Hydrologic and Thermal Conditions of the Eastbank Aquifer System

Presented May 27, 2008
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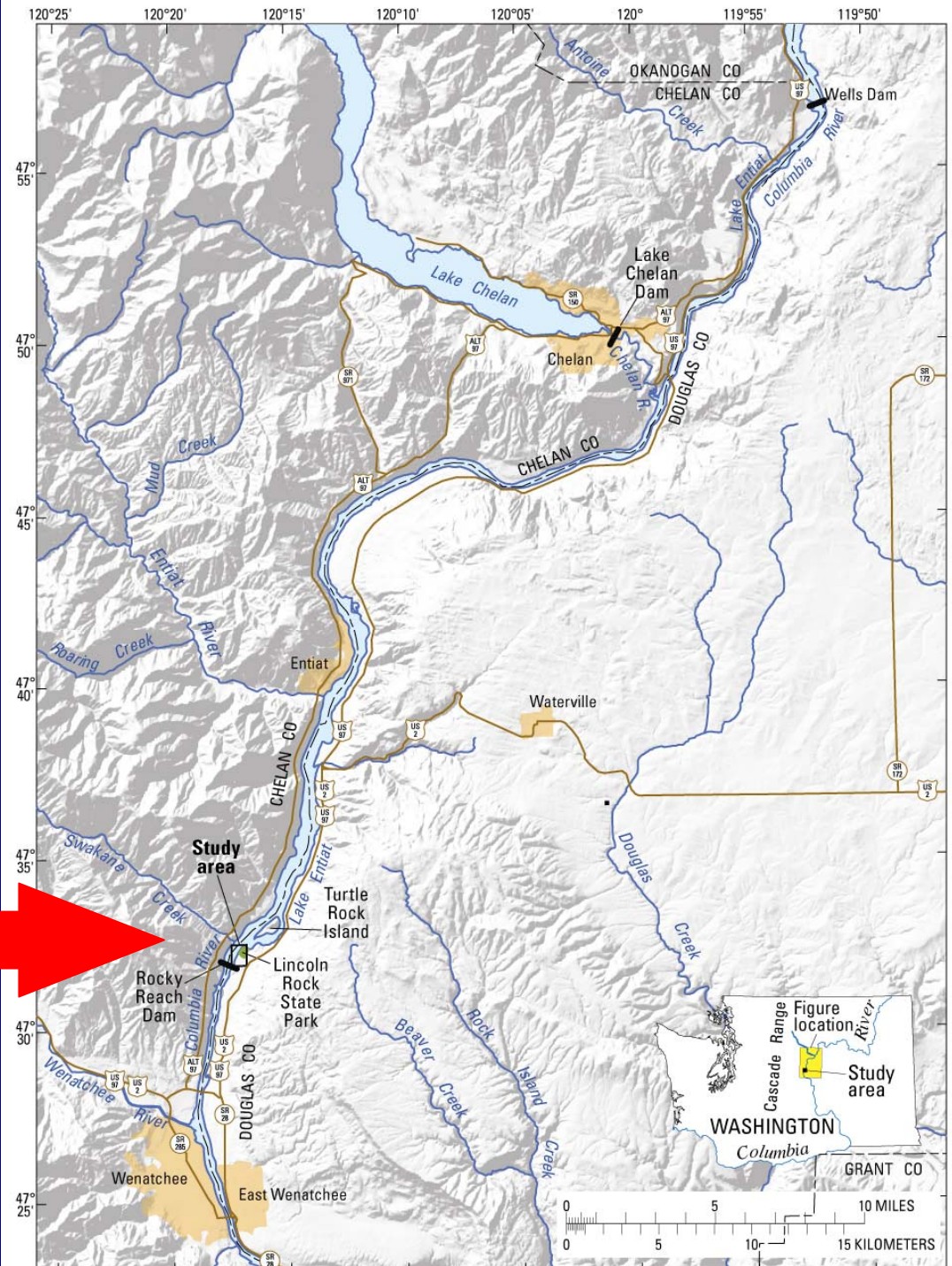
http://wa.water.usgs.gov

Study Location



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Why was the study conducted?

Eastbank Aquifer system supplies Regional Water System (RWS) and Eastbank Hatchery
(~16 and ~43 cubic feet per second in 2006, respectively)

Hatchery forms part of Anadromous Fish Agreement and Habitat Conservation Plans that allow operation of Rocky Reach and Rock Island Electric Projects under FERC license agreement

Hatchery needs cool water but temperatures have been increasing

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Objectives of Study

Phase 1:

Improve understanding of hydrologic and thermal conditions of the Eastbank Aquifer system and the processes that affect those conditions

Phase 2:

Determine if water resources of the Eastbank Aquifer system can be managed to meet future water-resources needs

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Study Steps

1) Review existing data and analyses
2) Evaluate existing data-collection program
3) Collect new data
4) Develop conceptual model and publish findings

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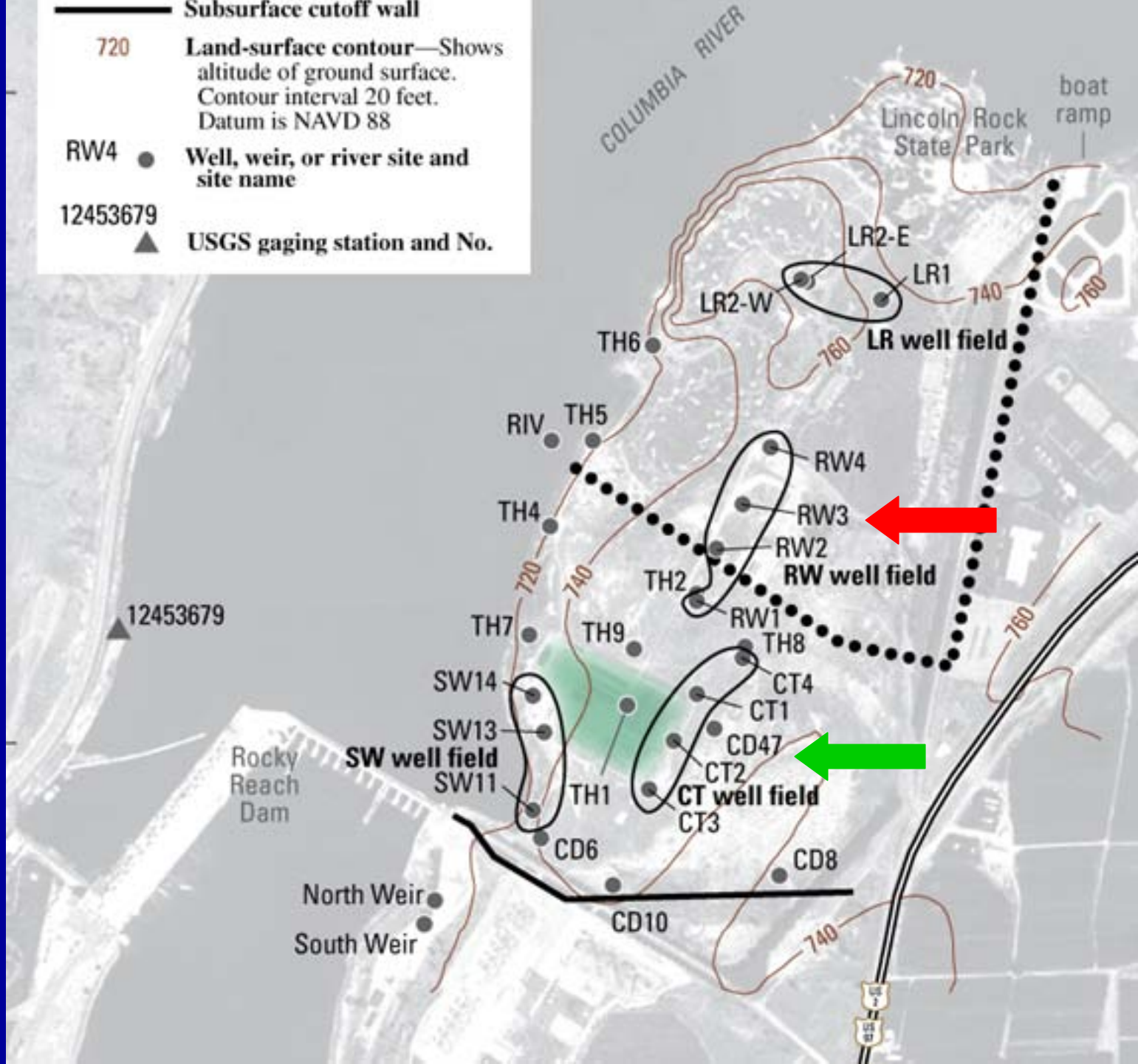
Study Site



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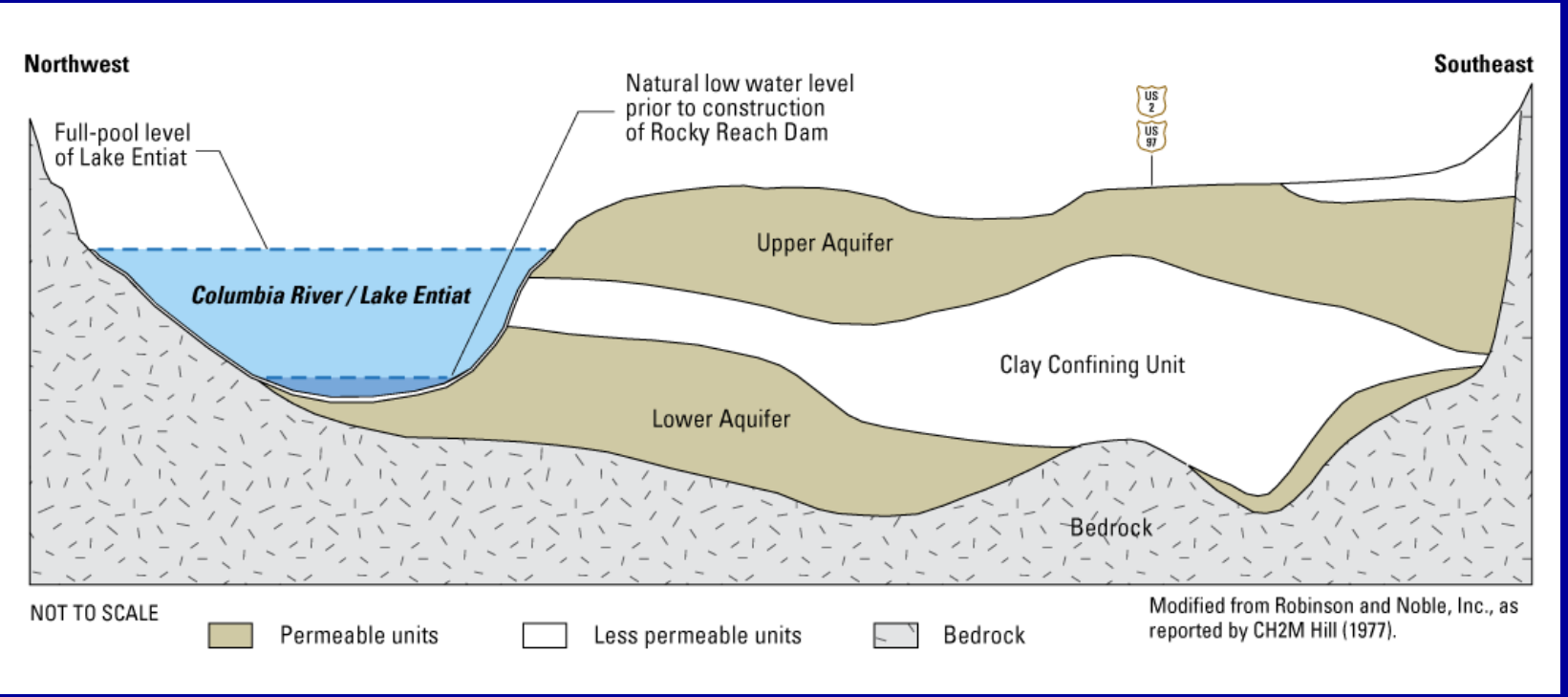
Hydrogeologic Framework



Where Clay Confining Unit is missing, Upper and Lower Aquifers form the Combined Aquifer

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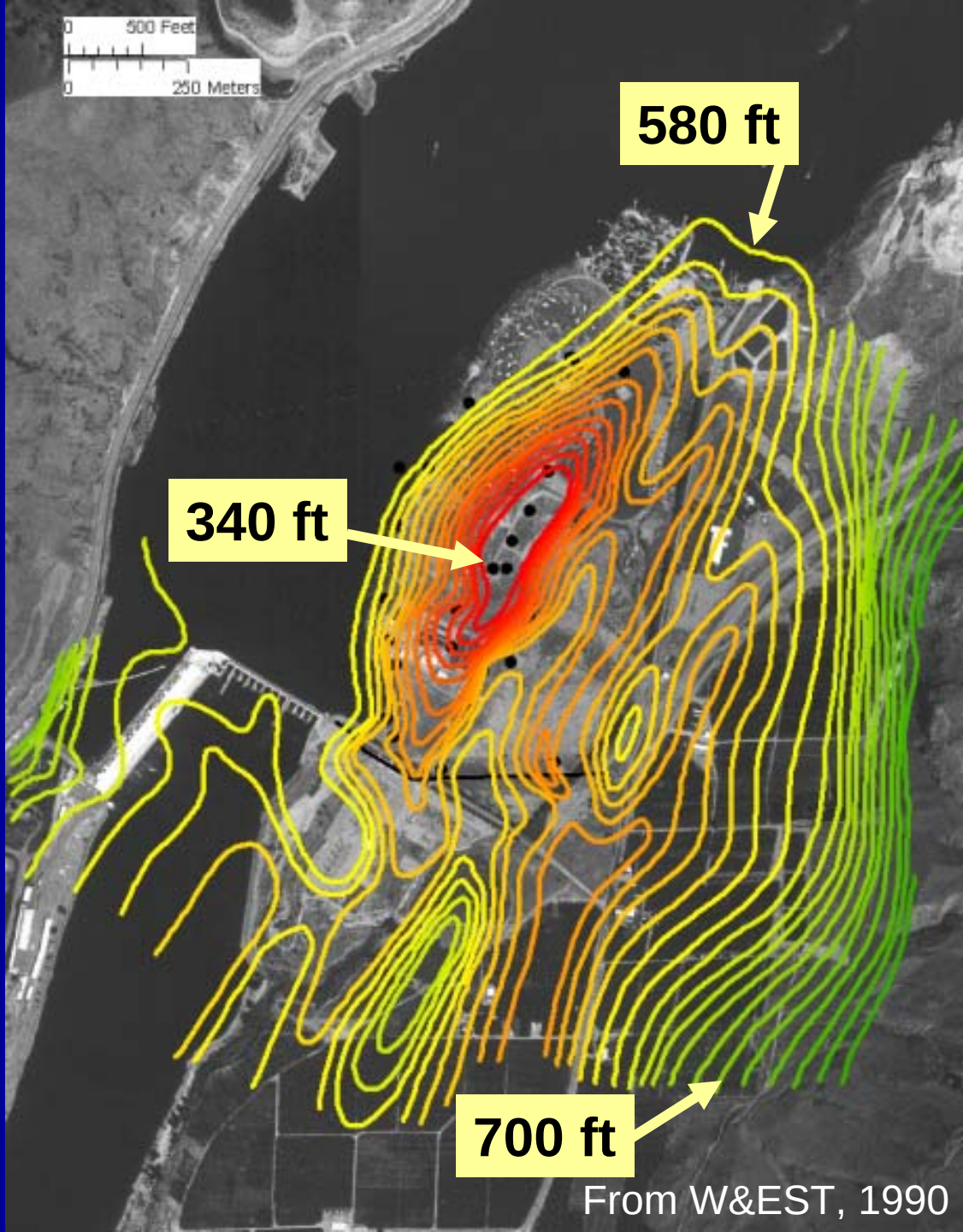
Altitude of Top of Bedrock

Contour interval is 20 ft

(land-surface altitude ~740 ft)



From W&EST, 1990

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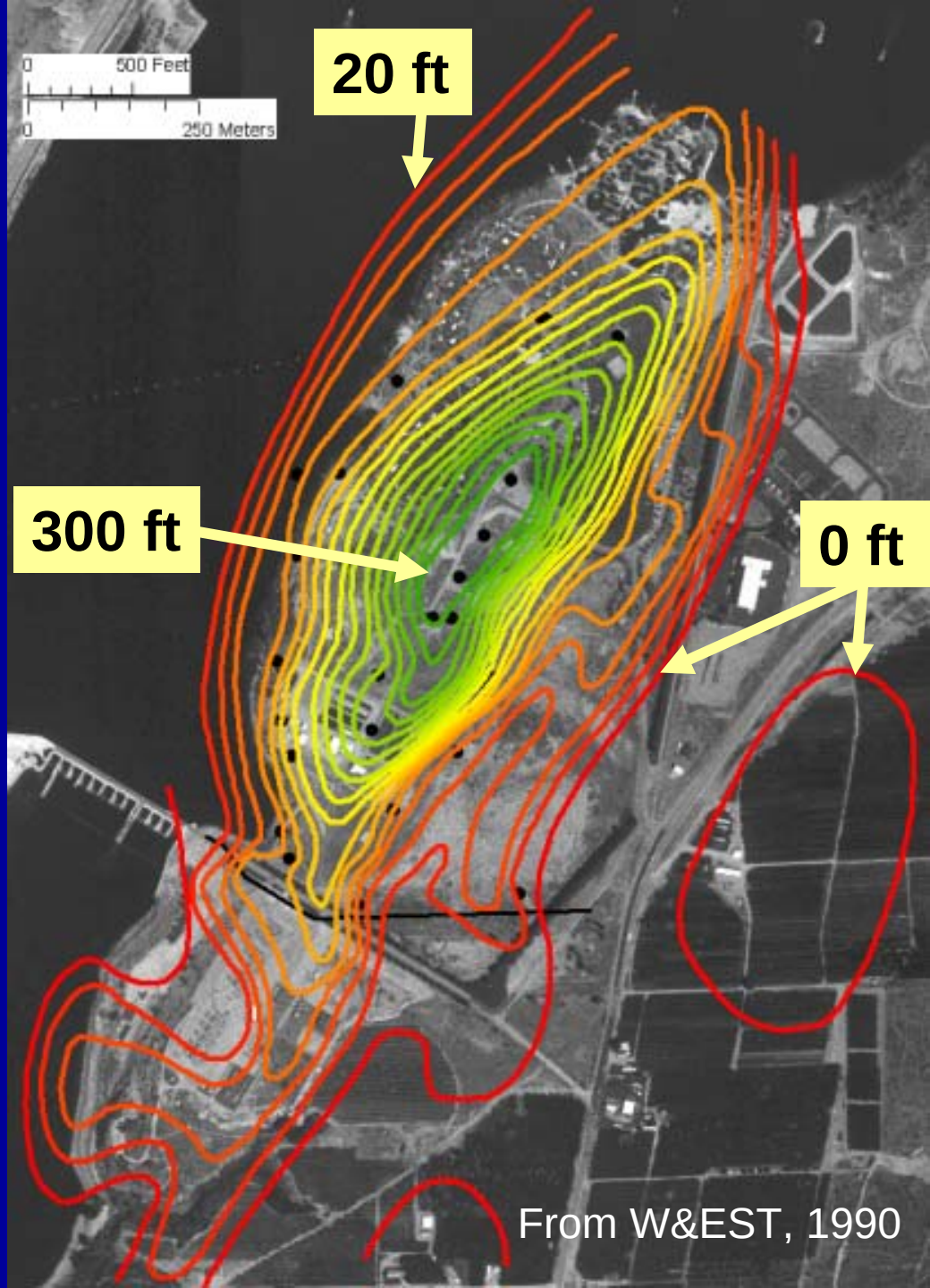
Thickness of Lower Aquifer

Includes Combined Aquifer

Contour interval is 20 ft



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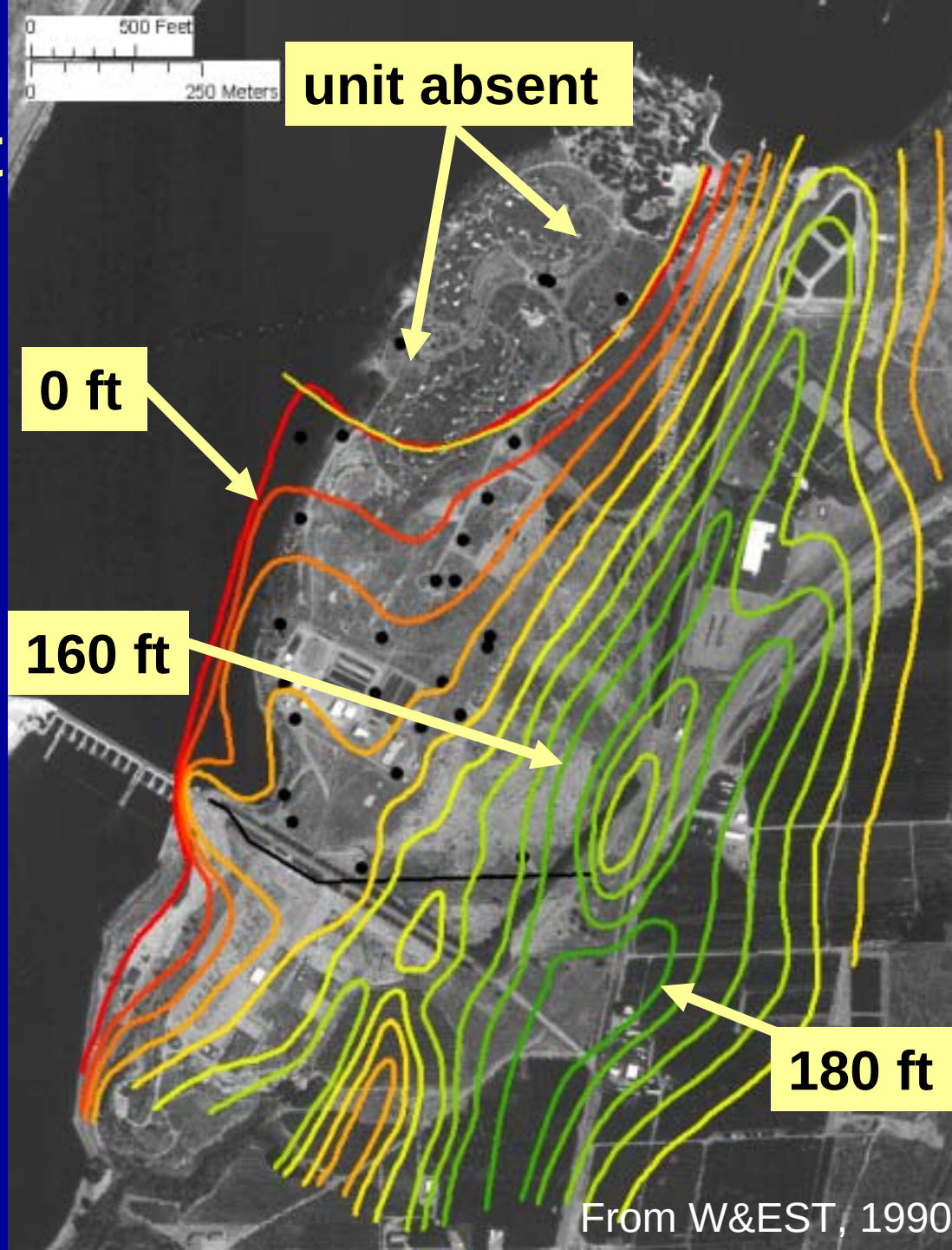
Thickness of Clay Confining Unit

Contour interval
20 ft



From W&EST, 1990

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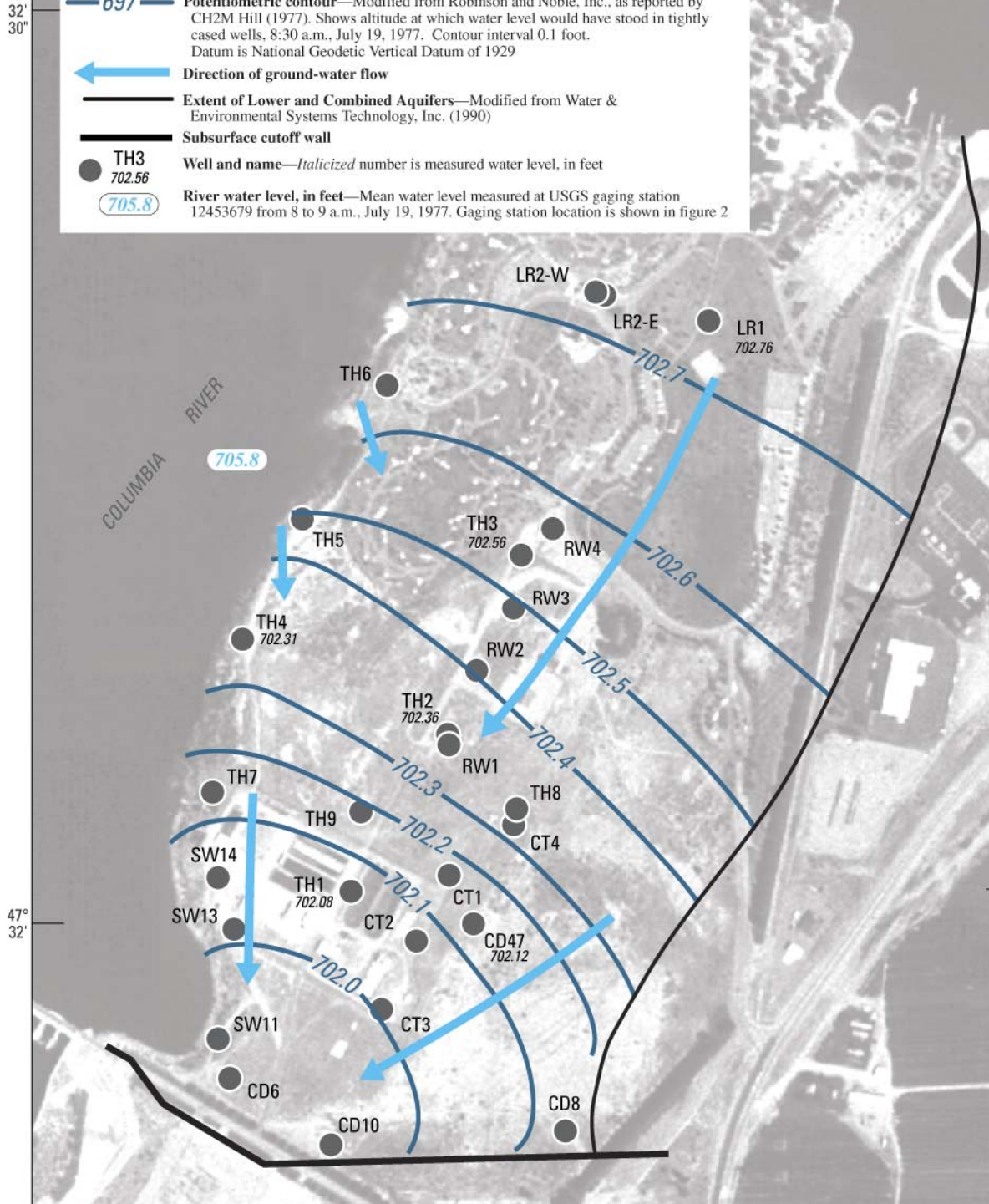
Post-Dam, Predevelopment Flow in Lower & Combined Aquifers

(July 19, 1977)



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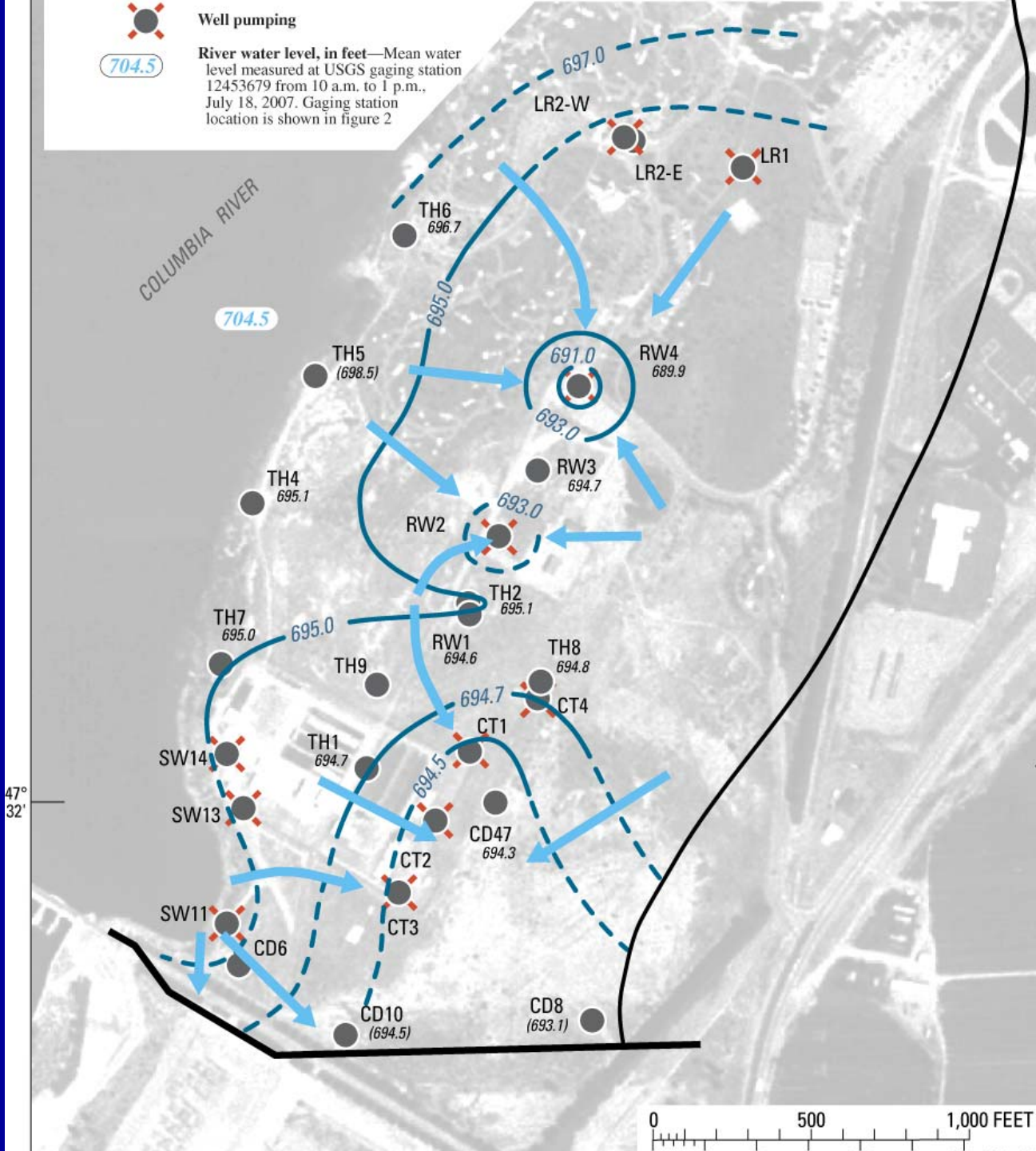
Flow with Pumping

(July 18, 2007)



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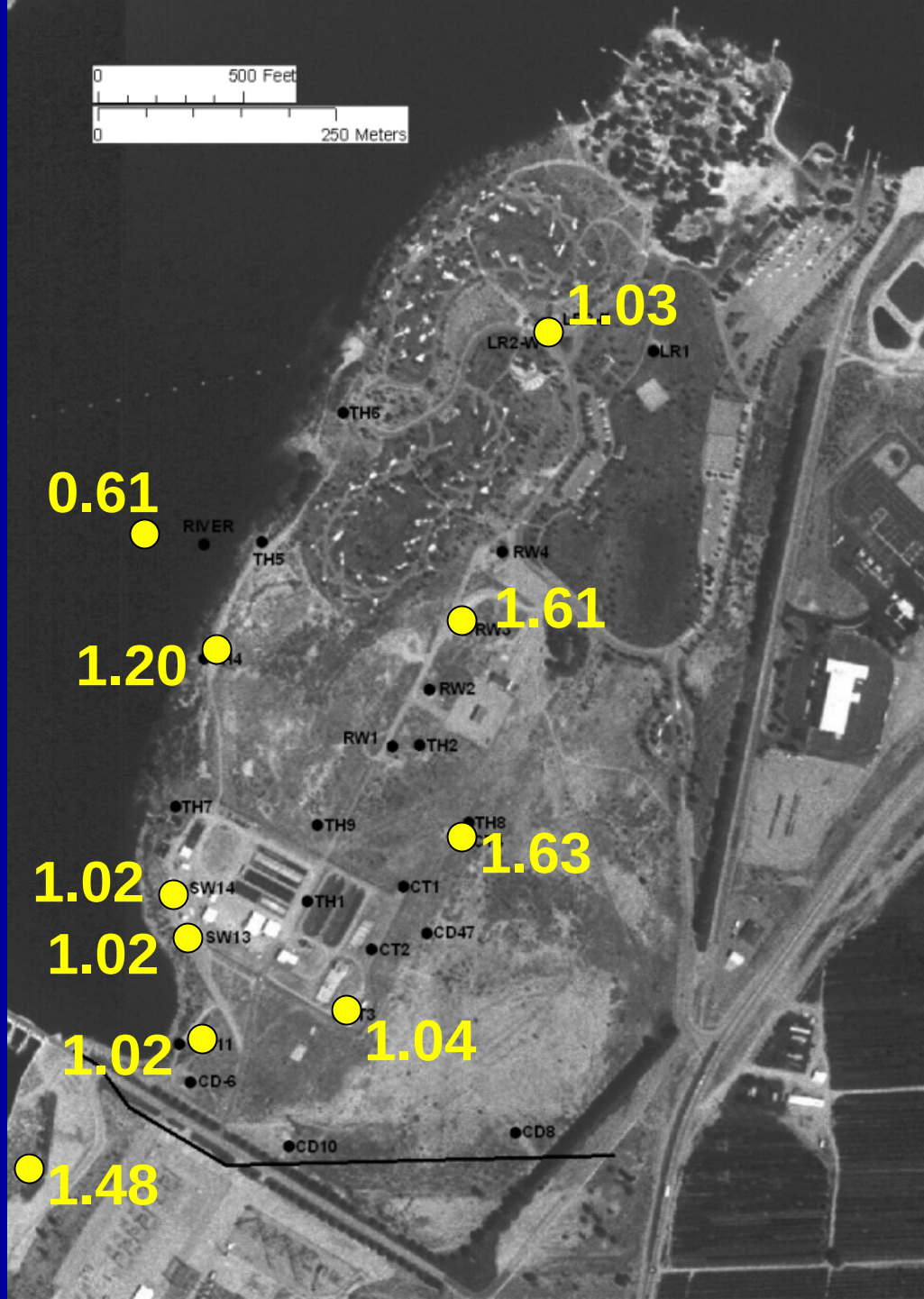
Potassium

Typical range of potassium concentration in the Columbia River at Northport, WA is 0.5-0.7 mg/L



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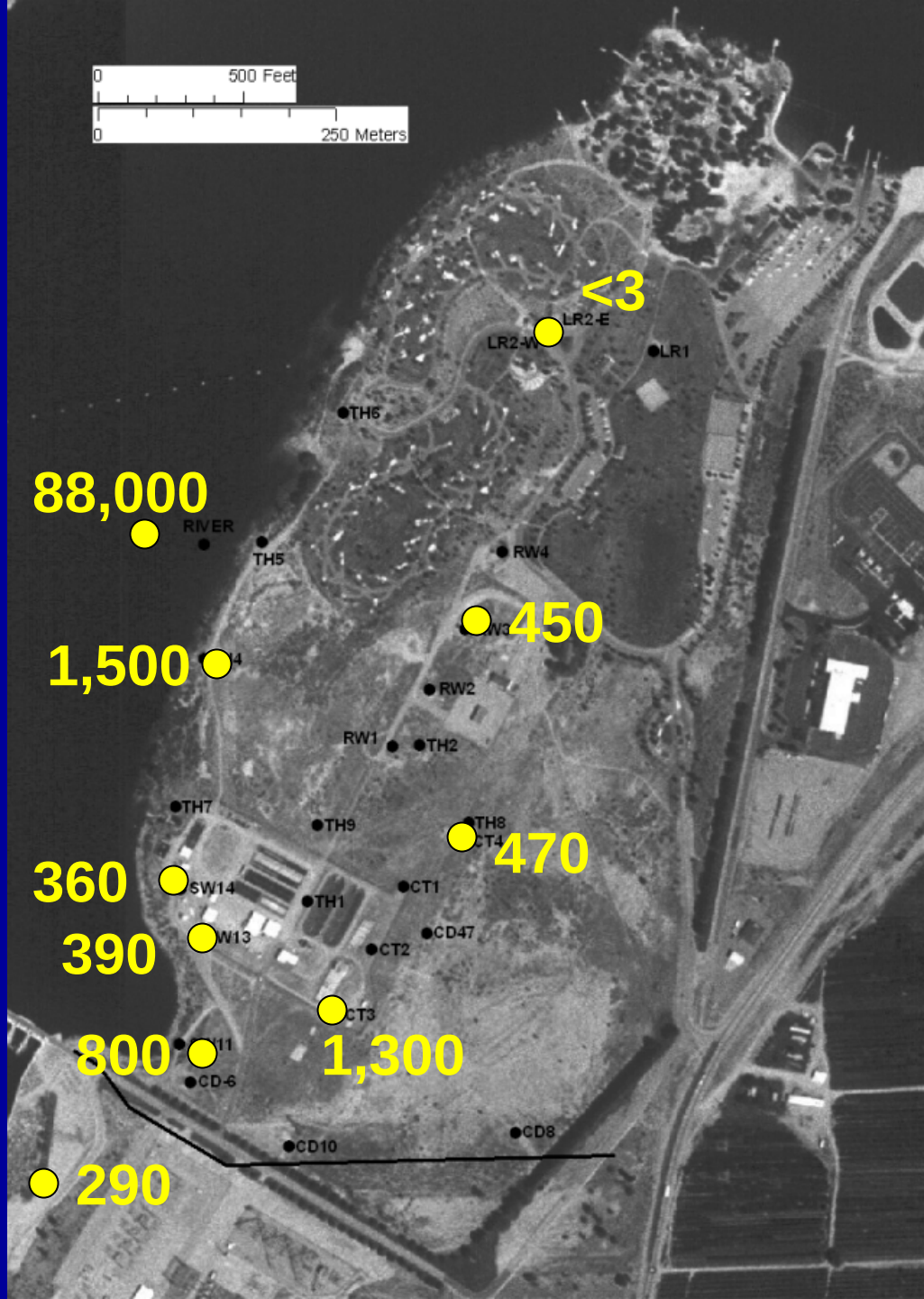
Bacteria Enumeration

Counts of live bacterial cells per milliliter of water using fluorescence stain methods



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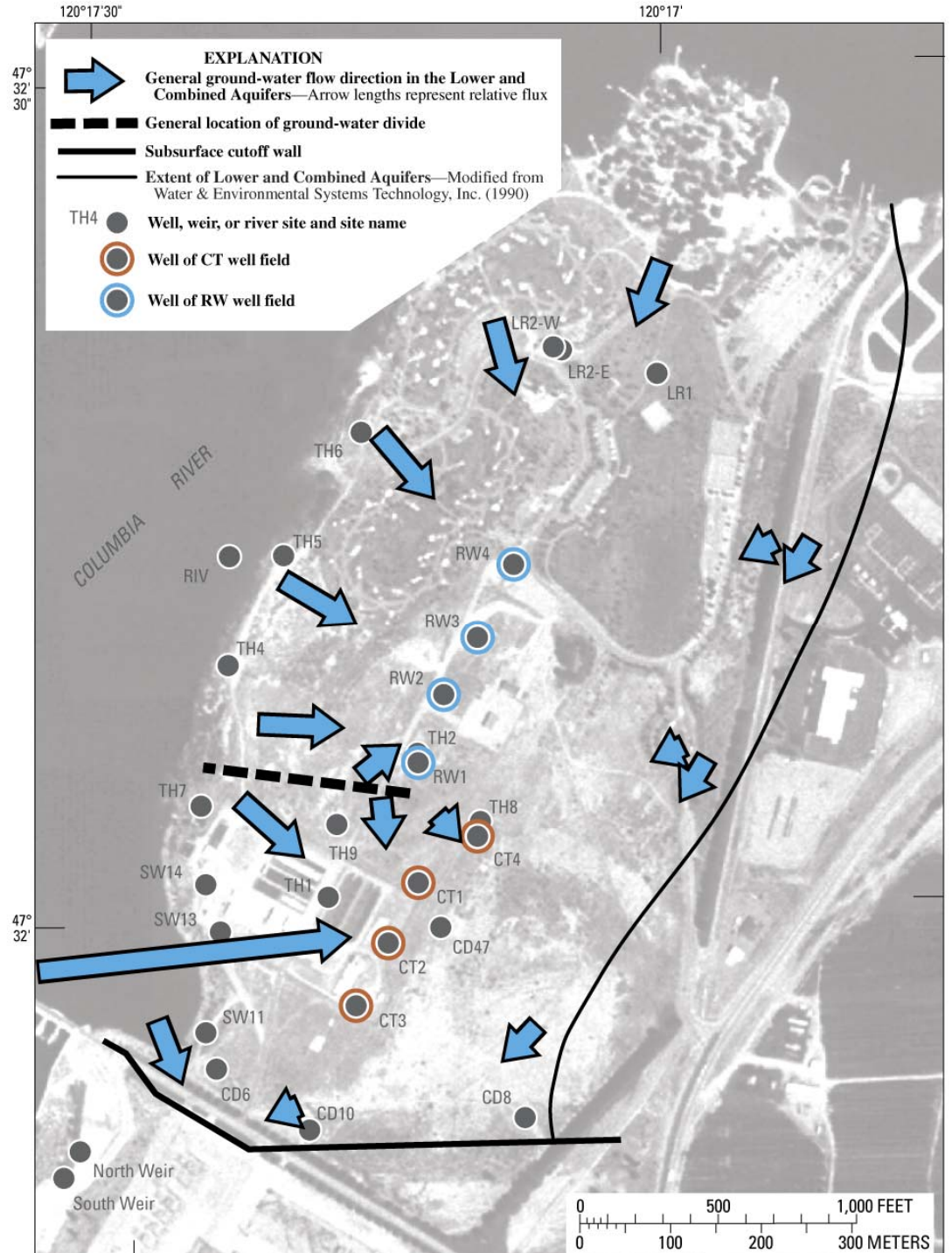
Generalized Ground-Water Flow Directions and Fluxes



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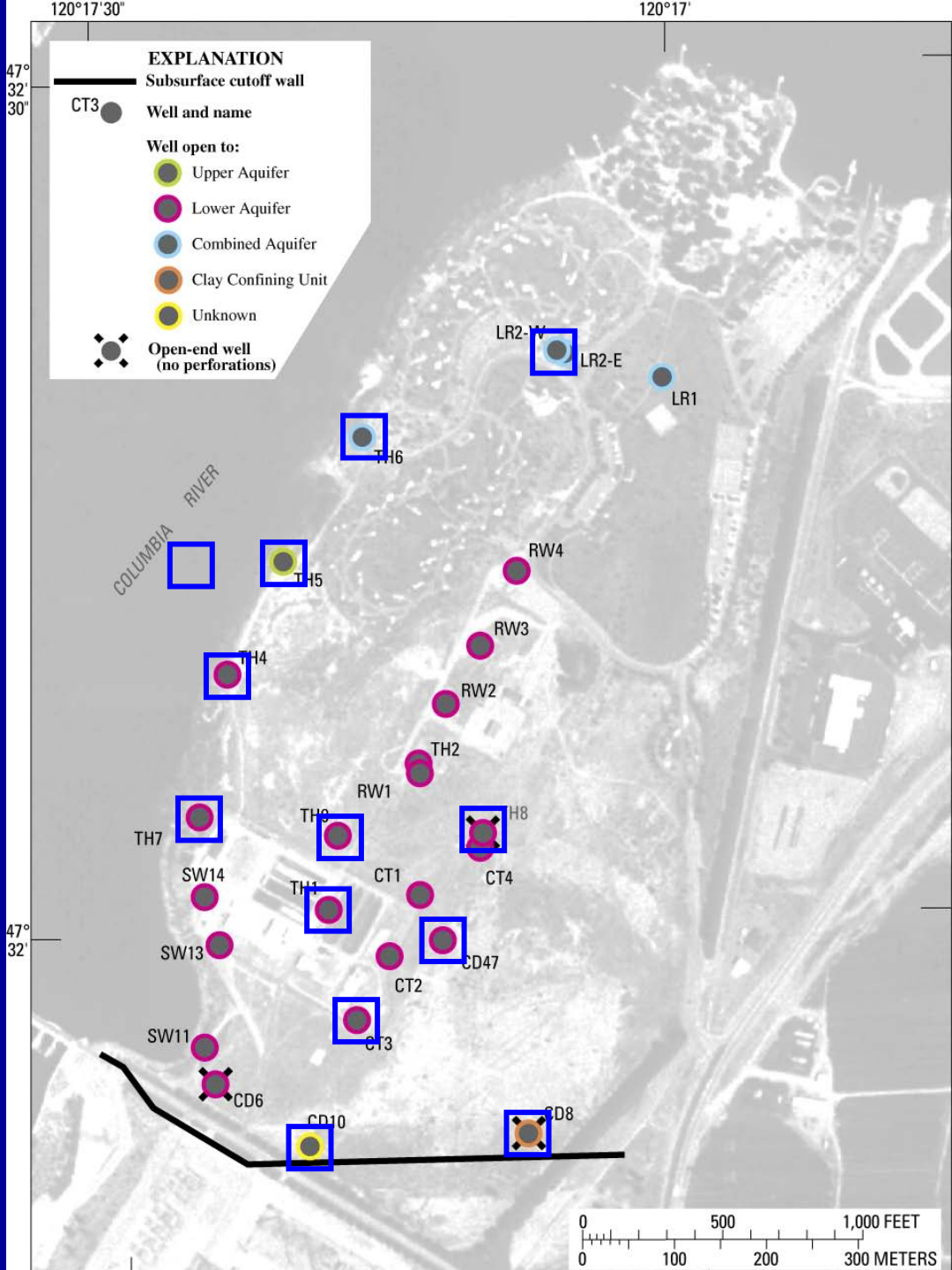
Continuous Monitoring

- Hourly water levels and temperatures since late 1989
- System recalibrated in mid-1998 and checked in 2006



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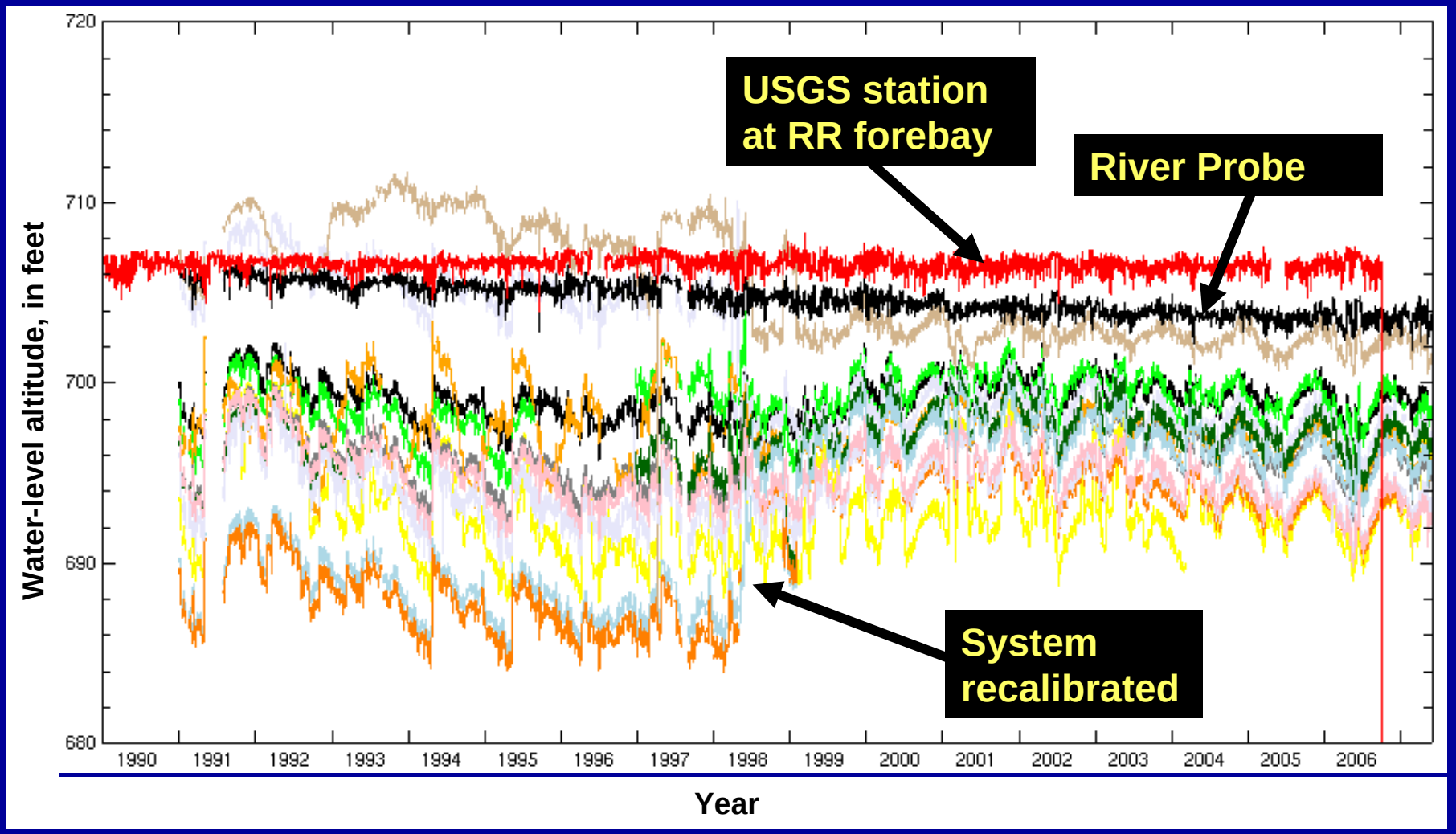
Water Levels, 1991-2007



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Ground-Water Levels are Affected by

- River water levels
- Location, rates, and timing of pumping
- Proximity to river, pumping wells, and cutoff wall
- Permeability and thickness of hydrogeologic units

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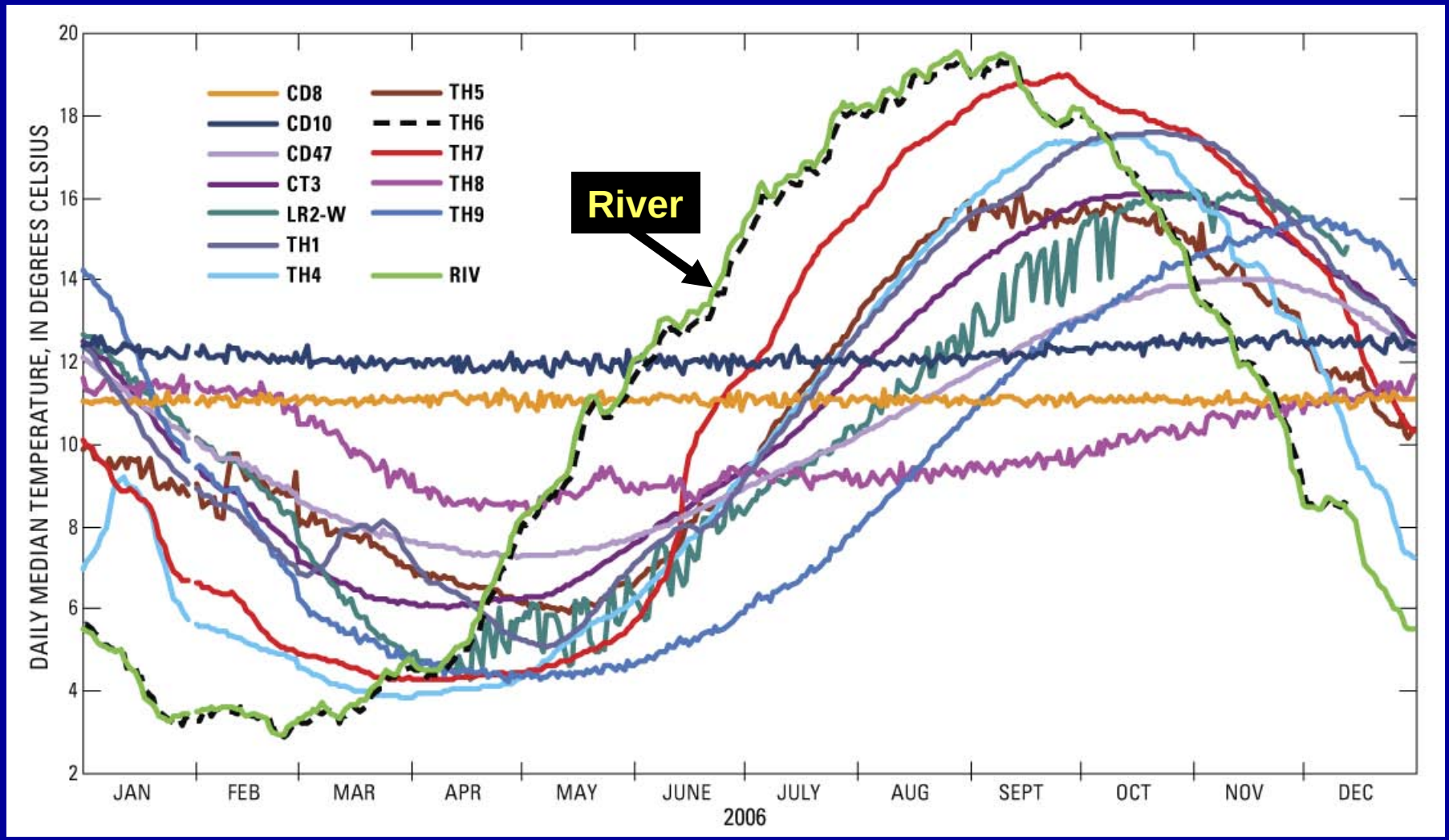
Water Temperatures, 2006



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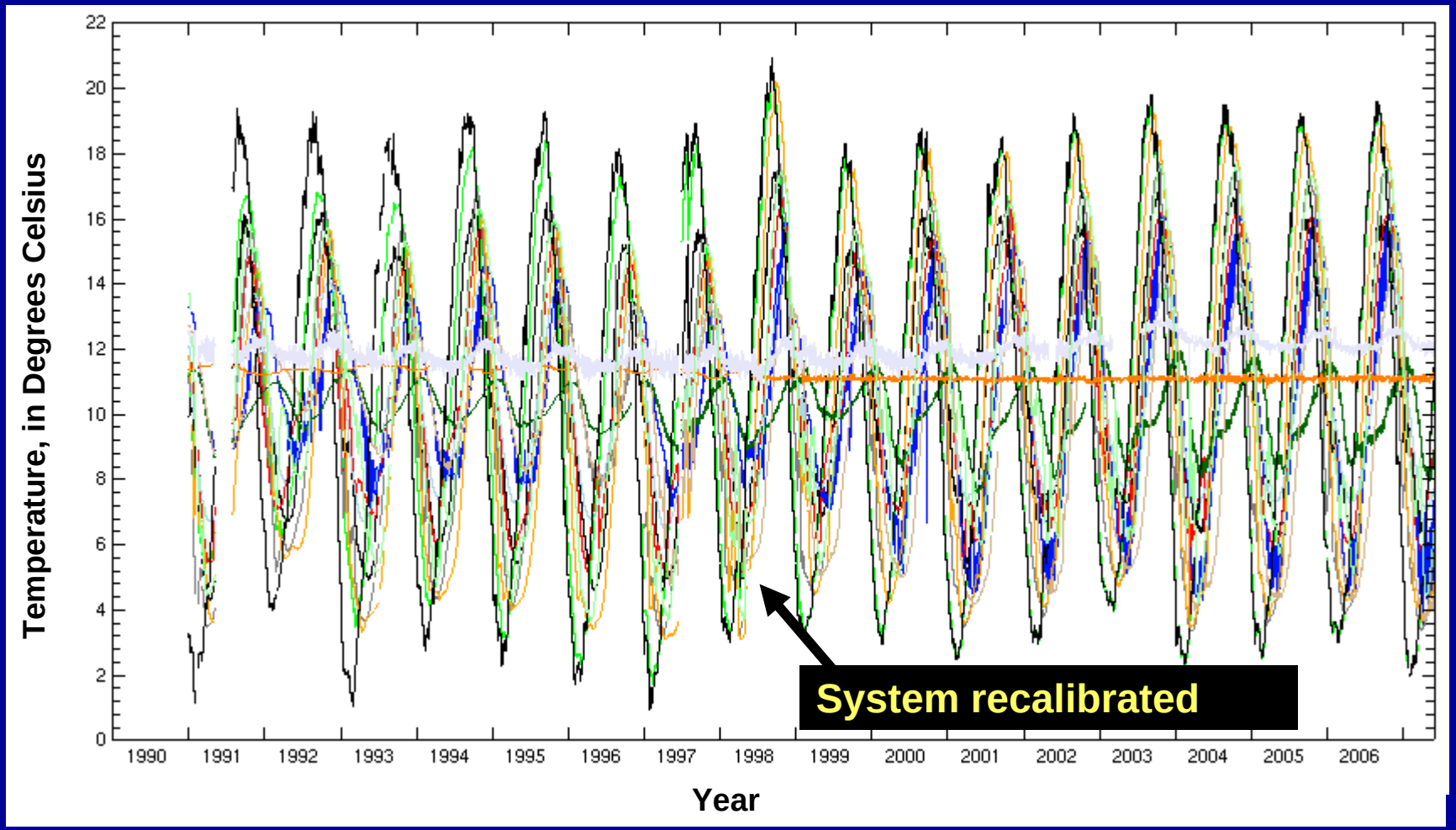
Water Temperatures, 1991-2007



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Ground-Water Temperatures are Affected by

- River temperatures and water levels
- Location, rates, and timing of pumping
- Proximity to river, pumping wells, and cutoff wall
- Permeability and thickness of hydrogeologic units
- Thermal properties of rocks

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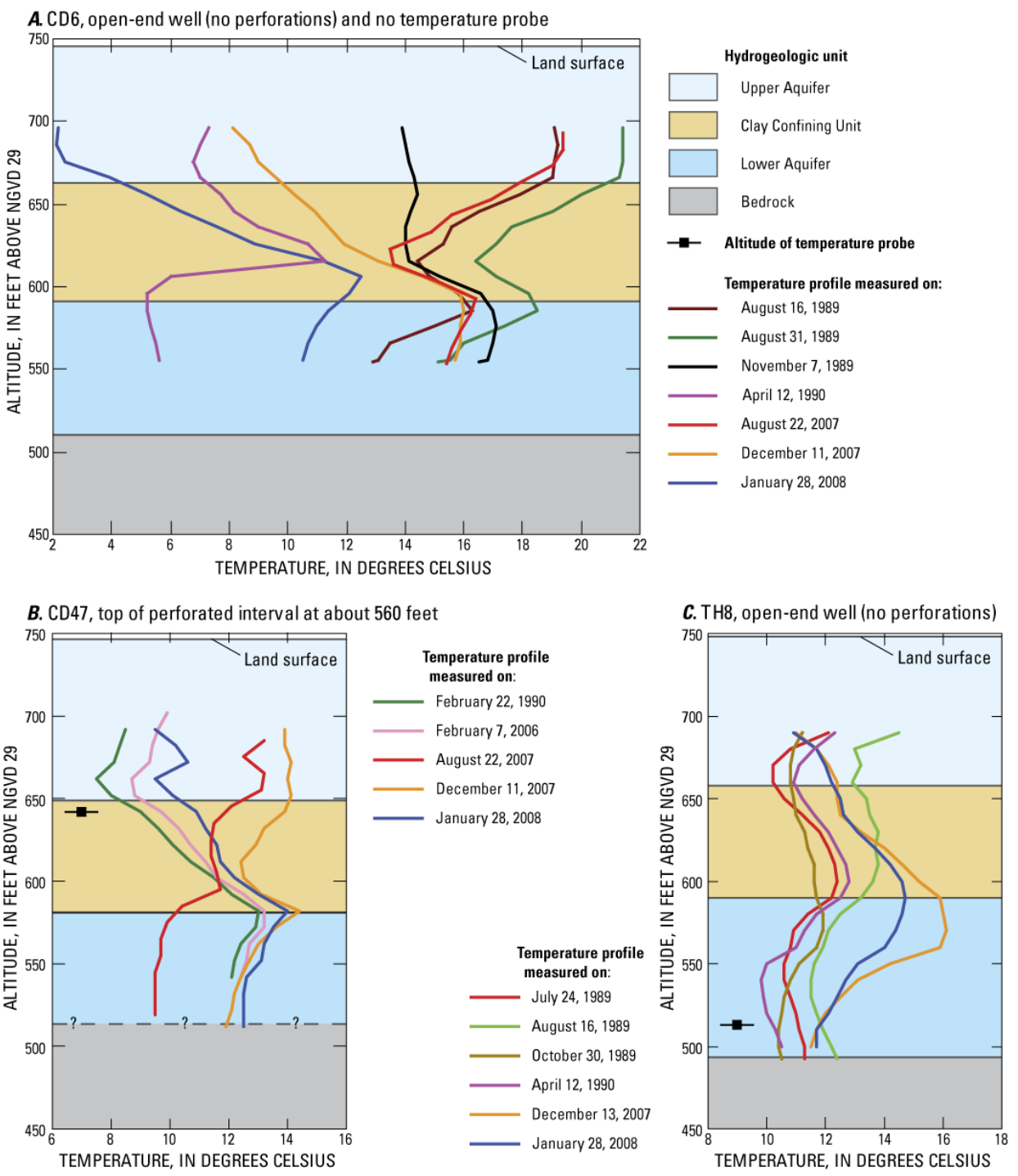
Vertical Temperature Profiles

Annual temperature range varies by location and unit

Probe depth determines record



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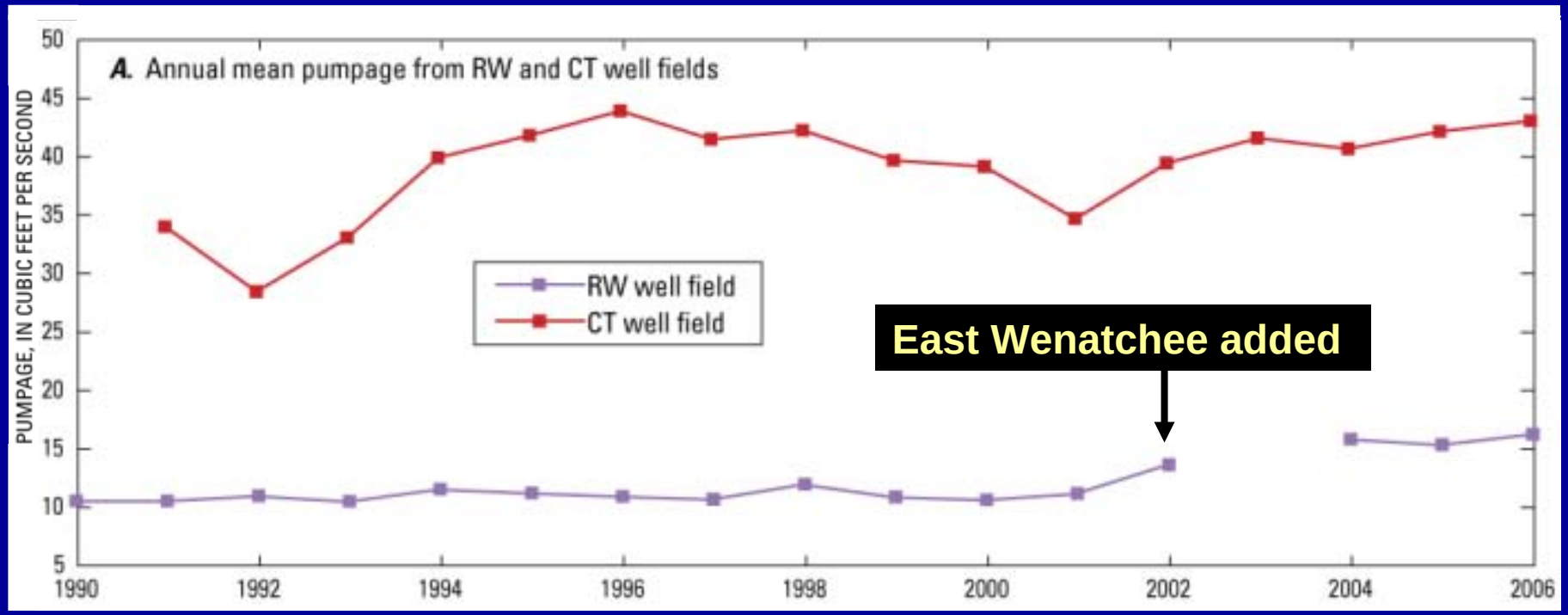
RWS and Hatchery Pumpage



Lincoln Rock State Park irrigation wells and SW wells annual pumpage ~0.2 cfs (~100 gpm) each

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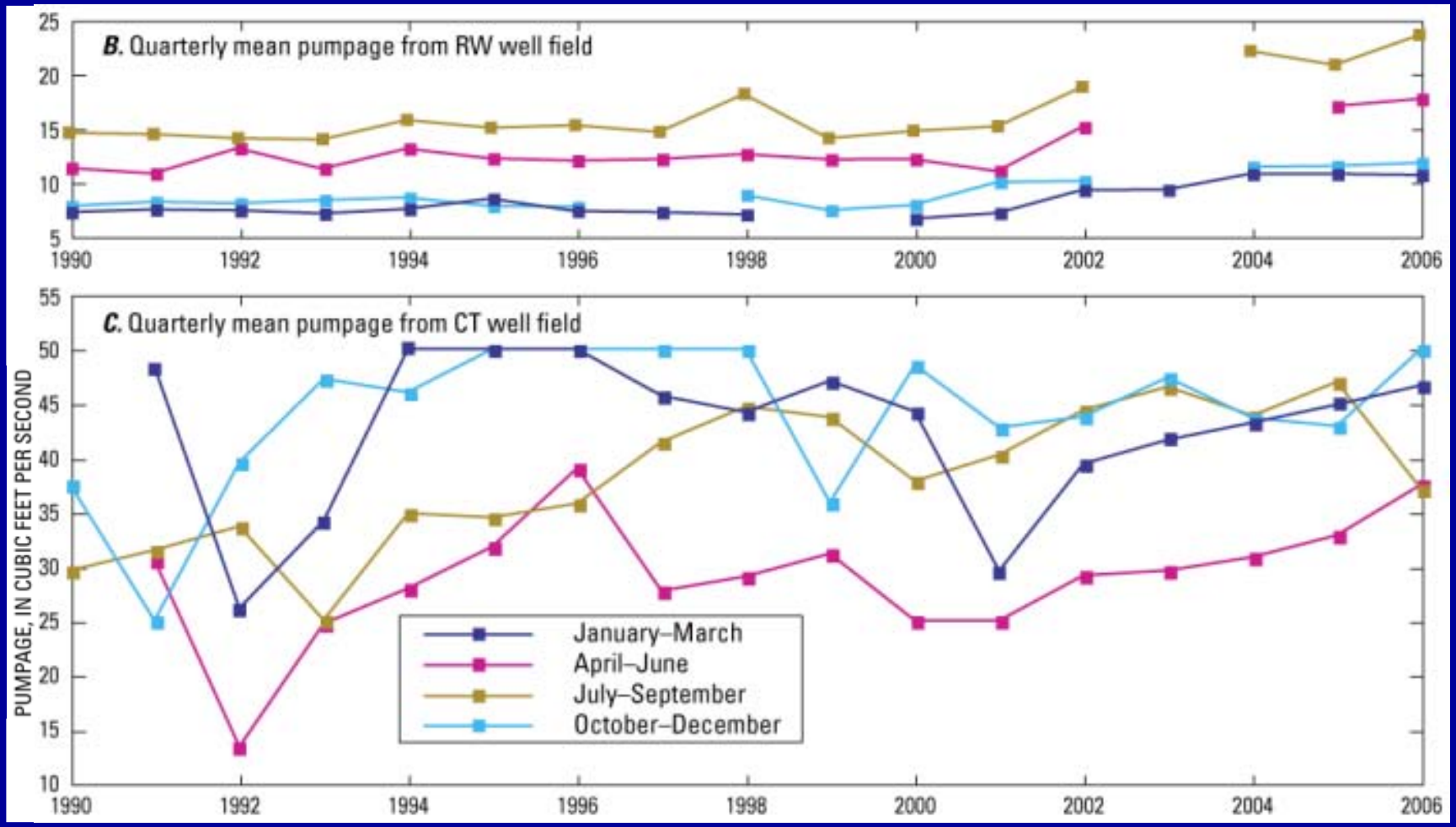
Seasonal Pumpage



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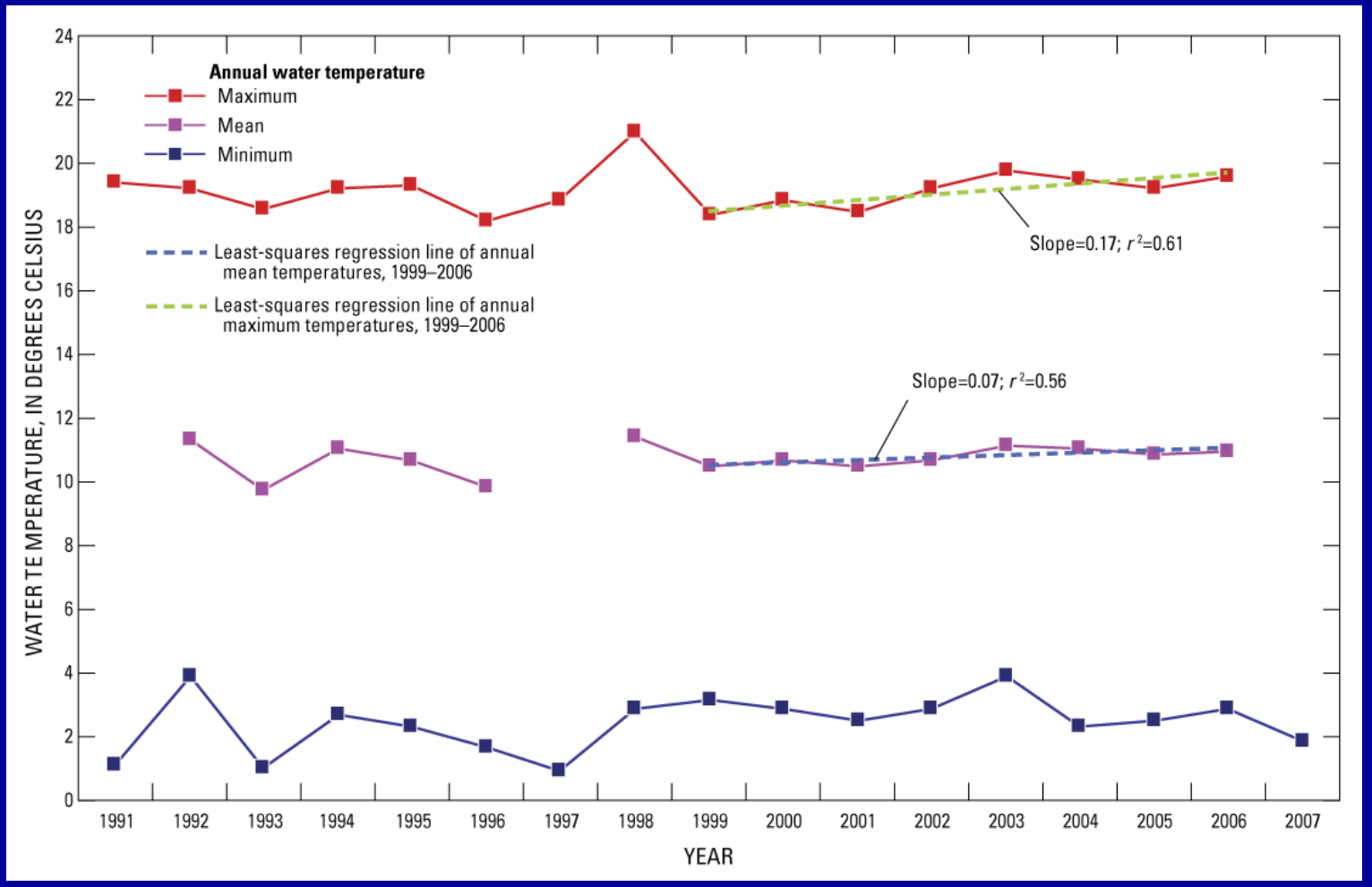
River Temperatures, 1991-2007



No trend 1991-2006. Also, insignificant stratification of reservoir

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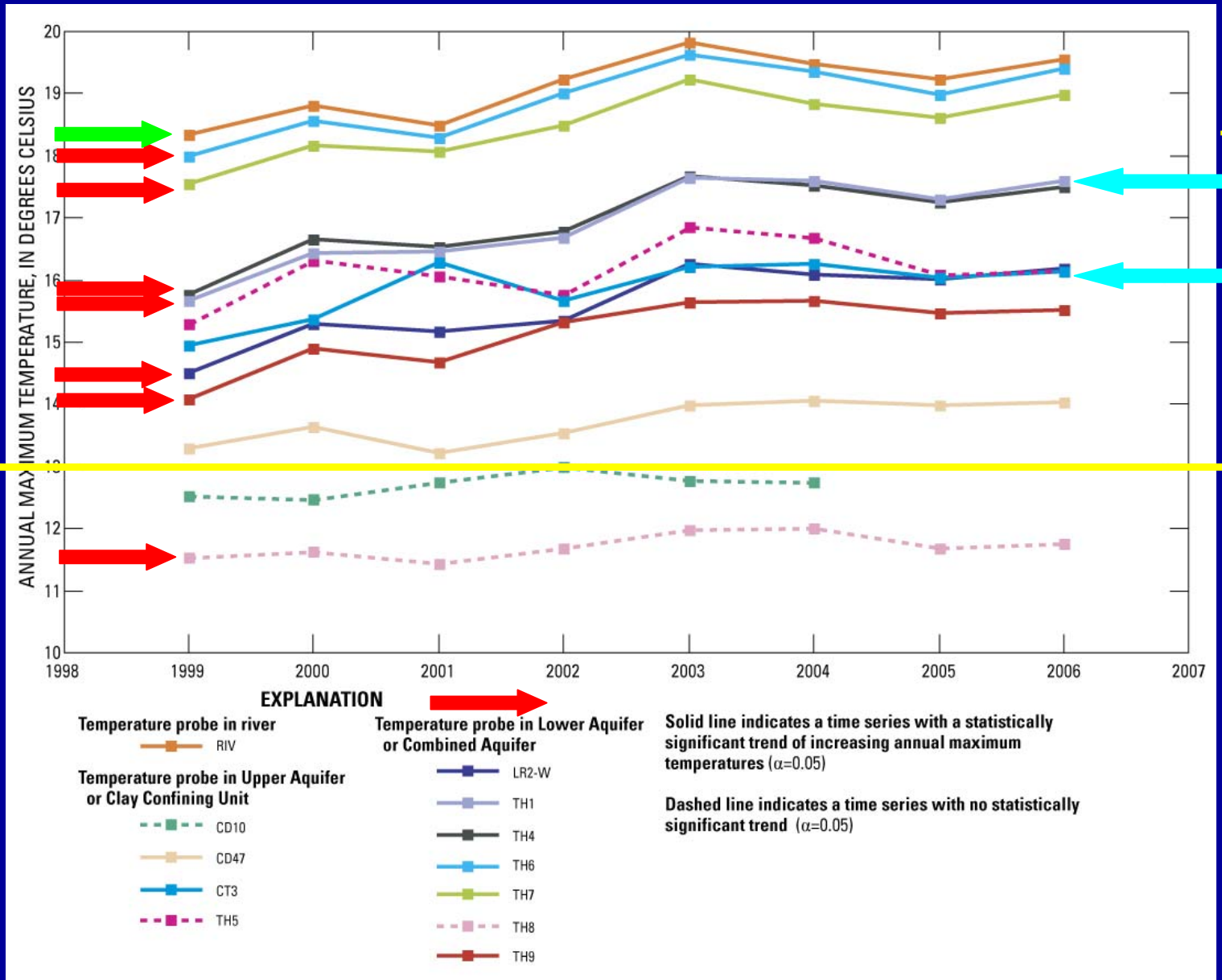
Annual Max. Temperatures, 1999-2006



preferred max. for fish

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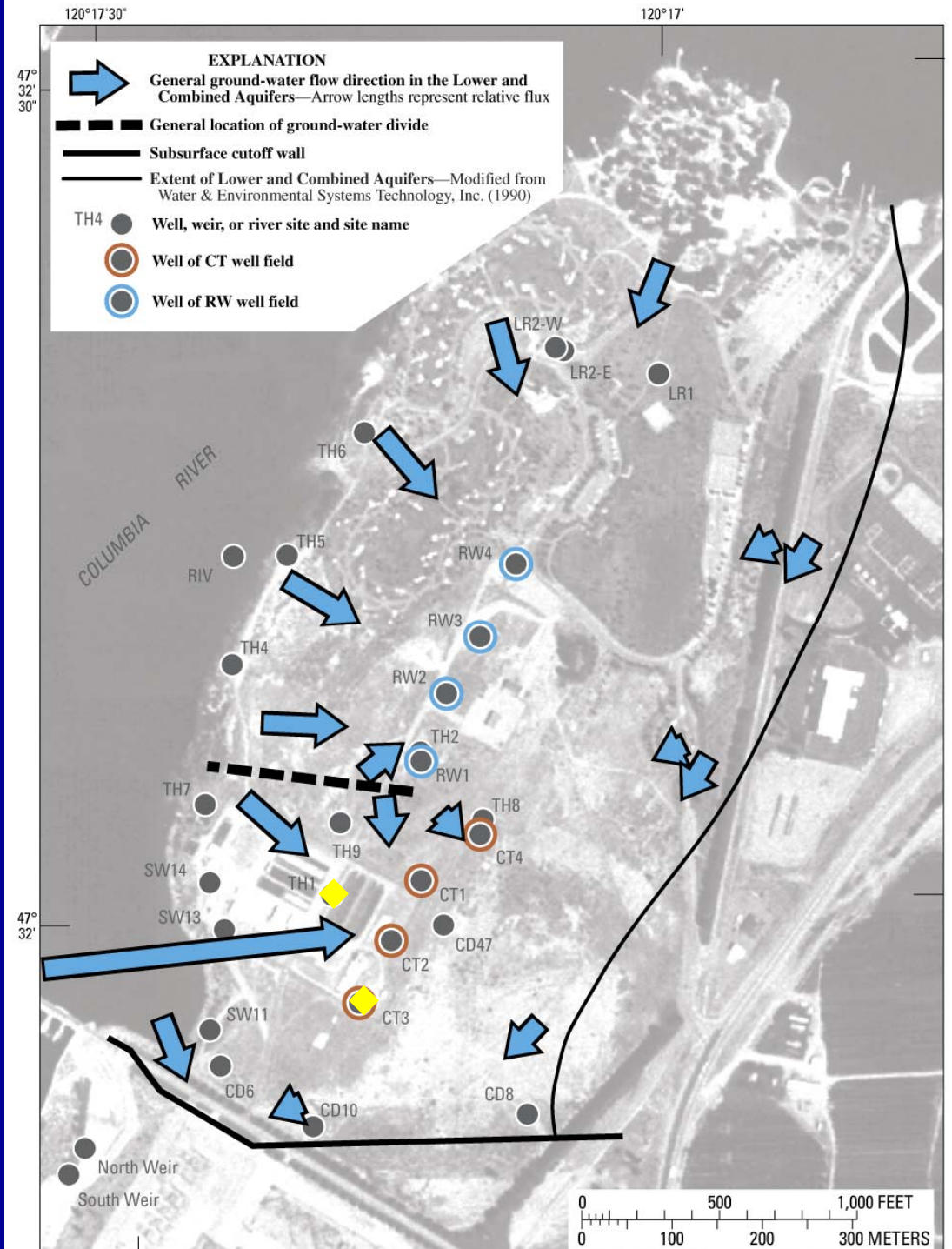
Generalized Ground-Water Flow Directions and Fluxes



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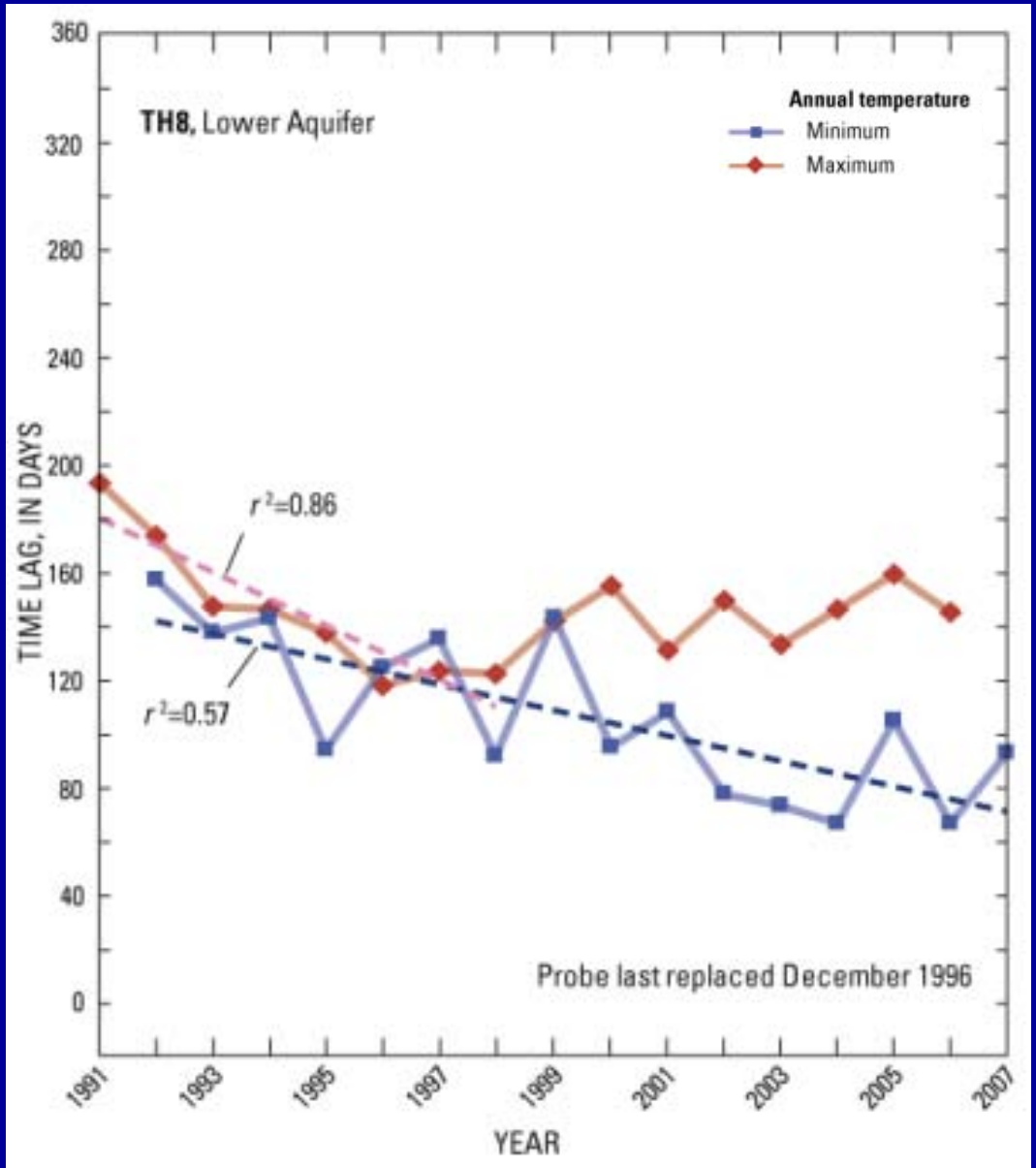
Temperature Time Lags, 1991-2007

Time lags may vary throughout the year due to time-varying pumping



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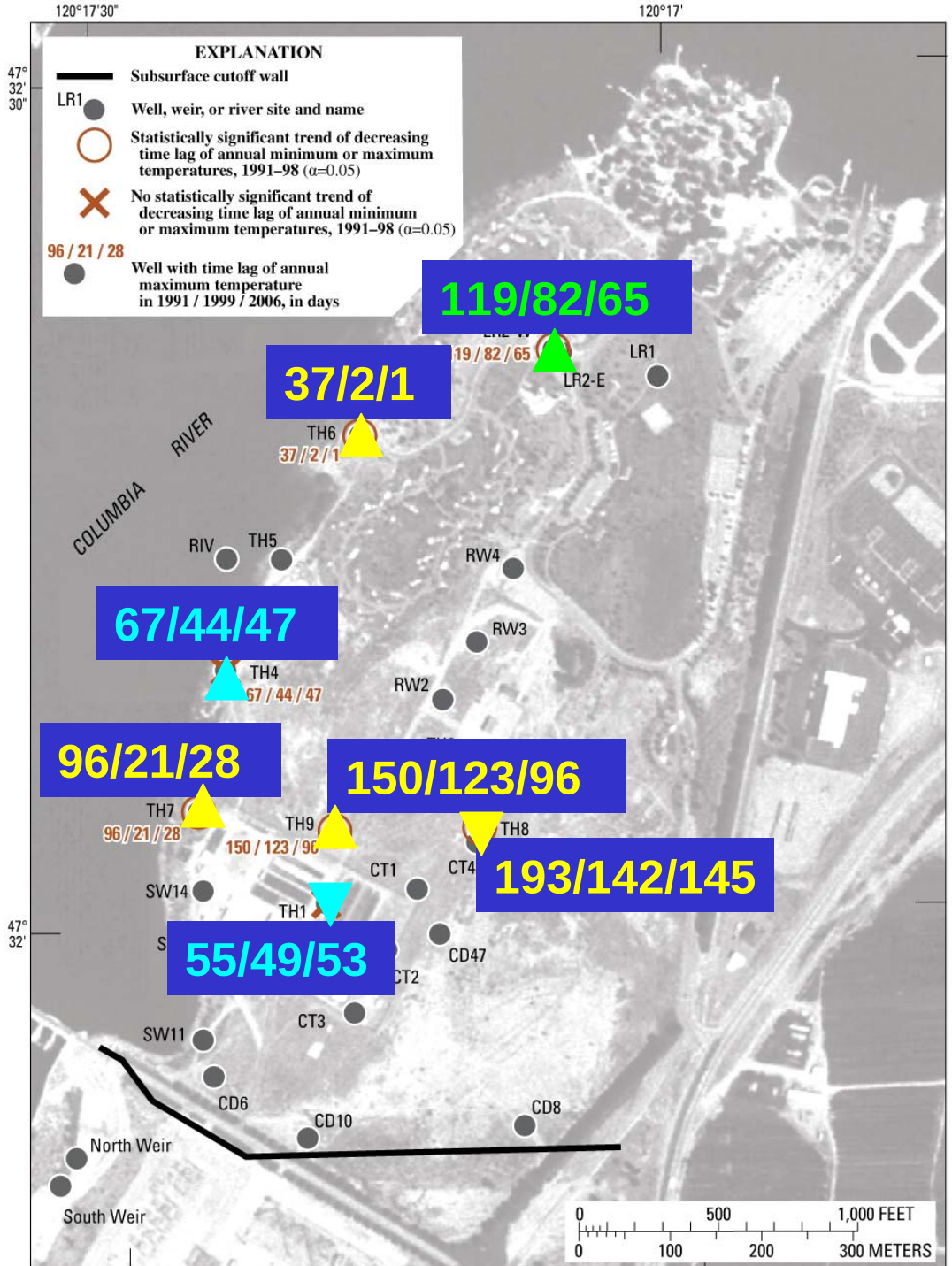
Temperature Time Lags in the Lower & Combined Aquifers in 1991, 1999, 2006

Thermal equilibrium reached

- ▲ prior to 1991
- ▲ during 1991-98
- ▲ not yet reached



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Summary of Findings

1) The Columbia River recharges the ground-water system
2) Water pumped by the hatchery primarily comes from the west and southwest
3) Water pumped by the Regional Water System primarily comes from the west and secondarily from the north
4) Regional Water System pumpage increased about 40% in late 2001 while hatchery pumpage has remained relatively constant since 1994

Summary of Findings, cont'd

5) Increasing interannual trends in ground-water temperatures from 1999-2006 correspond to increasing interannual trends in river temperatures
6) There are no trends in river temperatures from 1991-2007, indicating that trends from 1999-2006 are within natural variability
7) The northern extent of the hatchery well field may pump some colder water from a bedrock depression to the north and west

Summary of Findings, cont'd

8) Different water-management alternatives can be evaluated with a numerical model that simulates ground-water flow and temperature
9) The model would benefit from at least one year of detailed data collection (pumpage, water levels, and water temperature) and additional information about the hydrogeologic framework

Report is available on the Web at
http://pubs.usgs.gov/sir/2008/5071

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The July 18, 2007 field crew. Photograph by Sam Dilly.

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