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Groundwater level monitoring of the alluvial aquifer associated with the Belle Fourche River, Devils Tower National Monument

The Belle Fourche River flows through the southeast part of Devils Tower National Monument. Flow in the river is regulated by releases from Keyhole Reservoir, about 18 miles upstream from the park. As a result of the controlled streamflow through the park, natural recruitment of cottonwood trees and willows has been nearly eliminated in the associated riparian environment of Devils Tower National Monument. Hydrologic monitoring of the alluvial aquifer is being conducted to provide data necessary to develop a restoration plan for the area.

Ten shallow monitoring wells were constructed in the alluvium of the Belle Fourche River at Devils Tower National Monument in the summer 1996. The primary purpose for installing the monitoring wells was to obtain groundwater level data needed to develop a plan for restoration of cottonwood and willows in the riparian corridor. The primary objectives for the monitoring include; 1) determine the depth to groundwater, 2) determine the seasonal variability of the water table, 3) determine the interaction between surface water flow in the river and groundwater in the associated alluvial aquifer, and 4) facilitate testing the water chemistry of the alluvial groundwater.

Ten monitoring wells were constructed using a hand-powered soil augur. The wells were completed with 2-inch, Schedule 40 PVC. The bottom two feet of PVC in each well was perforated. Coarse sand was poured into the annular space to maintain hydraulic communication between the well and aquifer. The upper part of the borehole was sealed with bentonite pellets.

The wells were located in three areas (Figure 1). The four wells in the C-cluster are located on a large point bar extending southeasterly from the campground. The three wells in the M-cluster are located in association with an abandoned meander. The three wells in the P-cluster are located near the primitive campground, near the downstream boundary of the park. Table 1 provides a summary of the well construction.

Three more monitoring wells were installed in an abandoned meander of the river in summer 2012. I don't have the surveyed locations of those wells, but in general, they are south of the M-series of wells and north of the campground, on the east side of the river. Depth to water in these wells has been measured only once in May 2013, so I did not prepare graphs of the data.

Period of Record

Water levels in the monitoring wells were measured approximately monthly following construction of the wells in August 1996 until September 1999. Water levels were measured once in 2000; on July 13. No measurements were made in 2001 or 2002. One set of measurements were made in June and July 2004. Beginning in 2005, measurements were made approximately biweekly from late-May through September. The frequency of measurements is illustrated by the locations of dots on the hydrograph of Well P2 (Figure 2).

Dataloggers were installed in two wells, P2 and P3, on November 30, 2006. The dataloggers record total pressure, which can be converted to depth of water after correcting for barometric pressure changes. Due to a variety of problems, the continuous record from November 2006 through mid-September 2009 is not as accurate as it could be. A better SOP (Standard Operating Procedure) was established in September 2009, resulting in more reliable data since then.

Manual Measurements

Prior to 2010, water level measurements were made by sticking a long piece of rebar to the bottom of the well. The distance from the end of the rebar to the wetted mark was measured, i.e., measuring the depth of water from the bottom of the well up. They then used the depth of the well to compute the depth to water below ground surface.

In 2010, DETO staff were provided a length of steel surveyor's tape and chalk and instructed to measure from the top down. This is the standard method for measuring water levels in wells.

Continuous Data

HOBO® pressure transducer dataloggers were installed in Wells P2 and P3 in November 2006. The instruments measure total pressure, which varies depending on the depth of water in the well and barometric pressure. The pressure data can be converted to depth of water in the well by correcting for barometric pressure changes and providing an anchor (a manual water level measurement that can be correlated to a specific pressure reading). Pressure data were recorded and stored hourly, providing a continuous record of water level in the two wells.

Continuous record of water level data is available for the periods from November 2006 to July 2008, from September 2009 to September 2010, June-October 2012, and November 2012 to May 2013. The dataloggers were programmed incorrectly from July 28, 2008 until September 18, 2009. We do not have reliable continuous data for that period. There are also breaks in the continuous record from July 2011 to June 2012 and October and November 2012.

Continuous monitoring of water levels at Wells P2 and P3 is ongoing. Manual measurements are made approximately weekly in the summer and bi-monthly in the winter. Hydrographs of water levels in the various wells are shown in the attached hydrographs.

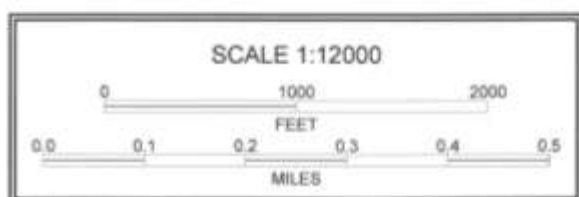
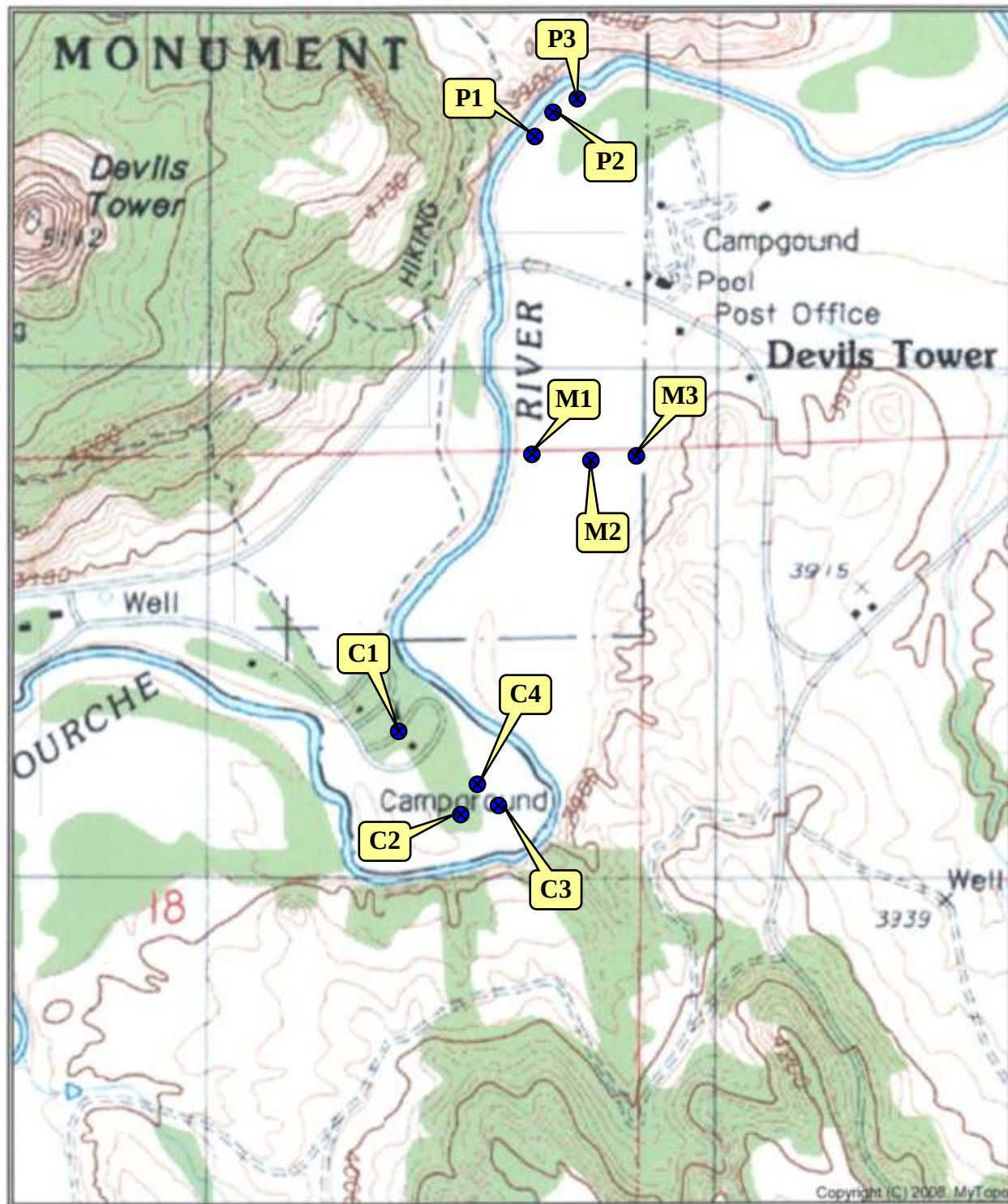
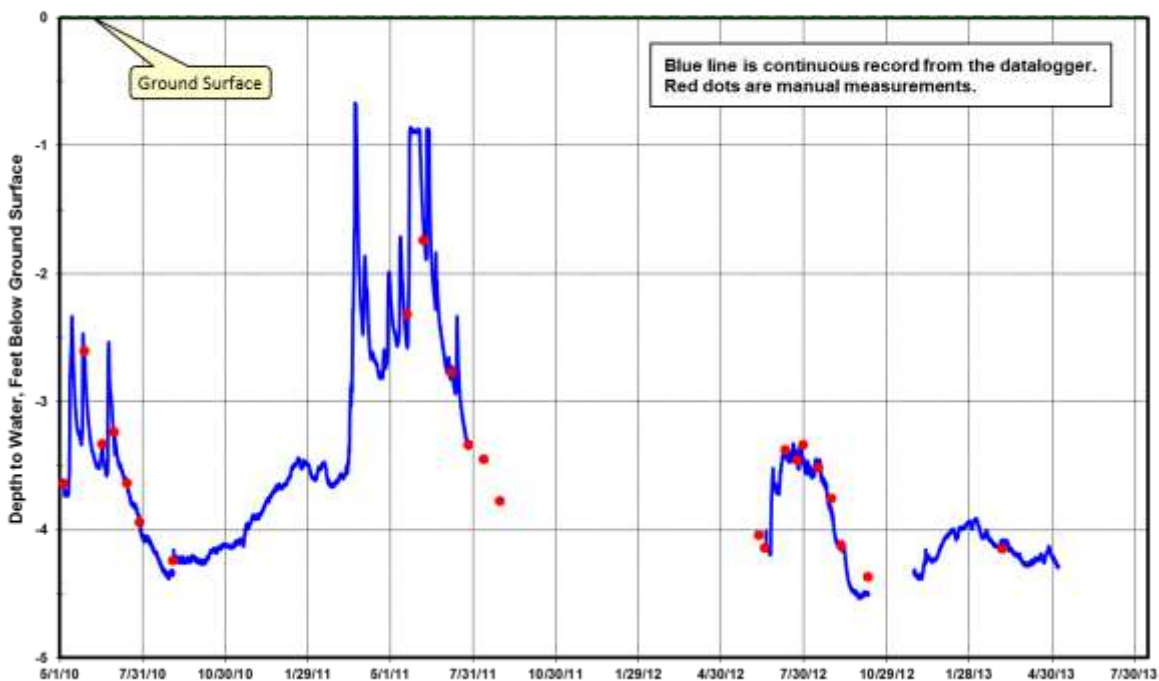
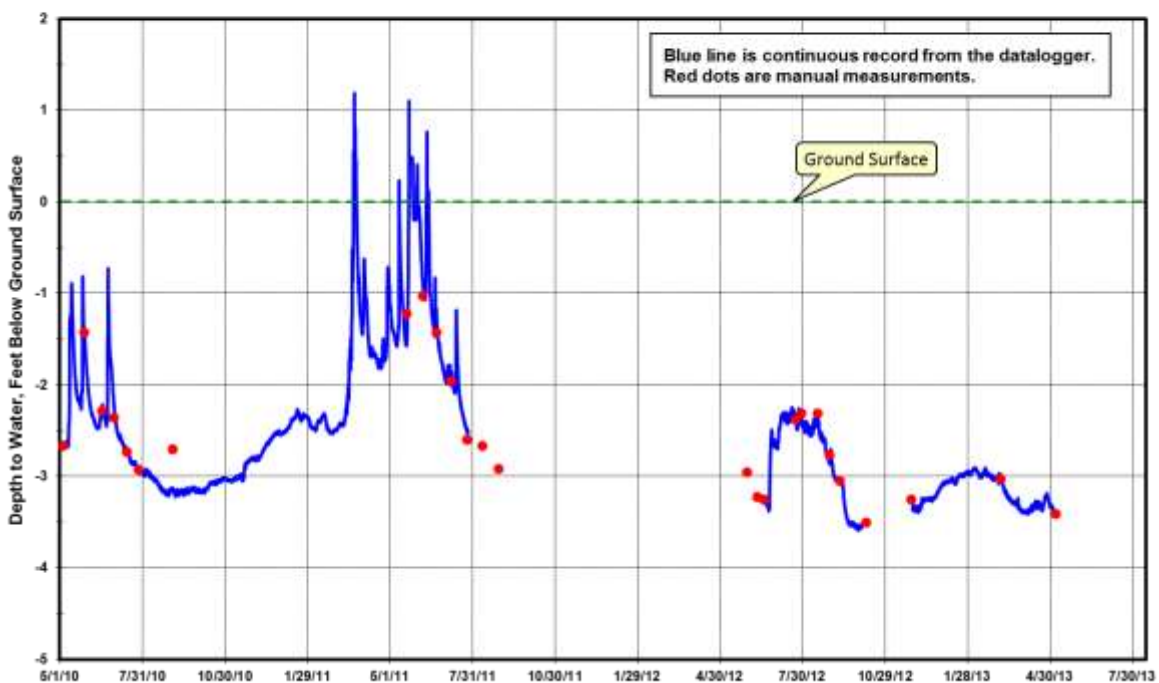


Figure 1. Locations of monitoring wells along the Belle Fourche River, Devils tower National Monument.

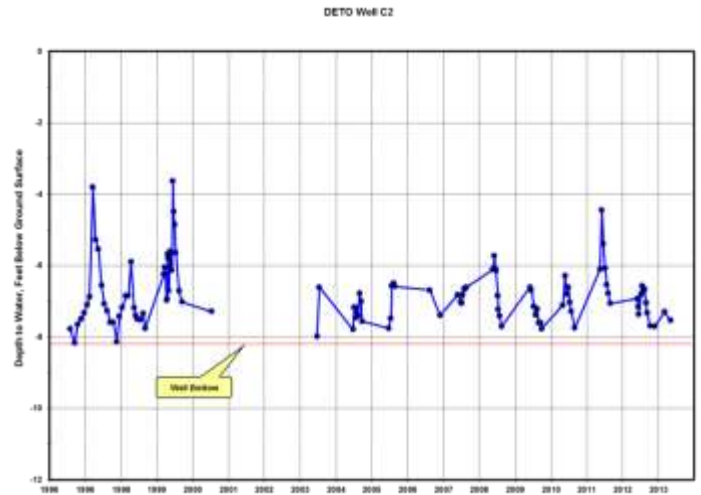
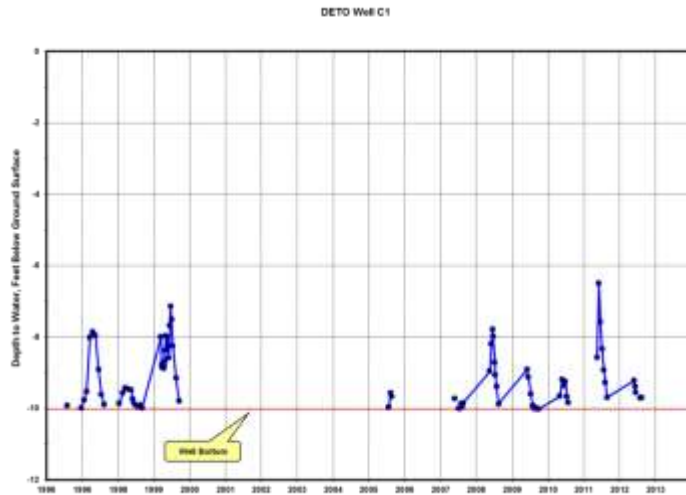
DETO Well P2



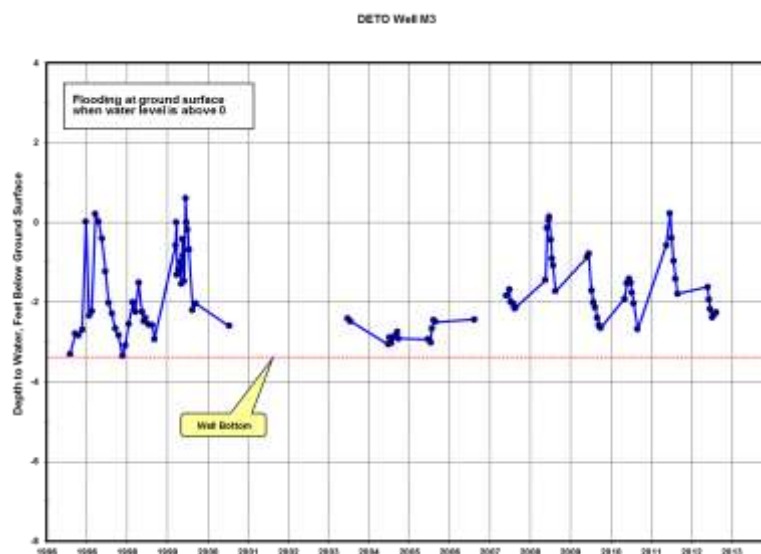
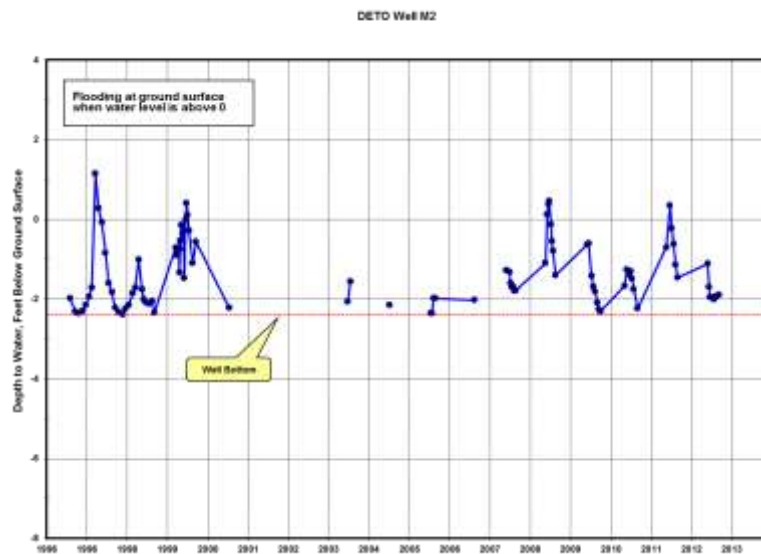
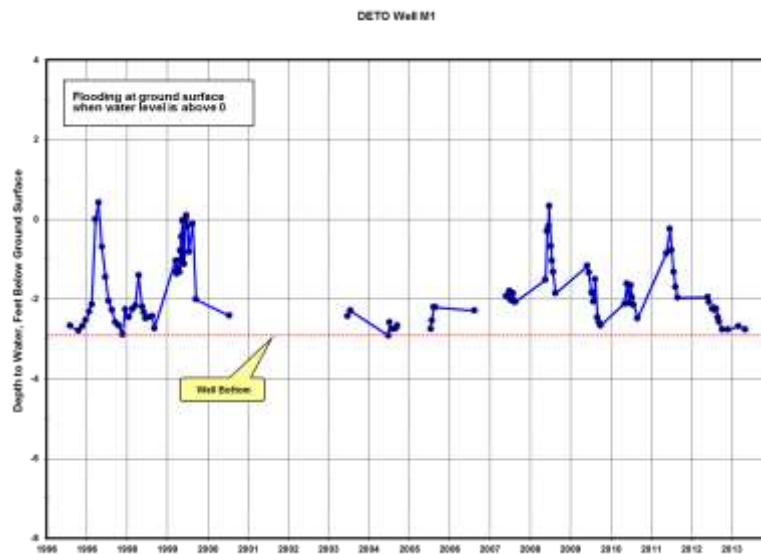
DETO Well P3



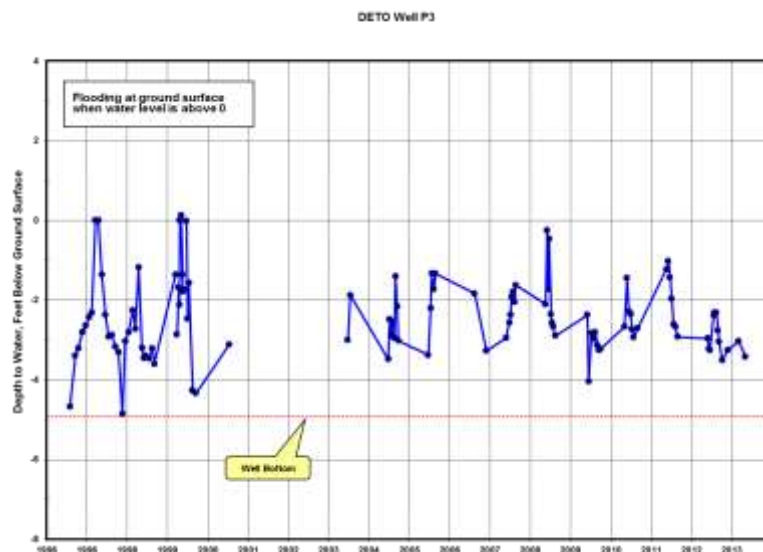
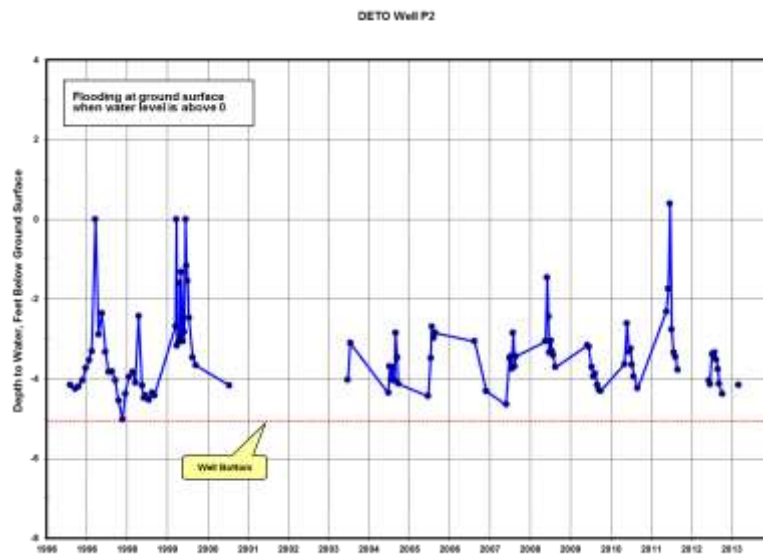
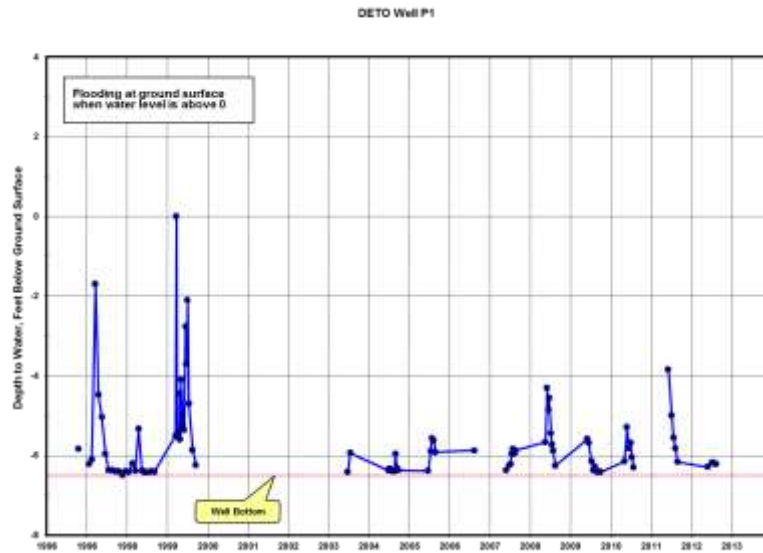
Hourly water levels at Wells P2 and P3 since May 2010.



Manual water level measurements at monitoring wells C1, C2, C3, and C4 at the campground



Manual water level measurements at monitoring wells M1, M2, and M3 in the abandoned meander of the river channel.



Manual water level measurements at monitoring wells P1, P2, and P3 at the primitive campground downstream of the bridge.