# Yakima River Basin Ground-Water Investigation : an Update

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February 28, 2007
Yakima Area Arboretum

# TODAY

## Present overview of results for selected study components and the planned work for the components

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# STUDY COMPONENTS

- Well information
- Mapping hydrogeologic units
- Estimating ground-water pumpage
- Estimating ground-water recharge
- Analysis of ground water–surface water interchanges
- Assessment ground-water flow system, including ground-water levels
- Estimating hydraulic characteristics of hydrogeologic units
- Ground-water flow modeling/assessment

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# WELL INFORMATION

- Well-driller logs/well inventory
- Mass water-level measurements
- Hydrogeologic databases
- Water-right associations
- Spatial distribution of wells

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# Well Inventory

- Locate wells
- Measure water levels if possible
- Input all information in the USGS National Water Information System (NWIS) as part of the Ground Water Site Inventory (GWSI)
- Input historical water levels

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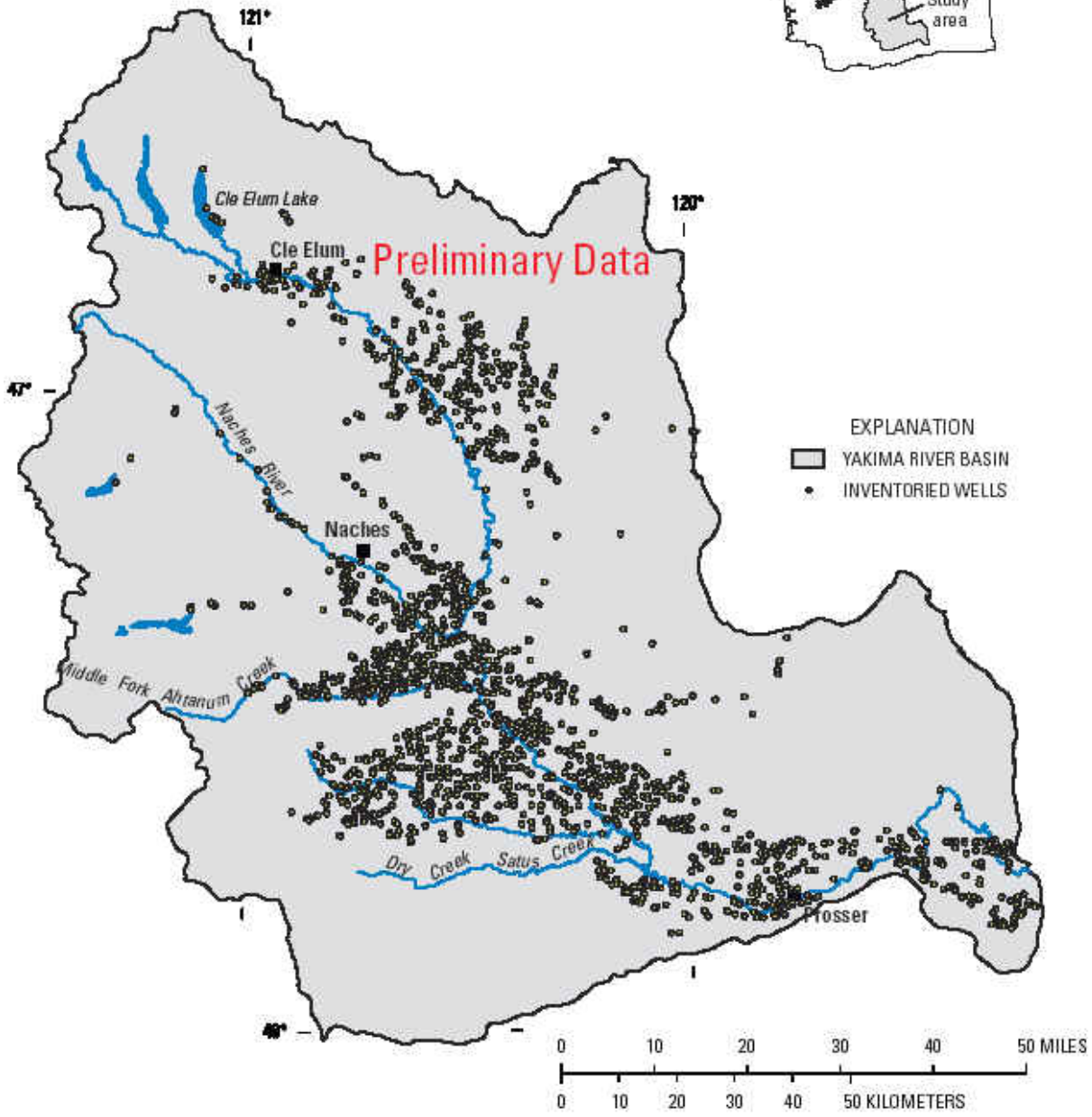

# Mass Water-Level Measurements

- Fall 2000 – Spring 2001 – Fall 2001 – Spring 2002
- Input all water-levels into GWSI

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# Developed Digital Files of Well Locations Using Available Well Logs

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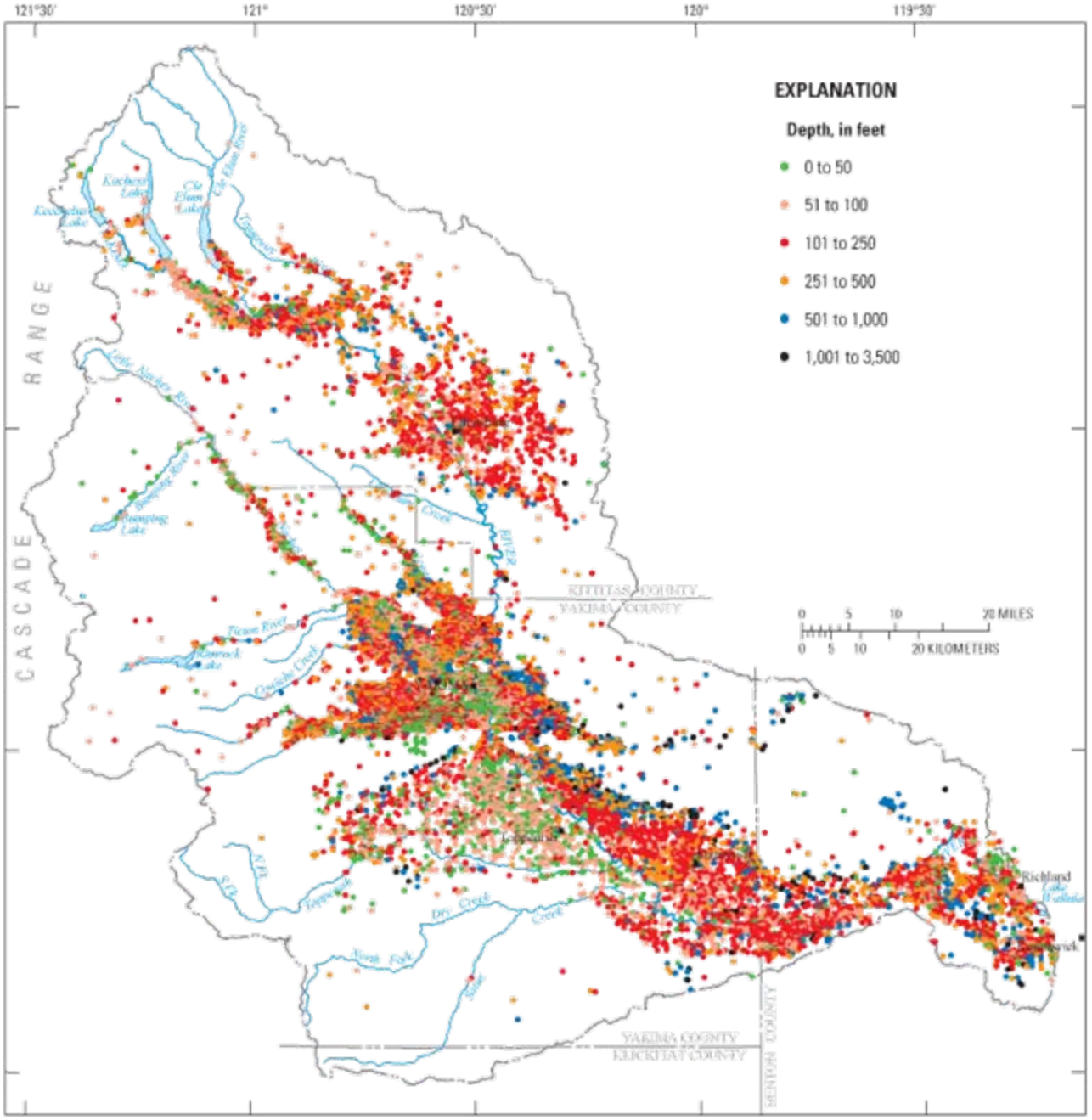
Wells in the Yakima River Basin

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# MAPPING HYDROGEOLOGIC UNITS

- Defined boundaries of six Sedimentary Basins
- Mapped hydrogeologic units in the basins
- Mapped lateral extents of basalt units

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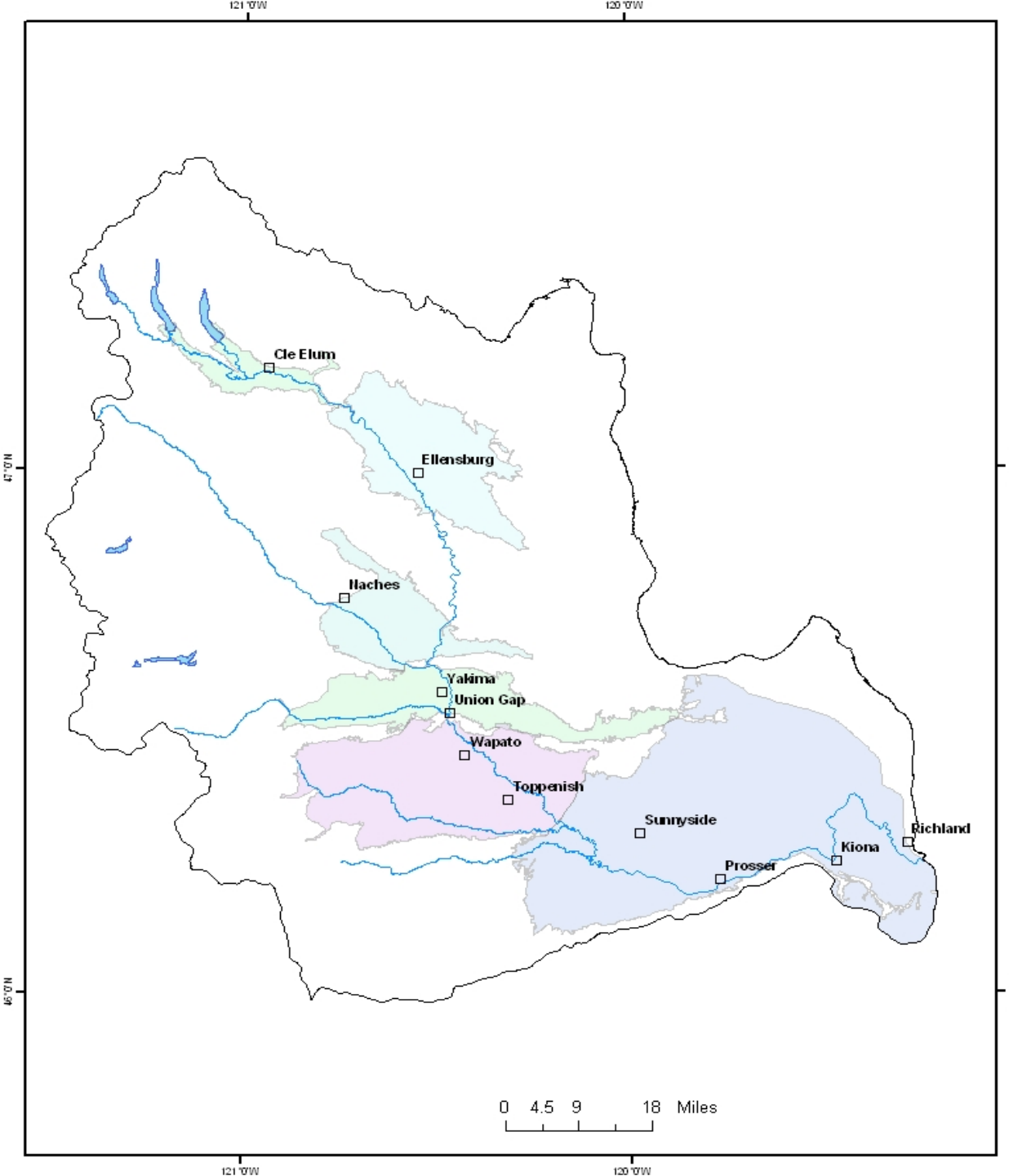
Sedimentary Basins that contain basin-fill deposits

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# Mapping Basin-Fill Deposits

- Mapped total thickness of Basin-Fill deposits
- Mapped thickness of hydrogeologic units

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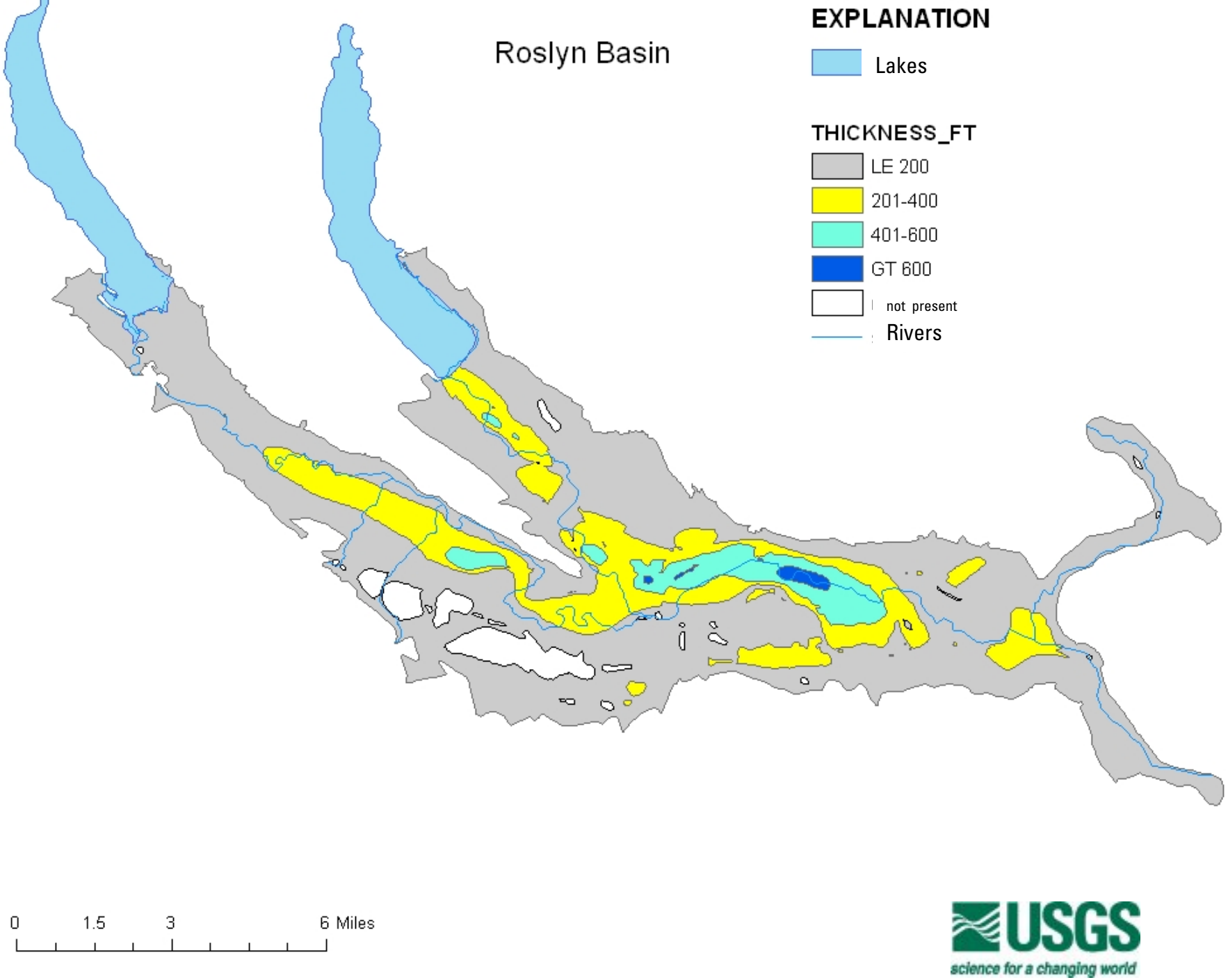
Roslyn Basin
EXPLANATION
Lakes
THICKNESS_FT
LE 200
201-400
401-600
GT 600
not present
Rivers
0
1.5
3
6 Miles
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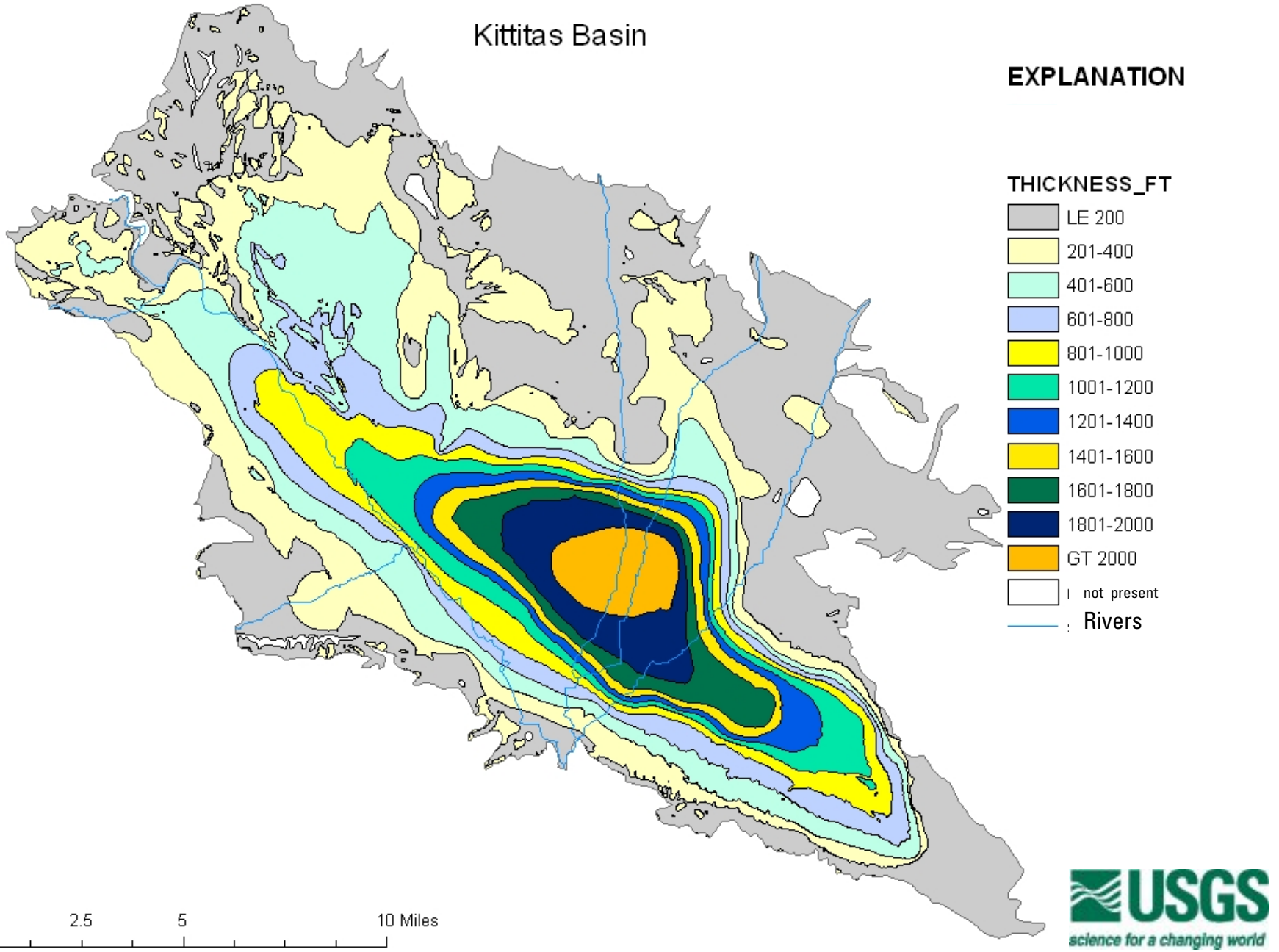
Kittitas Basin
EXPLANATION
THICKNESS_FT
LE 200
201-400
401-600
601-800
801-1000
1001-1200
1201-1400
1401-1600
1601-1800
1801-2000
GT 2000
not present
Rivers
0
2.5
5
10 Miles
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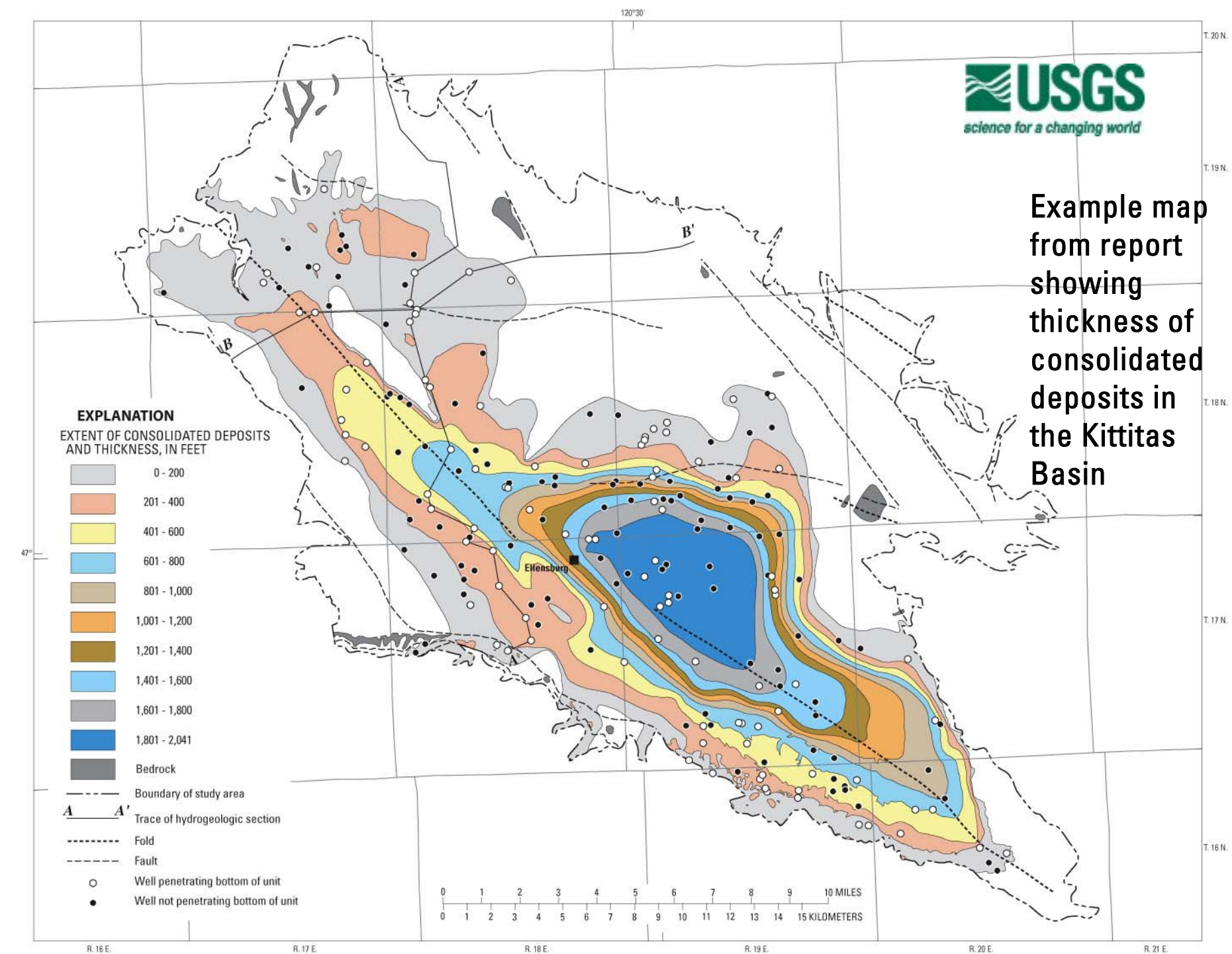
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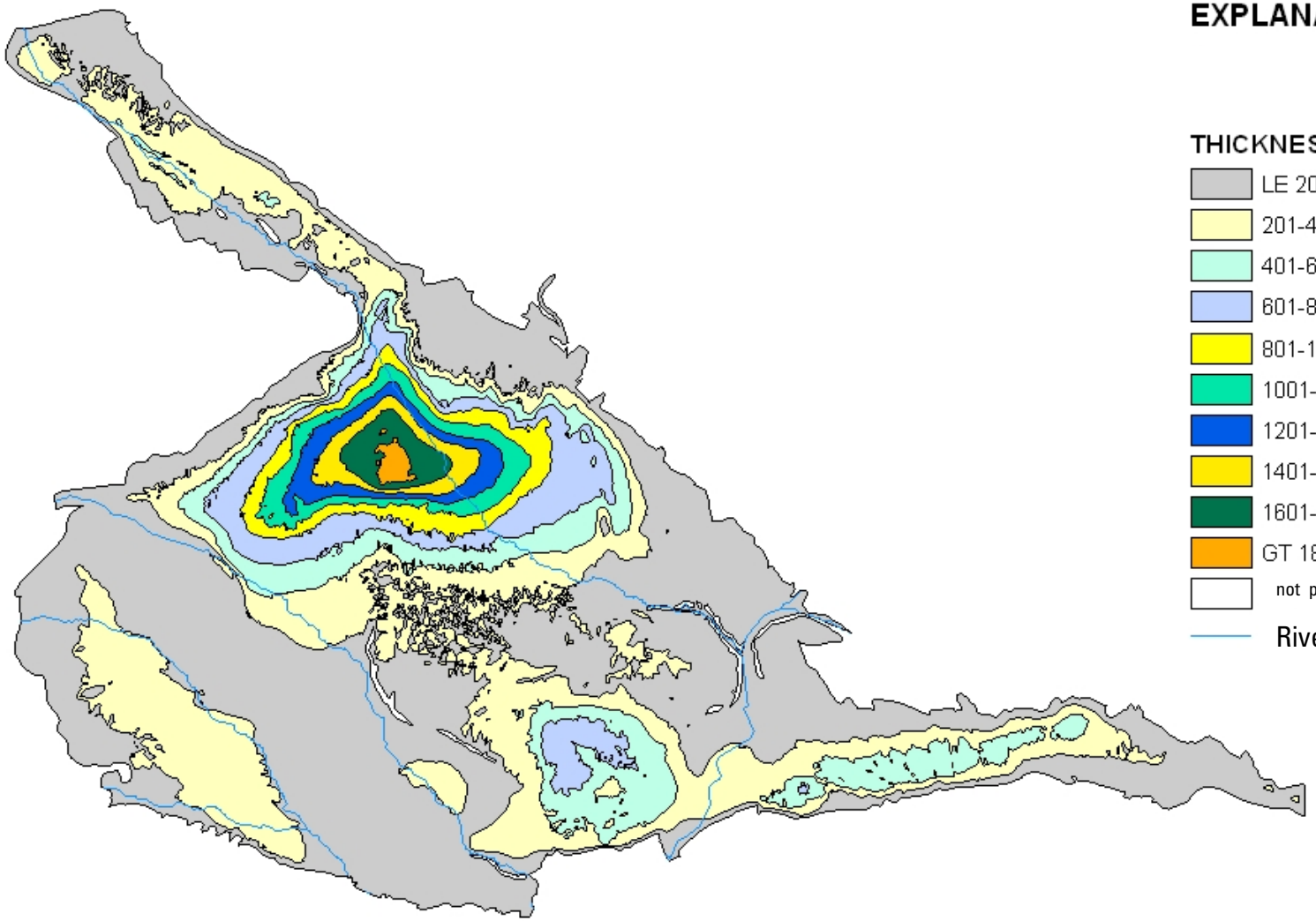
Example map from report showing thickness of consolidated deposits in the Kittitas Basin
EXPLANATION
EXTENT OF CONSOLIDATED DEPOSITS AND THICKNESS, IN FEET
0 - 200
201 - 400
401 - 600
601 - 800
801 - 1,000
1,001 - 1,200
1,201 - 1,400
1,401 - 1,600
1,601 - 1,800
1,801 - 2,041
Bedrock
Boundary of study area
A A'
Trace of hydrogeologic section
Fold
Fault
Well penetrating bottom of unit
Well not penetrating bottom of unit
Ellensburg
B
B'
A
A'
0 1 2 3 4 5 6 7 8 9 10 MILES
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 KILOMETERS
120°30'
47°
T. 20 N.
T. 19 N.
T. 18 N.
T. 17 N.
T. 16 N.
R. 16 E.
R. 17 E.
R. 18 E.
R. 19 E.
R. 20 E.
R. 21 E.

# Selah Basin



**EXPLANATION**

THICKNESS_FT

- LE 200
- 201-400
- 401-600
- 601-800
- 801-1000
- 1001-1200
- 1201-1400
- 1401-1600
- 1601-1800
- GT 1800
- not present
- Rivers

0 2.5 5 10 Miles

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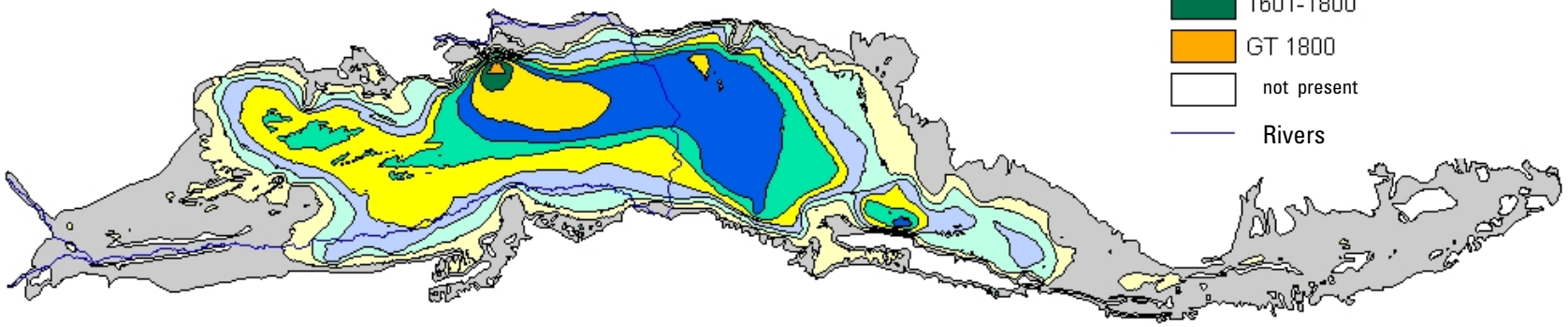
# Yakima Basin




0 2.5 5 10 Miles

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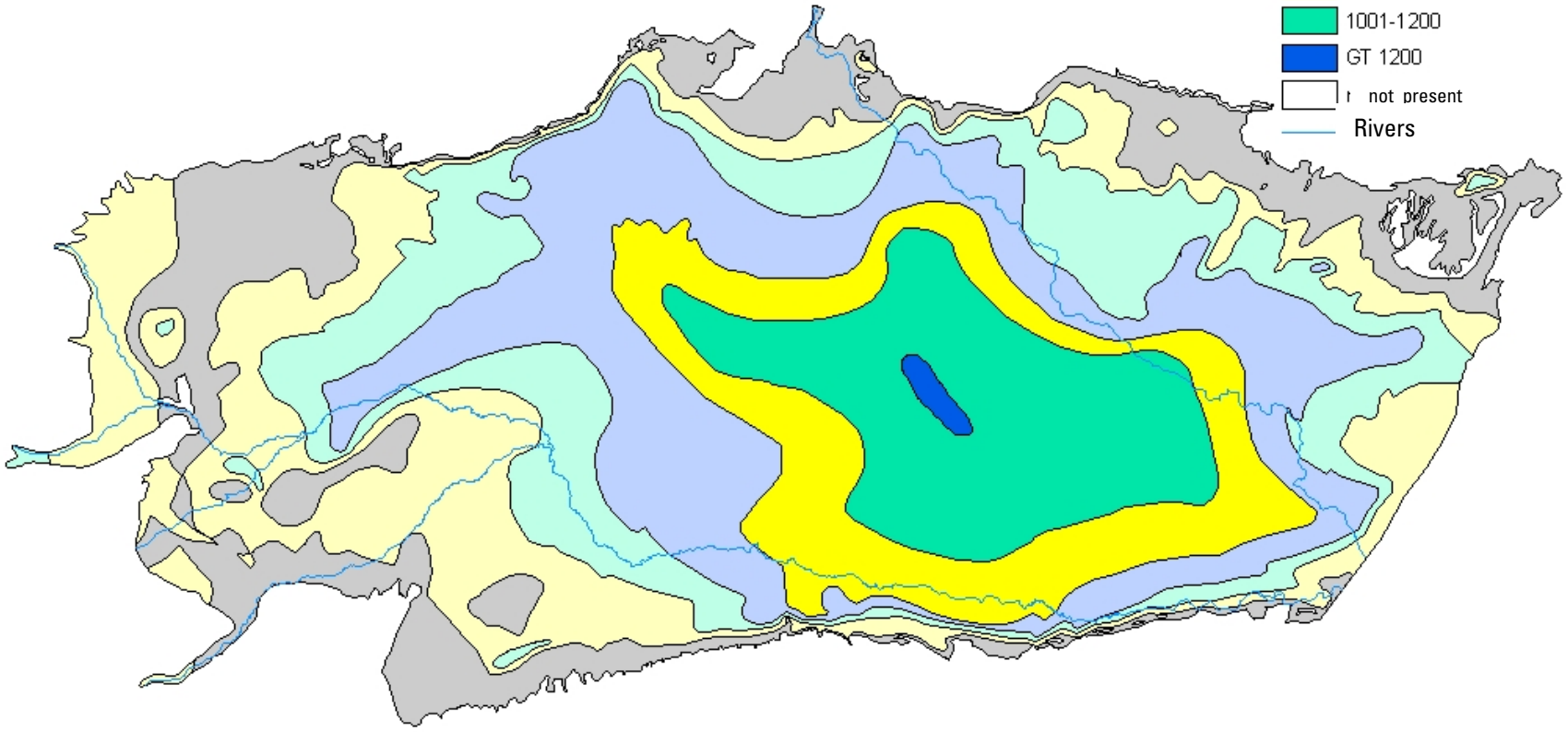
# Toppenish Basin




0 1.5 3 6 Miles

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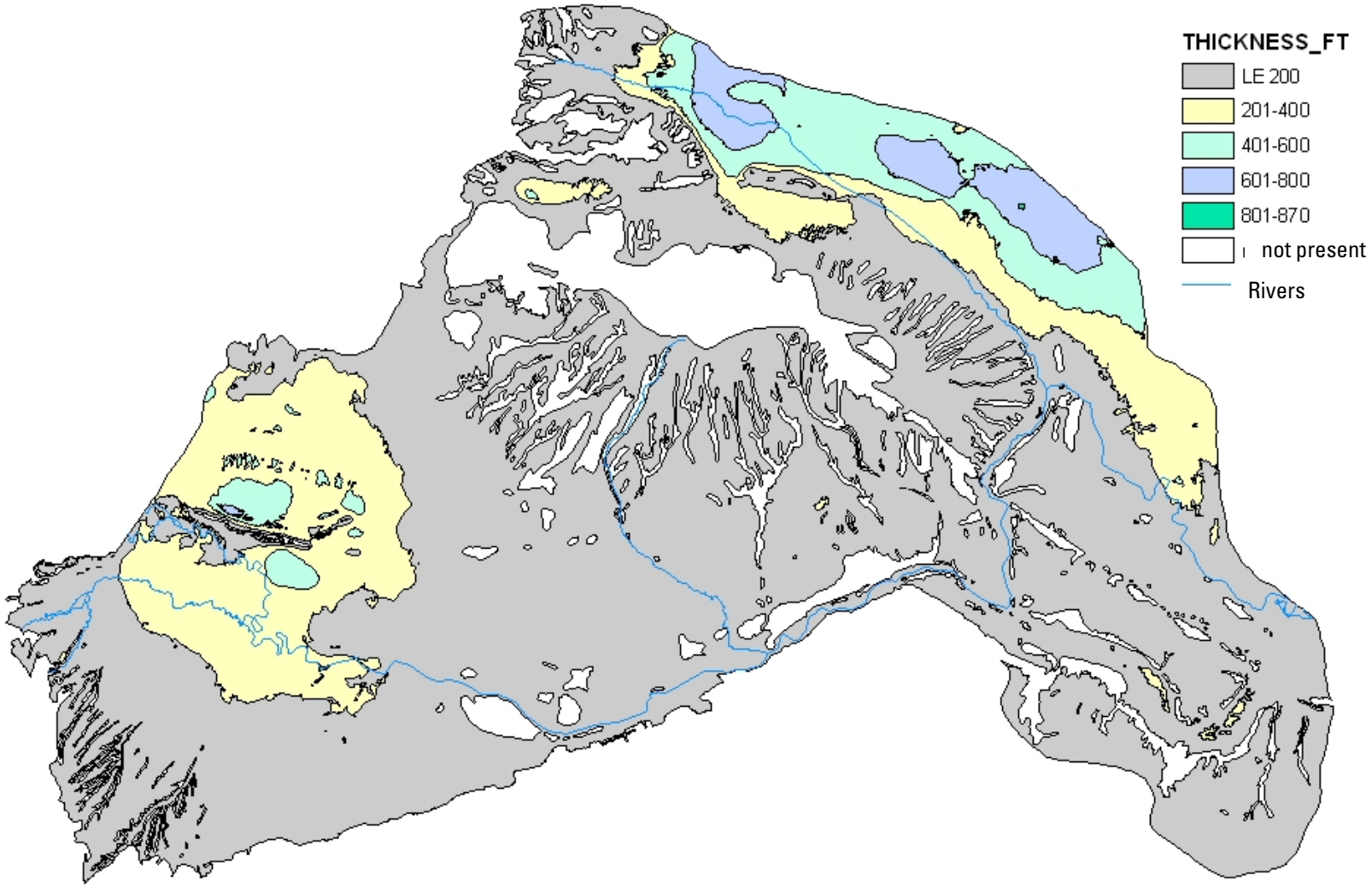
# Benton Basin

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# Mapping of Basalt Hydrogeologic Units

- Constructed maps of lateral extents

Saddle Mountains Basalt

Wanapum Basalt

Grande Ronde Basalt Basalt

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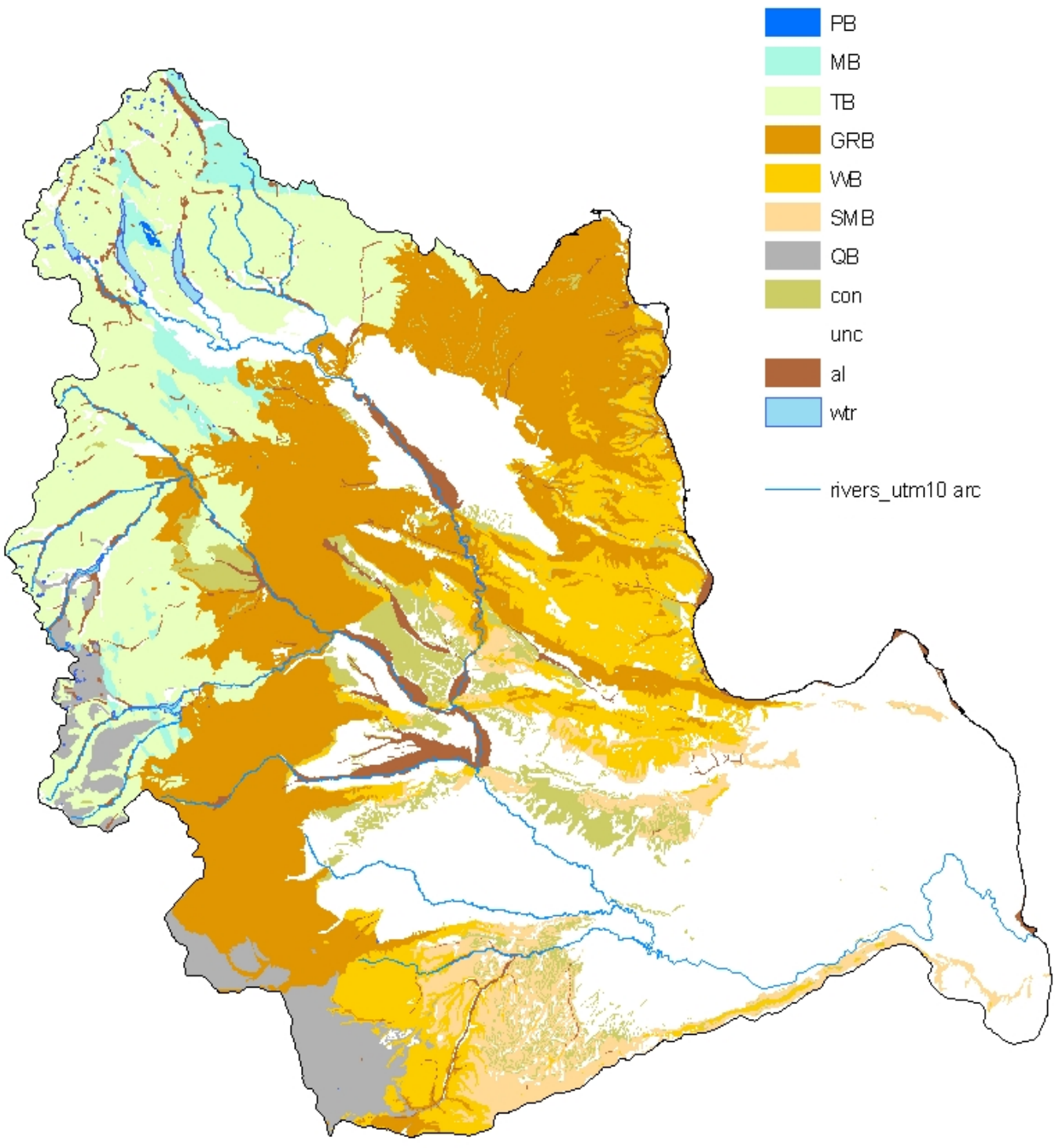
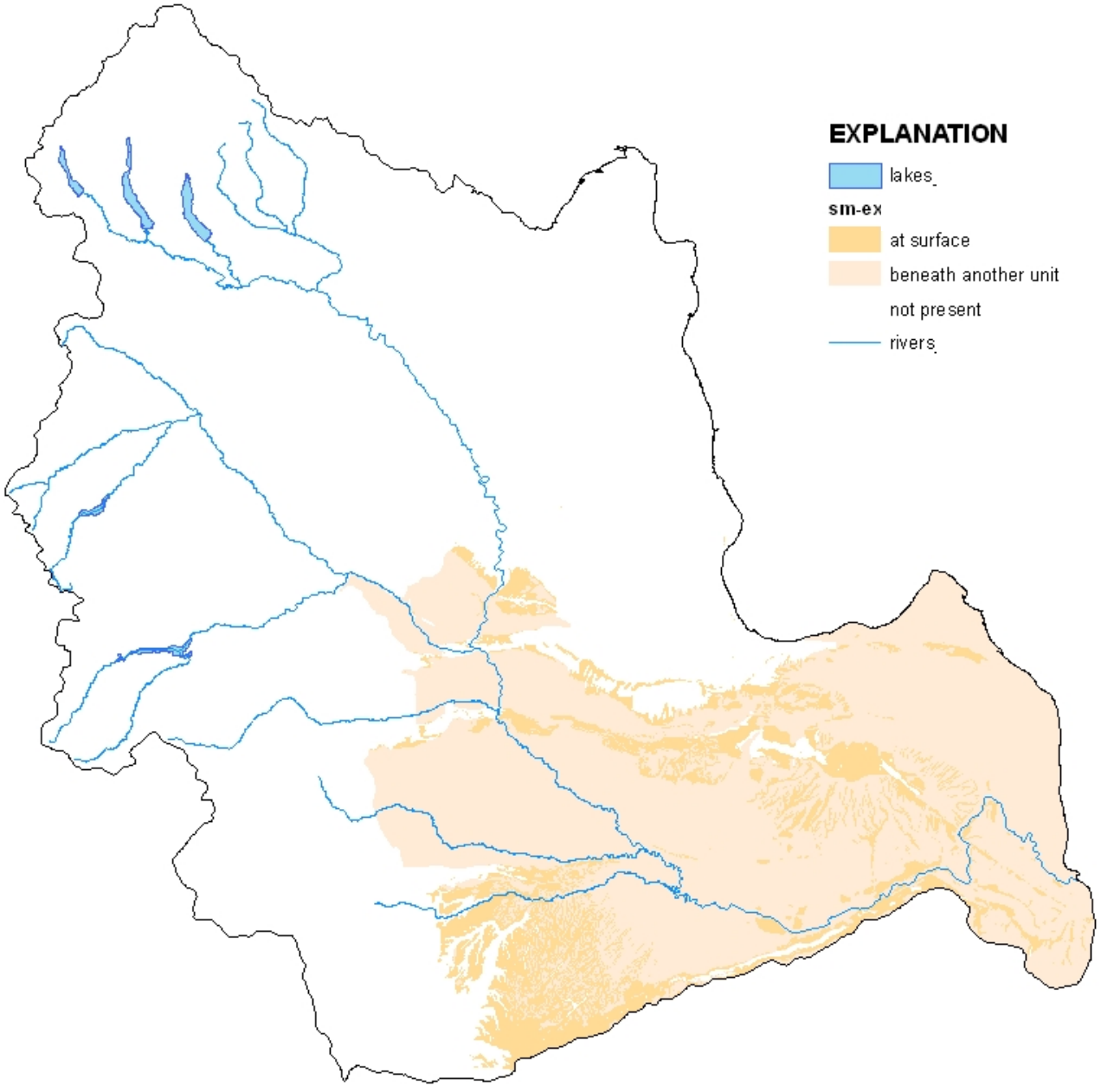
# Simplified Hydrogeologic Units



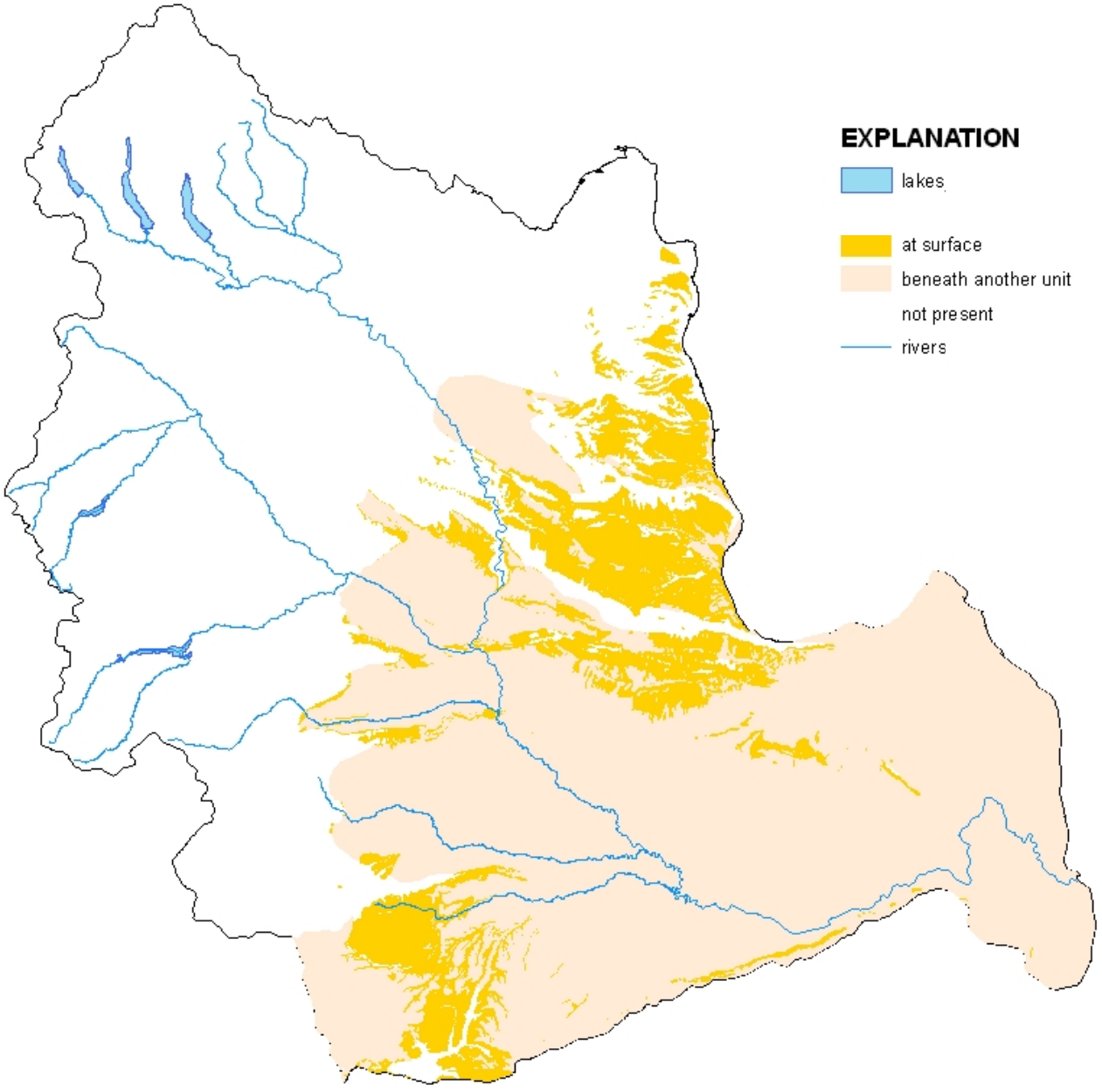
# Saddle Mountains Basalt




**Preliminary subject to revision**

0 5 10 20 Miles

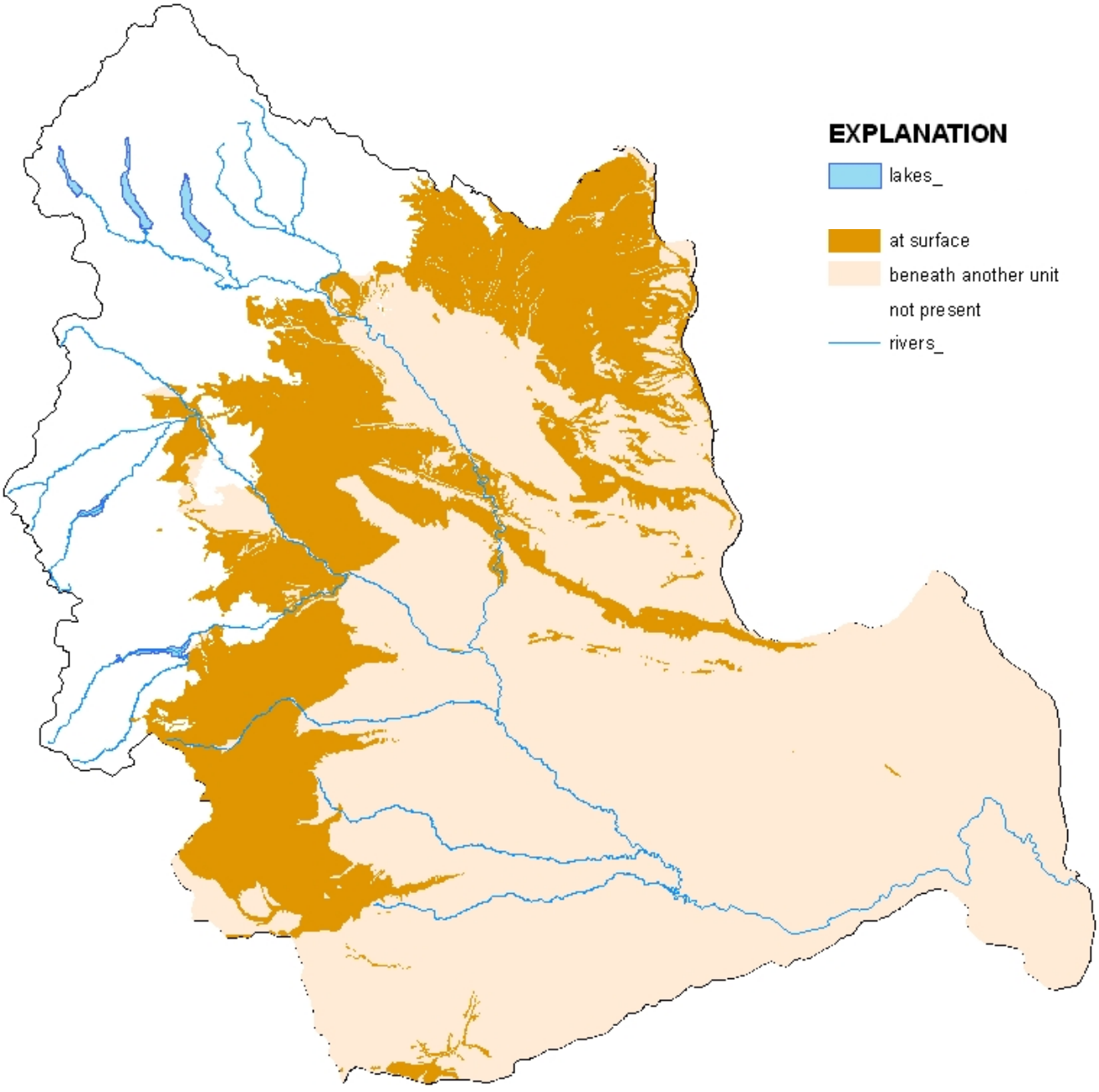
# Wanapum Basalt




**Preliminary subject to revision**

0 5 10 20 Miles

# Grande Ronde Basalt




**Preliminary subject to revision**

# Developed Map of Generalized Extent of Surficial Hydrogeologic Units

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# GROUND WATER PUMPAGE

- Identified well-driller's log associated with most Ground-Water Rights:

  Certificates: 2,575

  Permits: 299

- Estimated pumpage for eight categories for the period 1960-2000
- Documented methods and results in a report

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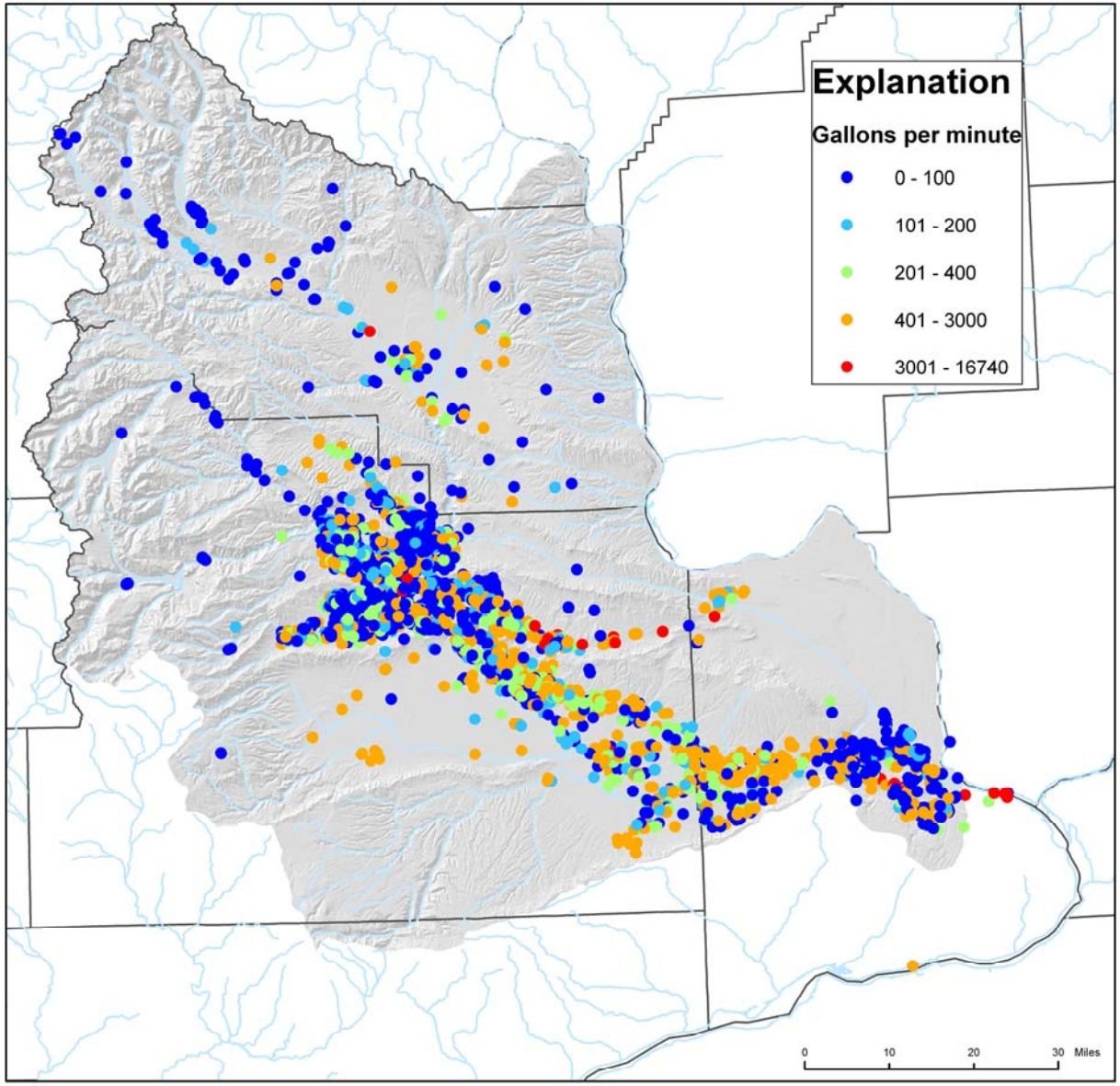
Wells with water rights

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# Ground-Water Pumpage Estimates

- Municipal pumpage
- Public Water Supply pumpage
- Domestic Pumpage (exempt wells)
- Irrigation pumpage
- Livestock pumpage
- Fish and Wildlife pumpage
- Commercial and Industrial pumpage
- Ground-water Claims
- Relate to Water Rights

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The following 9 slides are figures or graphs from the report describing ground-water pumpage from the Yakima River Basin Aquifer System

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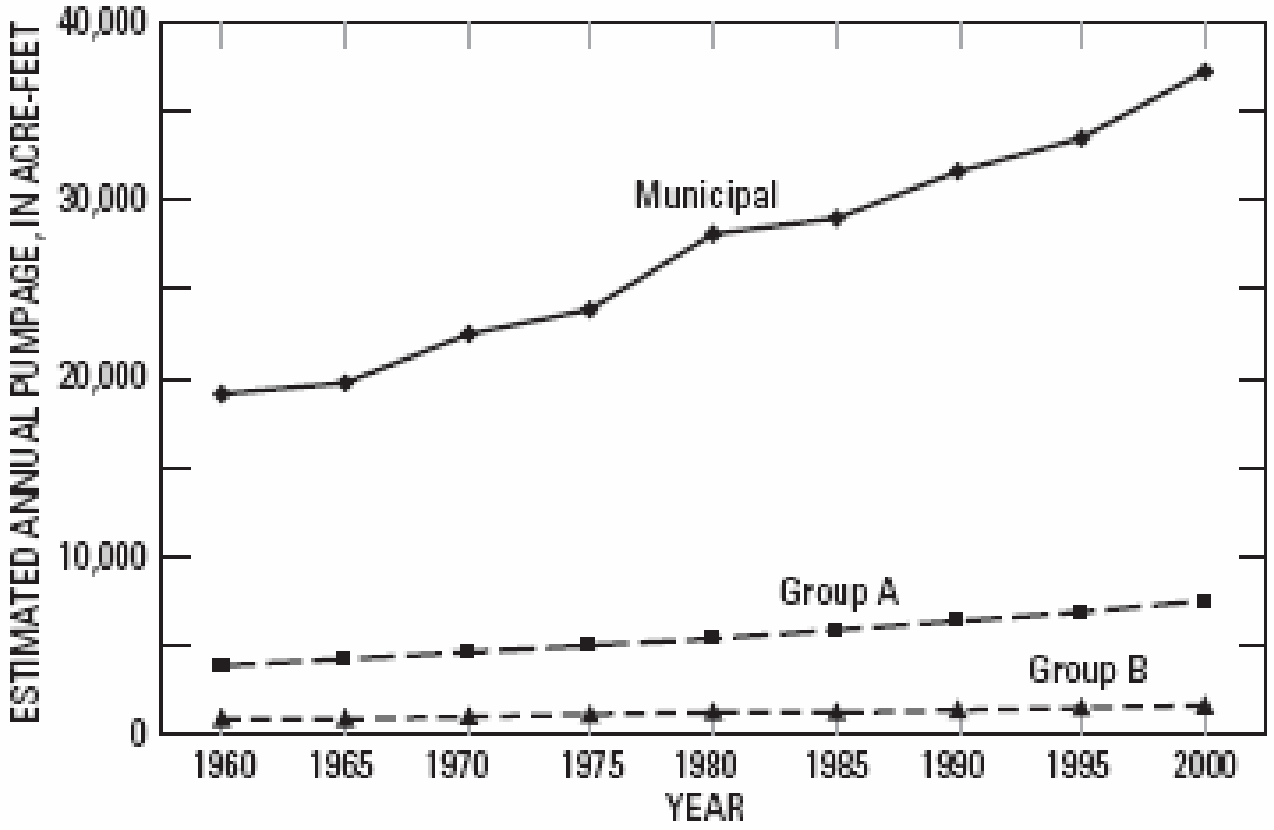


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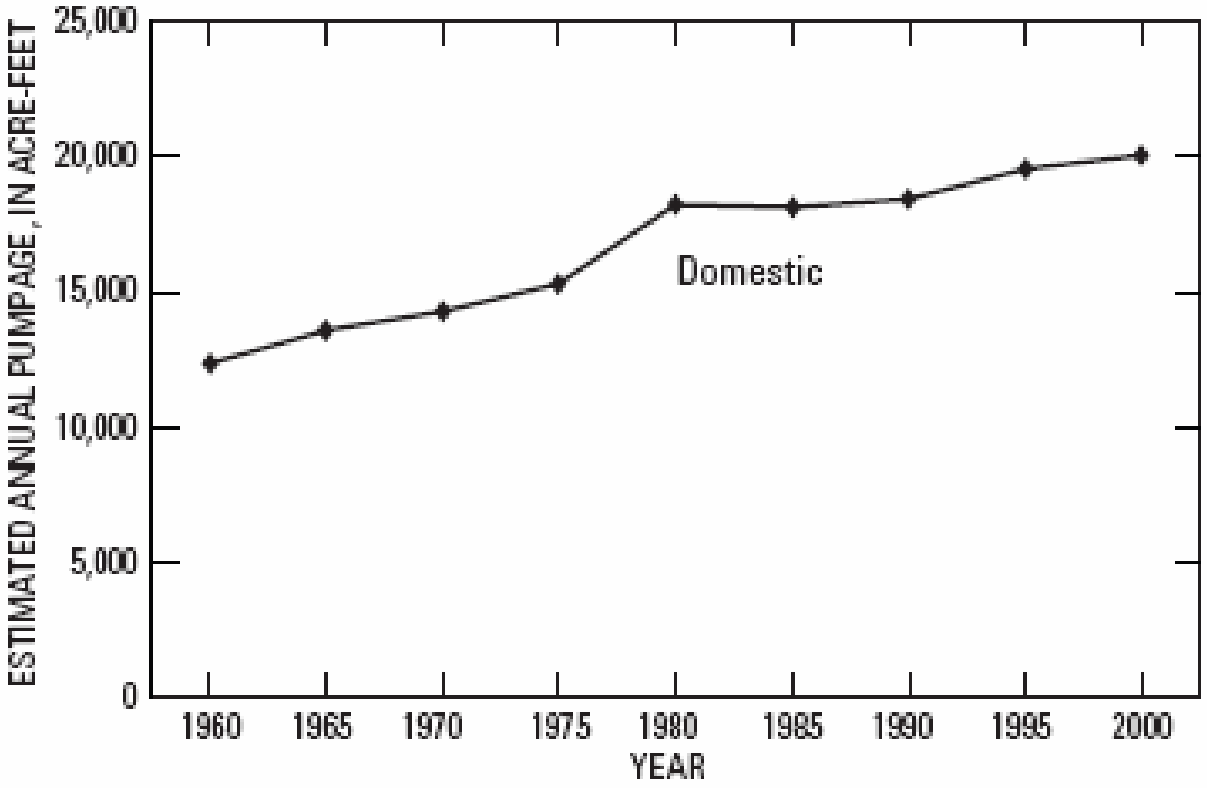


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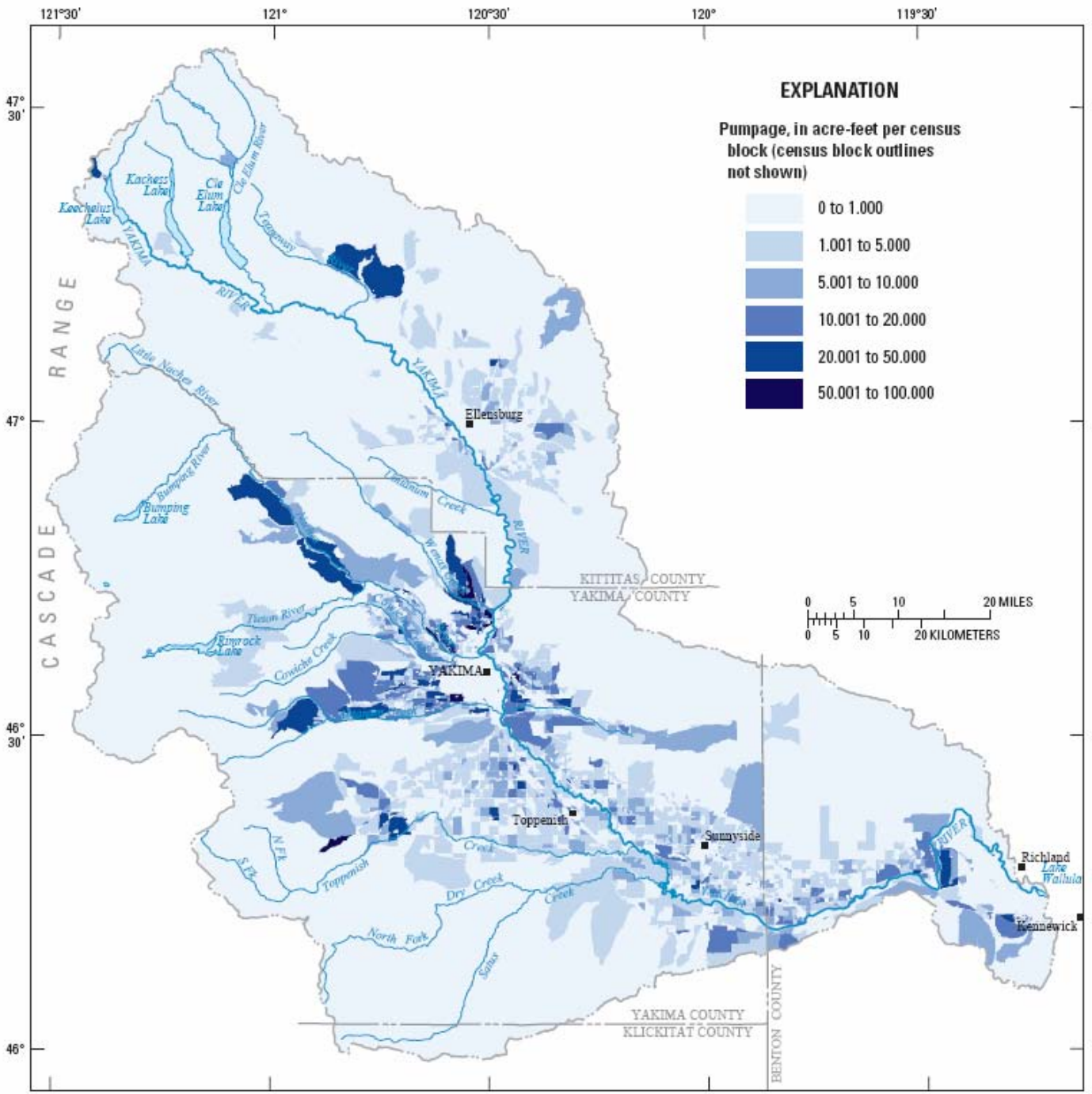
Exempt

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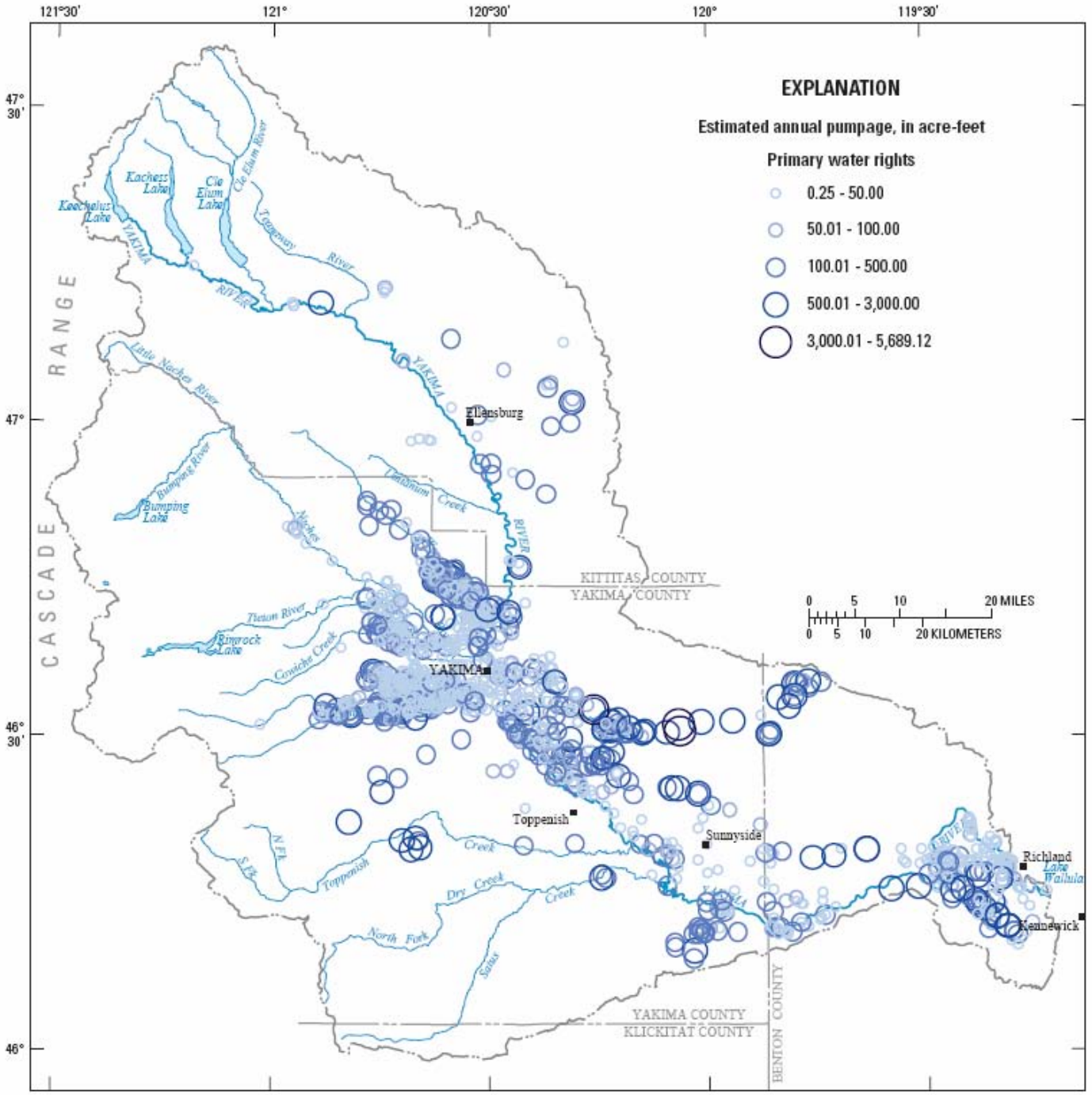
# Irrigation

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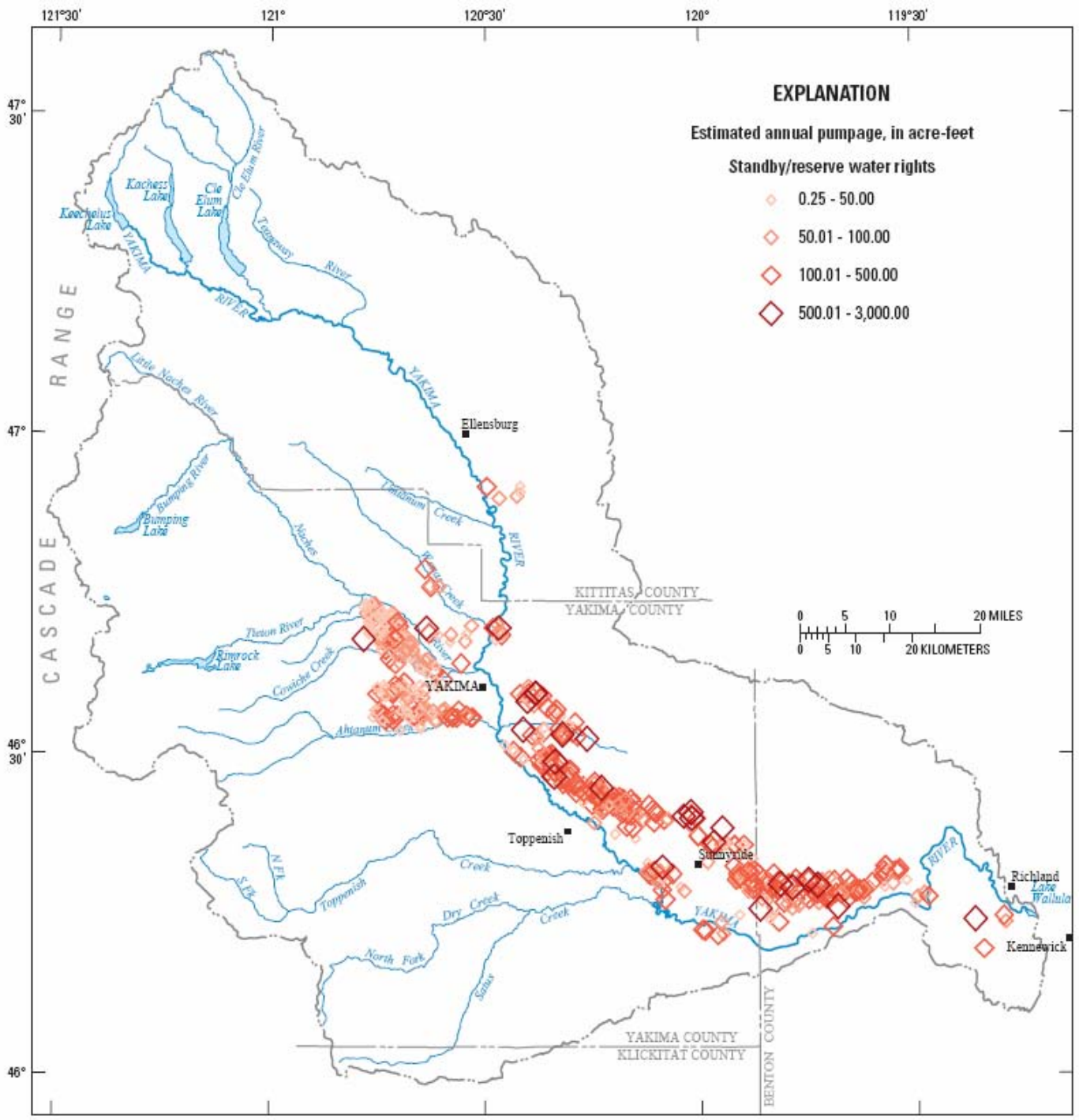
# Irrigation

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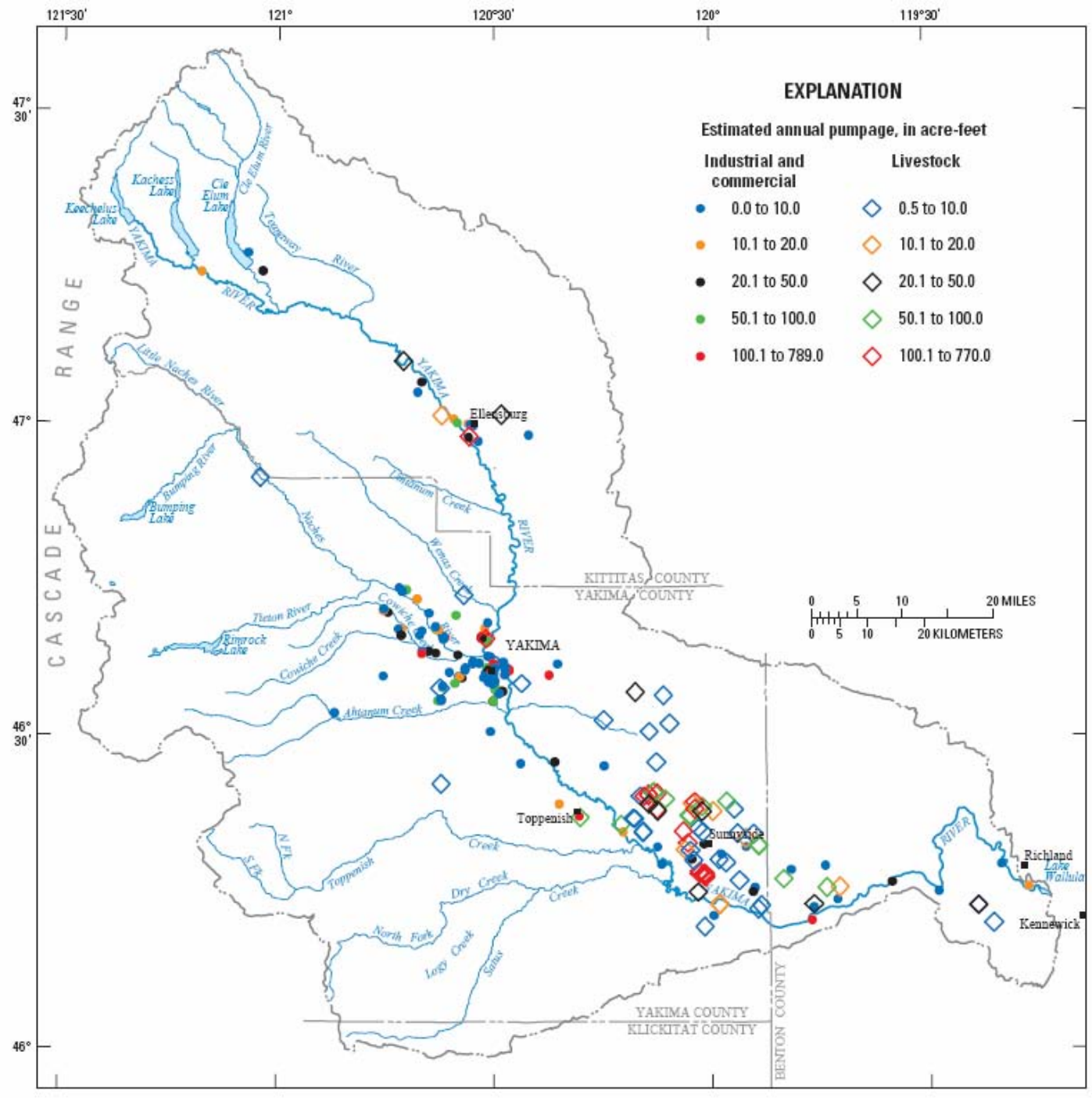
Industrial and Commercial

Livestock

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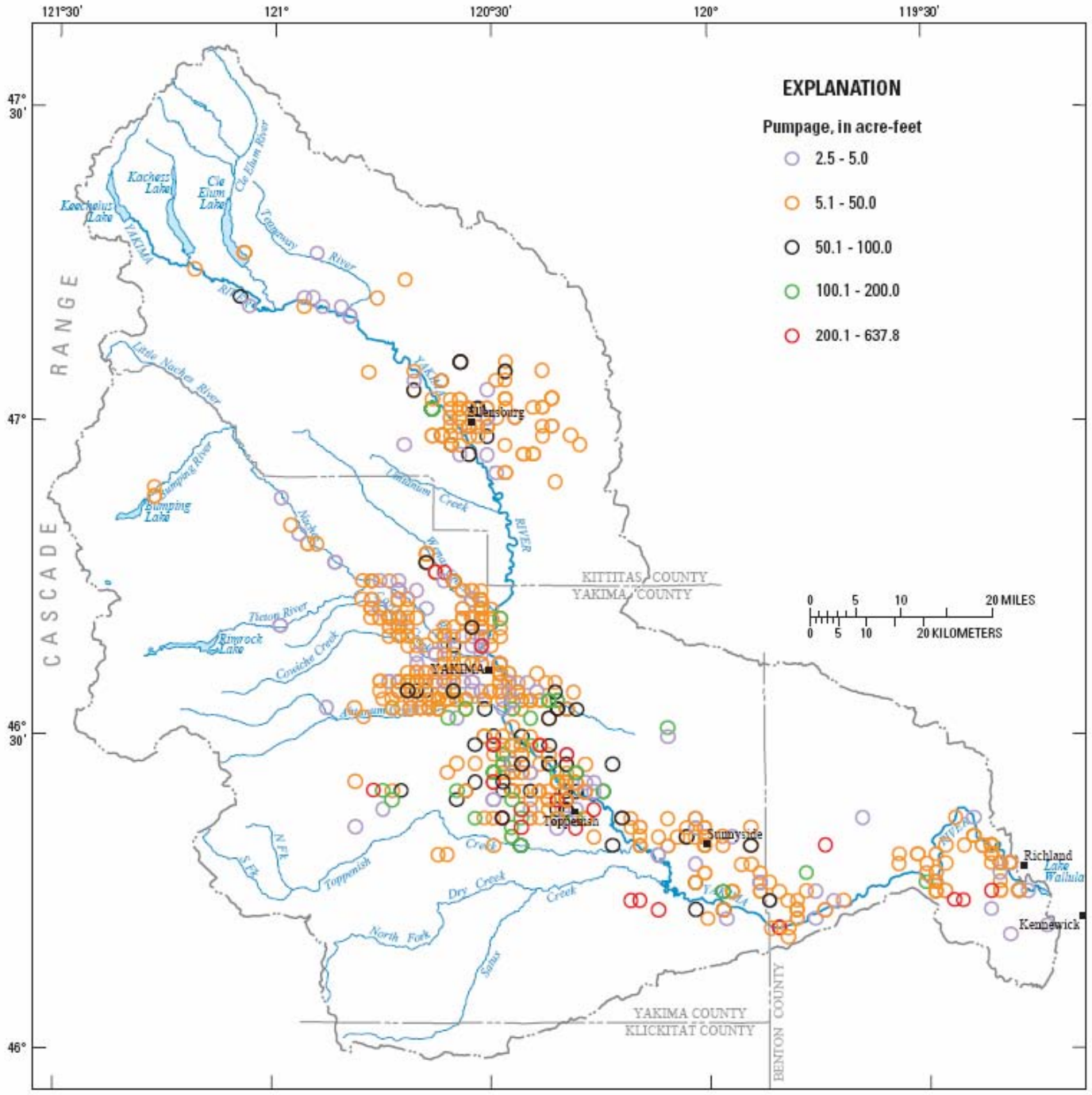
Claims

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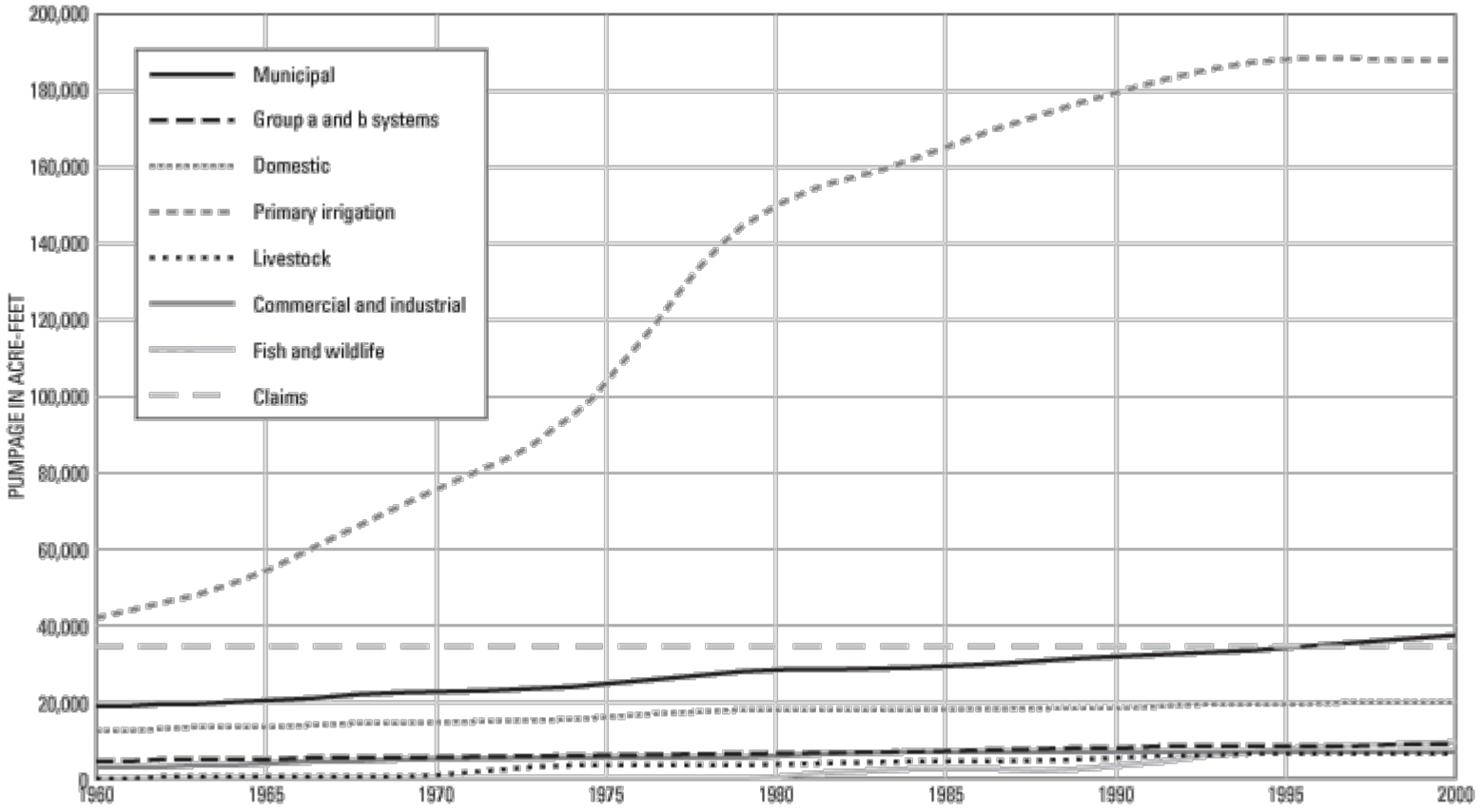


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# Ground-water pumpage, by category, in 5-year increments
values are in acre-feet per year

| Years | Public Water Supply | | | Domestic | Irrigation | | | Livestock | Commercial and industrial | Fish and wildlife | Ground-water claims | Total for all categories | Cumulative without standby/ reserve |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Municipal | Group A systems | Group B systems | | Total | Primary | Standby/ reserve | | | | | | |
| Pre-1960 | 19,127 | 3,888 | 858 | 12,379 | 42,000 | 41,896 | 104 | 222 | 3,093 | 3 | 34,310 | 115,880 | 115,776 |
| 1960-64 | 628 | 331 | 73 | 1,187 | 9,299 | 9,299 | 0 | 208 | 438 | 0 | 0 | 12,164 | 127,044 |
| 1965-69 | 2,702 | 358 | 79 | 716 | 20,271 | 20,249 | 22 | 39 | 1,428 | 0 | 0 | 25,593 | 153,510 |
| 1970-74 | 1,379 | 389 | 85 | 988 | 25,010 | 23,743 | 1,267 | 3,189 | 612 | 2 | 0 | 31,653 | 183,897 |
| 1975-79 | 4,236 | 422 | 93 | 2,914 | 99,474 | 49,399 | 50,075 | 84 | 44 | 58 | 0 | 107,324 | 241,147 |
| 1980-84 | 975 | 458 | 101 | -107 | 28,845 | 17,507 | 11,338 | 996 | 1,442 | 2,661 | 0 | 35,371 | 265,180 |
| 1985-89 | 2,614 | 586 | 110 | 305 | 20,687 | 14,927 | 5,760 | 461 | 170 | 0 | 0 | 24,933 | 284,352 |
| 1990-94 | 1,793 | 449 | 119 | 1,175 | 21,821 | 10,398 | 11,423 | 1,527 | 3 | 4,194 | 0 | 31,081 | 304,010 |
| 1995-2000 | 3,819 | 584 | 129 | 479 | 3,635 | 812 | 2,823 | 0 | 0 | 2,451 | 0 | 11,097 | 312,284 |
| Total in 2000 | 37,273 | 7,465 | 1,647 | 20,036 | 271,042 | 188,230 | 82,812 | 6,726 | 7,230 | 9,369 | 34,310 | 395,096 | 312,284 |

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# GROUND-WATER RECHARGE

- Used existing Watershed Models to estimate Daily Values of Recharge in upland areas
- Used a Daily Water-Budget Model (DPM) to estimate Recharge in remaining areas
- Documented DPM in a report
- Estimated recharge for predevelopment and current land-use and land-cover conditions
- Documented recharge methods and estimates in a report

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**GROUND-WATER RECHARGE**:

DRAINAGE FROM: THE ACTIVE ROOT-ZONE OR THE SOIL COLUMN FOR BARREN SOILS

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- SPATIAL DISTRIBUTION OF RECHARGE
- TEMPORAL VARIATIONS IN RECHARGE

FOR:

PREDEVELOPMENT AND CURRENT
LAND-USE AND LAND-COVER CONDITIONS

DAILY ESTIMATES FOR WATER YEARS
1950-1998/2003

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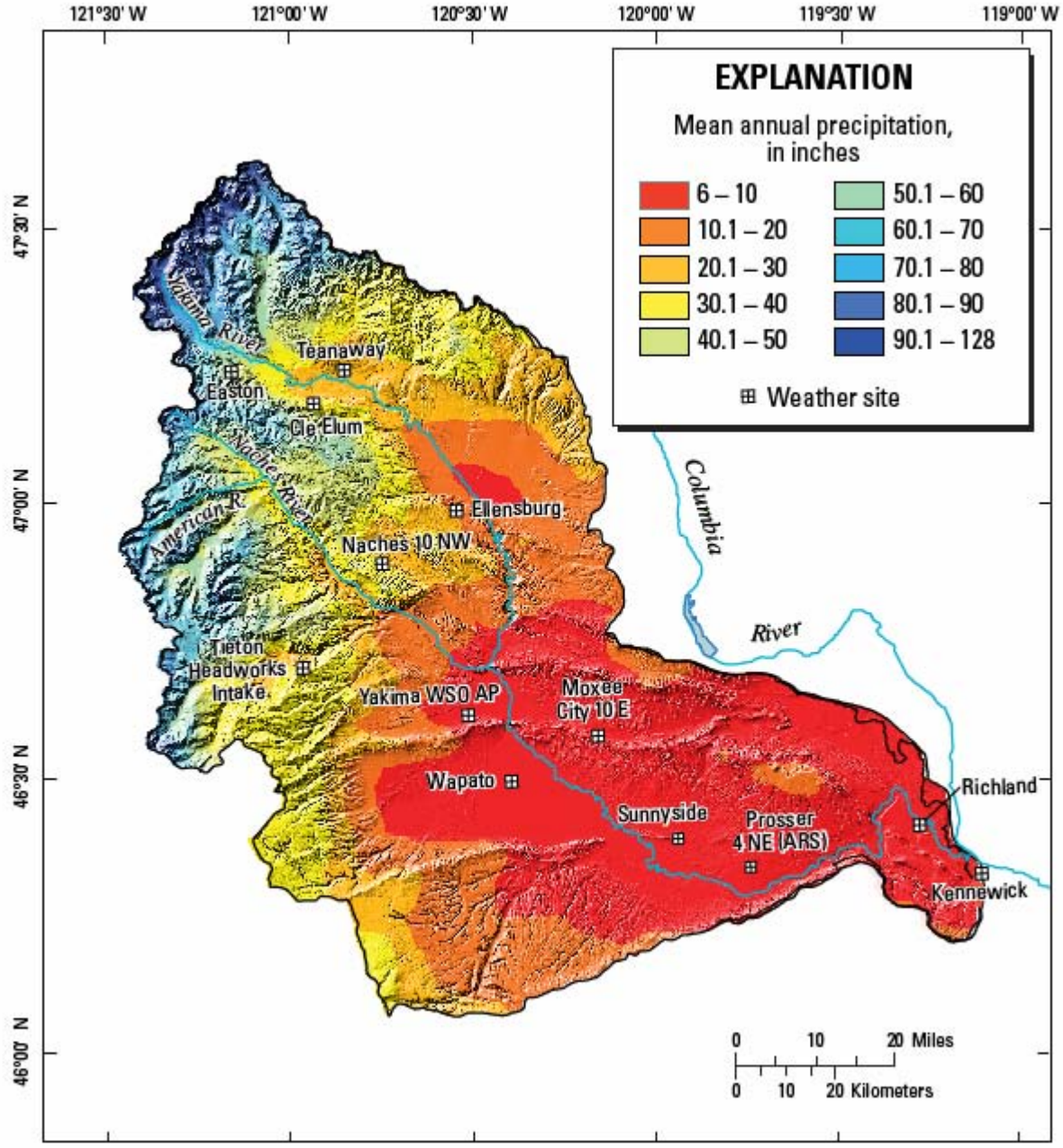


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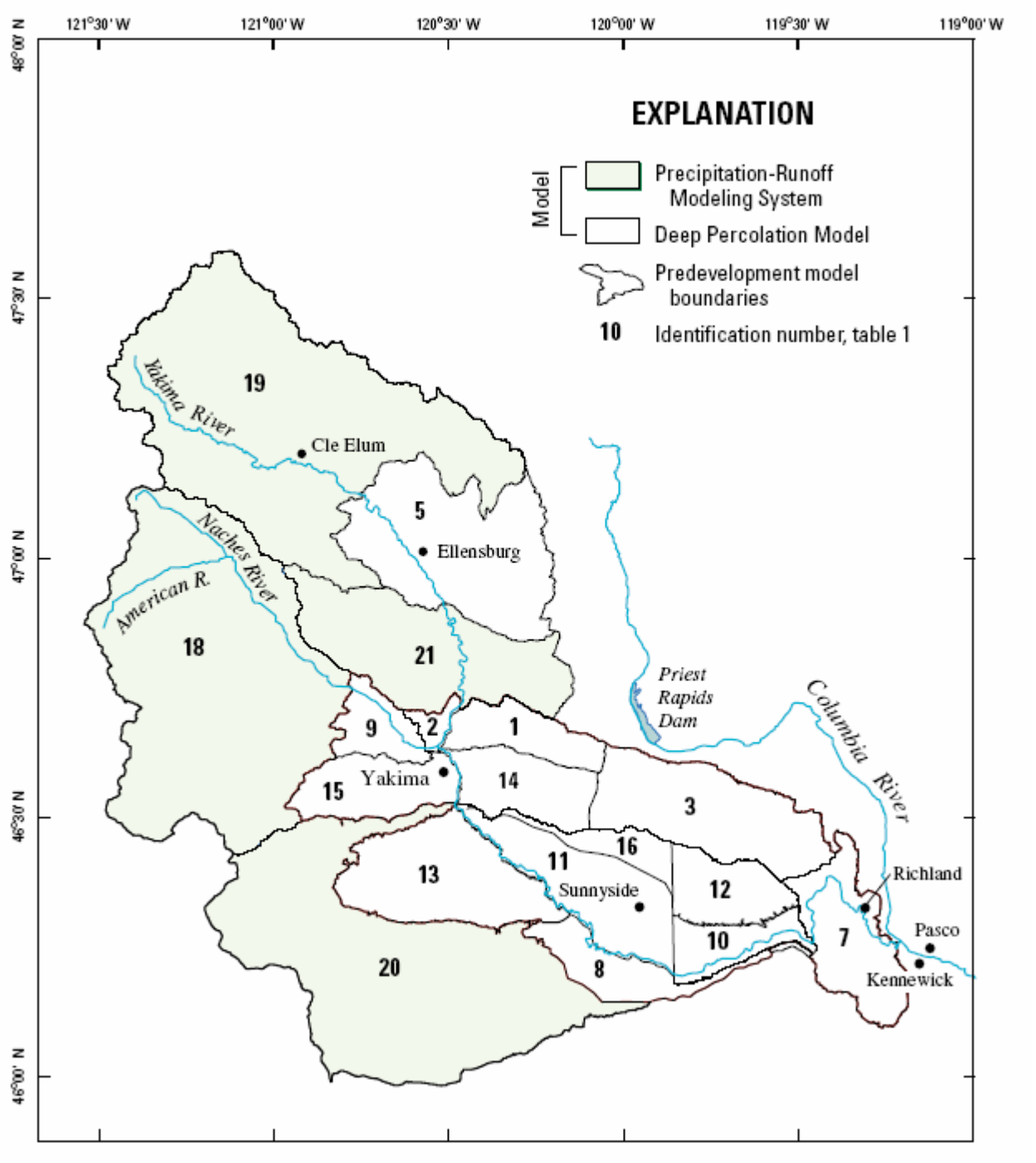
Areas modeled for estimating predevelopment condition recharge

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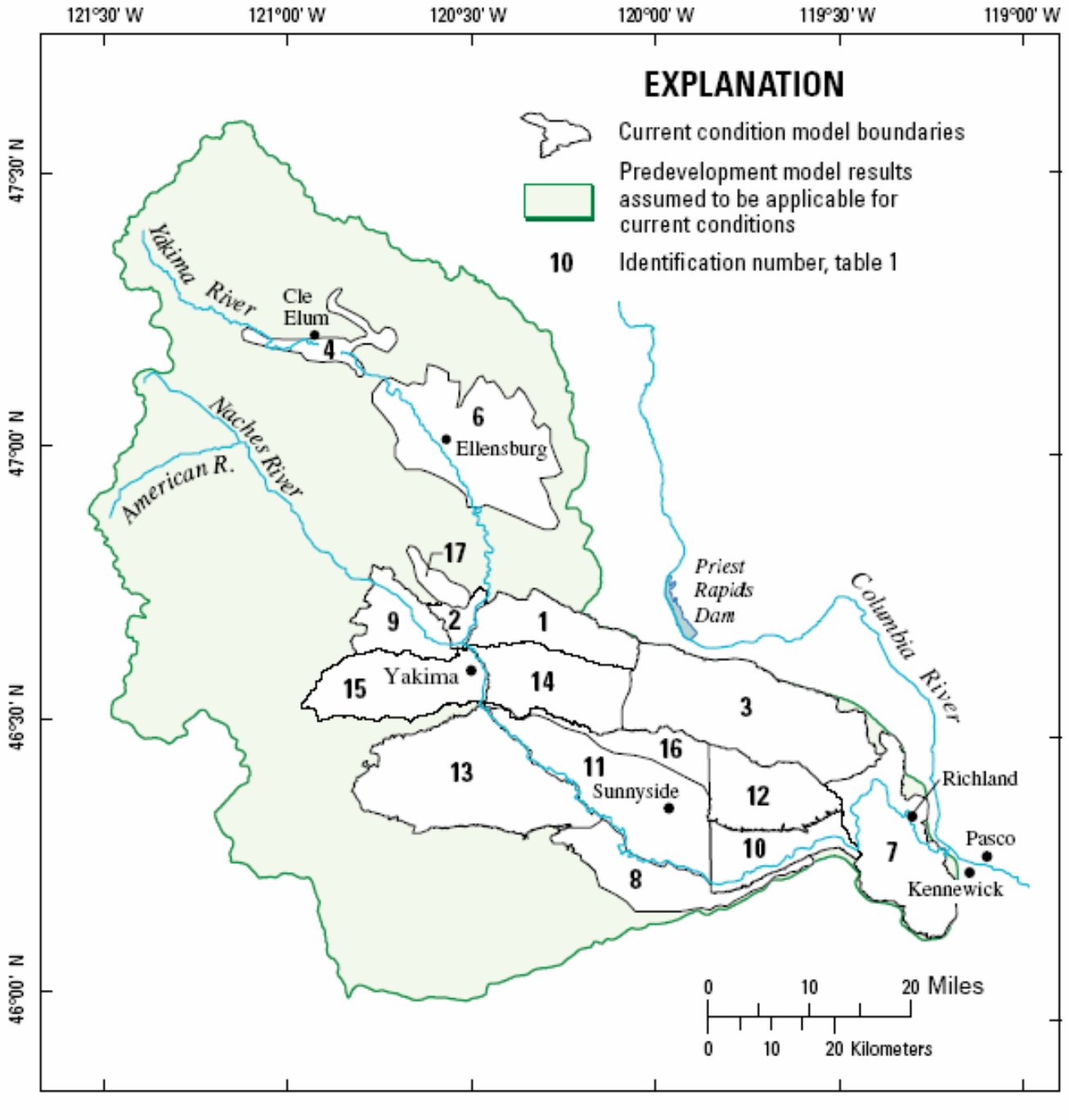
Areas modeled for estimating current condition recharge

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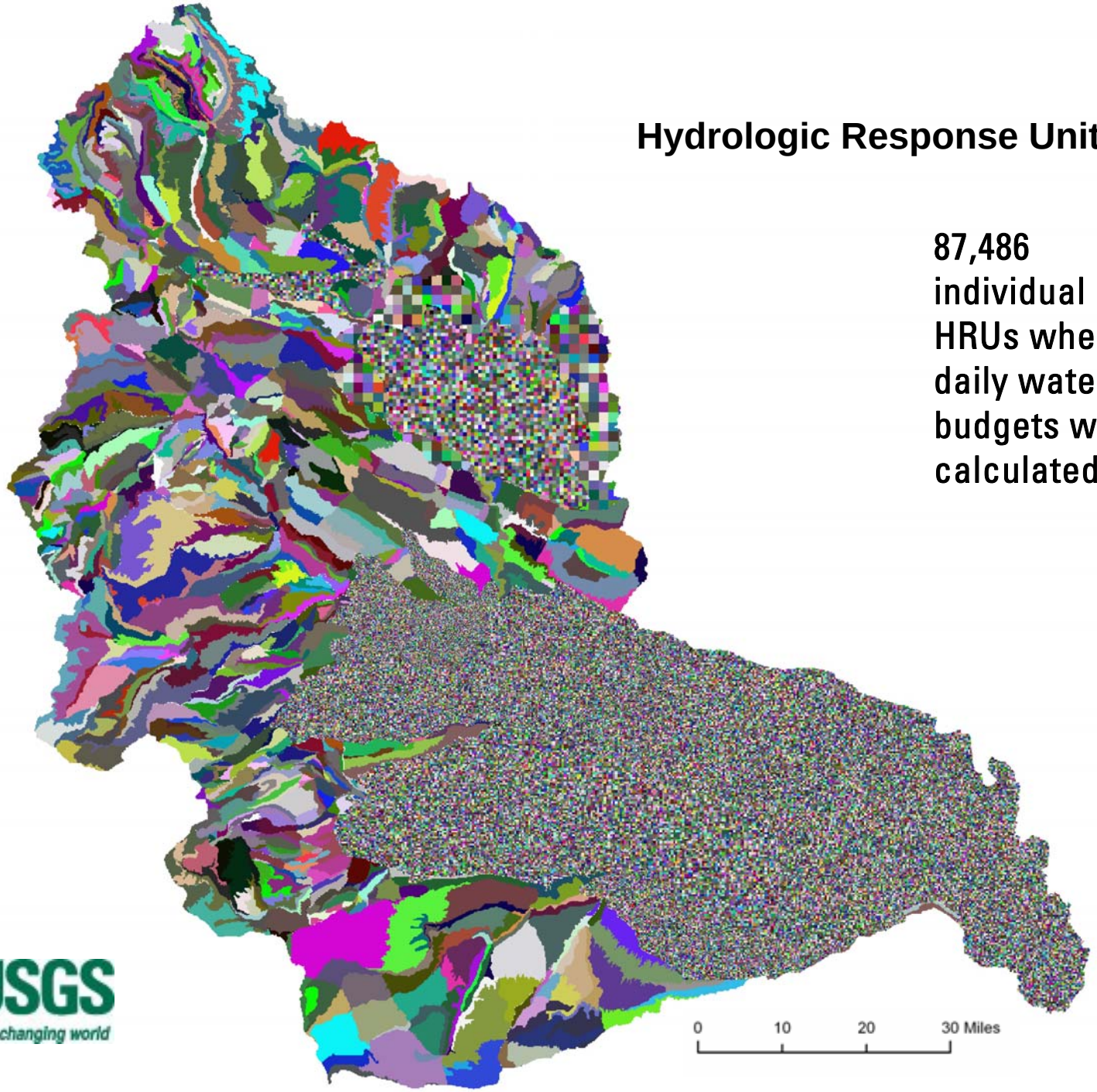
Hydrologic Response Units
87,486 individual HRUs where daily water budgets were calculated
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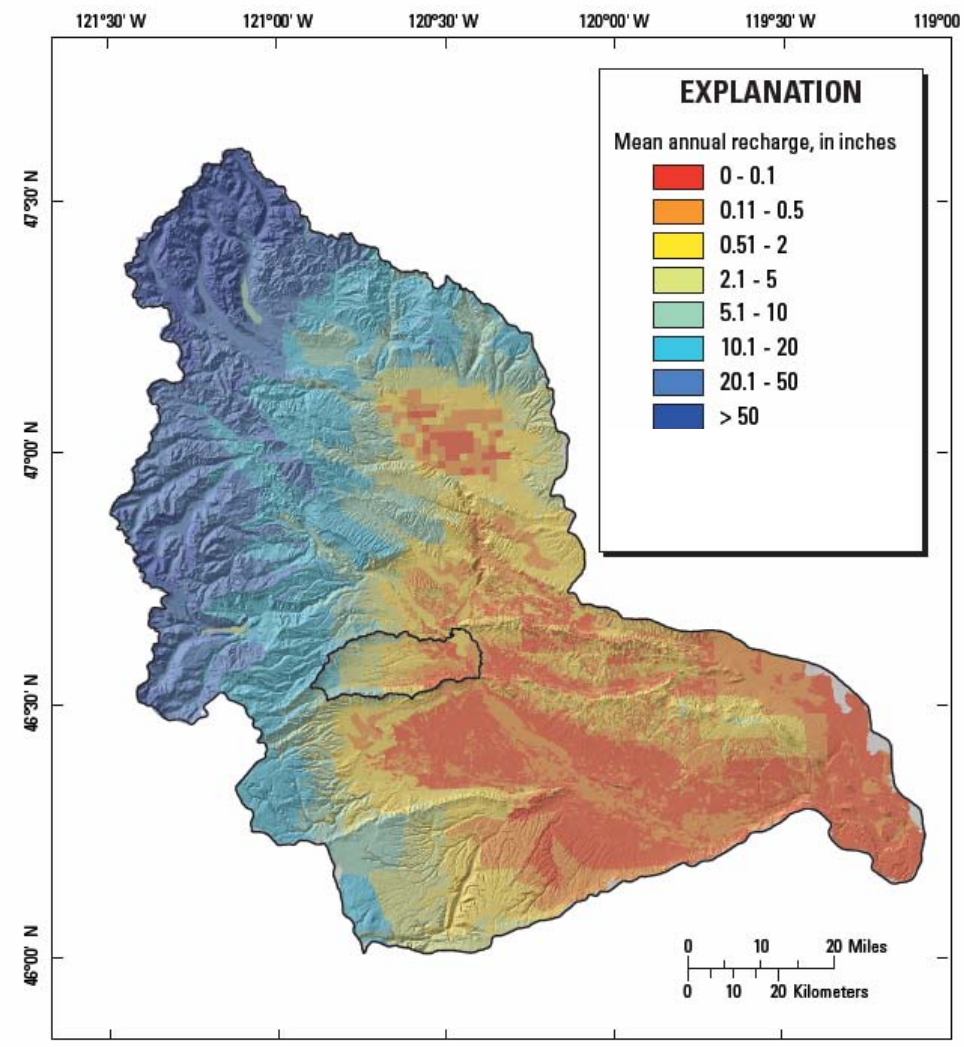
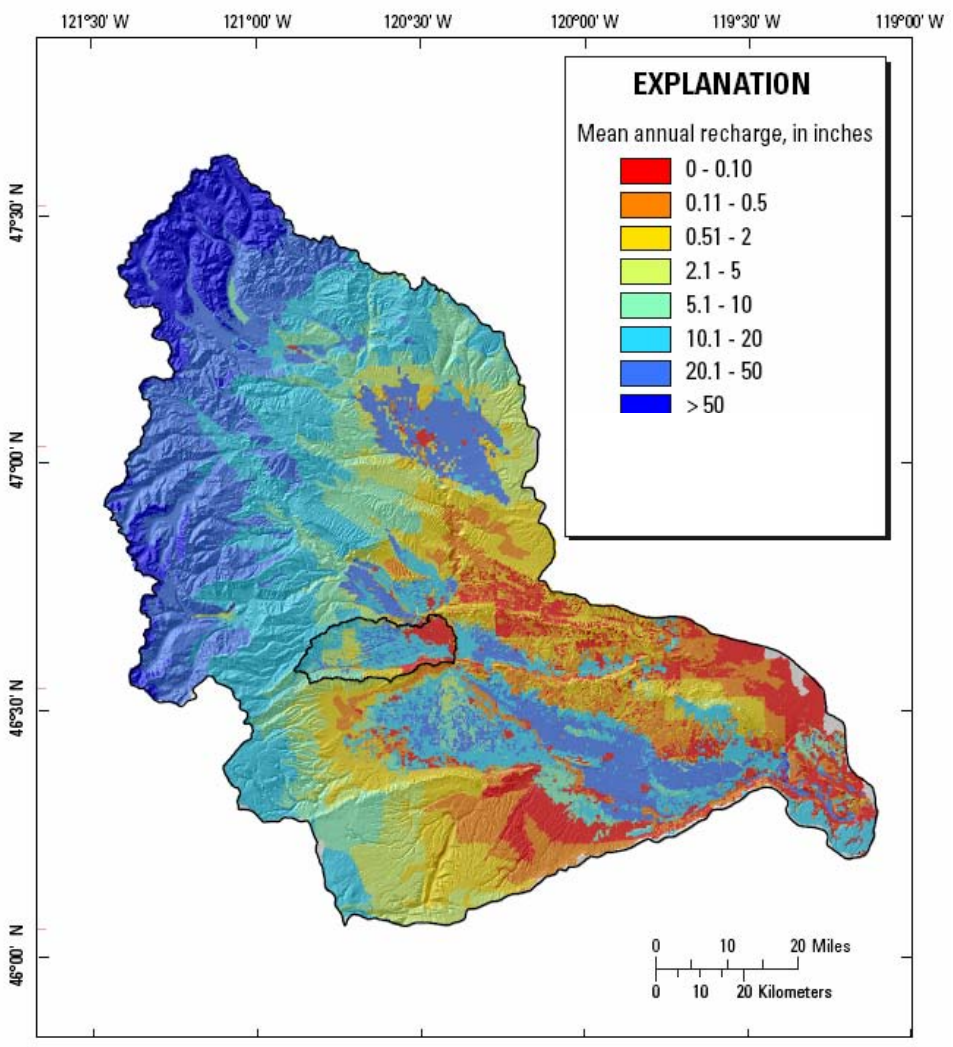
0
10
20
30 Miles




**PREDEVELOPMENT CONDITIONS**

**CURRENT CONDITIONS**

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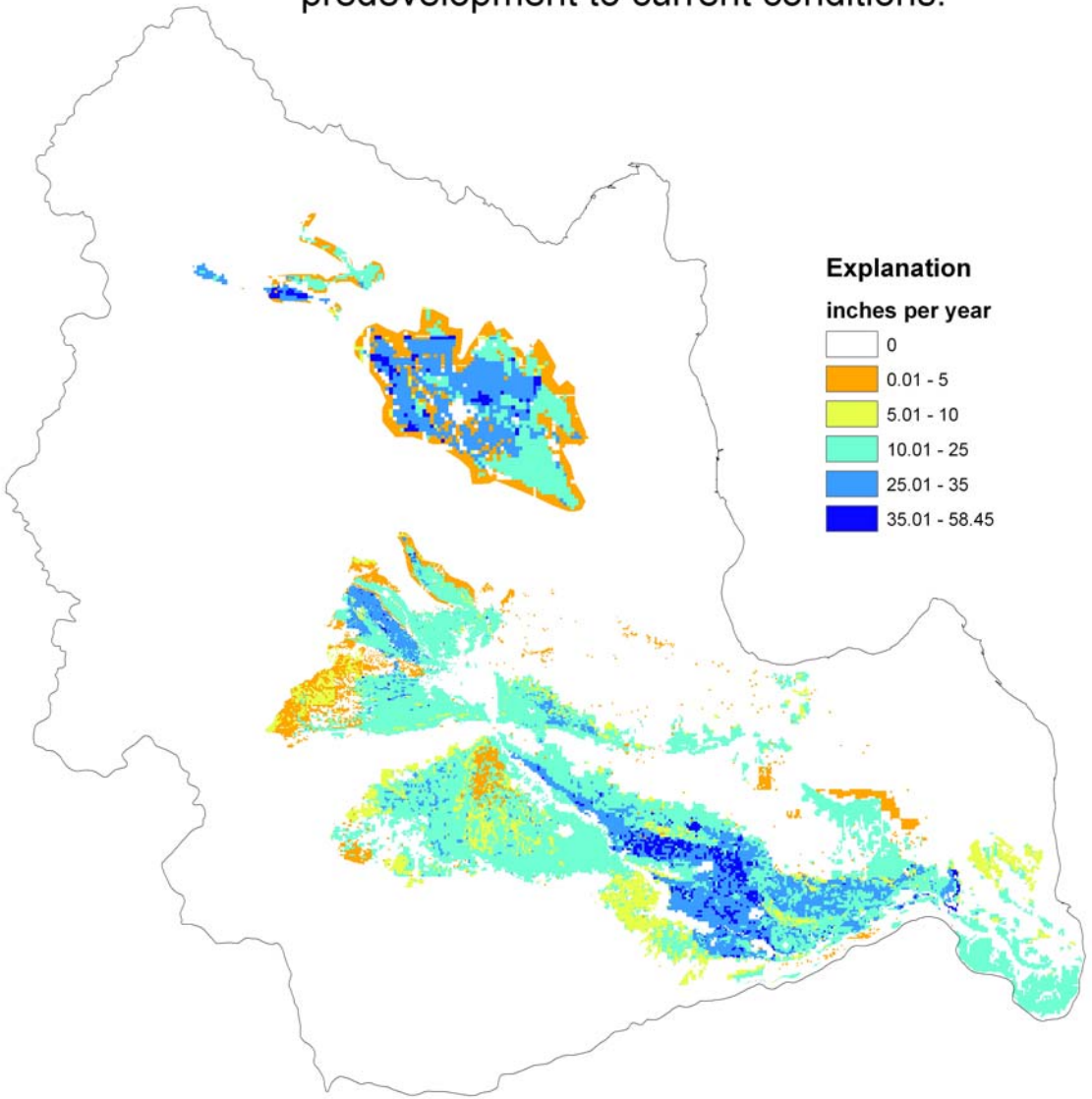
Mean annual increases in recharge from predevelopment to current conditions.

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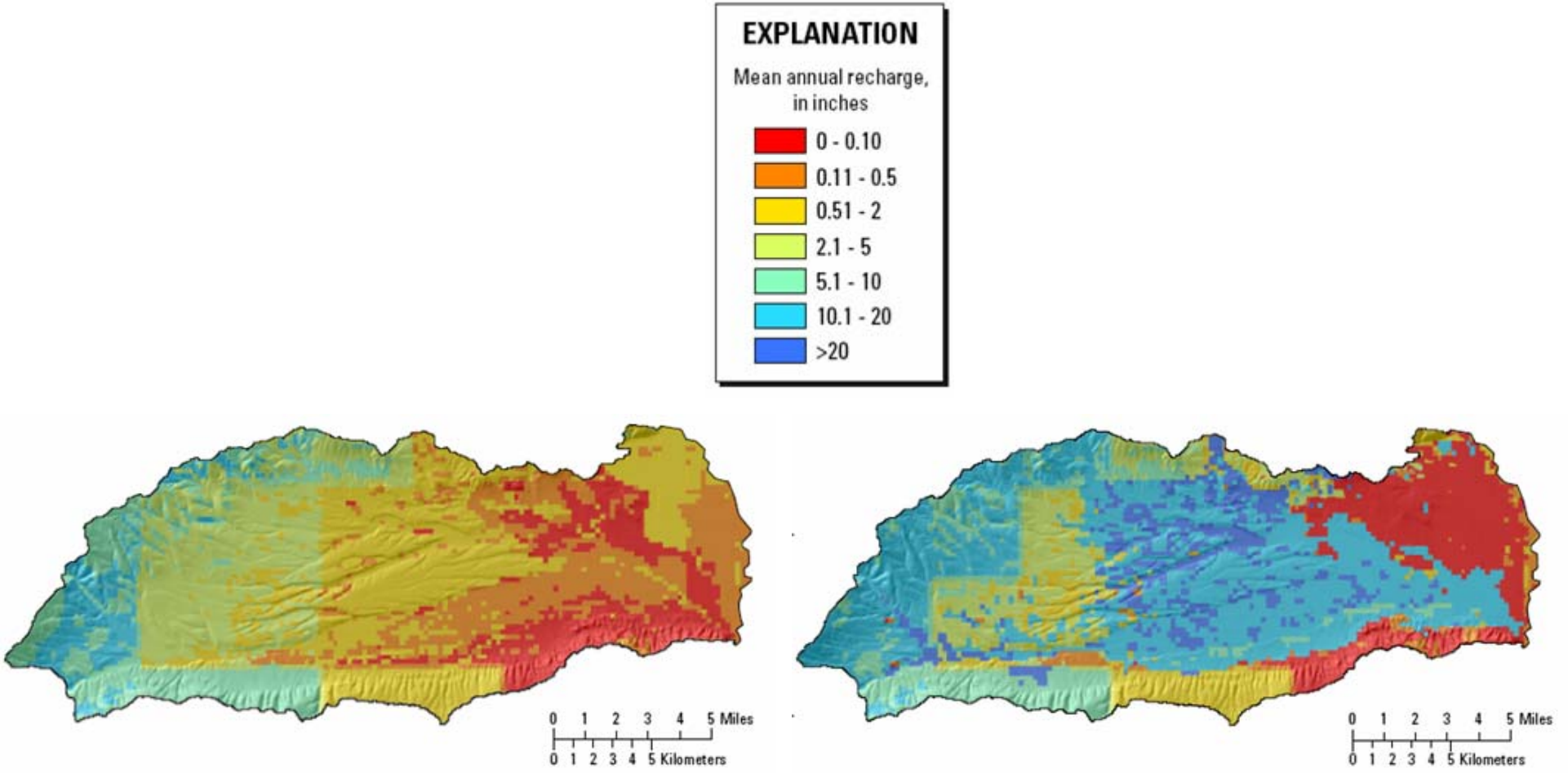


**PREDEVELOPMENT CONDITIONS**

**CURRENT CONDITIONS**

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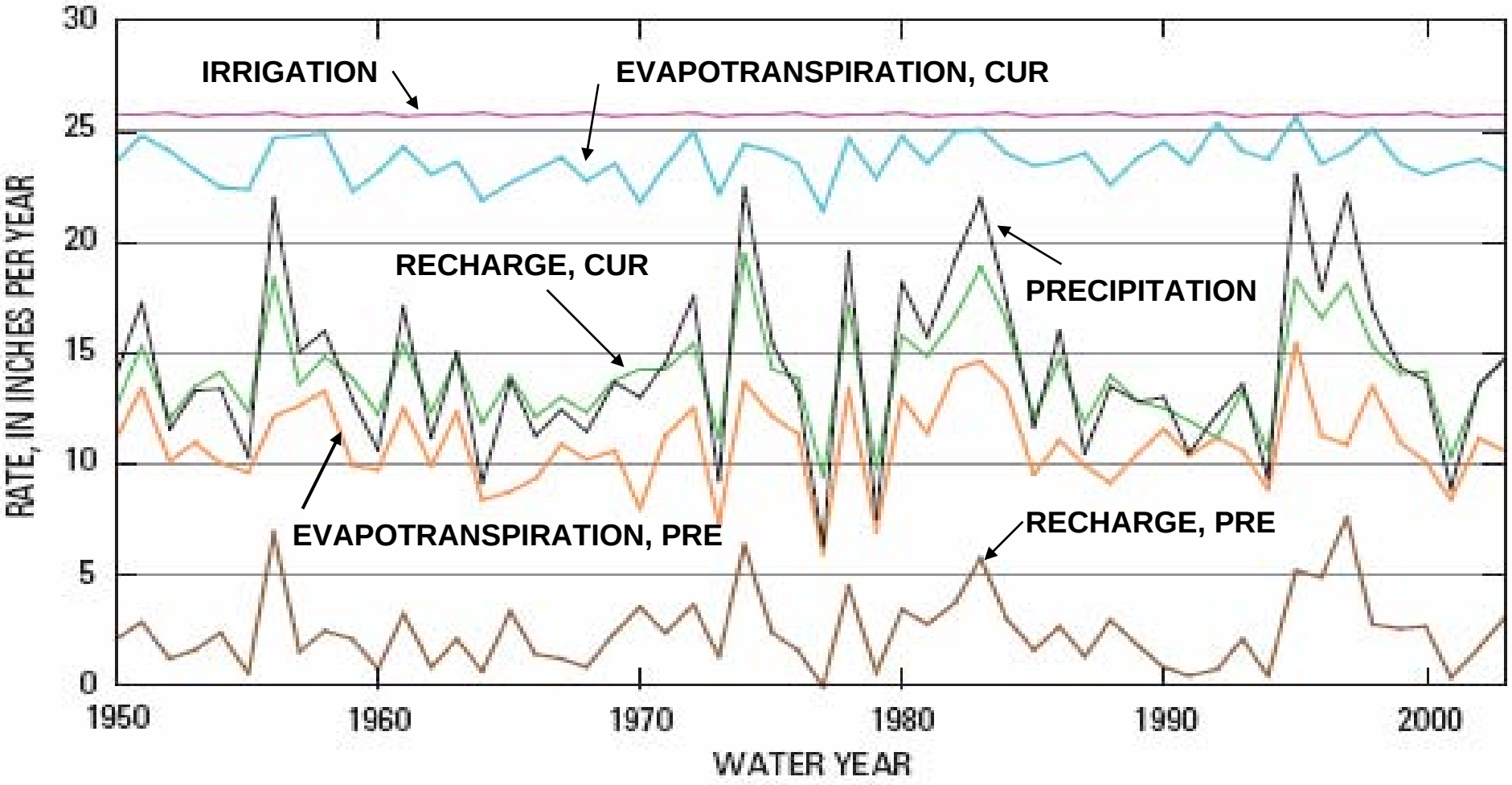
# ANNUAL WATER BUDGET FOR A SEMIARID MODELED AREA

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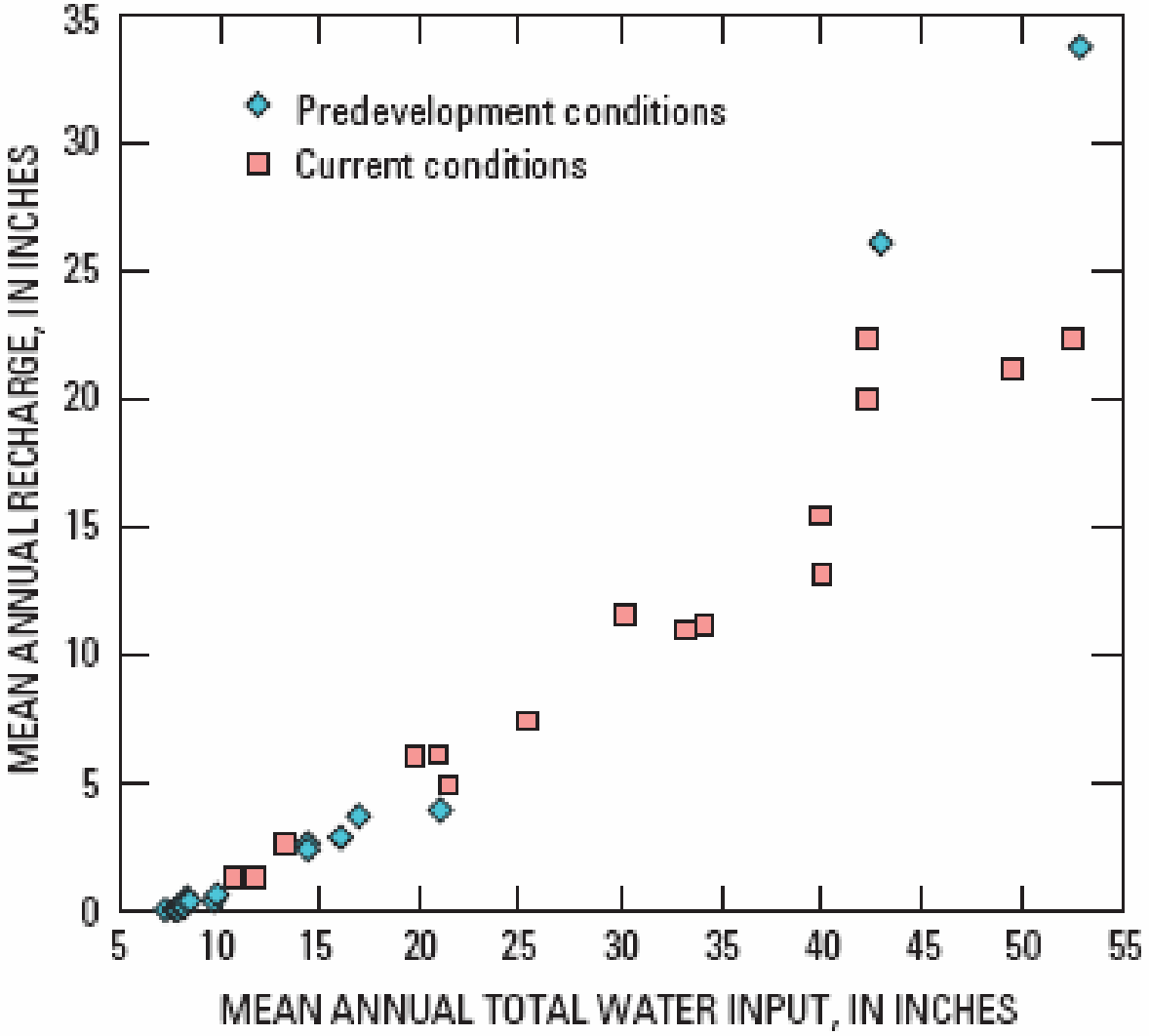


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# COMPARISON WITH OTHER WATER BUDGET ITEMS

| | |
|---|---|
| RECHARGE | |
| PREDEVELOPMENT | 5,450 $ft^3/s$ |
| CURRENT | 7,130 $ft^3/s$ |
| PRECIPITATION | 12,000 $ft^3/s$ |
| STREAMFLOW | |
| UNREGULATED | 5,600 $ft^3/s$ |
| REGULATED | 3,600 $ft^3/s$ |
| EVAPOTRANSPIRATION | |
| UNREGULATED | 6,400 $ft^3/s$ |
| REGULATED | 8,400 $ft^3/s$ |
| PUMPAGE | 430 $ft^3/s$ |

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# GROUND WATER – SURFACE WATER INTERCHANGES

- Measured streamflow at selected locations
- Monitored surface-water and ground-water levels and temperature at 4 sites and added an additional area
- Developed method to thermally-profile reaches and profiled selected reaches
- Documented method in report
- Gathering other historical and current information
- Made mini-piezometer measurements

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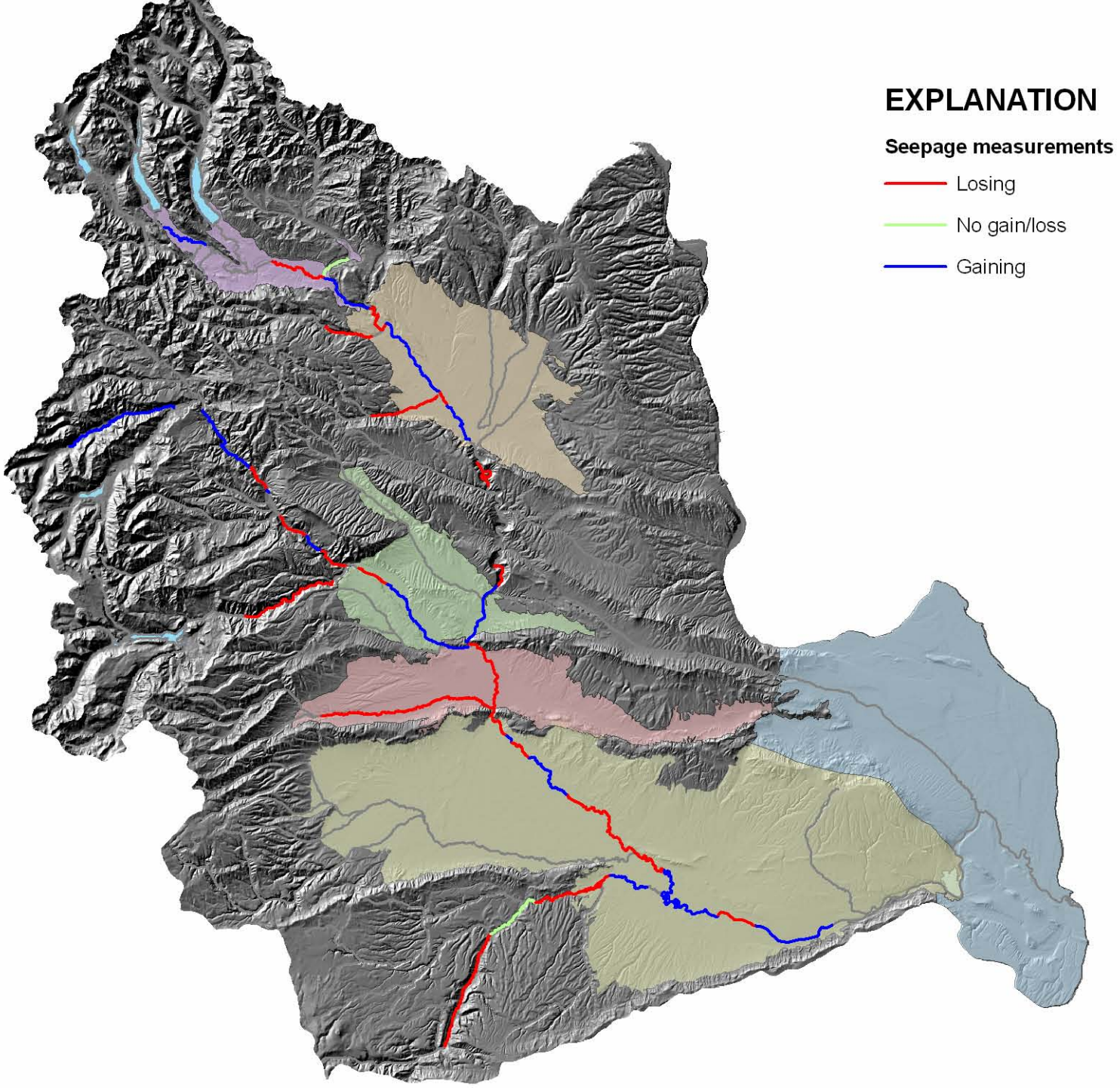
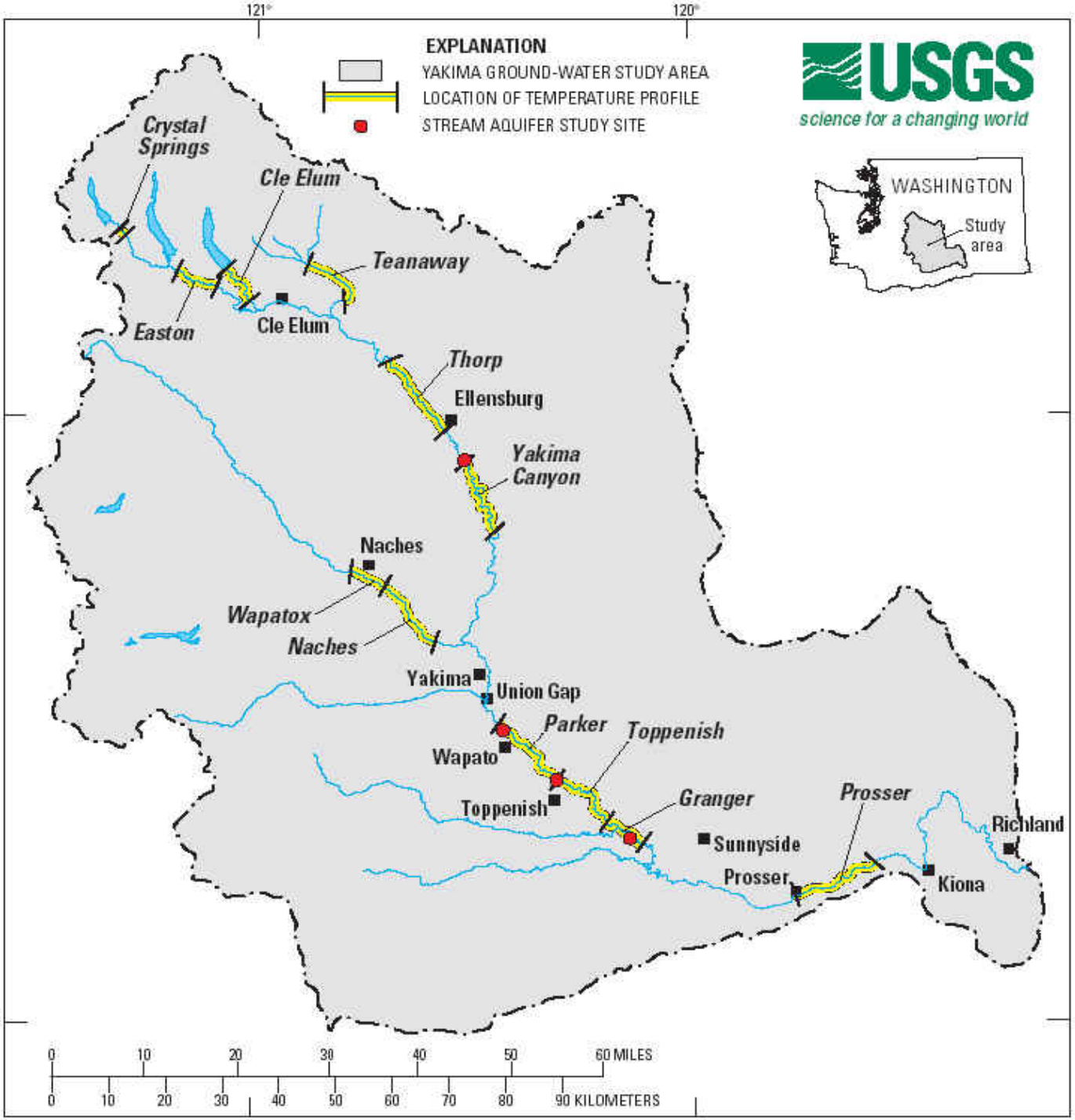

EXPLANATION
Seepage measurements
Losing
No gain/loss
Gaining


121°
120°
47°
46°
EXPLANATION
YAKIMA GROUND-WATER STUDY AREA
LOCATION OF TEMPERATURE PROFILE
STREAM AQUIFER STUDY SITE
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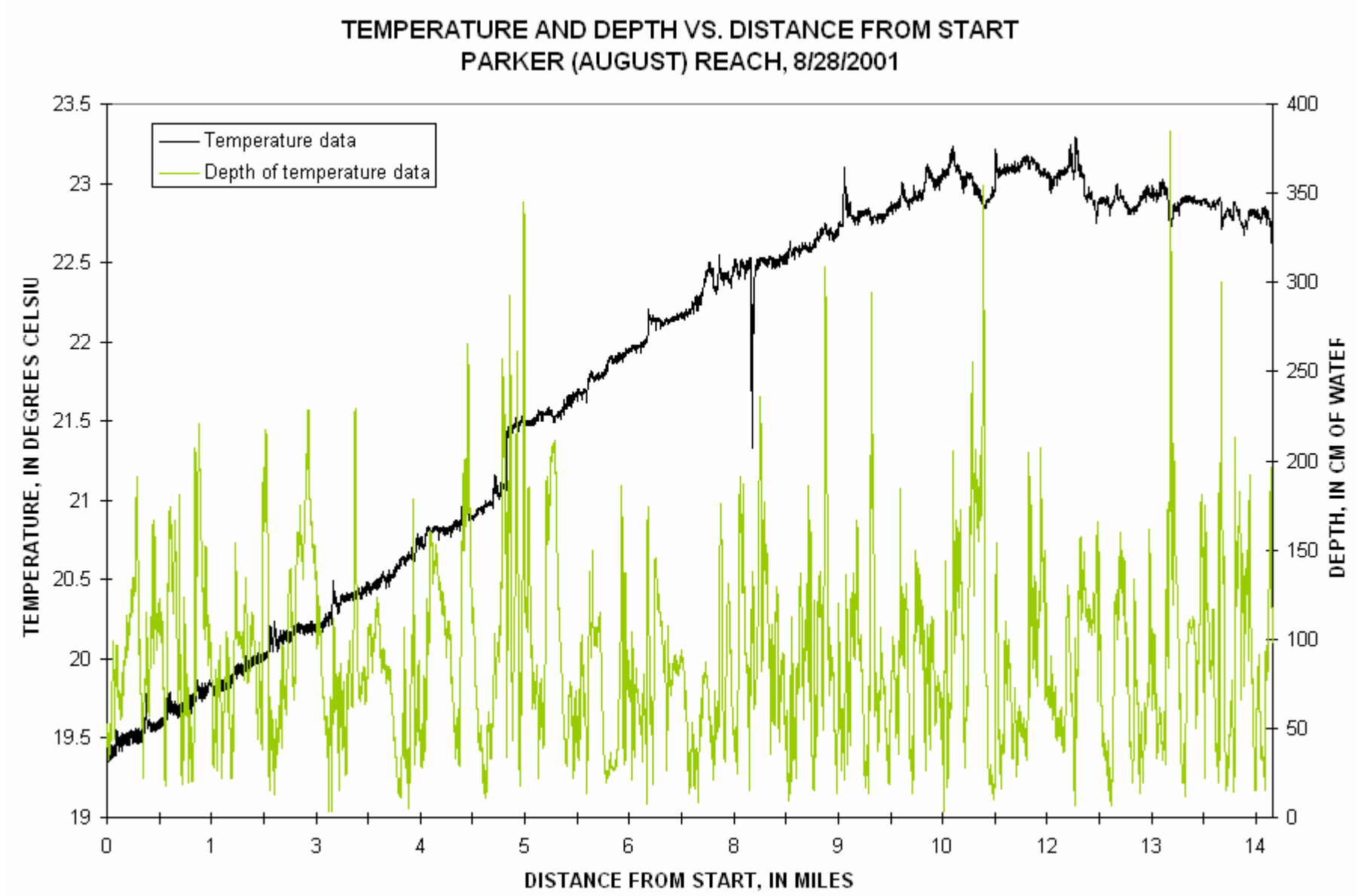
WASHINGTON
Study area
Crystal Springs
Cle Elum
Teanaway
Easton
Cle Elum
Thorp
Ellensburg
Yakima Canyon
Naches
Wapatox
Naches
Yakima
Union Gap
Parker
Toppenish
Wapato
Toppenish
Granger
Prosser
Richland
Sunnyside
Prosser
Kiona
0 10 20 30 40 50 60 MILES
0 10 20 30 40 50 60 70 80 90 KILOMETERS

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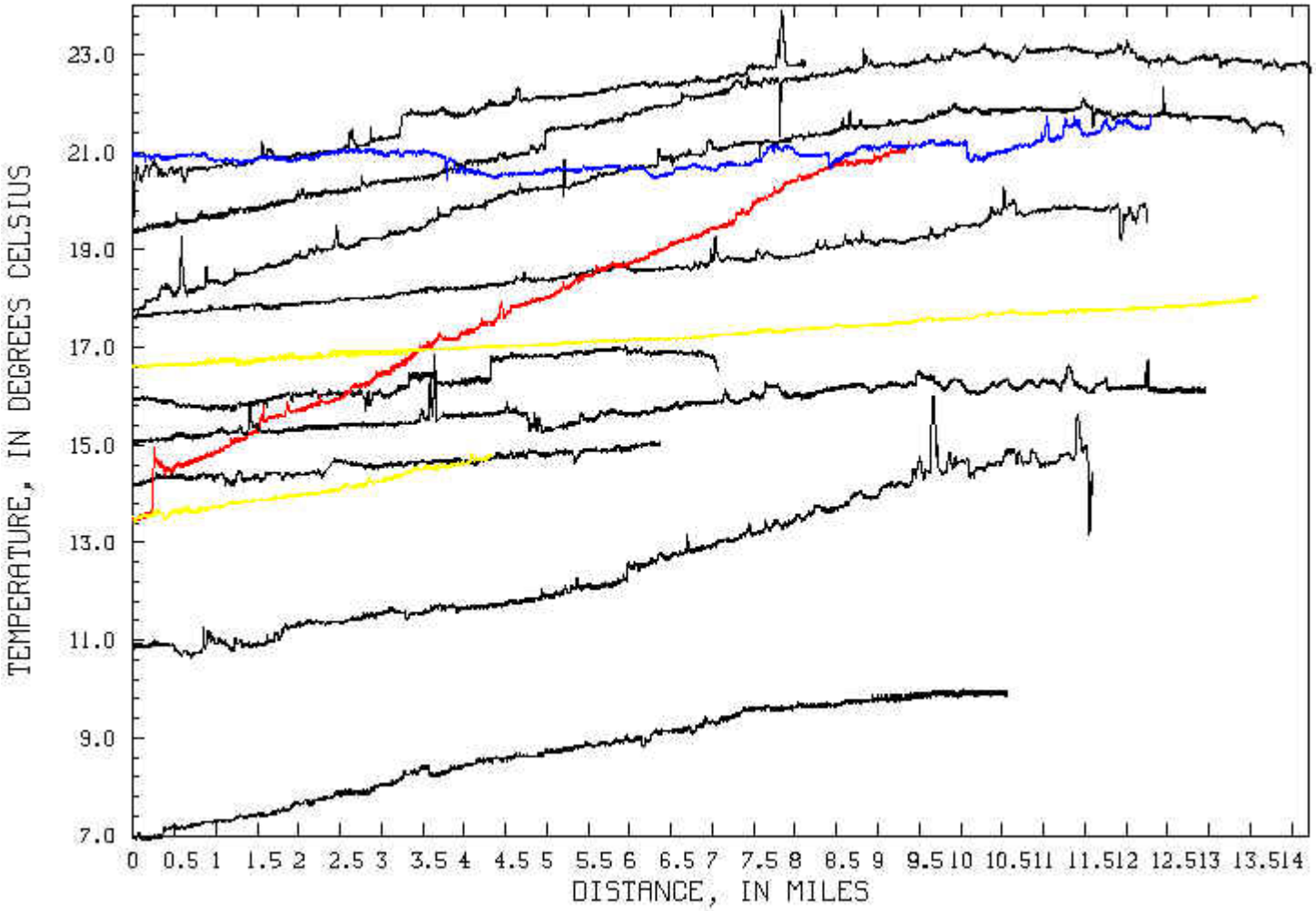
# Examples of thermal profiles along selected reaches

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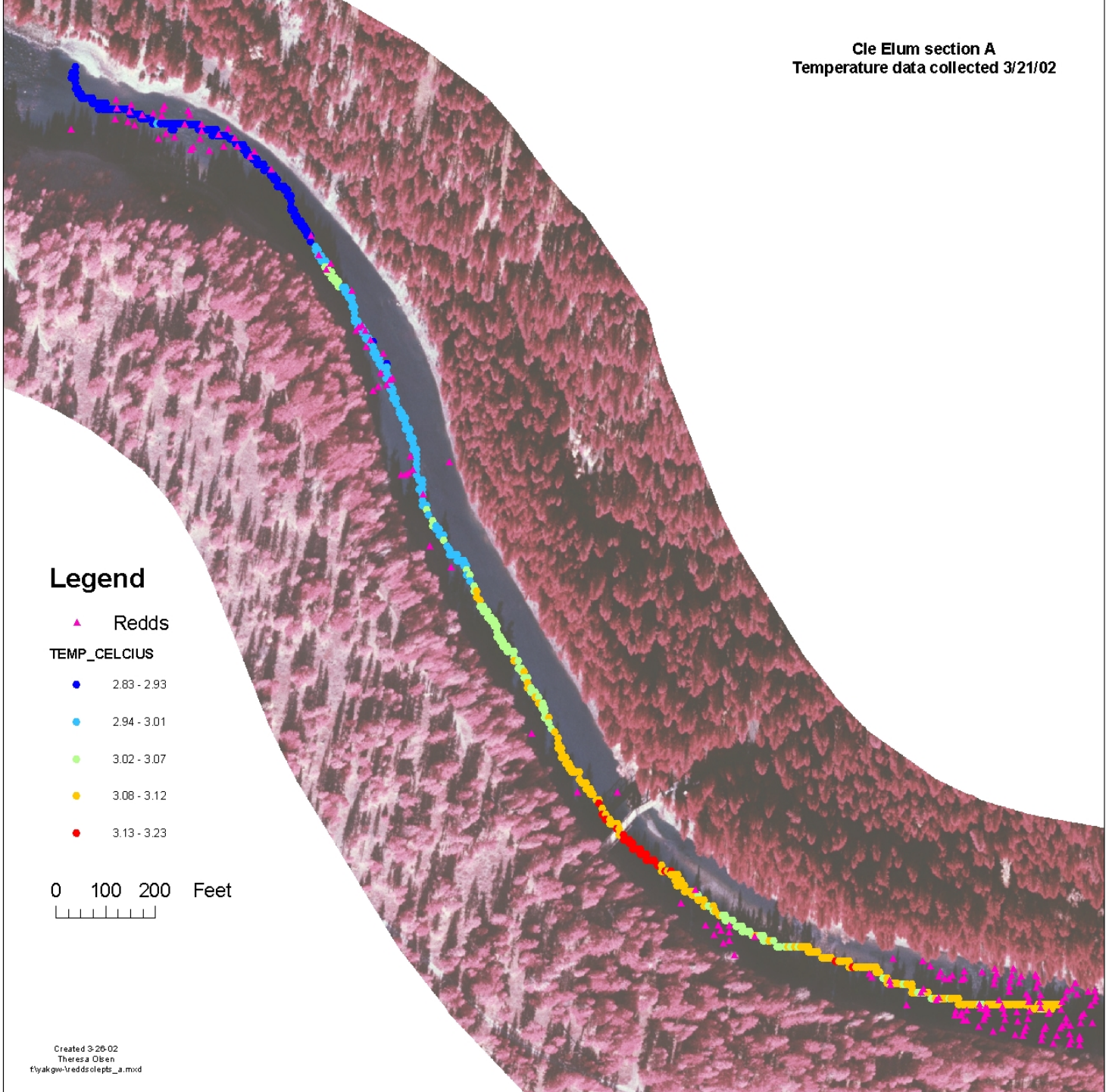


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# Monitoring of water-levels and temperature in ground water

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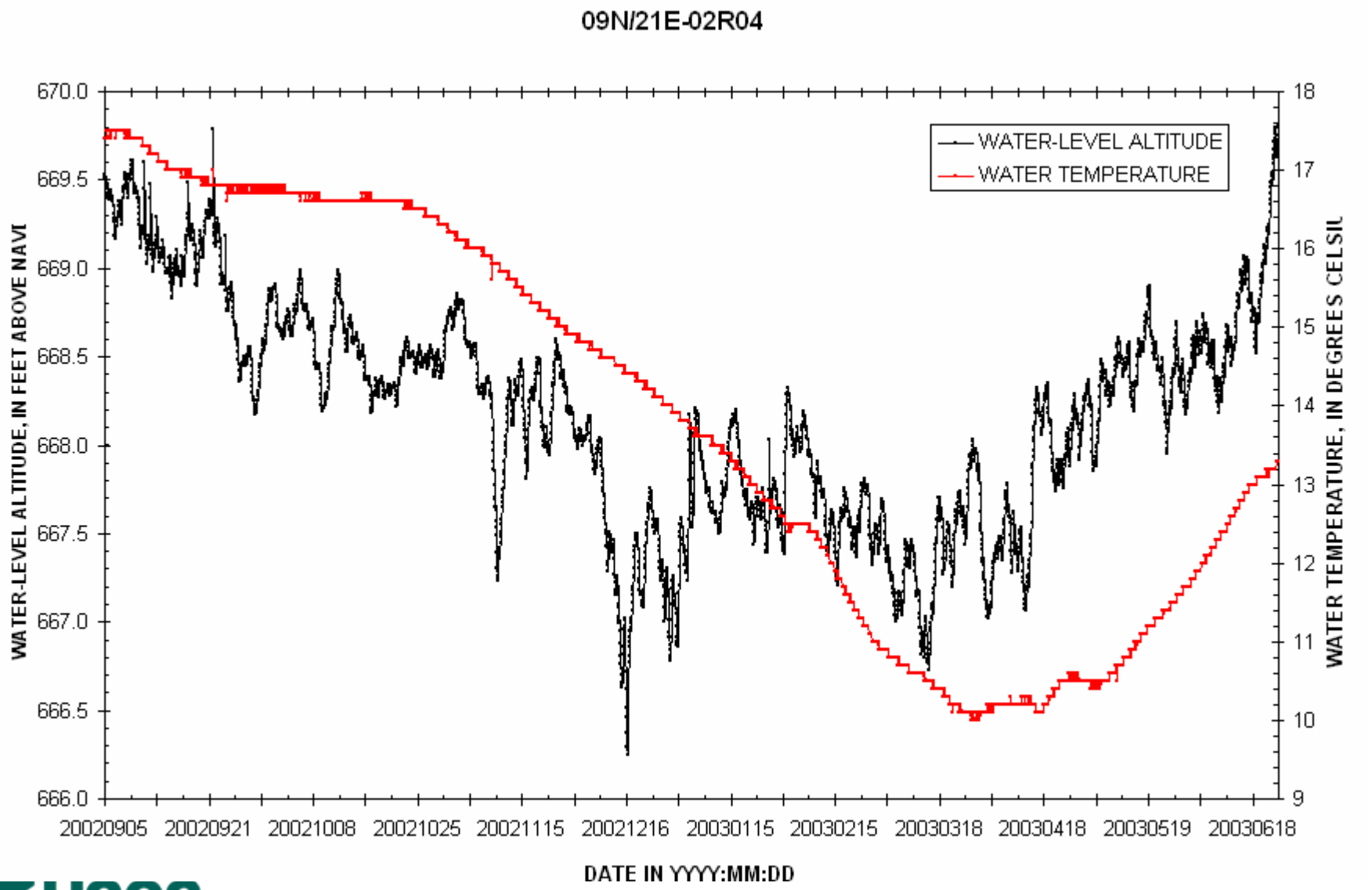


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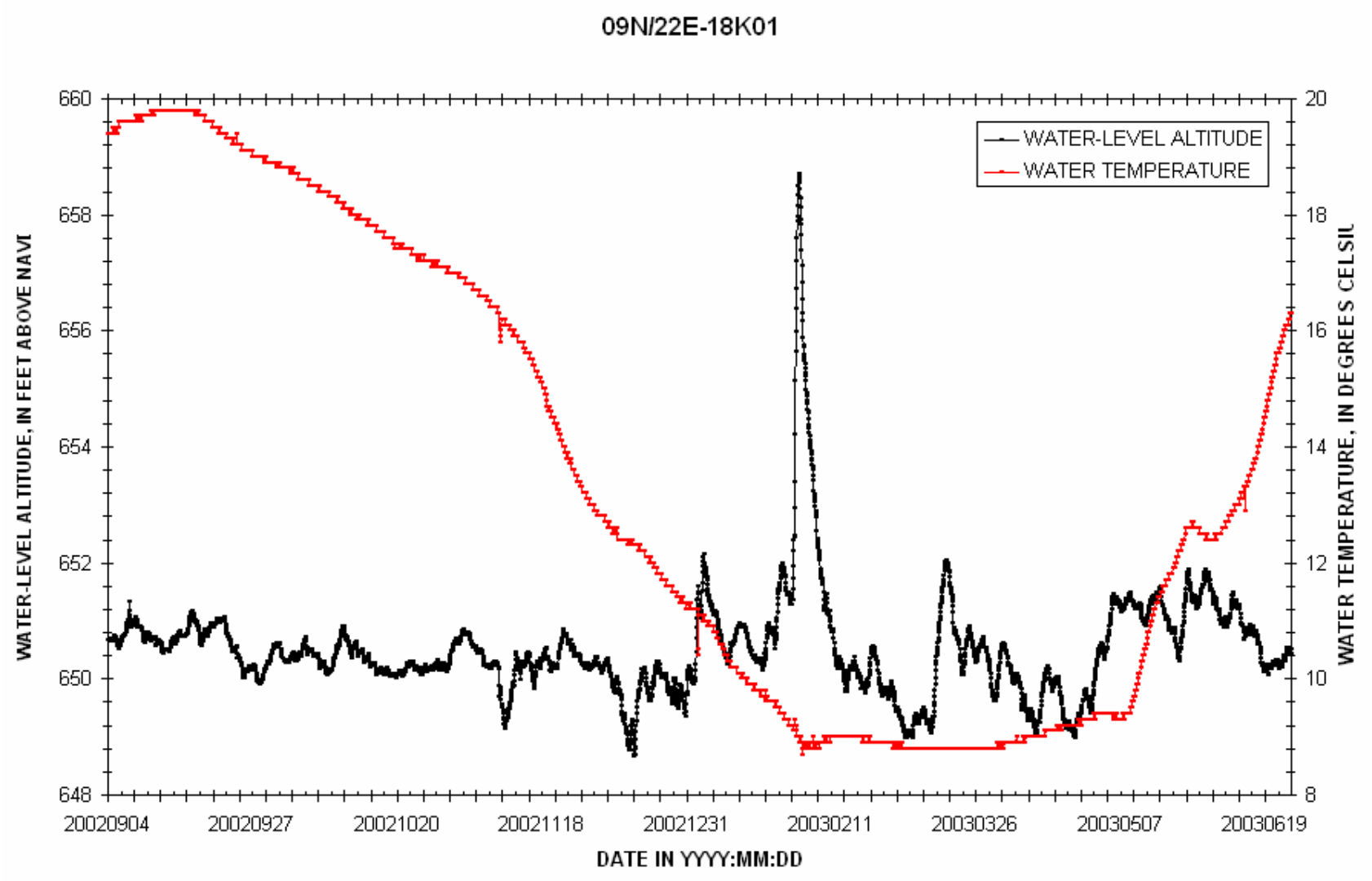


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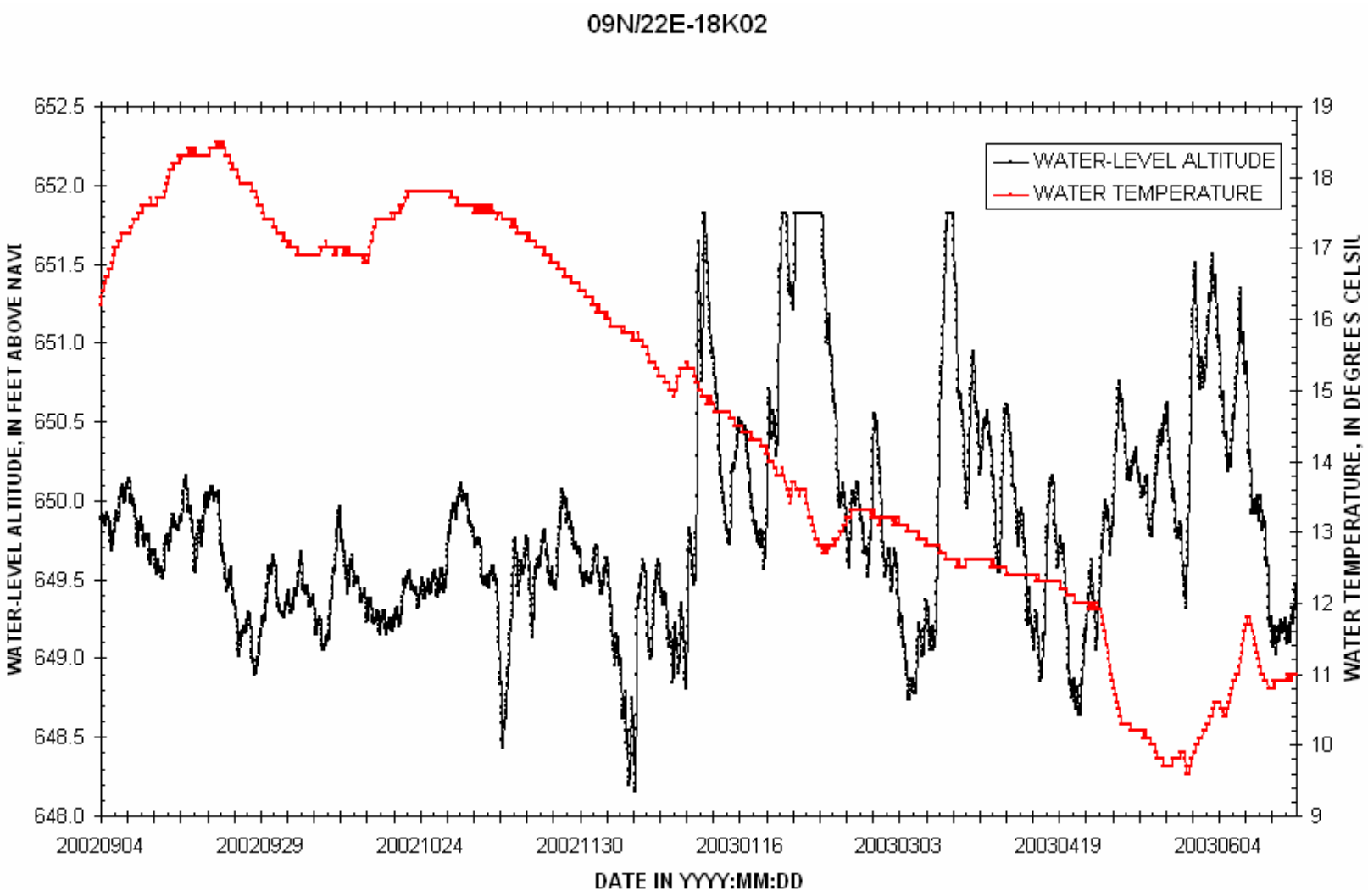


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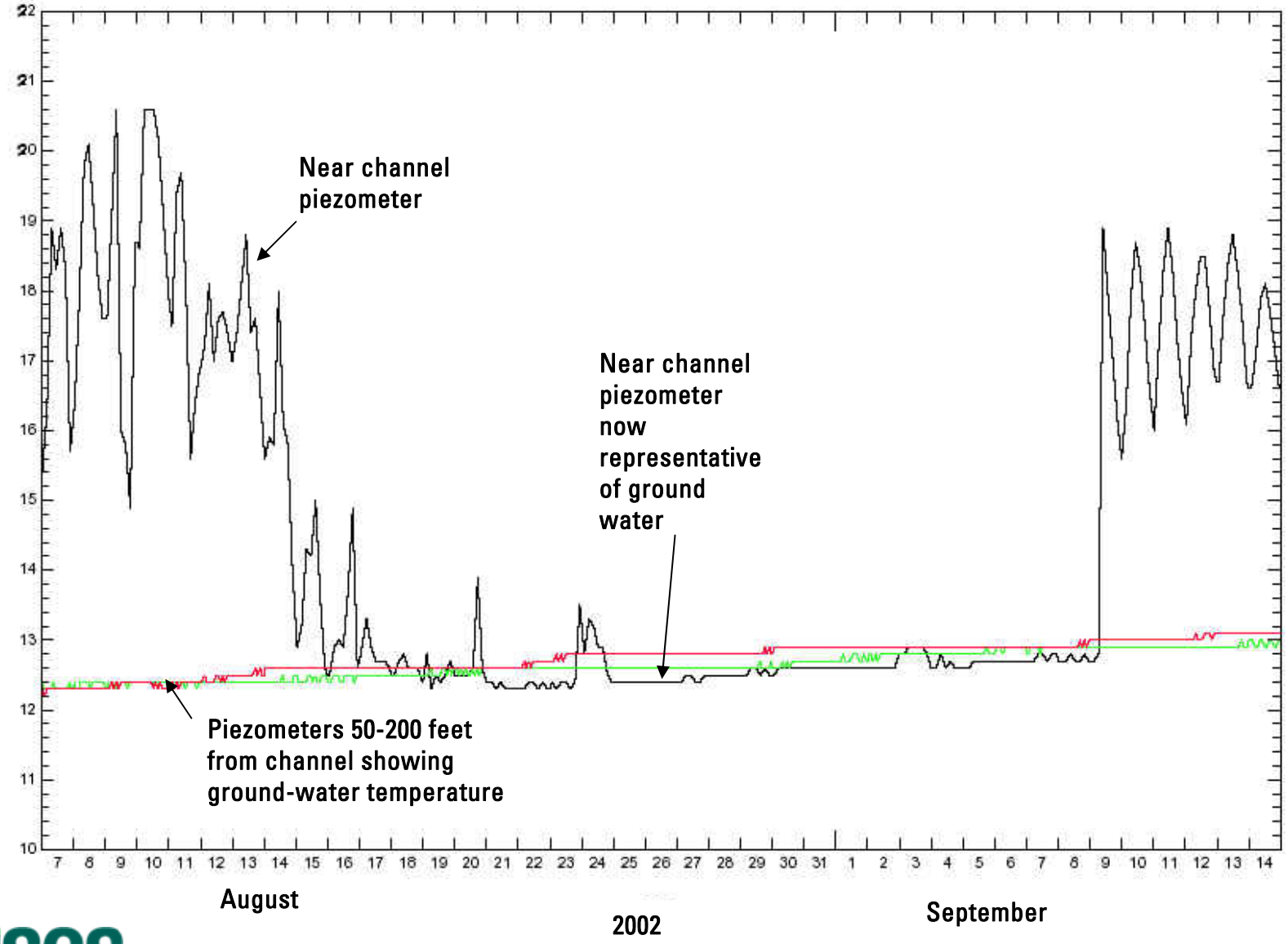
# Ground-water temperature in 3 piezometers—side channel

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# GROUND-WATER LEVELS and FLOW SYSTEM

- Input some 18,000 water-levels in the national database (GWSI)
- Identified wells tapping flowing artesian zones
- Collected samples for isotope and noble gas
- Analyzed hydrographs
- Constructed preliminary map of water-levels for surficial basin-fill deposits
- Constructing depth-to-water table map for complete aquifer system

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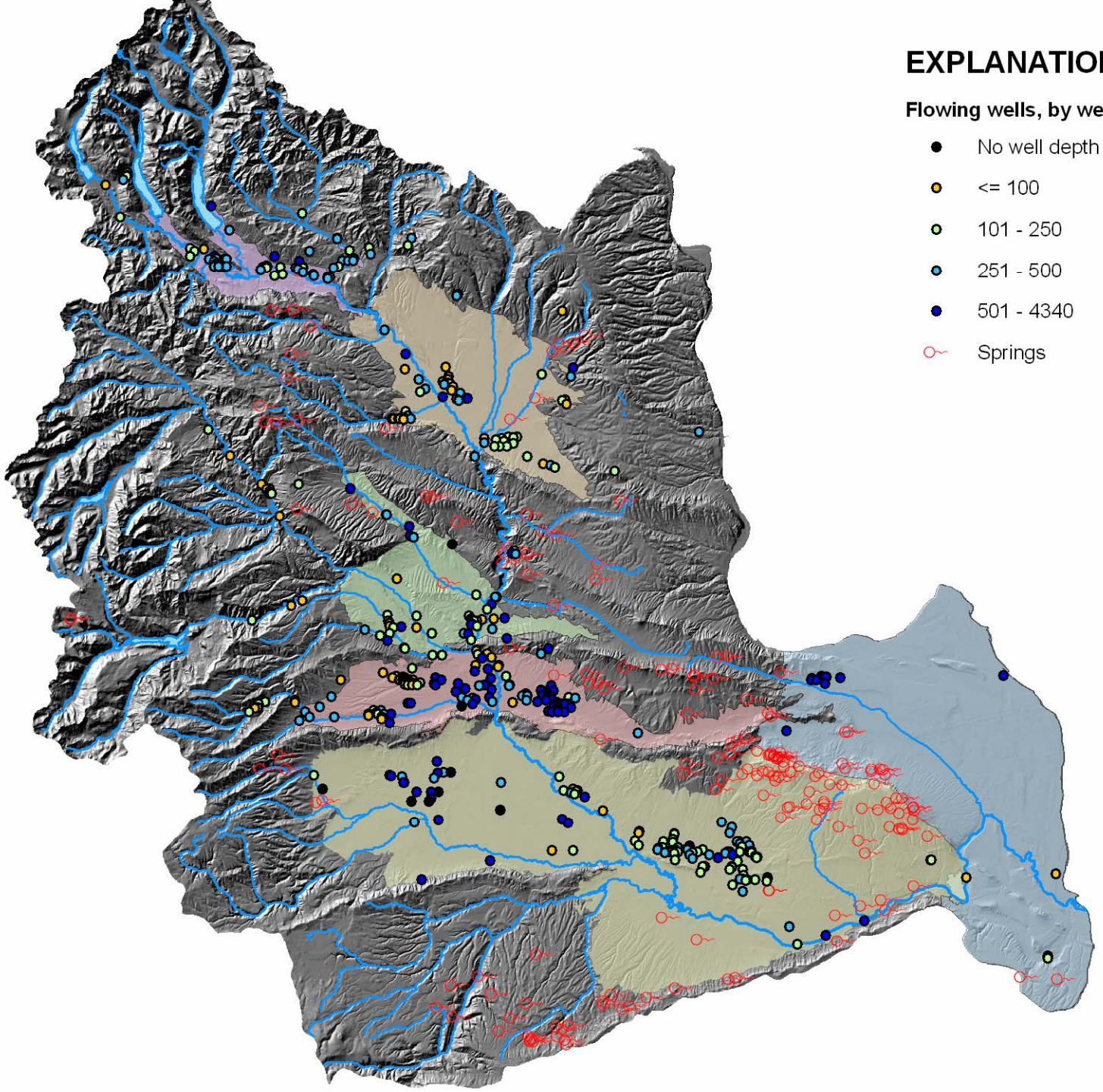
EXPLANATION
Flowing wells, by well depth (feet)
No well depth info
<= 100
101 - 250
251 - 500
501 - 4340
Springs

# Ground-Water Level Hydrographs

- Status: depth to water
- Trends: stable, slight declines, moderate declines, and large declines

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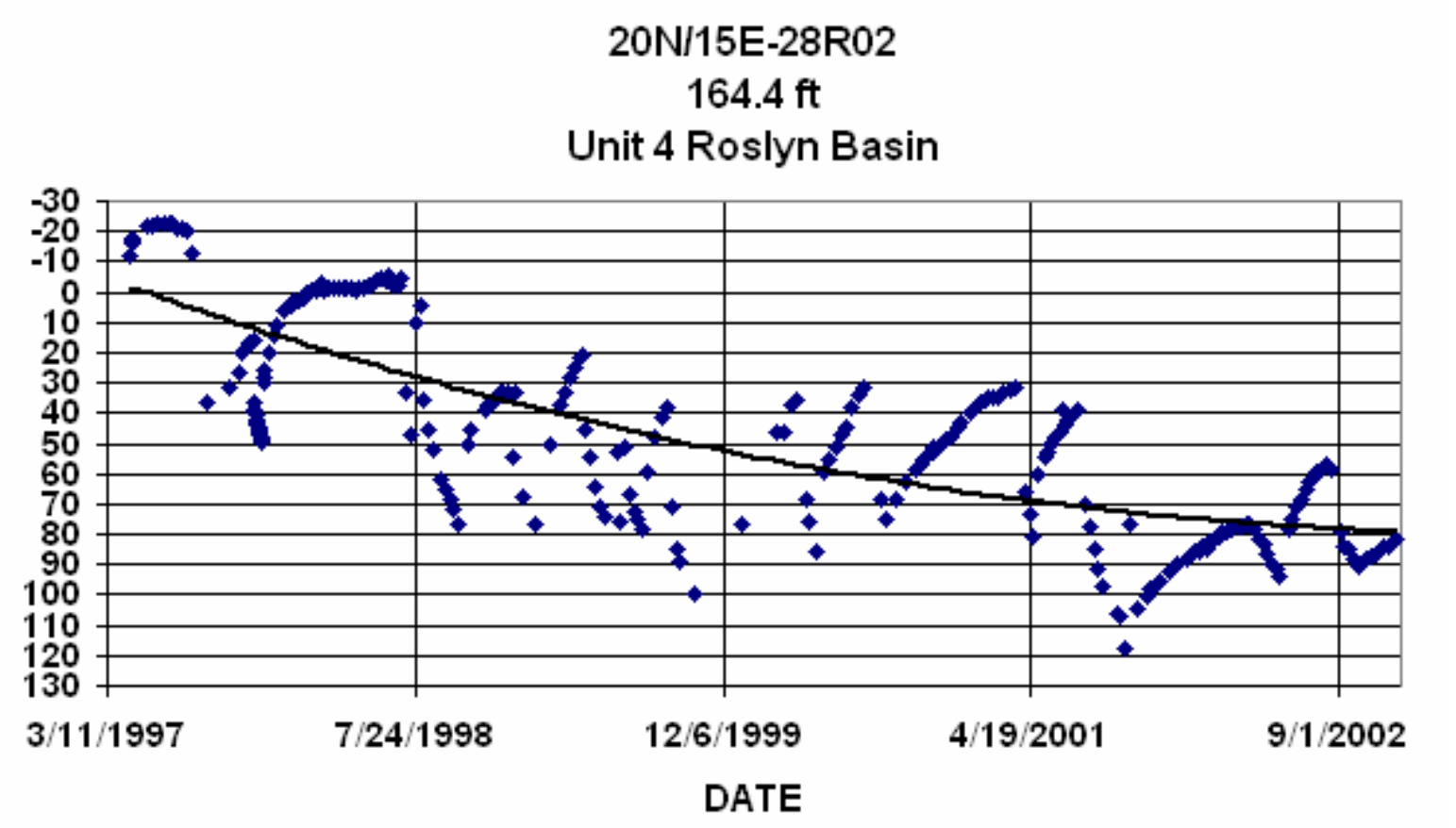


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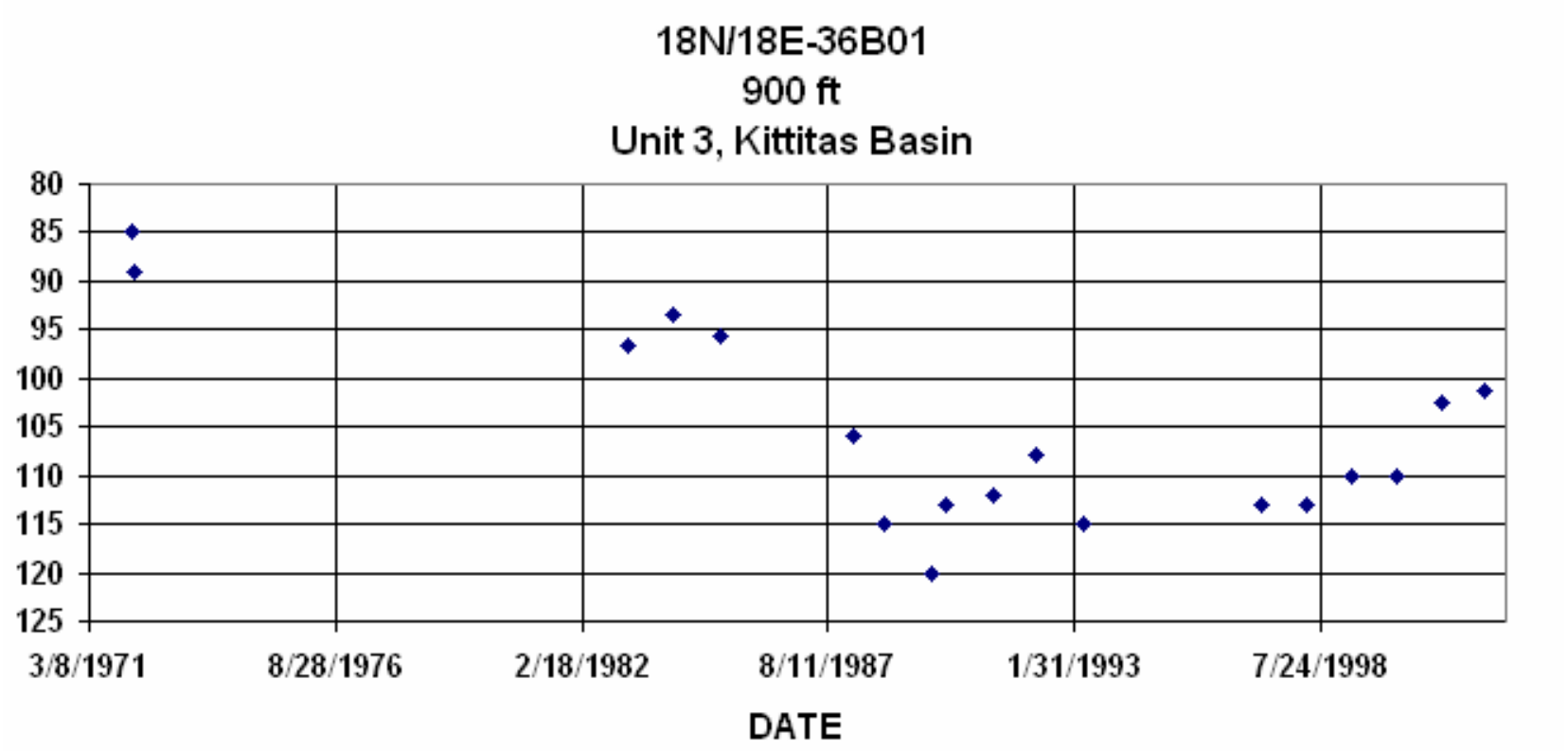


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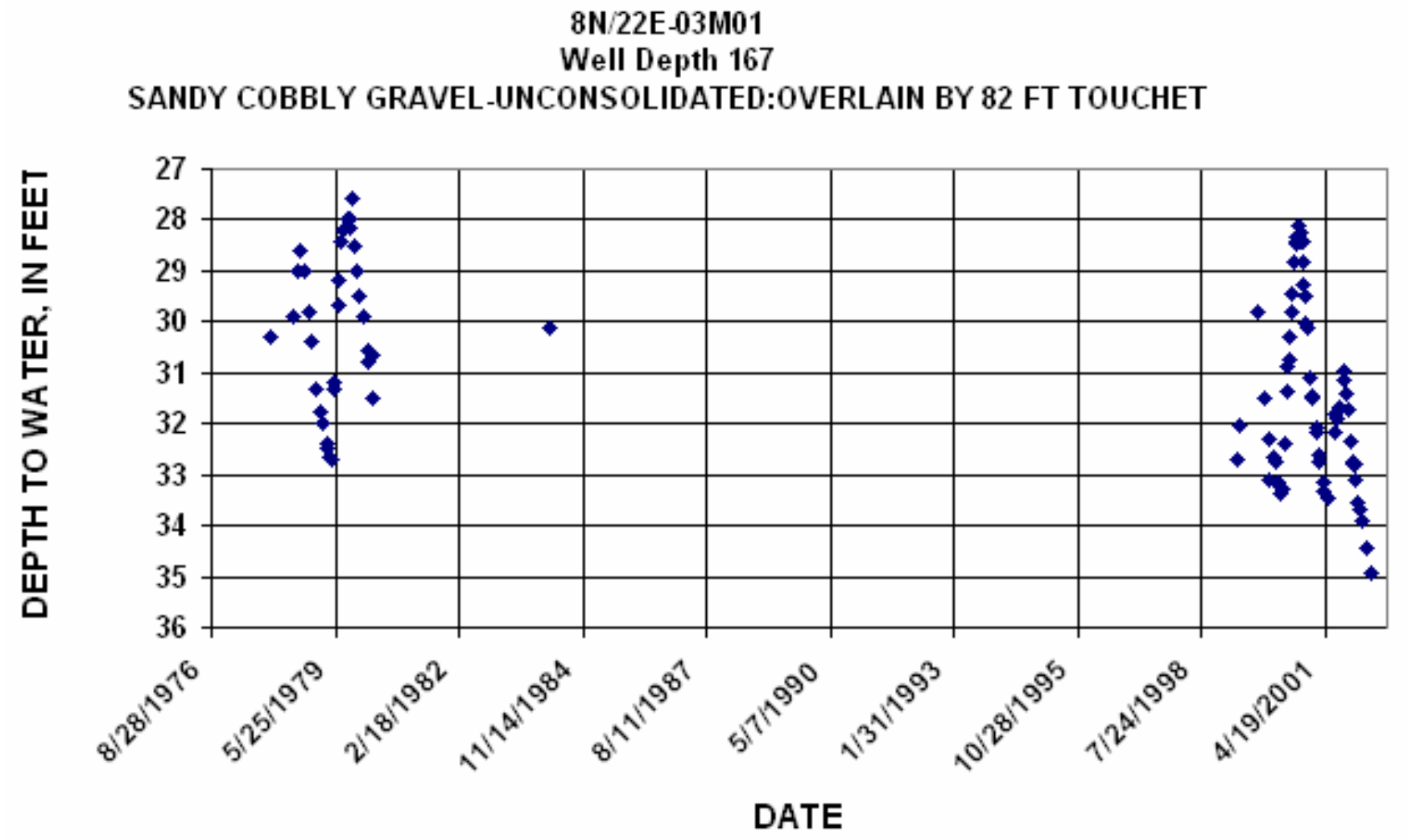


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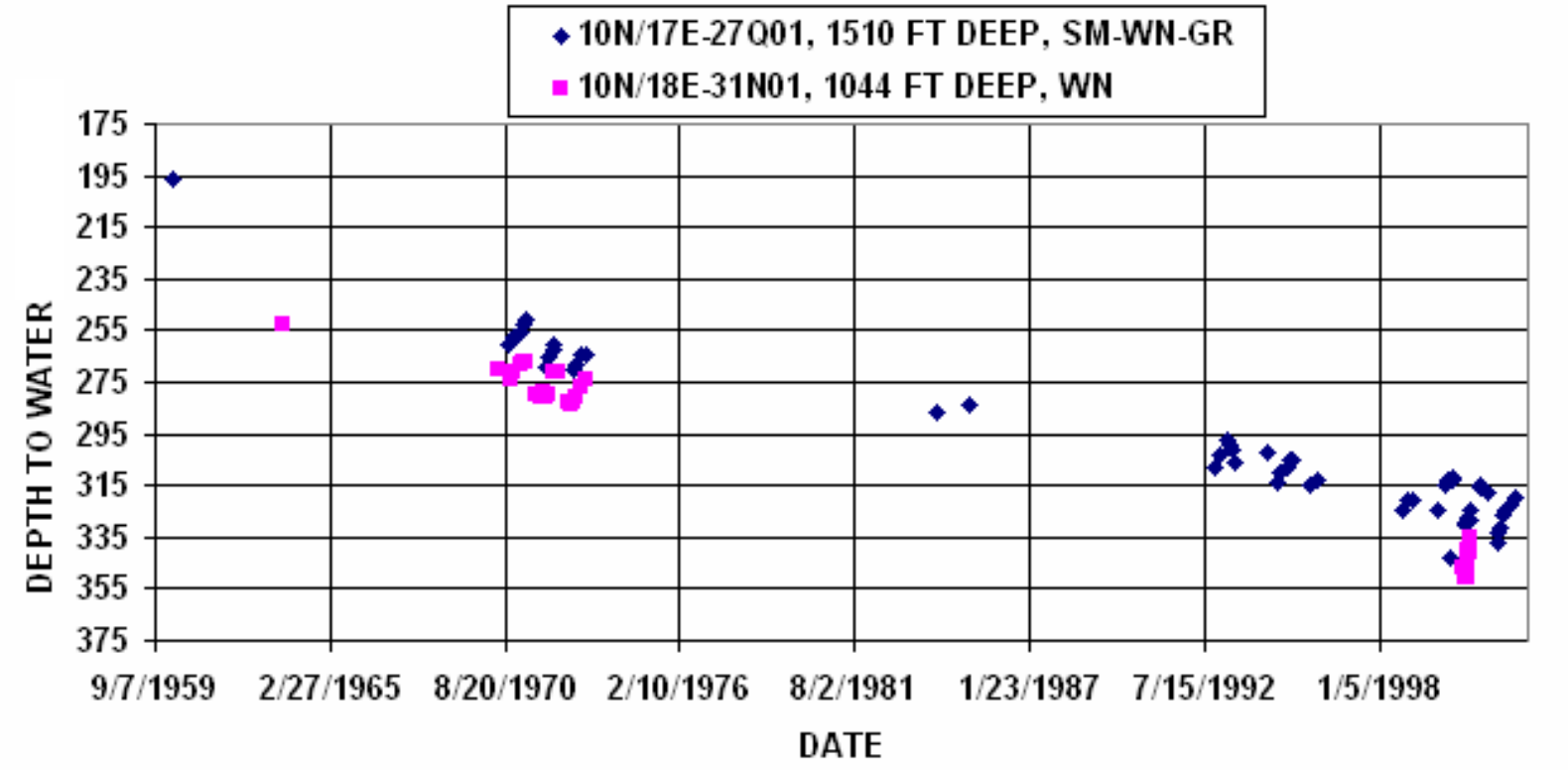


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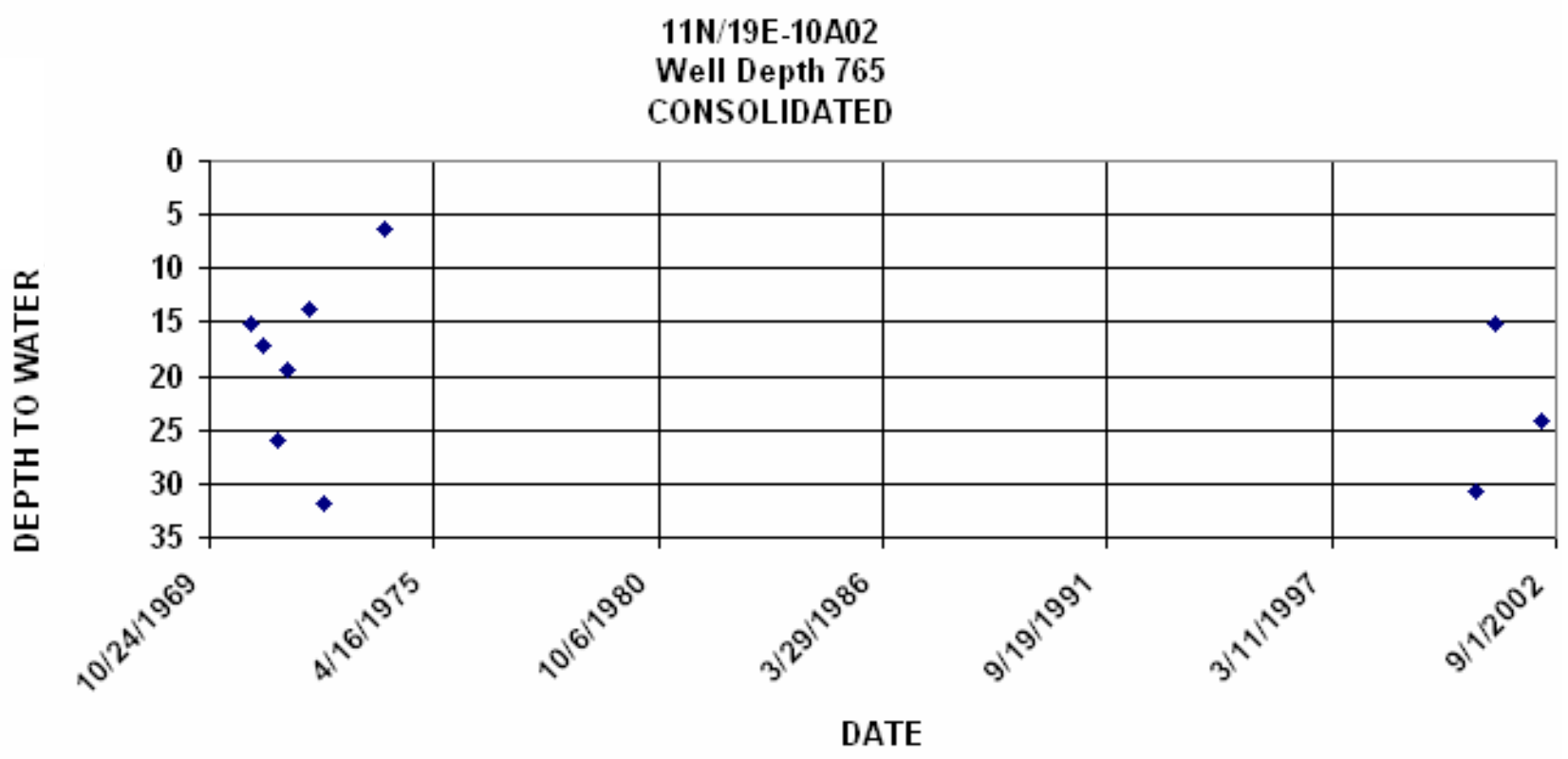


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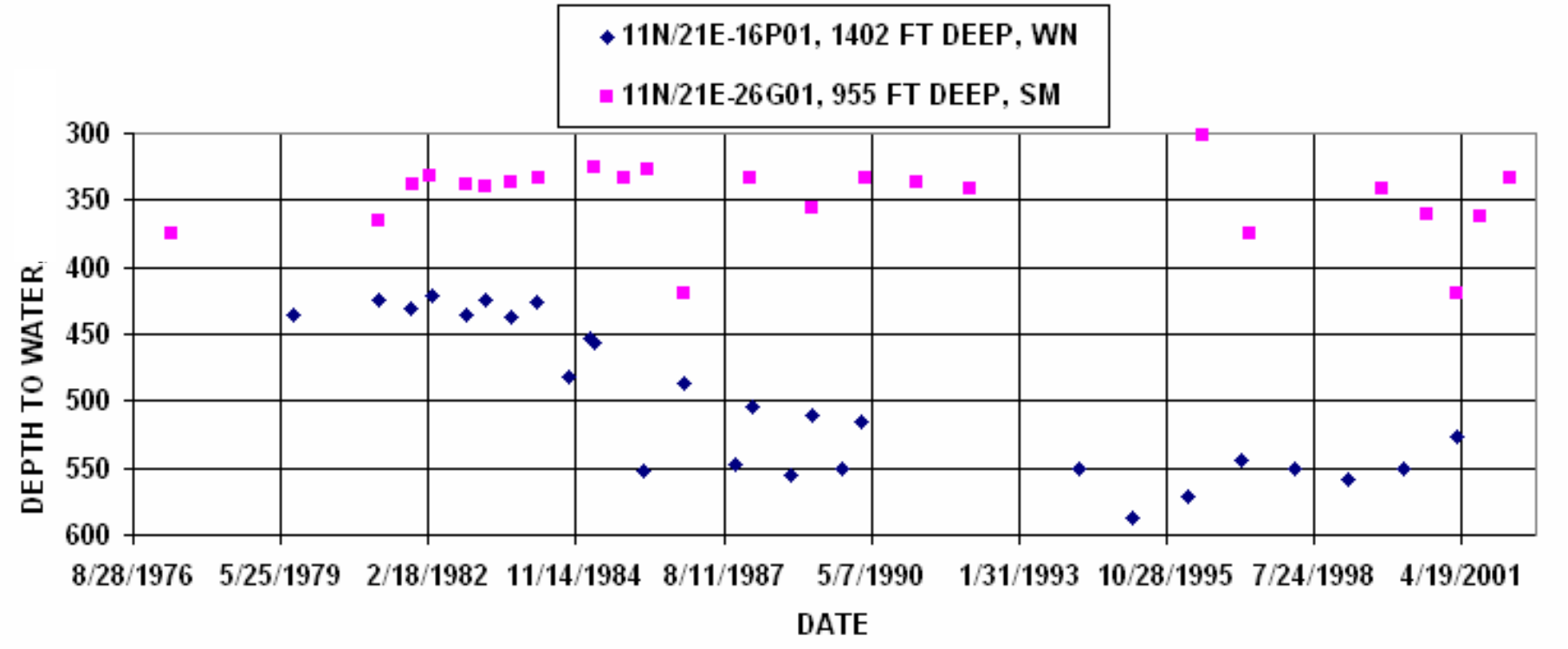


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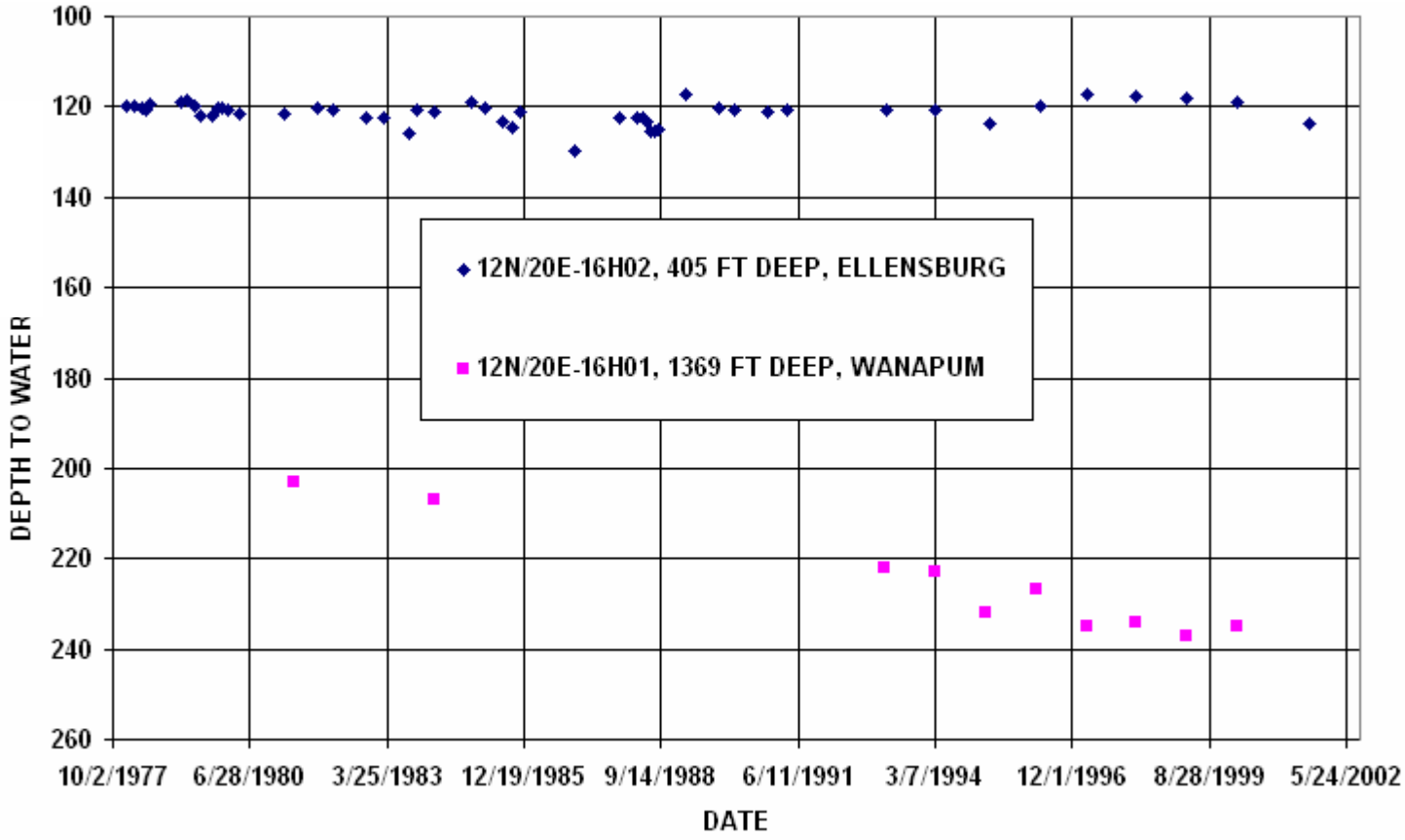


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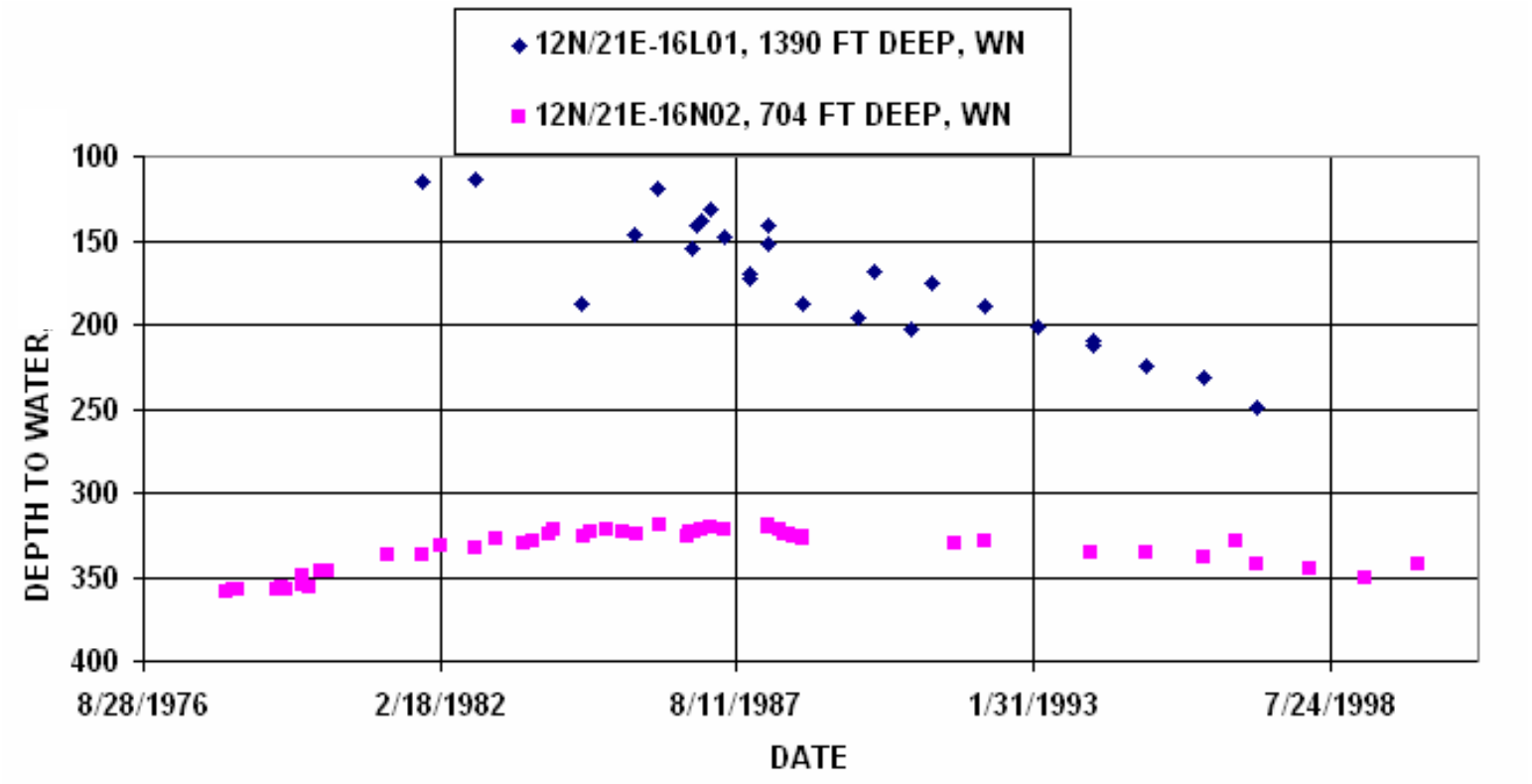
# BASALT WATER LEVELS WITH DEPTH

## Water levels indicate upward flow

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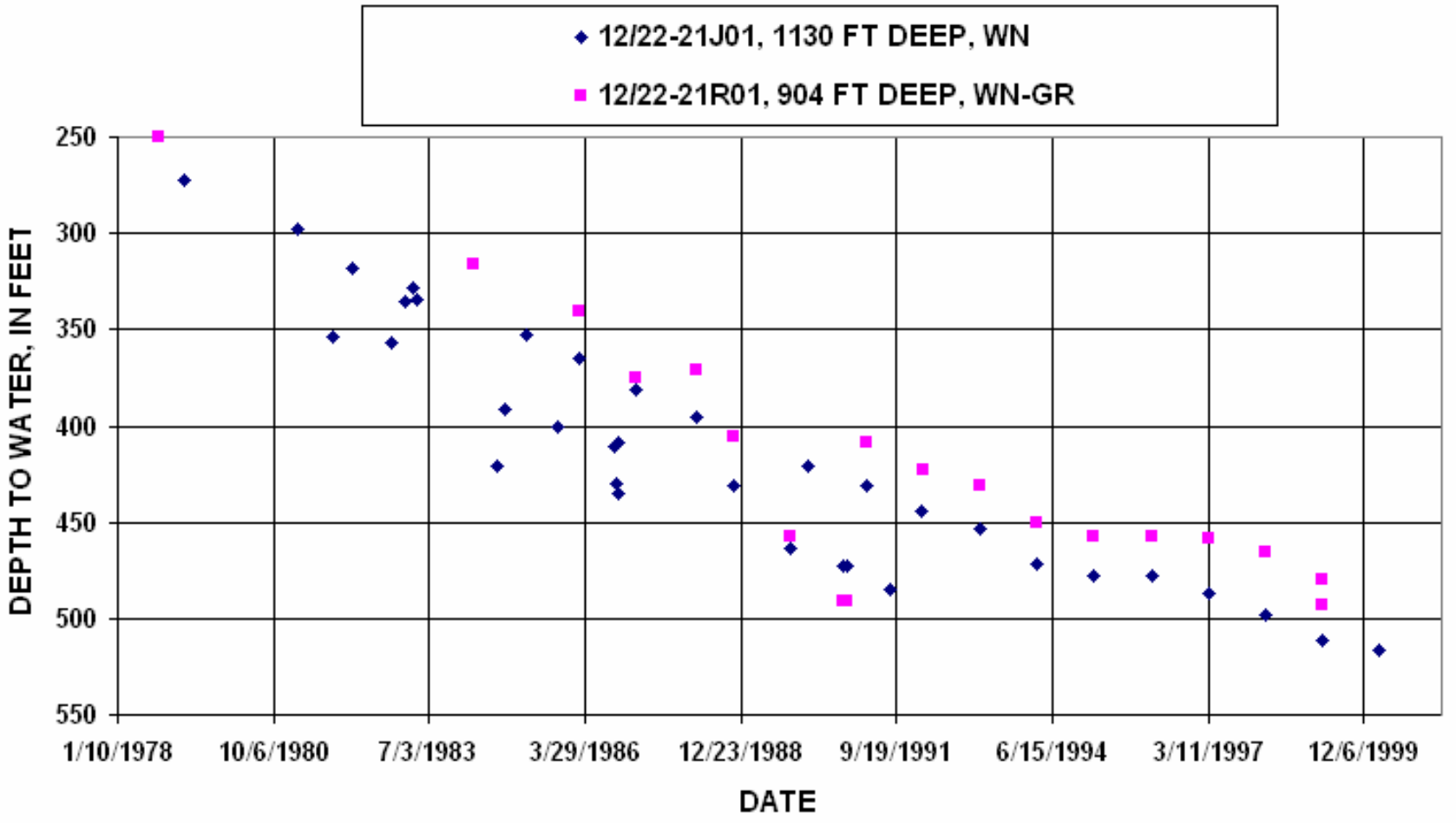


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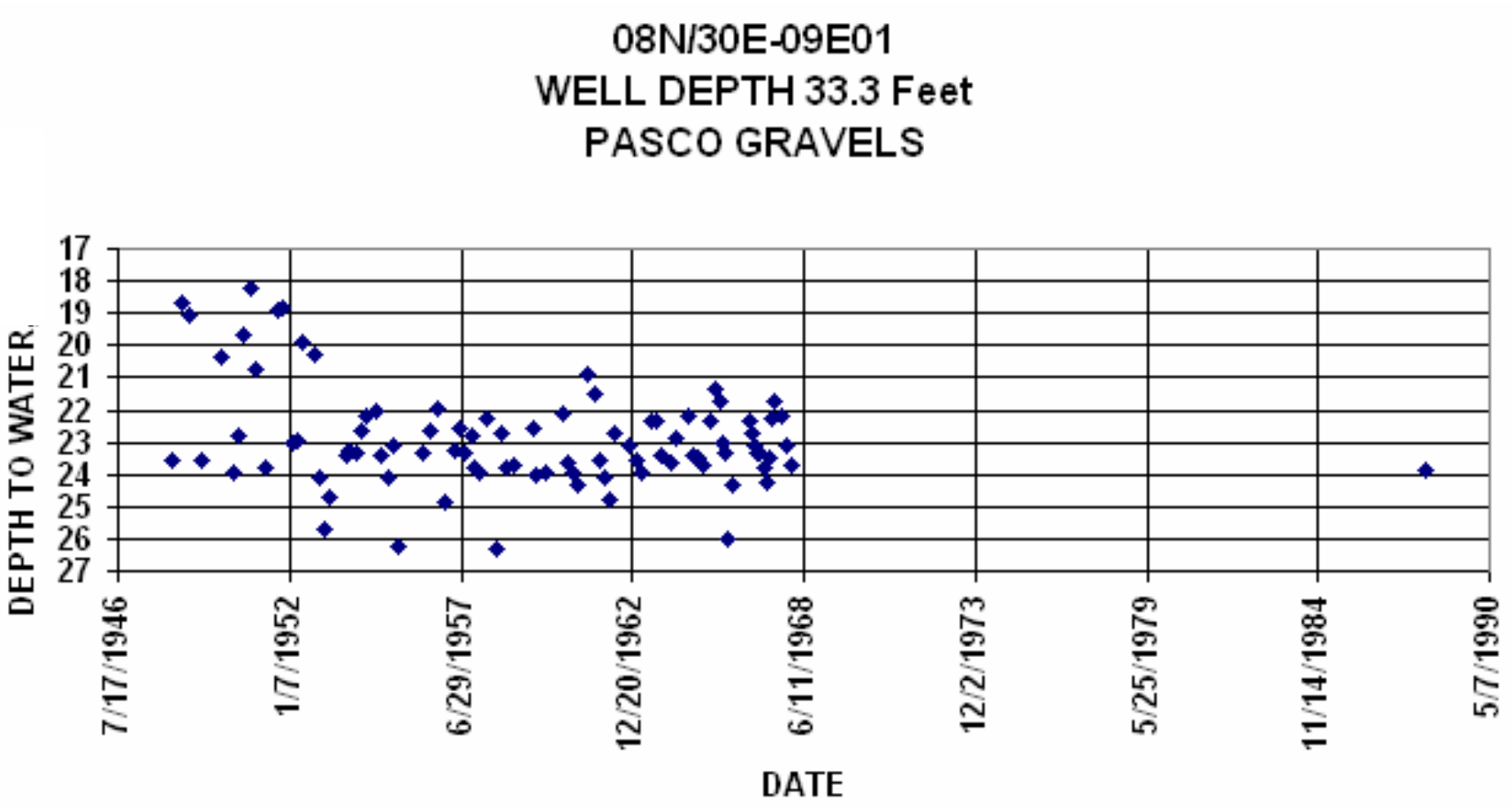


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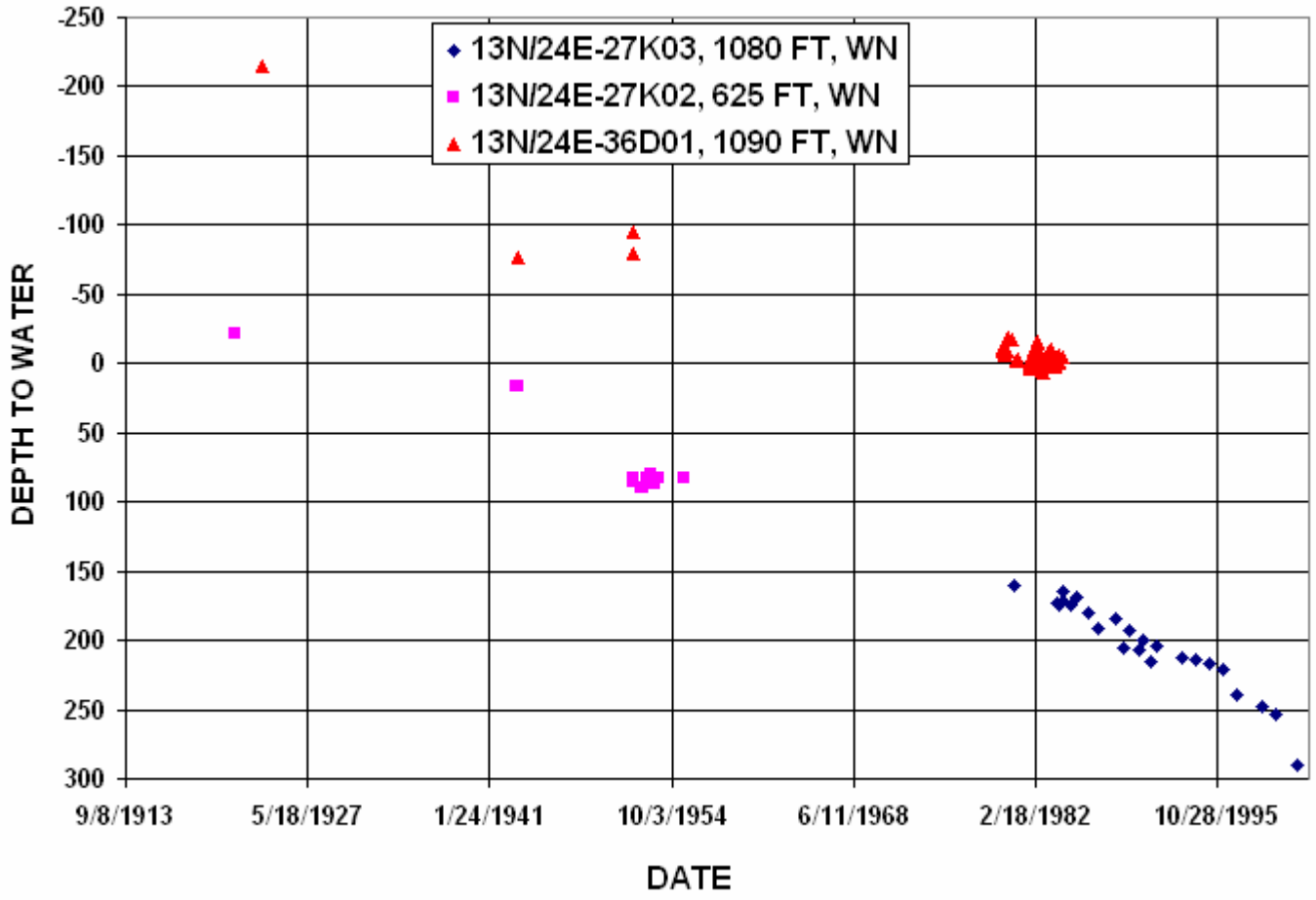


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# HYDRAULIC CHARACTERISTICS

- Developed spatial coverage of well yields
- Analyzed specific capacity data to estimate hydraulic conductivity
- Compiled previous estimates of hydraulic characteristics
- Analyzed well test data to estimate hydraulic conductivity

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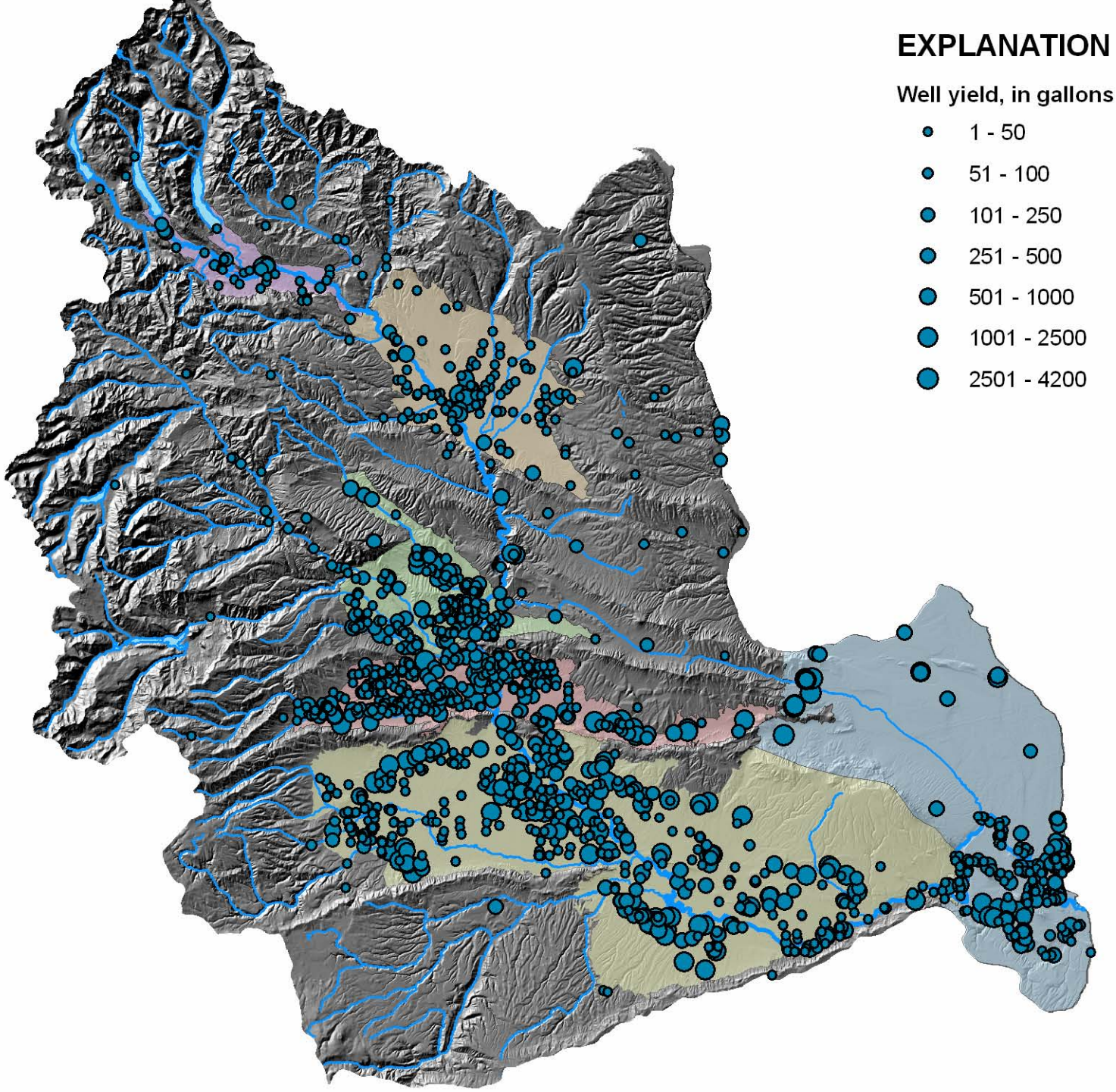
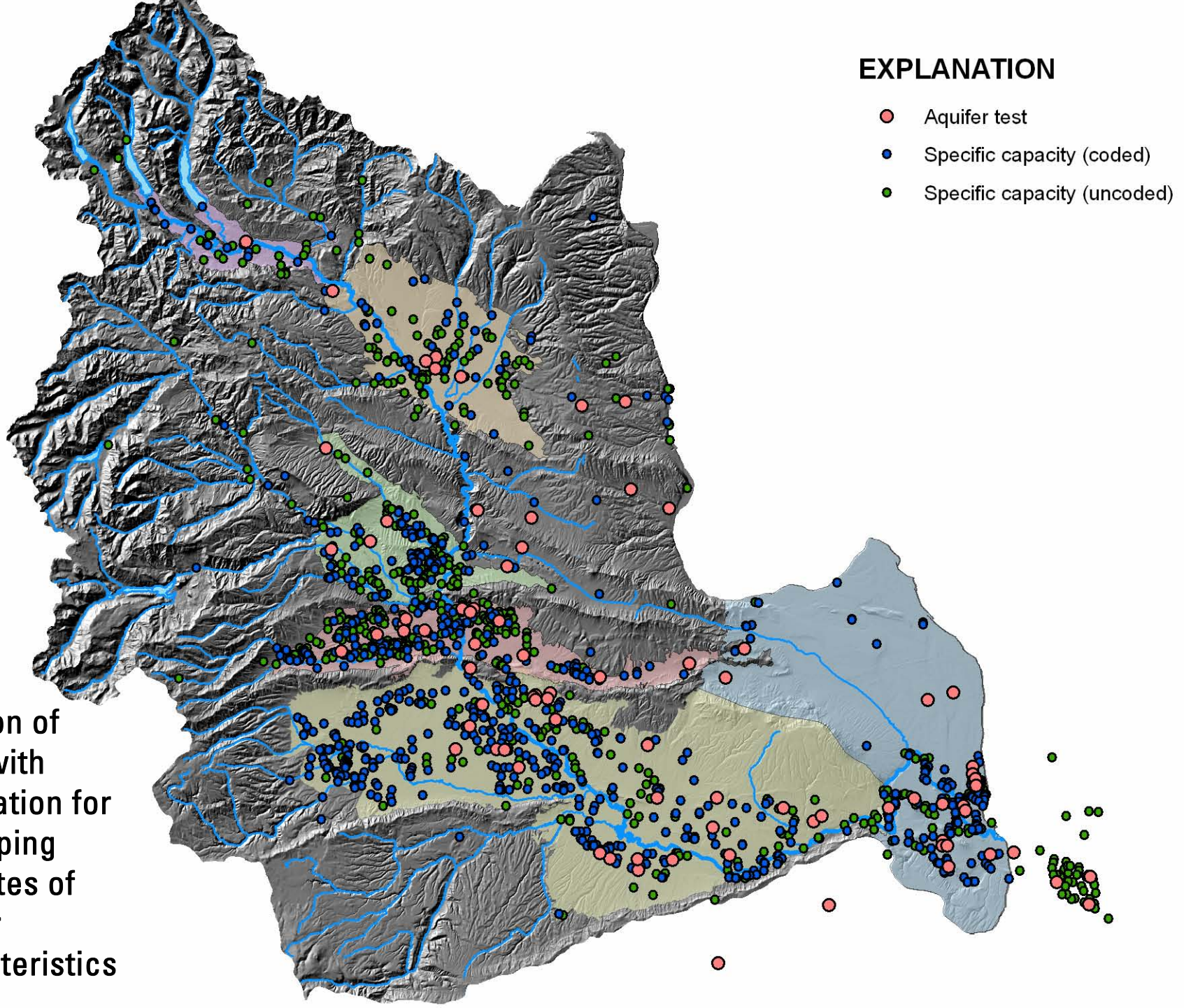
# Well yields


EXPLANATION
Well yield, in gallons per minute
1 - 50
51 - 100
101 - 250
251 - 500
501 - 1000
1001 - 2500
2501 - 4200




Location of wells with information for developing estimates of aquifer characteristics

# GROUND-WATER FLOW MODELING AND ASSESSMENT

- Constructed 6 preliminary predevelopment-condition models for the basin-fill deposits in the sedimentary basins

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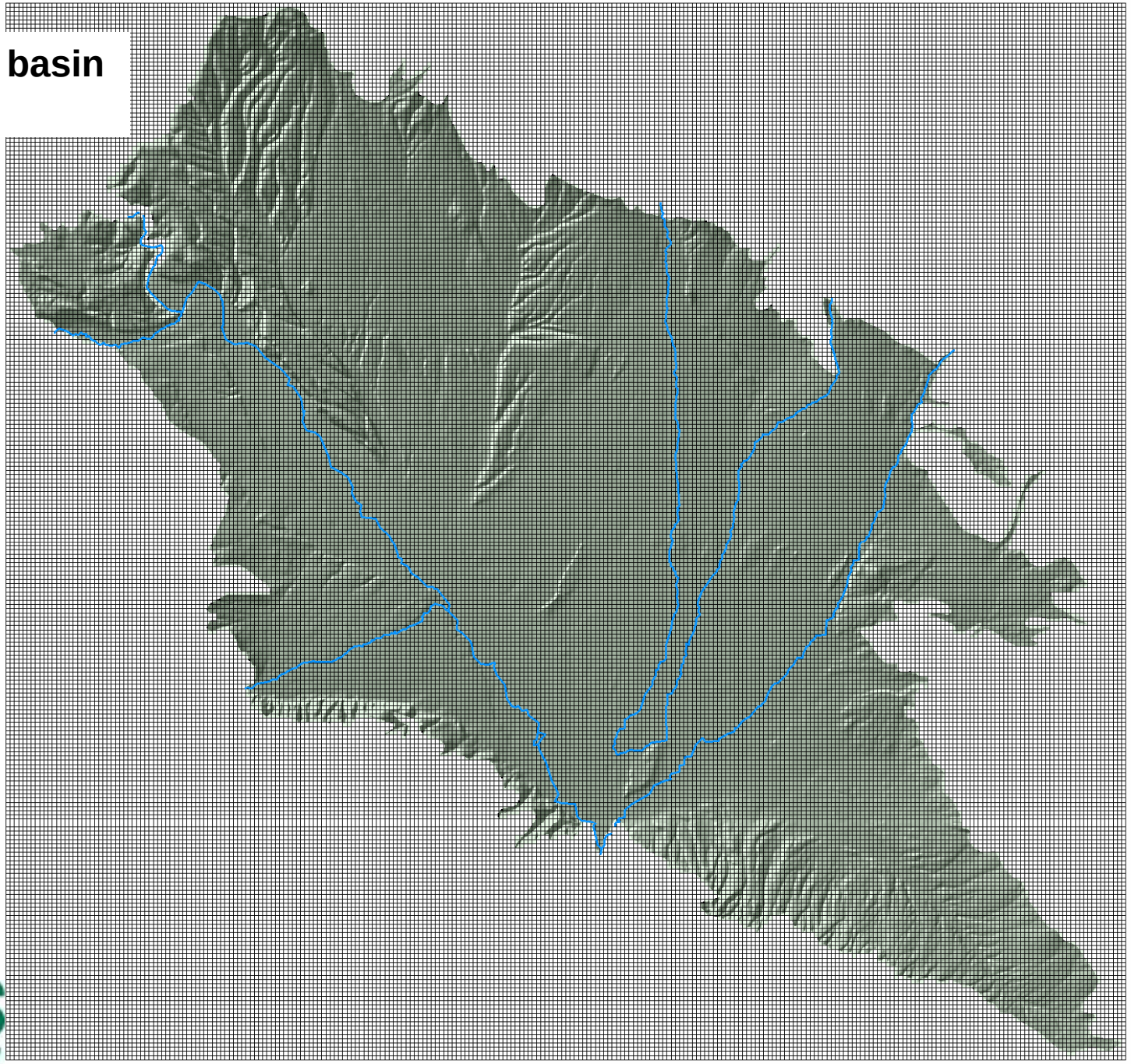
# Kittitas basin Model



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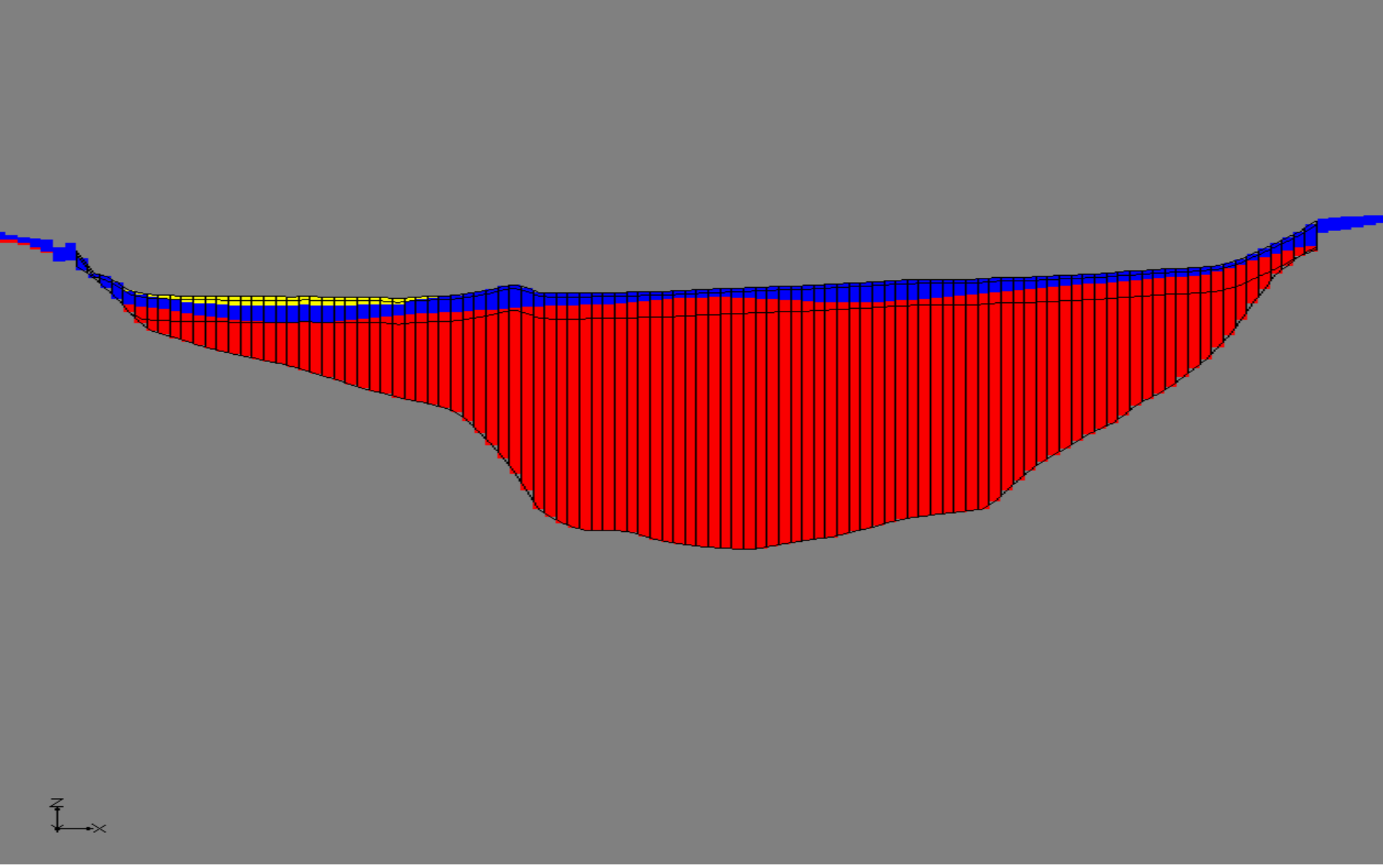


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Cross-section through Kittitas basin model

# PLANNED WORK FOR STUDY COMPONENETS

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# Mapping Hydrogeologic Units

- Map depth to top of basalt formations
- Documents maps in a report
- Extend the surficial extents of the non-Columbia River Basalt Group bedrock units to basalt

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# Ground-Water Pumpage

- Finish assigning open intervals of major wells
- Assign wells to hydrogeologic units
- Determine method to account for exempt wells
- Develop model input files

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# Ground-Water Recharge

- Develop method to move monthly values of recharge from ascii files to model input

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# Ground Water –Surface Water Interchanges

- Finishing compiling and checking all information
- Analyze data
- Document results in a report

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# Ground-Water Flow System

- Map depth to water table
- Map water levels for surficial deposits in basins
- Map, where possible, water levels in basalts and other units
- Analyze hydrographs
- Document status and trends
- Describe aspects of flow system based on isotope analyses
- Document results in a report

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# Ground-Water Flow Modeling and Assessment

- Develop monthly time series of streamflow, diversion, and return information
- Create river cross-sections for models
- Create agricultural drain-system in models
- Operate predevelopment basin models on a monthly basis
- Operate and calibrate current condition models, 1960-2001
- Document sedimentary basin models in a report
- Construct steady-state regional model for predevelopment conditions
- Construct and calibrate steady-state regional model
- Test calibrating transient regional model
- Assess selected model scenarios
- Document regional model and results in a report

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