



United States Department of the Interior

NATIONAL PARK SERVICE
Water Resources Division
1201 Oak Ridge Drive, Suite 250
Fort Collins, CO 80525

IN REPLY REFER TO:

July 29, 2013

To: Bob Wemple, Engineer, Grand Teton National Park

From: Larry Martin, Hydrogeologist, Water Resources Division

Subject: Assessment of local hydrogeology and potential well sites in the vicinity of the Triangle X Ranch

Summary

Two alternatives are identified for construction of a water supply well at the Triangle X Ranch.

A well could be constructed near the location of the 1991 test well. A productive sand aquifer exists between 58-88 feet below ground surface at the site of the test well. A properly designed and constructed well in this area would likely produce sufficient water to meet the demand of the ranch. The well site would be about 2500 feet from the existing water treatment and storage facilities. (The distance might be significantly more if a more circuitous route were taken to follow existing roads and trails.)

A test well could be attempted near the existing water collection system at the spring. The potential for getting sufficient water from a well at this location is unknown. Geologic conditions are somewhat favorable, but there is no guarantee of obtaining even a small amount of water from a well. The advantage of this site is that it is near existing water treatment and storage facilities. Pumping groundwater from a well near the spring might cause a decline of flow from the spring and in the creek downstream of the spring.

Background

Currently (2007), the public water supply for the Triangle X Ranch is obtained from a shallow collection system in a spring area few hundred feet up the hill, to the southeast of the ranch facilities. The collection system was rebuilt in 2004 and produces an adequate supply of water, but the system is susceptible to contamination from surface sources as evidenced by the increase in turbidity (up to 9.4 NTU) following a recent rain storm.

The purpose of this report is to evaluate local hydrogeologic conditions to assess the feasibility of constructing a water well to supply water for the facilities at Triangle X Ranch.

Hydrogeology

A general geologic map of the area is shown in Figure 1. In simple terms, the geology of the ranch area can be described as having been scoured by glaciers and floodwaters from melting glaciers and subsequent filling of scoured areas with sediments. Depending on the particular conditions occurring in different locales, the sediments range from clay and silt deposited in lake bottoms to coarse sand and gravel deposited by high-velocity streams. Bedrock geologic formations outcrop immediately east of the ranch, although in much of the area the bedrock formations are covered by a thin mantle of unsorted sediments that were deposited by glaciers.

The two primary bedrock formations in the immediate vicinity of the ranch are the Teewinot Formation (the blue Tt areas on the geologic map) and the Cutler Formation (the brown Tc areas on the geologic map).

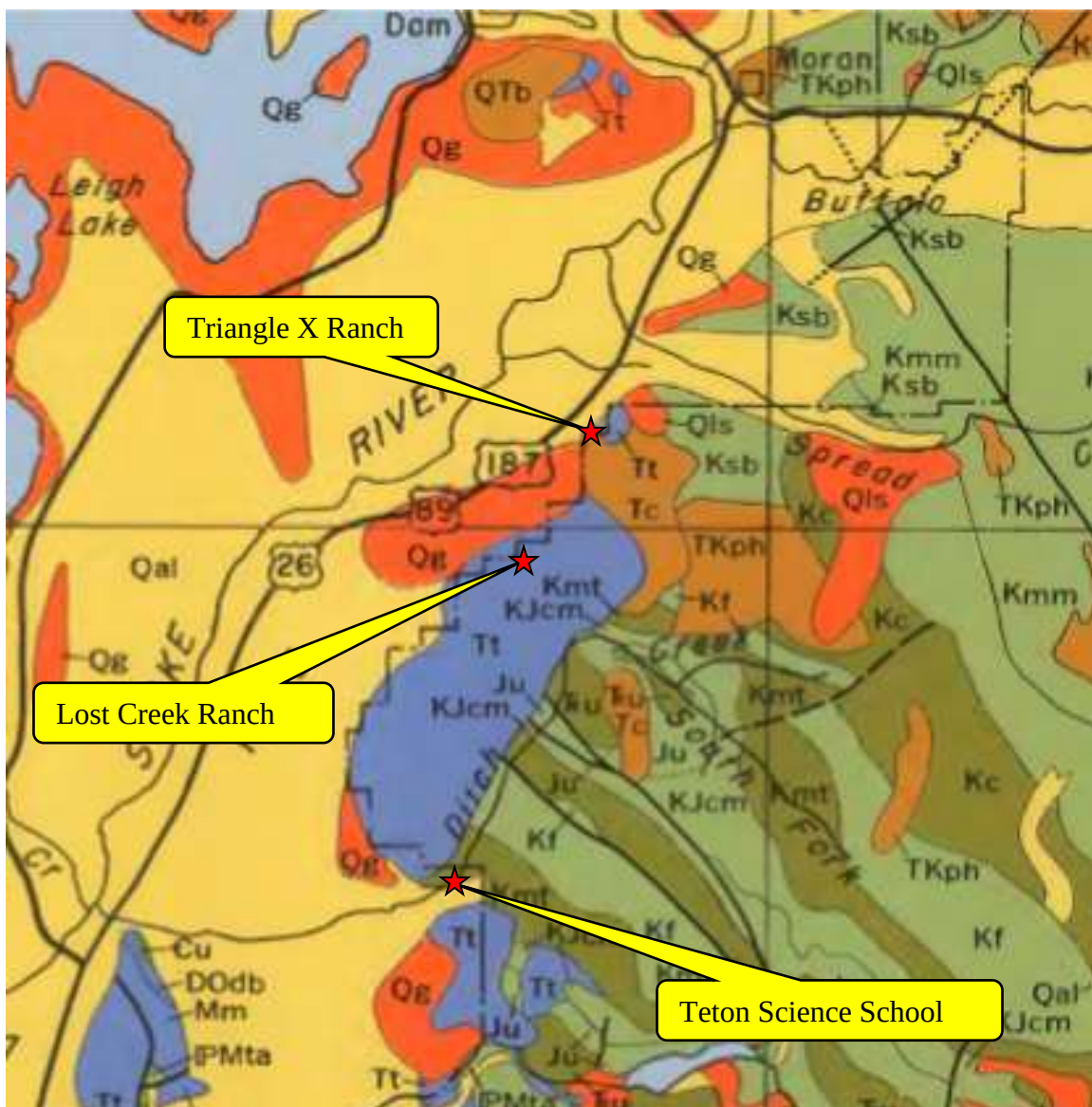


Figure 1. Geologic map of the area near Triangle X Ranch. From Cox (1976)

The Teewinot Formation is comprised of alternating layers of limestone, sandstone, claystone, and tuff and is the source of water for wells at the Lost Creek Ranch about 2 miles southwest of the Triangle X Ranch. The Teewinot Formation is also the source of water for the new well at the Teton Science School. There is a small block of Teewinot Formation outcropping as a ridge immediately east of the ranch buildings. Unfortunately, it appears as if this is a small isolated outcrop of Teewinot Formation that may not be connected to the main body of the formation. This is the northernmost outcrop of Teewinot Formation in Jackson Hole. A well drilled into the Teewinot Formation at the ranch is not likely to be a reliable long-term source of groundwater (and might not even be a short-term source) because the Teewinot in this area is either a small isolated block or the very edge of the formation.

The Colter Formation is a volcanic conglomerate which is comprised of tuff, sandstone, claystone, basalt, and andesite. It includes a variety of rock types from volcanic eruptions which were deposited in a lakebed environment and are interlayered with sand and other lakebed sediments. The potential yield for a well constructed into the Cutler Formation is unknown because no wells have been constructed in it. The lack of existing wells is likely due to the geographic location of the formation; it simply doesn't occur in areas where well exploration has occurred. The geologic description of the formation is inconclusive regarding the potential for water. It may, or may not, be a good source of groundwater.

The source of groundwater for the spring that currently supplies the ranch facilities is unknown. The surface drainage area upstream of the spring is too small to be the sole source of water. Also, because the outflow from the spring remains fairly constant, it is likely that the source is outflow of groundwater from underlying bedrock formations, possibly via flow through fractures or faults. The northeasterly-trending linear features (Figure 2) coinciding with the outcrop of the Colter Formation may be small, local faults or they might simply be erosional escarpments from the differential erosion rates of different layers in the bedrock geologic formations. The presence of the spring suggests that there may be localized faulting, providing a conduit for groundwater to emerge at land surface. The fault zone could be a good target for construction of a well.

Results of 1991 Test Drilling

A test well was constructed in 1991 about 2000 feet northeast of the ranch headquarters. The well was constructed into an alluvial fan, or delta, of an unnamed creek which flows northwesterly toward the Snake River. The fan/delta occurs where the stream emerges from the confined valley of the mountains onto the Snake River plain (Figure 2).

The well was drilled through poorly-sorted gravel mixed with silt and clay from 0-52 feet below ground surface. Clean, well-sorted, fine-grained sand was encountered from 52-88 feet. Gray shale occurred from 88-90 feet where drilling was stopped. The shale was probably the top of the Teewinot Formation, or possibly compacted clay from lakebed sediments. The water table was 58 feet below ground surface. Steel casing was installed from the surface to 83 feet. There was no well screen and no perforations in the casing. The well was tested by bailing and then monitoring the rate of recovery of the water level in the well. Yield was estimated in this manner to be around 12 gpm. This is a very inefficient way to construct a well; the only way for water to enter the well is through the opening at the bottom of the casing. Larger yield and less drawdown could be attained from a properly designed and constructed well.

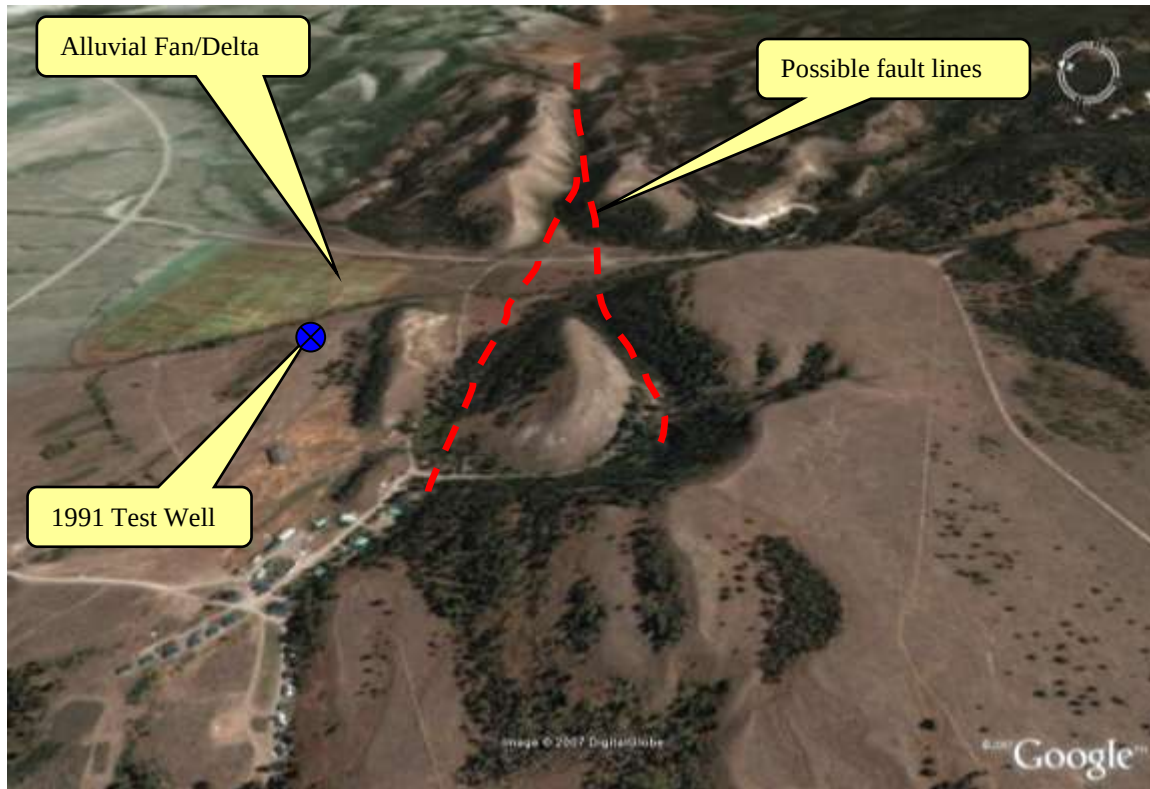


Figure 2. Some geologic and geomorphic features near the Triangle X Ranch.

A grain-size analysis was made of a sample of the sand from the 80 foot level (Figure 3). The analysis shows that a well screen with 0.010" openings (No. 10 slot) would retain about 50% of the formation (Figure 3). This would be the normal design criteria for a well with a naturally developed gravel pack. The potential yield from a properly designed and constructed well with a screened interval in the sand aquifer could only be determined after the well had been completed. A No. 10 slot well screen will pass 6 gpm per foot of well screen at the standard design flow rate of 0.1 ft/sec. A 10 foot long screen could pass 60 gpm to the well, but that doesn't mean that the aquifer will yield 60 gpm. However the aquifer is 25-30 feet thick at this site and should be able to supply the desired amount of water.

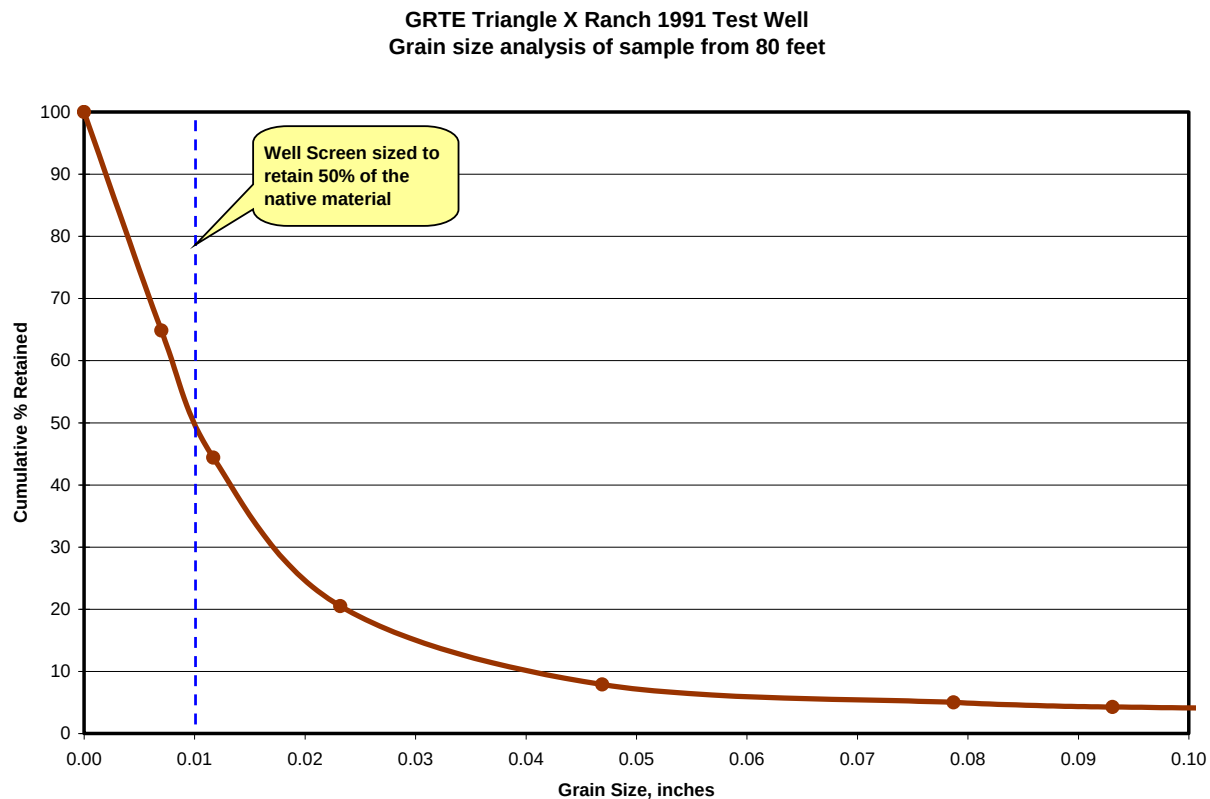


Figure 3. Grain-size analysis for the 1991 test well.

Recommendations for test wells at Triangle X Guest Ranch

There are two alternative locations for a water supply well for facilities at the Triangle X Ranch.

1. A test well could be drilled into the bedrock formations near the existing spring or storage tank. This would truly be a test well as there is no information regarding the potential yield of water from the geologic formations. The large amount of water discharging at the spring is an indication that there is abundant groundwater in the underlying formations. If a test well encountered fractures, it might provide the amount of water needed for ranch operations. It is likely that pumping water from a well near the spring would result in decreased outflow from the spring and lower streamflow downstream from the spring. The well site should probably be uphill from the spring area to reduce the potential for inflow of surface water into the well. One of the primary advantages of a well at this location would be the proximity to existing water treatment and storage structures and the availability of electricity. If there is no indication of a significant yield of groundwater after drilling 200 feet, the hole should be abandoned. If there is some groundwater in the first 200 feet, drilling might continue to as much as 400-500 feet to try to find additional water-bearing zones (depending on the geologic conditions encountered).
2. A production well could be constructed near the 1991 test well. The 1991 test well encountered the shale at a depth of 88 feet. The Teewinot Formation dips toward the west at about 15° in this area. If the shale is the top of the Teewinot Formation (rather than flat-lying

lakebed sediments), then locating a new well 100 feet further west should result in the top of the Teewinot Formation being 25 feet deeper. A properly designed, constructed and developed well in the sand aquifer at this location should be capable of producing 50 gpm. One of the main disadvantages to constructing a well at this location is the distance from existing water treatment and storage facilities and the cost of constructing water lines and electrical service to the well site. Locating the well closer to the ranch is not an option as the well must be located in the alluvial fan/delta of the stream. Moving the well site further south (closer to the ranch) would almost certainly result in much lower yield from the well. If a new well is constructed in this area, then considerable time (2-3 days) should be spent to develop the well (removing the fine-grained fraction of the sediments) from near the well screen by surging, jetting, and pumping.

Concluding Remarks

Apparently much of the water used at the ranch is for irrigation of lawns and landscaping. Would it be feasible to reconstruct the water systems so that treated, potable water was not used for irrigation? That could greatly reduce the need for large yield from a well. Instead, irrigation water could continue to be provided from the collection system at the spring. If a new well proved to be prolific, then this might be a moot point.

If a new well is constructed near the 1991 test well, additional grain-size analyses will be needed for the samples from the water-bearing sand layer. Samples should be collected at 5-foot intervals from the water table to the shale layer which forms the base of the aquifer. The grain-size distribution for each sample should be determined individually. These data can then be used to select the correct size well screen for the well and to assess whether the well screen can be the same size over its entire length or if different slot size should be used at different depths.

References

---, 1992, *Post Construction Report Triangle X Ranch Exploratory Well*, Denver Service Center Technical Information Center, File: Grand Teton, Document D-221, 7 pp.

---, 2003, *Wyoming State Water Plan – Snake/Salt River Basin Plan*, accessed on the internet at <http://waterplan.state.wy.us/basins/snake/snake.html>, on Sept. 6, 2007.

Cox, Edward Riley, 1976, *Water Resources of Northwestern Wyoming*, U.S. Geological Survey Hydrologic Atlas HA-558, 3 sheets.

Love, J.D., John C. Reed, Jr., and Ann Coe Christiansen, 1992, *Geologic Map of Grand Teton National Park, Teton County, Wyoming*, U.S. Geological Survey Geological Investigations Map Series Map I-2031, 1:62,500, 1 sheet and 17 pp.

Pierce, Kenneth L., and John D. Good, 1992, *Field Guide to the Quaternary Geology of Jackson Hole, Wyoming*, prepared for the Friends of the Pleistocene field trip on September 11-13, 1992, 56 pp.

A Brief Summary of Existing & Potential Water Sources for the Triangle X Ranch, Grand Teton National Park

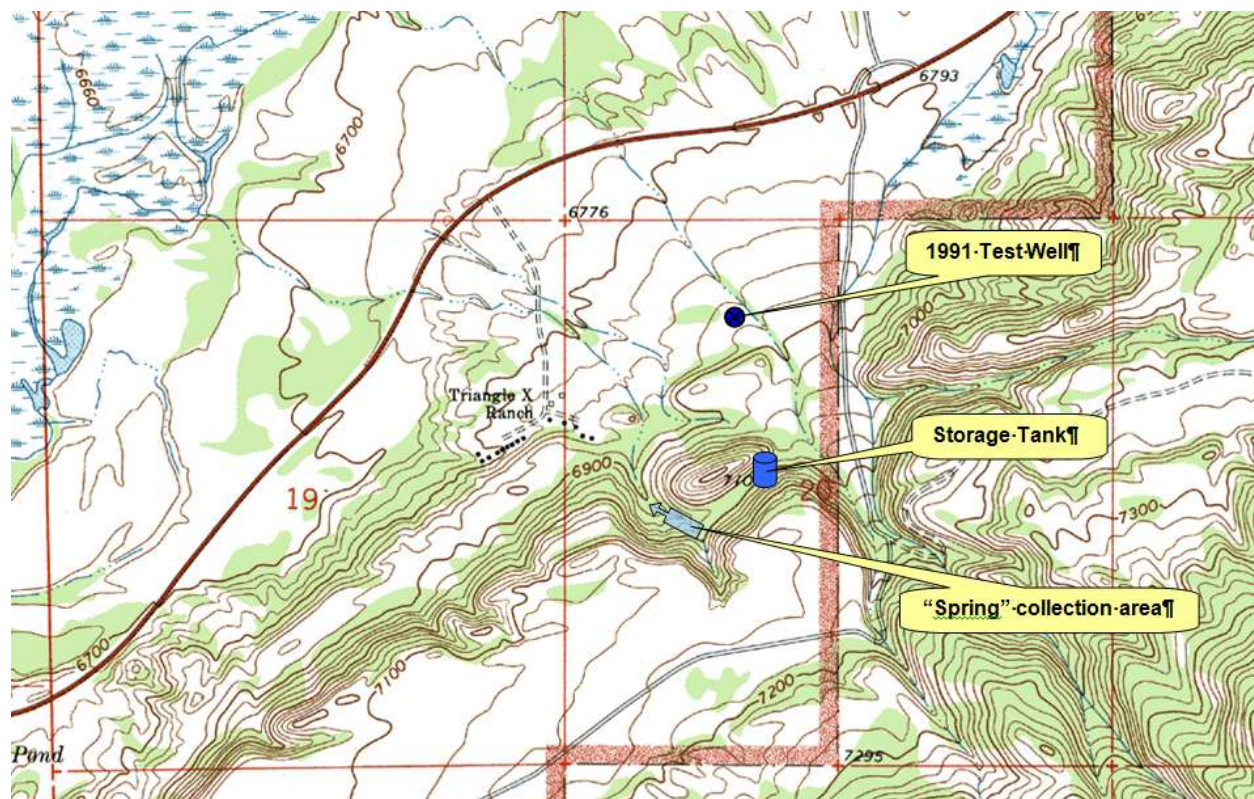
The “spring” supplying water for the Triangle X Ranch occasionally produces water with high turbidity, particularly after heavy rains. This is an obvious indicator of a direct connection with surface water. EPA and Wyoming DEQ don’t like that and ranch managers don’t like to tell their guests that the water from their faucets isn’t safe to drink. We would like to construct a well in the area that will supply the ranch with good-quality groundwater that is not susceptible to contamination from surface sources. Desired yield is in the 20-25 gpm range, but they have a 50,000-gallon storage tank, so they might get by with a lower pumping rate if it could be sustained over long periods.

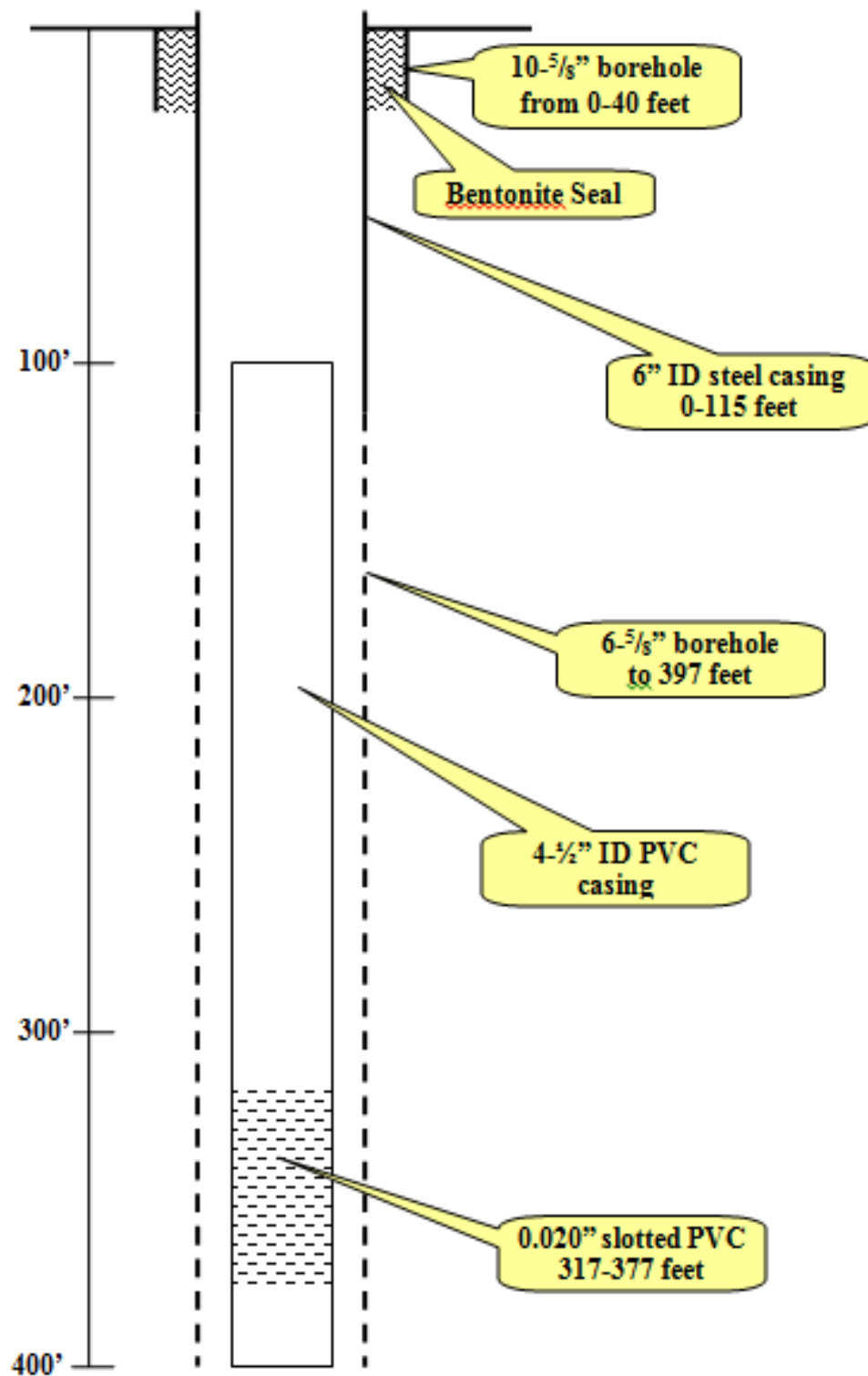
The current source of water for the ranch is a “spring” located about ¼ mile south of the ranch along an unnamed creek. In reality, it’s a marshy seep area along the creek bottom. I suspect the source of water is outflow from the Burned Ridge outwash south of the spring. Groundwater probably flows from the base of the outwash and then through alluvial sediments onto the Burned Ridge moraine deposits. Eventually, as the valley narrows and the coarse alluvium thins, groundwater is forced to the surface because there’s more water than can infiltrate into the lower permeability moraine deposits.

In 1991, the park drilled a test well on the fan about 2000 feet northeast of the ranch. The well drillers log shows poorly-sorted gravel mixed with silt and clay from 0-52 feet; clean, white, well-sorted, fine-grained sand from 52-88 feet; and shale from 88-90 feet. Water level in the well was 58 feet below ground surface. The well was tested by bailing and monitoring the recovery rate. Yield was estimated at 12 gpm. There was no screen and no perforations in the casing. All of the water enters through the open end at the bottom of the casing at 83 feet below ground surface. The test well could not be used as a permanent supply well because of its poor construction. I am fairly confident that a properly constructed well (fully screened through the aquifer with stainless steel well screen with the slot size based on grain-size analysis of the sand) at this location would provide an adequate supply. However, this location is some distance from the existing storage tank and electrical supplies, so development of this source would be more expensive. Since a new well would need to be constructed, there’s no real advantage to using this site, other than we have information from the test well that indicates a high probability of success.

The preferred well location would be near the existing water storage tank. This area is out-of-sight from ranch guests, in an already disturbed area with road access, near the chlorinator building and storage tank, and electricity is readily available.

A new well was constructed near the storage tank in 2009.





Schematic drawing of the new well (September 2009) at Triangle X Ranch

GRTE New Well at Triangle X Ranch
September 2009

