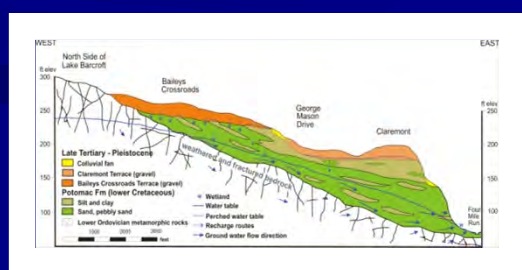
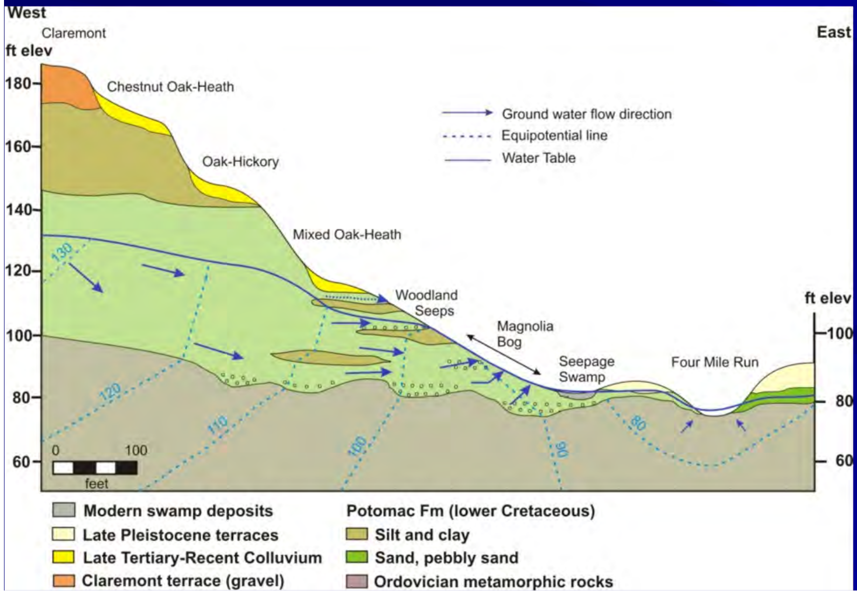
HYDROGEOLOGIC SETTING OF A FLORISTICALLY DISTINCTIVE GROUND-WATER SLOPE WETLAND ALONG THE FALL ZONE IN NORTHERN VIRGINIA

SCOPE OF PRESENTATION

- -Fall Line Magnolia Bogs: History and Background
- -Barcroft Magnolia Bog
  - -Physiographic and Cultural Setting
  - -Floristics
  - -Geology and Hydrostratigraphy
  - -Weathering and Geochemistry
  - -Flow System: Recharge, Discharge and travel time
  - -Management Issues



Ground Water Slope Wetlands



Major Features:

- **Commonly occur in the lower parts of steep regional slopes**
- **Hillside intersects perennial water table**
- **Springs and seeps commonly concentrated along toes of slopes**
- **Perched systems may also be present: ground water forced to surface along tops of poorly permeable units**
- **Seepage faces can extend significant distances upslope depending on geology**
- **Geochemistry ranges widely. Most are circum-neutral to acidic**
- **Other names: seepage faces, seepage bogs, seepage swamps, 'poor' fens, Fall Line Magnolia Bogs**

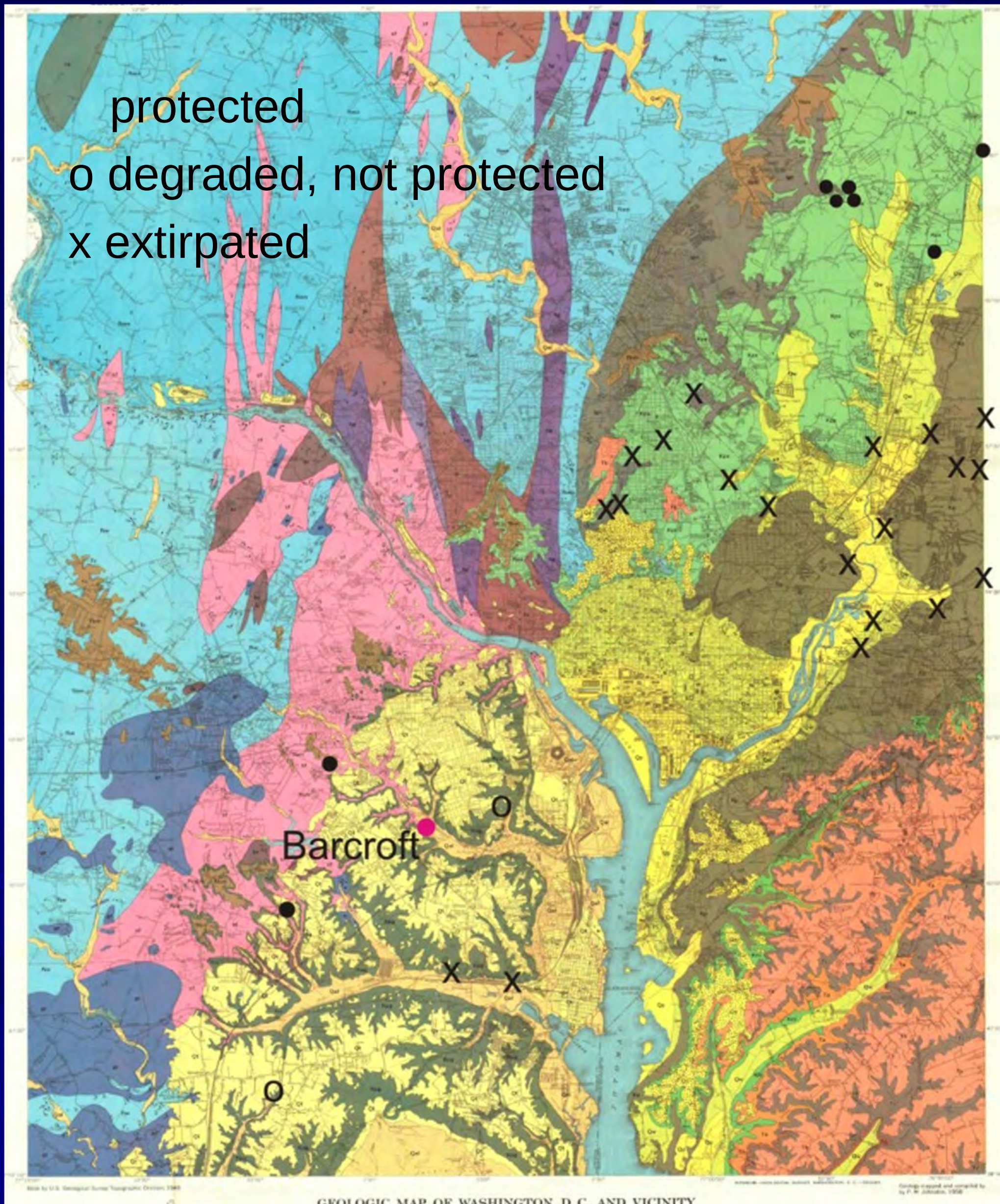
FALL LINE MAGNOLIA BOGS

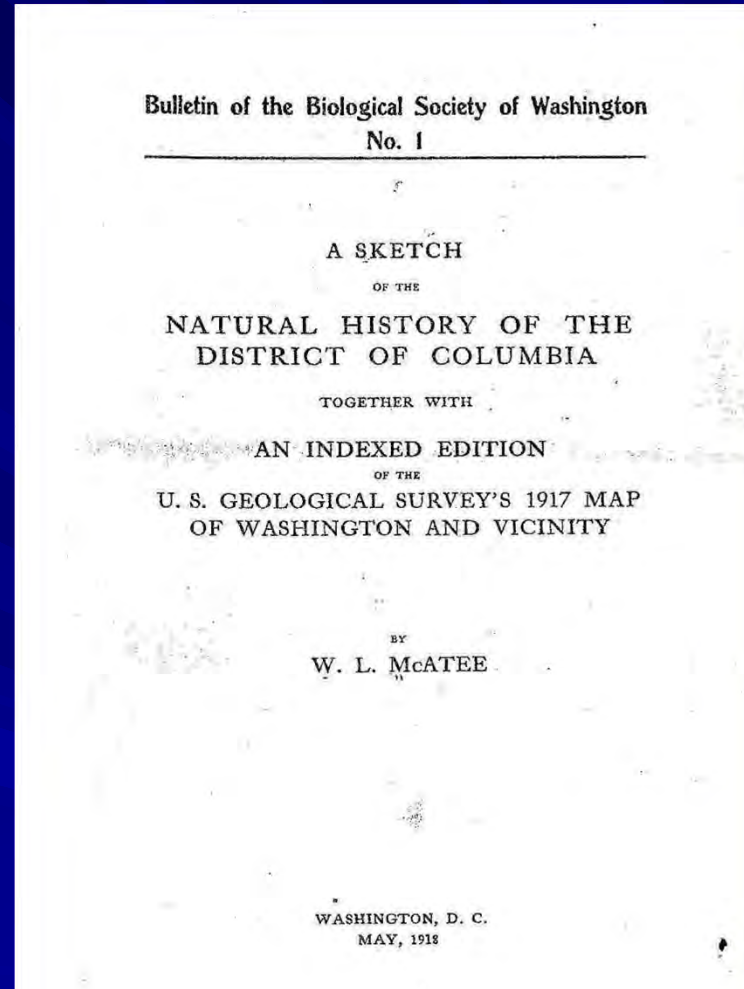
Named for ***Magnolia virginiana***, 'Sweetbay' or 'Swamp' Magnolia

FALL LINE MAGNOLIA BOGS

The Fall Line, or ‘Fall Zone’, is a first order physiographic boundary between the Piedmont Plateau on the west and the Atlantic Coastal Plain to the east. It is defined by deeply-entrenched stream valleys that commonly form gorges, cascades, and small waterfalls.

FALL LINE MAGNOLIA BOGS





Bulletin of the Biological Society of Washington
No. 1

A SKETCH
OF THE
NATURAL HISTORY OF THE
DISTRICT OF COLUMBIA
TOGETHER WITH
AN INDEXED EDITION
OF THE
U. S. GEOLOGICAL SURVEY'S 1917 MAP
OF WASHINGTON AND VICINITY

BY
W. L. McATEE

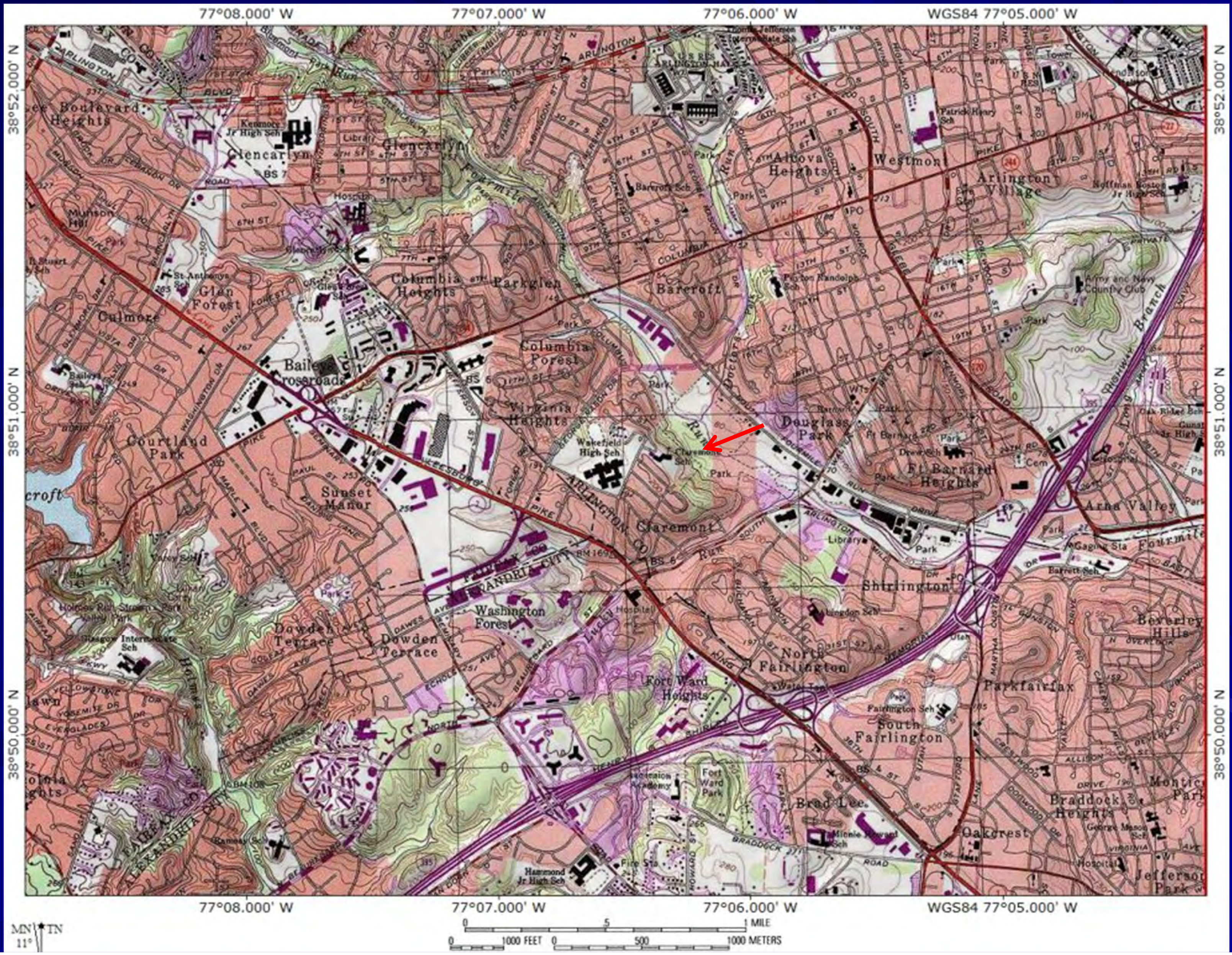
WASHINGTON, D. C.
MAY, 1918

-McAtee published first description of 'white sand and gravel bogs'

-Coined the name 'magnolia bogs'

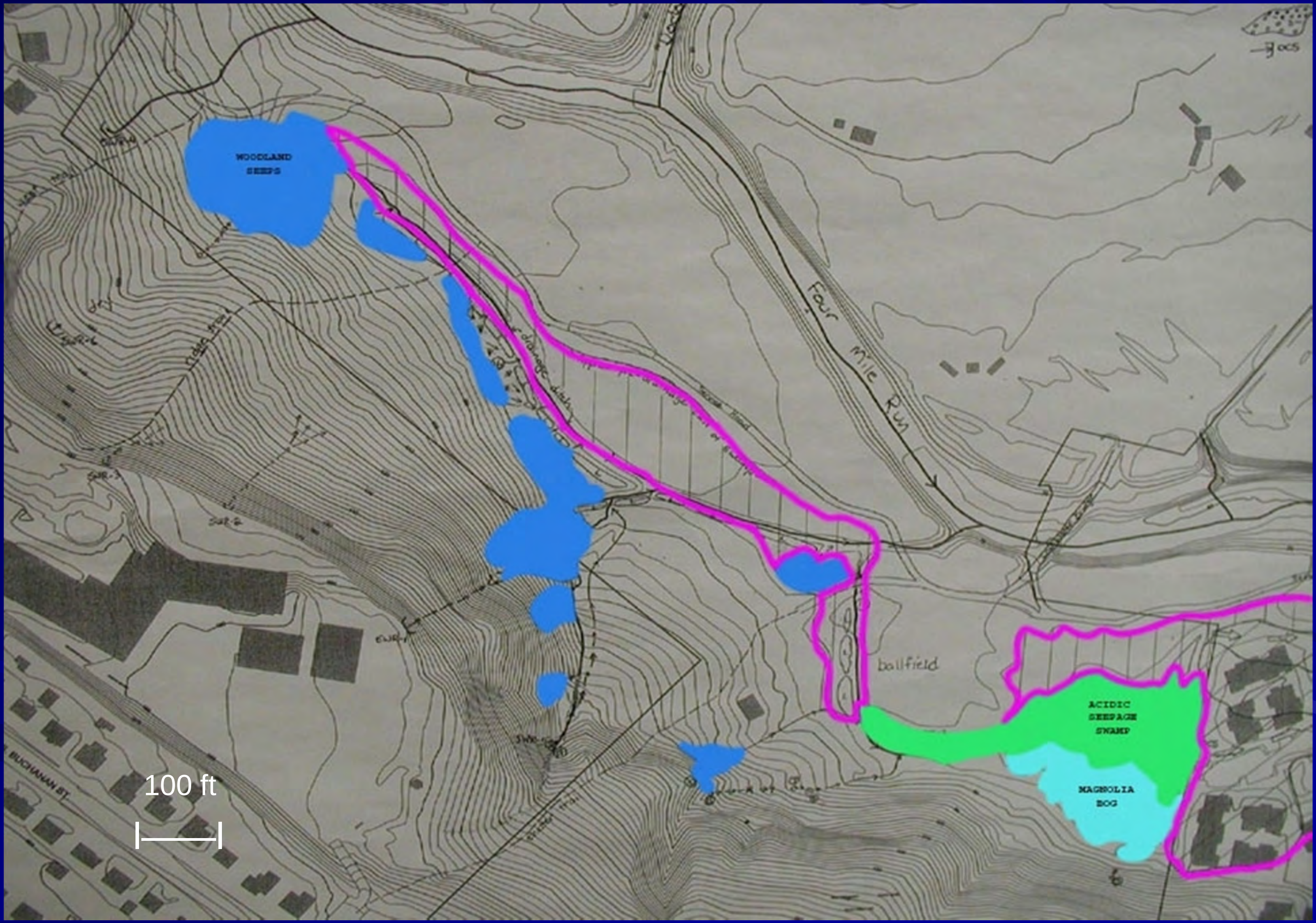
BARCROFT MAGNOLIA BOG

CULTURAL AND TOPOGRAPHIC SETTING



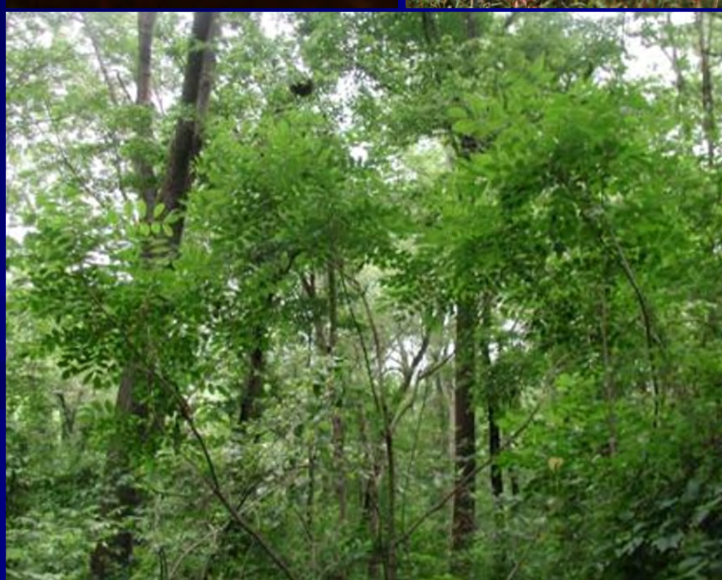
BARCROFT MAGNOLIA BOG

HISTORICAL EXTENT OF WETLANDS



BARCROFT MAGNOLIA BOG
FLORISTICALLY DISTINCTIVE





- -Barcroft was one of the original sites described by McAtee in 1918
- -The site was ‘rediscovered’ by ecologists in 2003, nearly a century later, almost by accident
- -Contains many regionally rare plants: some 2 dozen county records have been found at the site: highbush blueberry, sweetbay magnolia, false hellebore, Turk’s cap, sphagnum, slender wood oats, swamp haw, wood anemone, cinnamon fern, southern lady fern, and many others
- -Supports the largest colonies of poison sumac and swamp azalea in northern VA

BARCROFT MAGNOLIA BOG
FLORISTICALLY DISTINCTIVE

- Many plants here are acidophiles, as well as obligate or facultative wetland plants
- Two main ecological communities are classified at the site:

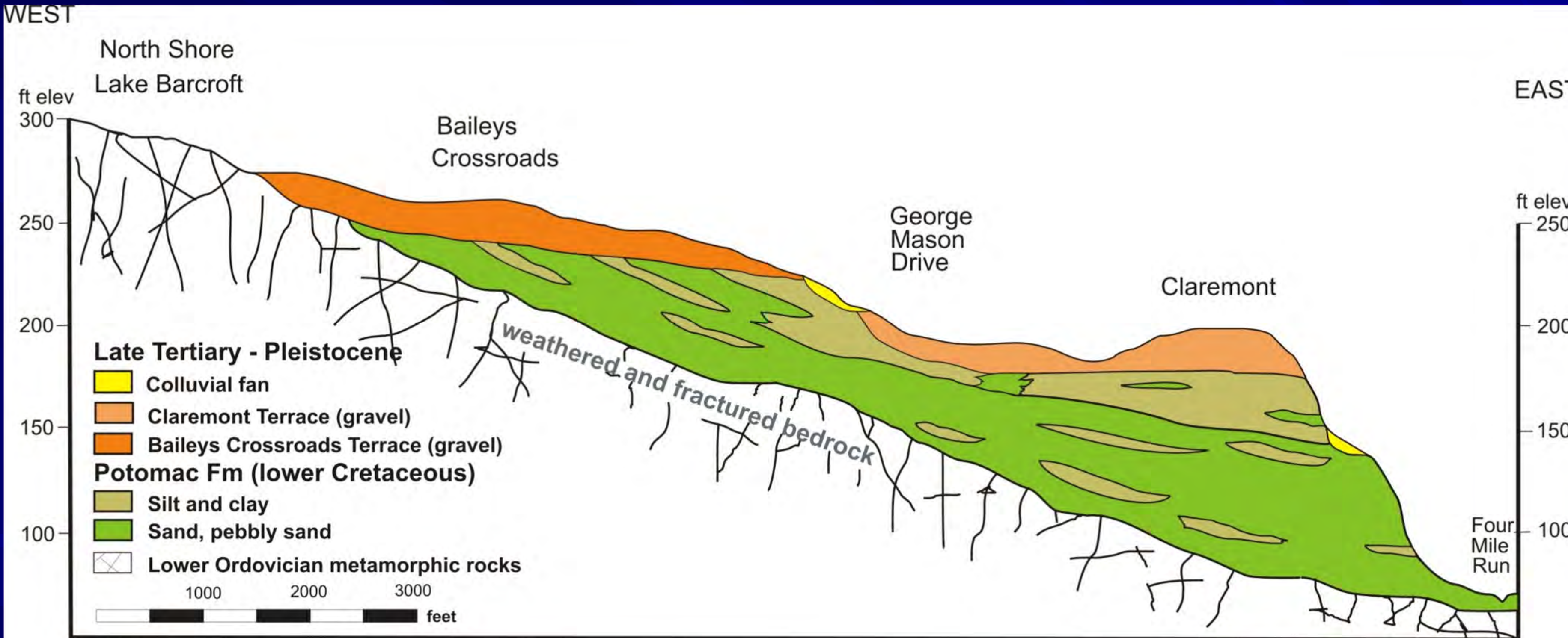
  -Fall-line Terrace Gravel Magnolia Bog (G1), extant at less than 10 sites globally

  -Acidic Piedmont Seepage Swamp (G3), uncommon
- Ecological and historical evidence indicates that fire was an important factor in maintaining the openness of the bog community type
- Closest facsimile: NJ pine barrens

Ecological Processes

- -Hummocky topography on bog floor
- -Hydrogeologically-driven process
- -Produced by growth of sphagnum mounds
- -Eventually colonized by shrubs and trees

HYDROGEOLOGIC FRAMEWORK



HYDROGEOLOGIC FRAMEWORK

QTc-Terrace gravel

Potomac Formation

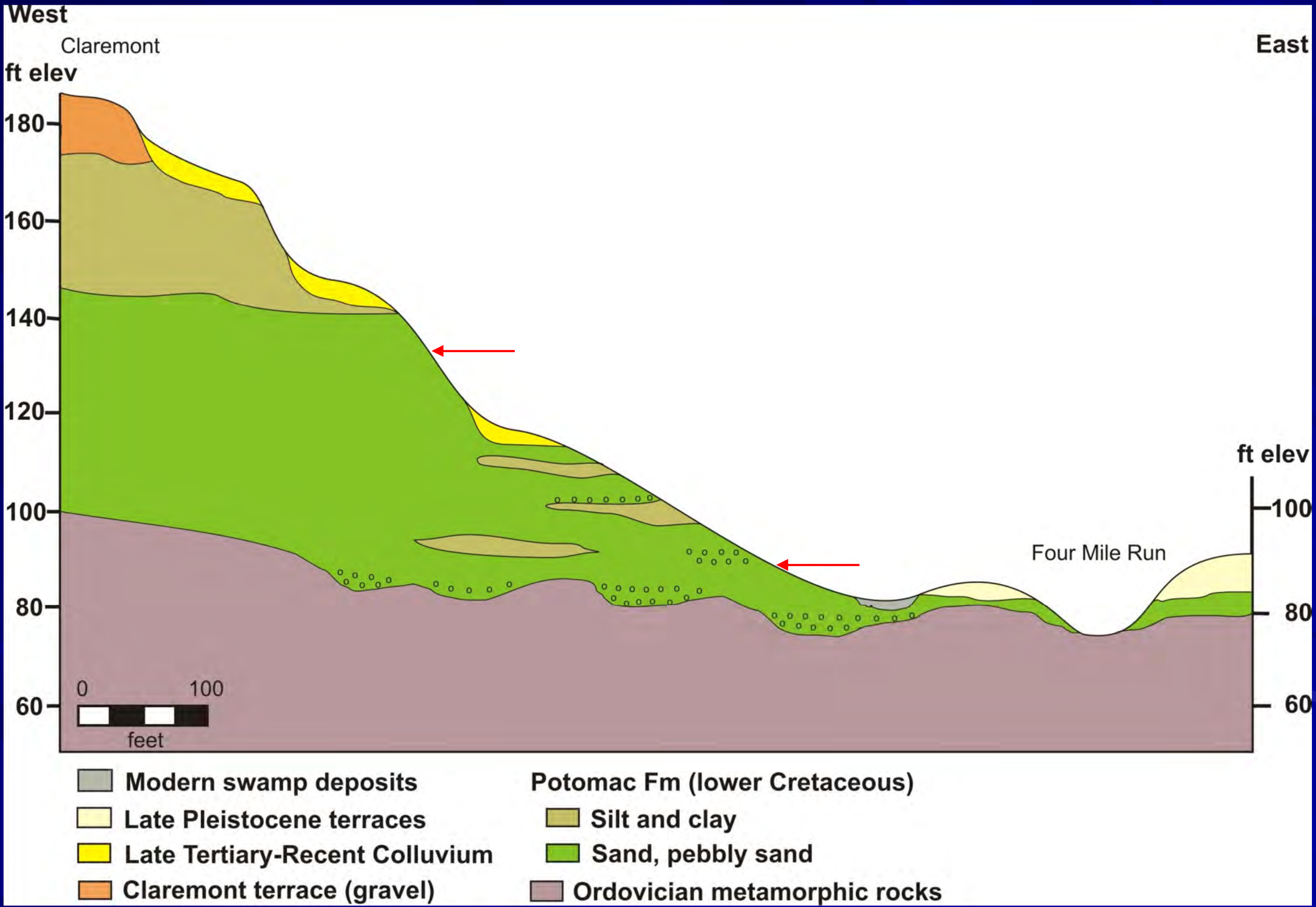
Kpc- Silty Clay (Lincolnia member) beneath colluvial fans

Kps-basal sand

Qs-modern swamp sediments over Kps

HYDROGEOLOGIC FRAMEWORK

LOWER POTOMAC AQUIFER



HYDROGEOLOGIC FRAMEWORK

Potomac Formation-Basal Sand Aquifer

HYDROGEOLOGIC FRAMEWORK

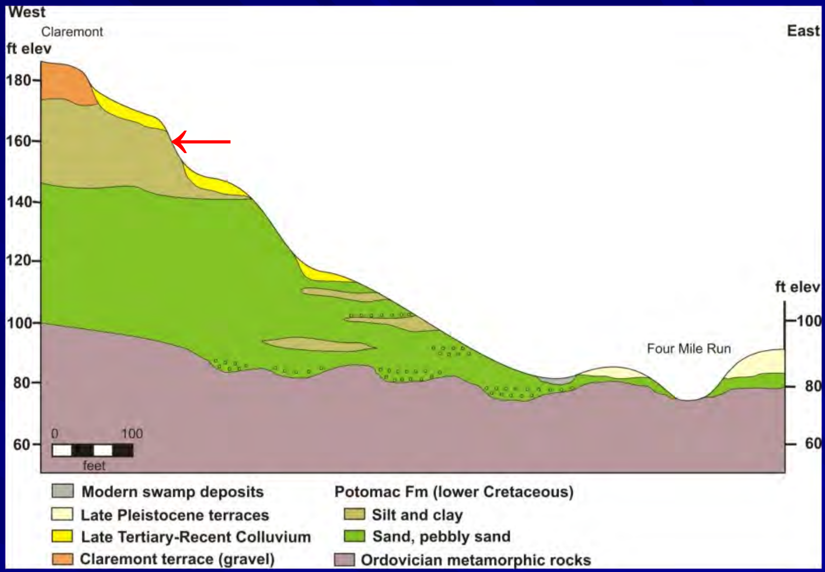
Potomac Formation-Basal Sand Aquifer

HYDROGEOLOGIC FRAMEWORK

Potomac Formation-Basal Sand Aquifer

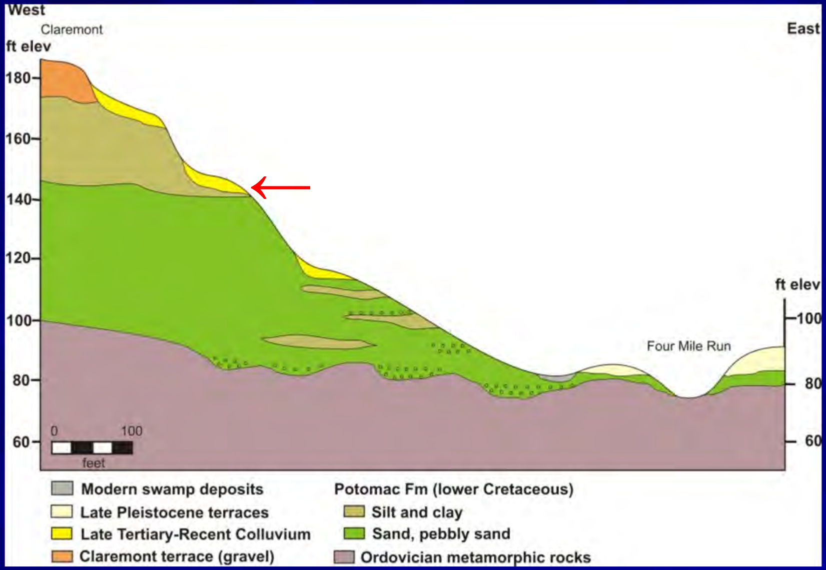
HYDROGEOLOGIC FRAMEWORK

Potomac Formation-Lincolnia Silty Clay



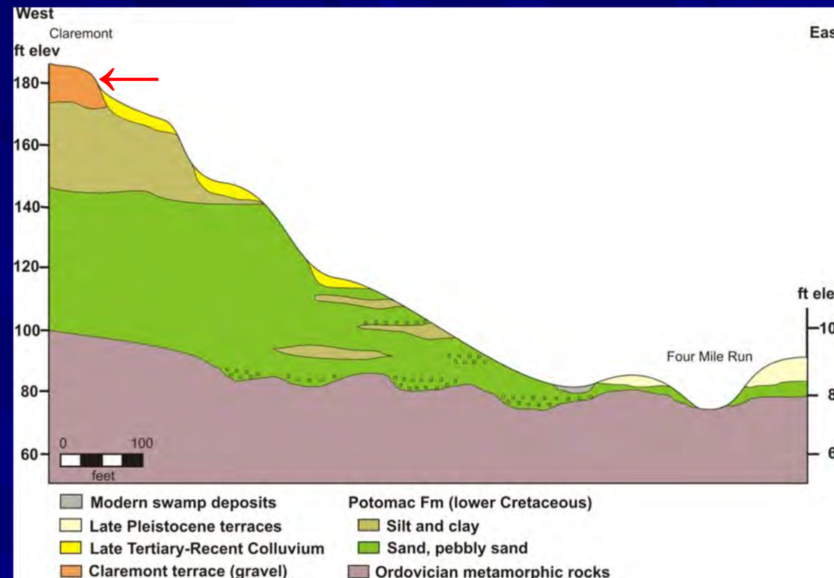
HYDROGEOLOGIC FRAMEWORK

Colluvial Fans



HYDROGEOLOGIC FRAMEWORK

Late Tertiary-Pleistocene Terrace Gravel



HYDROGEOLOGIC FRAMEWORK

Weathering and Geochemistry

-Strong Late Tertiary-Pleistocene weathering profiles preserved on uplands

-Depth of weathering locally >150 feet

-Extends into bedrock

-Thoroughly leached: no bases left

-Feldspars in Potomac Fm converted to kaolinite at depths >100 feet

-"Ghosts" of large siliceous clasts

-Sassafras-Neabsco-Croom Soils dominant on uplands

-Well developed ultisols on terrace gravel and Potomac Formation

-Acid: soil pH typically $\leq$ 5.0

-Thick fragipans common on level parts of terrace gravels (Neabsco Soils)

-Weathering profiles progressively truncated across regional slopes

-Toeslopes exhibit less colorful post-Pleistocene soil profiles, though still deeply weathered

HYDROGEOLOGIC FRAMEWORK

Ground-Water Geochemistry

Sources of Data

-This study: chemical analyses of two springs at Barcroft Magnolia Bog

-USGS WSP 1776: Samples from dozens of wells constructed before 1960. About 15 analyses are from the lower Potomac Formation aquifer, widely distributed in VA, DC, and MD

-Virginia Natural Heritage Database: Miscellaneous analyses of pH and temperature from magnolia bogs in Virginia, DC, and Maryland

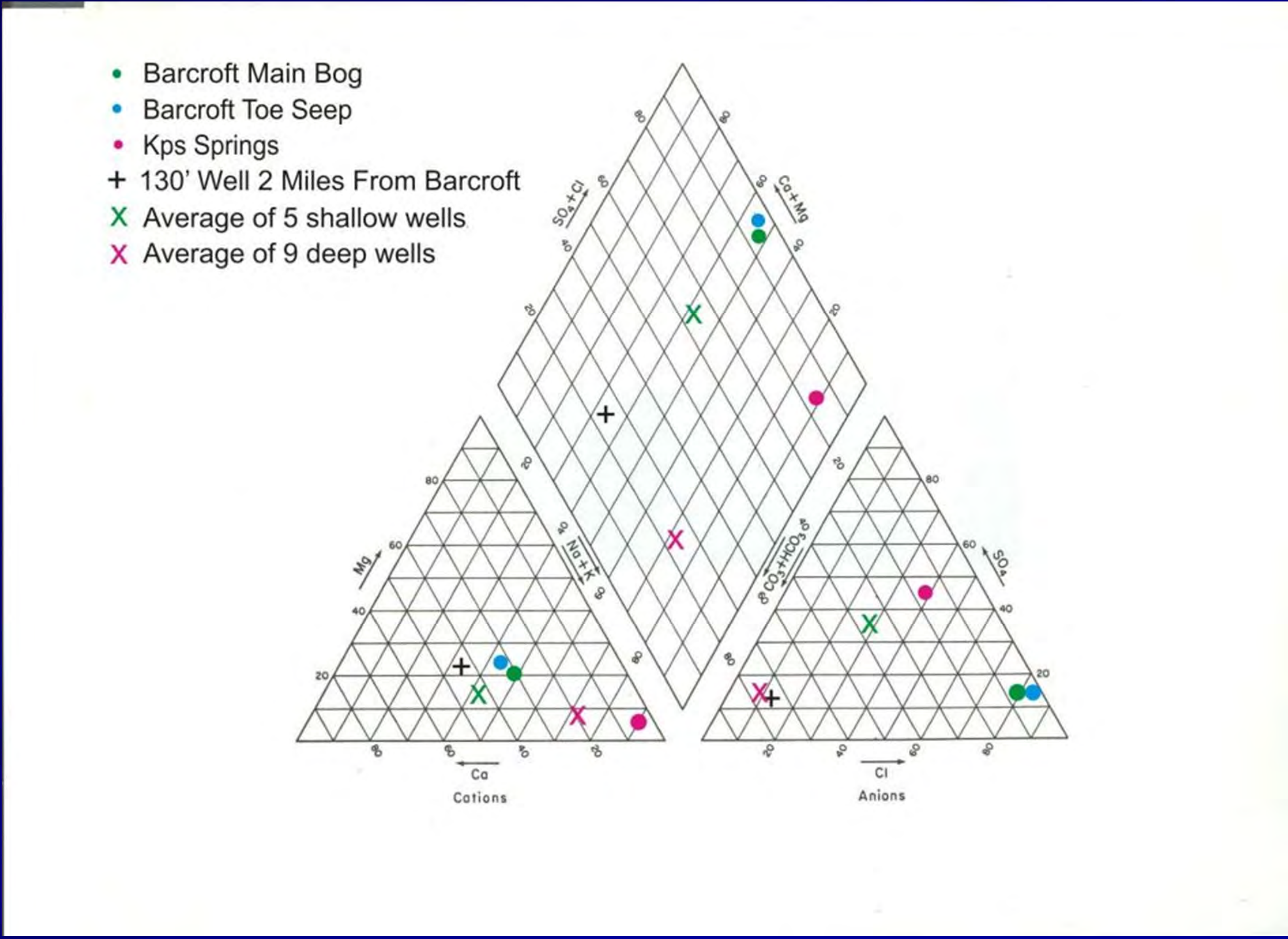
-Visual and ecological: prominent acidophiles (sphagnum, azalea, magnolia, etc). Thriving population of iron bacteria

HYDROGEOLOGIC FRAMEWORK

Ground-Water Geochemistry at Barcroft Bog

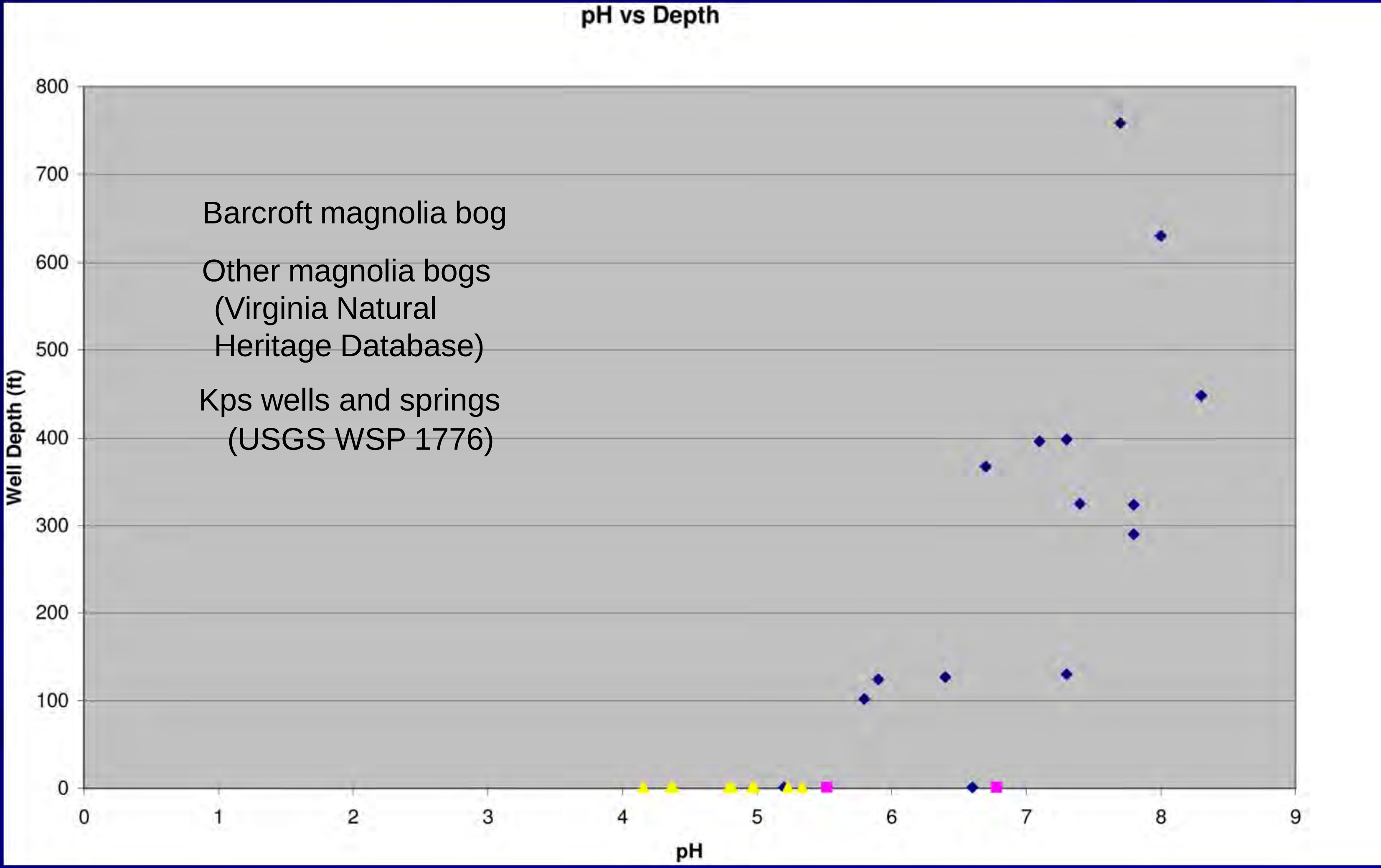
	Main Bog	Toe Seep
pH	6.78	5.52
TDS	102	116
Ca	7.6	9.2
Mg	5.4	5.8
K	3.9	4.4
Na	7.9	8.5
HCO3	2	1
SO4	7.4	7.6
Chl	40.5	40.8
NO3	1	1.4
PO4	<0.07	<0.07
B	<0.01	<0.01
Mn	5.4	5.8
Fe	0.8	0.7

Comparative Ground-Water Geochemistry Lower Aquifer of the Potomac Formation



HYDROGEOLOGIC FRAMEWORK

Ground-Water Geochemistry



Geochemistry: Visual and Ecological Evidence





Observed Water Temperature Range

4.5 – 13º C (40 – 55º F)

Skunk Cabbage (***Symplocarpus foetidus***)

Hydrogeologically Adapted Thermophile

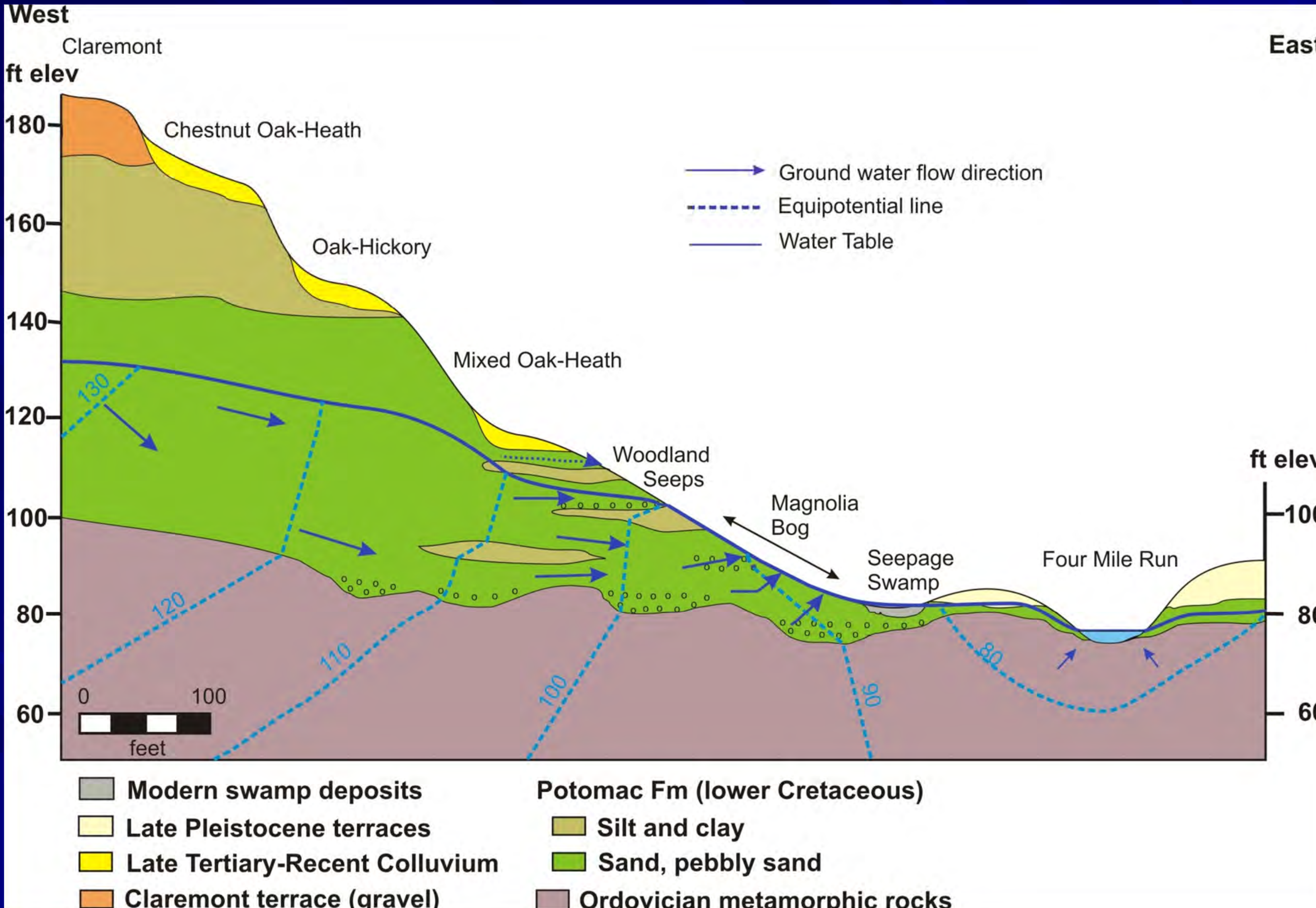
Ground Water Discharge Indicator

Ground Water Flow System

Well-Defined Discharge Area

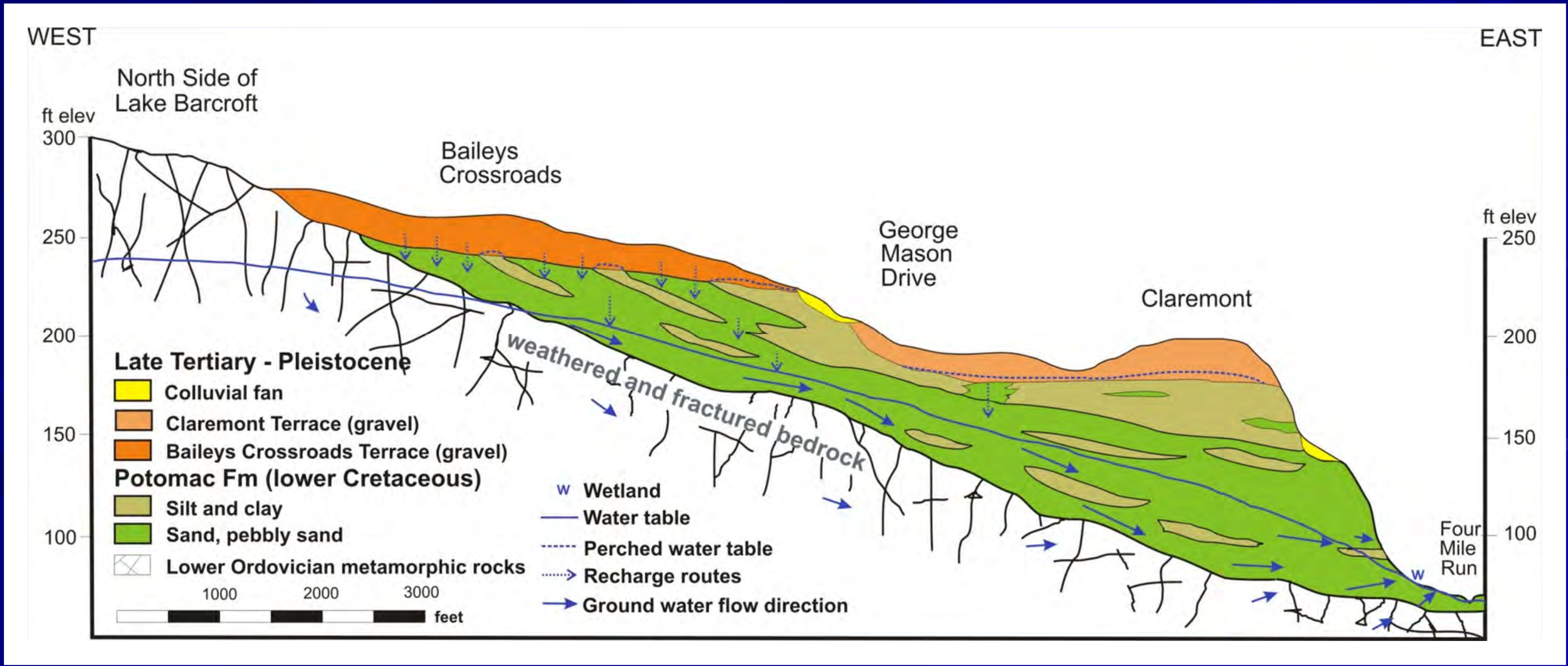
Ground Water Flow System

Where is the Recharge Area?



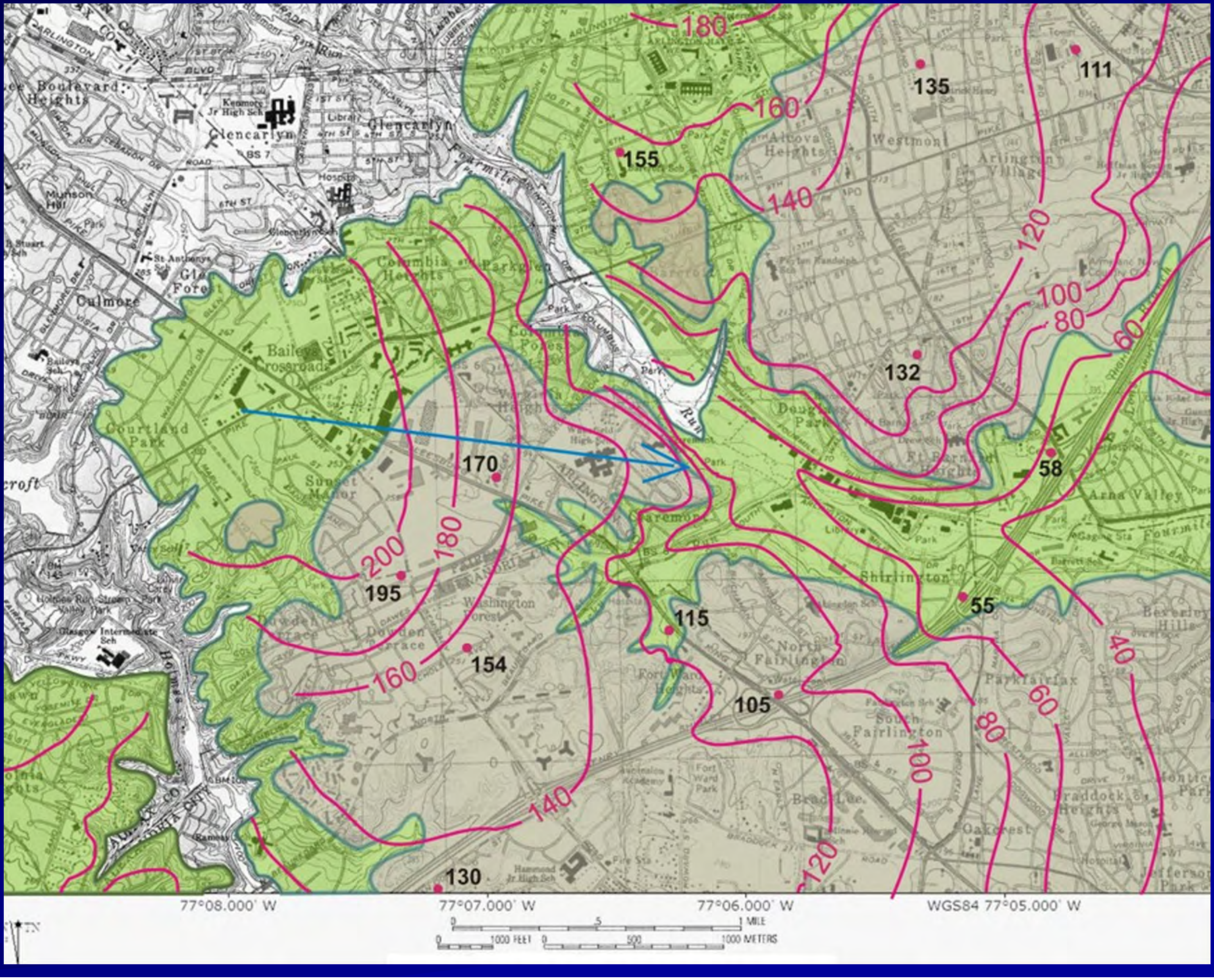
Ground Water Flow System

Local Cross-Section of the Basal Potomac Aquifer



Ground Water Flow System

Recharge Area-Subcrop of Aquifer



Ground Water Flow System

Discharge at Barcroft Natural Area: 300+ GPM

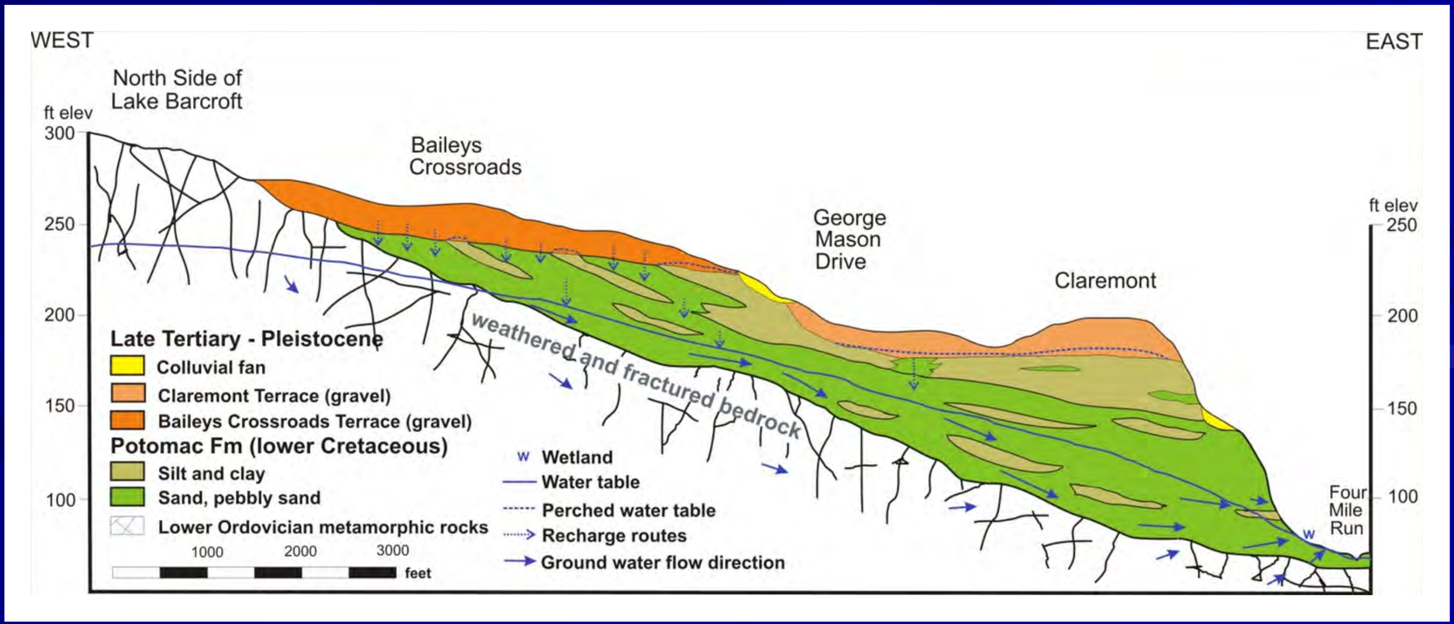
-Simple Empirical Calculation: Q = K x I x A

K = 20+ ft/day based on several long-term pump tests

I = 0.1 Hydraulic gradient below wetland

A = 30,000 sq ft (2,000 ft wide x 15 ft saturated thickness)

Q = 60,000 cubic feet per day, or about 312 gpm



Ground Water Flow System

Decadal Travel Time from Recharge Area to Wetland

Travel time = length (L) / seepage velocity (v)

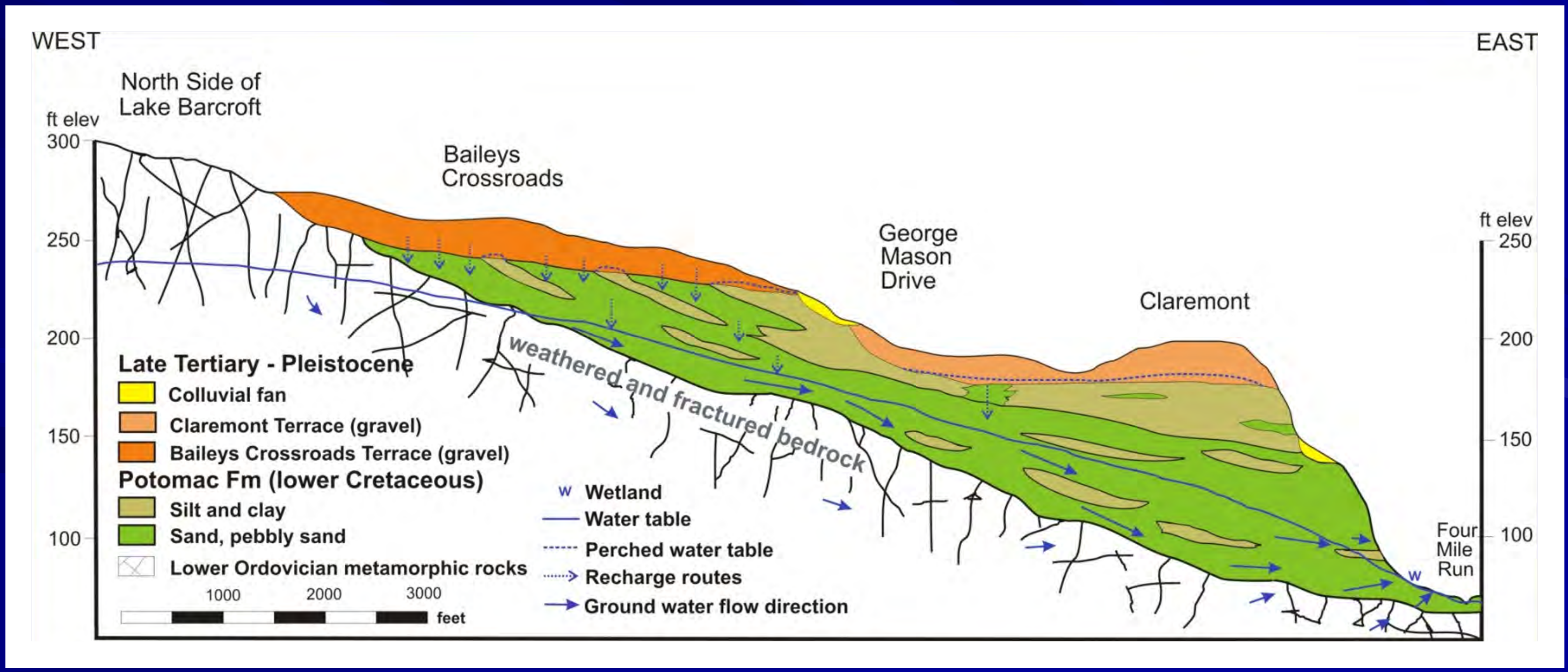
L = 8,000 feet, the distance from center of aquifer subcrop to wetland

v = (K x I)/n   effective n assumed to be 25% for weathered sand

I = 0.01 Water table slope between recharge area and site (80 ft/8,000 ft)

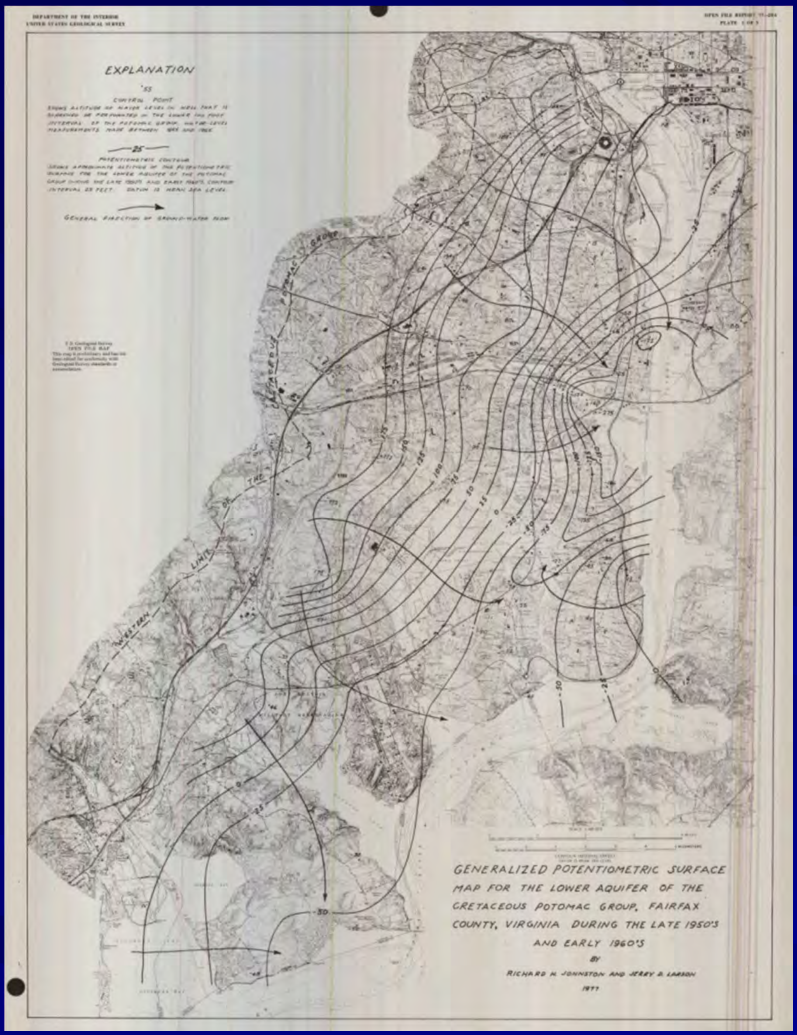
v = (20 feet/day)(0.01)/0.25 = 0.8 feet/day

travel time = (8,000 feet)/(0.8 feet/day) = 10,000 days, or roughly 27 years

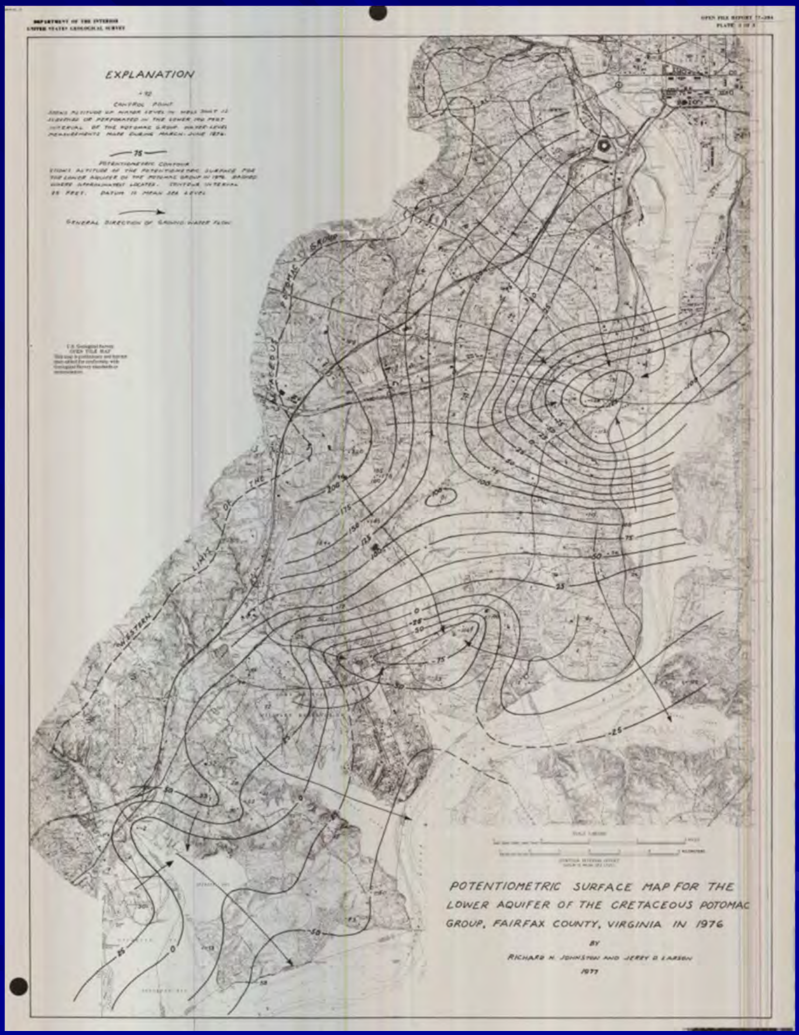


Management Issues

High-Capacity Wellfields: Dewatering of Aquifer



1960



1976

USGS OFR 77-284

Management Issues
Urbanization

BARCROFT MAGNOLIA BOG
THEN AND NOW-URBANIZATION

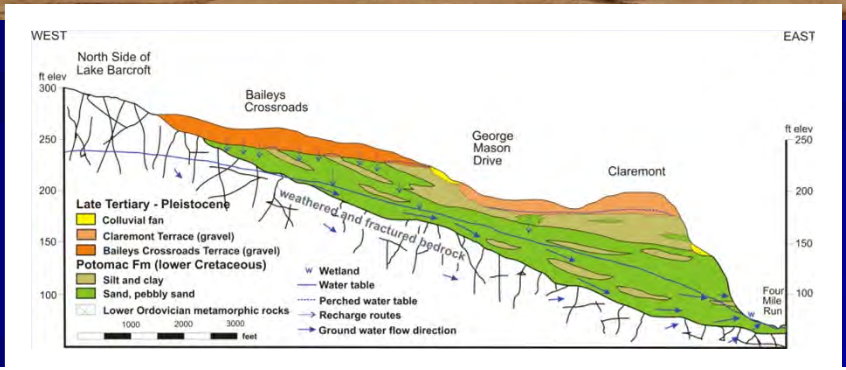
1934

1980

Management Issues

Urbanization of Recharge Area

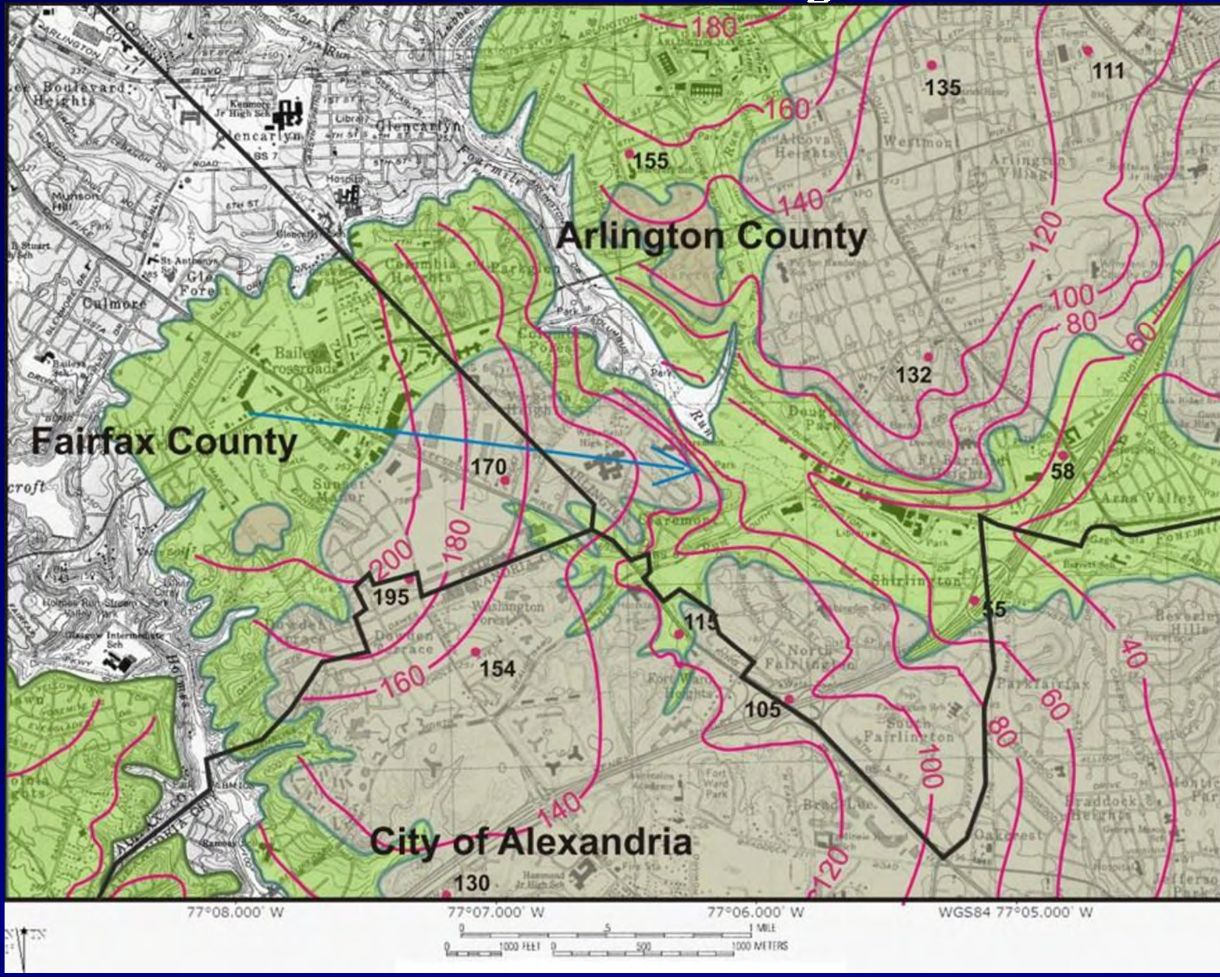
Byproduct: Geologic Opportunities!



Management Issues

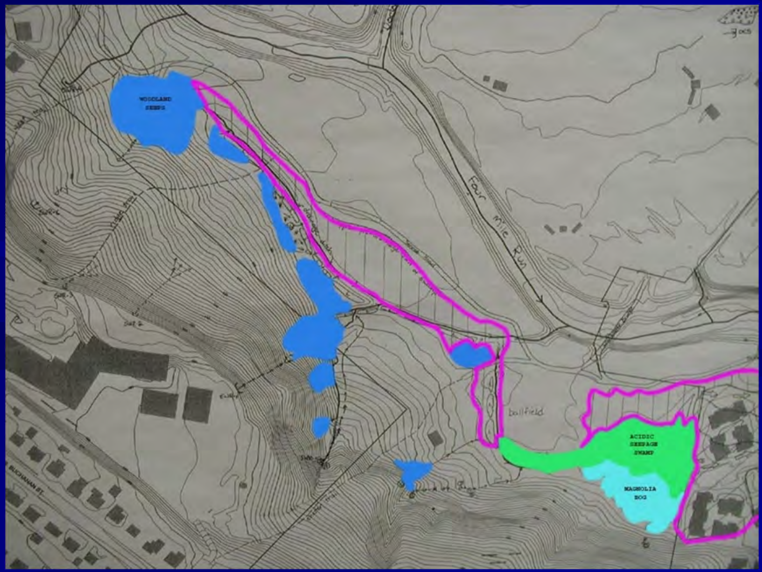
Urbanization of Recharge Area: 40-50% Impervious

Management Issues
Urbanization of Recharge Area



Management Issues

Storm-Water Erosion and Sediment Deposition



Management Issues

Storm-Water Erosion and Sediment Deposition




Acknowledgments

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