

Hydrogeologic Assessment of the water-supply well at Hunters Campground Lake Roosevelt National Recreation Area

Hunters Campground is located on the eastern shore of Lake Roosevelt, about 40 miles south of Kettle Falls or 21 miles north of Ft. Spokane (Figure 1). The campground has 39 sites and is open all year long, but the water system is only available seasonally from May to September. There are flush toilets at a central comfort station in the campground. The water system includes two drilled wells with submersible pumps, a 20,000 gallon steel water storage tank, and a continuous disinfection system. Water is distributed from the storage tanks to a number of hosebibs in the campground, a comfort station, a fish cleaning station, a trailer dump station, a VIP site, and an underground irrigation system. Water is treated by chlorination at the wellhead.

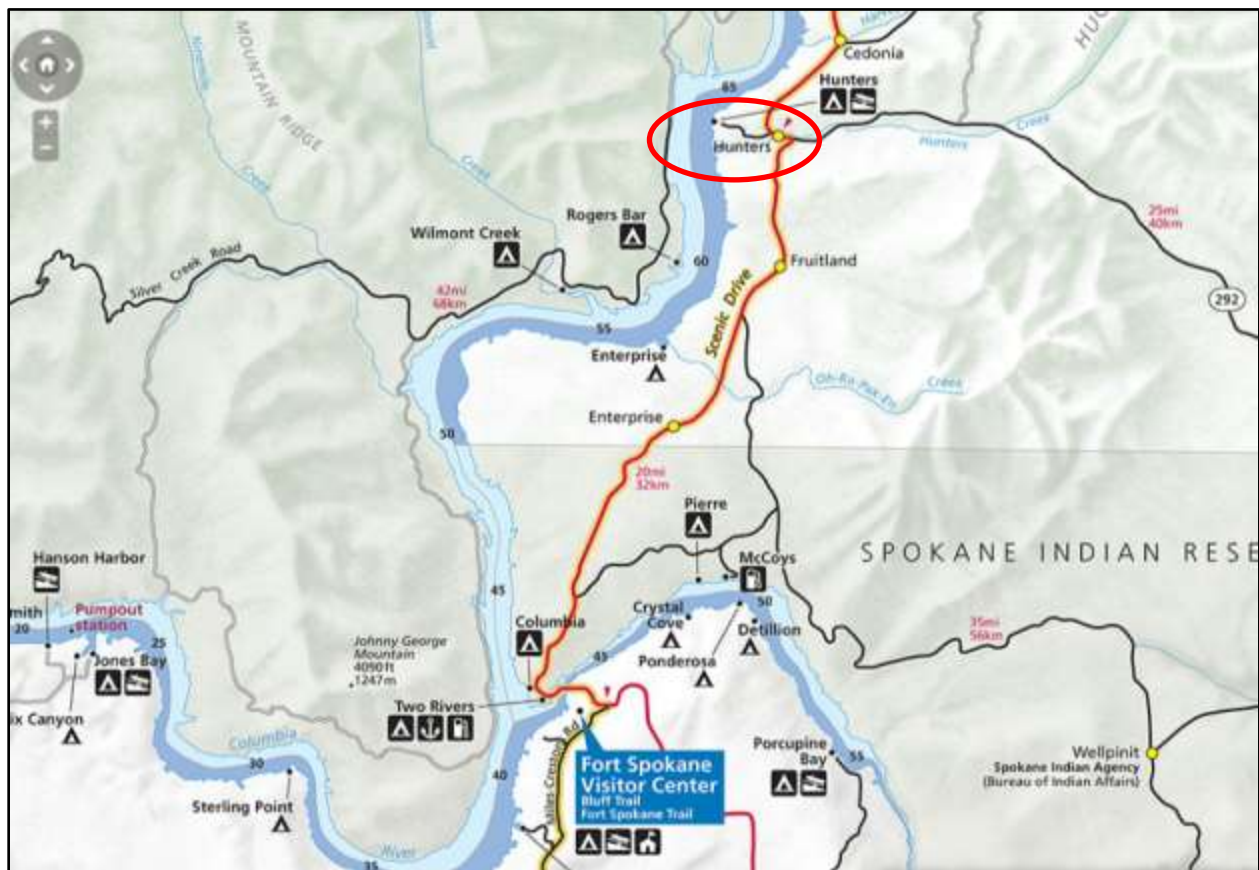


Figure 1. Location of Hunters Campground.

There are records for construction of four wells at Hunters Campground (Figure 2). There have also been two test wells that were probably plugged and abandoned (although that is not specifically noted in the files). Basic information for the wells are:

<u>Year</u>	<u>Well Log ID</u>	<u>Well Tag ID</u>	<u>Depth</u>	<u>Diameter</u>	<u>Screened Interval</u>
1967	173734	---	146'	8"	130-146'
1980	171038	---	71'	6"	63-68'
2000	253859	AFL-253	171'	8"	151-161'
2009	638731	BBL-412	189'	6"	179-189'

The 1967 well has apparently been plugged and abandoned. There is no remaining structure at land surface. The 2009 well was a test well constructed by the City of Hunters. Water from the well was high in arsenic so the well has never been used. It is capped with a welded steel plate.

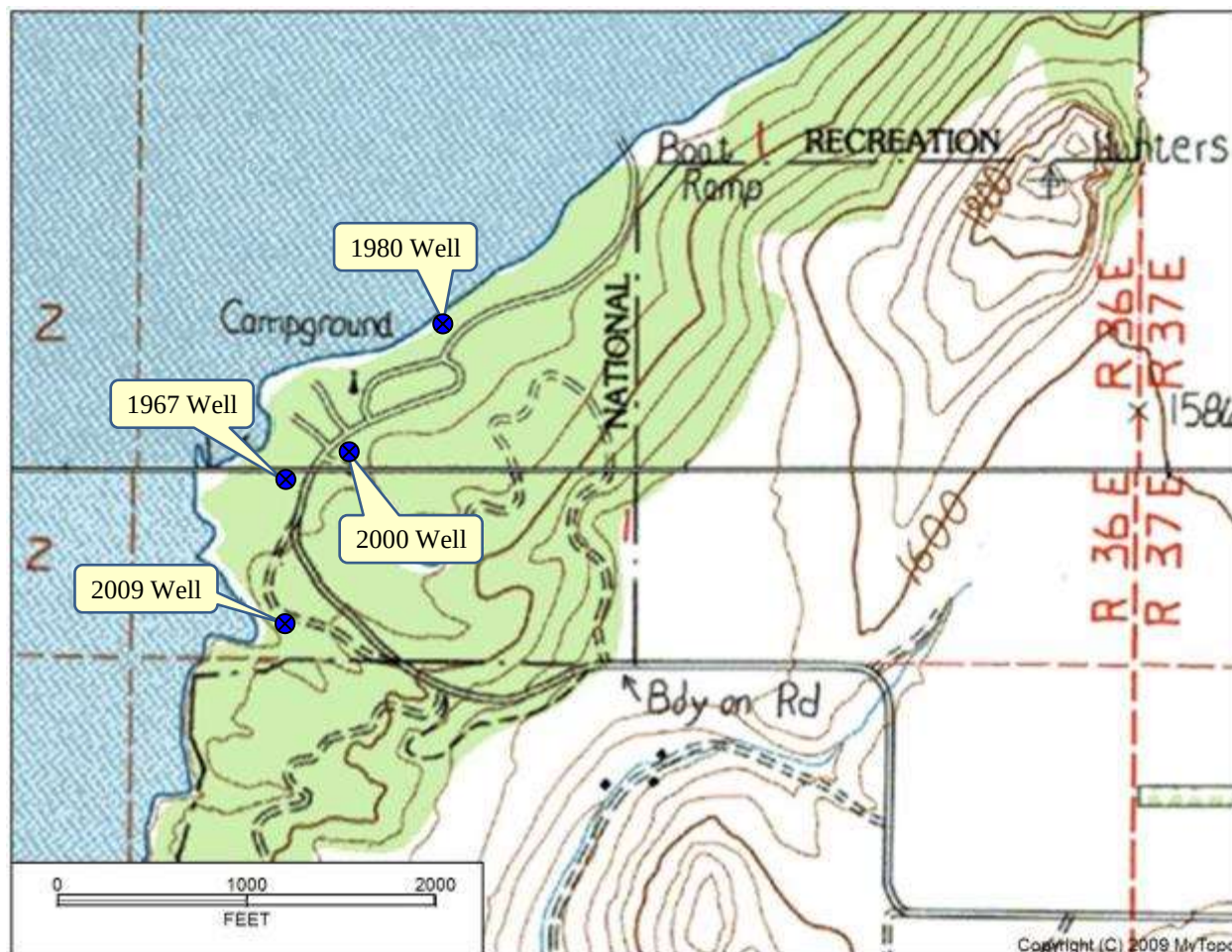


Figure 2. Well locations at Hunters Campground.

The 1980 well is Well No. 1 at the campground and is the primary water supply (Figure 3). The 2000 well is Well No. 2 at the campground. It has not been used because the water has high concentrations of arsenic, iron, and manganese.



Figure 3. Hunters campground Well No. 1 is inside the green building.
The well is 30 feet from the lake.

Well Construction and Testing

NPS constructed a well at Hunters Cove campground in 1967. The well was 146 feet deep and was completed with a screen at some depth. The size and depth of the screen is not specified in the well completion report. The well was gravel packed from 130-146 feet with $\frac{1}{2}$ - $\frac{3}{4}$ inch gravel. The well does not have a tag number in the Dept. of Ecology database. The drillers log for the 1967 well showed:

0-65 feet	Clay, brown
65-105 feet	Sand,, fine
105-128 feet	Clay, dark blue
128-132 feet	Sand
132-137 feet	Clay, some gravel
137-140 feet	Sand, fine
140-146 feet	Gravel, good water

A second well was constructed in 1980. The well is about 30 feet from the normal full-pool shoreline of the reservoir (Figure 3). It was drilled to a depth of 76 feet and was completed with 0.020" slot Johnson well screen from 63-68 feet. The well was gravel packed with 0.050" sand/gravel from 56-70 feet. The well does not have a tag number in the Dept. of Ecology database. The drillers log for the 1980 well showed:

0-36 feet	Clay, brown
36-63 feet	Sand, fine-to-medium, and Brown clay
63-70 feet	Coarse sand, little gravel (water bearing)
70-76 feet	Harder, fine sandy brown clay

This is the primary water-supply well for Hunters campground.

Two wells were constructed at the campground in 2000. A test well constructed in May did not produce sufficient water and was abandoned. The second well constructed in 2000 at Hunters (July 2000) yielded a usable amount of water. The well was drilled to 171 feet and was completed with a 7-inch, telescoping Johnson well screen with 0.008" slots from 151-161 feet. A bentonite surface seal extends to 20 feet below ground surface. The drillers log for the July 2000 well showed:

0-68 feet	Clay, brown, silty
68-116 feet	Fine sand
116-116 feet	Brown clay, with water
116-161 feet	Fine sand, gray, with water
161-171 feet	Rhyolite, Gray, medium

This is Well No. 2 at the campground. So far, it has not been used as part of the water-supply system because groundwater pumped from the well has high concentrations of arsenic, iron, and manganese.

A 6-hour pumping test was conducted on the July 2000 well. The well was pumped at 10 gpm for 1½ hours and then at 20 gpm for 4½ hours. Water level in the well stabilized at around 134 feet below ground surface (Figure 4).

Both of the wells constructed by NPS in 2000 show a location on the well completion report of NE¼ of the SW¼ of Section 11. This is incorrect. It should probably be Section 1 (T30N-R36E).

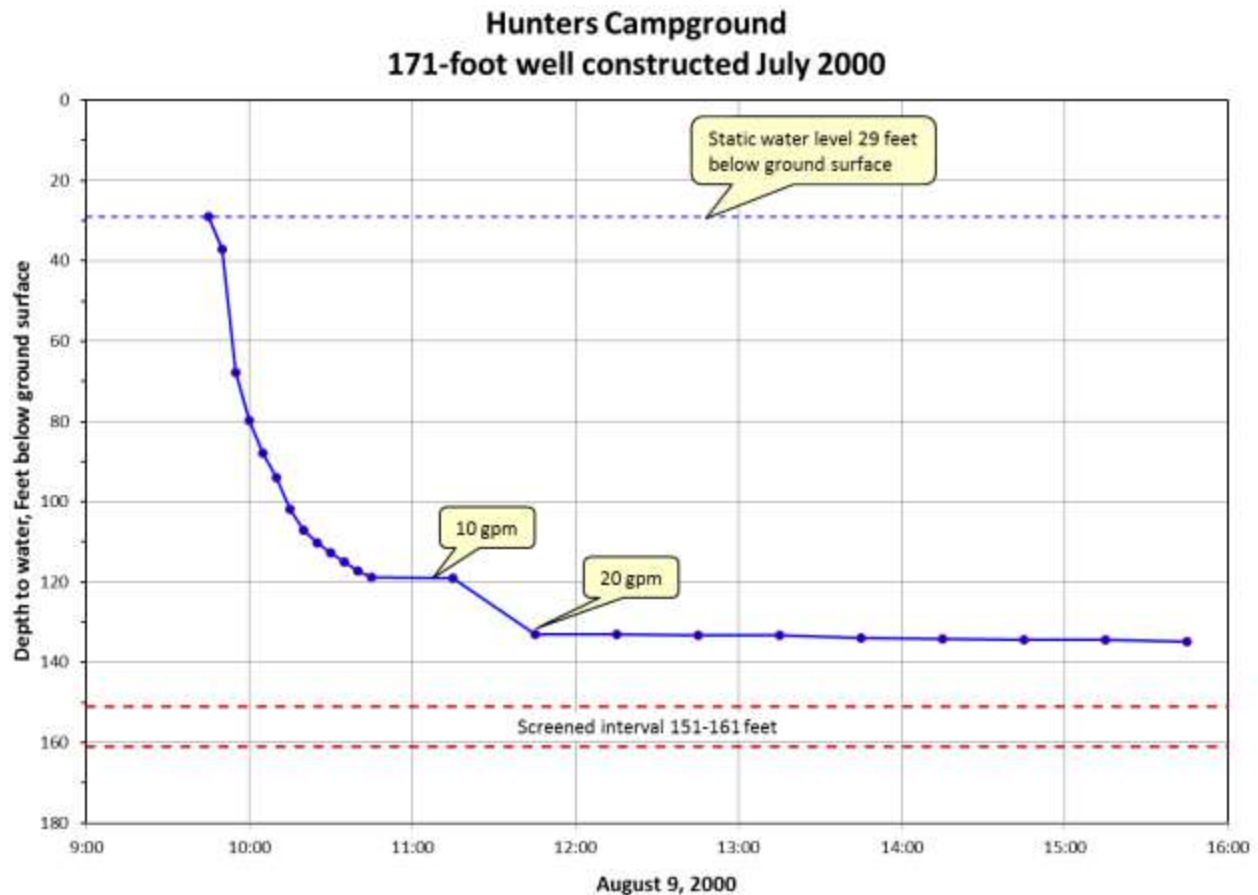


Figure 4. Water level drawdown during a pumping test at the July 2000 well at Hunters campground

The City of Hunters constructed a well on NPS property southwest of the campground in 2009. The well was drilled to 189 feet and was completed with 10 feet of 0.030" slot well screen from 179-189 feet. The well was reported to have produced more than 50 gpm during a one-hour airlift test. The source of water would be the basal layer of sand and gravel overlying the limestone bedrock. A bentonite surface seal extends to 19 feet below ground surface. The drillers log for the September 2009 well showed:

0-16 feet	Hard brown clay
16-28 feet	Dense grey clay
28-56 feet	Dense brown clay
56-109 feet	Grey clay, moist
109-170 feet	Brown clay with sand
170-188 feet	Sand and gravel, with water
188-189 feet	Grey limestone

This was a test well constructed by the City of Hunters. Water from the well has high concentrations of arsenic. The well has never been used. It is capped with a welded steel plate.

Water Use

Water meter records show water use at campground averaged 9,200 gallons per day during the peak season in summer 2013 (Figure 5). There was a similar use pattern in 2013, but with slightly higher average daily use of 10,000 gpd.



Figure 5. Water use at Hunters campground, 2013.

All of the wells at Hunters campground have thick layers of clay from the surface to several tens of feet below ground surface (36-109 feet). Although the clay layers will protect the sand and gravel lenses from infiltration of surface water, it does not preclude the lateral inflow of water from the lake where the sand and gravel outcrops on the bank of the reservoir at some depth below the water surface. Observations by park staff of fluctuation of water level in the wells in correlation with water level fluctuation in the reservoir shows that there is some lateral recharge from the reservoir to the aquifer. Thus, MPA tests should be conducted on the wells at Hunters campground to determine the potential for interconnection with surface water in the reservoir.

Geology

Hunters campground is on a terrace at about 1,300-foot altitude. It is between two bedrock knobs just east of the campground, in line with an abandoned and buried channel of Hunters Creek (Figure 6).

Two features influenced the selection of the test-well sites in 1967; (1) the location of the abandoned and buried channel of Hunters Creek, which is between the two bedrock knobs northeast and southeast of the campground, and (2) the distribution of coarse gravel exposed

along the shoreline of Roosevelt Lake at low water. The gravel is concentrated in line with the buried channel, and indicates the most promising site for a well (Anderson, 1969).

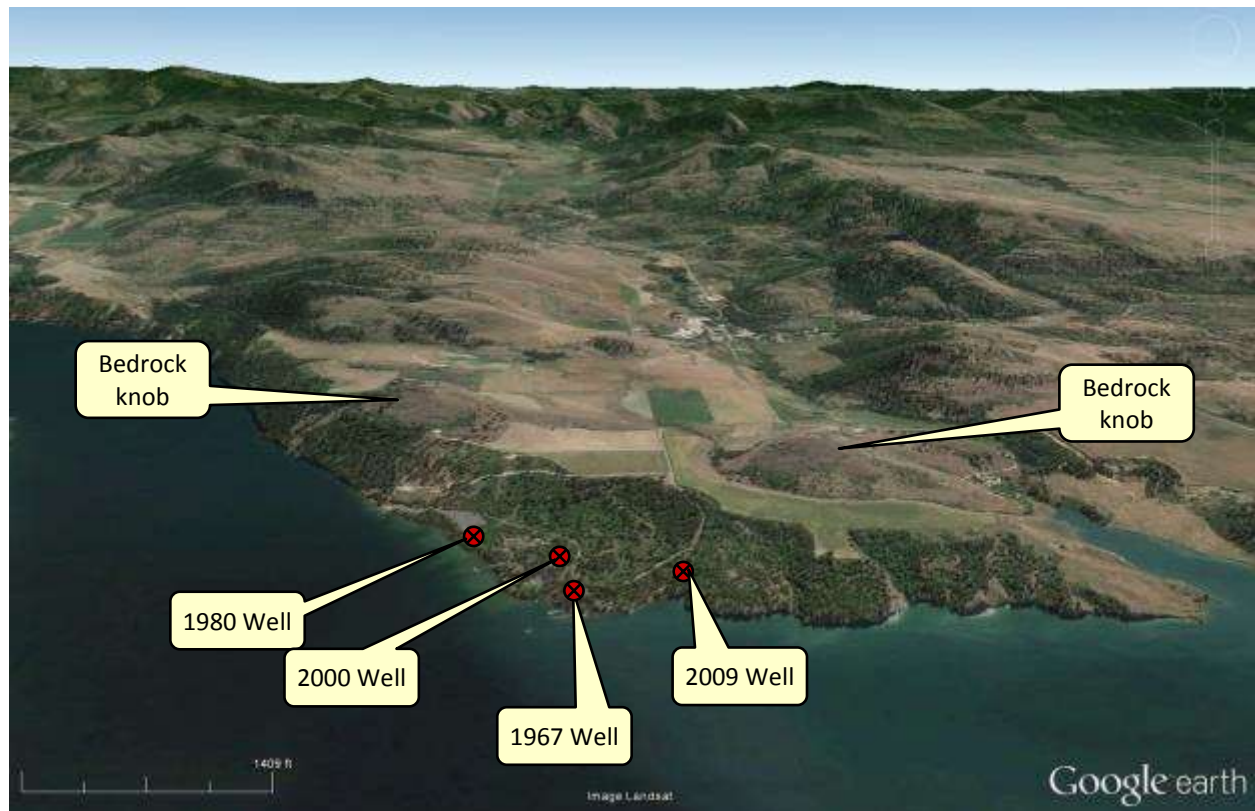


Figure 6. Google Earth view of the Hunters Campground area, looking east.

Most of the terrace occupied by Hunters campground is a deposit of glacial lake sediments, primarily silt and clay (Figure 7). Thus it is important to locate wells at Hunters where drilling will intersect the coarser sand and gravel sediments associated with the abandoned channel of Hunters Creek. Otherwise the well would intersect only fine-grained glacial lake sediments and would not yield much water.

Kiver and Stradling (1995) mapped the terrace (where the well is located) as **Qem/Qlz/Qt** – Quaternary eolian silt over Quaternary lacustrine clay and/or silt over Late Wisconsin cobble (mostly coarse gravel to cobbles) till with sand matrix. In other words, there is a base layer of glacial till (mostly sand, gravel, and cobbles) overlain by layers of silt and clay that were deposited in a lake environment, overlain by windblown silt.

Campbell and Raup (1964) described the geology of the terraces in more general terms, lumping them into a single unit they called Quaternary alluvium and glacial deposits. They identify the bedrock knobs as Gerome Andesite.

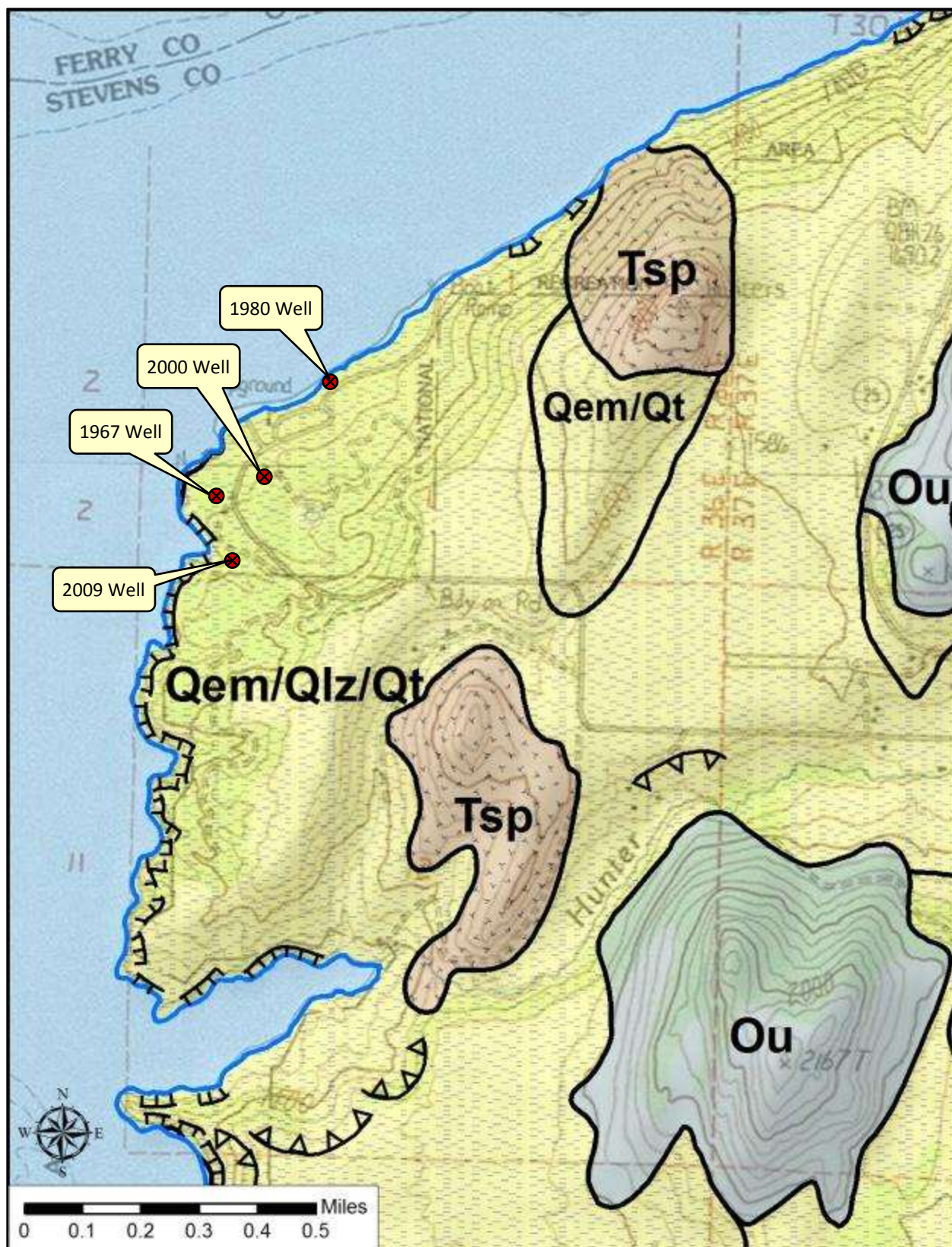


Figure 7. Surficial geology in the vicinity of Hunters campground.
From NPS Geologic Resources Inventory Program (2009)

Geologic units shown on Figure 7.

Qem/Qlz/Qt - Quaternary eolian silt over Quaternary lacustrine clay and/or silt over Late Wisconsin cobble (mostly coarse gravel to cobbles) till with sand matrix

Qem/Qt - Quaternary eolian silt over Late Wisconsin cobble (mostly coarse gravel to cobbles) till with clay matrix

Tsp - Tertiary Sanpoil (or San Poil) volcanic rocks

Ou - Ordovician undivided

Previous Drilling and Well Construction

Construction of wells on NPS property at Hunters campground is discussed in a previous section of this report.

Review of other well logs in the area (from the Dept of Ecology database) showed similar geologic conditions to that encountered during construction of the NPS wells. Wells located near the middle of the abandoned channel of Hunters Creek would intersect a layer of highly permeable sand and gravel and produce a good amount of water, greater than 10 gpm. Other wells would penetrate mostly lower permeability silt and clay, maybe with small lenses of sand or gravel, and would not produce very much water, less than 10 gpm.

Alternative Water Sources for Hunters Campground

The existing wells at Hunters campground provide an ample supply of water. New well(s) could be constructed farther from the reservoir, but since they would need to target the same groundwater source in the abandoned alluvial aquifer, it is likely they would also exhibit the same hydraulic interconnection with the lake.

Conclusions

Correlation of water level fluctuations in the wells with the surface elevation of the reservoir show the potential for interconnection between the two sources and the potential for surface water to be drawn toward the well(s) during pumping, or by lateral recharge of surface water in the reservoir into the sand and gravel aquifer that is the remnant of an alluvial aquifer of the abandoned channel of Hunters Creek. Therefore, we must assume that the water pumped from the well is hydraulically connected with the adjacent surface water. MPA tests should be conducted to determine the degree of filtration that occurs as the water flows from the reservoir to the well.

References

Anderson, Henry W., 1969, *Water Supplies for Coulee Dam National Recreation Area*, Washington, U.S. Geological Survey Open-File Report OFR-69-8, 141 pp.

Campbell, A.B. and Raup, O.B., 1964, Preliminary geologic map of the Hunters quadrangle, Stevens and Ferry Counties, Washington: U.S. Geological Survey, Mineral Investigations Field Studies Map MF-276, scale 1:48,000

Kiver E.P. and Stradling, D.F., 1995, *Geology of the Franklin D. Roosevelt Reservoir Shoreline: Glacial Geology, Terraces, Landslides, and Lineaments*, report to Bureau of Reclamation (BOR), 148 p., 21 geologic maps, scale 1:24,000 or 1:62,500

NPS Geologic Resources Inventory Program. 2009. Digital Surficial Geologic Map of the Bangs Mountain quadrangle, Washington (NPS, GRD, GRI, LARO, BAMO digital map). NPS Geologic Resources Inventory Program. Lakewood, CO. Geospatial Dataset-1047534.

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