



Future Water Use Assessment

Great Sand Dunes National Park and Preserve

Natural Resource Report NPS/NRSS/WRD/NRR—2017/1412



ON THE COVER

Four photos showing (top to bottom/left to right): Well House No.1, Well No.2 distribution piping, the Headquarters System water storage tanks, and Well No. 3 water meter (NPS - May 2016)

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1.0 Introduction

Staff from the National Park Service (NPS) Water Resources Division - Water Rights Branch (WRD-WRB) traveled to Great Sand Dunes National Park and Preserve (GRSA) in May of 2016 to assess the probable future consumptive use of groundwater, which is the source of potable water to visitors and staff at the Park. The park is located within the Rio Grande River basin in south central Colorado and is visited annually by over 250,000 people (on average). Established as a National Monument in 1932, the park was expanded to create a National Park and Preserve in 2000.

This future use assessment uses historical consumptive water use and visitation data to project future water use through the year 2065, a 50-year period. The estimate of future use will be used by NPS in evaluating its responsibilities under the State of Colorado's "Rules Governing the Withdrawal of Groundwater in Water Division No. 3" (Rules)¹.

2.0 Water Supply

In May of 2016, WRD-WRB staff visited the water supply systems at GRSA, collected pumping records, and interviewed water system operations staff. Four groundwater wells (Well Nos. 1-4) were installed between 1957 and 1978 to supply GRSA with water for domestic, administrative, and operational needs (**Table 1** and **Figure 1**). These four wells supply two separate water systems. Well Nos. 2 and 4 supply the Campground System and Well Nos. 1 and 3 supply the Headquarters System. Well No. 4 was disconnected in approximately 2000 due to very low yield (<10 gallons per minute (gpm)). Both systems are treated with chlorine and are classified as Public, Transient, Non-community Water Systems by the Colorado Department of Public Health and Environment.

In 1989, water right decrees 81CW161 and 81CW163 set aside water rights for 30, 25, and 10 gpm (absolute) for Well Nos. 2, 3, and 4, respectively. Decree 81CW164 set aside an additional 8.0 acre-feet per year (afy) for future municipal water use (**Table 1**).

Table 1. Water Supply Wells at GRSA.

Well Identifier	Status	Permit #	Case #	Structure ID #	Year Drilled	Maximum Pumping Rate	Annual Appropriation
Headquarters System (PWSID202300)							
Well No. 1	Active	36273-F	81CW164	5620	1957	---	8.0 afy
Well No. 3	Active	36263-F	81CW163	5053	1978	25 gpm	40.3 afy
Campground System (PWSID202350)							
Well No. 2	Active	04331-F	81CW163	5052	1963	30 gpm	48.4 afy
Well No. 4	Inactive		81CW161	5054	1978	10 gpm	16.1 afy

¹ By Order of the State Engineer – September 23, 2015.

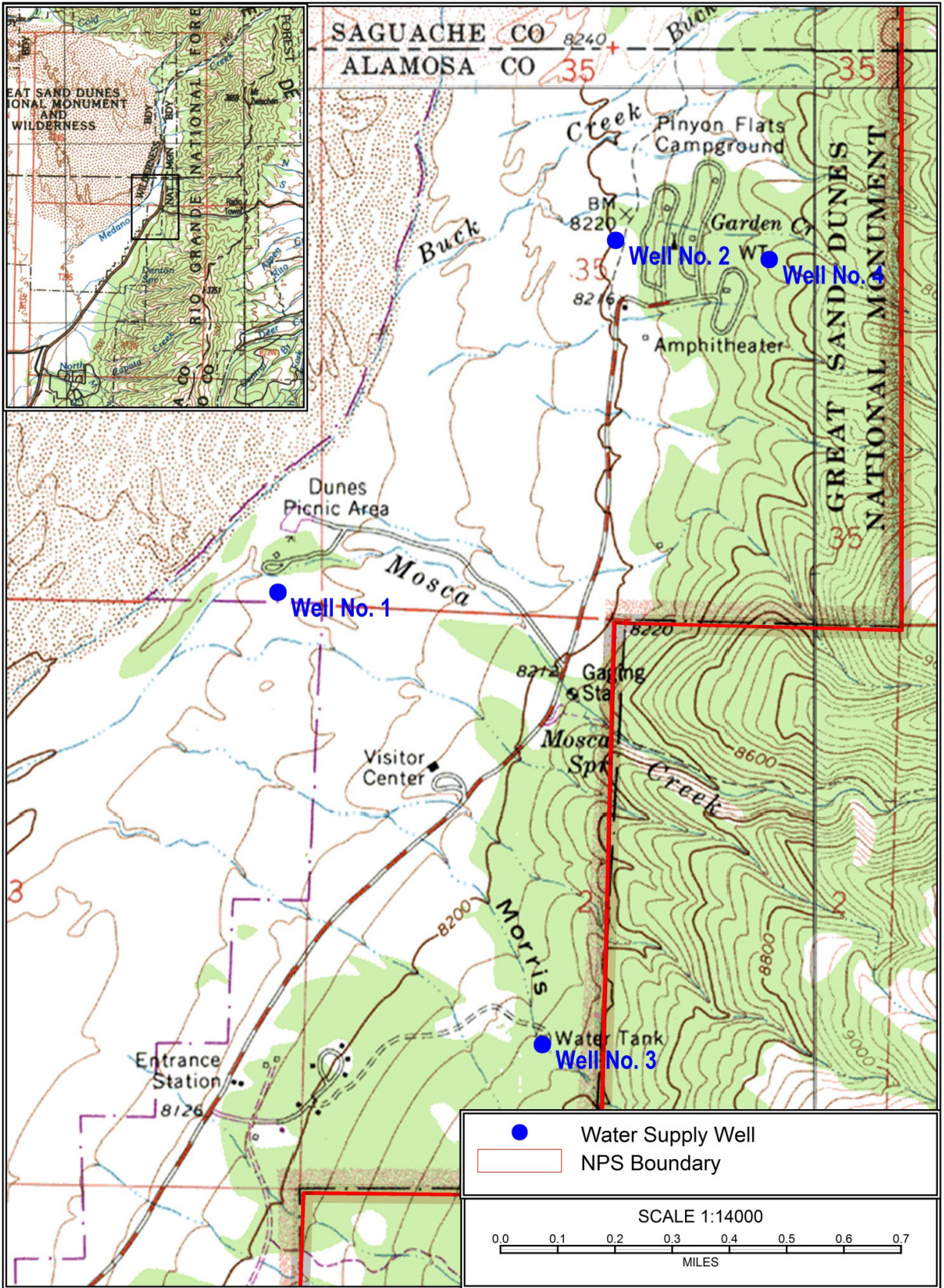


Figure 1. GRSA Well Location Map.

The Campground System serves the Pinon Flats campground area, which includes 88 individual sites and 3 group sites. Water use is from five campground restrooms with flush toilets, sinks and outside hydrants; a drinking fountain at the amphitheater; and a RV dump station. The pumping rate from Well No. 2 averages 19 – 21 gpm². A 50,000-gallon steel reservoir is located above the group campground loop near Well House No. 4. During most years, the use of this system is discontinued during the off-season (November –February).

The Headquarters System supplies water to the remainder of the Park's facilities: the visitor center and administrative offices, residential housing, entrance station and associated offices, maintenance shop, horse barn, residential picnic area, and the restrooms and showers at the dunes parking lot. This system is in operation year round. The pumping rate of Well No. 1 averages 16 – 21 gpm² and Well No. 3 averages 15 – 17 gpm². A 50,000-gallon steel reservoir and a 74,000-gallon steel reservoir are located just uphill from the horse barn and stables near Well House No. 3.

² Personal communication with Casey Hagaman (GRSA Utilities System Operator 2000-2012)

3.0 Water Use

As of March 1, 2007, pursuant to state rules³ all non-exempt wells within the Rio Grande Basin were required to be equipped with totalizing flow meters. GRSA staff report annual groundwater withdrawals to the Colorado Department of Water Resources (CDWR) Division Engineer for Water Division No. 3 before December 1st of every year. Water use for Well Nos. 1, 2, and 3 have been recorded on a semi-daily basis by GRSA staff since 2000. Pumping was recorded sporadically prior to 2000, but complete records could not be located. Therefore, for the purposes of this report, the period of record (POR) is defined as the calendar years 2000 – 2015. Pumping records have gaps and spikes and do not necessarily reflect actual water use as a result of maintenance and operational issues, such as water line breaks, system down-times, and tank overflow events.

Water use at GRSA is distributed among visitors, staff, and temporary and permanent residents. An average of approximately 10.5 afy (3.4 million gallons per year) was pumped from all active wells during the POR (**Table 2** and **Figure 2**). Total pumping ranged from 8 afy in 2007 to 15 afy in 2003. Pumping from Well No. 3 was relatively high in 2003 as a result of a water-line break and road construction⁴. Average annual water use for the POR from the Headquarters System (7 afy) is almost double that of the Campground System (3.5 afy).

Table 2. GRSA Pumping Totals for the Period 2000 – 2015.

Calendar Year	Total Annual Pumping (gallons)			Total Annual Pumping (acre-feet per year)		
	Well 2 (Campground System)	Wells 1 and 3 (Headquarters System)	Total All Wells	Well 2 (Campground System)	Wells 1 and 3 (Headquarters System)	Total All Wells
2000	944,510	2,323,034	3,267,544	2.90	7.13	10.03
2001	1,233,950	2,258,720	3,492,670	3.79	6.93	10.72
2002	993,290	2,595,640	3,588,930	3.05	7.97	11.01
2003	1,063,340	3,823,740	4,887,080	3.26	11.73	15.00
2004	1,201,990	2,131,590	3,333,580	3.69	6.54	10.23
2005	1,174,840	2,558,290	3,733,130	3.61	7.85	11.46
2006	1,109,350	2,294,120	3,403,470	3.40	7.04	10.44
2007	1,027,350	1,617,990	2,645,340	3.15	4.97	8.12
2008	1,065,640	1,699,780	2,765,420	3.27	5.22	8.49
2009	1,393,720	1,998,600	3,392,320	4.28	6.13	10.41
2010	1,424,230	1,730,160	3,154,390	4.37	5.31	9.68
2011	1,410,760	1,771,800	3,182,560	4.33	5.44	9.77
2012	1,270,830	2,116,715	3,387,545	3.90	6.50	10.40
2013	1,025,780	2,326,385	3,352,165	3.15	7.14	10.29
2014	688,530	2,779,030	3,467,560	2.11	8.53	10.64
2015	949,650	2,701,060	3,650,710	2.91	8.29	11.20
Average	1,123,610	2,295,416	3,419,026	3.45	7.04	10.49
Min	688,530	1,617,990	2,645,340	2.11	4.97	8.12
Max	1,424,230	3,823,740	4,887,080	4.37	11.73	15.00

³ Rules Governing the Measurement of Ground Water Diversions Located in Water Division No. 3 (September, 2005).

⁴ Personal communication with Rhonda Madril – GRSA Facilities, 5/19/2016

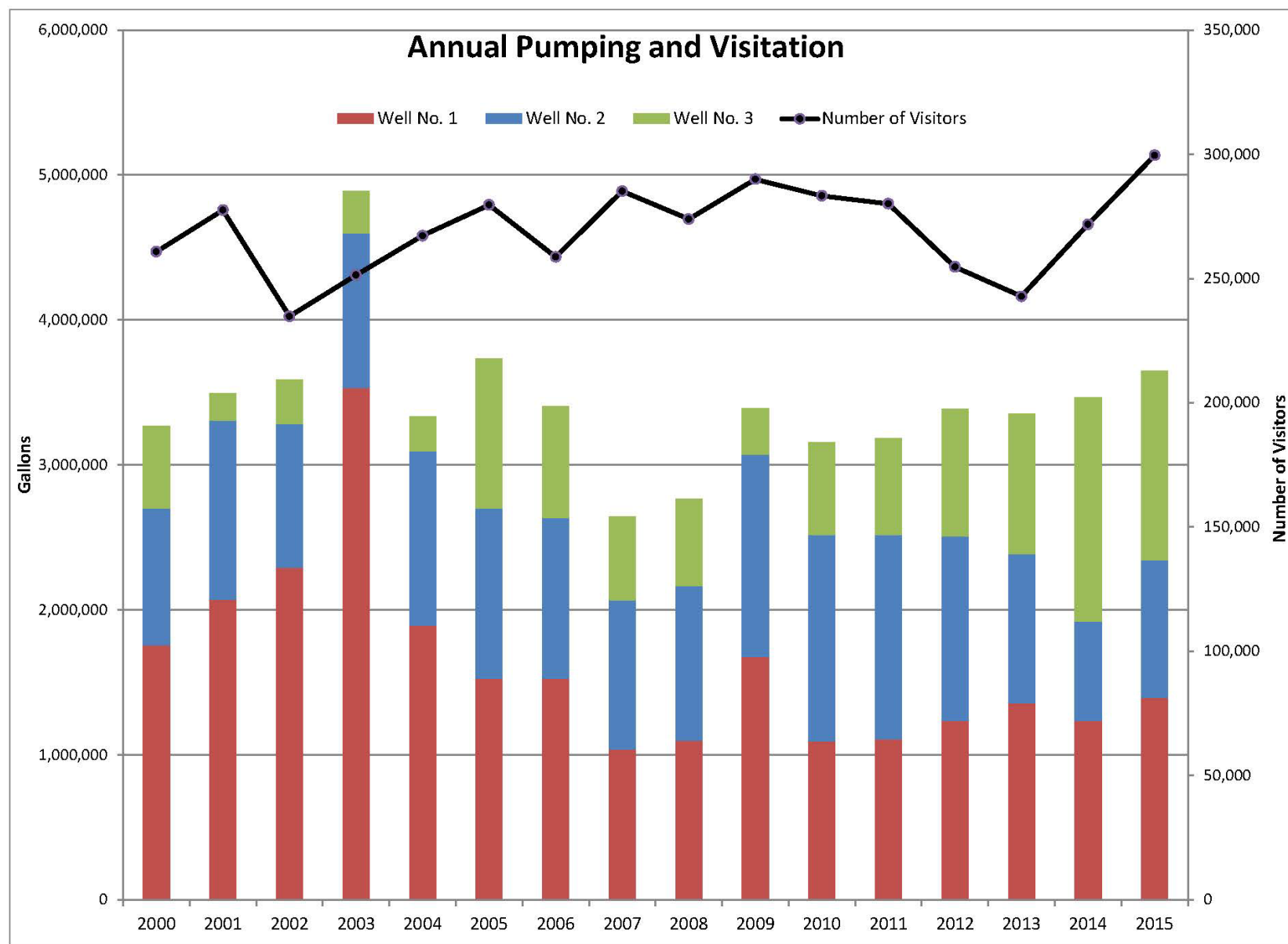


Figure 2. Annual pumping from Wells 1, 2, and 3 and visitation for 2000 – 2015 for GRSA.

Average monthly pumping for the POR increases during the summer months and decreases during the winter months (**Table 3** and **Figure 3**). This fluctuation is primarily a function of seasonal variations in visitation (**Section 4.0**). Average monthly pumping for the POR from all the wells ranges from approximately 0.5 afy from November through February to 1.4 afy during the months of June and July.

Table 3. GRSA Average Monthly Pumping for the period 2000 – 2015.

Month	Average Monthly Pumping (gallons)			Average Monthly Pumping (acre-feet)		
	Well 2 (Campground System)	Wells 1 and 3 (Headquarters System)	Total All Wells	Well 2 (Campground System)	Wells 1 and 3 (Headquarters System)	Total All Wells
Jan	23,683	134,679	158,362	0.07	0.41	0.49
Feb	13,778	118,562	132,340	0.04	0.36	0.41
Mar	72,535	129,217	201,753	0.22	0.40	0.62
Apr	77,371	159,856	237,227	0.24	0.49	0.73
May	162,909	223,969	386,877	0.50	0.69	1.19
Jun	183,189	286,469	469,658	0.56	0.88	1.44
Jul	176,294	291,548	467,842	0.54	0.89	1.44
Aug	161,347	256,069	417,416	0.50	0.79	1.28
Sep	125,888	216,912	342,800	0.39	0.67	1.05
Oct	73,493	203,653	277,146	0.23	0.62	0.85
Nov	29,751	144,898	174,649	0.09	0.44	0.54
Dec	23,907	122,276	146,183	0.07	0.38	0.45

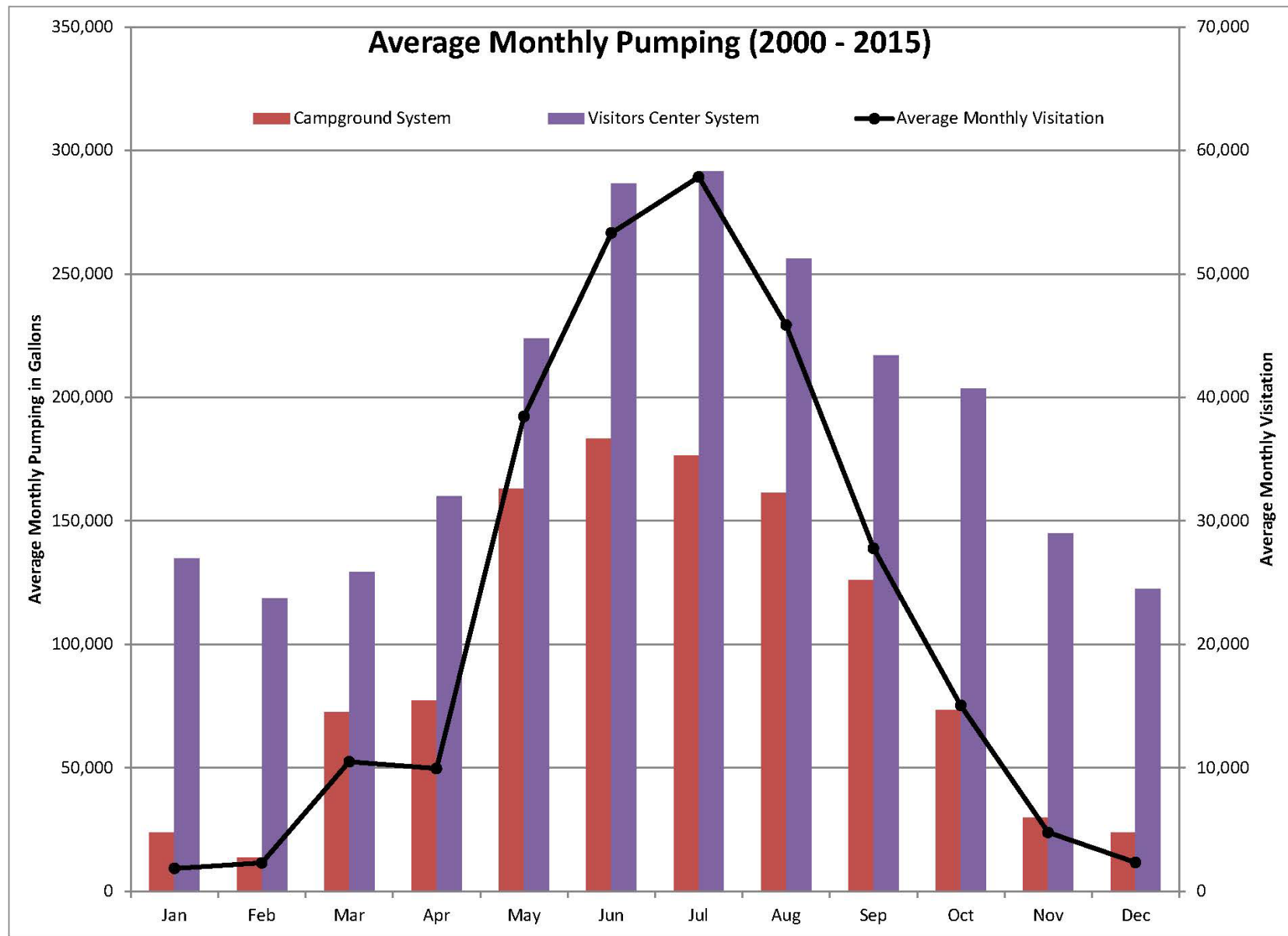


Figure 3. Average monthly pumping from the Campground and Headquarters System for 2000 – 2015 for GRSA.

4.0 Visitation

The NPS defines a “visit” as the entry of any person for recreational purposes onto lands or waters administered by the NPS (NPS, 2007). Annual, monthly, and overnight visitation data for GRSA was downloaded from the NPS Visitor Use Statistics website (NPS, 2016). Historical visitation at GRSA steadily increased from 1932 through the 1970’s, declined in the early 1980’s, and then rebounded again in the late 1980’s (**Figure 4**). Since the late 1980’s, annual visitation has fluctuated between approximately 230,000 and 315,000. General visitation trends at GRSA are similar to larger-scale trends in visitation to all NPS units nationwide (**Figure 4**).

Visitation counting procedures for GRSA were standardized and documented in 1992 when the NPS Socio-Economic Studies Division took over responsibility for nationwide visitor use statistics. Prior to 1998, a pneumatic rubber hose traffic counter located at the GRSA entrance station was used to estimate the total number of visitors using a person-per-vehicle multiplier. In 1998, GRSA converted to the more reliable inductive loop counter (NPS, 2007). It was estimated that the rubber hose counter inflated visitation by 9% (NPS, 2007).

During the 16-year POR, annual visitation has fluctuated between 230,000 and 300,000. A slight upward trend for the POR is evident with an average percent change per year of 0.60% (**Table 4**). This value is within the average percent change per year for NPS units as a whole (0.47%) and all NPS units in the Intermountain Region (0.78%) during this period. An increase in annual visitation is assumed to range from zero to one percent for the purposes of this report. Assuming a 1% increase in visitation per year, total annual visitation at GRSA could approach 500,000 by 2065.

Table 4. Annual Visitation for GRSA, all of the NPS, and all NPS Units in the Region for 2000 – 2015.

Year	GRSA Visitors	Percent Change	All NPS Visitors	Percent Change	All Region Visitors	Percent Change
2000	260,789	-9%	285,891,275	0%	42,431,637	-4%
2001	277,523	6%	279,873,926	-2%	40,857,123	-4%
2002	234,776	-15%	277,299,880	-1%	39,762,505	-3%
2003	251,375	7%	266,230,290	-4%	39,436,527	-1%
2004	267,204	6%	276,908,337	4%	39,404,658	0%
2005	279,589	5%	273,488,751	-1%	39,885,585	1%
2006	258,660	-7%	272,623,980	0%	39,360,697	-1%
2007	285,121	10%	275,581,547	1%	40,986,271	4%
2008	273,903	-4%	274,852,949	0%	40,561,032	-1%
2009	289,955	6%	285,579,941	4%	42,882,594	6%
2010	283,284	-2%	281,303,769	-1%	42,652,924	-1%
2011	280,058	-1%	278,939,216	-1%	40,543,746	-5%
2012	254,674	-9%	282,765,682	1%	41,274,385	2%
2013	242,841	-5%	273,630,895	-3%	39,317,965	-5%
2014	271,774	12%	292,800,082	7%	43,983,051	12%
2015	299,513	10%	307,247,252	5%	49,076,680	12%
Average:	269,440	0.60%	280,313,611	0.47%	41,401,086	0.78%

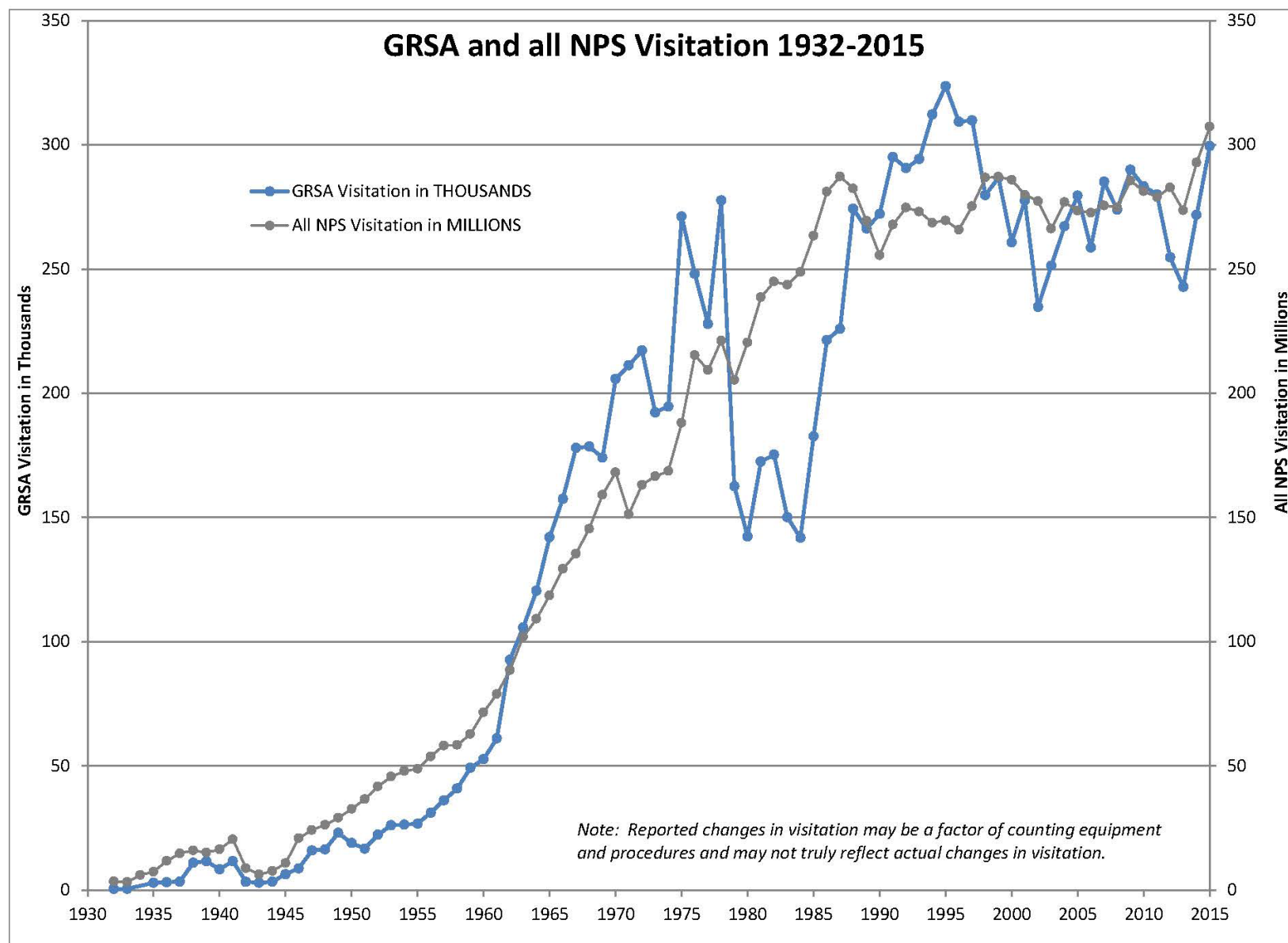


Figure 4. Annual Visitation for GRSA and for all NPS units for the period 1932 – 2015.

Monthly visitation data for GRSA (NPS, 2016) for the POR indicates that peak visitation occurs during the summer months (June – August) with an average of approximately 52,000 visitors per month and corresponds directly with peak water use (**Table 5** and **Figure 3**). Visitation is at its lowest during the winter (November – February) with only 1,800 – 5,000 visitors per month. During the shoulder season in the Spring and Fall (March, April, May, September, and October) visitation averages between 9,500 and 40,000 visitors per month.

Table 5. GRSA Average Monthly Visitation for 2000 – 2015.

Month	Average Visitation
Jan	1,857
Feb	2,304
Mar	10,497
Apr	9,943
May	38,449
Jun	53,309
Jul	57,850
Aug	45,855
Sep	27,786
Oct	15,049
Nov	4,769
Dec	2,338

The number of overnight visitors during the POR at GRSA (NPS, 2016) was also compared with water use at the Campground System (**Table 6**). Annual visitor overnight stays at GRSA ranged between 33,000 and 54,000 and averaged approximately 45,000. The number of annual overnight stays is not anticipated to exceed 60,000 per year since the number of campground sites is not anticipated to change⁵ and campground visitation is near the maximum during the POR because the campground is full most nights when it is open during the camping season⁶.

⁵ Personal communication with Chuck Tomkiewicz – GRSA Chief of Facility Management, 4/27/2016

⁶ Personal communication with Rhonda Madril – Acting GRSA Utilities System Operator, 5/19/2016

5.0 Water Use versus Visitation

Visitation data was compared with water use data for the 16-year POR. Total water use per visitor ranged between 9 and 20 gallons per visitor (**Table 6**). There does not appear to be a strong correlation between total water use and visitation at GRSA from year to year (**Figure 2**). There is, however, a direct correlation between visitation (specifically the number of overnight stays) from year to year and water use at the Campground System (**Table 6** and **Figure 5**). Prior to 2014, the total water use per overnight visitor at the Campground System ranged between 22 and 32 gallons per overnight visitor with an average of 27 gallons. There is a significant decrease in water use per overnight visitor in 2014 and 2015 as a result of upgrades made to campground restroom faucets and toilets.

Table 6. Pumping per Visitor at GRSA (2000 – 2015).

Calendar Year	Pumping Per Visitor (gallons)		Visitor Overnight Stays	Campground System Pumping Per Visitor with Overnight stay (gallons)
	All Wells	Headquarters System		
2000	12.5	8.9	34,723	27
2001	12.6	8.1	46,266	27
2002	15.3	11.1	37,954	26
2003	19.4	15.2	43,556	24
2004	12.5	8.0	43,110	28
2005	13.4	9.2	45,830	26
2006	13.2	8.9	40,969	27
2007	9.3	5.7	45,916	22
2008	10.1	6.2	45,414	23
2009	11.7	6.9	51,292	27
2010	11.1	6.1	49,826	29
2011	11.4	6.3	46,830	30
2012	13.3	8.3	39,339	32
2013	13.8	9.6	33,036	31
2014	12.8	10.2	50,084	14
2015	12.2	9.0	53,776	18
Average:	12.8	8.6	44,245	26

There does not appear to be a correlation from year to year between visitation and water use from the Headquarters System (**Figure 6**), which may be due to the fact that this system is not only used by visitors, but also by staff and seasonal and permanent residents. There is a wide range of calculated water use per visitor during the POR for the Headquarters System. Water use per visitor ranged between 5.7 and 15.1 gallons per visitor and averaged 8.6 gallons per visitor during the POR (**Table 6**).

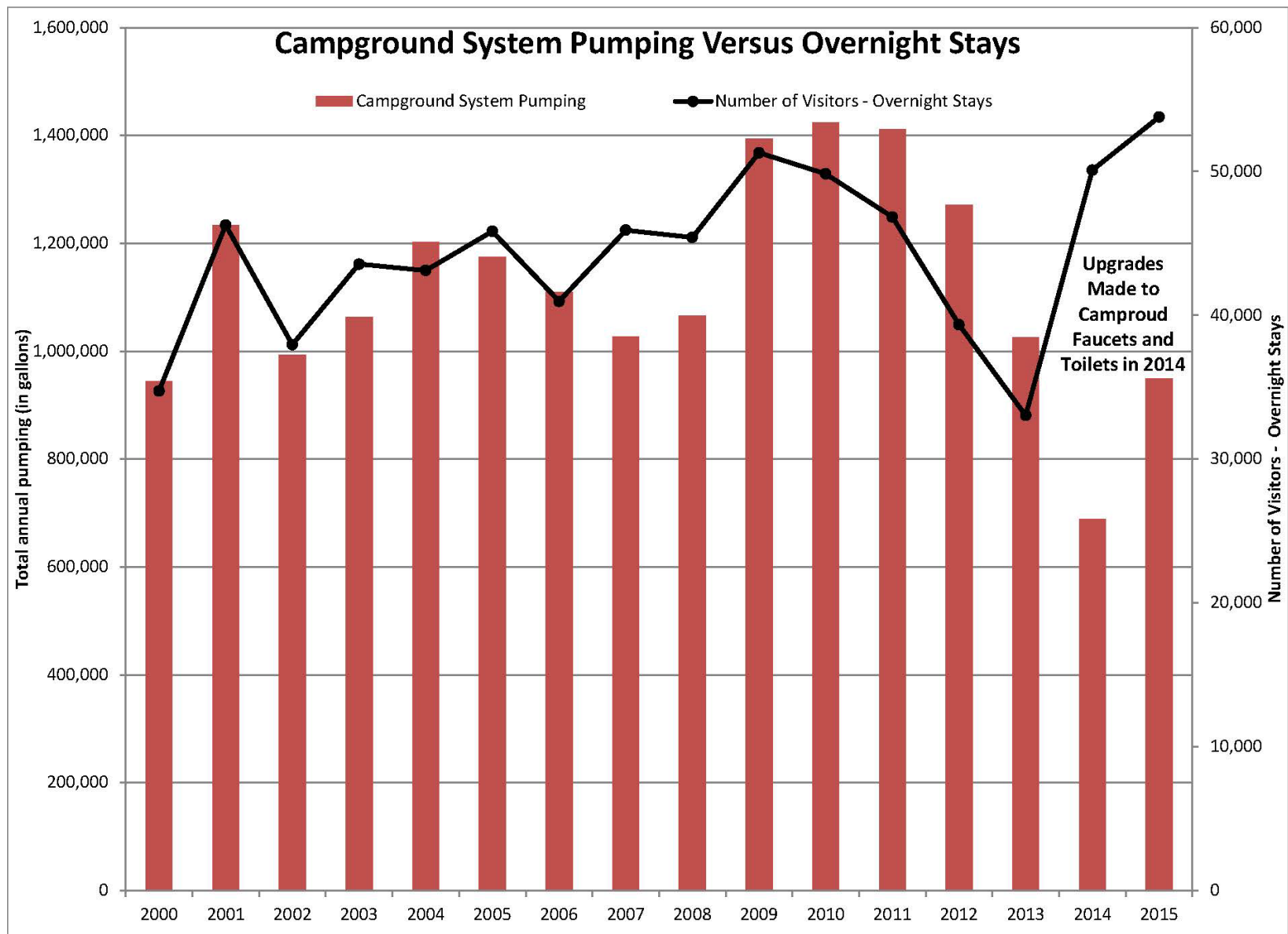


Figure 5. Campground System Pumping Versus Overnight Stays (2000 – 2015).

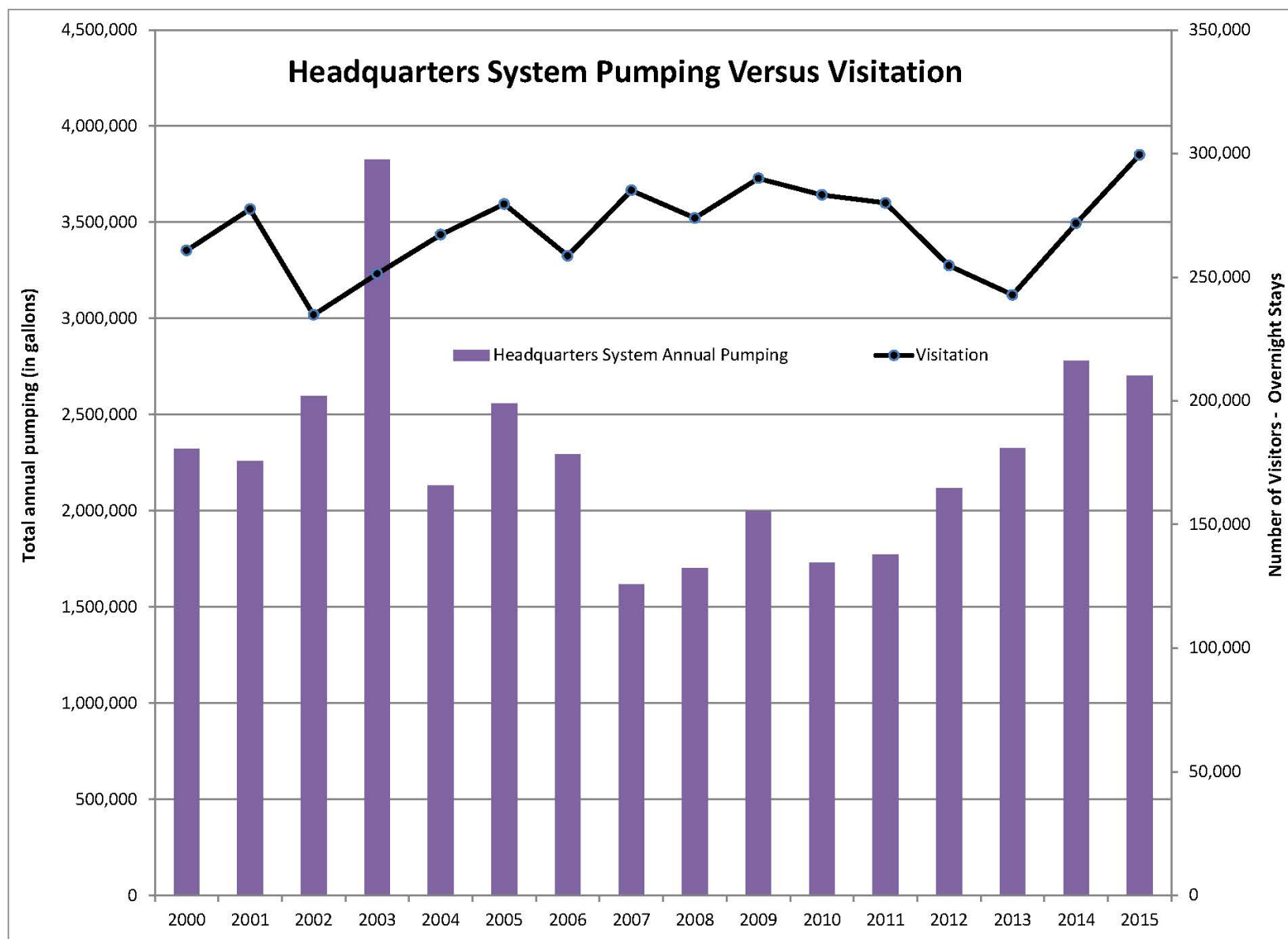


Figure 6. Headquarters System Pumping Versus Visitation (2000 – 2015).

6.0 Future Water-Use Projections

Future water use at GRSA is projected out for a 50-year period (to the year 2065) for the purposes of evaluating the NPS' responsibilities under the new Rules governing the withdrawal of groundwater in the Rio Grande Basin. The following are the four major variables that are considered to affect future water use at GRSA: #1) construction of new facilities requiring additional water use, #2) changes in the number of temporary and full-time employees living on site, #3) future maintenance problems, system upgrades, and operation issues, and finally #4) future visitation.

According to GRSA staff,⁷ there are currently no plans for adding facilities or operations that would increase water use in the foreseeable future. Therefore, it is assumed that variable #1 will remain unchanged. Also, for the purposes of this future water-use assessment, it is assumed that variables #2 and #3 will also remain constant throughout the projected record and will not differ from the 16-year POR. Therefore, future water-use projections in this report are assumed to be entirely dependent on future visitation.

Visitation was projected to be as high as 500,000 people by the year 2065 (**Section 4.0**). This number is almost double the average visitation over the last 16 years. GRSA would likely need to consider visitor use management actions prior to this degree of visitation occurring.

Water use at the Campground System is almost entirely a factor of the number of overnight visitors per year and, therefore, is estimated to range between 2 and 6 afy (given the assumptions listed in **Table 7**). Water use at the Headquarters System is not only a factor of changes in visitation, but also changes in Park staffing and the number of temporary and seasonal residents living on site. Assuming all variables remain constant with the exception of visitation, it is estimated that future use at the Headquarters System will range between 5 and 14 afy (given the assumptions listed in **Table 7**). Therefore, total future water use for GRSA is estimated to range between 7 and 20 afy.

⁷ Personal communication with Chuck Tomkiewicz – GRSA Chief of Facility Management, 4/27/2016

Table 7. Estimated Future Projections (2016-2065).

Projection Category	Estimated Future Projections: 50 Year Period (2016-2065)					Description and Assumptions
Visitation (Low)	270,000	people				This projection is the average visitation during the 16-year POR (2000-2015). It assumes that the visitation in 2065 will not be less than the average visitation during the POR. This projection effectively assumes a 0.00% change in visitation.
Visitation (High)	500,000	people				This projection assumes a 1% annual increase in visitation, as discussed in Section 4.0 . It was calculated by adding 1% per year to the visitation every year starting from the 2015 visitation (299,513).
Campground System Pumping (Low)	688,530	gallons	2.1	afy		This projection is equal to the lowest pumping for the POR (2000-2015). It assumes that the number of campsites will not increase and that the campground was at capacity during the summer months during the POR.
Campground System Pumping (High)	1,920,000	gallons	5.9	afy		This projection was calculated by multiplying the highest water use per overnight visitor for the POR (32 gallons per person) by the highest expected overnight visitation per year as discussed in Section 4 (60,000 people). It assumes that the number of campsites will not increase and that the campground was at capacity during the summer months during the POR.
Headquarters System Pumping (Low)	1,617,990	gallons	5.0	afy		This projection assumes that pumping in the year 2065 will not be lower than the lowest pumping during the POR (2000-2015)
Headquarters System Pumping (High)	4,500,000	gallons	13.8	afy		This projection was calculated by multiplying the projected high annual visitation (500,000 visitors) by the average water use per visitor at the Headquarters System (8.6 gallons per visitor) during the POR. This projection assumes that the number of staff and temporary and permanent residents living on-site remains constant.
Projected Total Pumping (Low)	2,306,520	gallons	7.1	afy	--	
Projected Total Pumping (High)	6,420,000	gallons	19.7	afy	--	

7.0 Summary and Conclusions

Three active groundwater wells supply water to GRSA for domestic, administrative, and operational needs via two separate water supply systems. An average of 10.5 afy of water was used during the 16-year POR. During this period, annual visitation averaged 270,000 and increased at an average of 0.60% per year. Future water use was projected to range between 7 and 20 afy in 50 years.

8.0 References

- Chatman M., Sharrow D., and Valdez A. 1997. Water Resources Management Plan Great Sand Dunes National Monument, Colorado. National Park Service.
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- NPS 2016. National Park Service Visitor Use Statistics. Available at <https://irma.nps.gov/Stats/> (accessed July 2016).

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