

July 23, 2013

L54(2380)
CRLA/General

Memorandum

To: Superintendent, Crater Lake National Park

Through: Ed Harvey, Chief, Water Resources Division (WRD)
Gary Rosenlieb, Chief, Aquatic Systems Branch (ASB)

From: Larry Martin, Hydrogeologist, Aquatic Systems Branch (ASB)

Subject: Trip Report to investigate potential groundwater sources for the park's public water-supply system.

Summary: I recommend constructing a test well at the parking area for the Pacific Crest trail on Hwy 62, about a half mile west of Mazama Village. The well would be constructed to evaluate the groundwater resources in the Wildhorse Bluff basalt lava flows. This location is the only site that could be identified within a reasonable distance of existing park infrastructure that might develop groundwater that is not directly associated with the surface waters of the upper Klamath Basin. The initial test well should be drilled to about 500 feet, unless poor quality groundwater is encountered at shallower depth or if crystalline volcanic rocks are encountered that have little potential to yield groundwater.

There is no assurance that a well drilled into the basalt lava flows will produce sufficient water to meet park needs. However, several factors hint at the potential for developing groundwater from bedrock in this area including: (1) observation of intense fracturing of the bedrock where it is exposed in outcrops, (2) perennial streams emanating from areas underlain by the basal lava flows, (3) potential for abundant recharge from snowmelt and precipitation, (4) potential for high-permeability zones between basalt flows, and (5) north-south trending fracture zones that might be conduits for groundwater flow.

Introduction: Water for facilities at Crater Lake National Park is obtained by diverting flow from Annie Spring. During the peak summer season, water use averages about 70,000 gpd (gallons per day), or 50 gpm (gallons per minute). Under normal conditions, Annie Spring produces more than enough water to meet the park's needs. However, the park has a junior water right (priority date of 1902) and its water supply is susceptible to being cut off during dry years, such as 2013. The park would like to find a groundwater source to use as a supplemental supply when senior water right owners request a call on the Park's Annie Creek water right.

The Oregon Water Resources Department (OWRD) is responsible for administering water rights in the state. OWRD administers water rights under the presumption that any well within ¼ mile of a stream may be producing water that is connected with a stream and is thus treated as a surface water source. Thus, NPS would need to locate a well more than ¼ from a stream, or prove that local geologic conditions preclude any effect on streamflow from pumping of the well. In the future, all proposed well locations within the Klamath Basin may be scrutinized more closely and the applicant might bear the responsibility of proving the lack of connection with surface waters (even those wells outside the ¼-mile distance).

This trip report evaluates all potential groundwater sources within a reasonable distance of the park headquarters and Mazama Village, regardless of the distance from streams or springs. Although we are not considering construction of a well near a stream at this time, such information might be useful in the future.

Existing Wells

The only existing wells at Crater Lake National Park are several shallow monitoring wells at the wastewater treatment lagoons in the Munson Valley, south of the headquarters area. These wells are completed in the unconsolidated overburden overlying volcanic ash bedrock. The volcanic ash bedrock is exposed on the canyon walls of Munson Valley and Annie Creek. These wells provide little useful information with respect to identifying a reliable source of groundwater for park facilities.

Two test wells were drilled in the park in 1962 north of Crater Lake (Frank and Harris, 1962). At Cleetwood Cove, a test well was drilled to 429 feet. Water entered the well from a perched aquifer at an estimated rate of 1 gpm and drained out the bottom of the borehole. No perched water bodies capable of supplying water to park facilities were encountered during the drilling of the well. A well near the north entrance was drilled to 1037 feet. As at the Cleetwood Cove well, no reliable sources of water from perched aquifers were found during the drilling of the well. Both wells were capped and abandoned. Geologic conditions encountered during the construction of the two wells in the northern part of the park provide little useful information regarding hydrogeologic conditions that would be expected at locations near headquarters and the campground. Rock types, volcanic deposits, and hydrogeologic conditions are different in the area south of Crater Lake, compared with the area north of the lake, because the majority of the final volcanic eruption of Mt. Mazama was directed to the north (Williams and Bacon, 1984).

Potential Well Sites

Potential well sites were initially screened qualitatively based on accessibility, distance to existing water mains and water treatment infrastructure, and the probability of obtaining a reasonable amount of water from a well. Four potential target areas were identified for potential groundwater development;

1. Shallow well(s) in the upper Munson Valley, near park housing.
2. Deep well(s) in the upper Munson Valley, near park housing
3. Well(s) drilled into the Annie Spring fault zone.
4. Bedrock well(s) on the plateau west of Annie Spring and the Mazama campground.

Shallow well(s) in the upper Munson Valley: Shallow wells in the upper Munson Valley could be constructed in the surficial aquifer. There are many springs in this area, providing evidence of the occurrence of groundwater in the unconsolidated sediments overlying the ashflow deposits from the climactic eruption of Mt. Mazama. The relation between the sediments comprising the surficial aquifer and the ashflow deposits is readily seen at overlooks of Annie Creek or along the Godfrey Glen trail, where the ashflow deposit is several hundred feet thick and obviously dry. The ashflow layer is likely an impermeable layer, preventing downward percolation of groundwater, and causing groundwater to emit as springs and baseflow to streams in the upper part of Munson Valley above the contact between the overburden and the ashflow unit. Groundwater pumped from a shallow well in the upper part of the Munson Valley would almost certainly be closely interconnected with surface water in the creeks and therefore subject to administration as a surface water source. Constructing a shallow well in the upper part of Munson Creek would not meet the goal of finding a groundwater source that could be utilized when there is a call on water rights by the senior appropriators.

Deep well(s) in the upper Munson Valley: A deep well could be constructed in the upper part of the Munson Valley, in the vicinity of park housing. The target for a deep well would be the geologic formations underlying the ashflow layer. The ashflow layer, as seen in the canyon of Munson Creek and Annie Creek is several hundred feet thick and dry. It is likely impermeable to groundwater flow. If a groundwater source exists in a geologic formation underlying the ashflow deposit, it might be isolated from the surface water associated with Munson Creek and Annie Creek, if the ashflow deposit is extensive enough. However, it might be difficult to convince water rights administrators that the deeper groundwater source really is isolated from surface waters in the area. Also, there is no evidence that there is a groundwater source at some reasonable depth below the Munson Valley that would be of acceptable quality for a drinking water source. Drilling a deep test well in this area would truly be an exploration well with no real expectation of success.

Well(s) drilled into the Annie Spring fault zone: The geologic map of Crater Lake National Park shows the trace of the Annie Creek fault zone trending north-south about 500 feet west of Annie Spring (Bacon, 2008). Fault zones can sometimes be a good target for construction of water-supply wells. The bedrock formations may be fractured and broken near the fault zone, providing a high-permeability zone for groundwater flow along and near the fault zone. There is no evidence that this is the case at the Annie Creek fault zone. A water supply well constructed in the fault zone would be so close to Annie Spring that groundwater pumped from the well would likely be assumed to be connected with the water flowing from Annie Spring, and therefore administered as a surface water source. Constructing a well in the Annie Creek fault zone would not meet the goal of finding a groundwater source that could be utilized when there is a call on water rights by the senior appropriators.

Bedrock well(s) on the plateau west of Annie Spring and the Mazama campground: The plateau area to the west of the Mazama campground and Annie Spring is underlain by a series of basalt lava flows. These basalt flows erupted from vents in the local area which would have been on the flank of Mt. Mazama, rather than eruptions from the top of the volcano. The basalt flows are dated as 300-350,000 years ago (Bacon, 2008). Bedrock outcrops of the basalt flows were examined in the field at roadcuts along Hwy. 62 at both the east and west margins of the basalt

flows and at outcrops along the Pacific Crest hiking trail both north and south of the highway. At all locations, the rock outcrops were highly fractured, providing at least some evidence that there might be enough secondary permeability to allow relatively rapid groundwater flow through the bedrock.

In addition to the fractures observed at land surface, in many places there is a high permeability zone between the various layers of basalt lava flows. If a well penetrated one or more of these interflow zones, and those interflow zones were saturated, the well might produce sufficient water to meet the park needs.

Several perennial streams have their headwaters on the plateau. The most likely source of water for these streams is groundwater draining from the basalt flows. Figure 1 shows part of the area underlain by the basalt flows with the perennial reaches of the streams draining this area highlighted. The presence of the perennial streams provides some evidence that there is a groundwater flow system within the basalt flows.

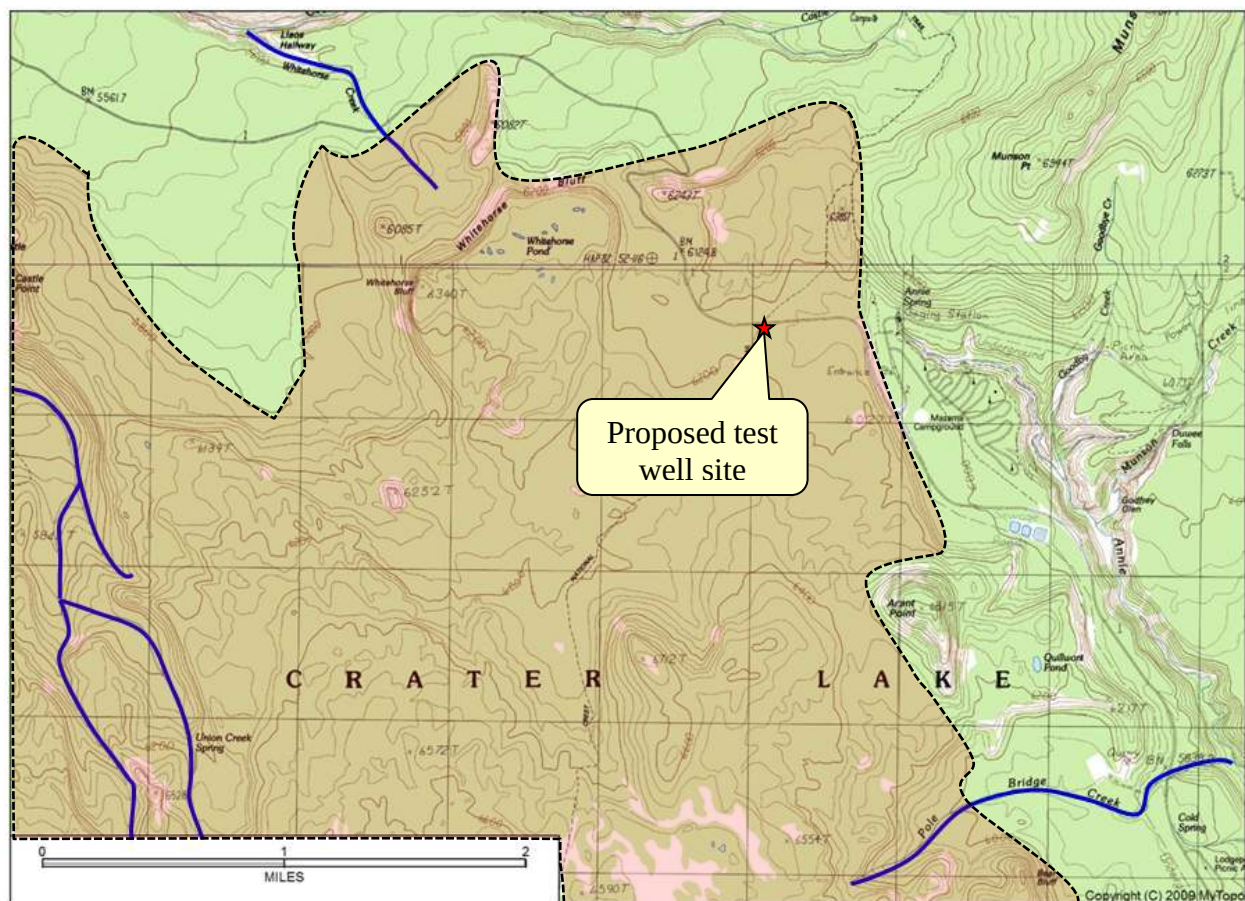


Figure 1. General area underlain by the Wildhorse Bluff basalt lava flows (brown shading). Geology is greatly simplified from the geologic map of Bacon (2008). Perennial streams emanating from the basalt lava flows are shown as dark blue lines.

A test hole to assess the groundwater resources of the basalt lava flows is proposed at the parking area for the Pacific Crest trail as shown in Figure 1. The location meets most of the criteria for a groundwater source that could be developed without impacting senior water rights in the Klamath Basin. The site is close enough to existing infrastructure to develop the groundwater source at a reasonable expense.

A test well can be constructed at the existing parking area at the trailhead with minimal disturbance to the surrounding area. Depending on the results of the test drilling at this site, a permanent water-supply well might be constructed there, or another location nearby. Another target site for drilling might be the fault zone shown on the geologic map (Bacon, 2008) about 500 feet east of the trailhead parking area. If the initial test well at the trailhead produces good quality water, but not enough quantity, then drilling a second well that would intersect the fault zone at a depth below the water table might yield a larger supply due to the fracturing of the rocks along the fault zone (Figure 2).

If there are any questions regarding this trip report, please call Larry Martin at (970)-225-3515.

cc:

CRLA – Ray Moore, Brian Coulter, Mac Brock, Scott Burch

REGION – Dave Kruse, Ray Sauvajot, Steven Bosiljevac

WRD – Bill Hansen, Jim Harte

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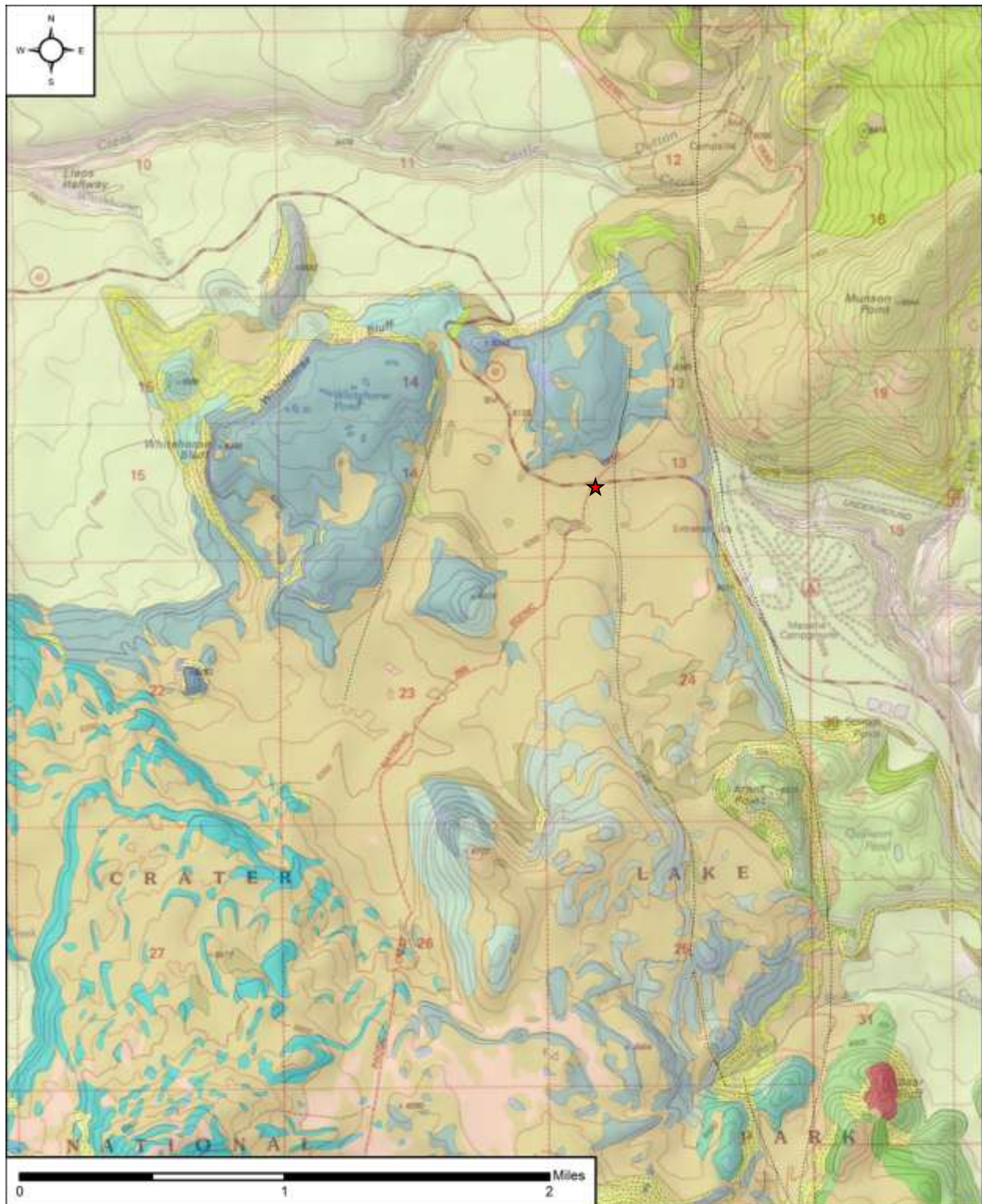


Figure 2. Geologic map of the area underlain by the Wildhorse Bluff basalt lava flows. Digital form of the geologic map from <https://irma.nps.gov/App/Reference/Profile/1048244> . Red star shows the proposed location of the initial test well. Fault zones are shown as black dashed lines, generally trending north-south.