

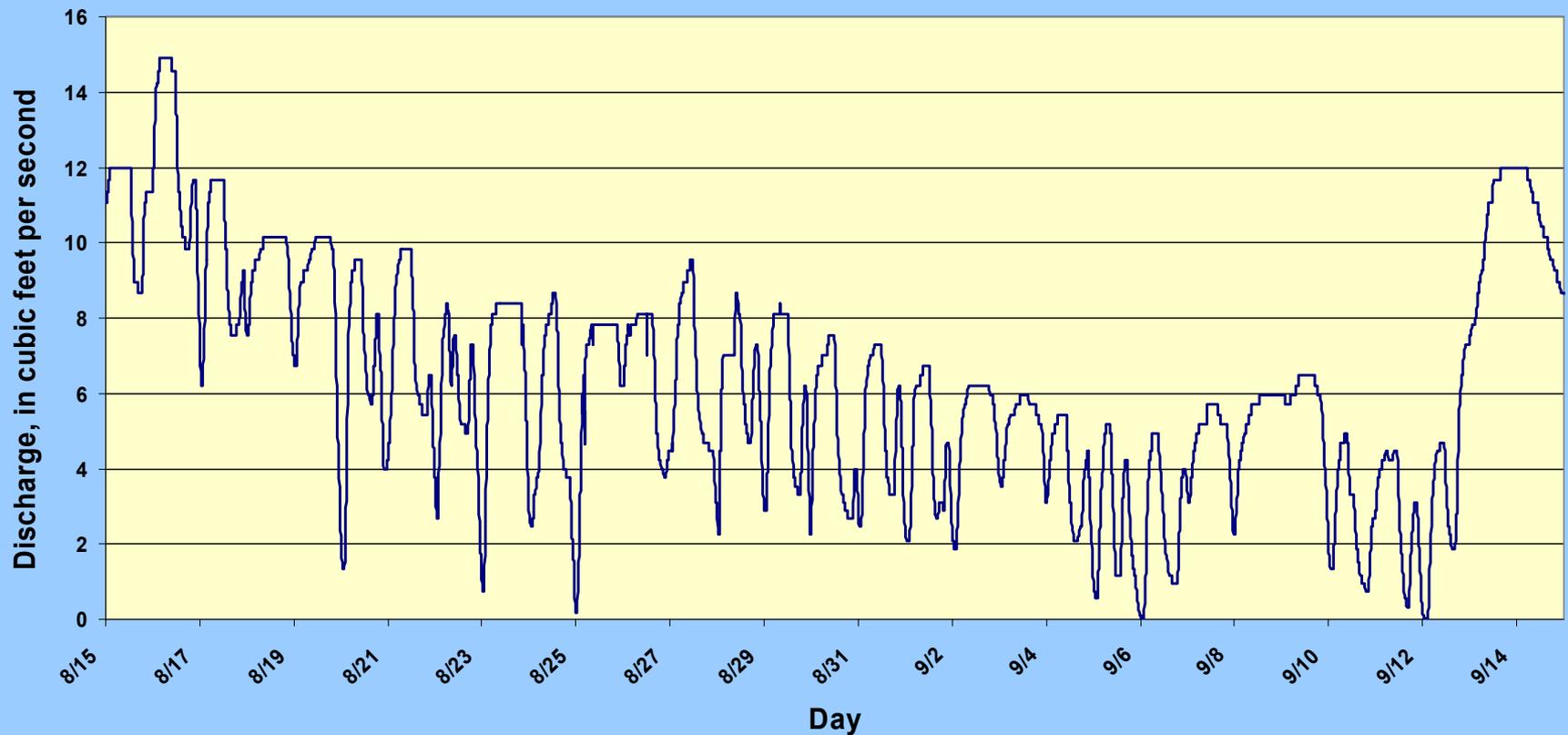
**MODELING OF WATER RESOURCES
IN THE PAWCATUCK RIVER BASIN,
SOUTHERN RHODE ISLAND AND
SOUTHEASTERN CONNECTICUT**

CONCERNS IN THE PAWCATUCK RIVER BASIN

- Meeting current and future water needs
- Determining the effects of increased population and changes in land use on ground-water availability and streamflows
- Maintaining the river environment for aquatic habitat and recreation

EXAMPLE OF THE EFFECTS OF WATER WITHDRAWALS ON STREAMFLOW

Instantaneous streamflow at the Usquepaug River,
at Rt. 2, near Usquepaug, RI
(USGS station 01117420) during August 15 - September 15, 1995



COOPERATORS

This study was initiated by the Pawcatuck Watershed Partnership's Water Use Stakeholders Group, and is funded by the Natural Resources Conservation Service, Rhode Island Water-Resources Board, and U.S. Geological Survey

OBJECTIVES

- Characterize water-resource conditions
- Test link between the ground-water flow model (MODFLOW) and the precipitation-runoff model (HSPF), within the basin

OBJECTIVES

- Assess the impact of existing and proposed water withdrawals on low flows and groundwater levels with the simulation models HSPF and MODFLOW
- Evaluate alternatives to meet projected water demands while minimizing streamflow depletion using a simulation-optimization model

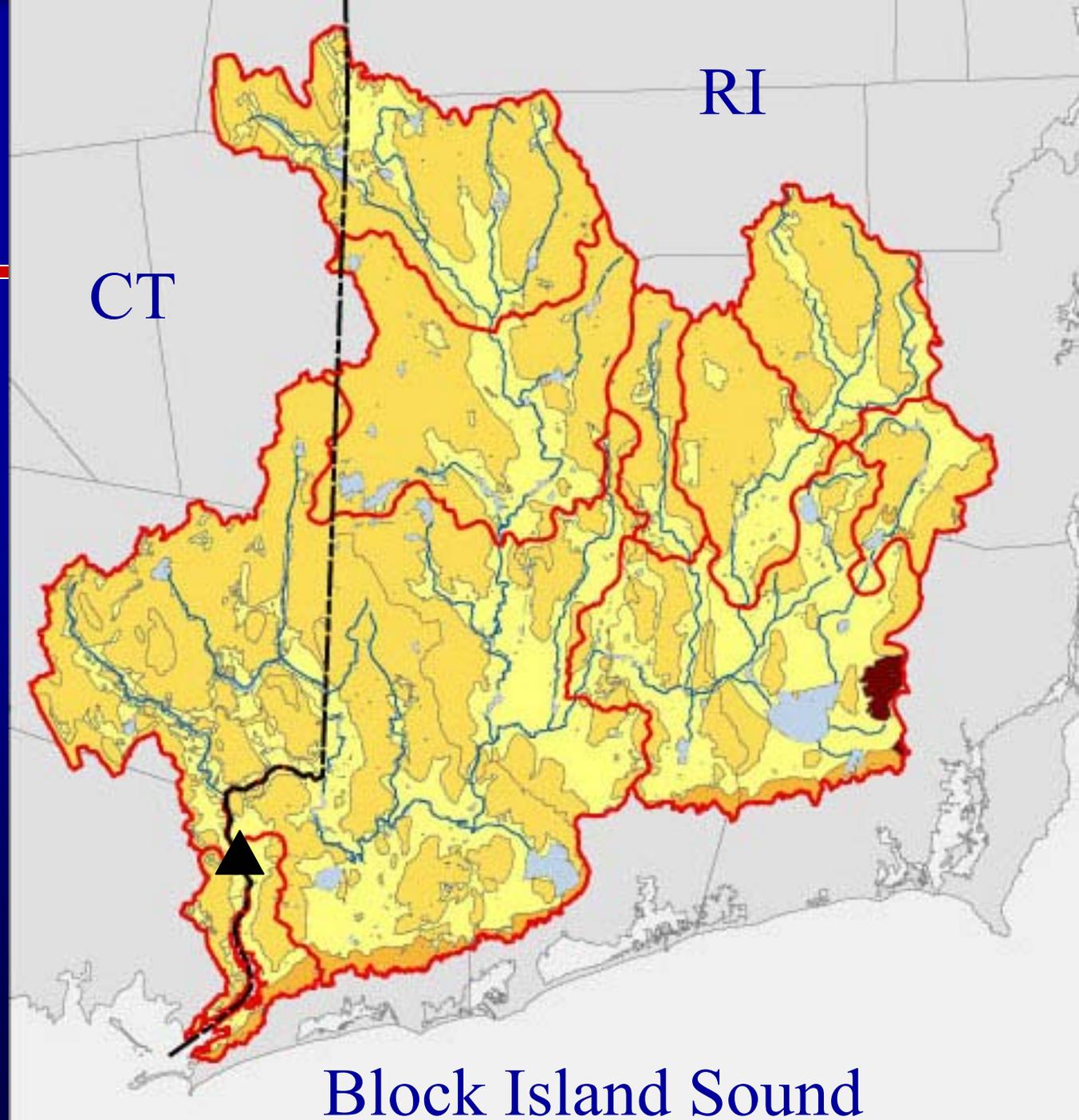
STUDY PERIOD

- April 2002 through September 2005



STUDY AREA

- Drainage area
 - 304 mi²
 - 245 mi² RI
 - 59 mi² CT
- Precipitation
 - 45-50 in/yr
- Streamflows
 - 27-33 in/yr
- Sand and gravel in river valleys



DATA NEEDS FOR CHARACTERIZING WATER RESOURCES AND MODELING

- Climate
- Streamflow
- Water use
- Hydrogeologic characteristics
- Basin and land-use characteristics

CLIMATOLOGICAL DATA

- Precipitation
- Air Temperature
- Wind Speed
- Solar Radiation
- Relative Humidity



CLIMATE DATA

- Fisherville Brook Wildlife Refuge (Exeter, RI)
 - <http://ri.water.usgs.gov> click on “Water Data”, then Precipitation, and then “CLIMATOLOGICAL STATION NEAR EXETER, RHODE ISLAND”
- Narragansett Improvement Co. (Hopkinton, RI)
 - near the Arcadia Management Area
- University of Rhode Island
- Westerly State Airport
- Providence T.F. Green Airport

CLIMATE STATIONS



■ Climate station

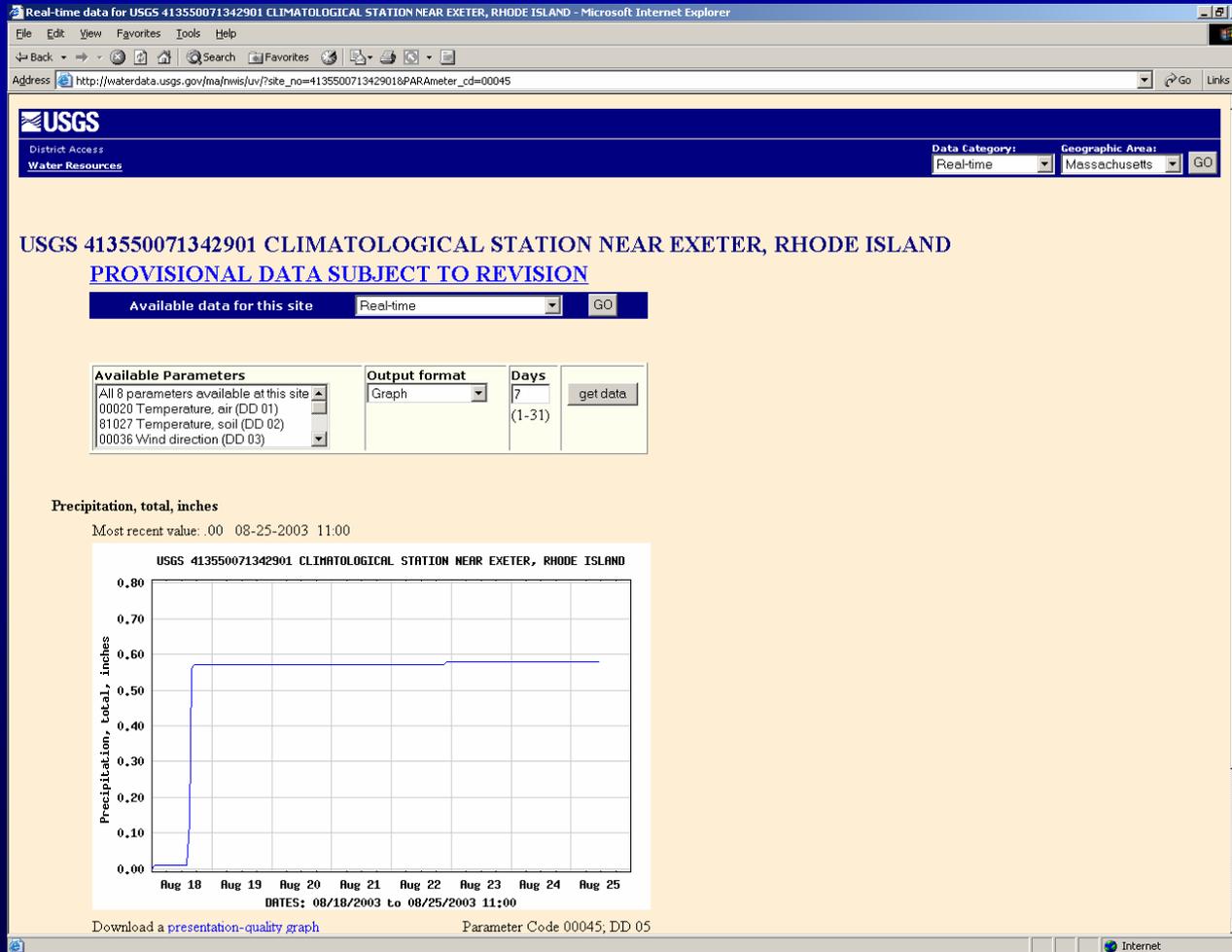
2 USGS stations

2 NWS stations

T.F. Green Airport
Providence
outside basin

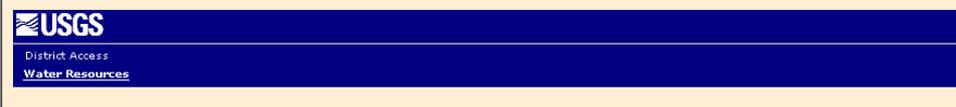


WEB CLIMATE DATA - PRECIPITATION



WEB CLIMATE DATA - SOIL MOISTURE AND TEMPERATURE

Real-time data for USGS 413550071342901 CLIMATOLOGICAL STATION NEAR EXETER, RHODE ISLAND - Microsoft Internet Explorer
 Address http://waterdata.usgs.gov/ma/nwis/uv?dd_cd=06&format=gif&period=7&site_no=413550071342901



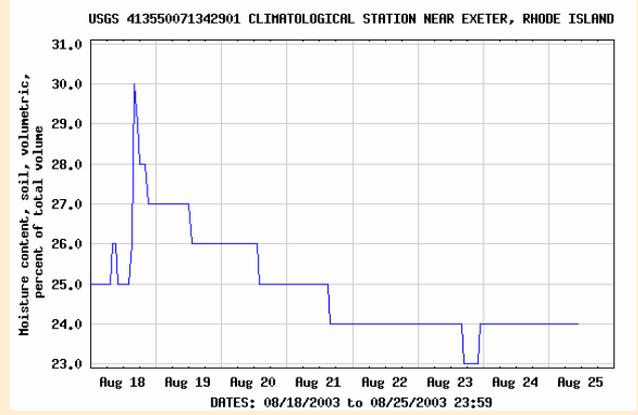
USGS 413550071342901 CLIMATOLOGICAL STATION NEAR EXETER, RHODE ISLAND PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Real-time GO

Available Parameters All 8 parameters available at this site 00020 Temperature, air (DD 01) 81027 Temperature, soil (DD 02) 00036 Wind direction (DD 03)	Output format Graph	Days 7 (1-31)	get data
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Moisture content, soil, volumetric, percent of total volume

Most recent value: 24 08-25-2003 11:00



Download a [presentation-quality graph](#) Parameter Code 74207; DD 06

Real-time data for USGS 413550071342901 CLIMATOLOGICAL STATION NEAR EXETER, RHODE ISLAND - Microsoft Internet Explorer
 Address http://waterdata.usgs.gov/ma/nwis/uv?dd_cd=02&format=gif&period=7&site_no=413550071342901

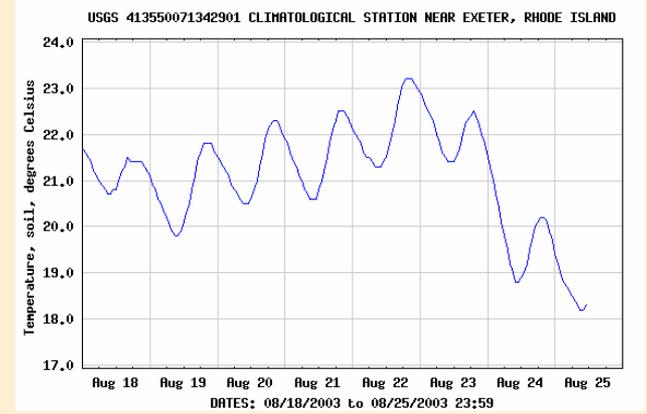
USGS 413550071342901 CLIMATOLOGICAL STATION NEAR EXETER, RHODE ISLAND PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Real-time GO

Available Parameters All 8 parameters available at this site 00020 Temperature, air (DD 01) 81027 Temperature, soil (DD 02) 00036 Wind direction (DD 03)	Output format Graph	Days 7 (1-31)	get data
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------	----------------------------	----------

Temperature, soil, degrees Celsius

Most recent value: 18.3 08-25-2003 11:00



Download a [presentation-quality graph](#) Parameter Code 81027; DD 02

Questions about data
 Feedback on this website
 Real-time Data for Massachusetts
<http://waterdata.usgs.gov/ma/nwis/uv/>

gs-w-ma_NWISWeb_Data_Inquiries@usgs.gov
gs-w-ma_NWISWeb_Maintainer@usgs.gov

Retrieved on 2003-08-25 13:04:20 EDT
 Department of the Interior, U.S. Geological Survey

LONG-TERM CONTINUOUS STREAMFLOW-GAGING STATIONS

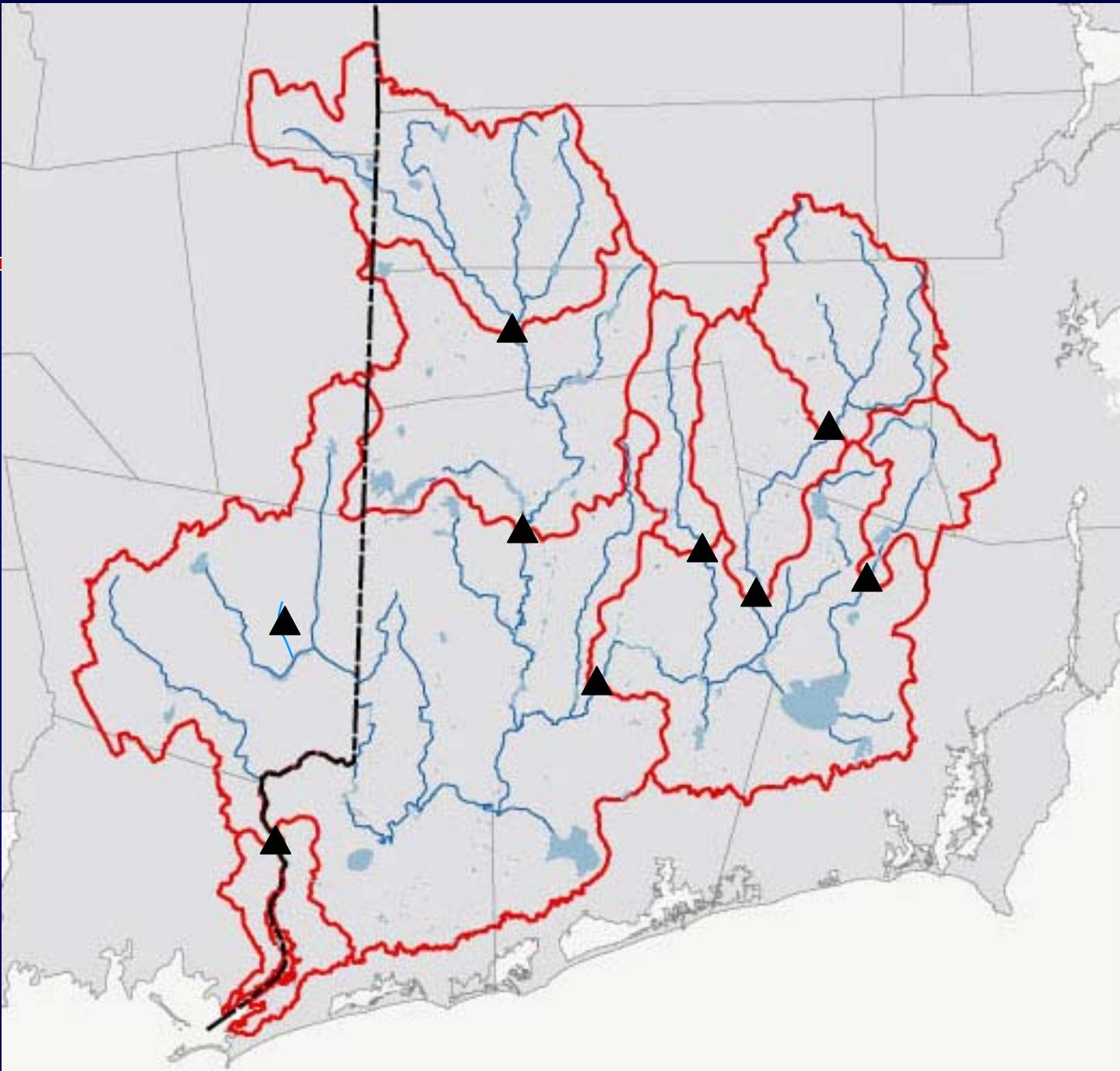
- Chipuxet River at W. Kingston *(1958-60, 1973–present)*
- Queen River at Liberty *(1998–present)*
- Usquepaug River nr Usquepaug *(1958-60, 1974–present)*
- Beaver River nr Usquepaug *(1974–present)*
- Pawcatuck River at Wood River Jct. *(1940–present)*
- Wood River nr Arcadia *(1964–81, 1982-present)*
- Wood River at Hope Valley *(1941–present)*
- Pendleton Hill Brook nr Clarks Falls, CT *(1959-present)*
- Pawcatuck River at Westerly *(1940–present)*

EXISTING SW GAGING STATIONS



▲ Existing
gaging station

8 of 9 existing
gages > 30 yrs



SHORT-TERM CONTINUOUS STREAMFLOW-GAGING STATIONS

- Queen River at Exeter (*operated water years 2000-01*)
- Usquepaug R. at Usquepaug (*operated water years 2000-01*)
- Chickasheen Brook at W. Kingston
- Pawcatuck River at Kenyon (*operated 1958-60*)
- Beaver River nr Shannock
- Meadow Brook nr Carolina (*operated water years 1965-74*)
- Pawcatuck River at Burdickville
- Ashaway River at Ashaway
- Shunock River nr N. Stonington, CT

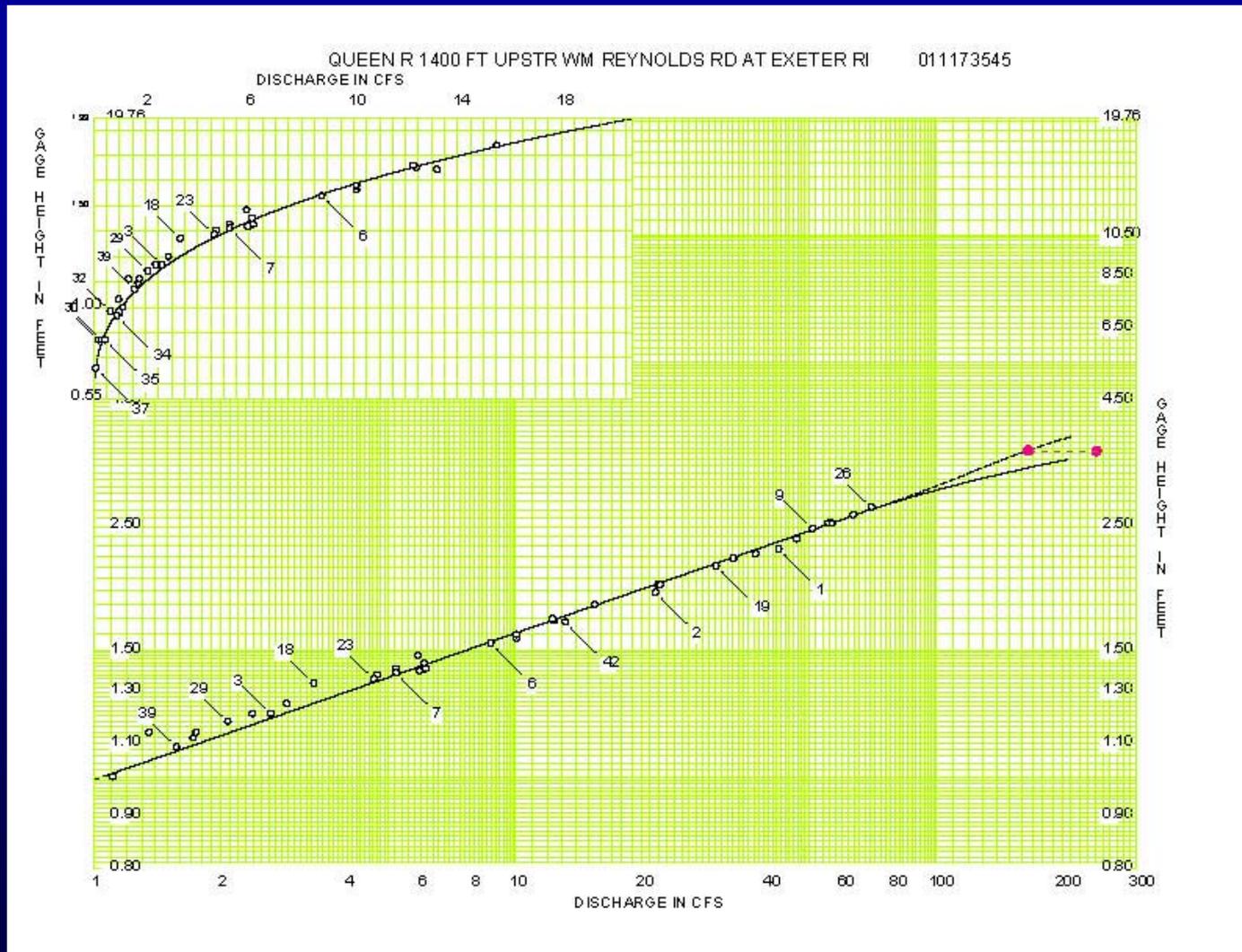
SHORT-TERM STREAMFLOW-GAGING STATIONS



STREAMFLOW (DISCHARGE) MEASUREMENT

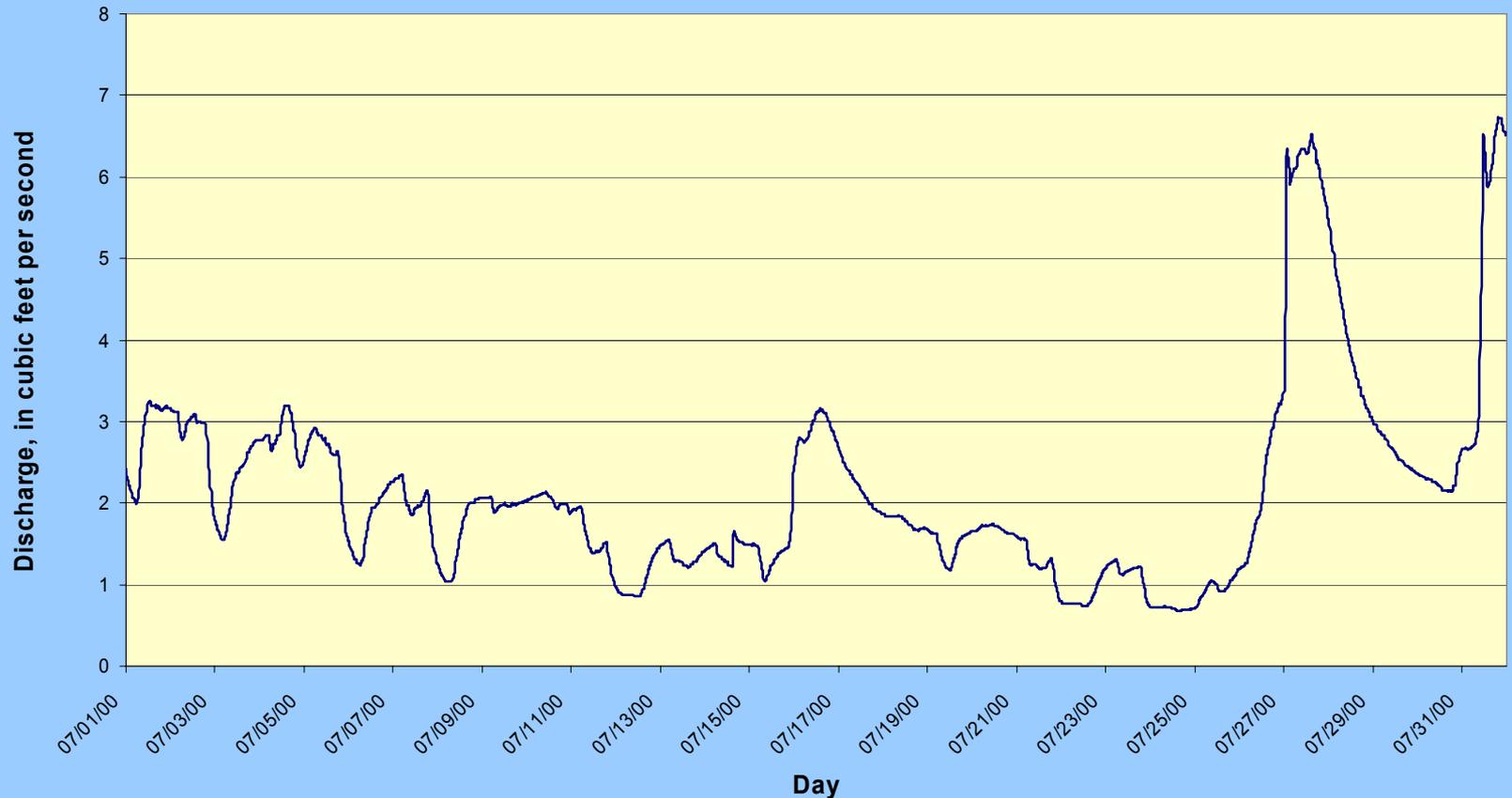


EXAMPLE STAGE-DISCHARGE RATING CURVE



EXAMPLE OF CONTINUOUS STREAMFLOW OVER TIME

Instantaneous streamflow at the Queen River,
1,400 ft. upstream of Williams Reynolds Rd. at Exeter, RI
(USGS station 011173545) during July 2000

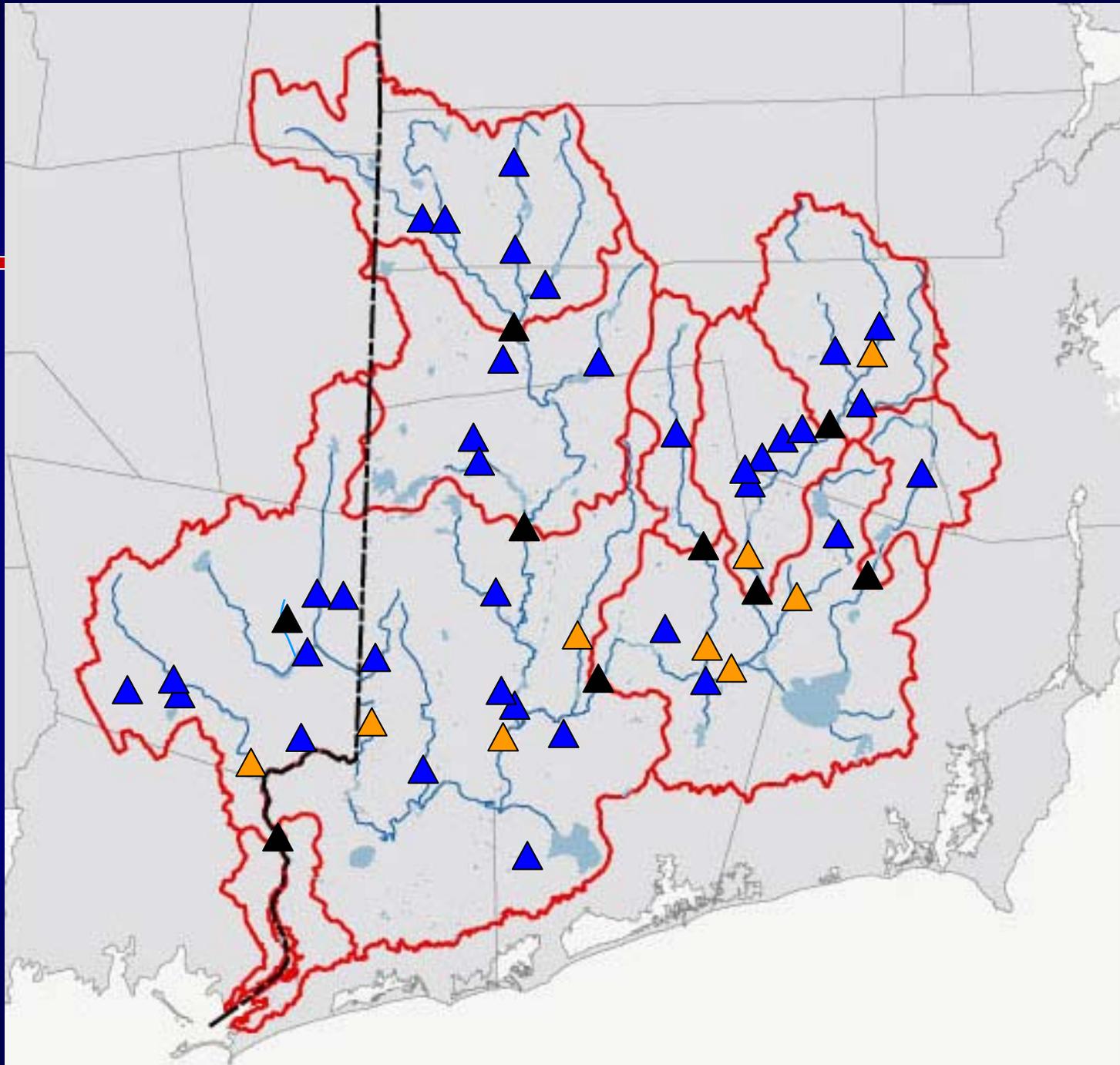


PARTIAL-RECORD STATIONS

- Partial-record stations
 - 36 sites across basin
 - All have measured about monthly since Aug. 2002
 - Every site has at least 10 discharge measurements
 - Drainage areas range from 0.25 – 85.7 mi²
 - Stratified-drift deposits range from 0 to 75 percent of the subbasin areas
 - Several basins have wetlands

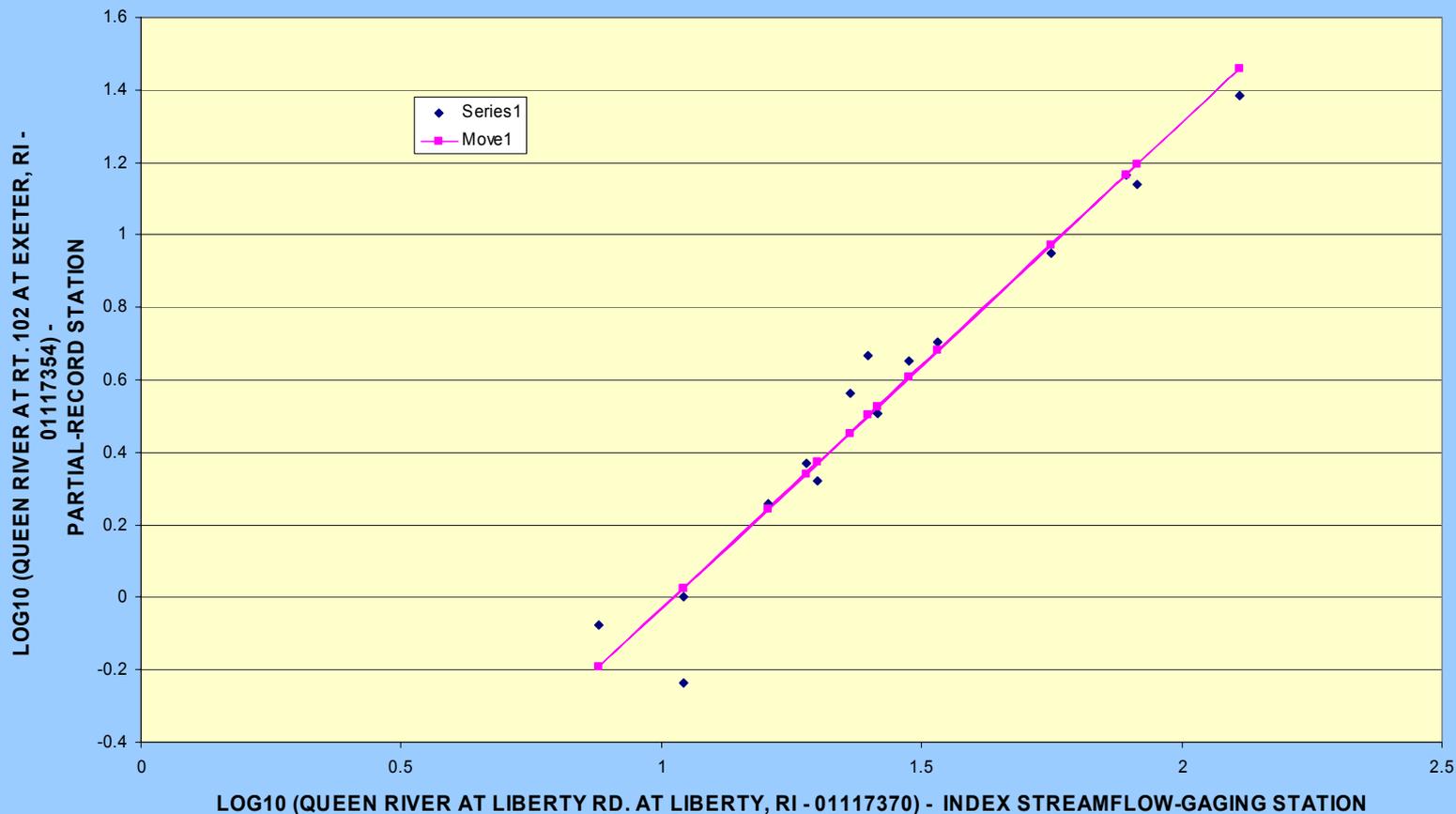
PARTIAL-RECORD STATIONS

- ▲ Partial-record station
- △ Existing gaging station
- ▲ Proposed gaging station



EXAMPLE RELATION OF STREAMFLOW AT A PARTIAL-RECORD STATION TO A NEARBY GAGING STATION

RELATION OF DISCHARGE MEASUREMENTS AT PARTIAL-RECORD STATION TO A NEARBY INDEX STREAMFLOW-GAGING STATION USING THE MOVE.1 ANALYSIS



WATER-USE DATA

- Ground-water and surface-water withdrawal rates from:
 - Public water supplies
 - Agricultural/Recreational users
 - Commercial/Industrial users
 - Waste-water discharges



WATER-USE DATA

- Approximately 30 public-water supply wells and approximately 20 well-head protection areas as of 1996
- Public-water supply wells provide year round serve to at least 25 people or have 15 service connections

WATER-USE DATA

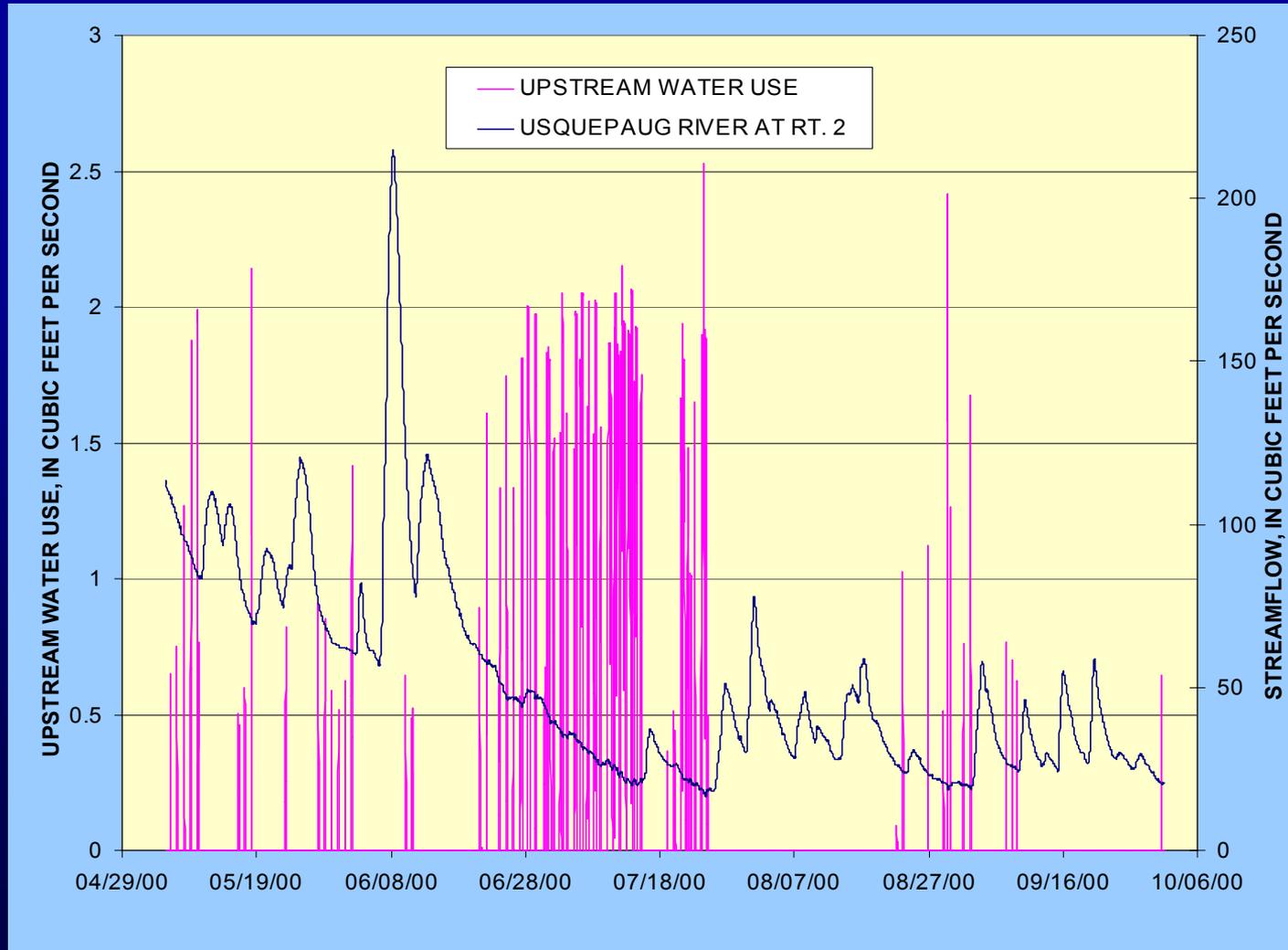
- Agricultural monitoring sites
 - 5 of 14 possible sites
 - 8 surface-water withdrawal sites
 - 3 ground-water withdrawal sites
- Recreational monitoring sites
 - 2 of 10 possible sites in basin and 1 outside
 - 2 surface-water withdrawal sites
 - 2 ground-water withdrawal sites



INSTRUMENTATION



EXAMPLE OF WATER USE AND STREAMFLOW OVER TIME



WATER-USE DATA

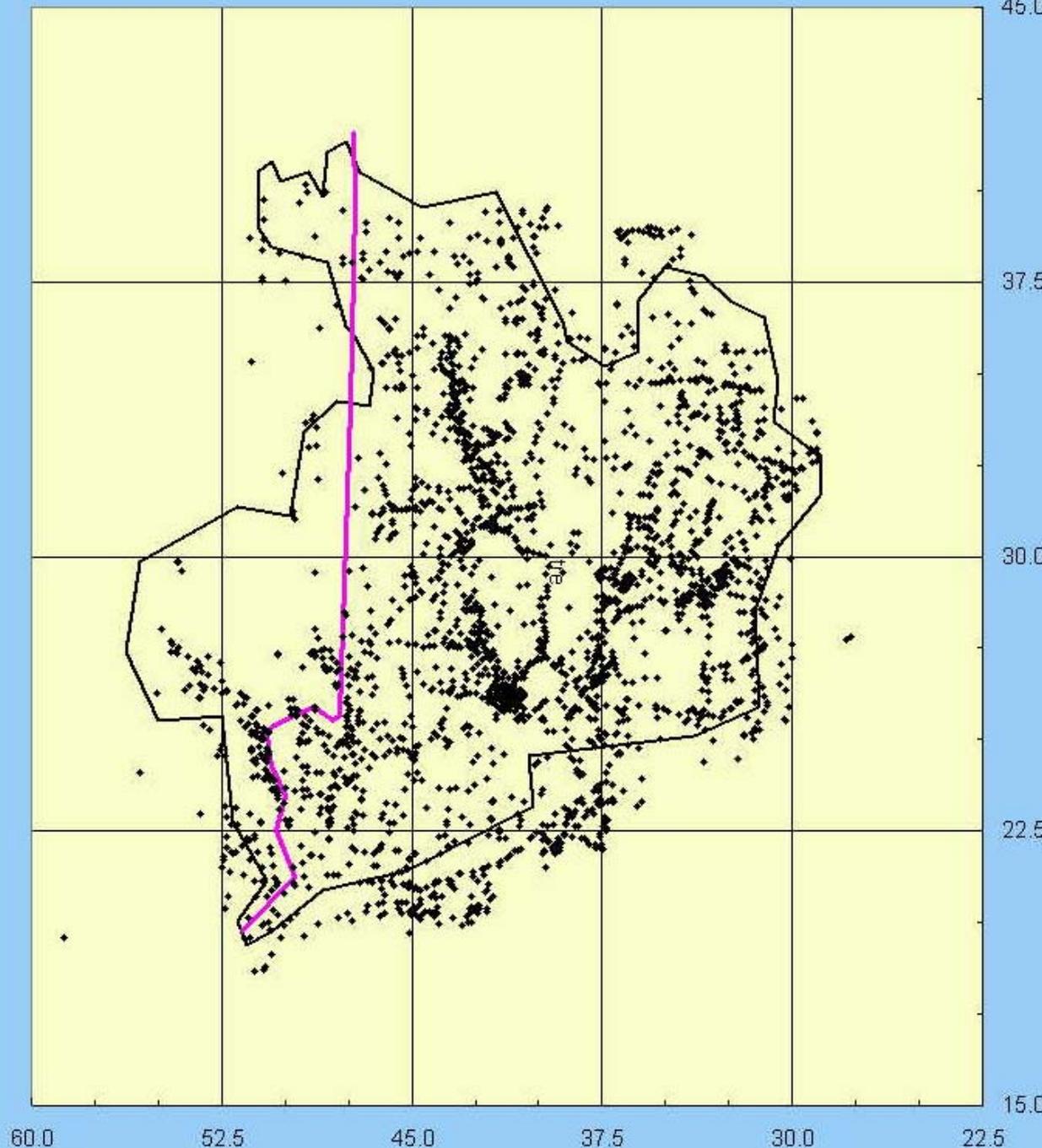
- Commercial/industrial water-use data available from Pawcatuck water use and availability study (report in draft)
- Waste-water discharge data available from Pawcatuck water use and availability study (report in draft)

HYDROGEOLOGIC DATA

- ACCESS database of approximately 3,900 wells, of which about 1,500 wells are currently inventoried in the USGS GWSI database and about 1,400 wells are in the USGS town files
- Evaluating well information for altitude, water table, bedrock depth, refusal depth, and lithologic logs
- Evaluating existing studies' water table, bedrock elevation, surficial geology, and cross-sectional geology maps
- Evaluating all information to determine areas of no data, limited data, and conflicting data

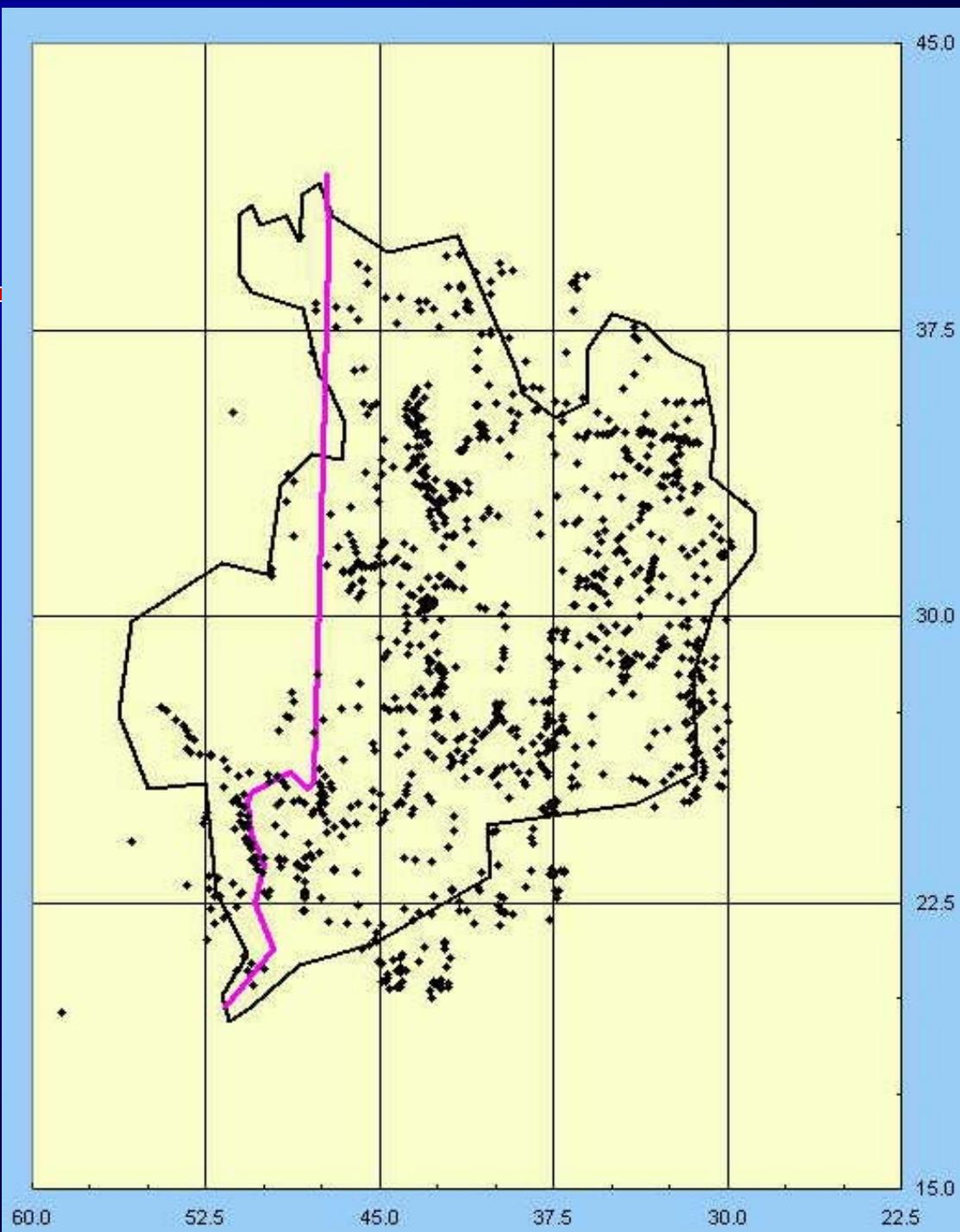
WELL DATA

- Locations of all wells 3,897 inventoried to date



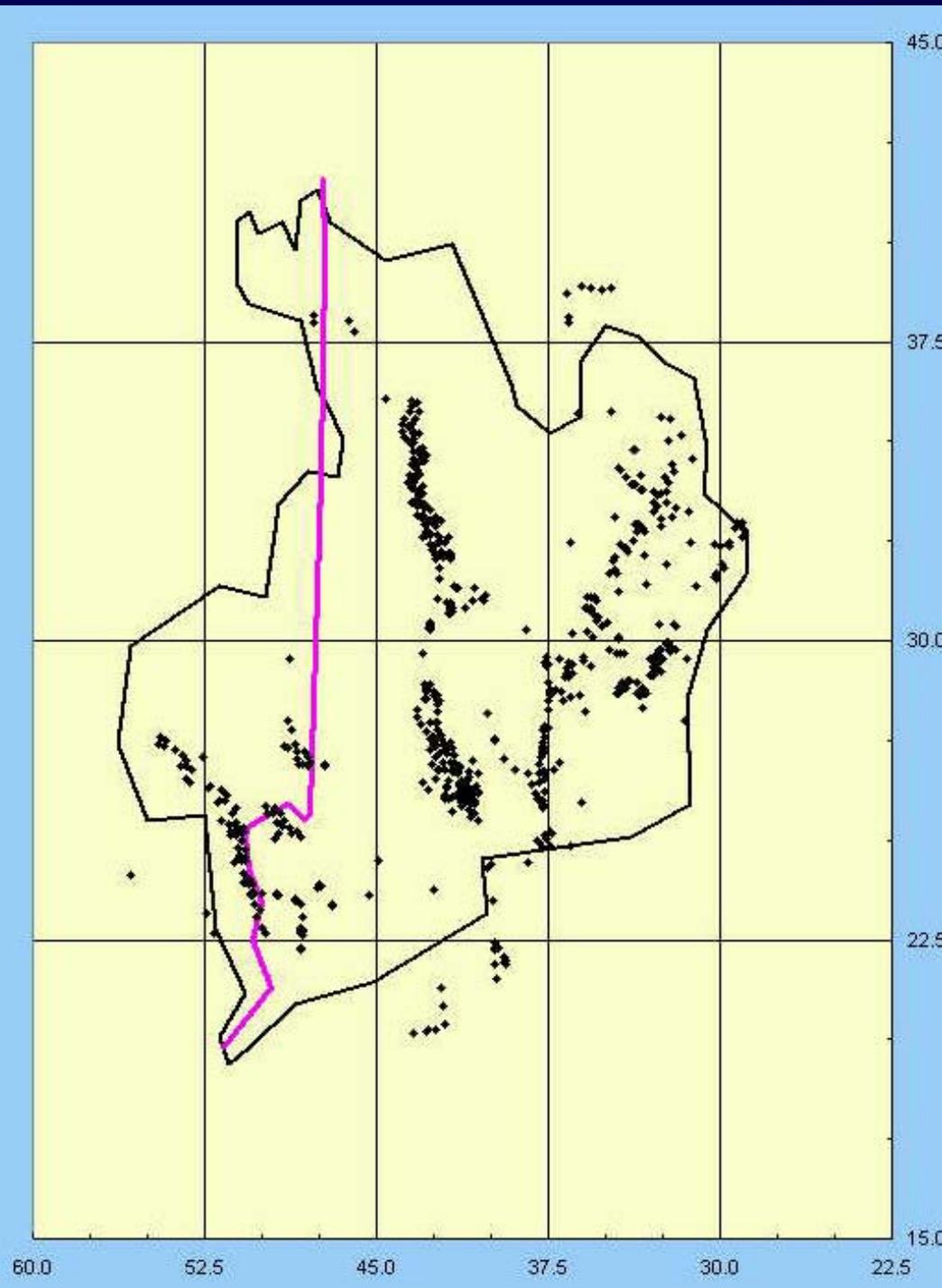
WELL DATA

- Location of 1,136 wells with altitude, water-level, and depth to refusal or bedrock data inventoried to date

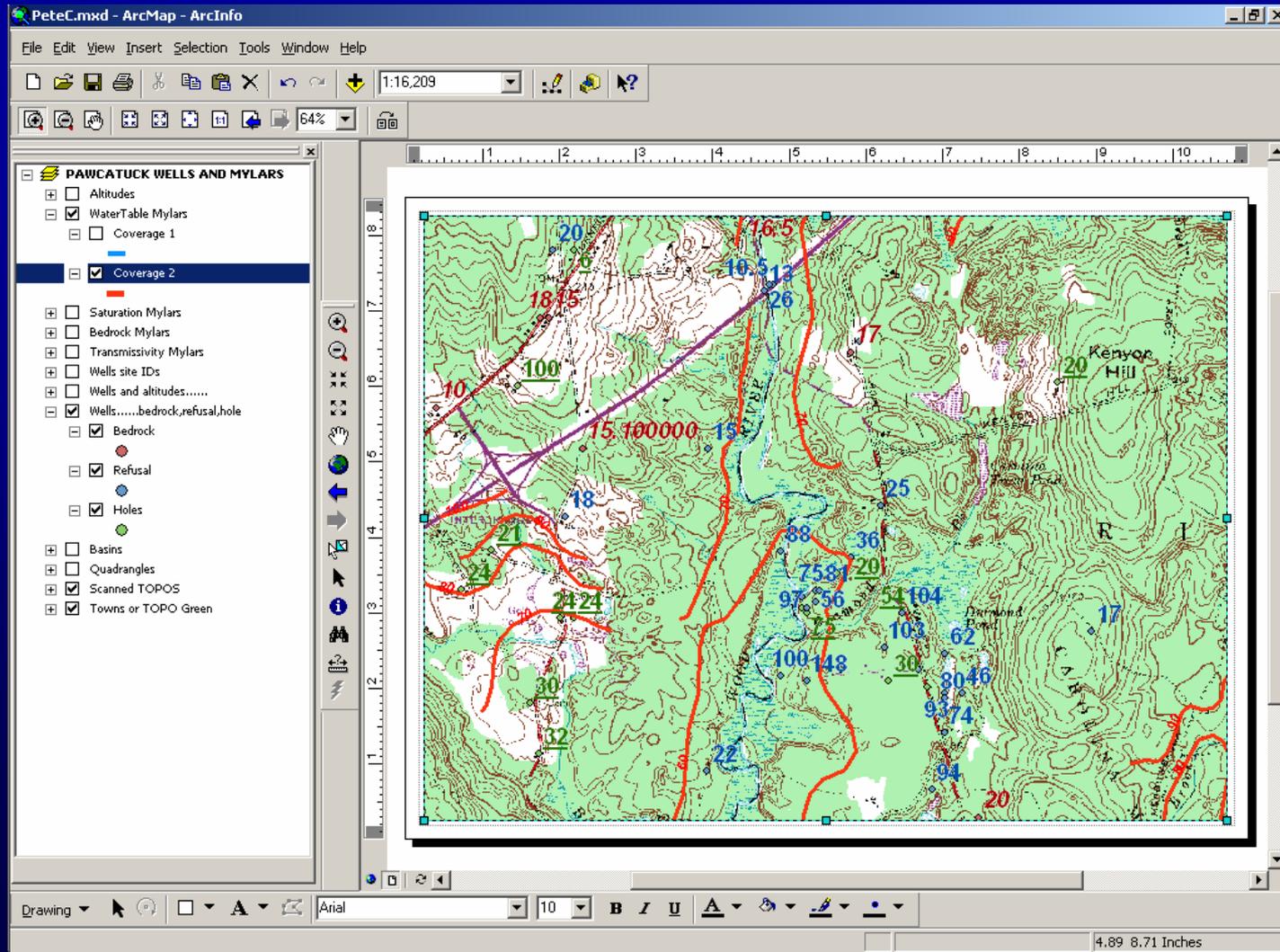


WELL DATA

- Location of 967 wells with lithologic data inventoried to date

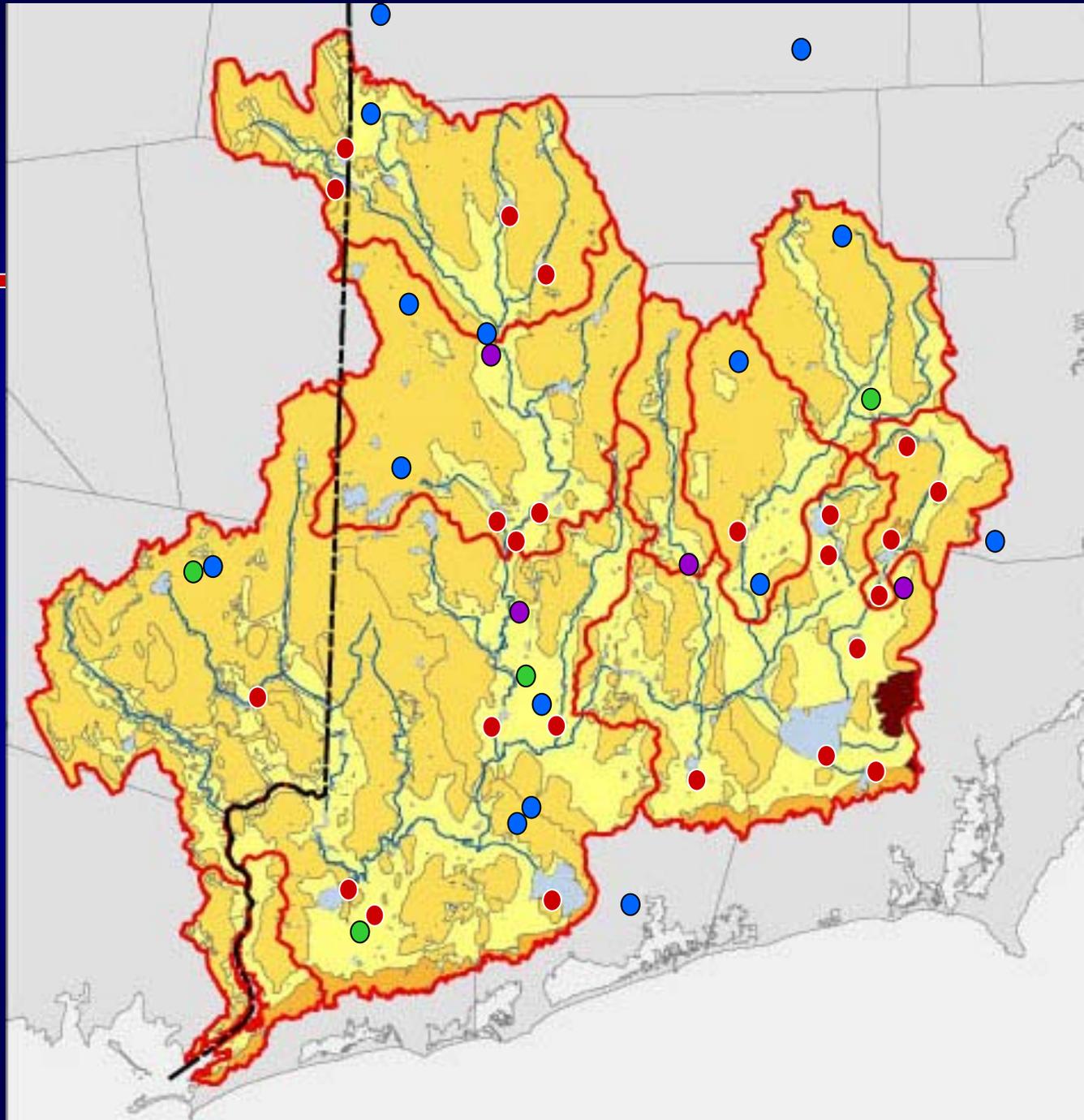


EXAMPLE A GIS VIEW FOR EVALUATING HYDROGEOLOGIC DATA



GW LEVEL DATA COLLECTION SITES

- Continuous record well
- Bi-monthly record well
- New continuous record well
- Pond gages



NEW CONTINUOUS GROUND-WATER-LEVEL STATIONS



BASIN AND LAND-USE CHARACTERISTICS

- Topography (Digital Elevation Models)
- Hydrography
- Land Use (residential, agricultural, commercial, and recreational)
- Soils (hydrologic soil groups)
- Surficial Geology (sand & gravel and till)
- Vegetation (wetlands)

SURFICIAL GEOLOGY AND WETLANDS

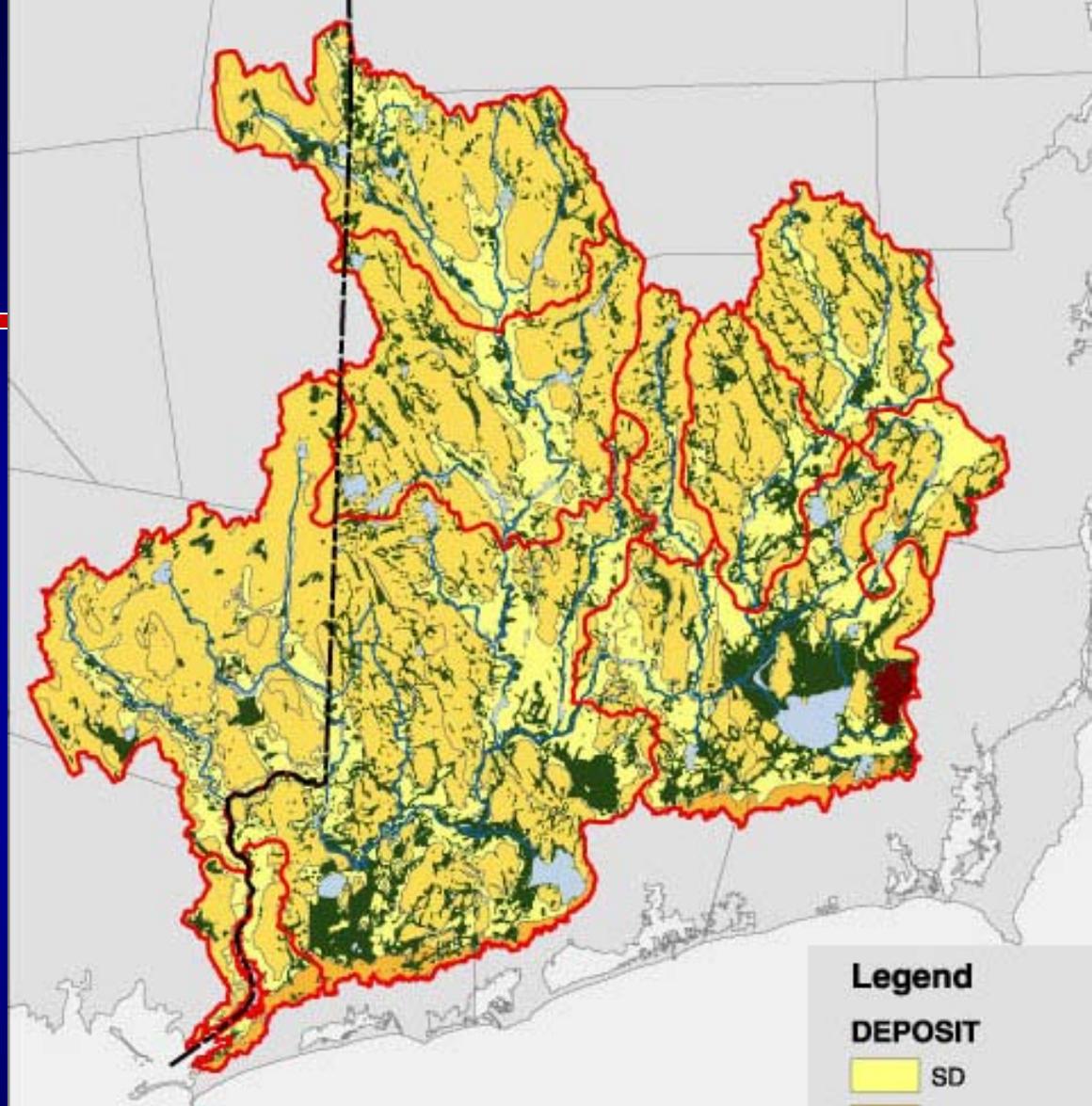
SD = stratified drift

T = till

M = mixed

W = water

S/T = sand over till



Legend

DEPOSIT

SD

T

M

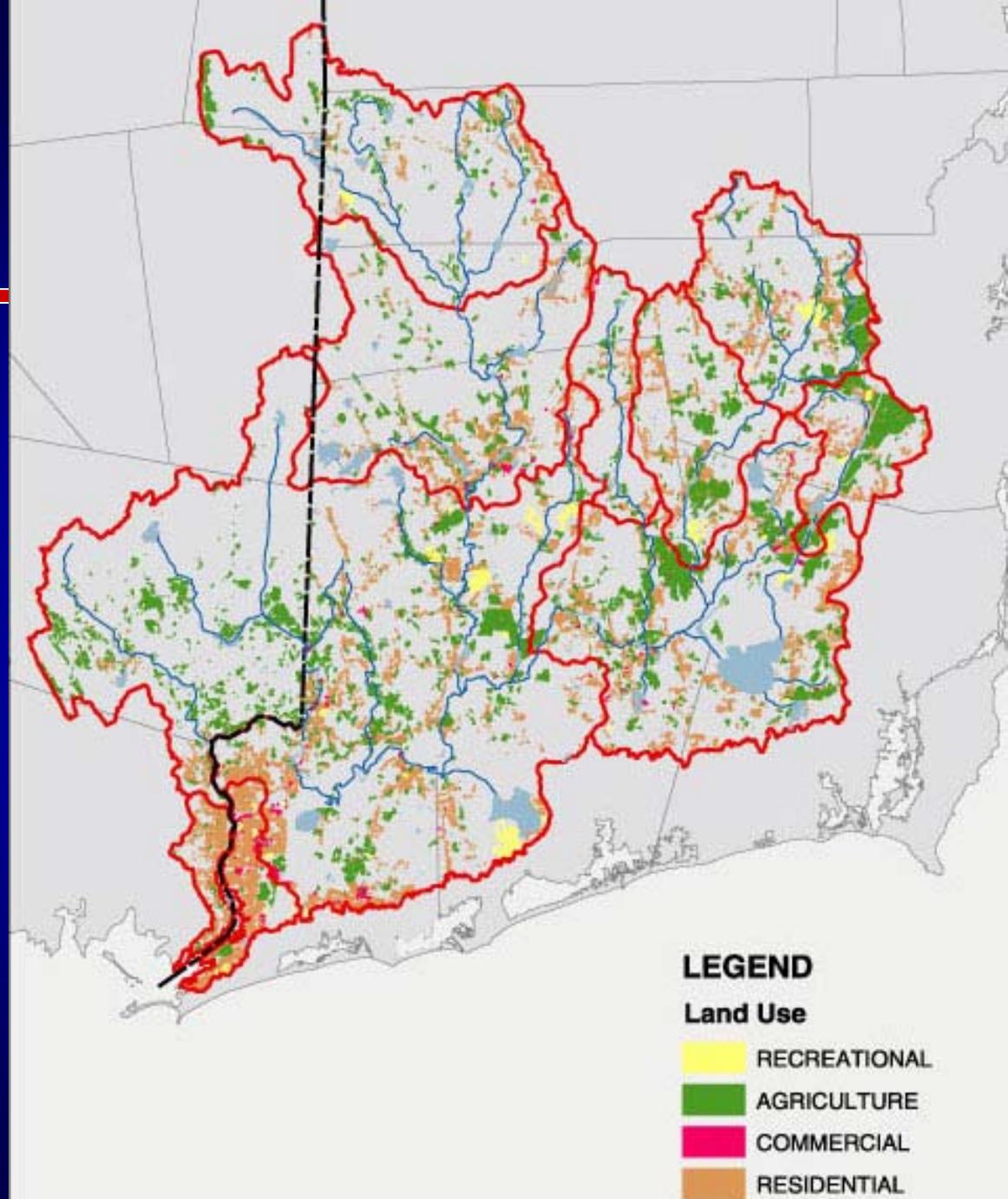
W

S/T

WETLANDS

LAND USE

Gray areas
within basin
are forest land



MODELING

