Heat as a Tracer

Study Methodology and Design

- Techniques using heat as a natural tracer described in USGS Circular 1260 (Stonestrom and Constantz, 2003)
- Five piezometers in each cross section. Each piezometer instrumented with two Tidbits (upper (30 cm) and lower (90 cm)) or Tidbit and miniTroll (fig. 5)
- Measure transport of heat (by advection and/or conduction) between stream and adjacent sediments by collecting temperature and water-level data. Use data as model input to determine streambed properties

Installation and instrumentation of piezometer cross section.

Initial Qualitative Results

- Large variability in temperature and pressure head/stage data between the three sites (located less than 10 miles apart)
- Strong advective heat transport at the Teton Village site causes temperature at 30-cm and 90-cm depth to be identical when creek is flowing (fig 6). At the Resor's Bridge and Wilson sites gradient can be seen at the 30-cm and 90-cm depths.

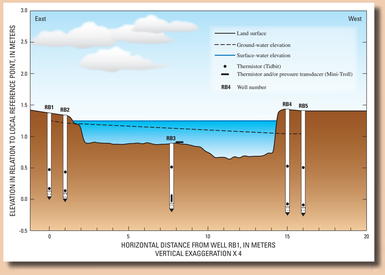

Figure 5. Channel geometry, piezometer installation, and thermistor and/or pressure transducer locations at Resor's Bridge cross section. Water-level and stage data for August 24, 2005.

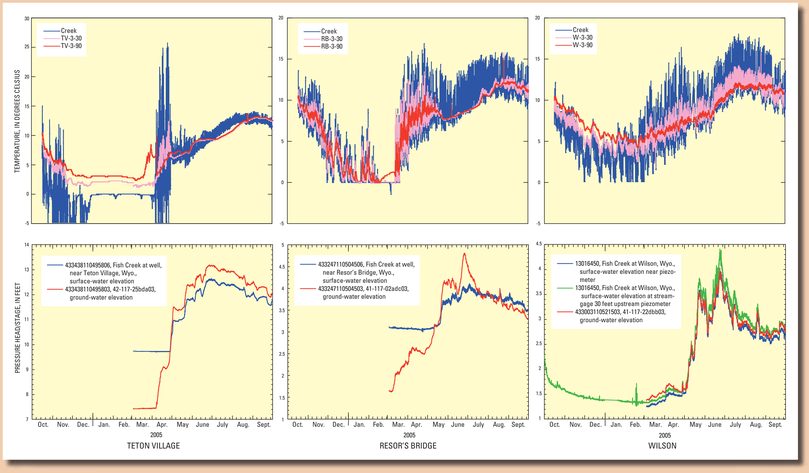

Figure 6. Temperatures and head/stage recorded at three sites on Fish Creek.

DTS (Distributed Temperature System)

- Demonstration/Evaluation Project, Branch of Geophysics
- Collects temperature at 1 meter interval along 1 km fiber optic cable

Fish Creek Deployment (July 14-15, 2006):

- Looking for areas where there are increased flows of ground water to the surface water, shown by:
  1. Lower mean temperature
  2. Dampened diurnal

Other data collected:

- Discharge measurements
- Water-levels at cross-section

Results:

- Technique can be used in stream environment (although there are limitations)
- On the Fish Creek reach studied, there were no significant areas with large temperature difference
- A few small areas of temperature difference can be seen, but are due to either local, small volume springs or changes in channel morphology and/or plant cover
- No statistical difference in temperature between the two sides of creek (fig. 7)
- Discharge measurements verify that there is no significant ground-water input in the section of creek studied, during the study period

Winter and summer flows in Fish Creek near Resor's Bridge.

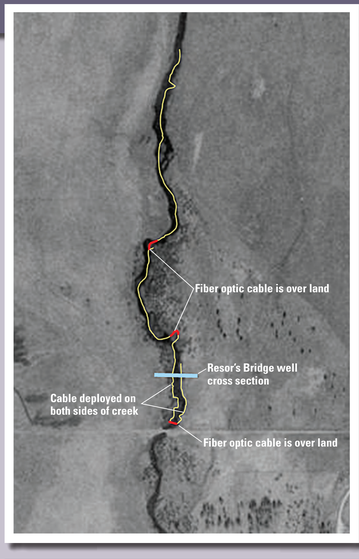

Figure 7. Location of fiber optic cable and Resor's Bridge well cross section.

DTS fiber optic cable deployment (photos 1–4), DTS controller and field housing (photo 5), and plant material caught on cable (photo 6), causing the cable to stretch and transmit erroneous data. Plant material was removed along entire cable length and DTS restarted to obtain data in fig. 8.

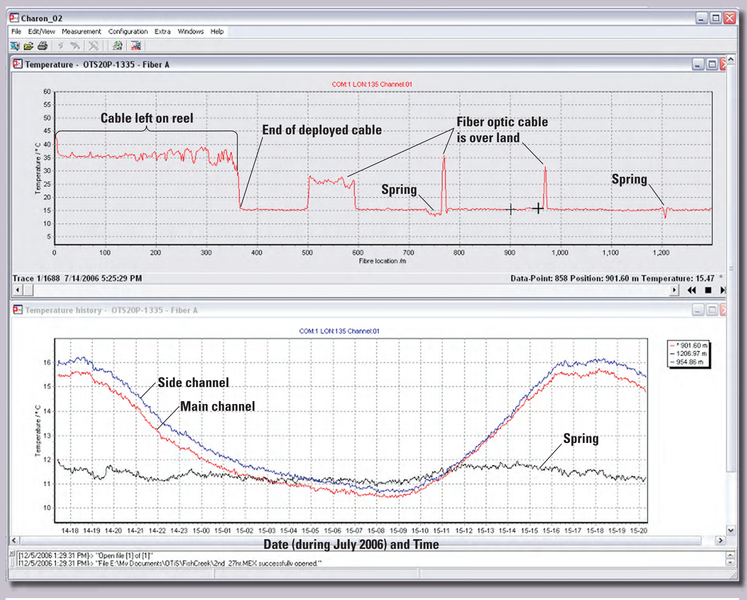

Figure 8. Output from LIOS DTS software.

More to come...

- 1-D and 2-D modeling of temperature data using VS2D
- Algae sampling
- Water-quality (low-level nutrients and waste-water chemicals) in surface water and ground water
- Look for this poster and additional information about this and other projects by the USGS Wyoming Water Science Center at ***http://wy.water.usgs.gov/***

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References

Stonestrom, D.A. and Constantz, J.E., eds., 2003, Heat as a tool for studying the movement of ground water near streams: U.S. Geological Survey Circular 1260, 96 p.

Wheeler, J.D., and Eddy-Miller, C.A., 2005, Seepage investigation on selected reaches of Fish Creek, Teton County, Wyoming, 2004: U.S. Geological Survey Scientific Investigation Report 2005-5133, 15 p.

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