

Trends in Shallow Ground-Water Quality of the Delmarva Peninsula

Results from regional and local studies

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Regional Network Design

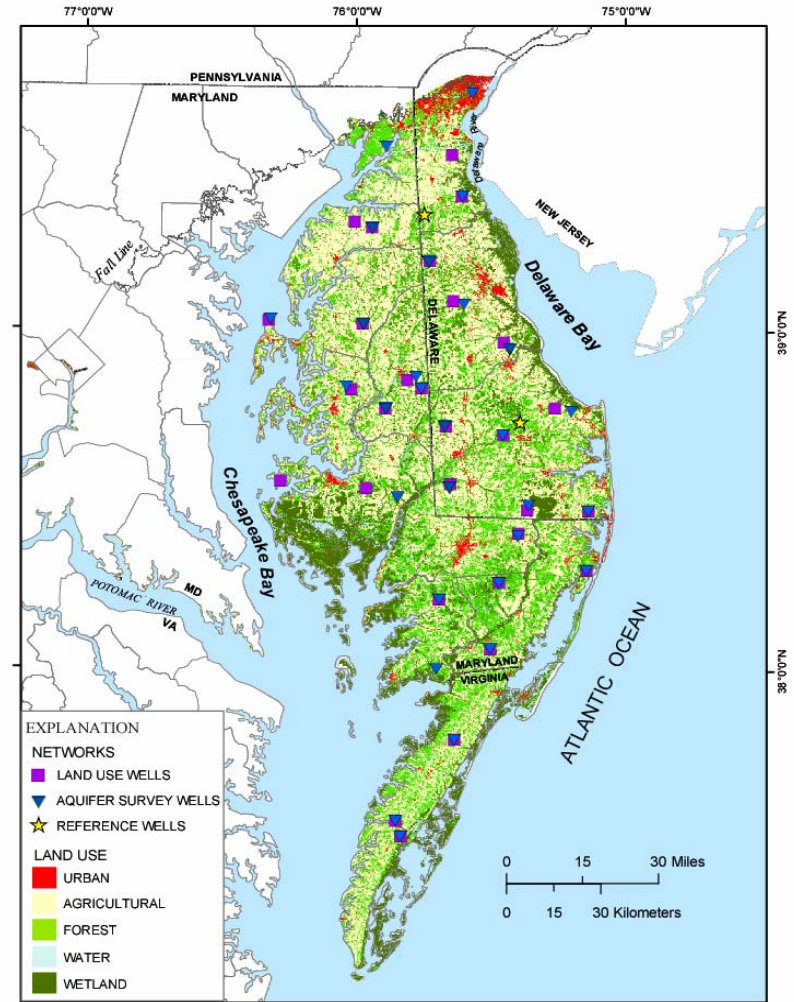
Sampled in 2001

Agricultural Land Use (agLUS)

- 29 regional wells
- Median depth 22 feet
- 16 trend wells (1988 and 2001)

Major Aquifer Survey (MAS)

- 29 domestic wells
- Median depth 45 feet
- 23 trends wells (1988 and 2001)



Local Flow-System Studies

Locust Grove

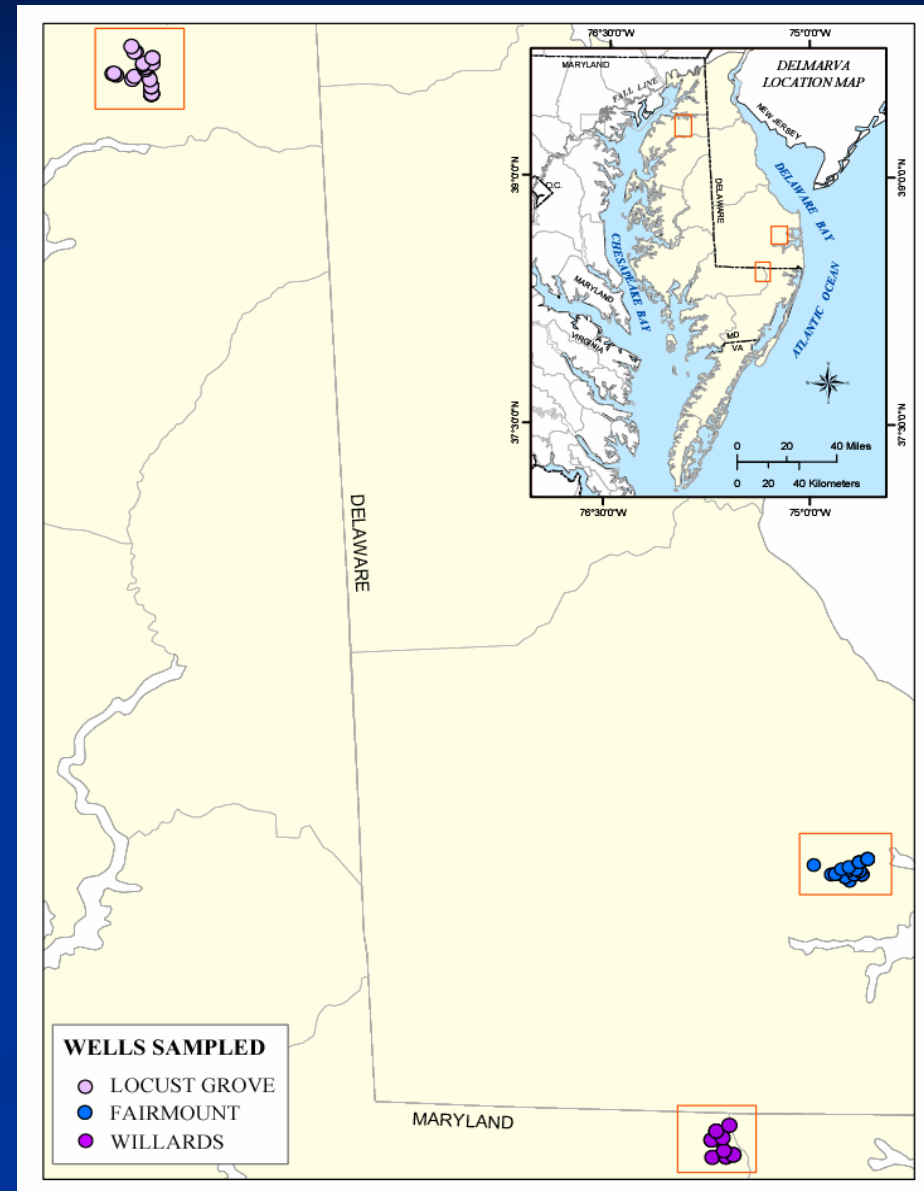
- Well-drained upland
- Oxidic conditions in surficial aquifer
- Anoxic discharge from deeper aquifer

Fairmount

- Well-drained upland
- Thick sandy surficial aquifer
- Oxidic conditions throughout

Willards

- Complex sedimentation
- Variable redox conditions



Delmarva Peninsula

Aquifer Sediments

Quartz sand, clay, silt, gravel, with some shell

Organic matter in swamps and wetlands

Unconfined surficial aquifer

- Covers 90% of study area
- Highly permeable
- Ranges from 20 feet to over 100 feet in thickness

Water table: 0 to 30 feet below land surface

Natural Water Chemistry

Controlled by:

- Rainfall and mineral dissolution
- Redox reactions
- Residence time in flow system
- Saline intrusion near coasts

Generally dilute, acidic, low nitrate

Generally found beneath forested areas

Spatial Trends in Nitrate

Elevated concentrations throughout Delmarva

- Above background in 68 percent of wells in both networks
- Above MCL in about 33 percent of wells from both networks

Median concentrations similar at all depths

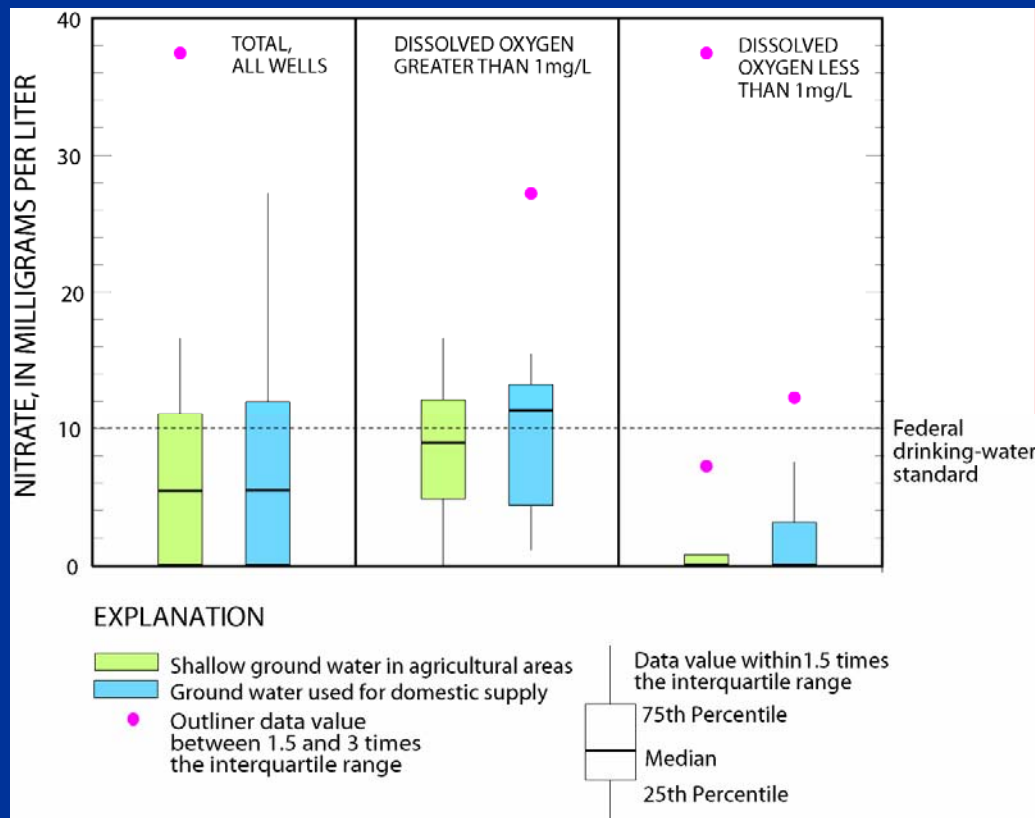
- 5.4 mg/L, agLUS (median 22 feet)
- 5.5 mg/L, MAS (median 45 feet)
- 5.2 mg/L, public supply wells (median 85 feet)

Spatial Trends in Nitrate

Nitrate significantly higher in:

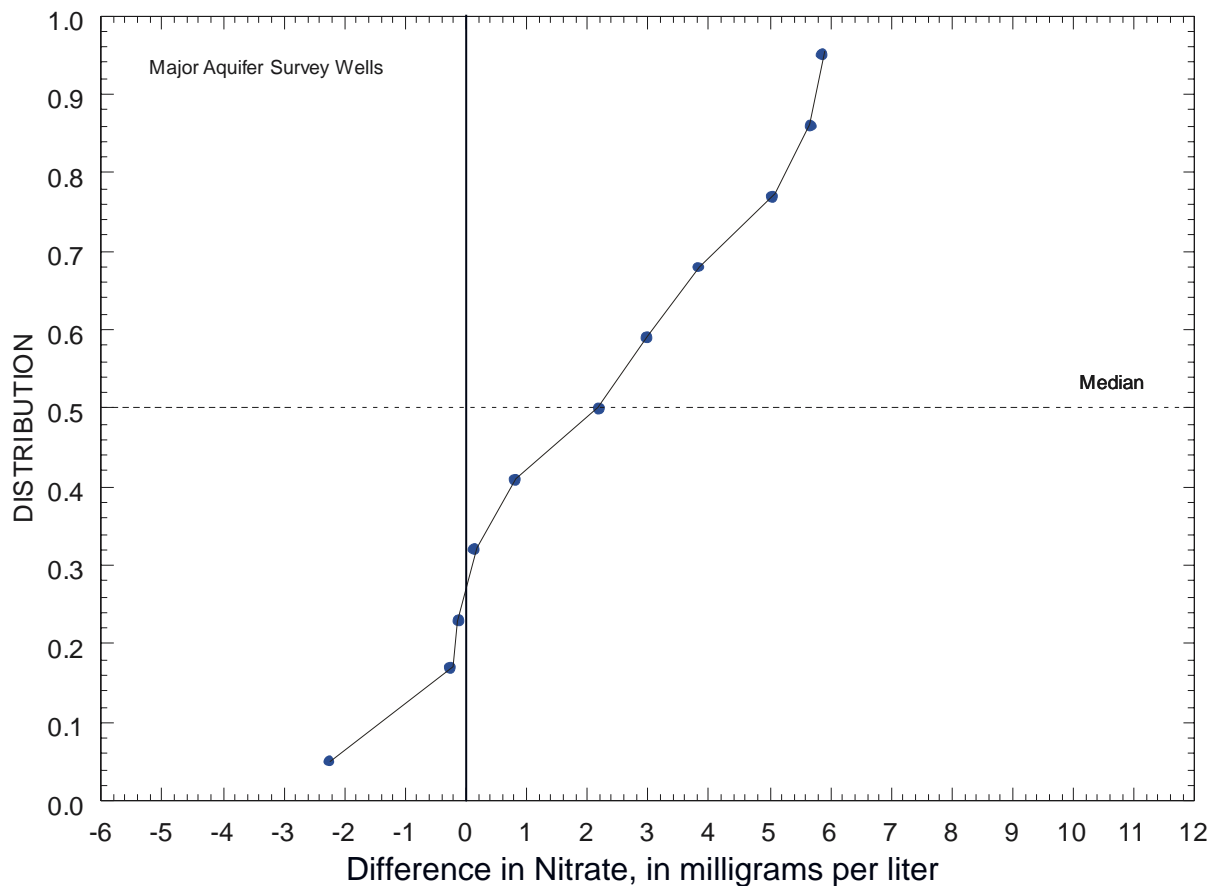
- Oxygen-rich areas throughout surficial aquifer
- Well-drained areas in shallow network

Positively correlated with percent agricultural land use

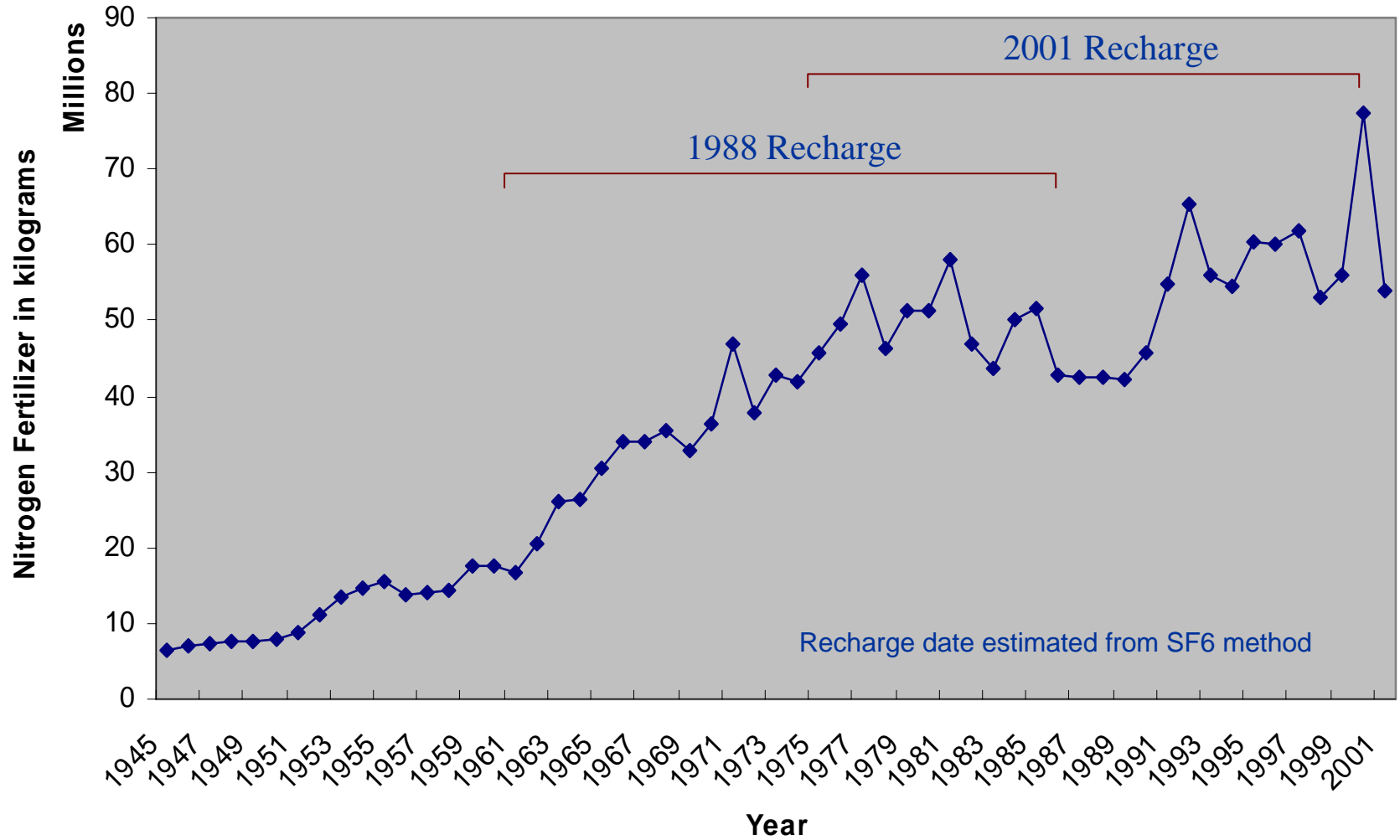


Temporal Trends in Nitrate

Increase of **2 mg/L** in deeper, older samples in oxygen-rich areas from 1988 to 2001

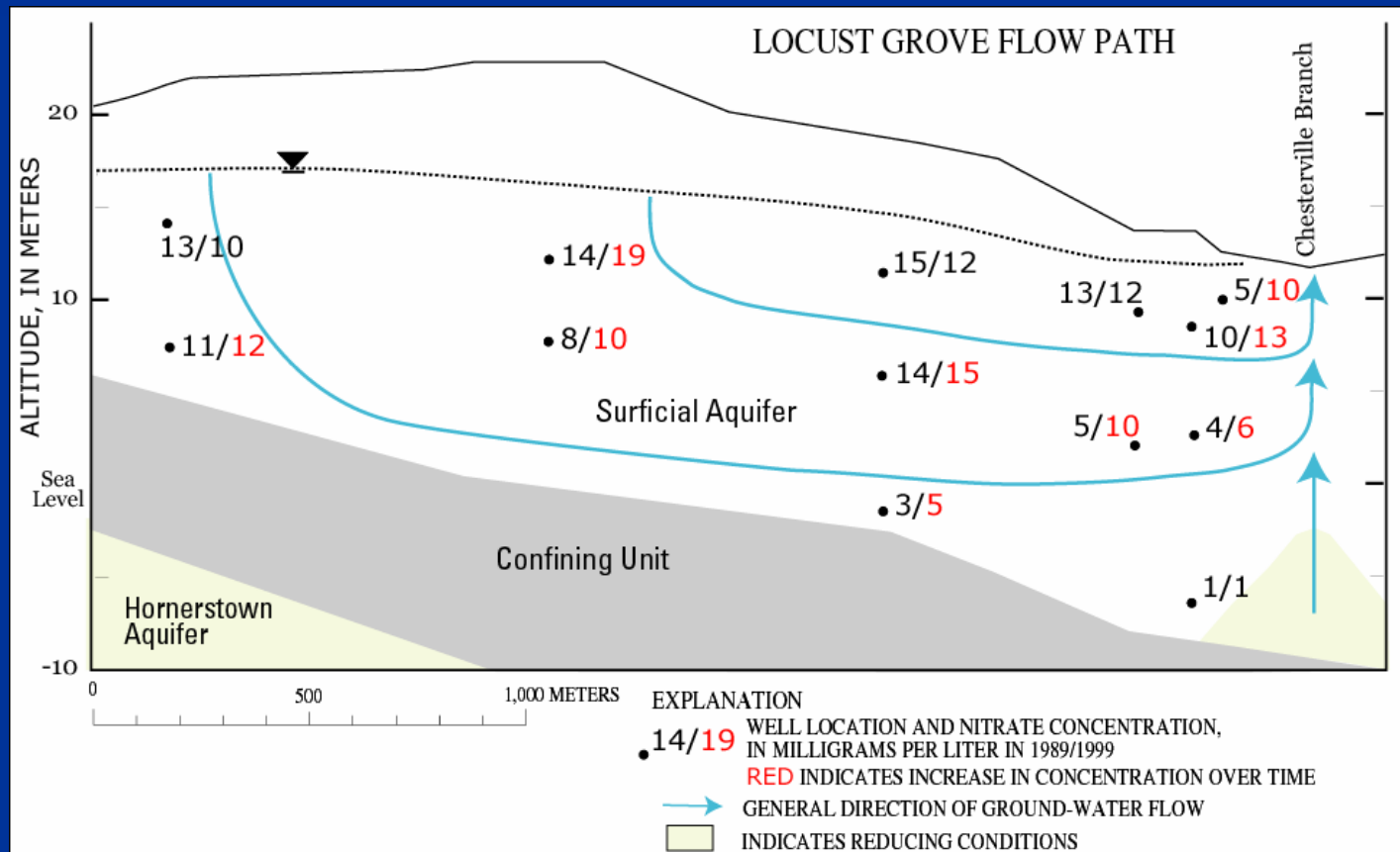


Nitrogen Fertilizer Use



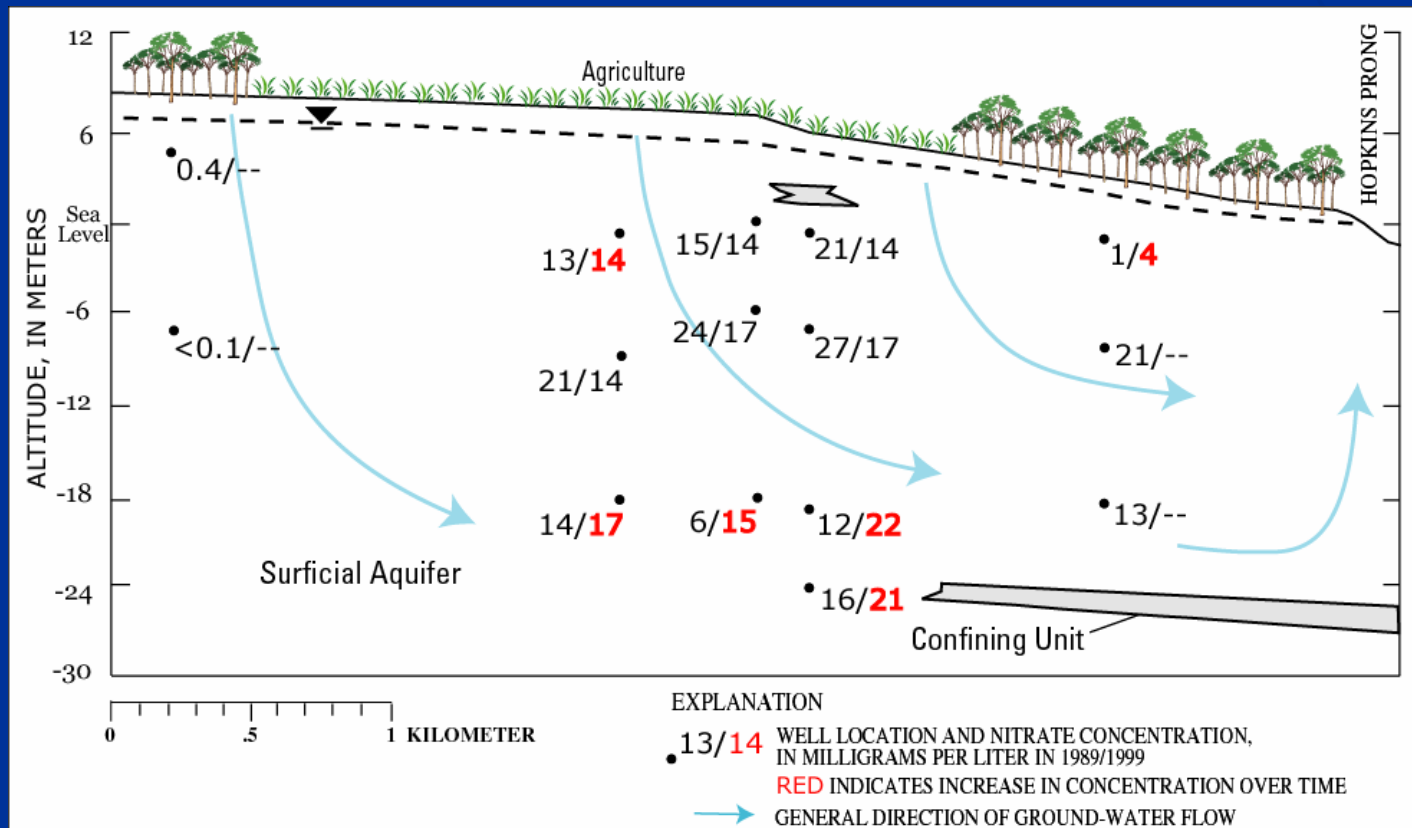
Locust Grove Flow System

- Sandy well-drained sediments
- Lower nitrate at depth: historical use and anoxic discharge from confined
- Higher nitrate moved farther into system over time
- Median unchanged (~10 mg/L)



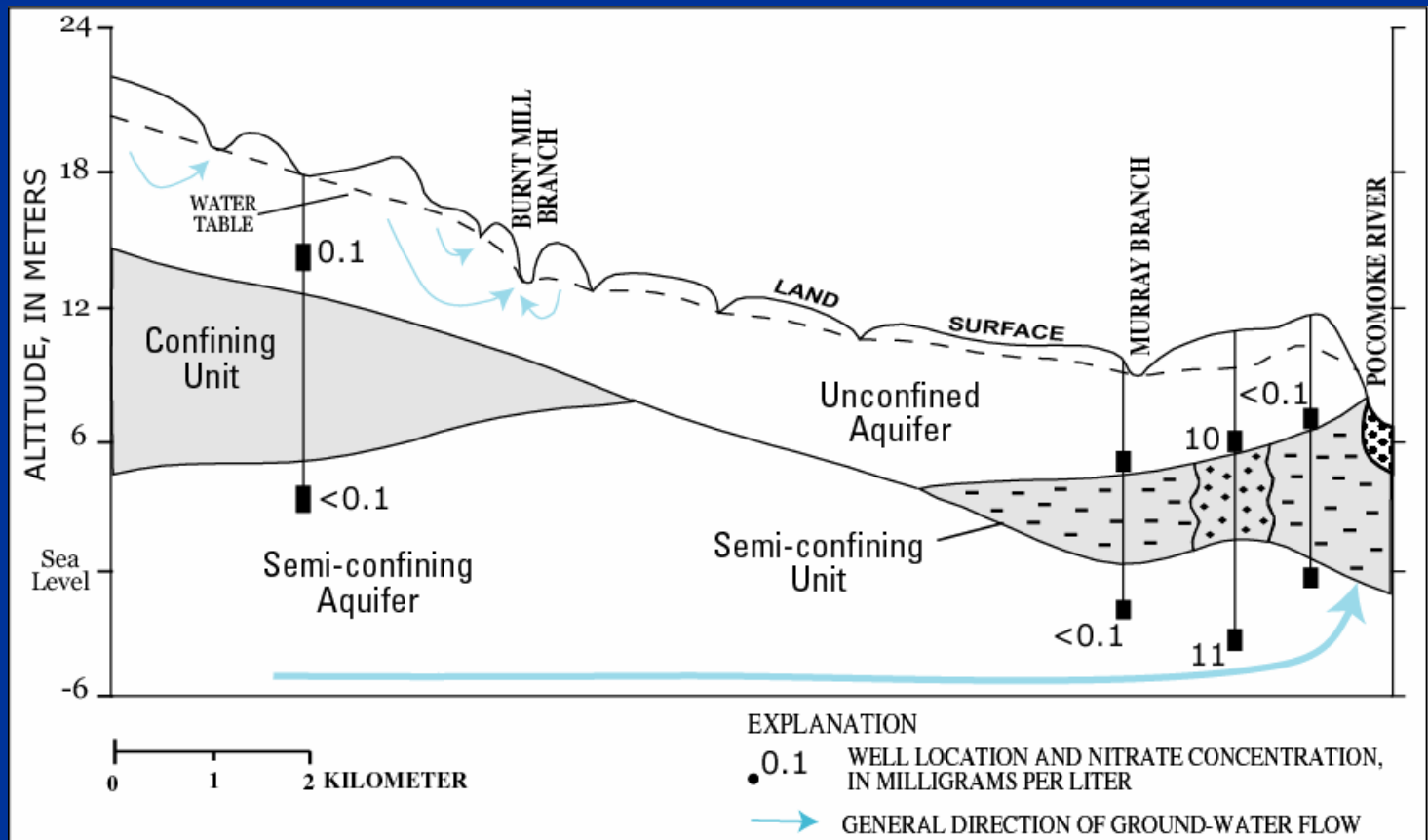
Fairmount Flow System

- Thick, sandy aquifer and oxic conditions throughout
- Nitrate affected by application of chicken manure
- Lower nitrate in shallow water beneath forested areas
- Higher nitrate at depth in upgradient agricultural land use



Willards Flow System

- Complex local flow system in shallow aquifer; regional flow in deeper aquifer
- Nitrate generally below detection level
- Higher nitrate in areas with sandy sediments
- Anoxic conditions and no evidence of human impact in deeper aquifer



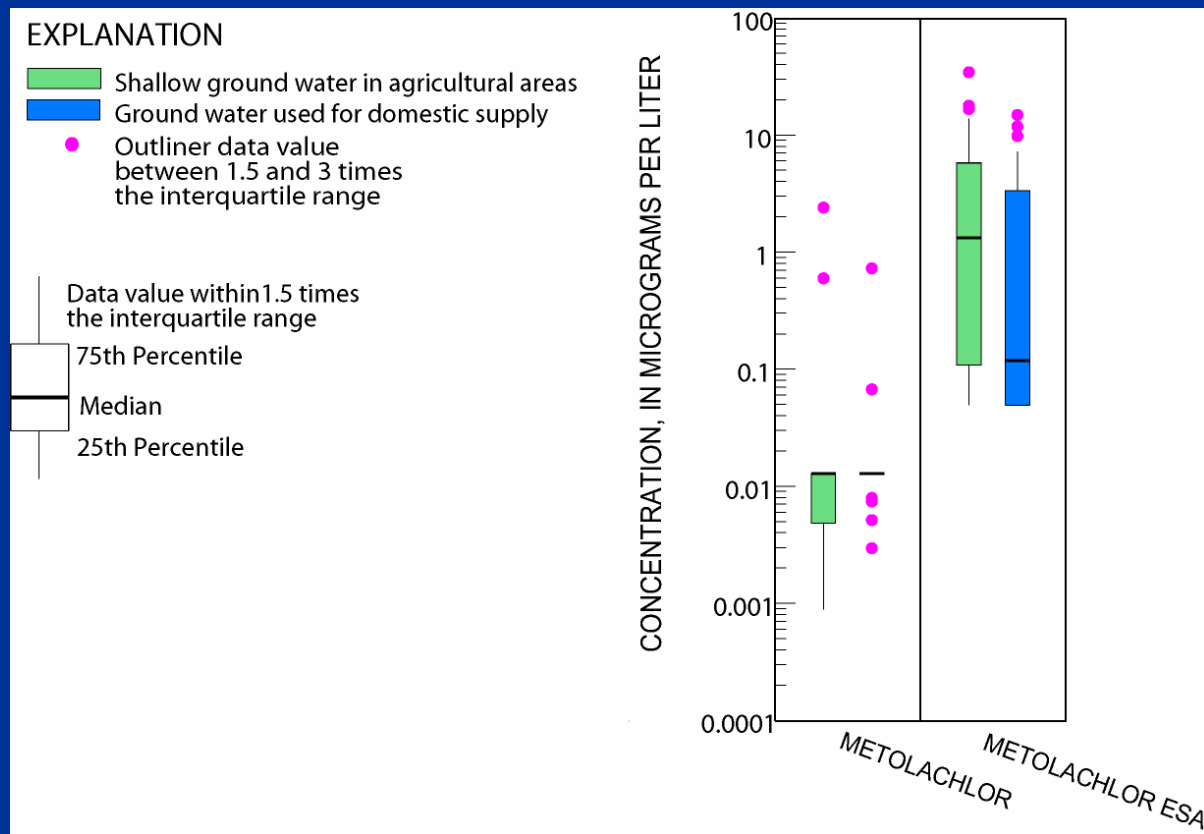
Spatial Trends in Pesticides

Regional Networks

- Pesticides and degradates detected in 93 percent of agLUS and 83 percent of MAS
- Widespread detection reflects abundant use, chemical properties, and aquifer characteristics
- Metolachlor, alachlor, and atrazine most commonly used and detected

Spatial Trends in Pesticides

- Degradates detected more frequently and at higher concentrations than parent compounds
- Pesticides higher in well-drained soils in the shallow agricultural wells and in oxygen-rich environments throughout aquifer



Temporal Trends in Pesticides

1988 to 2001

Higher detection frequencies in 2001 due to better analytical methods and lower reporting limits rather than increases in pesticide concentrations

Atrazine and metolachlor were the only compounds detected in both 1988 and 2001 in the same wells

Trends in Pesticides

Local-Scale Studies

- Occurrence similar in local-scale studies and regional studies
 - Atrazine and metolachlor or their degradates persist at low levels in water as old as 30 years in well-drained settings
 - Pesticides are not detected or present at very low levels even in shallow sediments in the poorly drained, organic-rich setting
- Generally little evidence of degradation as water travels along flow paths

Issues Related to Study Scale

Regional-scale studies

- Design has minimal control to limit factors affecting water quality
- Generalized results require use of statistics to distinguish between trends and noise in data
- Determine overall occurrence and distribution of compounds

Local-scale studies

- More control over factors affecting water quality
- Results used to help understand regional statistical analyses

Issues Related to Study of Long Term Trends

- Maintaining consistent network of sampling sites
- Changing lab methods, reporting levels, and analytical schedules
- Age-dating useful in flow-system studies to track changes in water chemistry over time; less useful on regional scales with mixed land uses