A Brief Discussion of the Potential for Construction of a Water Supply Well for the North Rim of the Black Canyon of the Gunnison National Park

Water is supplied to campground facilities and a ranger station at the North Rim of the Black Canyon of the Gunnison. Drinking water is supplied at a couple of spigots in the campground, but the toilets are non-flushing, vault-type. The ranger station & residence has flush toilets, a shower, and a washing machine. There is no water supplied to the various picnic areas and overlooks along the North Rim. Facilities at the North Rim are open from May through October.

Water is trucked to the North Rim from Paonia by a private contractor. Average annual use is about 25,000-30,000 gallons; requiring 10-15 truckloads of water at a cost of about $300 per truckload. Peak demand is about 450-500 gallons per day. Construction of a well to supply water for the facilities at the North Rim could result in a cheaper, more reliable water source.

Hydrogeology

PreCambrian igneous intrusive rocks are exposed at land surface along the North Rim and underlie sedimentary rocks north of the canyon. The rocks are granite, gneiss, quartz monzonite, and similar type rocks. In layman's terms, we might refer to them collectively as being granitic rocks. These rocks have no pore spaces for groundwater to move through them. The only groundwater to be found in these geologic formations is in fractures and faults. In some geologic settings, we might be able to construct a low volume well in these types of rocks; enough to supply a single-family home if they practice prudent water conservation. In the North Rim area, this is unlikely because any water that may have infiltrated into cracks or crevices in the granitic rocks would drain into the canyon. In a hydrologic sense, the Black Canyon of the Gunnison functions as a 2500 foot deep drainage ditch.

Sedimentary rocks overlying the PreCambrian granitic rocks include (from oldest to youngest) the Entrada Sandstone, Wanakah Formation, Morrison Formation, Dakota Sandstone, and valley-fill alluvium. There are also some relatively small, unconsolidated landslide deposits, most notably on the flanks of Grizzly Ridge and the Fruitland Mesa in the lower part of the Grizzly Gulch drainage basin. A geologic map and cross-section showing the relationship of these formations is attached to this report.

The Entrada Sandstone is a fine-to-medium grained sandstone that is a major geologic unit to the west and southwest, into Utah and Arizona. The North Rim area is near the easternmost extent of the Entrada Sandstone, it disappears entirely at Poison Spring Hill. Because the Entrada Sandstone is thin and pinches out a short distance east of the campground, it is unlikely to be a reliable source of groundwater.

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The Wanakah Formation is a series of alternating beds of limestone and silty mudstone. It contains considerable amounts of gypsum ($CaSO_4$). The Wanakah Formation is not likely to contain appreciable amounts of groundwater due to the impermeable nature of the silty mudstone and gypsum that predominates the formation. If it did contain groundwater, it would likely be of very poor quality due to dissolution of the gypsum, which would result in high concentrations of sulfate in the groundwater. The Wanakah Formation is probably around 200 feet thick in this area.

The Morrison Formation consists of alternating thin layers of siltstone, mudstone, claystone, and a few layers of limestone. The Morrison Formation is about 650 feet thick in this area. It is unlikely to contain or transmit appreciable amounts of groundwater due to the impermeable nature of the sediments comprising the formation. There are some lenses of sandstone and conglomerate contained within the Morrison, however, these lenses are small and are surrounded by relatively impermeable sediments.

The Burro Canyon Formation and the Dakota Sandstone have been mapped as a single unit in this area due to their similarity. The Dakota Sandstone is a fine-to-very-fine grained sandstone, containing more conglomerate toward the base of the formation. The Burro Canyon Formation is primarily conglomeratic sandstone. The combined thickness of the two units is about 200 feet. Although the formations are permeable, there is only a relatively thin zone of saturation near the base of the formations. Water infiltrates into the formation from precipitation on the outcrop areas and then flows along the dip of the rocks toward the north where it discharges as springs or seeps; for example Poison Spring. Because of the relatively small outcrop area on Fruitland Mesa and Grizzly Ridge in the park and the close proximity of discharge areas, it is impossible for a thick saturated zone to develop at the base of the formation.

A few low-yield domestic wells have apparently been constructed into the Dakota Sandstone and Burro Canyon Formation on Grizzly Ridge where the formation is thicker. Access to park lands on Grizzly Ridge would require construction of roads into an undeveloped area. The distance from potential well locations on Grizzly Ridge to the North Rim campground (via Grizzly Gulch) would be about 3 miles or more. Records for domestic wells that have been constructed on Grizzly Ridge indicate that the potential yield ranges from ½-12 gpm. It is doubtful that the larger pumping rates could be maintained for very long, or throughout the camping season. A more realistic estimate for long-term yield would be more in the range of 500-1000 gallons per day.

Alluvium in Grizzly Gulch is comprised of sediment from the weathering and transport of material from the Morrison, Burro Canyon, and Dakota Sandstone Formations. The alluvium is an unconsolidated mix of silt, sand, and gravel. Moulder (1960) estimated the maximum thickness to be 30 feet. No wells or test holes are known to have been drilled into the alluvium to determine its thickness and water-bearing characteristics.

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Groundwater Quality

Water quality samples were collected from the alluvium of Grizzly Gulch and from Poison Spring during the USGS study of potential groundwater sources to supply the North Rim (Moulder, 1960). Water from Poison Spring is though to be representative of groundwater from the Dakota Sandstone. Both sources had excellent water quality. The specific conductivity indicated that the water has a very low mineral content.

Nearby Wells

Several low-yield domestic supply wells are located on the Grizzly Ridge to the northwest of the North Rim campground and ranger station. Basic construction data for these wells were obtained from the Colorado State Engineer's Office website (http://water.state.co.us/). The wells are probably completed in the Dakota Sandstone and Burro Canyon Formation and are reportedly capable of producing ½, 1, 7, and 12 gpm. Depths of these wells range from about 300-400 feet.

Hydrology of Grizzly Gulch

The Grizzly Gulch drainage basin is about six square miles. All of the streams in the basin are mapped on the USGS topo map as being intermittent. Several tributary streams flow toward the north off of Grizzly Ridge before emptying into the main Grizzly Gulch valley. The main Grizzly Gulch valley drains toward the southwest where it empties into the Black Canyon. Runoff from tributary streams draining Grizzly Ridge is the primary source of recharge for the groundwater in the alluvium in the upper reaches of Grizzly Gulch.

The Grizzly Ridge topo map shows several perennial ponds in Grizzly Gulch. The presence of perennial ponds along an intermittent stream drainage indicates that there is sufficient groundwater in the alluvium to maintain water in the ponds. The ponds are an expression of the water table in the alluvium.

It should be possible to construct a well to pump groundwater from the alluvium in Grizzly Gulch, provided that the alluvium is thick enough. The geologic map of the area (Hansen, 1971) shows that the alluvium in the upper part of the Grizzly Gulch drainage basin is wider, and presumably thicker, than in the lower part of the drainage basin. The geologic map also shows landslides on both sides of the creek in Section 18, about ½ mile north (upstream) of the intersection of the Grizzly Gulch and North Rim roads. It may be that these landslides created earthen dams across the drainage and caused the area upstream of the dams to be filled with sediments. If this is the case, then there should be a sufficient thickness of alluvium to allow successful construction of a well in the area just upstream of the landslides.

The northwest part of Section 17 (upstream of the landslide deposits) is the hydrogeologically preferred target for constructing test wells to determine the water-bearing characteristics of the alluvium. Field reconnaissance is needed to evaluate the potential for constructing test wells further downstream and closer to the campground and ranger station.

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Potential Well Sites

The only realistic possibility for developing a groundwater supply for the North Rim is construction of a shallow well into the alluvium along Grizzly Gulch. Test wells at several locations could be constructed quickly and relatively cheaply be use of a hollow-stem augur drilling rig. Where conditions appear favorable (depth to bedrock greater than 25 feet and at least 15 feet of saturated alluvium) a test well could be constructed by installing PVC well screen and casing inside the hollow-stem augur before withdrawing the augur from the test hole. Test wells constructed in this manner would not meet construction standards for public water supply wells, but could be test pumped and monitored to determine the potential yield and reliability of a permanent well and to provide data for design of a permanent well.

Although it is impossible to make the final site selections for test holes from an office study, it appears that the area in the northwest part of Section 17, about 1-1½ miles upstream from the intersection of the Grizzly Gulch and North Rim roads, would be the most favorable location for test drilling. This is the area upstream from the mapped landslide deposits.

It may be possible to locate a well closer to the ranger station and campground. A field reconnaissance will be needed to assess whether conditions appear favorable for construction of a test well near the intersection of the Grizzly Gulch road and the North Rim road. This location would be about ½ mile east of the ranger station. This would be the closest possible location that might have favorable hydrogeologic conditions for construction of a well.

Selection of potential well sites will require evaluation of local geologic conditions and will be a tradeoff between distance from the ranger station and campground to the well site and the potential to encounter a sufficient thickness of saturated alluvium. From examination of the geologic map, it appears that there is less alluvium in the lower part of Grizzly Gulch, perhaps as a result of the steeper gradient near the canyon which would increase the potential for sediments to be flushed into the Black Canyon. Further upstream, it appears that the alluvial deposits are more extensive, but because it's higher in the drainage basin there may be less water available to recharge groundwater in the alluvial sediments.

Summary

The only realistic potential groundwater source for facilities at the North Rim is the alluvium in Grizzly Gulch. There has been no known groundwater exploration in the area. If groundwater is available in the alluvium, it would be from shallow wells, less than 50 feet deep. The most promising locations for wells appears to be about 1-1½ upstream (north) of the intersection of the Grizzly Gulch and North Rim roads. A site visit will be necessary to evaluate the potential for locating a test well closer to the North Rim. Further evaluation of field conditions may change the conclusions presented in this report.

References

Hansen, Wallace R., 1971, Geologic Map of the Black Canyon of the Gunnison River and Vicinity, Western Colorado, USGS Miscellaneous Geologic Investigations Map I-584, 2 sheets

Moulder, Edward A., 1960, Memorandum on the ground-water investigation of the North Rim of the Black Canyon of the Gunnison National Monument, memo from USGS to NPS Region Two Office, 6 pp.

Attachments:

Map of the North Rim area showing potential test well locations
Geologic Map of the North Rim area
Geologic cross-sections of the North Rim Area

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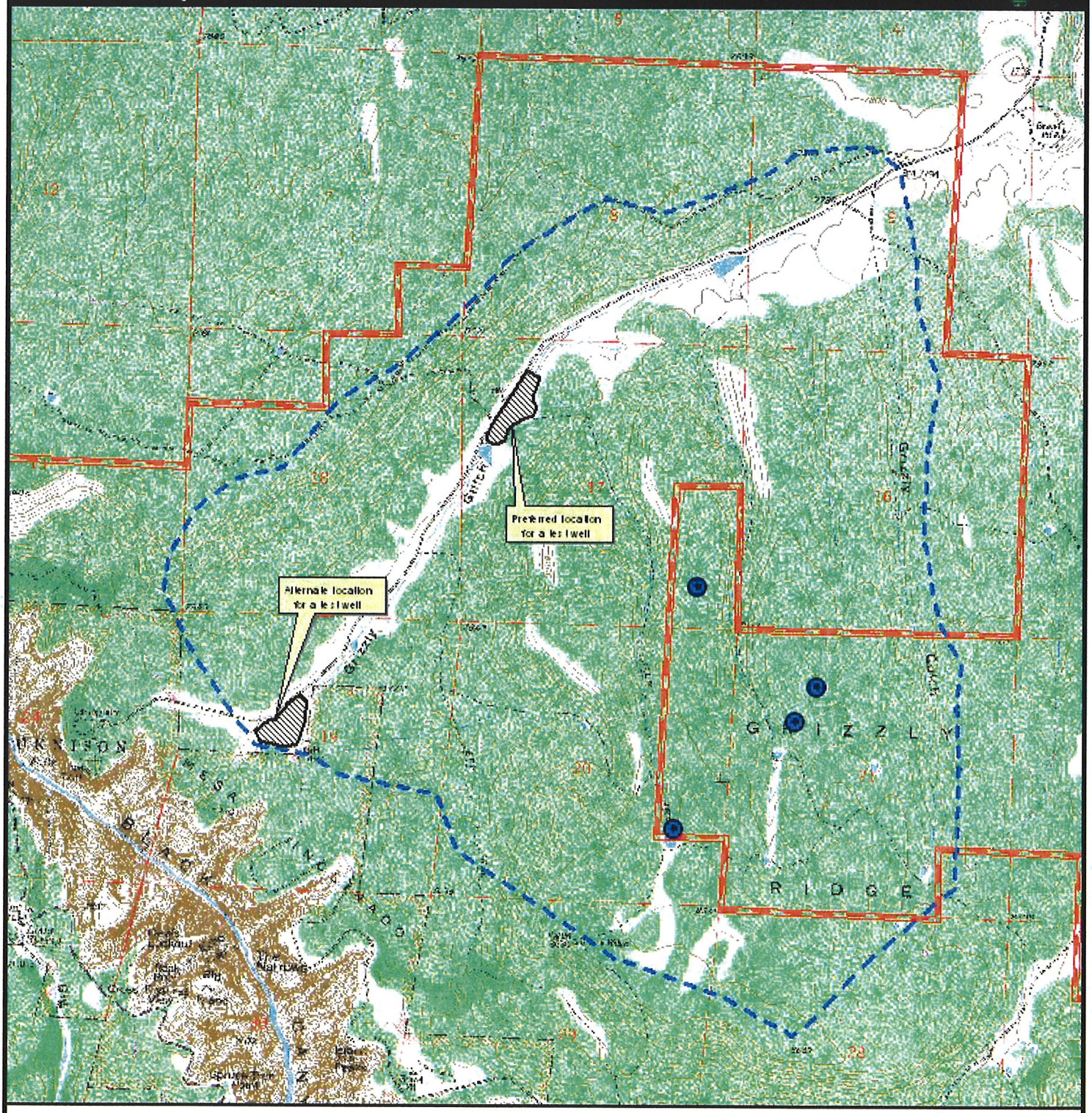
North Rim Area

Black Canyon of the Gunnison

National Park Service
U.S. Department of the Interior



Proposed Areas for Test Wells

Private Domestic Wells

Grizzly Gulch Drainage basin

Park Boundary

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N W E S

0.25 0 0.25 0.5 0.75 1 Miles

1 : 31,680 1 inch = 0.50 miles

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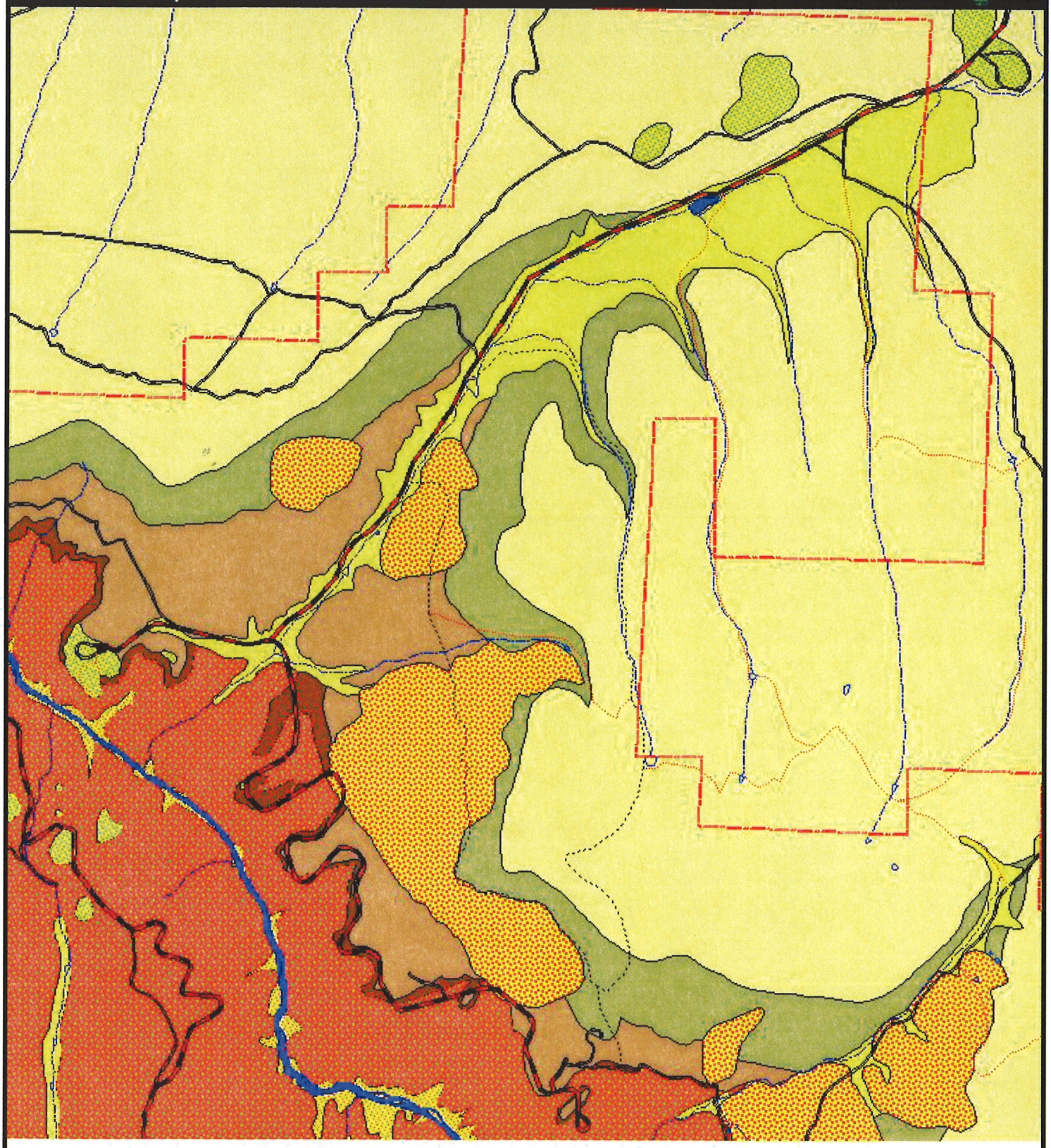
North Rim Area

Black Canyon of the Gunnison

National Park Service
U.S. Department of the Interior



Geologic Map of the North Rim Area

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0.25 0 0.25 0.5 0.75 1 Miles

1 : 31,680 1 inch = 0.50 miles

N
W E
S

January 6, 2005

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Legend for Geologic Map

Park Boundary

Hydrography

Intermittent Stream
Perennial Stream
Lake or Pond

Roads

Primary Road
Unimproved Road
Jeep Trail
Trail

Geologic Formations

Quaternary Alluvium
Landslides
Talus
Boulder Gravel
Terrace Gravels
Mancos Shale
Dakota Sandstone and Burro Formation
Morrison Formation
Wanakah Formation
Entrada Sandstone
PreCambrian Rocks

Water

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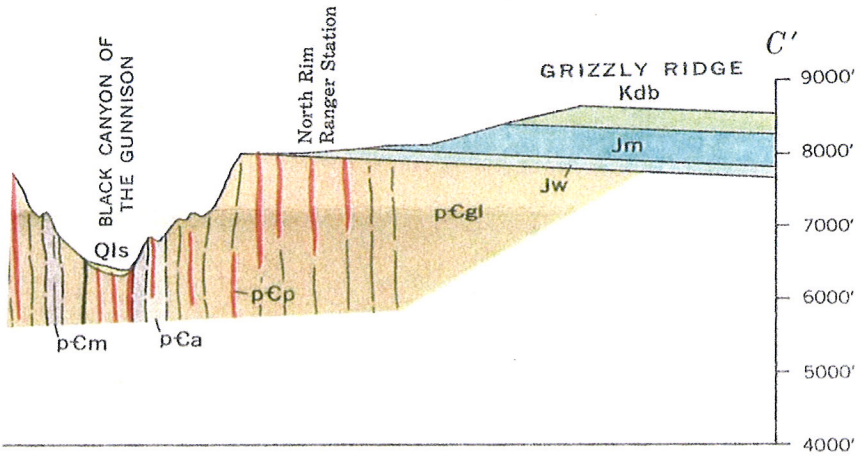

The picture above is a geologic cross-section of the north rim area from the geologic map of the Black Canyon of the Gunnsion River (Hansen 1971). The brown-colored area with the vertical black and red lines is PreCambrian granitic rock. The sedimentary rocks labeled Jw (Wanakah Formation) and Jm (Morrison Formation) are mostly impermeable. The unit labeled Kdb (Burro Canyon Formation and Dakota Sandstone) will likely contain some groundwater. However, because the outcrop area near the North Rim is small and the formation dips toward the north, there would only be a thin saturated zone near the base of the formation. The thickness of the saturated zone increases toward the north. Moulder (1960) included a cross-section of this same area in his report, but with a vertical exaggeration of 10X (see figure below). The vertically exaggerated cross-section provides a better visual description of the thin saturated zone at the base of the Dakota Sandstone and Burro Formations.