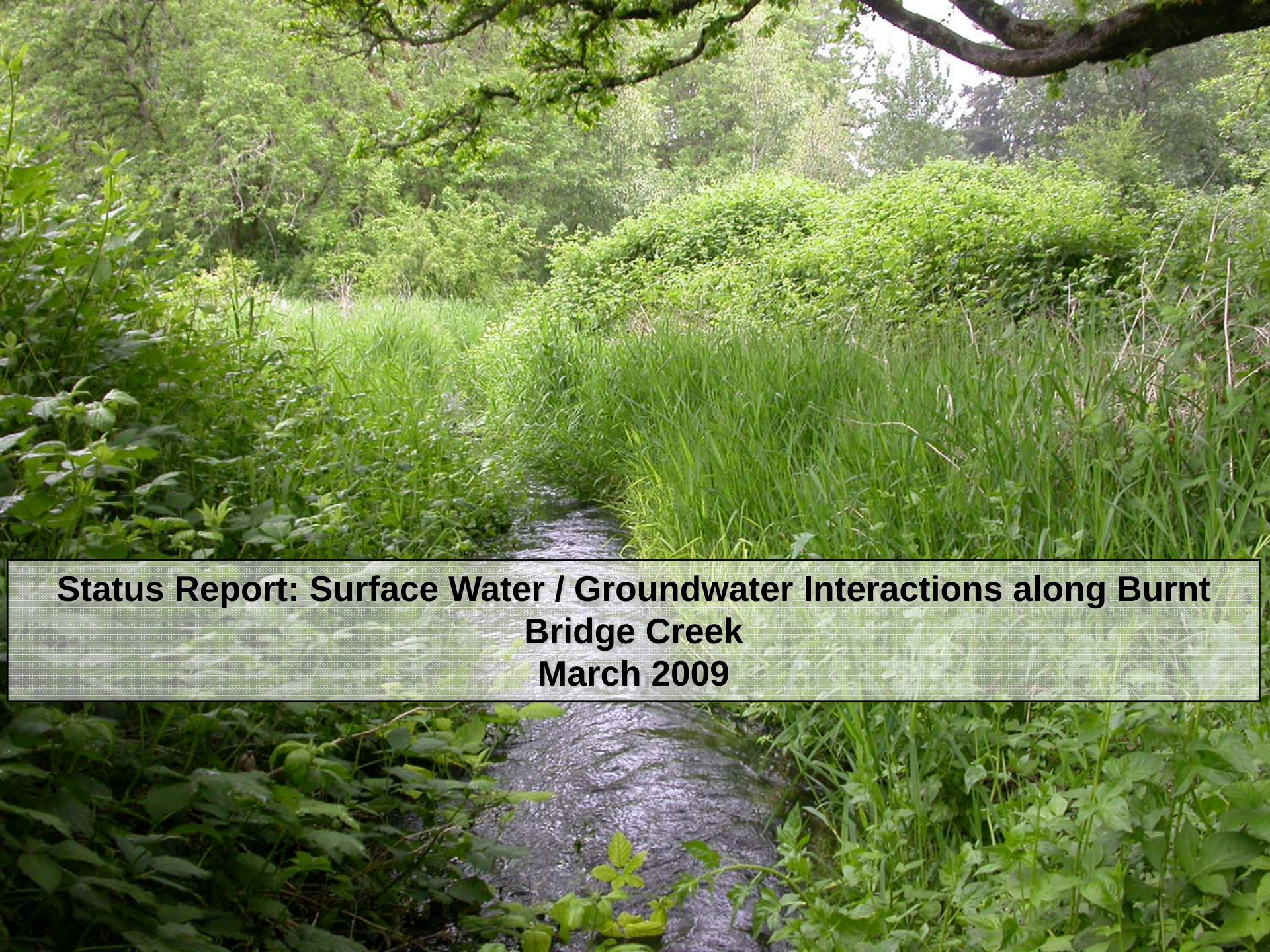


Status Report: Surface Water / Groundwater Interactions along Burnt Bridge Creek

March 2009

Question…

How does groundwater influence the temperature and water quality of Burnt Bridge Creek?

Study Objectives...

- Identify gaining and losing reaches of the creek
- Quantify the gain or loss along these reaches over time, and
- Define the chemical characteristics of the GW that discharges to the creek along gaining reaches.

Study Approach and Methods

Stream Seepage Surveys - reach scale streamflow gains/losses during summer baseflow conditions;

Instream Piezometers (wells) - point based SW/GW head relationships at specific points in the watershed over time;

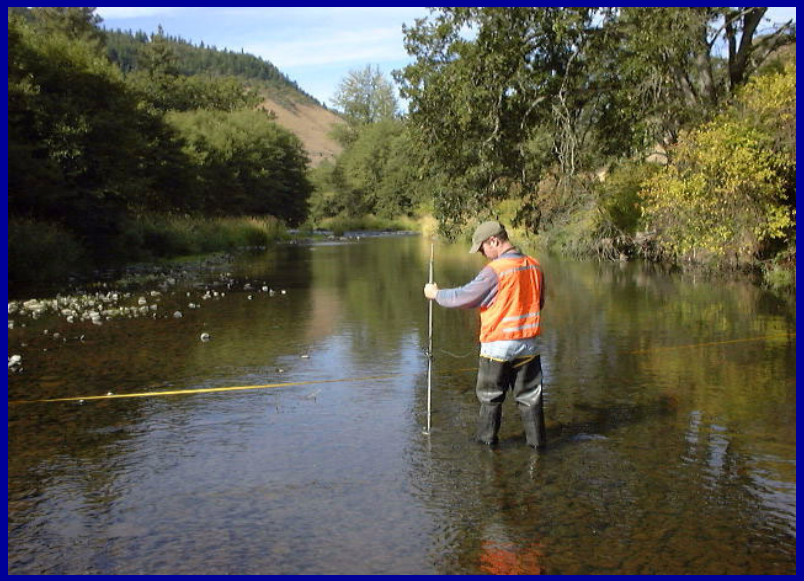
Streambed Thermal Profiling - measure continuous time series temperature profiles of the upper 1± meters of the streambed (seasonality of interactions);

Groundwater Quality Sampling - to define GW nutrient concentrations near the point of discharge to surface water at specific points of interest;

Stream Seepage Surveys

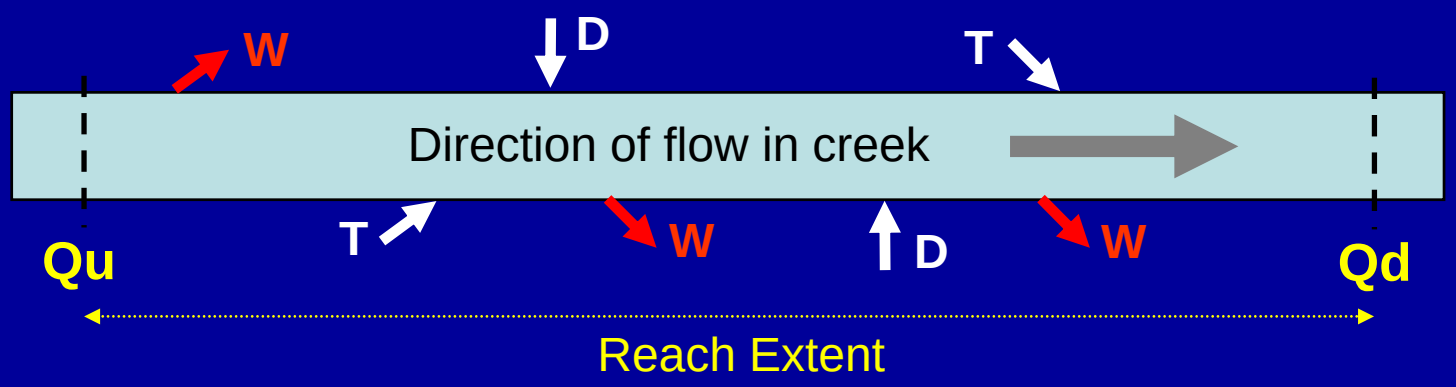
Two surveys: July and Sept, 2008 – conducted to define reach scale exchanges

For each survey, same-day discharge measurements are made at convenient points along the creek, at all known tributary inputs and point discharges, and at active withdrawal sites.



Worker measuring stream discharge

Example Mass Balance Calculation for a Hypothetical Seepage Reach



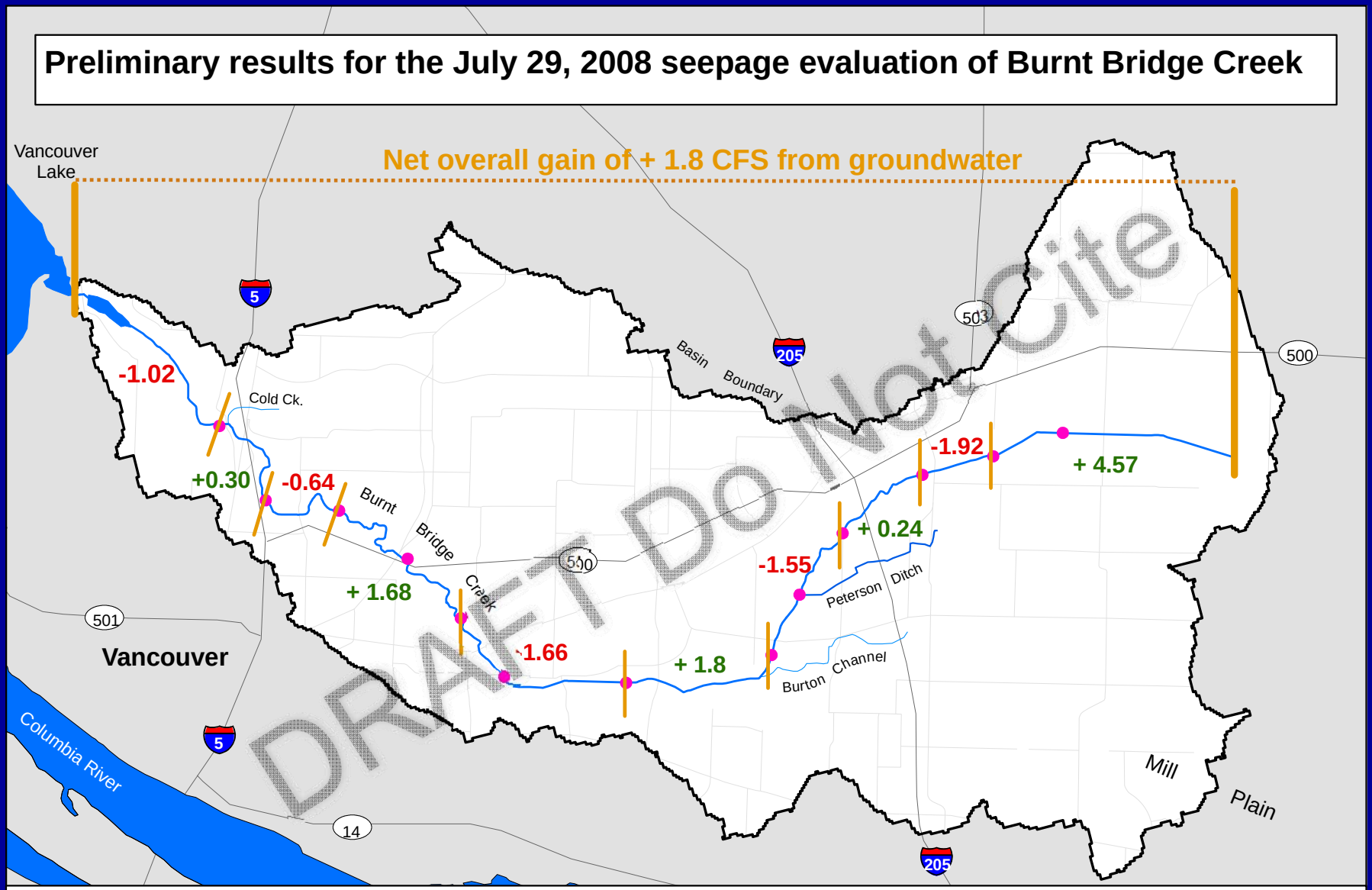
For each reach, the **NET** volume of water exchanged between the creek and ground water (Qn) can be described as:

$$Qn = Qd - Qu - \Sigma T - \Sigma D + \Sigma W \text{ ; Where}$$

Qd = The streamflow measured at the downstream end of the reach (ft^3/s);
Qu = The streamflow measured at the upstream end of the reach (ft^3/s);
ΣT = The sum of all tributary inputs to the creek along the reach (ft^3/s);
ΣW = The sum of all artificial withdrawals from the creek along the reach (ft^3/s); and
ΣD = The sum of all point discharges to creek along the reach (ft^3/s).

Positive values of Qn suggest that groundwater discharge caused the river flow to increase across the seepage reach. Negative values of Qn suggest that the river lost water to groundwater storage across the seepage reach.

Preliminary results for the July 29, 2008 seepage evaluation of Burnt Bridge Creek



EXPLANATION

+0.30 Seepage reach with net streamflow gain or loss

Instream Piezometer

N W E S

0 0.5 1 Miles

0 0.5 1 2 Kilometers

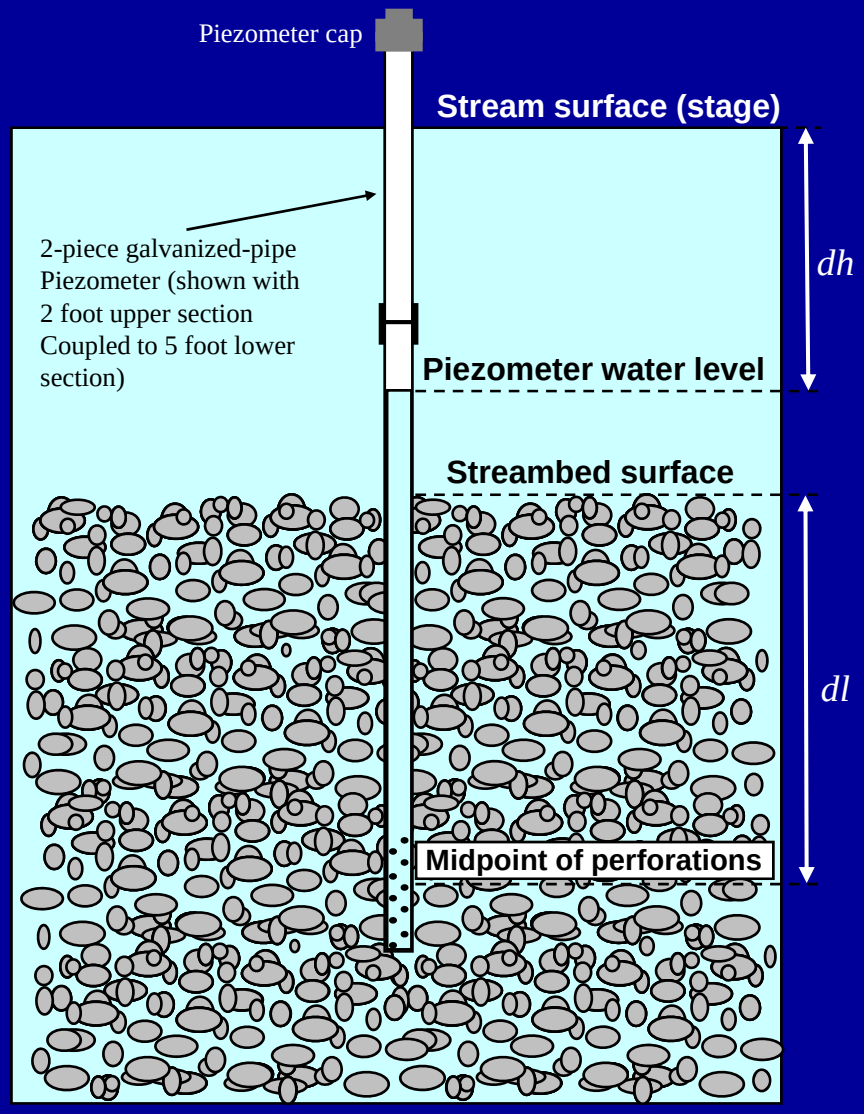
Instream Piezometers (small diameter wells)

13 piezometers installed along Burnt Bridge Creek in May 2008.

Visited 1-2 times per month to measure stream and groundwater water levels

Piezometer development following installation

Schematic of a typical in-stream piezometer



(diagram not to scale)

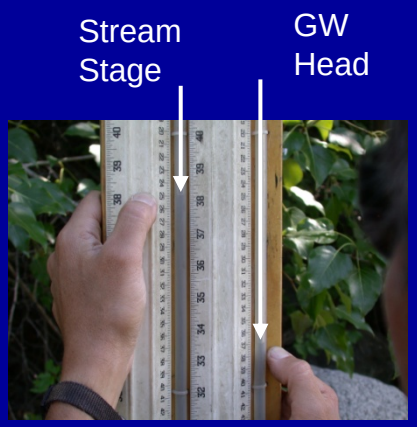
We used the following equation to derive vertical hydraulic gradients for each piezometer

Where $$i_v = \frac{dh}{dl}$$

i_v = vertical hydraulic gradient (dimensionless);

dh = the measured difference in head between the stream stage and in-stream piezometer water level, in units of length; and

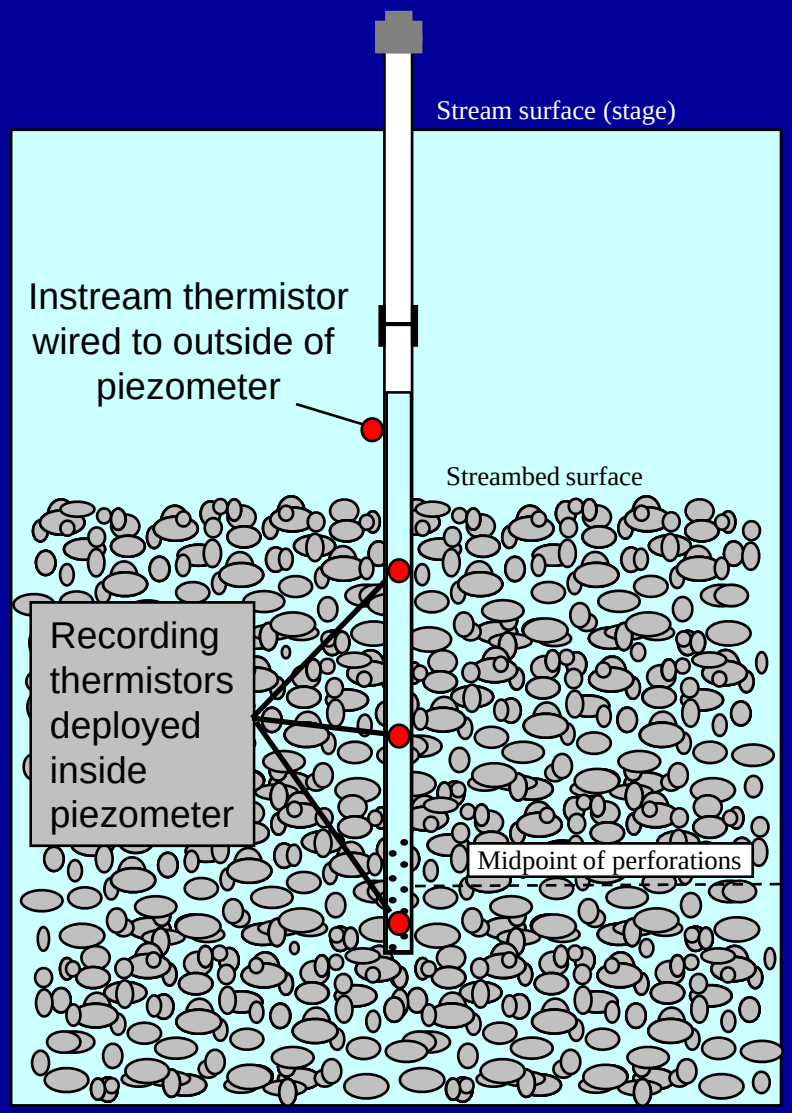
dl = the vertical distance between the streambed and the mid-point of the piezometer perforations, in units of length.



Using a manometer board to measure water levels in a piezometer

Measuring the water level in a piezometer

Schematic of a typical piezometer and thermistor array

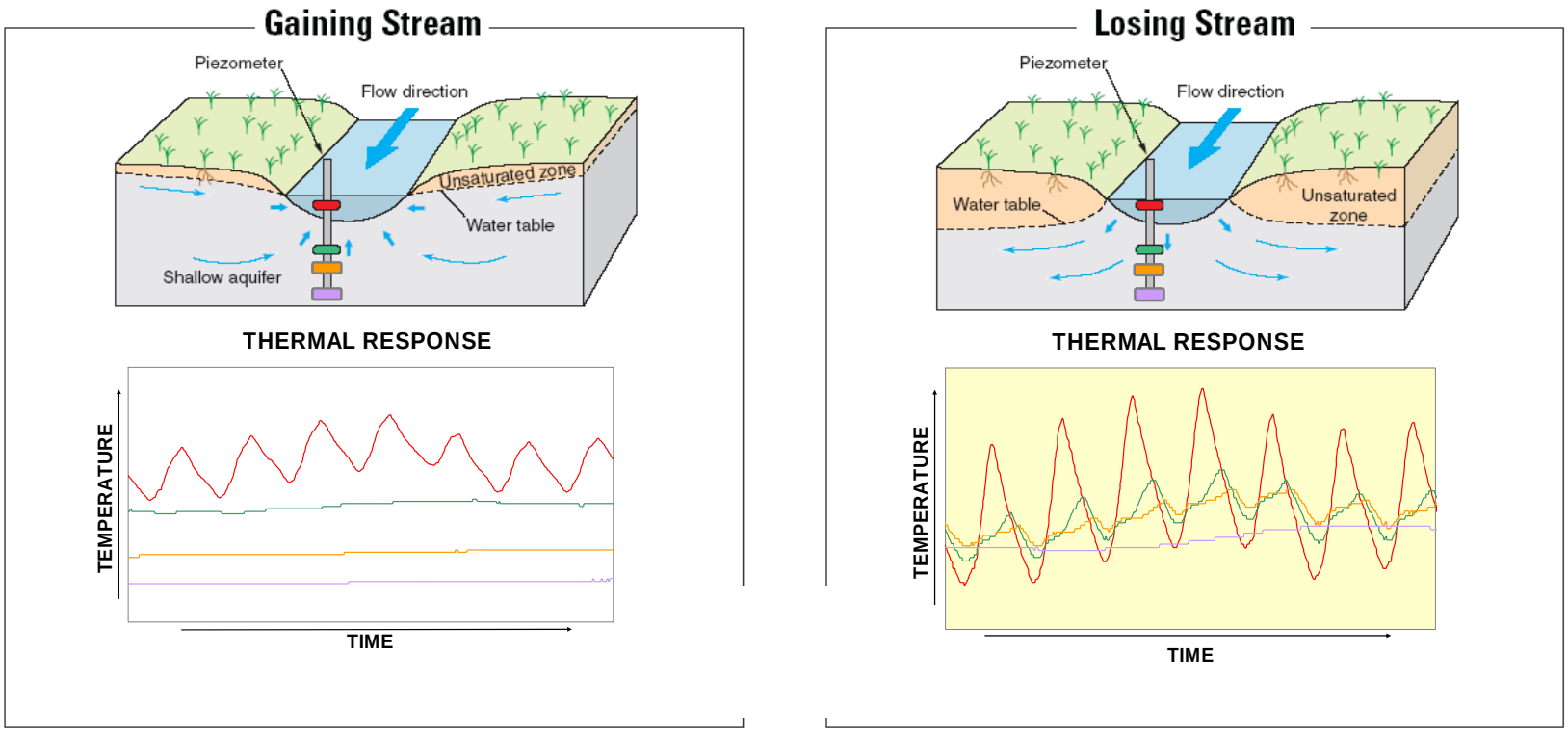


(diagram not to scale)

Thermistor detail

Preparing to deploy a thermistor string in a piezometer.

Heat Tracing Within Streambed Sediments

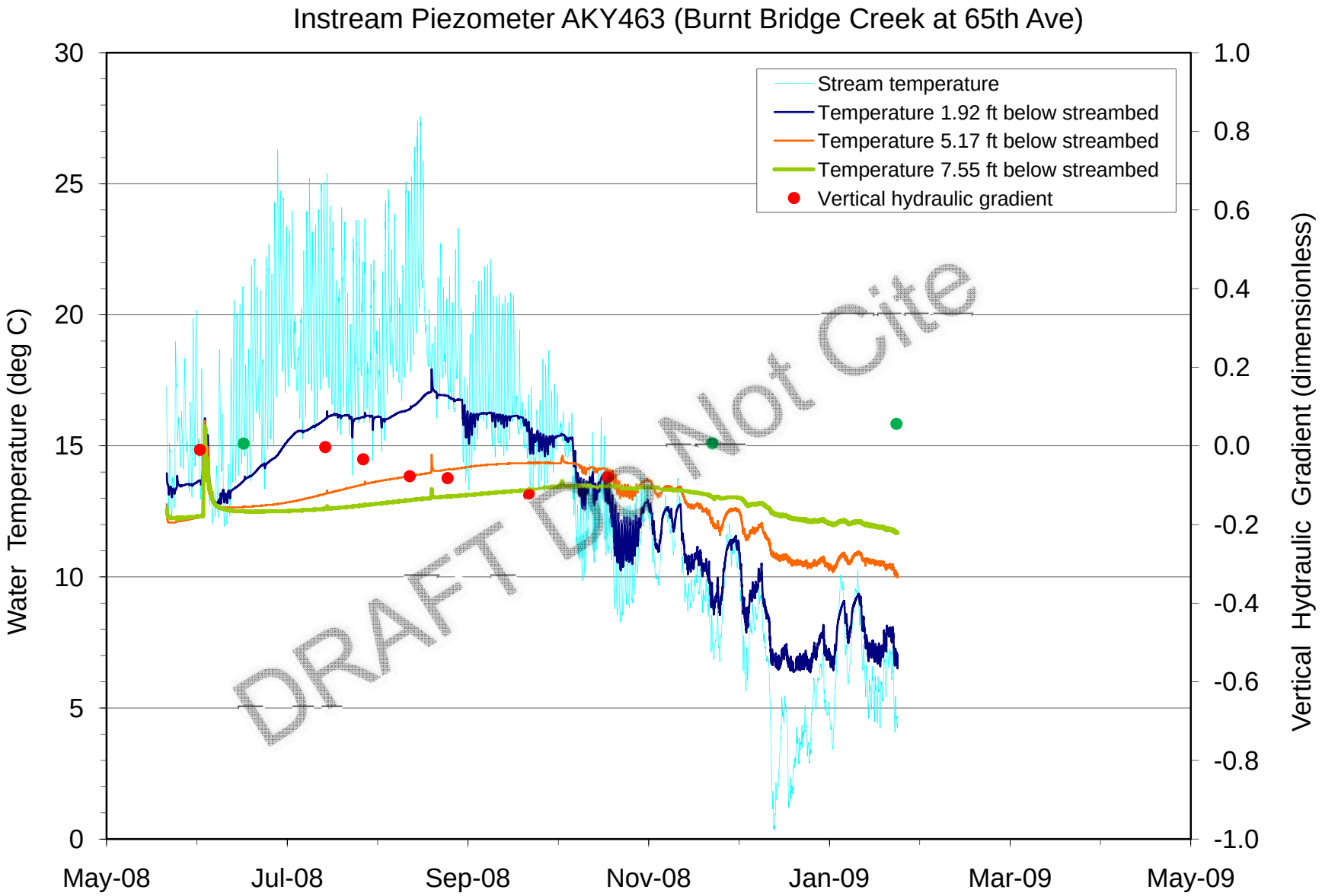


Graphic adapted from USGS Scientific Investigations Report 2004-5058.

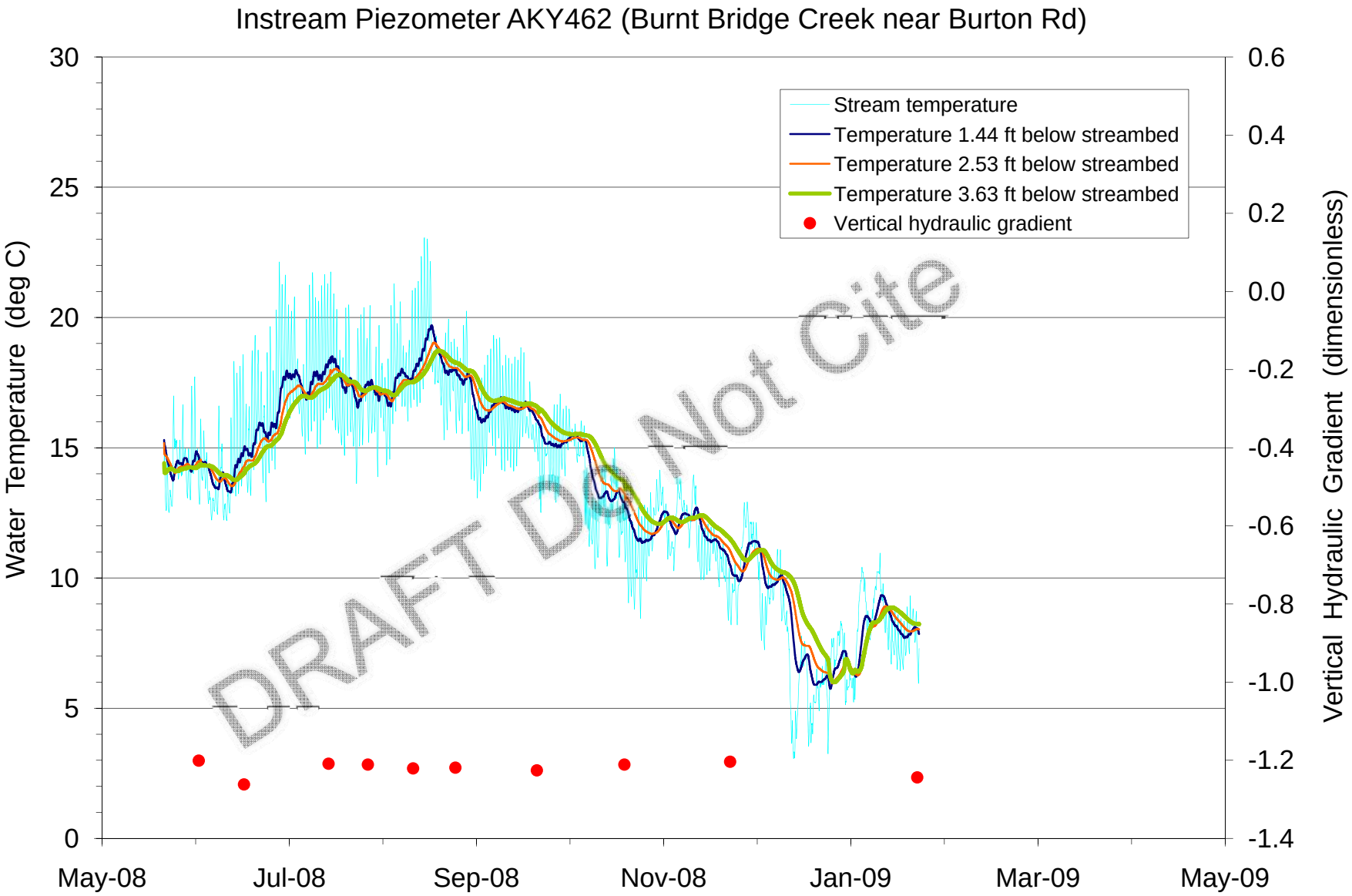
Explanation

- Instream Thermistor
- Upper Piezometer Thermistor
- Middle Piezometer Thermistor
- Lower Piezometer Thermistor

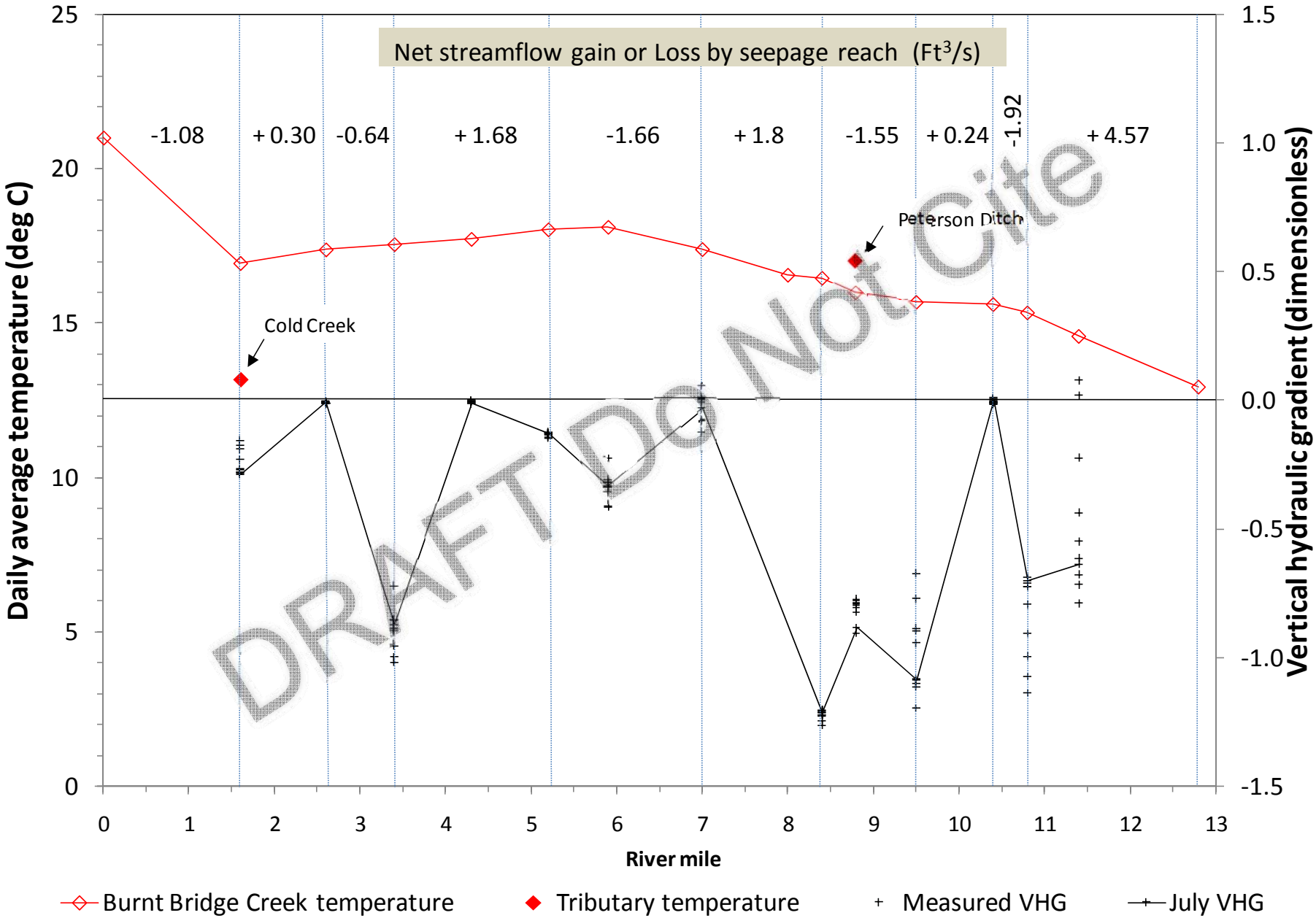
Streambed temperature and hydraulic gradient patterns in an area where groundwater discharges to Burnt Bridge Creek



Streambed temperature and hydraulic gradient patterns in an area where Burnt Bridge Creek recharges groundwater



Plot of daily average stream temperature, vertical hydraulic gradient, and net seepage values (July 29, 2007)



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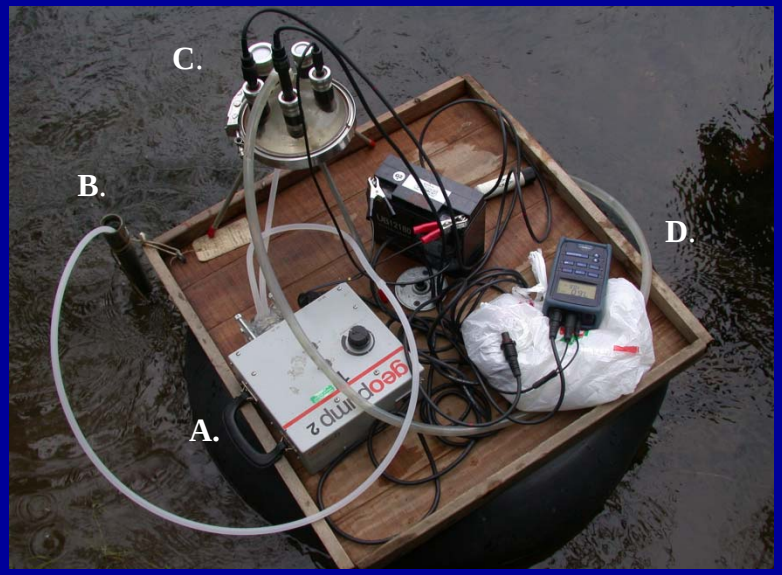
Near-Stream Groundwater Quality at Sampled Instream piezometers



Field staff using a syringe to filter GW samples for later nutrient analyses.

Our sampling equipment includes:

(A) a peristaltic pump and battery

(B) dedicated sample tubing for each piezometer

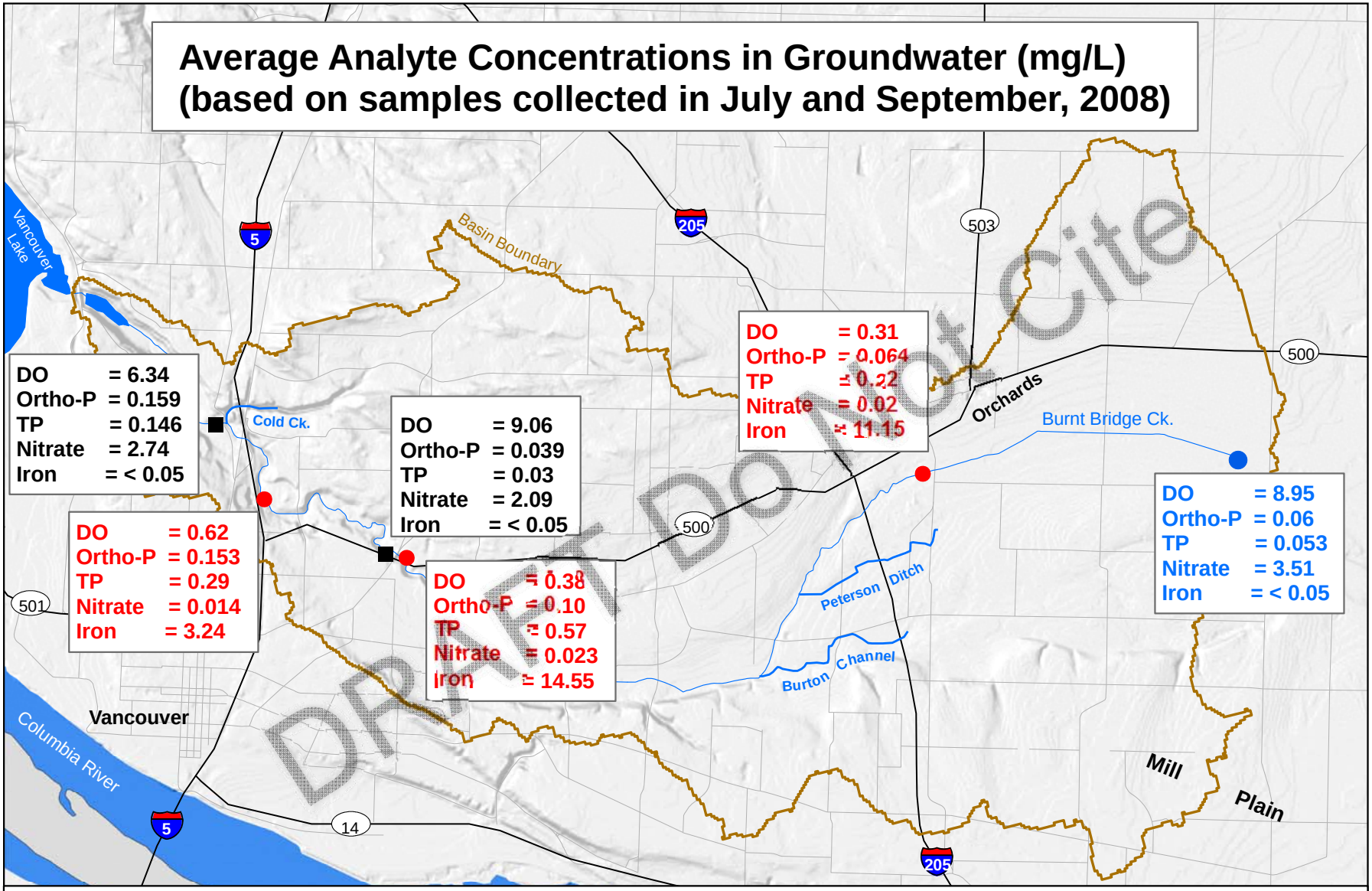
(C) a flow cell

(D) a multimeter with conductivity, temperature, DO, and pH probes

Groundwater Quality parameters included:

- Dissolved Organic Carbon
- Dissolved Ortho-Phosphate
- Dissolved Total Phosphate
- Dissolved Nitrate + Nitrite
- Dissolved Ammonia
- Dissolved TPN
- Dissolved Iron
- Field Parameters (Temp, pH, DO, Cond.)

Average Analyte Concentrations in Groundwater (mg/L) (based on samples collected in July and September, 2008)



N
W E
S

Instream Piezometer

Headwater "Spring"

Off-stream Well

0 0.5 1 Miles

0 0.5 1 2 Kilometers

Future Work

- Continue piezometer monitoring through August 2009
- Compile and analyze additional off stream well data – to refine conceptual model of area GW movement and discharge
- Conduct a final round of water quality sampling at instream piezometers this spring (dependant on funding availability)

Questions?