already accounted for in the biological opinion before calculating induced jobs. Induced jobs are a reflection of the economic activity generated by Fort Huachuca spending (both by the installation and individuals employed by the fort). But a share of this spending occurs on-post, through purchases by military personnel at post facilities, such as the AAFES Post Exchange, Commissary, Movie Theater, bowling alley, and other concessionaires and facilities. Additionally, some of the spending by the installation generates jobs on-post. These 4,517 jobs must also be subtracted from any estimates of population increases produced using economic multipliers, since they are already counted in the numbers provided by Fort Huachuca.
The 2002 biological opinion cites 7,093 induced employees and their families, attributable to the fort's activities. However, it is the opinion of the CER that the number of induced jobs must be reduced by 7,382 (based on 2005 data) to control for the number of jobs created on Fort

Huachuca, reduced unemployment, and jobs taken by family members of active duty military personnel, since all of these have already been counted in the fort's noonday population (plus family members living off-post, plus contractor jobs off-post). Thus, reducing the estimate for double counting provides an adjustment to the number of induced jobs (based on 2005 data) that is actually larger than the number of induced jobs projected (based on 2002 data). The simple explanation for this, aside from the different reference periods, is that spending by military installations and the personnel they employ creates jobs, but those jobs are then taken by family members of military personnel, and also reduce unemployment in the area. Most input-output models that use economic multipliers do not take into account these factors; thus, their use to estimate population growth is inappropriate.

Another problem associated with using economic multipliers to estimate population growth is that the smallest region to which the multipliers can be accurately applied is the non-metropolitan county level (U.S. Department of Commerce, 1997). Data constraints preclude the application of multipliers to estimate factors, such as jobs created, to non-metropolitan cities or other non-metropolitan, sub-county areas; thus their application in this case cannot be narrowed to the Sierra Vista sub-watershed. The specific region for which economic impacts in the Sierra Vista-Douglas Micropolitan Area apply is Cochise County. Thus, it would be inappropriate and inaccurate to attempt to narrow multipliers for Cochise County to the more specific area of the Sierra Vista sub-watershed. A basic principle of the application of economic multipliers is that, as the study region narrows, the multiplier decreases. One way to attempt to account for the narrower study region would be to reduce the estimate of induced jobs in Cochise County to reflect the proportion of jobs countywide located within the Sierra Vista sub-watershed. In 2000, the proportion of countywide jobs in the Sierra Vista sub-watershed was 63.7 percent (see Table 3).

Yet another threat to the validity of using economic multipliers in an attempt to estimate population growth is that this approach fails to take into account increased in-commuting and decreased out-commuting. It also presumes a 100-percent relocation rate (i.e., that all employees relocated to the area for these jobs, and would relocate from the area if not for the fort), which results in overestimation. A study conducted by Science Applications International Corporation (SAIC) (1999) indicated only 57.2 percent of DoD and defense contractor personnel employed on Fort Huachuca relocated to the area for the specific purpose of obtaining employment at the fort.

With respect to the previous estimate that the fort was responsible for 54 percent of the population of the Sierra Vista sub-watershed, there is also the issue of retired military personnel. The 2002 biological opinion included retirees in reaching the conclusion that the fort is responsible for 54 percent of the population (FWS, 2002). However, the mere presence of military retirees in the area does not mean Fort Huachuca is responsible for their presence. For example, a 2002 study conducted in Arizona by the McGuire Company (as cited in Lahr, 2004, p. 16) estimated that only 25 percent of military retirees in the state would move if the military bases in Arizona closed. This suggests that Fort Huachuca is responsible for the presence of no more than 25 percent of the retired military population, and a significant number of these are likely to be connected to the fort in other ways, such as being family members of active-duty military personnel or DoD or non-DoD civilian employees. As of 1999, approximately 18.8

percent of Fort Huachuca's DoD employees, and 40.7 percent of the contractors employed by the fort were military retirees.

Table 3: Proportion of Cochise County Employment in the Sierra Vista Sub-watershed, 2000

Area	*Number of Jobs*	*Share of Countywide Total*
Cochise County	42,626	100%
Sierra Vista Sub-watershed	27,166	63.7%
85603	3,326	7.8%
85613	1,220	2.9%
85615	2,959	6.9%
85616	1,856	4.4%
85635	12,646	29.7%
85638	827	1.9%
85650	4,332	10.2%

Source: U.S. Census Bureau, 2000

In summary, it is the opinion of the CER that the use of economic multipliers in an attempt to forecast population growth is inappropriate. Accounting for threats to the validity of this approach, which was used in the 2002 biological opinion, mitigates estimates of increased population. This indicates the increased population resulting from the economic activity of Fort Huachuca, beyond the military, government, and non-governmental employees and their family members already accounted for, is negligible. The CER offers an alternative approach to estimating the share of the population of the U.S. side of the Sierra Vista sub-watershed (see Appendix C).

References

Arizona Department of Economic Security. (n.d.). *2005 Estimates methodology*. Retrieved October 30, 2006, from http://www.workforce.az.gov

Arizona Department of Economic Security. (2006a). *July 1, 2005 population estimates for Arizona, counties and incorporated places ranked by percent change: 2000- 2005*. Retrieved August 18, 2006, from http://www.workforce.az.gov

Arizona Department of Economic Security. (2006b**).** *2005 Occupational Wage & Employment Estimates***.** Retrieved August 18, 2006, from http://www.workforce.az.gov

Arizona Department of Economic Security. (2006c**).** *Cochise County population projections 2006-2055***.** Retrieved September 30, 2006, from http://www.workforce.az.gov

Arizona Department of Economic Security. (2006d). *2001-2006 Nonfarm jobs data.* Retrieved September 30, 2006, from http://www.workforce.az.gov

Bright Future Business Consulting (2006). *Cochise County Scorecard*. Tucson: Author.

Center for Biological Diversity. (2005). *Fort Huachuca violations of San Pedro compact challenged*.

Center for Economic Research. (2000). *Sierra Vista Economic Focu*s. Sierra Vista, AZ: Cochise College.

Civil No. 05-261-TUC-CKJ. (2005). *Center for Biological Diversity and Maricopa Audubon Society v. United States Department of Housing and Urban Development, et al.*

Consejo para la Promoción Económica de Sonora (2005). *Sonora exports: Sonora main economic activities*. Retrieved August 18, 2006, from http://www.sonora.org.mx

Fort Huachuca. (2006). *Annual economic impact statement: October 1, 2004-September 30, 2005*.

Lahr, M. (2004) *Report on Research Submitted to Governor James E. McGreevey on the Economic Contribution of Military and Coast Guard Installations to the State of New Jersey*. Retrieved September 17, 2006 from http://policy.rutgers.edu/

Science Applications International Corporation. (1999). *1999 Fort Huachuca Demographic Survey*. Phoenix: Author.

Sprouse, T. W. (2005). *Water issues on the Arizona – Mexico border: The Santa Cruz, San Pedro and Colorado Rivers*. Retrieved September 30, 2006, from http://cals.arizona.edu

StaTools Professional Edition (Version 1.1.0) [Computer software]. (2005). Newfield, NY: Palisade Corporation.

U.S. Census Bureau. (2000). *Census 2000*. Retrieved August 17, 2006, from www.census.gov

U.S. Census Bureau. (2005). *Population Estimates*. Retrieved August 17, 2006, from www.census.gov

U.S. Census Bureau. (2006a). *American Community Survey*. Retrieved September 25, 2006, from www.census.gov

U.S. Census Bureau. (2006b). *Nevada Edges Out Arizona as the Fastest-Growing State*. Retrieved August 18, 2006 from http://www.census.gov

U.S. Fish and Wildlife Service. (2002). *Ft. Huachuca Reinitiation (02-21-02-F-229 and 02-21-98-F-266)* [Biological Opinion]

U.S. Geological Survey. (2004). *Estimated use of water in the United States in 2000*. Retrieved August 17, 2006 from http://water.usgs.gov/watuse

Yuma Proving Ground. (n.d.). *FY 2003 Economic Impact*. Retrieved August 18, 2006, from http://www.yuma.army.mil

Appendix A: Population Estimates and Projections

Table A-1 shows population estimates for Cochise County for 2005, prepared by the U.S. Census Bureau (2005), and projections for 2006 through 2016, prepared by the Cochise College Center for Economic Research (CER). To prepare population projections for Cochise County, the CER applied Holt's method of exponential data smoothing (see Appendix B) to the Census Bureau's population estimates for 2000 through 2005. To prepare population estimates and projections for the Sierra Vista sub-watershed, the CER applied Holt's method of exponential data smoothing (see Appendix B) to track the trend in the proportion of the countywide population residing in the sub-watershed from 1990 to 2000 and to project this trend into the future. The CER then applied the projected changes in the proportion of the population residing in the sub-watershed to the projected population of Cochise County to produce estimates and projections for 2005 through 2016.

Table A-1: Population Projections for Cochise County and the Sierra Vista Sub-watershed

Year	*Cochise County*	*% in Sierra Vista Sub-watershed*	*Sierra Vista Sub-watershed*
2005	126,106	59.585%	75,140
2006	128,348	59.606%	76,503
2007	130,590	59.627%	77,867
2008	132,832	59.648%	79,232
2009	135,074	59.669%	80,597
2010	137,316	59.690%	81,964
2011	139,558	59.711%	83,331
2012	141,800	59.732%	84,700
2013	144,042	59.753%	86,069
2014	146,284	59.774%	87,440
2015	148,526	59.795%	88,811
2016	150,768	59.816%	90,183

Source: Estimates for Cochise County for 2005 produced by the U.S. Census Bureau; Sierra Vista sub-watershed estimate for 2005, and Cochise County and Sierra Vista sub-watershed projections for 2006-2016 by the Cochise College CER

Table A-2 shows population estimates for Cochise County for 2005, and projections for 2006 through 2016, prepared by the Arizona Department of Economic Security (DES) (2006c). The Sierra Vista sub-watershed projections are prepared by the CER applying Holt's method of exponential data smoothing (see Appendix B) to track the trend in the proportion of the countywide population residing in the sub-watershed from 1990 to 2000 and to project this trend into the future. The CER then applied the projected changes in the proportion of the population residing in the sub-watershed to the projected population of Cochise County prepared by DES to produce estimates and projections for 2005 through 2016.

Table A-2: DES Population Projections for Cochise County and CER Projections for the Sierra Vista Sub-basin

Year	*Cochise County*	*% in Sierra Vista Sub-basin*	*Sierra Vista Sub-basin*
2005	131,790	59.585%	78,527
2006	134,789	59.606%	80,342
2007	137,708	59.627%	82,111
2008	140,560	59.648%	83,841
2009	143,346	59.669%	85,533
2010	146,037	59.690%	87,169
2011	148,672	59.711%	88,774
2012	151,258	59.732%	90,349
2013	153,784	59.753%	91,891
2014	156,247	59.774%	93,395
2015	158,650	59.795%	94,865
2016	160,996	59.816%	96,301

Source: Cochise County estimates and projections provided by Arizona DES; Sierra Vista sub-watershed estimates and projections by the Cochise College CER

Appendix B: Forecasting Methodology

Exponential data smoothing is a statistical method that smoothes the random ups and downs inherent in time series data to identify underlying patterns in the historical data series. Forecasts are then produced taking weighted averages of the observations, placing more weight on recent observations. Holt's method of exponential data smoothing employs two smoothing constants, one to track level and the other to track trend. A smoothing constant is a number between 0 and 1 that determines of weight placed on recent versus previous observations to control the amount of smoothing. The constant used to estimate level is labeled α (Alpha) and the constant used to estimate trend is labeled β (Beta). Holt's method, rather than simple exponential data smoothing, is used for data series that have an upward or downward trend. This is because simple exponential data smoothing, which estimates only level, will produce forecasts that tend to lag behind the trend, if such a trend is present. StatTools 1.1.0 (2005) software was used to perform this analysis; StatTools output is shown below.

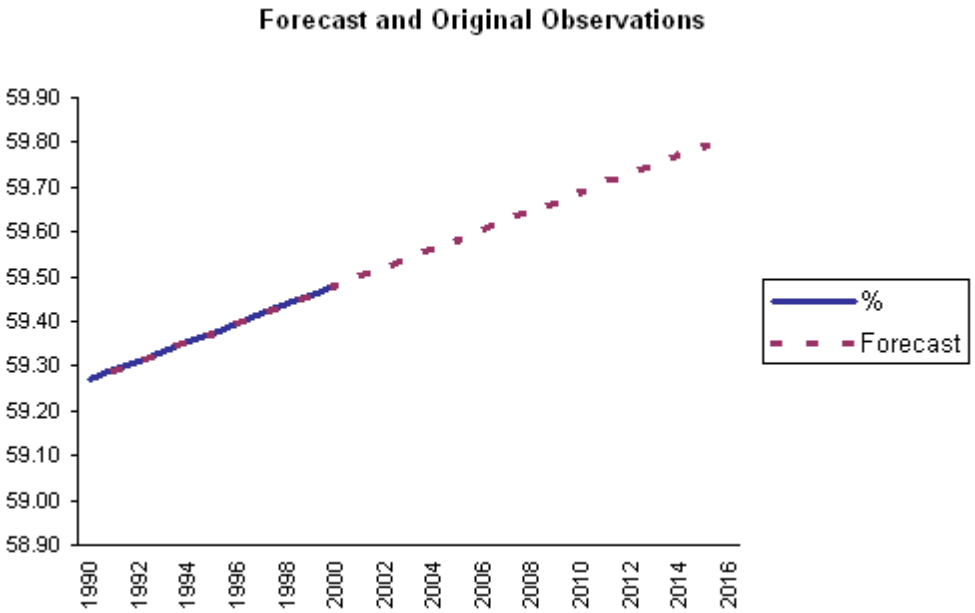
Estimating/Projecting the Proportion of the Cochise County Population Residing in the Sierra Vista Sub-watershed

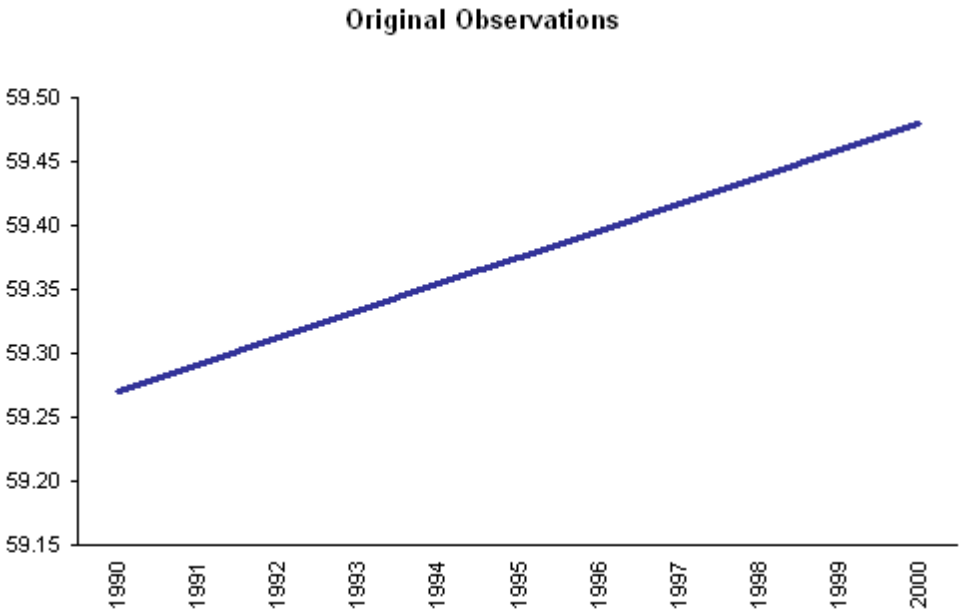
This section shows StatTools 1.1.0 output for estimating and projecting the proportion of the Cochise County population residing in the Sierra Vista sub-watershed.

StatTools	(Core Analysis Pack)
Analysis:	Forecast
Performed By:	carreirar
Date:	Thursday, October 05, 2006
Updating:	Live/Unlinked

Forecasting Constants (Optimized)	
Level (Alpha)	1.000
Trend (Beta)	1.000

Holt's Exponential	
Mean Abs Err	0.00019
Root Mean Sq Err	0.00060
Mean Abs Per% Err	0.00%





Forecasting Data	%	Level	Trend	Forecast	Error
1990	59.2700	59.27000	0.01909		
1991	59.2910	59.29100	0.02100	59.28909	0.00191
1992	59.3120	59.31200	0.02100	59.31200	0.00000
1993	59.3330	59.33300	0.02100	59.33300	0.00000
1994	59.3540	59.35400	0.02100	59.35400	0.00000
1995	59.3750	59.37500	0.02100	59.37500	0.00000
1996	59.3960	59.39600	0.02100	59.39600	0.00000
1997	59.4170	59.41700	0.02100	59.41700	0.00000
1998	59.4380	59.43800	0.02100	59.43800	0.00000
1999	59.4590	59.45900	0.02100	59.45900	0.00000
2000	59.4800	59.48000	0.02100	59.48000	0.00000
2001				59.50100	
2002				59.52200	
2003				59.54300	
2004				59.56400	
2005				59.58500	
2006				59.60600	
2007				59.62700	
2008				59.64800	
2009				59.66900	
2010				59.69000	
2011				59.71100	
2012				59.73200	
2013				59.75300	
2014				59.77400	
2015				59.79500	
2016				59.81600	

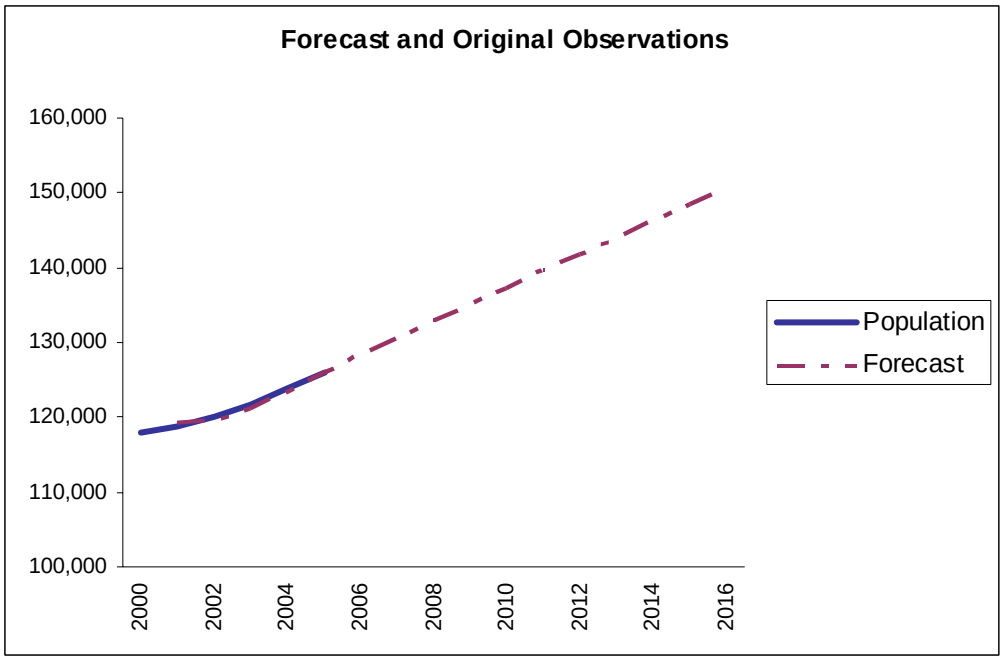
Estimating/Projecting the Cochise County Population Residing in the Sierra Vista Sub-watershed

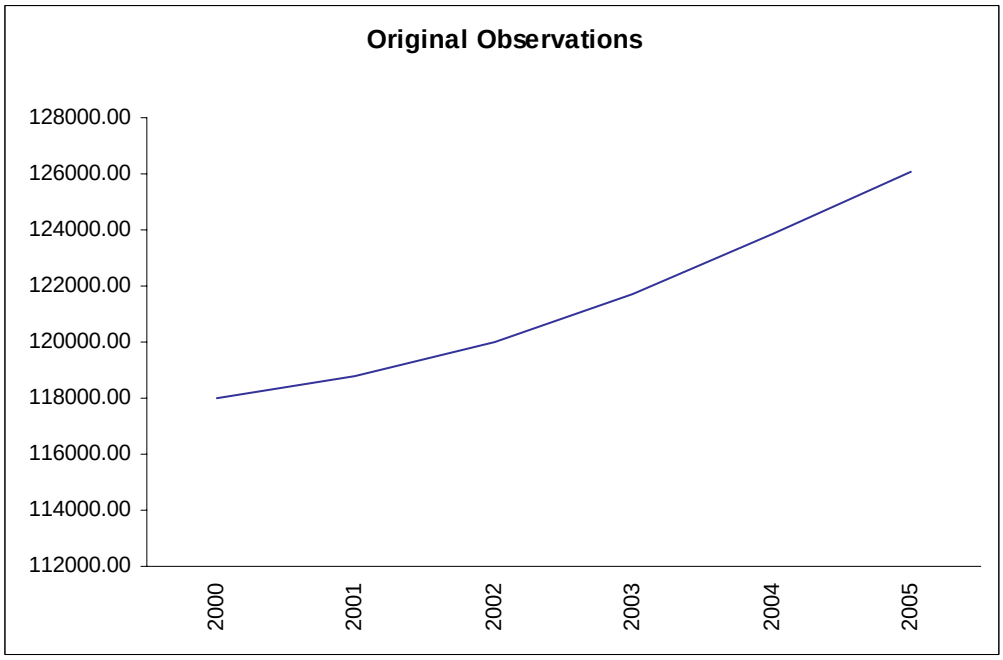
This section shows StatTools 1.1.0 output for estimating and projecting the Cochise County population based on Census Bureau estimates for 2000-2005.

StatTools	(Core Analysis Pack)
Analysis:	Forecast
Performed By:	carreirar
Date:	Monday, November 20, 2006
Updating:	Live/Unlinked

Forecasting Constants (Optimized)	
Level (Alpha)	1.000
Trend (Beta)	1.000

Holt's Exponential	
Mean Abs Err	430.30
Root Mean Sq Err	468.83
Mean Abs Per% Err	0.36%





Forecasting Data	Population	Level	Trend	Forecast	Error
2000	118,033	118,033	1,346		
2001	118,751	118,751	718	119,379	-628
2002	120,008	120,008	1,257	119,469	539
2003	121,704	121,704	1,696	121,265	439
2004	123,864	123,864	2,160	123,400	464
2005	126,106	126,106	2,242	126,024	82
2006				128,348	
2007				130,590	
2008				132,832	
2009				135,074	
2010				137,316	
2011				139,558	
2012				141,800	
2013				144,042	
2014				146,284	
2015				148,526	
2016				150,768	

Appendix C: CER Methodology to Estimate the Share of the Population of the U.S. Side of the Sierra Vista Sub-Watershed Attributable to the Presence of Fort Huachuca

To estimate the share of the population of the U.S. side of the Sierra Vista sub-watershed attributable to Fort Huachuca, the CER utilized data from Fort Huachuca's (2006) economic impact study for Fiscal Year 2005. The following equation was used:

(A*B*C)+(D*B*C)+([E-F]*B*C)+([G-H-I]*B*C)+([J-K-L]*B*C)+([M-N]*B*C)+([O-P]*B*C)+(Q*B*C)+([R-S-T]*B*C)+(U*B*C)

Where:

A = the number of assigned military personnel (3,428) *Note 1*

B = the relocation rate (i.e., what proportion relocated to the area specifically due to Fort Huachuca) (100% for assigned military, military students, and military family members; 57.2% for DoD civilians and their family members, and other civilians who work on Fort Huachuca and their family members; and 25% for retirees and their family members, and family members of deceased retirees) *Note 2*

C = the proportion that resides in the Sierra Vista sub-watershed (100% for military students, military retirees and their family members, and family members of deceased military retirees; 96.8% for all others) *Note 3*

D = the number of military students (2,252) *Note 1*

E = the number of military family members (5,511) *Note 1*

F = the number of military family members who are also counted as active duty military personnel (295) *Note 4*

G = the number of DoD civilian employees (2,901) *Note 1*

H = the number of DoD civilian employees who are also reported as military retirees (545) *Note 4*

I = the number of DoD civilian employees who are also reported as military family members (255) *Note 4*

J = the sum of the number of non-DoD civilian employees on Fort Huachuca and off-post contractors working in support of Fort Huachuca (4,798) *Note 1*

K = the number of non-DoD civilian employees who are also reported as military retirees (1,953) *Note 4*

L = the number of non-DoD civilian employees who are also reported as military family members (72) *Note 4*

M = the number of family members of DoD civilian employees (3,109) *Note 5*

N = the number of family members of DoD civilian employees who are also counted as DoD or non-DoD civilian employees (545) *Note 4*

O = the number of family members of non-DoD civilian employees (4,104) *Note 6*

P = the number of family members of non-DoD civilian employees who are also counted as DoD or non-DoD civilian employees (1,017) *Note 4*

Q = the number of military retirees residing in Sierra Vista sub-watershed (3,687) *Note 1*

R = the number of family members of military retirees residing in the Sierra Vista sub-watershed (5,457) *Note 1*

S = the number of family members of military retirees who are also counted as military retirees (317) *Note 7*

T = the number of family members of military retirees who are also counted as DoD or non-DoD civilian employees (737) *Note 8*

U = the number of family members of deceased military retirees (296) *Note 1*

Thus, the equation becomes:

(3,428*1*0.968)+(2,252*1*1)+([5,511-295]*1*0.968)+([2,901-545-255]*0.572*0.968)+([4,798-1,953-72]*0.572*0.968)+([3,109-545]*0.572*0.968)+([4,104-1,017]*0.572*0.968)+(3,687*0.25*1)+([5,457-317-737]*0.25*1)+(296*0.25*1) = 18,543

See Appendix D for this equation solved using Microsoft Excel.

Notes

1. Figures are from the Fort Huachuca Economic Impact Study, FY 2005

2. It is assumed that all active duty military (including students) and their family members relocated to the area due to reassignment orders. The proportion of DoD civilians and their family members, and other civilians who work on Fort Huachuca and their family members who relocated to the area specifically due to Fort Huachuca is derived from Question 12 of the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999). The relocation rate for military retirees and their family members (including family members of deceased retirees) is derived the McGuire Company study conducted in 2002 (as cited in Lahr, 2004, p. 16).

3. It is assumed that 100% for military students reside in the Sierra Vista sub-watershed; the number of military retirees and family members of deceased military retirees residing in the Sierra Vista sub-watershed is from the Fort Huachuca Economic Impact Study, FY 2005; the rate of 57.2% for all others is derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999).

4. Figures are derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999).

5. This figure is determined by applying the average household size (2.48, as reported in Census 2000) to the number of DoD civilian employees as reported in the Fort Huachuca Economic Impact Study, FY 2005, after subtracting the estimated number of DoD civilian employees who are

also counted as military retirees or military family members, as derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999).

6. This figure is determined by applying the average household size (2.48, as reported in Census 2000) to the number of non-DoD civilian employees as reported in the Fort Huachuca Economic Impact Study, FY 2005, after subtracting the estimated number of non-DoD civilian employees who are also counted as military retirees or military family members, as derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999).

7. This figure is derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999). It is assumed that the proportion of dual military retiree families is approximately the same as the number of dual active duty military families.

8. This figure is derived from the Fort Huachuca Demographic Survey conducted in 1999 (SAIC, 1999). It is assumed that the proportion of family members of military retirees who are employed on Fort Huachuca is approximately the same as the proportion of active duty military family members who are employed on Fort Huachuca.

APPENDIX J:
SUMMARY OF URBAN-ENHANCED RECHARGE IN SIERRA VISTA SUBWATERSHED (ARIZONA)

APPENDIX J: SUMMARY OF URBAN-ENHANCED RECHARGE IN SIERRA VISTA SUBWATERSHED (ARIZONA)

Laurel J. Lacher – September 30, 2006

The amount of increased runoff and groundwater recharge that occurs as a result of increasing impermeable surface area within urban developments is the subject of intense interest in the Sierra Vista subwatershed. The Upper San Pedro Partnership (USPP) has identified recharge attributable to urbanization as an unintended, yet beneficial "yield" of water by Partnership members that can be included in the tally of water-management measures designed to offset the groundwater deficit caused by pumping (USDOI, 2005). The concept is described below:

> Also included … [is] a volume of recharge, enhanced beyond the natural recharge, attributable to urbanization and caused by concentration of rainfall runoff into ephemeral-stream channels. In arid and semiarid climates, the opportunity for recharge is increased (and the likelihood of loss by evaporation is decreased) if runoff is concentrated in channels. Most precipitation that wets soils but does not run off is evaporated or transpired; the water that escapes evaporation and plant transpiration infiltrates very slowly so only a small percentage recharges the aquifer. Water that runs off into ephemeral-stream channels can collect in sufficient quantity to exceed the immediate demands of evaporation and plant transpiration and therefore recharge the regional aquifer.
>
> Covering soils with impermeable surfaces increases the amount of water that runs off into channels. Although the areas of greatest urbanization generate the greatest enhancement in recharge, the effect is not intended by a particular Partnership member, so the yield is listed separately from intended efforts. Increased recharge due to urbanization is expected to only partially mitigate the increased pumping that accompanies increased urbanization. *(USDOI, 2005)*

Since high-volume storms generate significant runoff under natural conditions, the most important *gains* from urban-enhanced recharge come in the form of runoff from frequent, low-intensity, low-volume storms that would otherwise not generate runoff on the natural desert floor. Although storm runoff from high-volume storms may be partially detained and recharged through artificial recharge facilities, this action serves to relocate recharge closer to the pumping centers (as opposed to letting it occur in the river corridor), and may not significantly change the

amount of recharge from that which would occur naturally in ephemeral stream channels or within the San Pedro River floodplain aquifer.

An important caveat to any attempt to estimate the net change in recharge as a result of urbanization is that inter-drainage recharge must be addressed. Several researchers (see GSA (2004)) have documented slow but definite recharge in inter-drainage desert areas of the southwestern United States. Most water balance estimates conducted for the Sierra Vista subwatershed ignore this component of recharge, dismissing it as inconsequential. However, if some recharge does occur through the natural desert floor and that area becomes unavailable to recharge because of urbanization, then the inter-drainage recharge lost to urbanization must be subtracted from any gains in ephemeral-channel recharge attributable to urban-enhanced runoff.

In 2005, the USPP funded a study by Stantec Consulting and GeoSystems Analysis, Inc. to develop a flood control and urban runoff recharge plan (Stantec, 2006). As part of this study, GeoSystems Analysis, Inc. (GSA) undertook a detailed analysis of anticipated changes in runoff attributable to urbanization and the addition of proposed flood control/recharge facilities in the Sierra Vista area from about Palominas in the south to the northern boundary of Fort Huachuca in the north. The analysis included: 1) estimation of land-cover characteristics at complete build-out, 2) the application of in-situ recharge data collected from existing recharge facilities, 3) a review of existing hydrogeologic data, and 4) a numerical simulation of the runoff/recharge response of 13 subwatersheds flanking the east side of the Huachuca Mountains.

The numerical simulations of runoff, infiltration, and incidental recharge through ephemeral drainages and recharge facilities were based on an earlier GSA (2004) study in the Coyote Wash (CW) watershed which used the state-of-the-art Automated Geospatial Watershed Assessment Tool (AGWA) (USDA, undated report) developed by the USDA-ARS in Tucson to assess whether natural groundwater recharge rates can be enhanced by capturing stormwater runoff in flood control retention/detention facilities. The CW AGWA model simulated rainfall, runoff, and infiltration into ephemeral channels and facilities. Channel and basin recharge was then estimated using in-situ monitoring estimates of the percent of infiltration that goes to recharge. In order to extend the results of the CW AGWA model to the larger study area (i.e., Palominas to

Fort Huachuca) without the expensive process of developing a new AGWA model for the entire area, GSA developed a suite of regressions based on the CW AGWA model (Stantec, 2006).

The following paragraphs excerpted from Stantec (2006) summarize the analytical process of evaluating incidental recharge potential:

> Precipitation-runoff and runoff-infiltration regression relationships determined from the CW AGWA model (GSA, 2004) were used to predict the stormwater runoff and channel infiltration for low-intensity, high-frequency precipitation events. These events represent the normal precipitation that occurs on an annual basis. Daily precipitation events from the 1954-2000 Sierra Vista/Fort Huachuca precipitation record were used with the regression equations from the CW AGWA model to simulate runoff into channels under pre-development and post-development conditions.
>
> Following the runoff simulations, runoff into channels was input into inflow-infiltration regression relationships developed for channels and stormwater detention facilities (stand-alone and in-series). These regressions were used to estimate infiltration into both channels and facilities in the study areas based on the 45-year precipitation record.
>
> Channel and facility recharge was then estimated as a function of infiltration by two methods: one based on in-situ experimental data, and the other based monthly evapotranspiration data.

Once the runoff/recharge model was developed, GSA applied it to two end-member conditions representing minimum and expected maximum urban-enhanced recharge. The minimum enhanced recharge condition represents pre-development conditions and was modeled with zero impervious surface in the study area. Maximum urban-enhanced recharge was simulated under post-development conditions defined as total build-out under current zoning rules. Aerial photographs from 2004 overlain with city and county zoning maps were used to estimate the current impervious surface area. These estimates were then used to generate estimates of predicted (maximum) impervious surface area at full build-out (GSA, 2006). Based on these estimates, impervious surfaces currently account for 55% of the predicted maximum potential impervious surface area in the Sierra Vista area, and about 48% in the unincorporated area south of Sierra.

Table 1 summarizes findings presented in Stantec (2006) regarding the urban-enhanced runoff and recharge for Fort Huachuca, Sierra Vista, and the unincorporated Cochise County area south of Sierra Vista. The second row of the table provides pre-development values for precipitation, evapotranspiration (ET) within the watersheds[1], runoff within the watersheds, total channel recharge and ET, and runoff leaving the watersheds and flowing out to the San Pedro River. The third row in the table shows the same values for post-development (full build-out) conditions without considering any impacts from recharge facilities. The differences between pre- and post-development values represent changes resulting strictly from increasing impervious area as a result of urban development. The difference values are shown in row 4 of Table 1.

Table 1 shows that impervious surfaces associated with development transfer water previously lost to ET into urban-enhanced runoff (estimated 9522 acre-feet annually (afa)). Of this 9522 afa, approximately 1754 acre-feet recharge the aquifer within the study areas, 940 acre-feet are lost to ET within ephemeral channels, and the remaining 6,828 acre-feet leave the watershed as flow in ephemeral channels discharging to the San Pedro River.

While no figures on urban-enhanced runoff and recharge are available for current development conditions, some generalizations may be drawn from the full build-out impervious area estimates developed by GSA and Stantec. GSA estimates current (2004) impervious surface for the entire study area at roughly 29,000 acres, or about 21% of the study area, not including mountain areas. Full build-out impervious area is estimated at roughly 59,000 acres, or 42% of the study area. Details of how this impervious area is distributed within the watersheds are important for estimating channel (and facility) recharge. In lieu of such information, however, a rough estimate that urban-enhanced runoff and ephemeral channel recharge are currently approximately 50% of their potential at full build-out would mean that roughly 4,800 afa of water is being transferred from ET to runoff within the study area. Likewise, of this 4,800 acre-feet, about 880 acre-feet are estimated to be recharging through ephemeral channels, while 470 acre-feet are being lost to ET from ephemeral channels, and 3,414 acre-feet are flowing out of the watersheds to the San Pedro River under current conditions.

[1] The study areas terminate just west of the San Pedro River.

GSA also estimated facility recharge for existing and proposed storm-water/recharge detention and retention basins along the east flank of the Huachuca Mountains. These estimates were also based on in-situ measurements and reference ET rates, with the average of the two estimation methods considered to be most appropriate. The facility recharge values were only made for conditions of full buildout. The method described above for approximating current urban-enhanced recharge without facilities is not applicable to facility recharge because facility recharge is highly sensitive to location. An in-depth study of this issue was requested by USPP in early 2006 but has not yet funded (Milczarek, 2006).

In order to estimate the upper limit on urban-enhanced facility recharge under current conditions, only those existing facilities which receive runoff from urbanized areas are considered. The Rostron facility within Sierra Vista is the only existing facility outside of Fort Huachuca that receives urban runoff west of the San Pedro River. This facility is located in a highly urbanized area of Coyote Wash which currently has approximately 75% of all of the impervious surface area predicted for full buildout conditions. Several facilities on Fort Huachuca receive runoff from urbanized areas. Table 2 shows maximum urban-enhanced recharge estimates for the Fort Huachuca (FH) and Sierra Vista facilities. The total value of 265 acre-feet per year is probably an upper limit on current facility recharge from urban-enhanced runoff because the Stantec estimates incorporated the impacts of overflow from upstream to downstream facilities, which generally enhances overall recharge. If upstream facilities do not currently exist or have not been expanded as planned, and the watershed has not yet been fully built out, facility recharge will undoubtedly be lower than indicated in Table 2. On the other hand, these estimates do not account for any resulting decreases in ephemeral channel recharge that occur when water is detained in facilities and channels are thus deprived of that water for recharge and ET. This effect compensates for the facility recharge overestimate to some unknown degree.

The Stantec (2006) study did not address urban-enhanced runoff and recharge east of the San Pedro River or for Huachuca City, but these areas likely contribute only a small amount of urban-enhanced recharge for the following reasons: 1) the communities of Huachuca City (2004 population (pop.) 1,830), Tombstone (2004 pop. 1,595), Naco (2000 pop. 833) and Bisbee (2004 pop. 6,390, partly outside the San Pedro watershed) are considerably smaller than Sierra Vista

(2004 pop. 42,805) (not including unincorporated areas south of the city or Fort Huachuca), and presumably have vastly less impervious area (see Figure 1); 2) Bisbee is built on granite bedrock which suggests that precipitation falling there in pre-development conditions would have either run off to the ephemeral drainages downstream or recharged through fractures with very little ET loss outside of the drainages. In that situation, urbanization effectively eliminates some fracture recharge pathways but it does not "salvage" much water from ET; 3) ET losses in ephemeral channels increase with decreasing flow. Relatively high precipitation rates in the Huachuca Mountains contribute significant flow to ephemeral channels west of the San Pedro, thereby increasing hydraulic conductivity, promoting recharge, and reducing ET losses from urban runoff.

In summary, urban-enhanced runoff west of the San Pedro River (not including Huachuca City) is estimated to have increased recharge by 880 afa without considering detention/retention facilities. Existing facilities are predicted to have increased urban-enhanced recharge by an additional 265 afa, for a total predicted urban-enhanced recharge value of 1,145 afa. This value may slightly underestimate total urban-enhanced recharge because it does not account for runoff from the communities of Huachuca City, Tombstone or Naco. Urbanization in Bisbee is not expected to increase overall recharge significantly.

TABLE 1. ESTIMATED URBAN-ENHANCED RUNOFF AND RECHARGE FOR FORT HUACHUCA, SIERRA VISTA, AND UNINCORPORATED COCHISE COUNTY AREA SOUTH OF SIERRA VISTA. "POST-DEVELOPMENT" VALUES REPRESENT IMPERVIOUS SURFACE CONDITIONS AT FULL BUILDOUT (SOURCE: TABLE 5-1 IN STANTEC (2006)). (ACRE-FEET PER YEAR)

FORT HUACHUCA, SIERRA VISTA, COCHISE CO. SOUTH OF SIERRA VISTA	ANNUAL RAINFALL	ET IN WATER-SHED	RUNOFF IN WATER-SHED	TOTAL CHANNEL		RUNOFF LEAVING WATERSHED	% CHANGE FROM PRE-DEVELOPMENT		
				RECHARGE	ET		Runoff Leaving Watershed	Recharge	Runoff Within Watershed
PRE-DEVELOPMENT	**156,133**	**142,102**	**14,031**	**1,841**	**1,814**	**10,376**			
POST-DEVELOPMENT without FACILITIES	**156,133**	**132,579**	**23,554**	**3,595**	**2,755**	**17,204**			
difference	0	-9,522	9,522	1,754	940	6,828	66%	95%	68%

TABLE 2. ESTIMATED URBAN-ENHANCED RECHARGE FOR EXISTING FACILITIES UNDER CURRENT CONDITIONS (ACRE-FEET PER YEAR).

Stantec Facility Name	Estimated Average Annual Rechgarge at Full Buildout	Recharge Value After Reduction for Current % Buildout	Recharge Value After Reduction for Lack of Planned Facility Expansion
FH4	105	56	56
FH5	180	104	35
FH6	49	44	38
FH7	184	95	95
FH10	42	31	31
Rostron	12	9	9
TOTAL			265

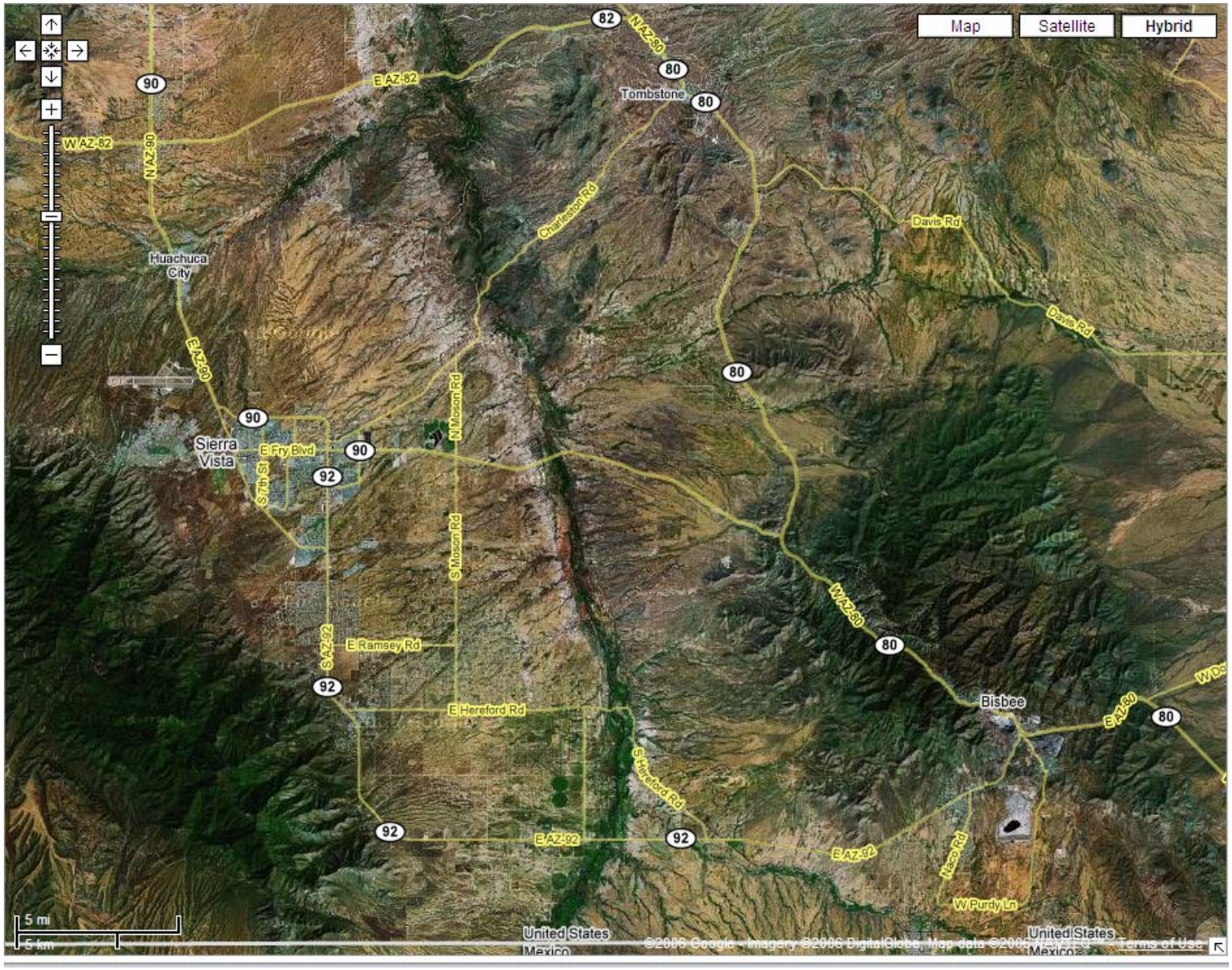


FIGURE 1. SATELLITE IMAGE ILLUSTRATING URBAN DEVELOPMENT IN UPPER SAN PEDRO SUBWATERSHED (SOURCE: HTTP://MAPS.GOOGLE.COM).

References

GeoSystems Analysis, Inc. (GSA) 2004. Project SP-0011 Storm Water Recharge Feasibility Analysis, Appendix B: AGWA/KINEROS Simulations for Coyote Wash Watershed.

Milczarek, M.A., 2006, GeoSystems Analysis – personal communication.

Stantec, 2006, Cochise County Flood Control Urban Runoff Recharge Plan, Stantec Project No. 185120049, April 2006.

U.S. Department of Agriculture (USDA) – Agricultural Research Service, http://www.tucson.ars.ag.gov/agwa/docs/agwa/AGWA%201.5%20Fact%20Sheet.pdf

U.S. Department of the Interior (USDOI), 2005, Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona – 2004 Report to Congress, 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.

APPENDIX K:
WATER BUDGET COMPARISON FOR THE SIERRA VISTA SUBWATERSHED

Table 1. Sierra Vista Subwatershed Water Budget Comparison

	Source									
	ADWR (2005) Table 3-2	DOI (2005)	Wahi (2005) p.57	Pool and Coes (1999)	Anderson, et al (1992)	Scott, et al (2006)	Schwartzman (1990)	ACOE 1987	Goode & Maddock (2000)	Corell, et al (1996)
Inflows to Groundwater System										
Natural Recharge	**18000**	**15000**							15236	**19000**
									based on Corell (1996) and Anderson, et al (1992)	
Mountain Front			1500-7300	8800-18700	17,054			10357	12236	15000
			avg=4400	based on Anderson et al (1992), Freethy (1982), and Corell (1996)	based on regional regression eq'n				based on ADWR 1991 and Anderson et al (1992)	
Ephemeral Channel	15000	15000								1000
										bsflws 1935-1941 and incl 1000 in Greenbush Draw
Inflow fr Mexico	3000	3000							3000	3000
Artificial Recharge	**1500**									
detention basin (stormwater)										
effluent (munic. artif rechg)	1500									
Reduction of Riparian ET										
Urban-enhanced Recharge										
Incidental Recharge	**2000**									
industrial return flow/rechg	50*									
	ADWR Table 3-2, but shown in Table 4-7									
municipal incidental (septics, turf watering, effl. dischg)	2000									
Total Inflow	**21500**	**18000**								

	ADWR (2005) Table 3-2		Wahi (2005) p.57	Pool and Coes (1999)	Anderson, et al (1992)	Scott, et al (2006)	Schwartzman (1990)	ACOE 1987	Goode & Maddock (2000)
Outflows from Groundwater System									
Agricultural Demand	**2500**								
Municipal Demand	**14500**								
water companies & public supply - gross									
rural/exempt - gross									
	2002 popln of 70,000								
Industrial Demand	**1300**								
Stock Demand	**160**	**16500**		15000					
Riparian Use	7700	7700		7500		9600-12055			
						avg=10827; large discrepancy w/Corell for Babocomari			
						2250-3044 for Babo	approx. 600-640 afa for Babo in "river stretch 3"		
Underflow from Subbasin	440	440		350					
Baseflow out	**3250**	**3250**		5900					
	based on 1997-2004 record only			(Freethey, 1982)			approx 1985 afa in Babo "river stretch 3" but 38% loss before reaching SPR, so total bsflw to SPR = 1216 afa (616 after ET)		
Total Outflow	**29850**	**27890**							
Difference	**8350**	**9890**							

Table 1. (continued)

	Vionnet & Maddock (1992)	Stantec (2006)	Coes & Pool (2005)	Goodrich et al (2004)	Estimated Range of Values	
Inflows to Groundwater System					min	max
Natural Recharge					**15927**	**19968**
Mountain Front	12546				10877	13,218
	based on Freethey (1982)					
Ephemeral Channel			2392	2760-7860	2051	3751
			(2001-2002); 30% less precip than 1999-2000	(1999-2000); avg=5310		
Inflow fr Mexico	3728				3000	3000
Artificial Recharge						
detention basin (stormwater)						265
						based on Stantec (2006); 256=FH
effluent (munic. artif rechg)					1500	**2087**
						(ADWR for SV WWTP; FHBO Rpt 2005)
Reduction of Riparian ET						
Urban-enhanced Recharge		1754				880
						based on Stantec (2006)
Incidental Recharge						
industrial return flow/rechg					**50**	
municipal incidental (septics, turf watering, effl. dischg)					**2000**	2310
Total Inflow					20357	24630

	Vionnet & Maddock (1992)	Stantec (2006)	Coes & Pool (2005)	Goodrich et al (2004)	Estimated Range of Values	
Outflows from Groundwater System						
Agricultural Demand					**1600**	2500
Municipal Demand					14500	**15730**
water companies & public supply - gross						
rural/exempt - gross						
Industrial Demand					1300	**1430**
Stock Demand						160
Riparian Use	**7898**				**7750**	12055
	pre-dev					
Underflow from Subbasin	**933**				**506**	531
	steady-st; 651 @ Fairbank and 282 in NE corner					
Baseflow out					3250	5600
						5600 from 5000 in SPR based on total POR, non-storm flows + 600 Babo
Total Outflow					**28906**	**38006**
Difference					**8548**	**13376**
					max inflow - min outflow=	min inflow - max outflow=
					4276	17648
					average=	10962

Table 2. 2005 Fort Huachuca GW Storage Change Liability Calculation

(all water use values in acre-feet (AF) unless otherwise stated)
(assumes FH personnel live on west side of San Pedro River)

Abbreviations: SV=Sierra Vista; FH = Fort Huachuca; SVS= Sierra Vista Subwatershed; GW= groundwater
gals = gallons; pop. = population

			Source/Notes
2005 Sierra Vista (SV) + Fort Huachuca (FH) Per Capita GW demand			
SV Pop	34,694		City of SV
FH Resid. Pop	6,911		T. Cochran
Total Sierra Vista Pop	41,605		
SV Pumping	6,058		City of SV
FH Pumping	1,403		FH
Total Pumping	7,461		
Gals per capita per day for SV+FH (SVS incorporated area)	**160**		
2005 Unincorporated Area Population in SVS			
SVS total population	75,337		Revised DES estimates from J. Leenhouts (USGS)
Unincorp population in SVS	23,717		Revised DES estimates from J. Leenhouts (USGS)
% pop. in unincorporated areas of SVS	31%		" "
Unincorpated-area water demand (ac-ft/pers/yr)	0.132	117.825	ADWR, 2006 - Final Report on Safe Yield Impediments, Opportunities, and
(gpd)	118		Strategic Directive
2005 - FH Pumping Responsibility			
FH personnel	25,398		T. Cochran, FH
FH incorp pop (FH personnel)	19,578		
FH unincorp pop (FH personnel)	5,820		31% of off-post personnel
FH - Induced Pop. in SVS (26.7% of FH personnel)	6,781		2002 BA -> 26.7% of total FH pers. = # induced persons
FH-Induced pop. in incorp area	4,646		
FH-Induced pop. in unincorp area	2,135		
Total FH Incorp area pop	24,225		
Total FH Unincorp area pop	7,955		
Total FH-responsible pop	**32,179**		
FH Incorp area gw demand (gpdc = 160) (acre-feet)	4,344		
Unincorp area demand (afa/pers=0.132) (acre-feet)	1,050		
total industrial demand in SVS (2002-2010)	1,250		ADWR (2005), App. L - golf courses and sand & gravel oper.
% total SVS population attributable to FH	43%		
FH-resp. industrial	534		
Total FH Pumping Responsibility	**5,928**		
Fort Huachuca Recharge			
stormwater (facilities)	49		2005 BO Annual Rpt - FH
effluent	426		2005 BO Annual Rpt - FH minus 2.5% evap as per SVWWTP report from
Total artif recharge on FH	**475**		
Sierra Vista Recharge			
stormwater (urban-enhanced)	880		Based on Stantec, 2006 - entire east flank of Huachuca Mtns not incl. Huachuca City
treated effluent (2004)	1,868		Kusel, D., 2006, ADWR, pers. comm.
turfgrass	55		2002 est from ADWR (2005) App. F - Mtn View Golf Course & Chaffee
Total SV Rechg (except septic)	2,897		
Percentage of SV recharge attributable to FH	50%		Assumes all FH incorp-area off-post pop is in SV
SV recharge attributable to FH	**1,446**		
Total urban area recharge attrib. to FH	**1921**		
% septic flow recharge	0.70		Kevin Lansey, 2006 pers. comm.; also used by USPP
Recharge from SV septics (5% of SV)	94		
FH resp. for SV septic recharge	47		
Unincorp Area septics - FH resp	430		
Total FH-resp septic recharge	**477**		
Total FH-attributable recharge	**2,398**		
FH NET storage change:			
2005			
FH-attributable groundwater demand	5,928		
recharge offset	2,398		
% of gw pumping from gw storage	55%		Goode and Maddock (2000); Corell, et al (1996), Freethey, et al (1982), Vionnet (1992)
TOTAL NET STORAGE CHANGE ATTRIBUTABLE TO FH in 2005	**1,942**		Does not account for 1073 ac-ft in conservation easements acquired by FH
			2005 Total FH Pumping Responsibility less planned water conservation measures totaling 116
2016 FH-attributable groundwater demand	5,812		acre-ft/year
2005 recharge offset	2,398		Assumes same proportion of recharge attributable to FH as in 2005
			From Appendix H - 246.1 acre-ft/year of increased effluent recharge and 590 acre-ft/year of
Planned increase in recharge of effluent and stormwater	836		increased stormwater recharge
PREDICTED NET STORAGE CHANGE ATTRIBUTABLE TO FH IN 2016	**1,418**		

Table 2a. 2005 Fort Huachuca GW Storage Change Liability Calculation Using Carreira Fort Huachuca Attributable Population

(all water use values in acre-feet (AF) unless otherwise stated)
(assumes FH personnel live on west side of San Pedro River)

Abbreviations: SV=Sierra Vista; FH = Fort Huachuca; SVS= Sierra Vista Subwatershed; GW= groundwater
gals = gallons; pop. = population

2005 Sierra Vista (SV) + Fort Huachuca (FH) Per Capita GW demand			**Source/Notes**
SV Pop	34,694		City of SV
FH Resid. Pop	6,911		T. Cochran
Total Sierra Vista Pop	41,605		
SV Pumping	6,058		City of SV
FH Pumping	1,403		FH
Total Pumping	7,461		
Gals per capita per day for SV+FH (SVS incorporated area)	**160**		
2005 Unincorporated Area Population in SVS			
SVS total population	75,337		Revised DES estimates from J. Leenhouts (USGS)
Unincorp population in SVS	23,717		Revised DES estimates from J. Leenhouts (USGS)
% pop. in unincorporated areas of SVS	31%		" "
Unincorpated-area water demand (ac-ft/pers/yr)	0.132	117.825	ADWR, 2006 - Final Report on Safe Yield Impediments, Opportunities, and
(gpd)	118		Strategic Directive
2005 - FH Pumping Responsibility			
FH personnel	18,543		Refer to Appendix I
FH incorp pop (FH personnel)	14,881		
FH unincorp pop (FH personnel)	3,662		31% of off-post personnel
FH - Induced Pop. in SVS	0		
FH-Induced pop. in incorp area	0		
FH-Induced pop. in unincorp area	0		
Total FH Incorp area pop	14,881		
Total FH Unincorp area pop	3,662		
Total FH-responsible pop	**18,543**		
FH Incorp area gw demand (gpdc = 160) (acre-feet)	2,669		
Unincorp area demand (afa/pers=0.132) (acre-feet)	483		
total industrial demand in SVS (2002-2010)	1,250		ADWR (2005), App. L - golf courses and sand & gravel oper.
% total SVS population attributable to FH	25%		
FH-resp. industrial	308		
Total FH Pumping Responsibility	**3,460**		
Fort Huachuca Recharge			
stormwater (facilities)	49		2005 BO Annual Rpt - FH
effluent	426		2005 BO Annual Rpt - FH minus 2.5% evap as per SVWWTP report from
Total artif recharge on FH	**475**		
Sierra Vista Recharge			
stormwater (urban-enhanced)	880		Based on Stantec, 2006 - entire east flank of Huachuca Mtns not incl. Huachuca City
treated effluent (2004)	1,868		Kusel, D., 2006, ADWR, pers. comm.
turfgrass	55		2002 est from ADWR (2005) App. F - Mtn View Golf Course & Chaffee
Total SV Rechg (except septic)	2,897		
Percentage of SV recharge attributable to FH	23%		Assumes all FH incorp-area off-post pop is in SV
SV recharge attributable to FH	**665**		
Total urban area recharge attrib. to FH	**1141**		
% septic flow recharge	0.70		Kevin Lansey, 2006 pers. comm.; also used by USPP
Recharge from SV septics (5% of SV)	94		
FH resp. for SV septic recharge	22		
Unincorp Area septics - FH resp	198		
Total FH-resp septic recharge	**220**		
Total FH-attributable recharge	**1,360**		
FH NET storage change:			
2005			
FH-attributable groundwater demand	3,460		
recharge offset	1,360		
% of gw pumping from gw storage	55%		Goode and Maddock (2000); Corell, et al (1996), Freethey, et al (1982), Vionnet (1992)
TOTAL NET STORAGE CHANGE ATTRIBUTABLE TO FH in 2005	**1,155**		Does not account for 1073 ac-ft in conservation easements acquired by FH
			2005 Total FH Pumping Responsibility less planned water conservation measures totaling 116
2016 FH-attributable groundwater demand	3,344		acre-ft/year
2005 recharge offset	1,360		Assumes same proportion of recharge attributable to FH as in 2005
			From Appendix H - 246.1 acre-ft/year of increased effluent recharge and 590 acre-ft/year of
Planned increase in recharge of effluent and stormwater	836		increased stormwater recharge
PREDICTED NET STORAGE CHANGE ATTRIBUTABLE TO FH IN 2016	**631**		

APPENDIX L:
FORT HUACHUCA WATER USE MITIGATION POLICY

DEPARTMENT OF THE ARMY
UNITED STATES ARMY INTELLIGENCE CENTER AND FORT HUACHUCA
1903 HATFIELD STREET
FORT HUACHUCA ARIZONA 85613-7000

REPLY TO
ATTENTION OF

ATZS-CG 5 July 2005

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: POLICY 119 – Fort Huachuca Water Use Mitigation Policy

1. Fort Huachuca has an obligation to be a responsible steward of our desert environment. Water conservation is required at Fort Huachuca, and constitutes part of the Fort's compliance with the Endangered Species Act. One way we can accomplish this legal mandate is to implement mitigation methods whenever the number of employees, to include contractors, increases. This policy memorandum instructs all organizations and tenant activities on how to mitigate water consumption whenever the size of their workforce increases.

2. Fort Huachuca was issued a Biological Opinion by the US Fish and Wildlife Service (USFWS) on 23 August 2002. In that document, Fort Huachuca agreed to stringent water management practices to reduce potential effects on threatened and endangered species and avoid adverse modification of their designated critical habitat in the San Pedro River Basin. The USFWS monitors the installation's compliance with the Biological Opinion, and expects each year's water use to be less than the previous year.

3. To comply with the Biological Opinion, and allow for mission requirements, any organization increasing its overall personnel strength in the Fort Huachuca area must mitigate the water use associated with these additional personnel and their family members. This mitigation policy also applies to contract employees working on the installation.

4. Each employee adds direct, indirect and cumulative water usage for themselves, their families, and within the community. Mitigation will be assessed based on increases from the organization's personnel baseline on 30 September 2001, as reflected in the Post Population Report (PPR) (enclosure).

5. Mitigation for large increases (over 30 personnel associated with a single project or action) in personnel, to include civilian contractors who work on post, will occur prior to the personnel increase or hiring action. Otherwise, mitigation will be paid when the annual 30 September PPR is issued. Mitigation may be accomplished by the gaining organization in at least two ways. Either method must be coordinated through the Environmental and Natural Resources Division, Directorate of Public Works (DPW).

ATZS-CG
SUBJECT: POLICY 119 – Fort Huachuca Water Use Mitigation Policy

a. The first mitigation method is on-site. For organizations with large facilities, conservation technology may be installed in their facilities if it will completely mitigate the increased water use of the additional personnel. However, this will be done at the gaining organization's expense.

b. If the organization increases personnel and cannot reduce water use at their facilities sufficiently on their own, the second method of mitigation requires working with the DPW. Cost for this mitigation method is $1,500 per additional employee. This money will be paid to the DPW and is a *one-time fee per position added*. The fee applies to all personnel increases, regardless of where the employee or contractor worked or was located prior to the hiring action. The mitigation fee is not an augmentation to the Garrison's appropriated funds budget because it pays to mitigate water consumption resulting from personnel increases that have not been otherwise funded by Department of the Army in the Garrison's annual budget.

c. Finally, organizations may develop in coordination with the DPW, a hybrid of the above two mitigation methods.

6. Mitigation fees for temporary personnel increases, new processes that use water or existing processes that increase water use will be based on the specific action, and will be assessed according to the amount and duration of the increase in water use. Estimated water use will be calculated based upon the mission, the number of personnel, whether personnel are TDY or permanent party, and other factors. Fees will be based upon a charge of $1,500 per acre foot per year, as a one-time fee for the increase.

7. The proponent for this Policy Memorandum is the DPW, Environmental and Natural Resources Division, ATZS-ISB. The point of contact is Mr. Robert Bridges, Environmental and Natural Resources Division, at 533-1863.

Encl

BARBARA G. FAST
Major General, USA
Commanding

DISTRIBUTION: E

2