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Groundwater Development and Water Supply Wells at Mount Rushmore National Memorial

Introduction

In October 2006, I visited Mount Rushmore National Memorial to evaluate local hydrogeologic conditions and advise the park staff on the location for a new water-supply well. At that time, the water supply for the entire park was obtained by pumping from a single well. The well could barely keep up with the demand during the peak season.

A site was selected near the burn pit area and a test well was constructed. Preliminary testing showed that this new well could probably produce a sustained yield of 30 gpm. The well is about 3000 feet from the water treatment plant and on the opposite side of Hwy 244. Construction of a water line between the well and the treatment plant would be expensive, including crossing under a major highway.

A second well was constructed near the water treatment plant in 2010. Testing of this well showed that it would have a sustained yield of nearly 40 gpm. This well was completed as the second water-supply source for the park.

A new water treatment plant has been completed to reduce the arsenic concentration in the pumped groundwater to meet drinking water standards.

This report will provide an historical accounting of wells that have been constructed throughout the park. An assessment of the water-supply situation in 2006 is provided. Information regarding the construction and testing of the new wells at the burn pit area (2009) and at the water treatment plant (2010) is also provided.

Well Numbering

The wells currently used to provide water for the park are known to park staff as Well No. 1 and Well No. 2. Those names will be retained in this report to avoid confusion. Test wells constructed in the 1960s will be referred to by letter (A, B, C, etc.) to separate them from production wells. The well that was constructed in 2008 will be referred to as the Burn Pit Well.

Previous Investigations

A previous investigation by the USGS (Powell and others, 1973) provided an assessment of hydrogeologic conditions and resulted in construction of several test wells in the park. The location of these test wells are shown on Figure 1.

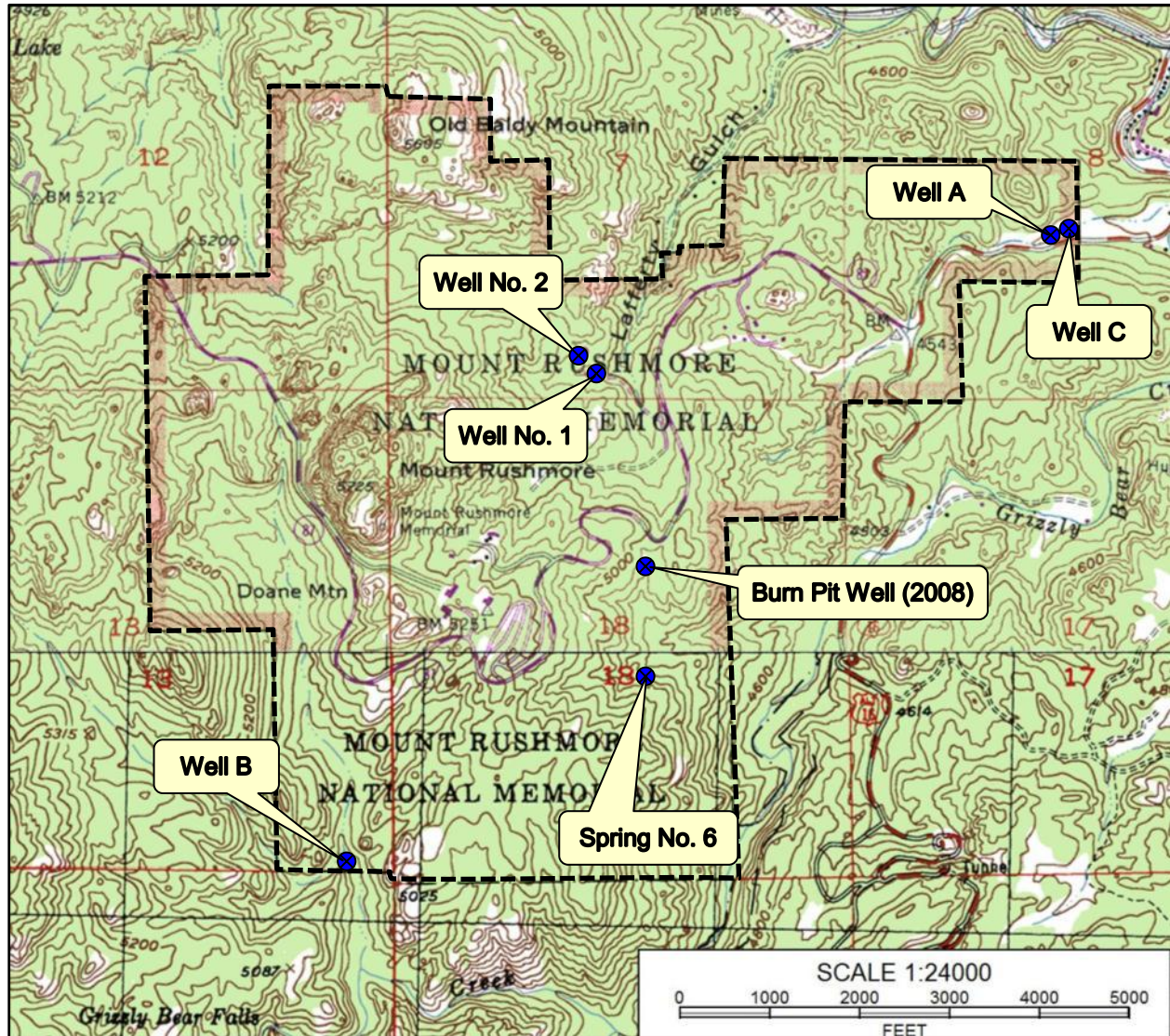


Figure 1. Locations of water-supply sources at Mount Rushmore National Memorial.

Table 1. Summary of water-supply wells constructed at Mount Rushmore National Memorial.

Well name/number	Year constructed	Depth (feet)	Est. Yield (gpm)
Well A	1960	61	20-30
Well B	1960	58	Unknown
Well C	1967	500	20-30
Well No. 1	1967	200	50
Burn Pit Well	2008	580	35
Well No. 2	2010	500	40

Wells A and C are located along the creek near the east boundary of the park. Well A is a shallow well (61 feet deep) completed in the alluvium along the creek. Well C is a deep well (500 feet) completed in the fractured bedrock. Both wells are capable of producing 20-30 gpm, but the water has high concentrations of iron and manganese and would require treatment to make it potable. Utilization of water from these wells would require pumping the water uphill for about 1½ miles with an elevation gain of about 400 feet.

Well B is located along the creek near the southwest boundary of the park. No information was found regarding the yield of the well. Well B is virtually inaccessible. Adjacent U.S. Forest Service land has been designated as wilderness area, so it would be impossible to construct access from the south. There is a hiking trail from the parking area at the Memorial to the well, but it is narrow and rugged. Access to the well would require constructing about ¾ mile of new access road, water line, electrical service, etc. For all practical purposes, Well B is inaccessible.

Well No. 1 was constructed in 1967. It is 200 feet deep and obtains water from fractured bedrock. Yield from the well is around 50 gpm. Until May 2012, Well No. 1 was the sole source of water for the park.

Spring No. 6 was at one time developed as a water source for the Forest Service's Grizzly Bear Campground about ½ mile east of the spring. The spring is no longer used for a water supply. The Forest Service drilled a well at the campground.

Powell and others (1973) identified several areas where water supplies could potentially be developed. They suggested that a well could be constructed in the alluvium along Grizzly Bear Creek; however, most of the creek valley is on Forest Service property, and outside the boundary of the Park. Only a short reach of the valley is on NPS property in the extreme southeast part of the Park. There is no road access to this area. Lafferty Gulch near the north boundary of the Park was mentioned as a potential location for a test well, but it also lies in rugged terrain with no road access.

2006 Investigation

The author visited the park in October 2006 to obtain data regarding water use at the park, assess the need for an additional water-supply well, and recommend a location for construction of a new well.

The report by Powell and others (1973) provided most of the background information and geologic mapping necessary to evaluate hydrogeologic conditions. The primary area of consideration for a new well was limited to the area east of the Memorial, and in particular within close proximity to the existing water treatment plant to limit the distance for water and electrical connections between a new well and existing infrastructure. Two areas were identified as potential locations for well construction; the burn pit north of Spring No. 6 and near the water treatment building (within about 200-300 feet northwest of Well No. 1).

The area near Spring No. 6, at the center of Section 18 is geologically similar to the area with Well No. 1, the existing water supply well. The presence of a perennial spring and favorable geologic conditions make this a good potential area for construction of a test well. It is likely that

the fractured bedrock extends for some distance from the spring area, most likely trending in a north-south direction following the geologic structure. Thus, it isn't necessary to drill a well at the spring; the well can be located some distance away and would probably still intersect fractures in the bedrock that feed groundwater toward the spring. A good potential area for a test well is off the south end of the wood disposal area (aka Burn Pit), about 200 yards south of the highway. This area has good access for a drill rig, is already disturbed, and most importantly has favorable geologic conditions.

Another potential site for a supplemental supply well is in the vicinity of Well No. 1 and the water treatment plant. A potential well site was identified on the west side of the water plant that would be more than 100 yards from the existing well. It's impossible to predict beforehand whether this distance might be too small, with some risk that the drawdown effects from pumping each well individually would overlap, resulting in increased drawdown in both wells. There are advantages to having all of the water production facilities in the same general area at a site that has previously been disturbed. In a paper presented in the South Dakota Academy of Science, Rahn (1990) determined the spring discharge in this basin was more than 5 million gallons per year (in addition to the 6.5 million gallons pumped from Well No. 3), representing additional groundwater that could be captured.

Subsequently, two wells were constructed. The well at the Burn Pit was constructed in 2008. Well No. 2 was constructed north of the water treatment building in 2010. The locations of these wells are shown on Figure 1.

The single water-supply well at Mount Rushmore provided all of the water for facilities at the park from 1967 to May 2012 when a second well was brought on-line. Groundwater pumping from Well No. 1 was barely able to meet the demand during the summer tourist season. As an example, during the week of Aug. 4-11, 2006, the well was pumped for about 150 of the 168 hours of the week. Demand typically ranged from less than 200,000 gallons per month in the winter to about 1.5 million gallons per month in the summer.

Burn Pit Well (2008)

A test well was constructed south of the burn pit area (Figure 1) in Fall 2008. The well was drilled to a total depth of 580 feet. The bottom 100 feet was drilled through hard gray schist that did not produce an appreciable amount of water. There were no water-bearing fractures below a depth of 485 feet.

The well has 8-inch steel casing cemented in place to a depth of 40 feet. Below 40 feet, the well was completed as an open borehole.

The well driller reported a sustained yield of 55 gpm during an 8-hour pumping test in December 2008. The data from this test could not be located by the drilling company (Alexander Drilling) or in the park files.

The author conducted a pumping test of the well in August 2009. The first step of the pumping test was conducted at 20 gpm. Water level in the well was drawn down from the static level of 30 feet to more than 150 feet below ground surface during the 3:15 duration of pumping (Figure 2).

The water level was allowed to recovery for 2½ hours. We then attempted to conduct a second test at the maximum pumping rate for the pump; initially 60 gpm. The water level was quickly drawn down below 260 feet. We could not get a probe to pass beyond the 260-foot depth and therefore have no water level measurements. The pumping rate gradually decreased during the 2½ hours of this step to about 45 gpm.

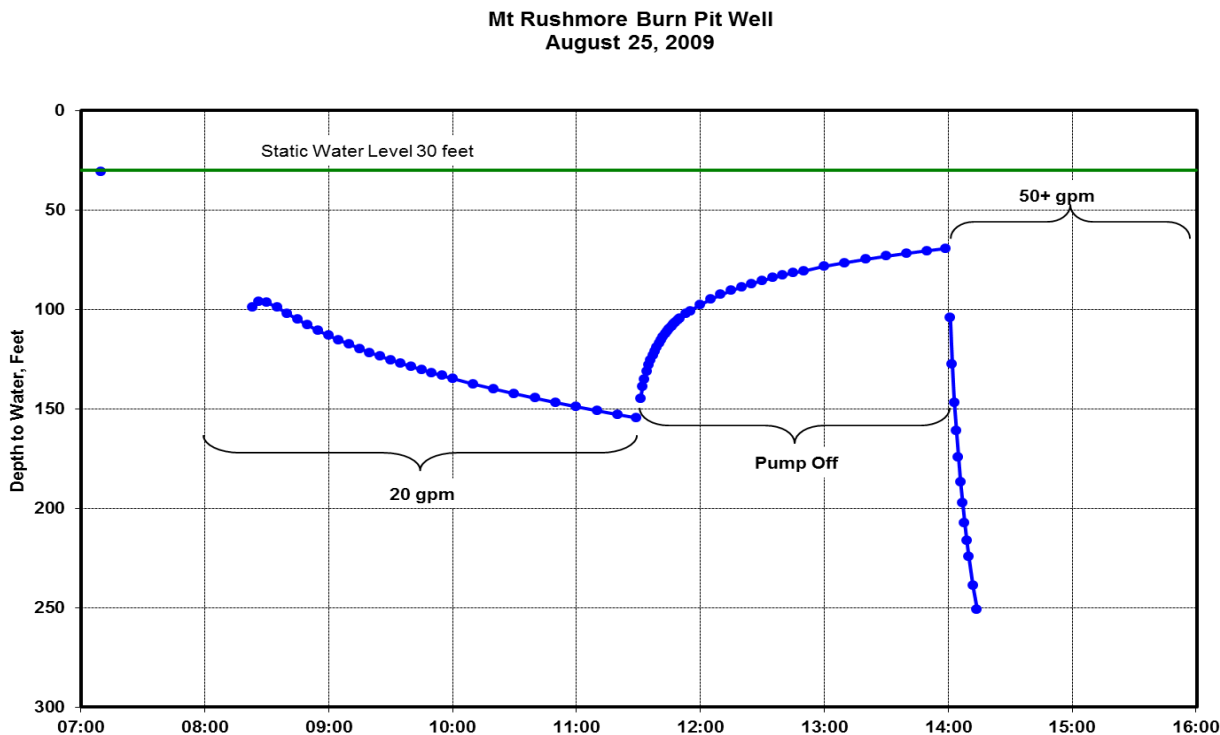


Figure 2. Water levels during a pumping test of the Burn Pit Well, August 2009.

Since we could not make water level measurements in the well, we decided to conduct an 8-hour test at the maximum pumping rate while monitoring the pumping rate to get an idea of how much water the well could produce. The pumping rate decreases as the water level is drawn down and the pumping lift increases. The pump is rated to produce about 50 gpm from a depth to water of 500 feet. Since the pumping rate was much lower, the water level must have been drawn down to the pump intake (at 500 feet) and the well was pumping air. Based on the data from this test, it appears that the sustainable yield of the well is not more than 35 gpm, and is possibly less (Figure 3).

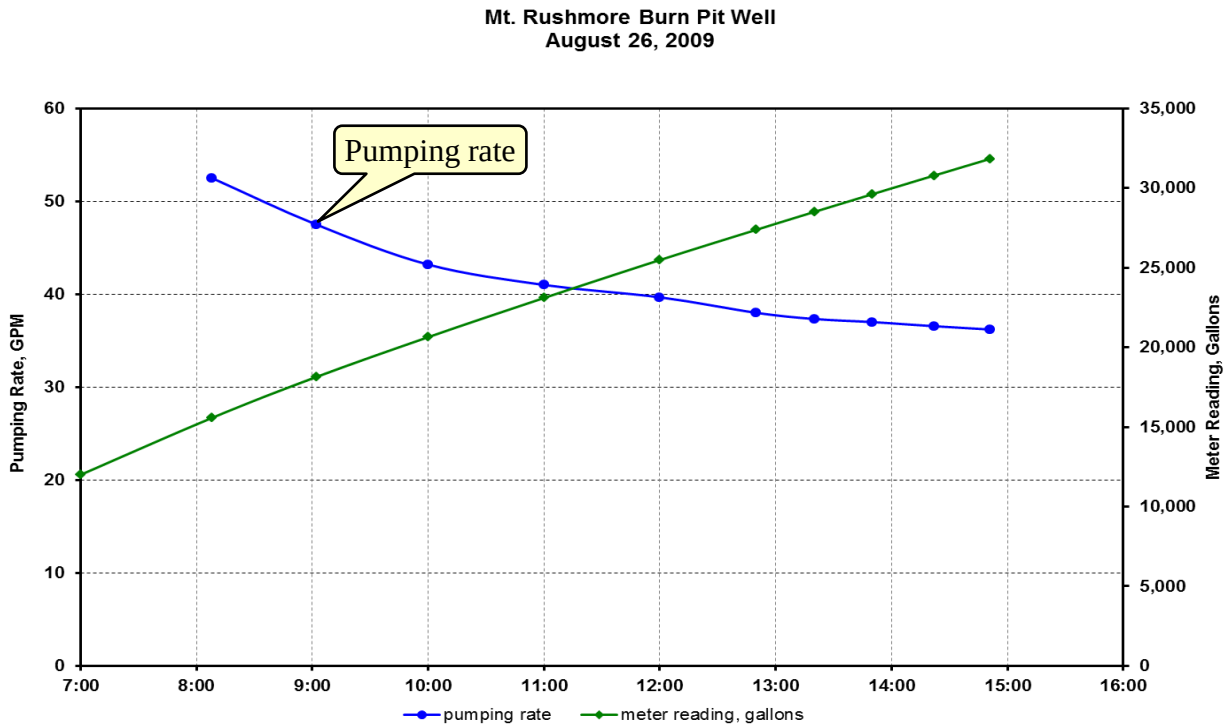


Figure 3. Pumping rate during an 8-hour test of the Burn Pit Well.

Well No. 2 (2010)

A second test well was constructed a few hundred feet north of the water treatment plant in Fall 2010. The well was drilled to a total depth of 500 feet. Groundwater is obtained from fractures in the schist bedrock at various depths.

The well has 8-inch steel casing cemented in place to a depth of 38 feet. There is a 6-inch PVC liner and screen from 40-500 feet. Sections of perforated pipe is alternated with solid PVC pipe over the 460 feet from 40-500 feet depth.

The static water level was reported to be 22 feet, but with no indication of whether that is measured from the top of the casing or ground surface. The well driller (Alexander Drilling) reported a yield of 40 gpm during a 14-hour hour pumping test (Figure 4). Maintaining a pumping rate of 40 gpm caused the water level to be drawn down to the pump intake. Thus, 40 gpm is the maximum sustained yield for the well.

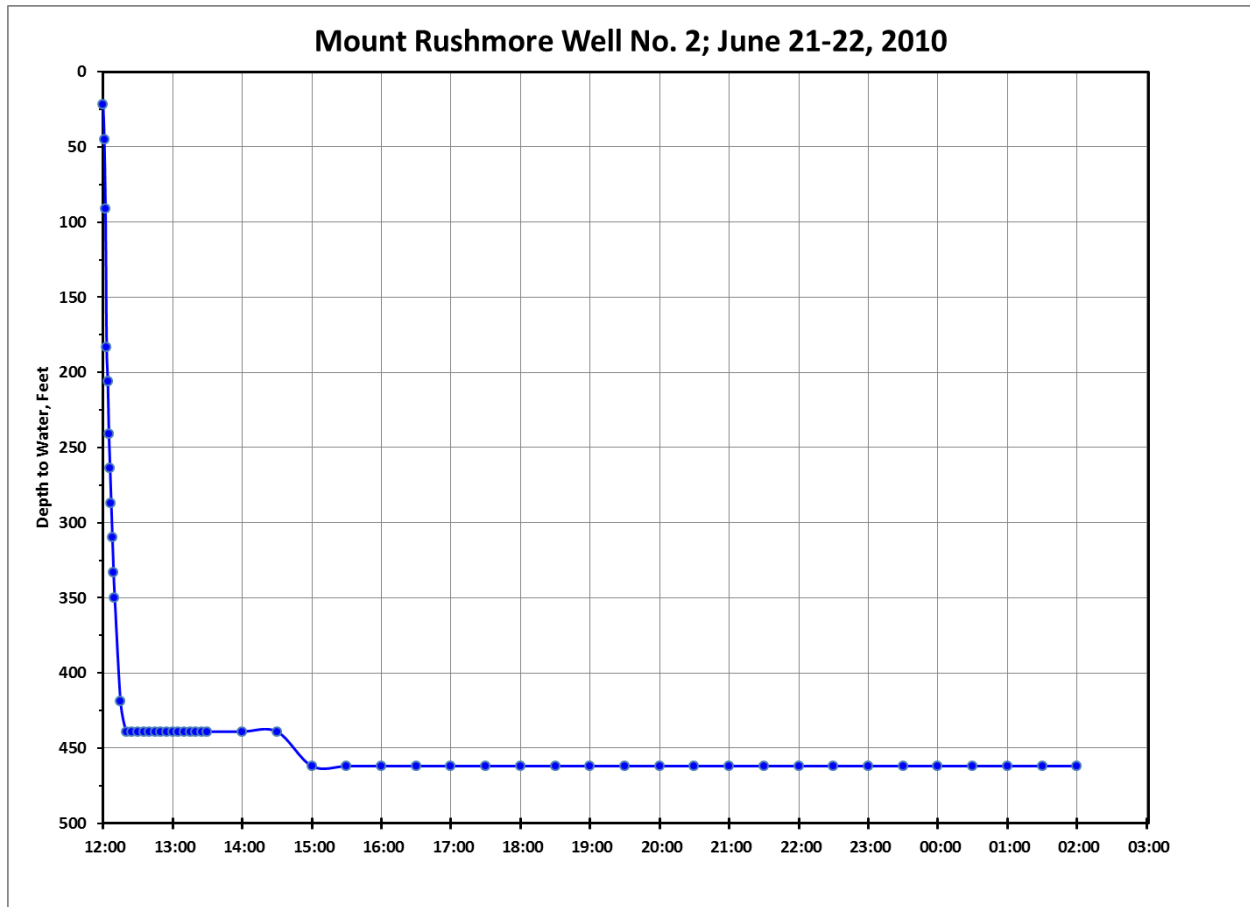


Figure 4. Water level in Well No. 2 during a 14-hour pumping test at 40 gpm.

Water Use

Water use data were provided by park staff. Visitation, and therefore water use, is largest during the summer months. Peak demand is 50-60,000 gallons per day in July and August. In the winter months, demand is less than 10,000 gallons per day (Figure 5). Daily meter readings are available for the summer months from 2005-2011. These data were averaged and are graphed in Figure 6, showing the average daily use for each day from May 1 to September 30 for seven years from 2005-2011.

Figure 7 shows the water level monitoring data from Well No. 1 for three years (October 2003 to October 2006). During the off-season, the static water level is 1-2 feet below ground surface and the pumping water level is about 30 feet below ground surface. In the summer time, the static level drops to around 30 feet below ground surface and the pumping water level is around 80 feet below ground surface. The pump is set at 160 feet below ground and the well is 200 feet deep. There is still plenty of water in the well, even during peak season, but it's impossible to predict whether the pumping rate could be increased significantly without further testing of the well. The well has been a reliable source of water for the past 45 years.

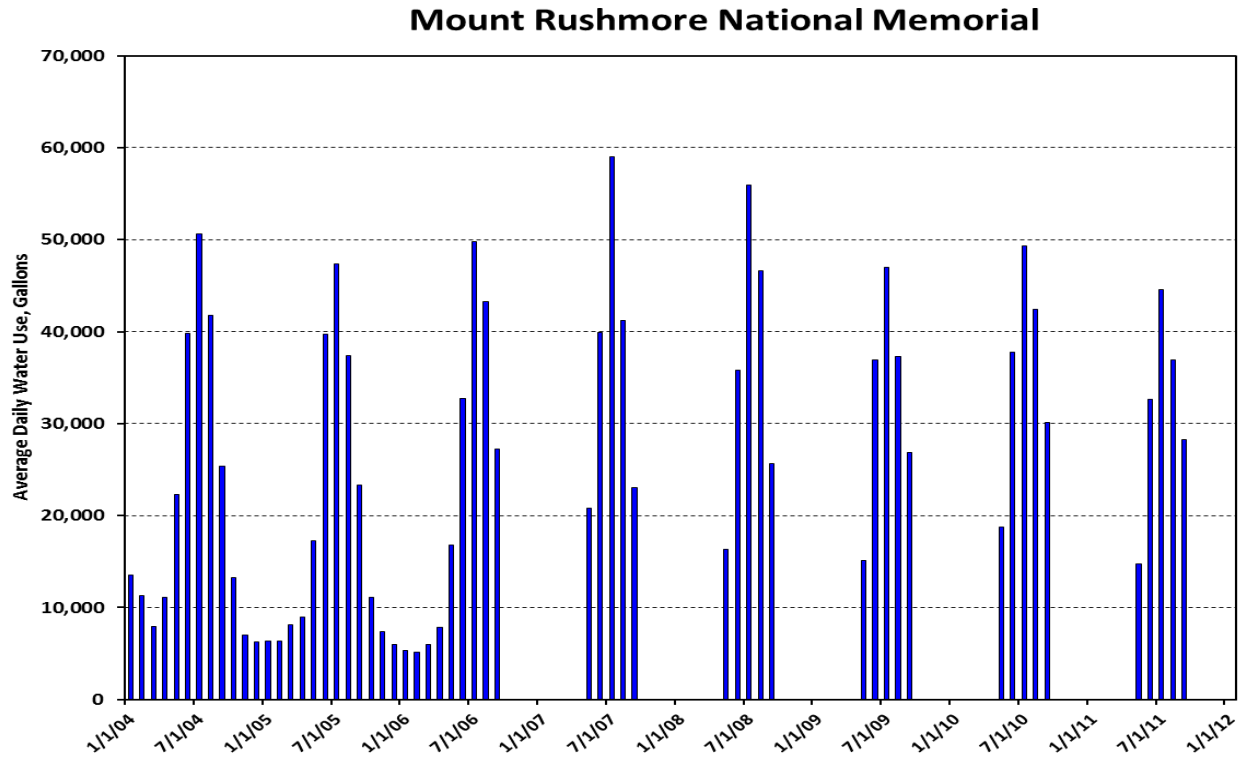


Figure 5. Average daily water use, derived from monthly totals (monthly total/# days).

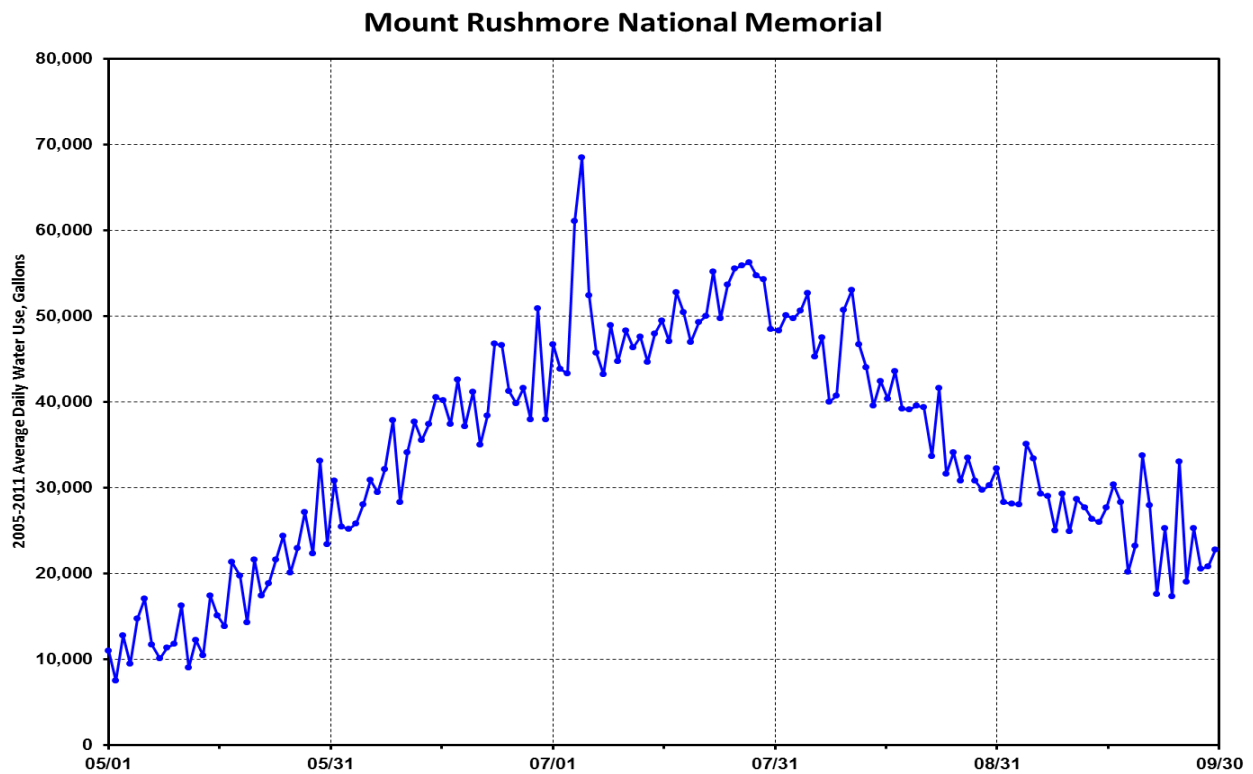


Figure 6. Average daily water use derived from daily meter readings, May-September for seven years; 2005-2011.

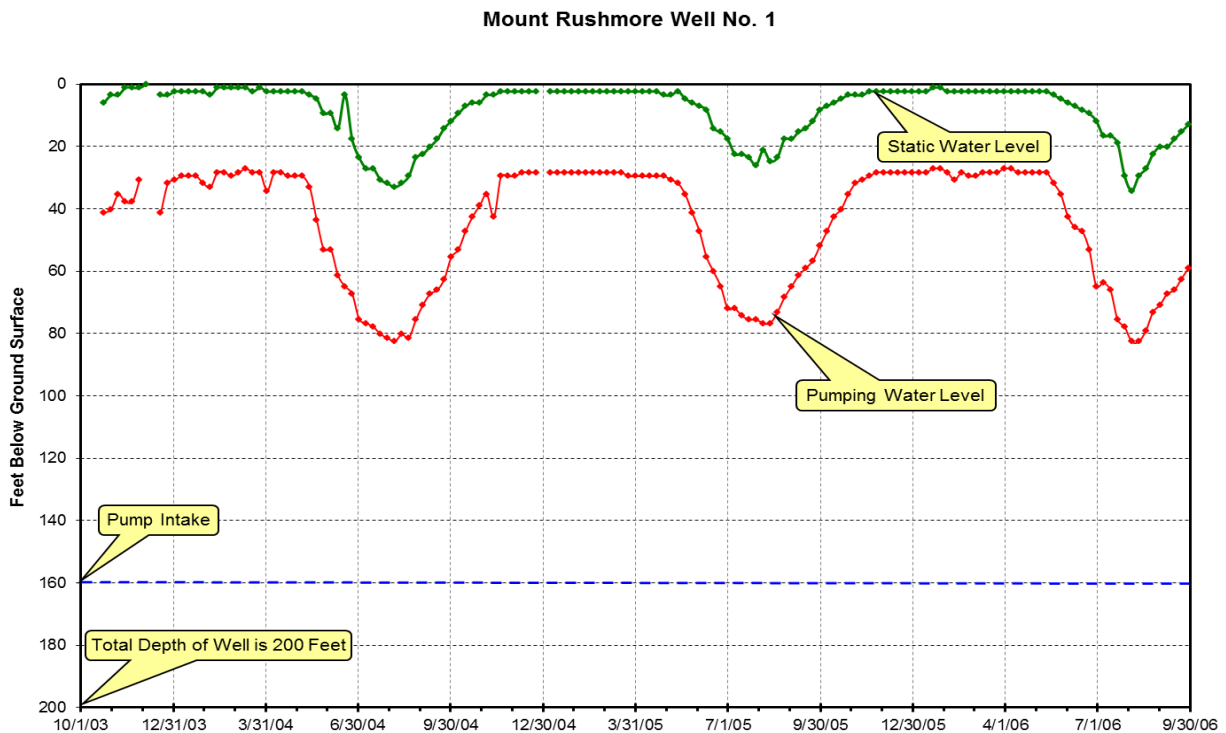


Figure 7. Weekly high and low water levels in Well No. 1, Oct. 2003 to Oct. 2006.

Current Situation (2012)

As of May 2012, Well No. 2 has been connected to the water system. The plan is to use both wells during the peak summer season and alternate pumping between wells in the winter.

An arsenic mitigation plant has been added to the water treatment plant. Groundwater from either Well No. 1 or Well No. 2 is routed through the treatment plant to remove arsenic. Both wells can be pumped at the same time during the peak season to meet demand.

References

Powell, J.E., J.J Norton, and D.G. Adolphson, 1973, *Water Resources and Geology of Mount Rushmore National Memorial, South Dakota*, U.S. Geological Survey Water-Supply Paper 1865, 50 pp.

Rahn, Perry H., 1990, *Ground-Water Recharge at Mount Rushmore*, Proc. S.D. Acad. Sci., Vol 69, pp. 129-138.