



1201 Oak Ridge Dr., Suite 250
Ft. Collins, CO 80525

August 4, 2011

Larry Martin
Hydrogeologist
970-225-3515

Groundwater traveltime and capture zones for wells at the East Creek wellfield, Bryce Canyon National Park

There has been discussion regarding fencing an area around the existing wells at the East Creek wellfield to preclude prairie dogs from encroaching too close to the wells. The thought is that prairie dogs burrowing close to the wells could be a source of fecal coliform contamination of groundwater pumped from the wells. The park is proposing a 50-foot exclusion area around each well. This report presents the results of modeling groundwater flow and travel times to the wells in the shallow alluvial aquifer to evaluate whether the 50-foot enclosure might provide a reasonable level of protection.

Modeling was done with EPA's WhAEM (Wellhead Analytical Element Model), which is commonly used to model capture zones for water-supply wells. Descriptions of local hydrogeologic conditions and well construction are in a previous report (Martin, 1998). Pumping tests were conducted at the site in September 1997 as part of the data collection component of that project.

Input data for this modeling work was the same as for the previous modeling in 1997-98. Data are from a USGS report (Marine, 1963), a USGS geologic map (Bowers (1990), fieldwork by the author and BRCA staff in 1997-98 (primarily Larry Martin and Jeff Stock). Input data for the model include;

Pumping rate	15,000 ft ³ /d (110,000 gpd)
Transmissivity	8,900 ft ² /d
Hydraulic conductivity.....	150 ft/d
Regional hydraulic gradient.....	0.005 ft/ft
Angle of ambient groundwater flow.....	330° (30°West of North)
Aquifer Porosity.....	0.35
Aquifer thickness	60 feet

The modeling results are shown in the attached series of figures. Most of the capture zone for a 10-day travel time for groundwater flow to the well is contained within the 50 foot radius of the

well. The capture zone extends about 100 feet upgradient from the well for a 20-day travel time, 130 feet for a 30-day travel time, and about 300 feet for the 100-day travel time.

The model results only indicate the approximate area of the capture zone for a pumping well for the stated conditions. These numbers should be used with a great deal of caution. The model produces a precise numerical solution for ideal conditions, which do not exist in the physical world. There is a great deal of geologic variability, even in the relatively small area of the wellfield which could result in larger or smaller, narrower or wider capture zones. The model output should only be viewed as a general depiction of the relative size and shape of the capture zones for various travel times to the pumped well.

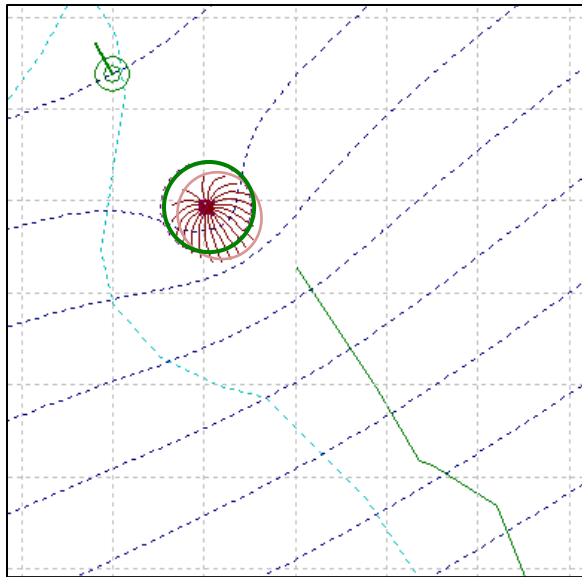
More accurate modeling results would require a large amount of site-specific data that could only be obtained by drilling several monitoring wells, conducting geophysical surveys to determine the configuration of the aquifer, and several years of monitoring rainfall, runoff, groundwater level fluctuation, pumping from the wells, evapotranspiration, streamflow, and perhaps other features. The resultant model would be better, but still not perfect. Hardly worth the effort.

I conducted a limited search on the internet to get an idea of the survival rate/travel time for pathogens in groundwater. A publication from the UK reports that, “the survival of bacteria in groundwater is generally thought to be limited; 90% reduction may be expected at 20°C within about 10 days, ...” Viruses and protozoan parasites, such as *Cryptosporidium* and *Giardia* may persist longer.

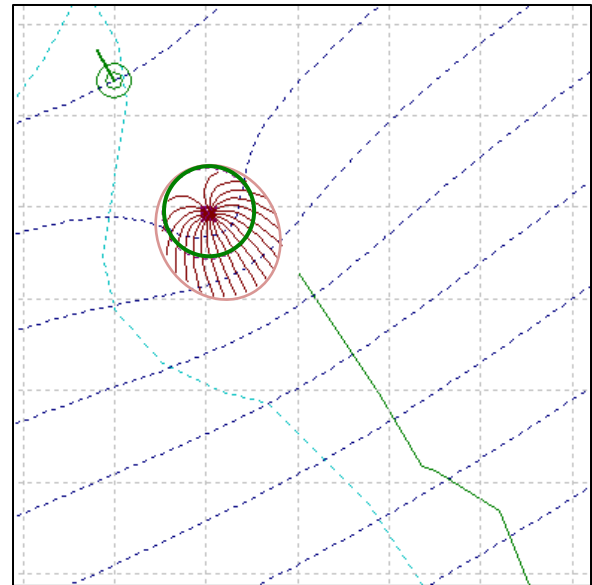
http://www.groundwateruk.org/downloads/Pathogens_and_groundwater_final%20version.pdf

References

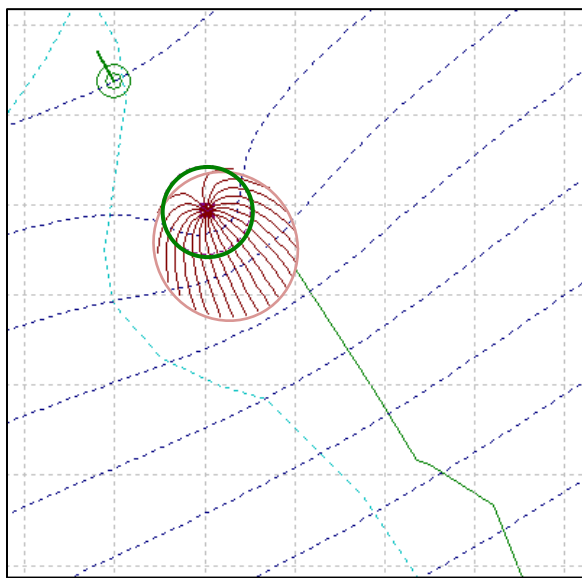
- Bowers, William, 1990, *Geologic map of Bryce Canyon National Park and vicinity, Southwestern Utah*, USGS Miscellaneous Investigations Series Map I-2108.
- Marine, I. Wendell, 1963, *Ground-Water Resources of the Bryce Canyon National Park Area, Utah*, USGS Water-Supply Paper 1475-M, pp. 441-486.
- Martin, Larry, 1998, *Drinking Water Source Protection Plan, East Creek Well Field, Bryce Canyon National Park*, unpublished report, NPS Water Resources Division, Ft. Collins, CO, 38 pp.



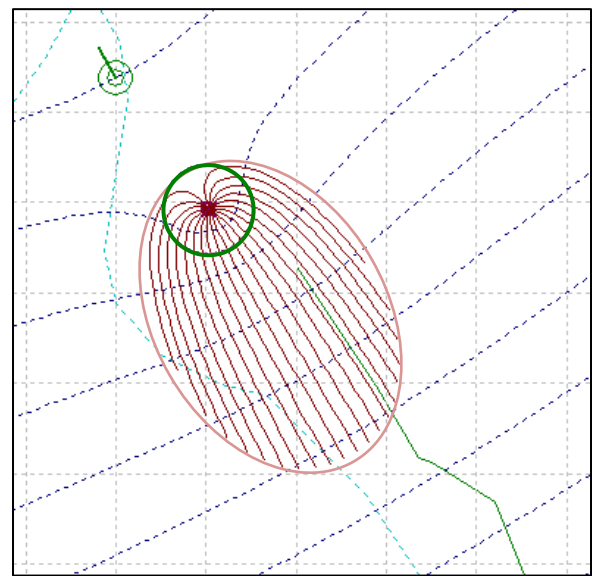
10 days



20 days



30 days



100 days

Results of computer modeling of capture zones for a well at the East Creek wellfield, Bryce Canyon National Park. The green circle shows a radius of 50 feet around the well. The rectangular background grid has 100-foot spacing. Contour interval is 0.5 foot. Capture zones are shown for 10, 20, 30, and 100 days of continuously pumping 110,000 gallons/day. The dashed blue line is the creek flowing through the area. The green circle and line in the upper left of each figure points in the direction of the ambient groundwater flow in the alluvial aquifer.