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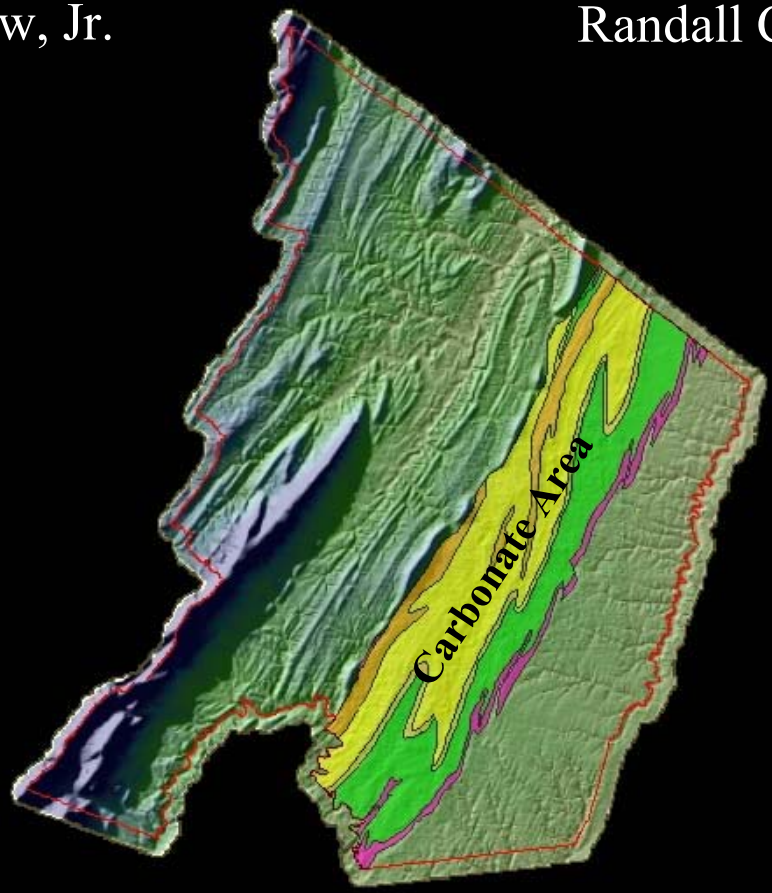
Frederick County Ground-Water

George E. Harlow, Jr.

Randall C. Orndorff



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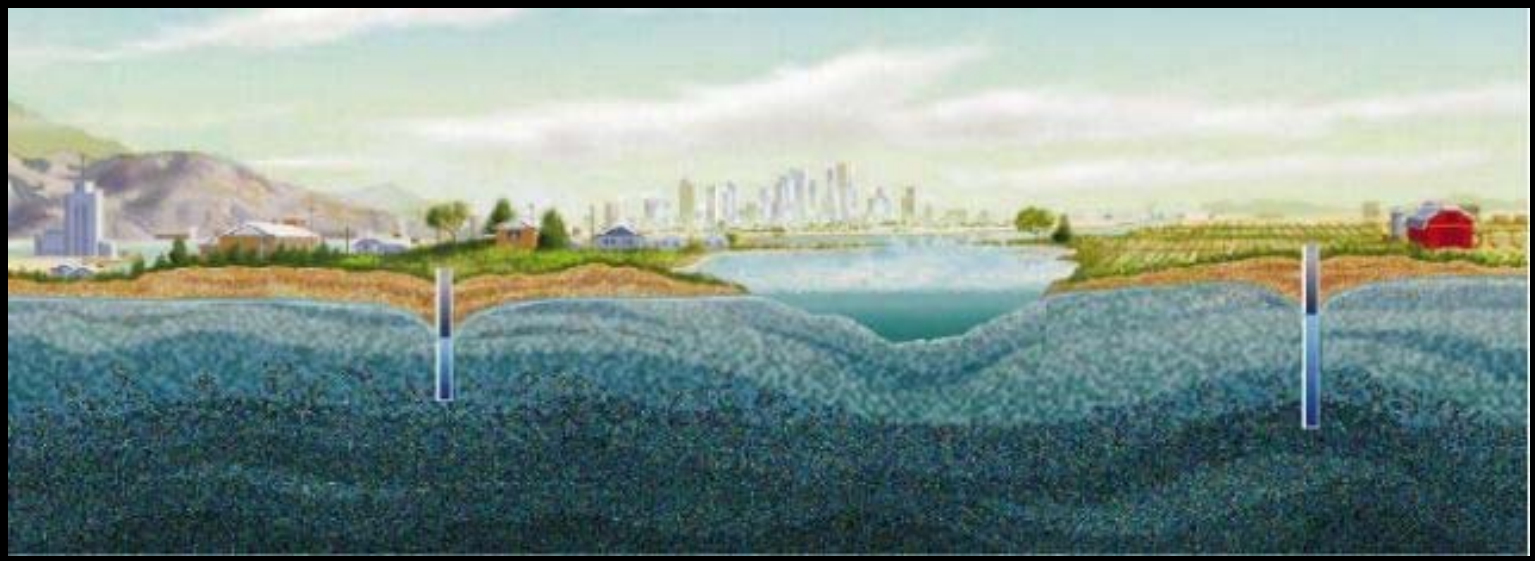
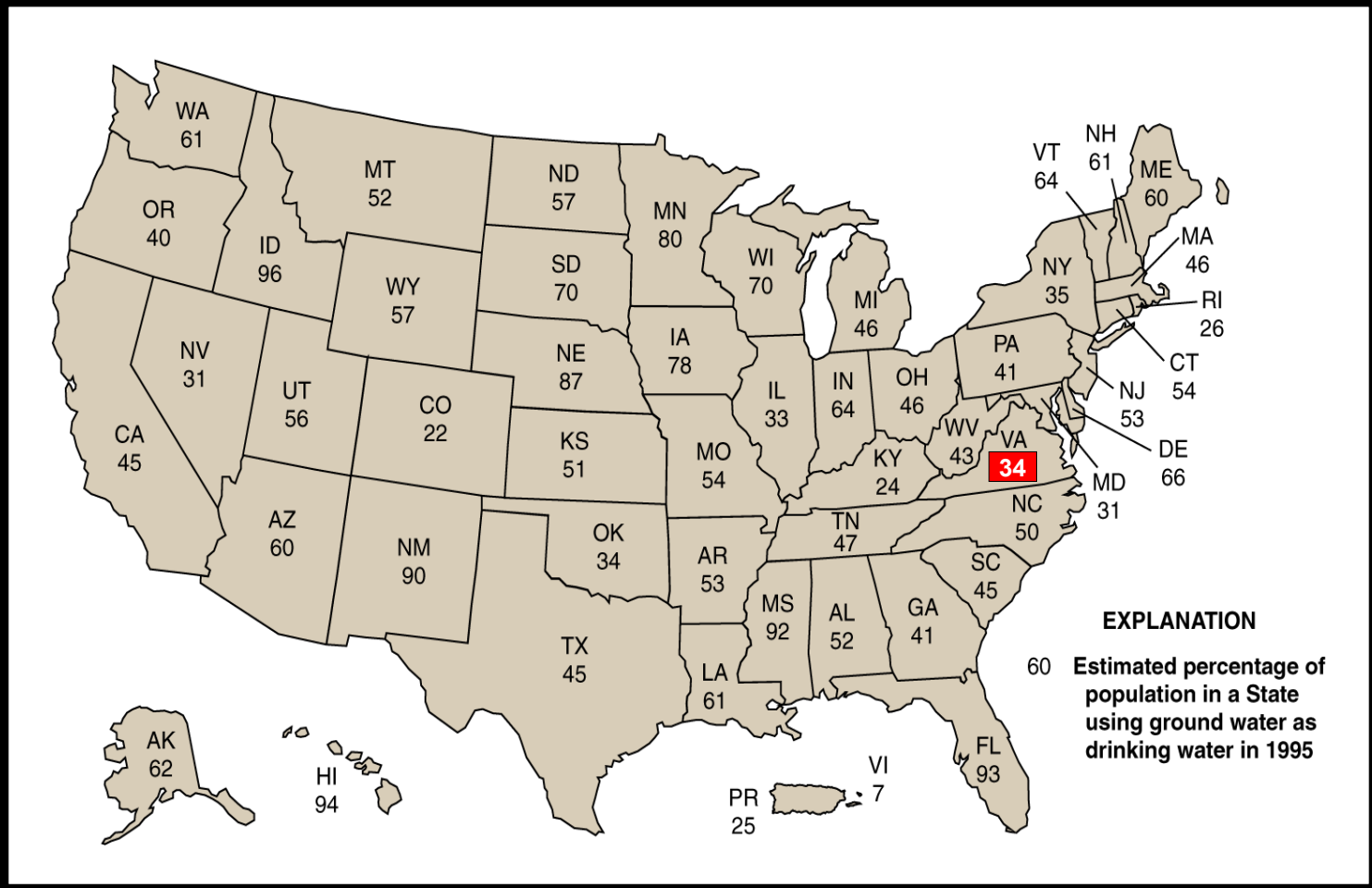
Ground-Water Basics



Ground-Water Use in the United States (1995)



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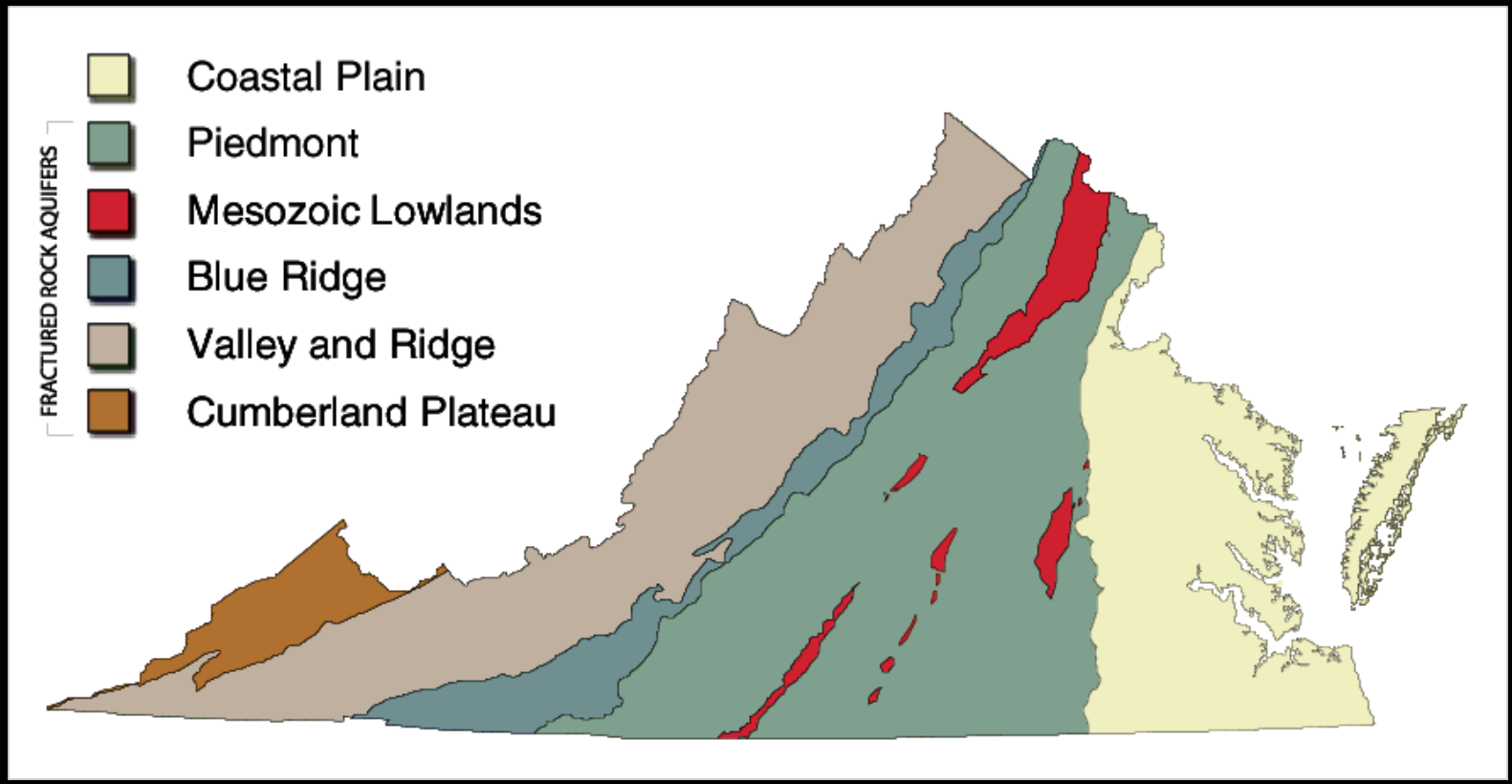
Physiographic Provinces of Virginia



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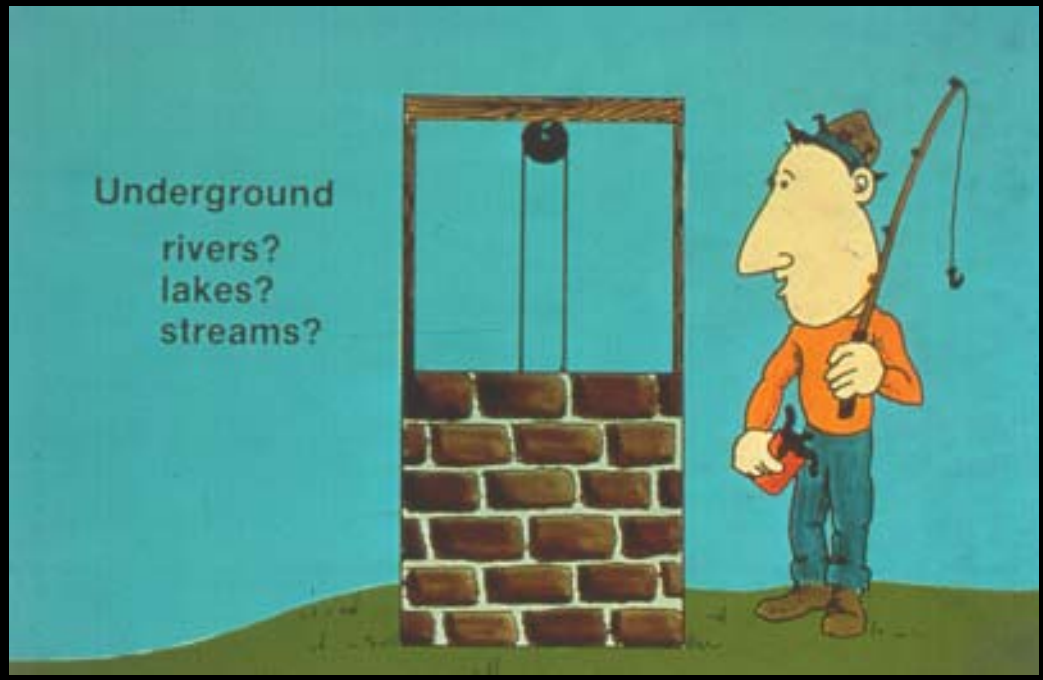
Ground-Water Misconception



Aquifer Material

Sand

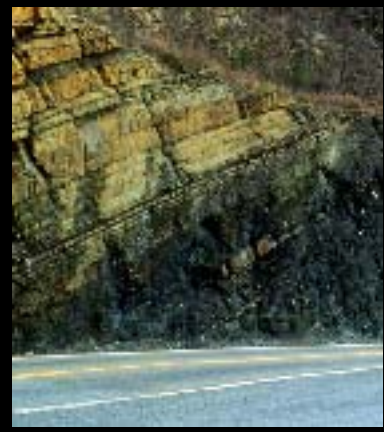
Crystalline rock

Carbonates

Shell material

Sedimentary rock

Coal



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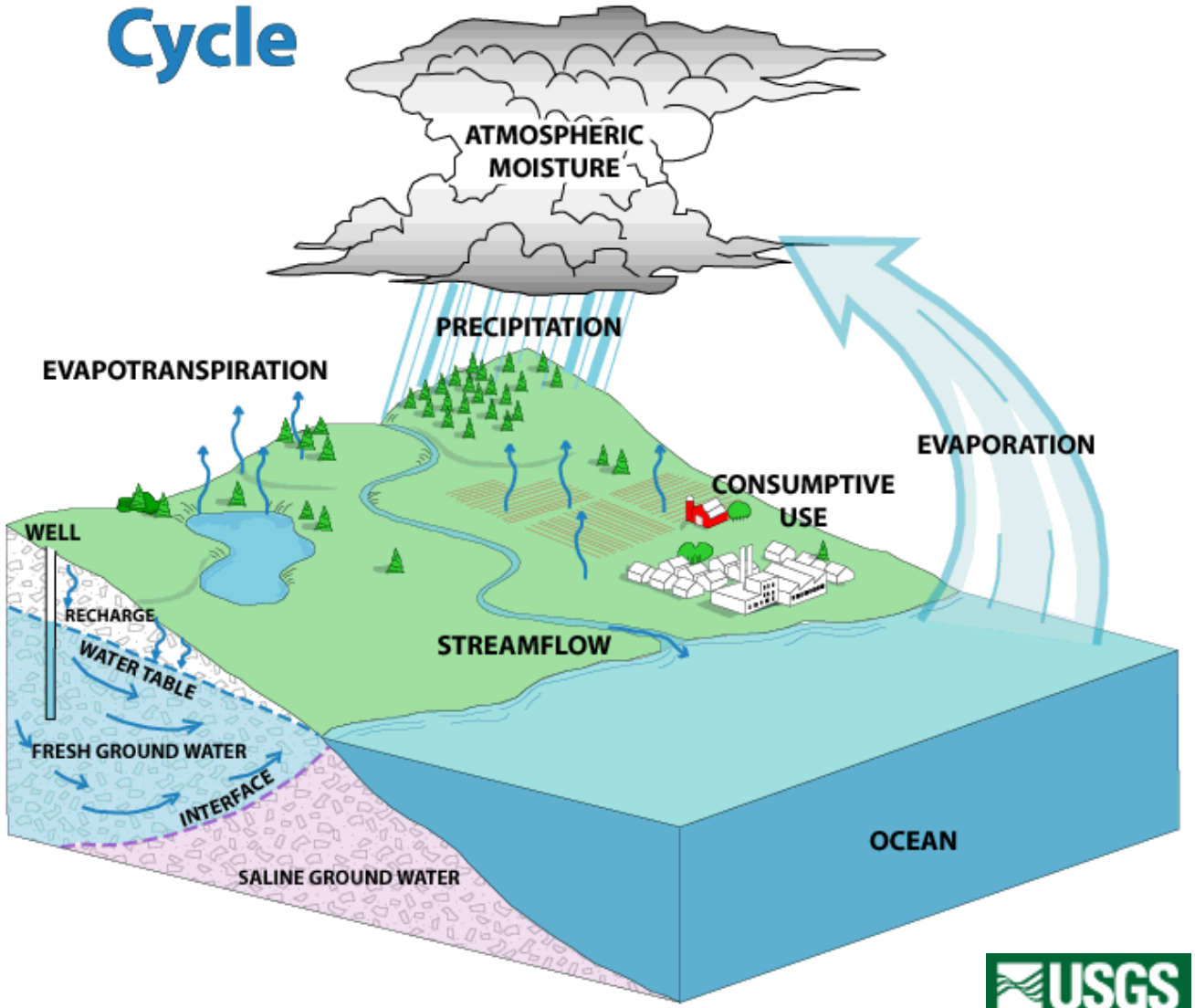
Hydrologic Cycle



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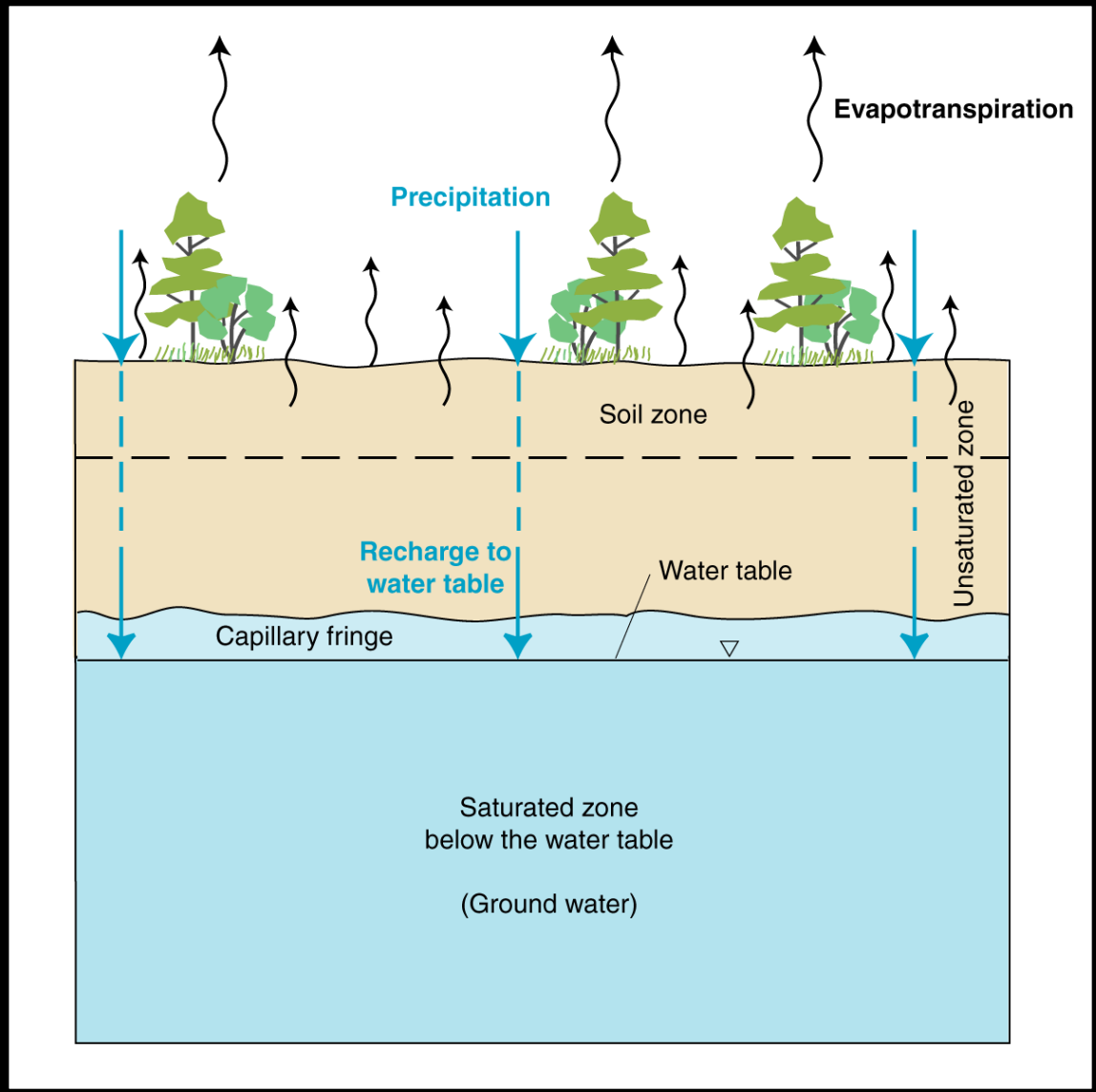
Unsaturated zone, Capillary fringe, Water table, & Saturated zone



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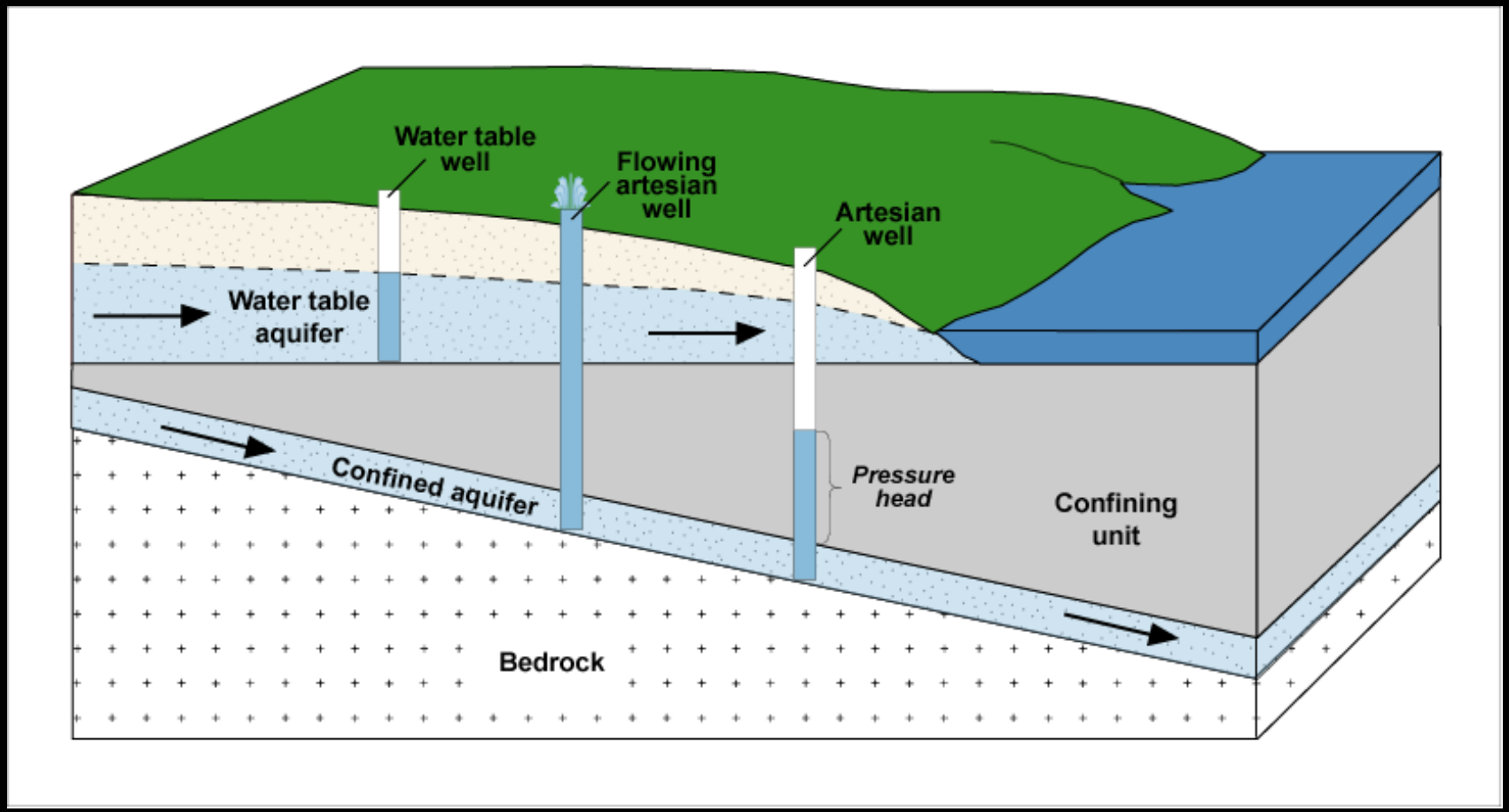
Water Table and Confined (*artesian*) Aquifers



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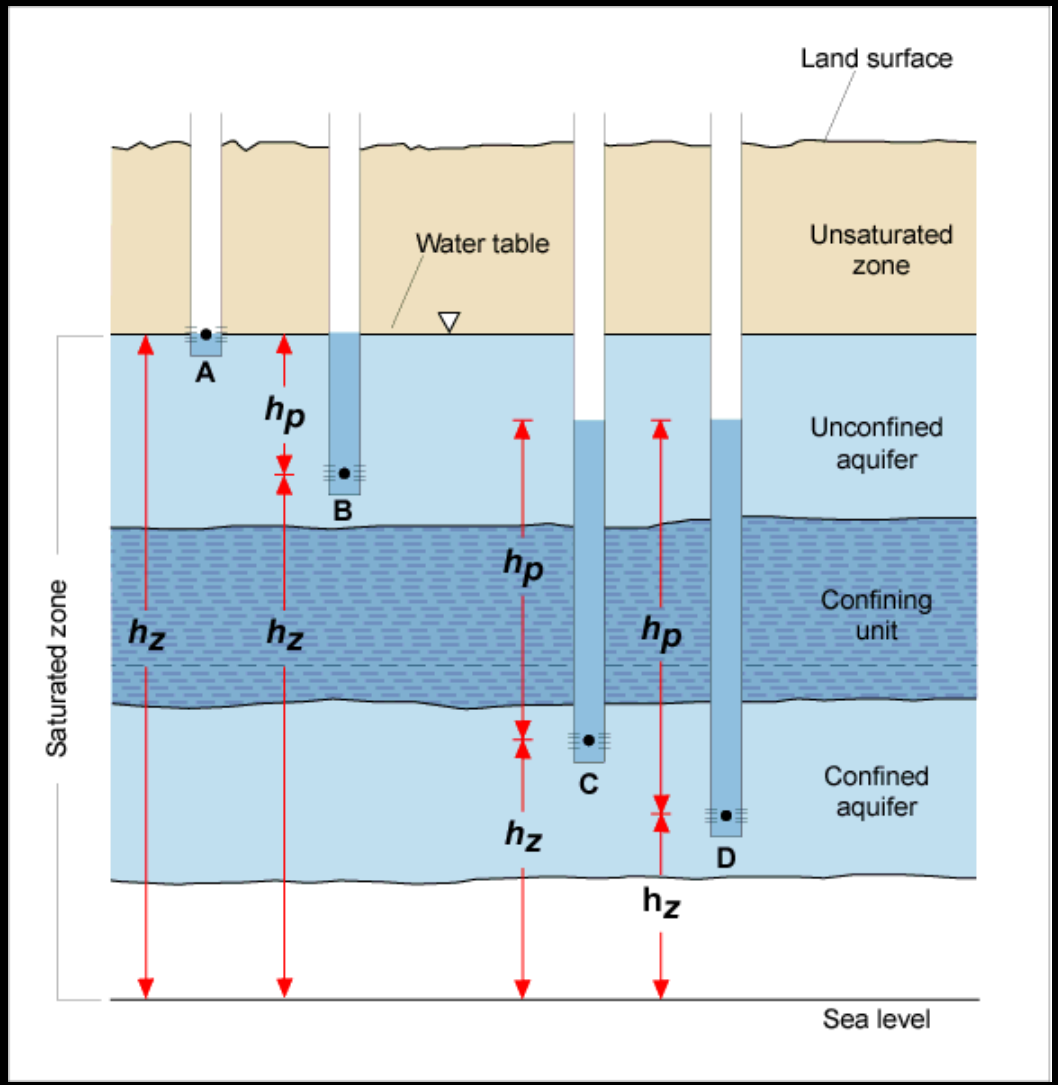
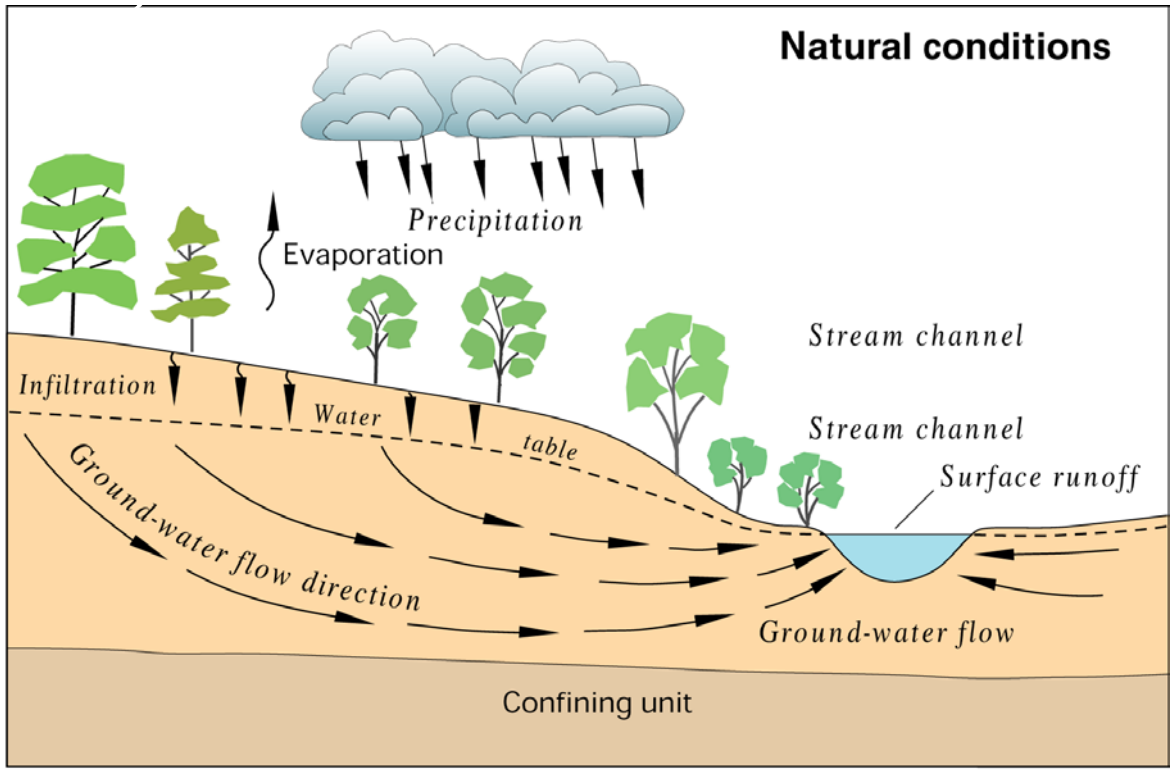
Hydraulic Head



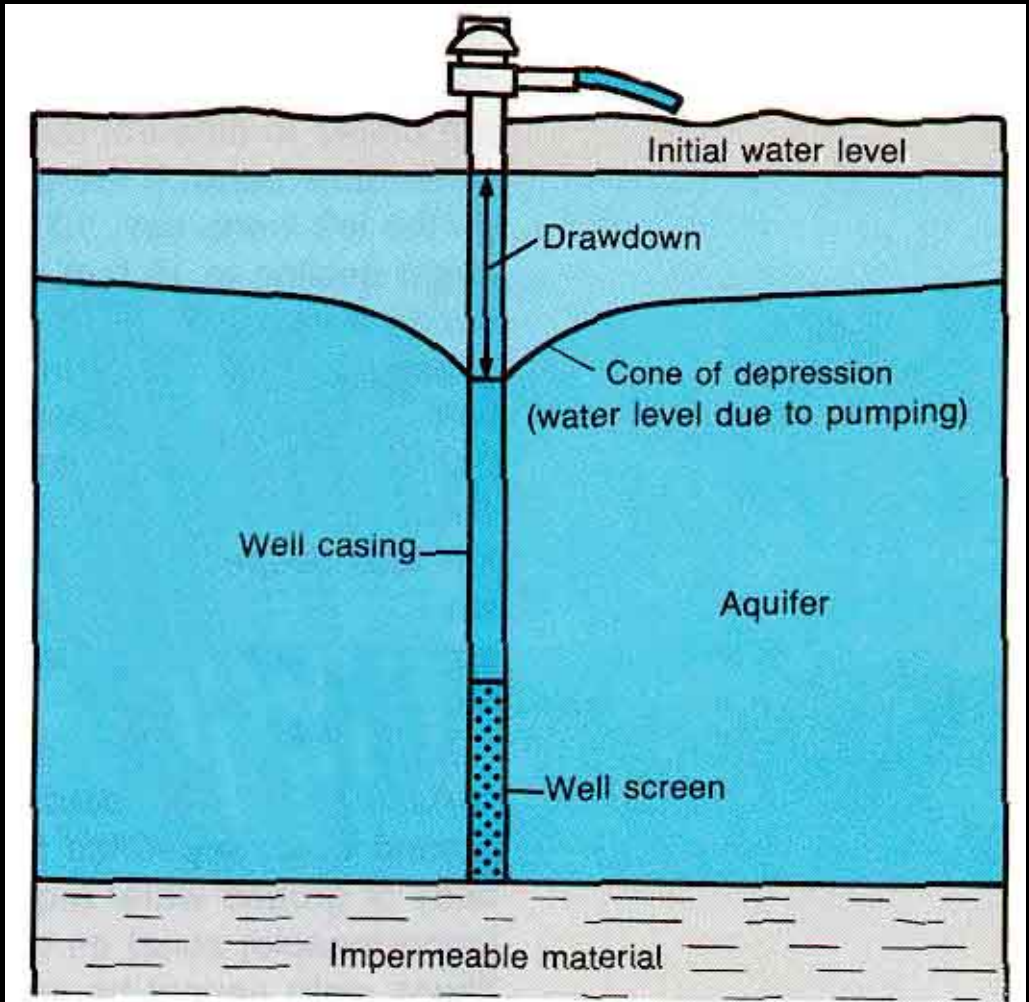
Total head (h_t)	=	Elevation head (h_z)	+	Pressure head (h_p)

Ground-Water-Flow System (*Natural Conditions*)



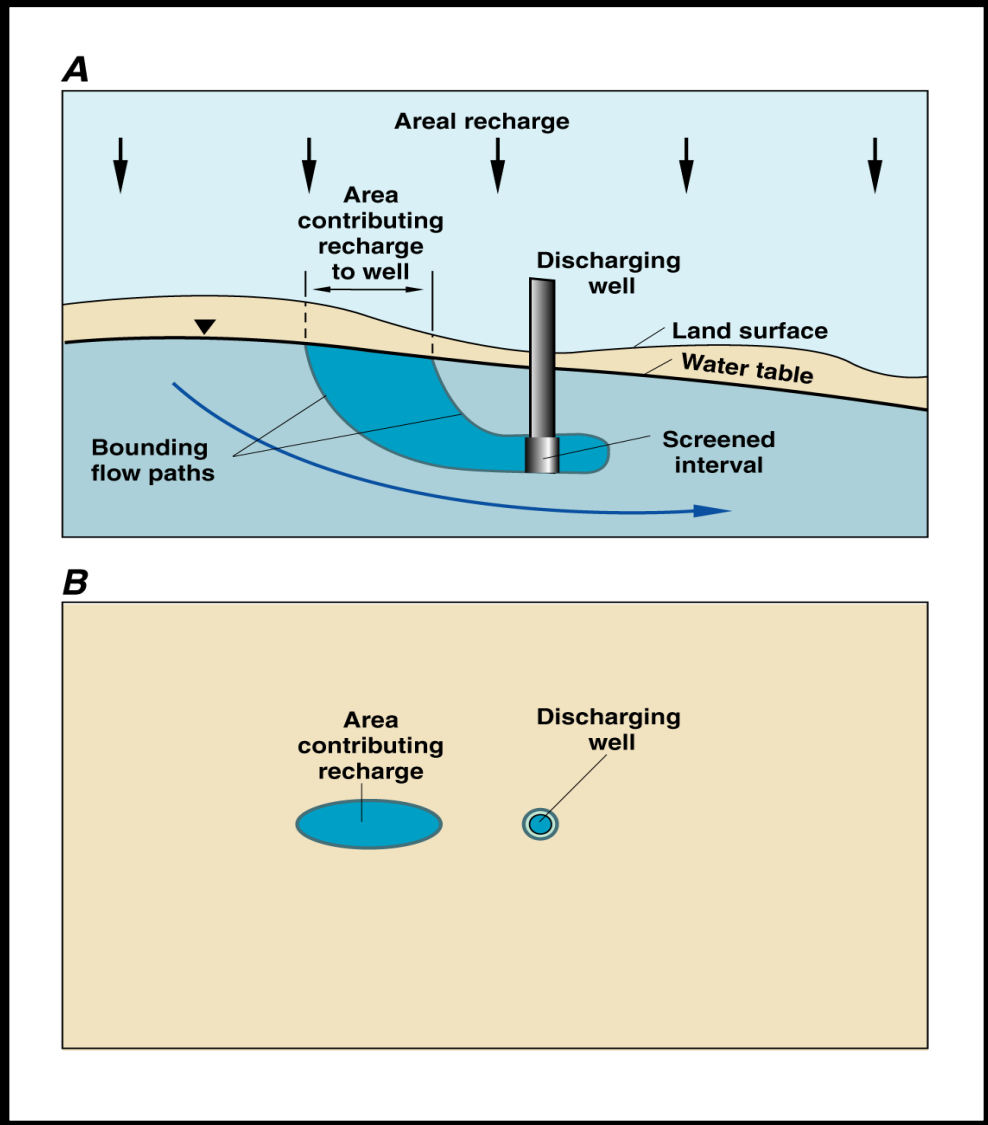
Water is recharged to the ground-water system by percolation of water from precipitation and then flows to the stream through the ground-water system.

Ground-water pumpage terms

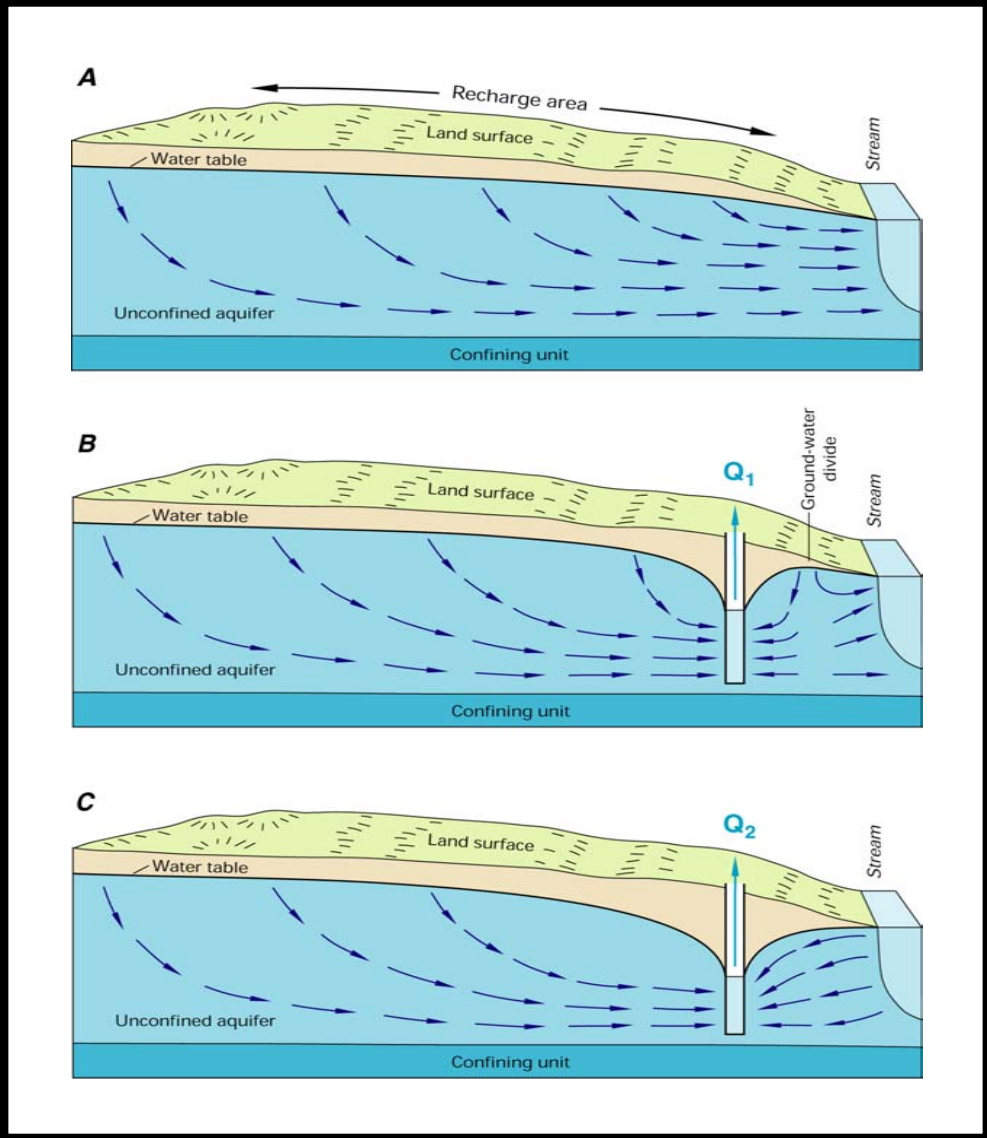


Cone of depression caused by pumping.

Area contributing recharge to a well



Relation of ground-water pumpage and surface water

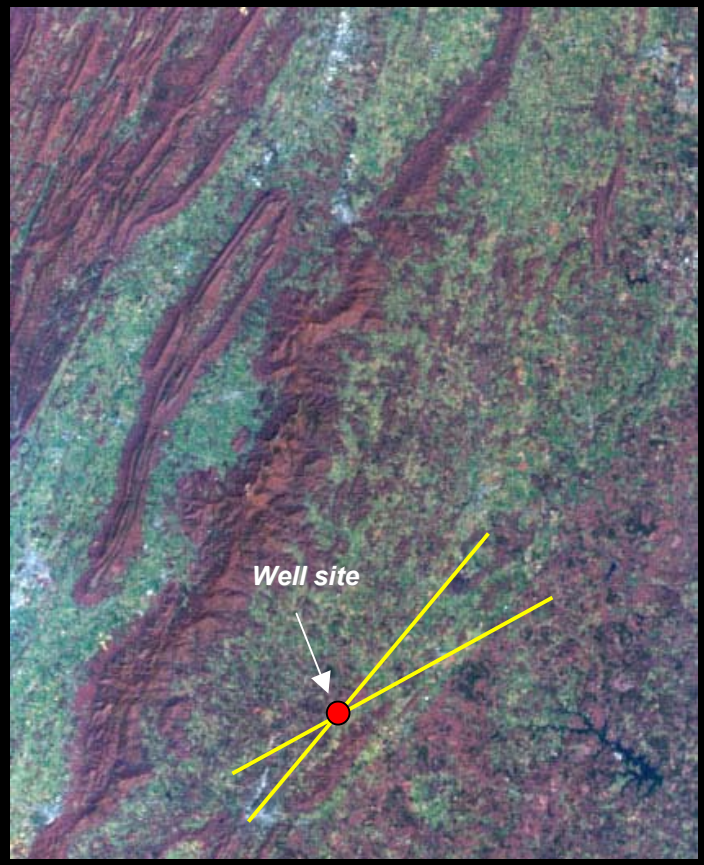


Fractured rock aquifers

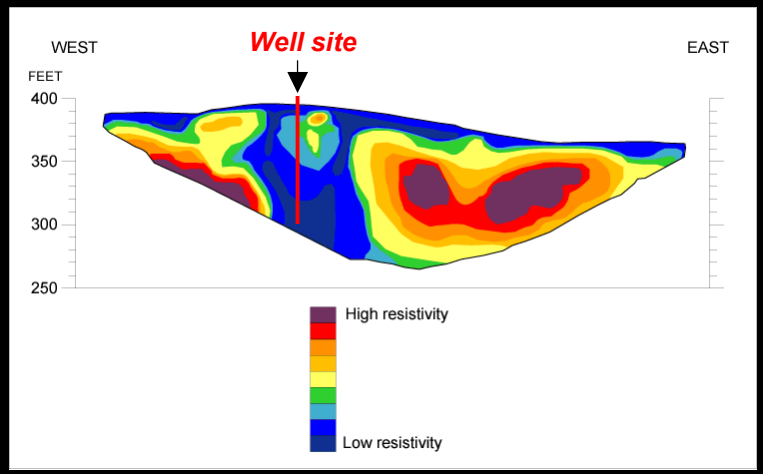
Crystalline rock aquifers

Carbonate rock aquifers

Siting Wells in Fractured Rock Terranes



Satellite Imagery



Geophysical Methods

Aerial Photograph

EXPLANATION

Lineament or fracture trace

Well site

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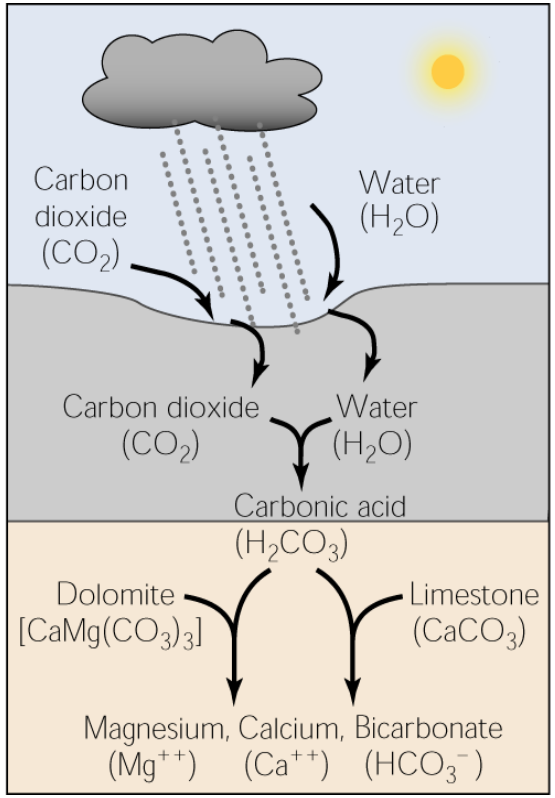
Karst Aquifers

From "*Living on Karst*"

Geochemical Formation of Karst



Water (H_2O) falling through the atmosphere and percolating the ground dissolves carbon dioxide (CO_2) gas from the air and soil, forming a weak acid—carbonic acid (H_2CO_3).

As the carbonic acid infiltrates the ground and contacts the bedrock surfaces, it reacts readily with limestone ($CaCO_3$) and/or dolomite [$CaMg(CO_3)_3$].

Cavities and voids develop as limestone or dolomite is dissolved into component ions of calcium (Ca^{++}), magnesium (Mg^{++}), and bicarbonate (HCO_3^-).

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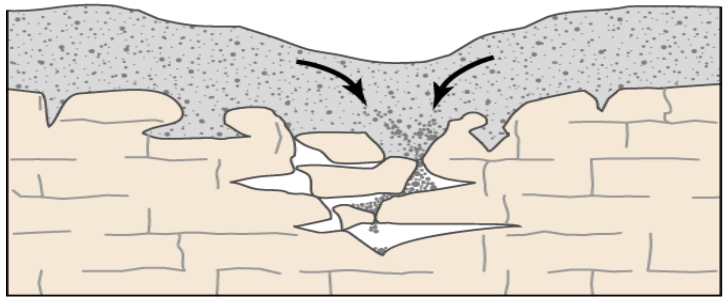
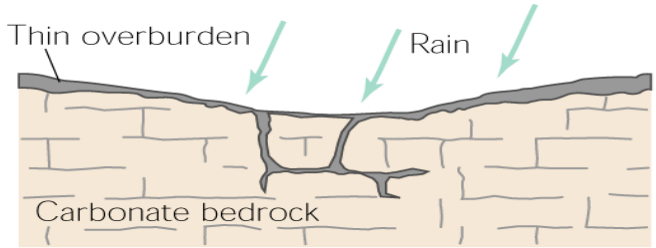
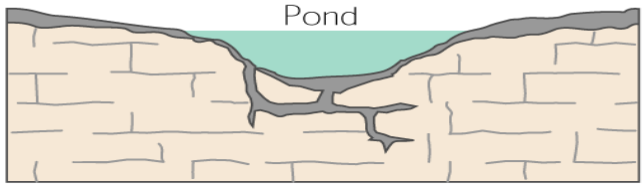
Formation of Sinkholes



The erosion begins at the top of the carbonate bedrock and develops upward through the overlying sediments toward the land surface.



Rainfall and surface water percolate through joints in the limestone. Dissolved carbonate rock is carried away from the surface and a small depression gradually forms.



On exposed carbonate surfaces, a depression may focus surface drainage, accelerating the dissolution process. Debris carried into the developing sinkhole may plug the outflow, ponding water and creating wetlands.

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Types of Sinkholes

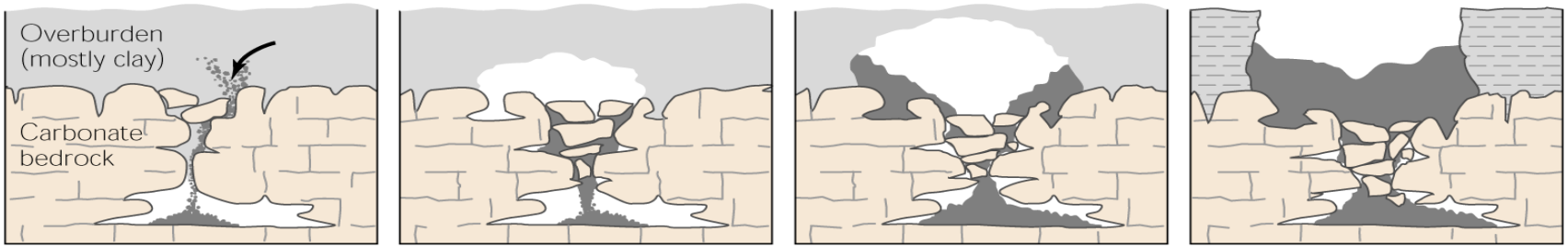
Cover-Collapse *(Clay Overburden)*

Sediments spall into a cavity.

As spalling continues, the cohesive covering sediments form a structural arch.

The cavity migrates upward by progressive roof collapse.

The cavity eventually breaches the ground surface, creating sudden and dramatic sinkholes.



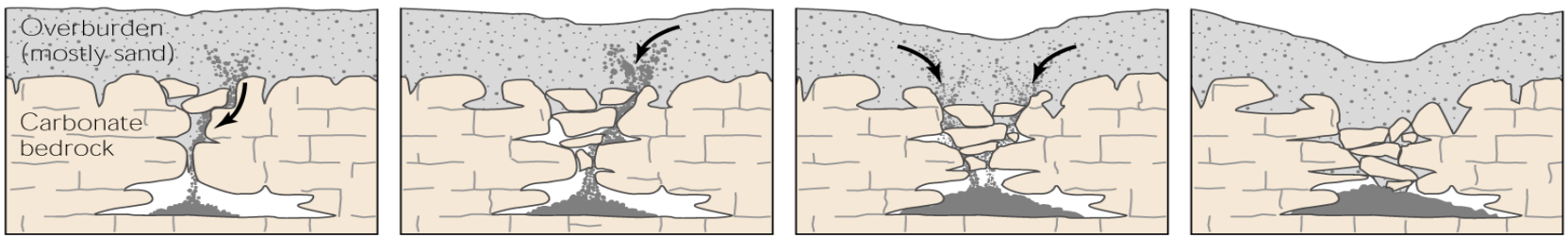
Cover-Subsidence *(Sandy Overburden)*

Granular sediments spall into secondary openings in the underlying carbonate rocks.

A column of overlying sediments settles into the vacated spaces (a process termed "piping").

Dissolution and infilling continue, forming a noticable depression in the land surface.

The slow downward erosion eventually forms small surface depressions 1 inch to several feet in depth and diameter.



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Karst Features (*Sinkholes*)

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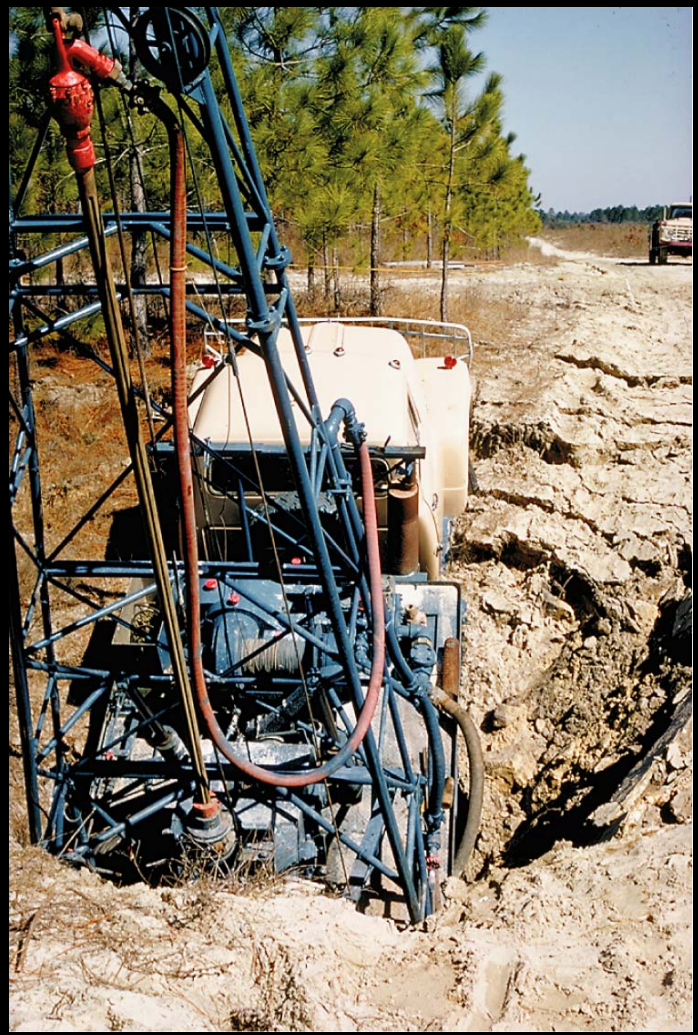
Karst Features (*Sinkholes*)



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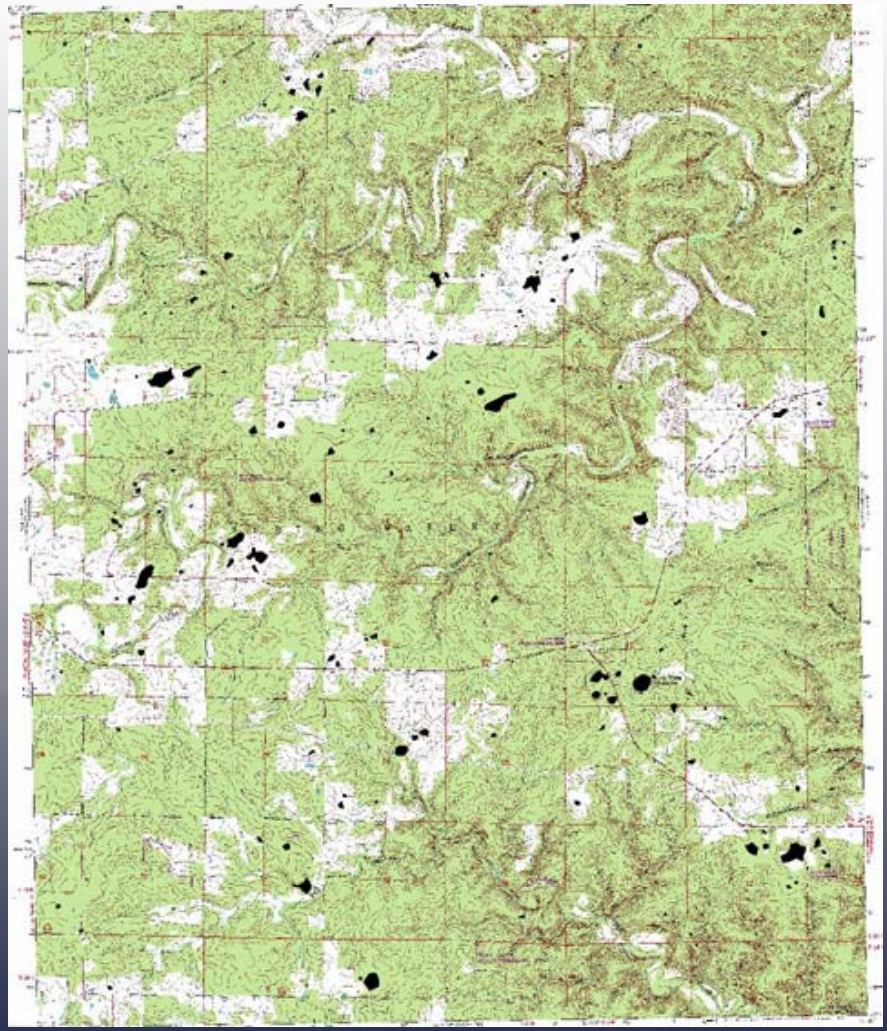

7.5-min. map showing sinkholes shaded in black.

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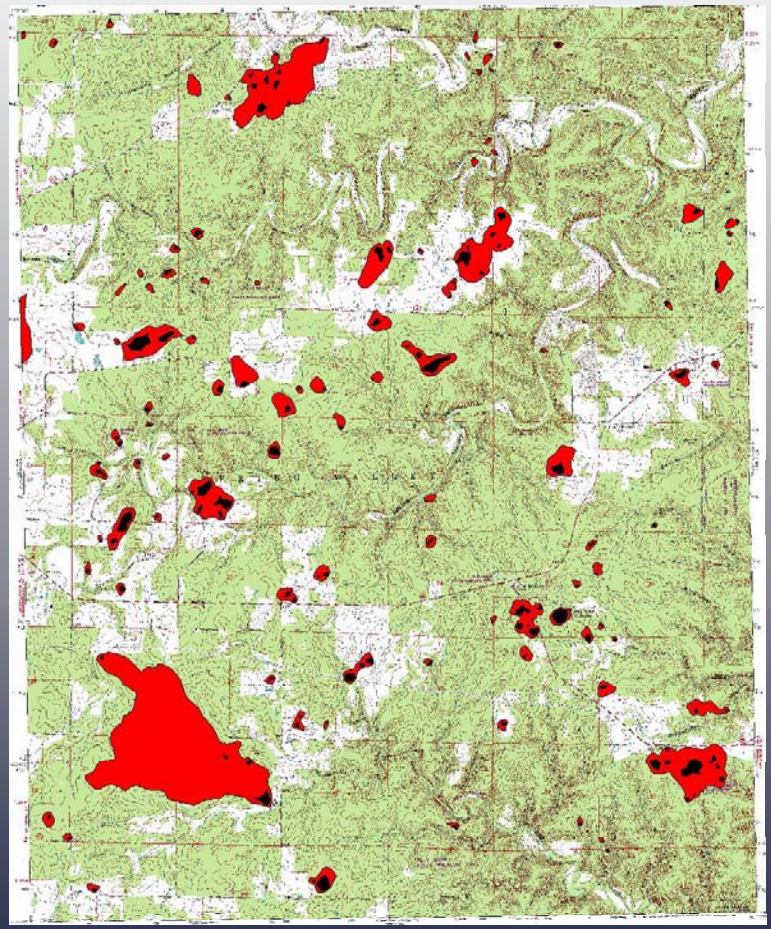
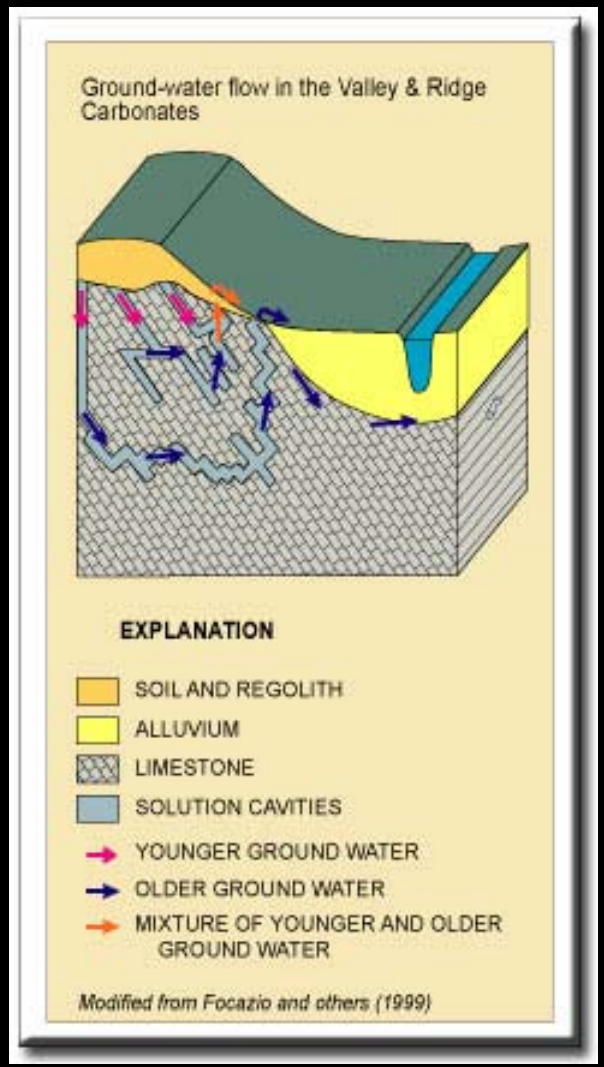


Sinkholes
(789,345 sq meters, 0.5% of area)

Area drained by sinkholes
(9,017,287 sq meters, 5.86% of area)

Ground-Water Flow in the Valley & Ridge



Ground-Water Flow

Ground-water flow in the carbonate rocks of the Valley & Ridge occurs (1) in the regolith (alluvium, colluvium, and residuum), (2) along fractures, joints, and bedding plane partings in the bedrock, and (3) in solution channels and cavities (caves) formed by the dissolution of carbonate minerals. Ground-water storage in the carbonate rocks can be in the regolith and in the solution channels and cavities in the bedrock.

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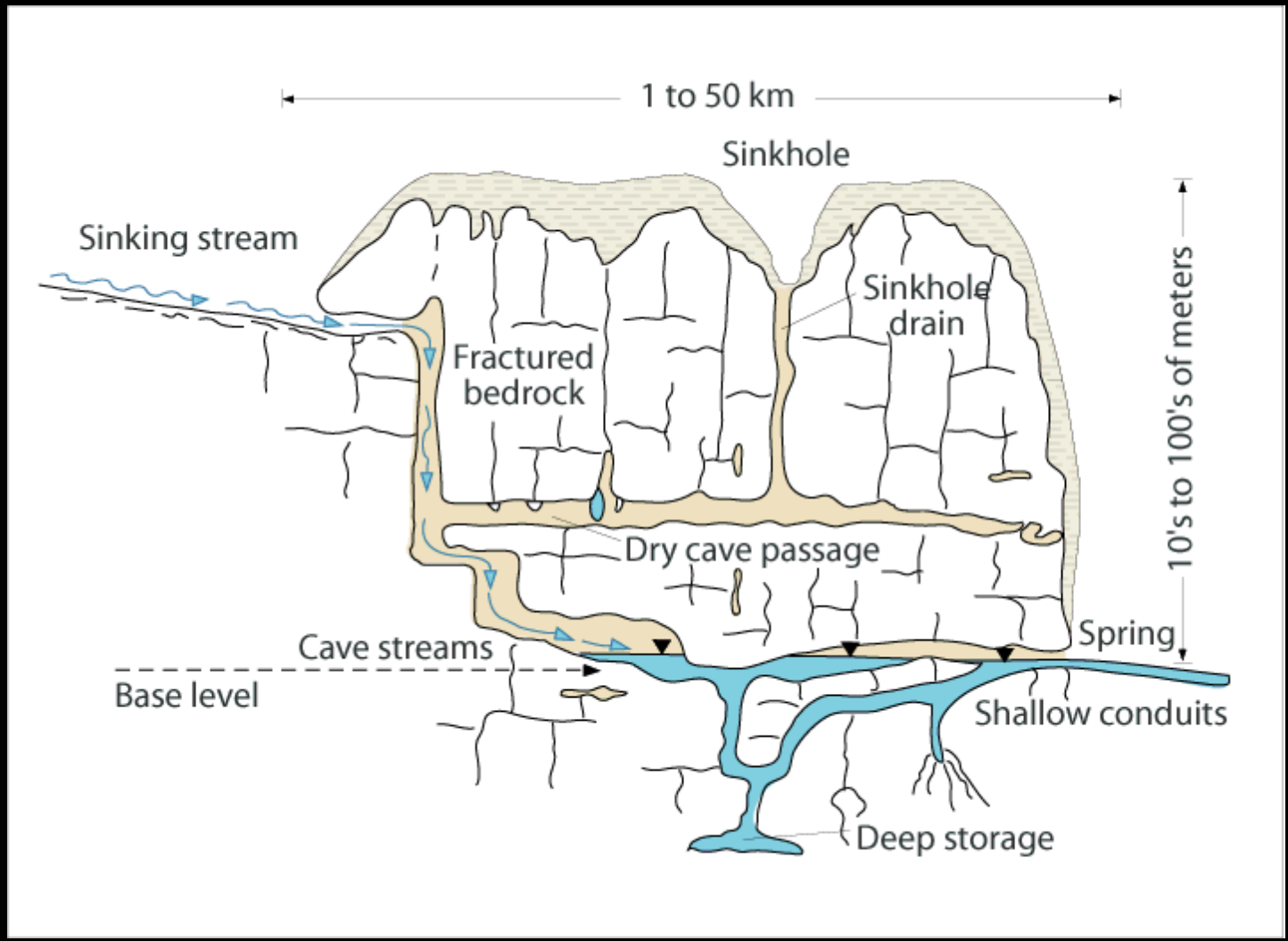
Ground-Water Flow in Karst



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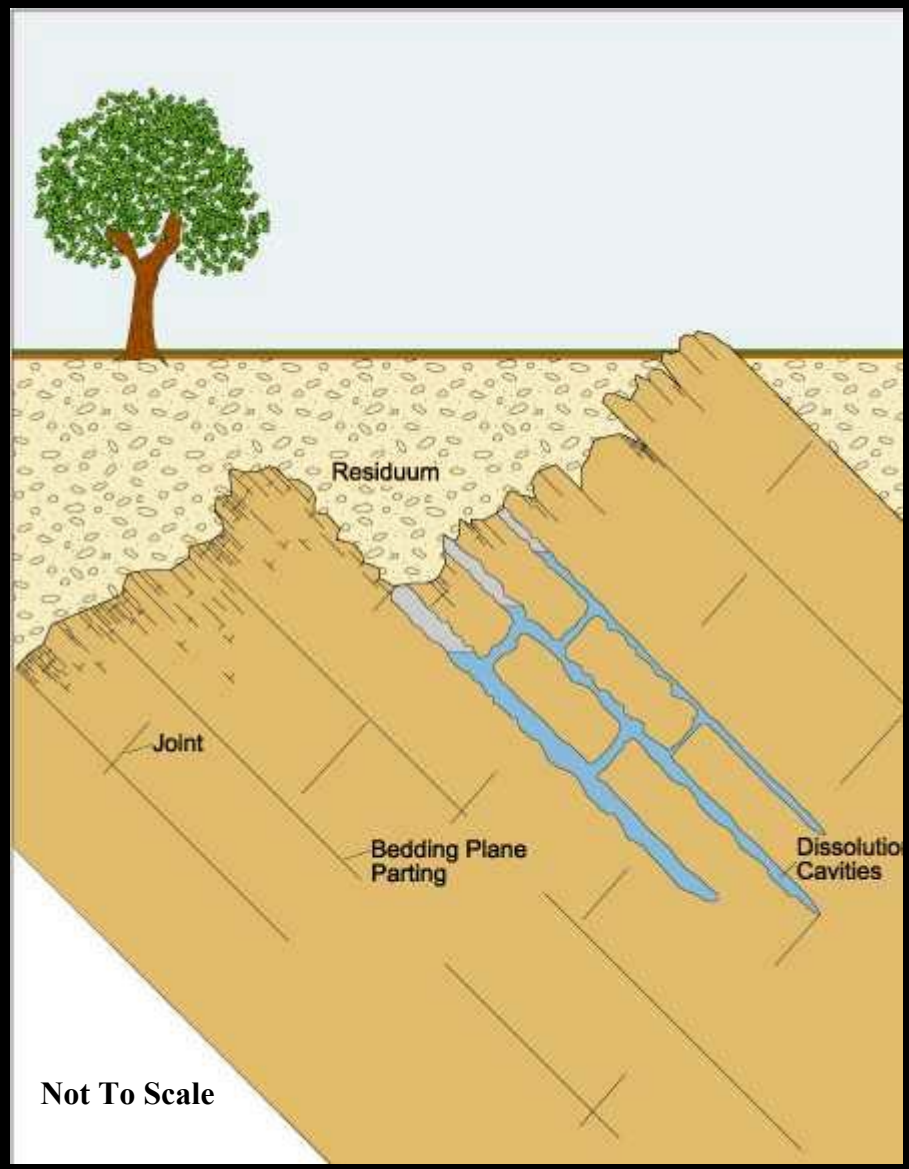
Ground-Water Flow in Carbonate Rocks



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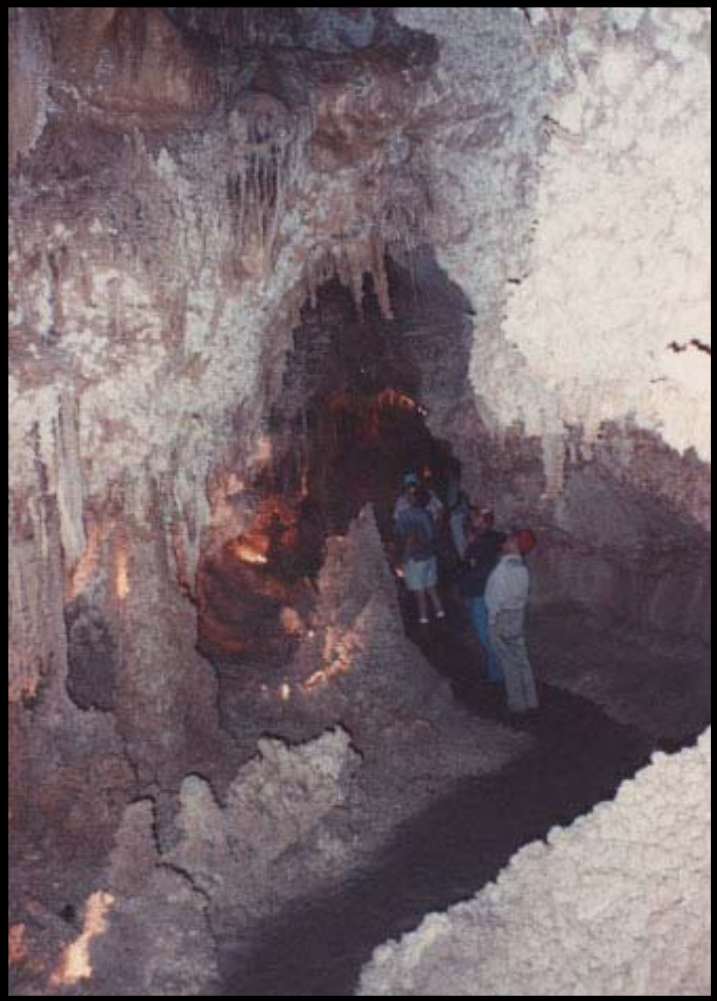
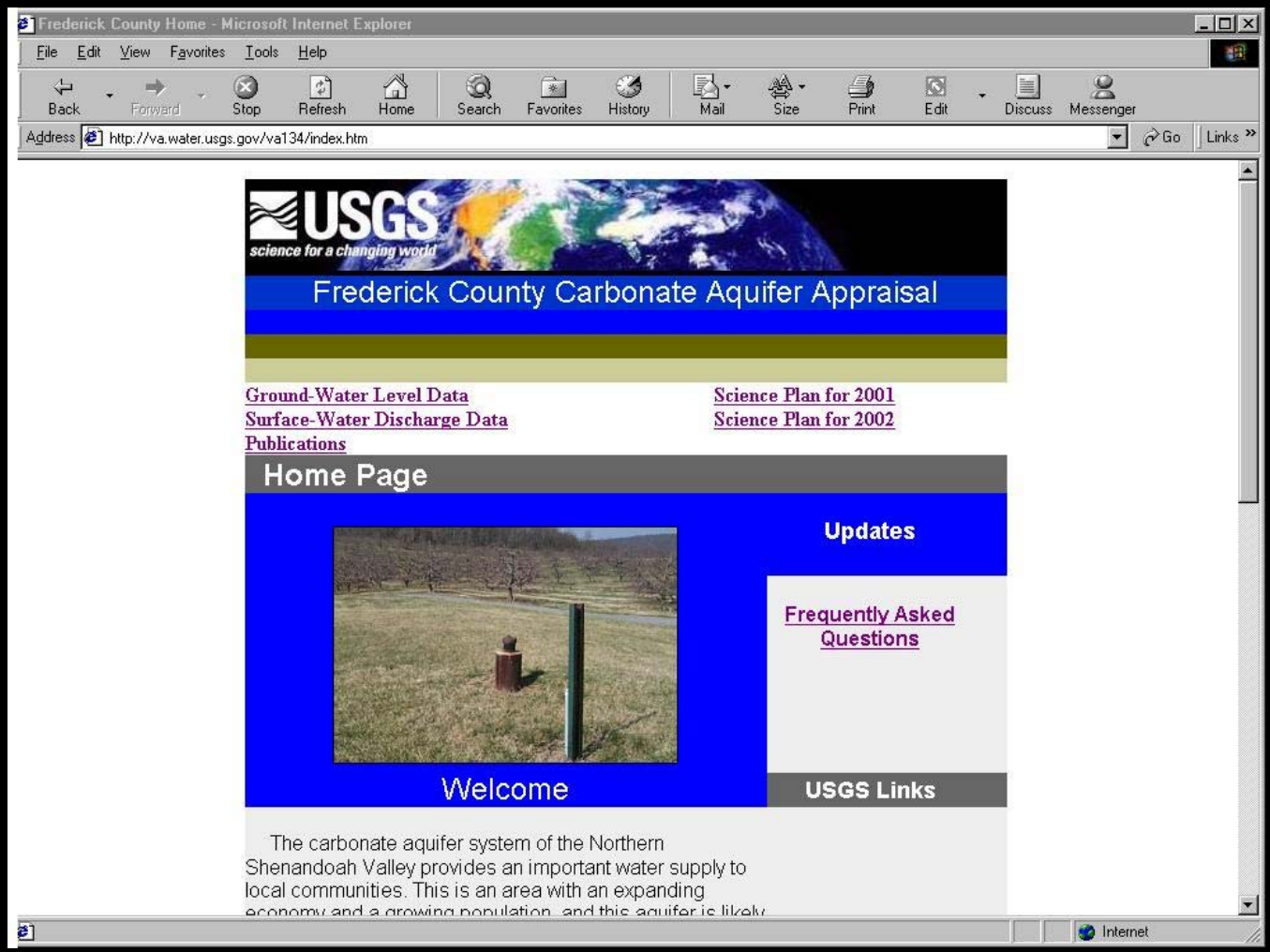
Karst Features (*Caves*)



Ground-Water Flow from Karst Spring

Frederick County Carbonate Aquifer Web Link

- http://va.water.usgs.gov/va134/index.htm



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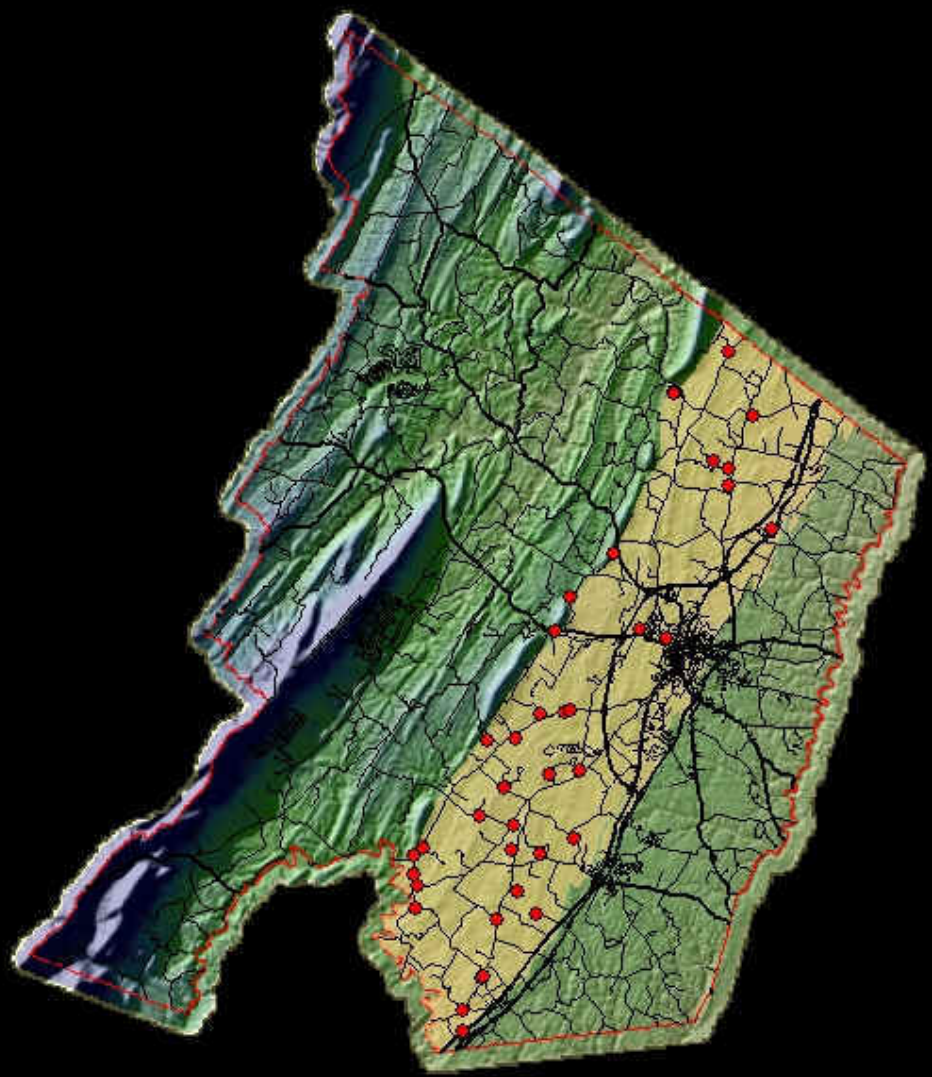
Ground-Water Level Data



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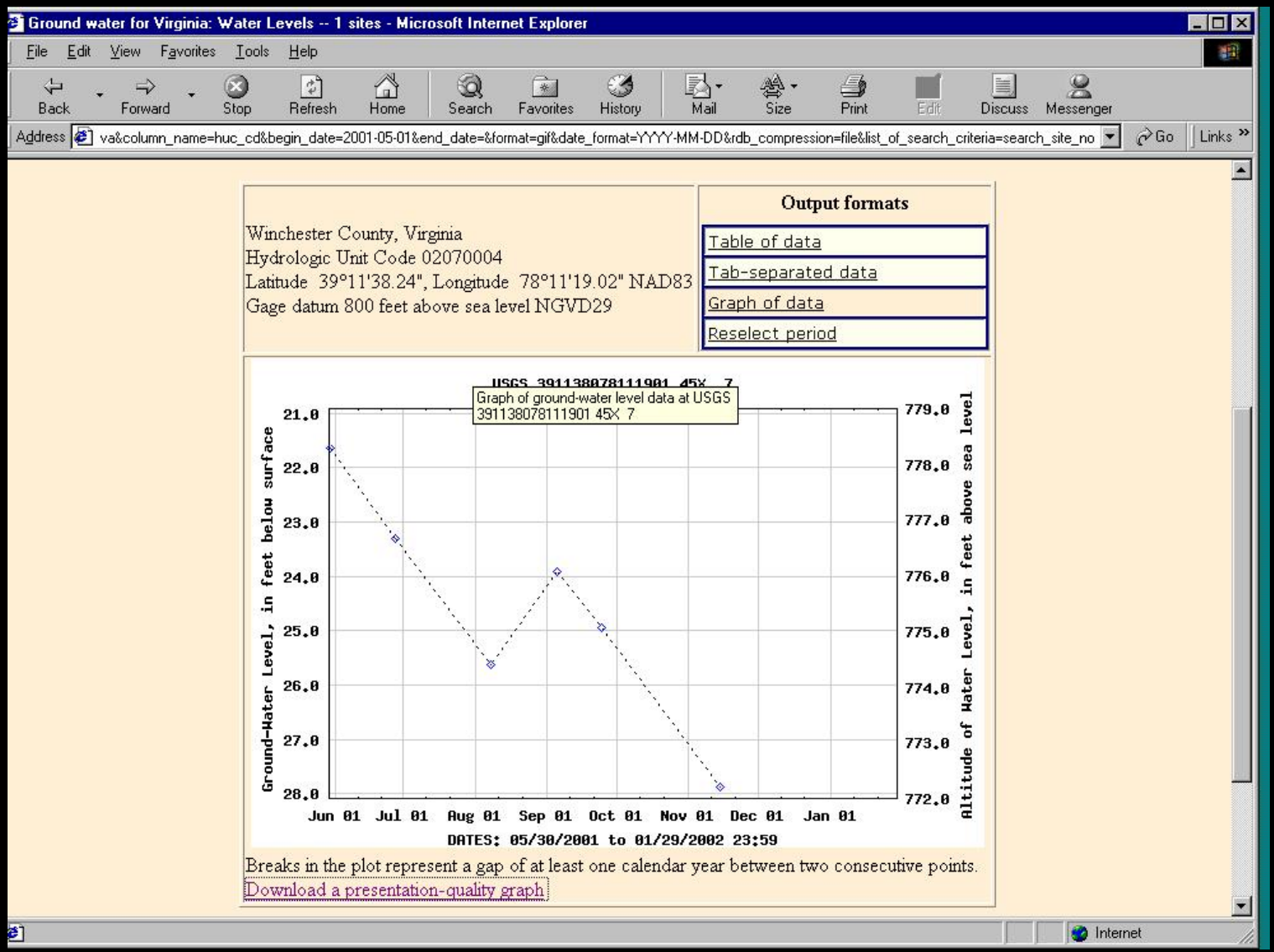
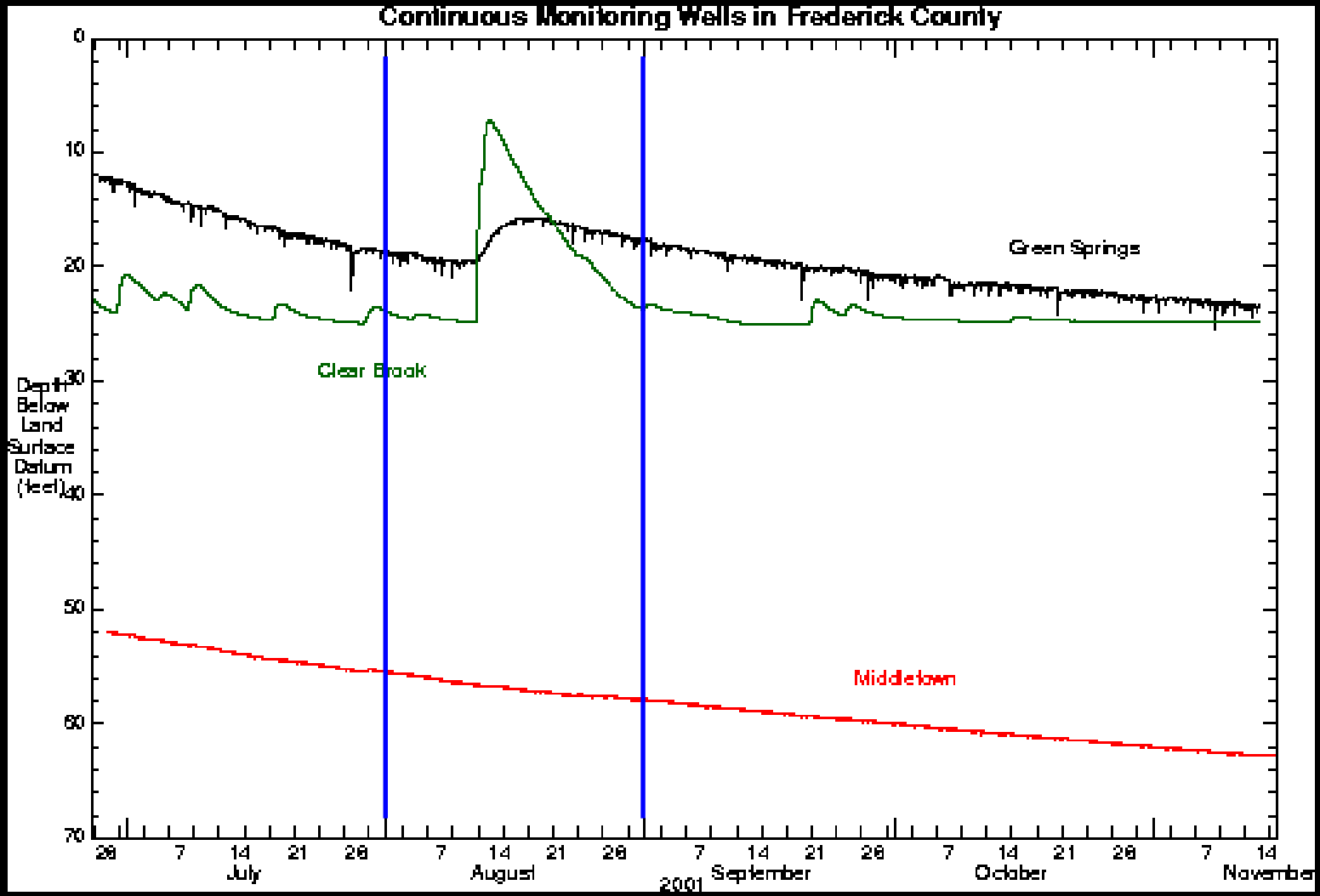
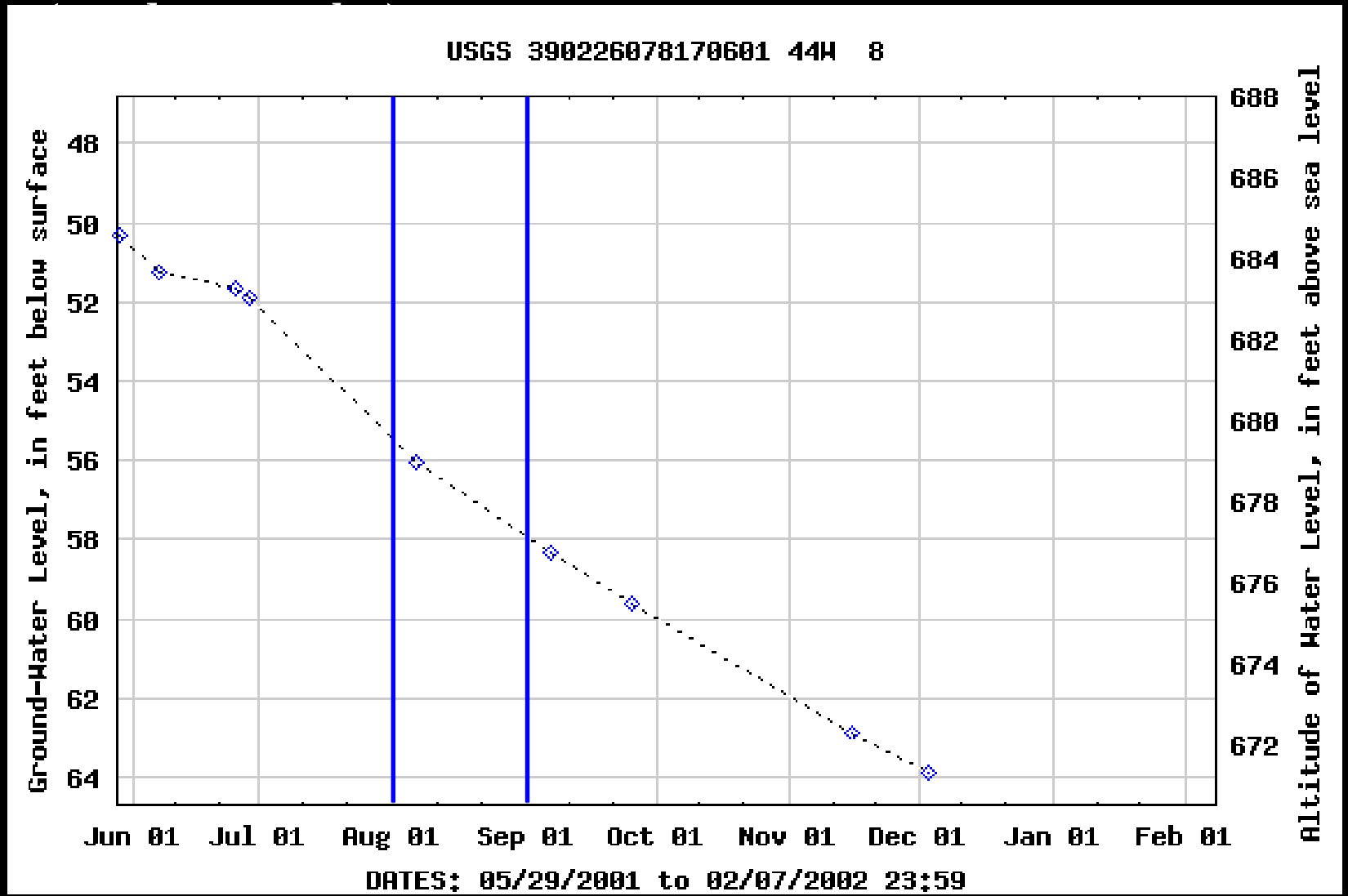
Ground-Water Level Data



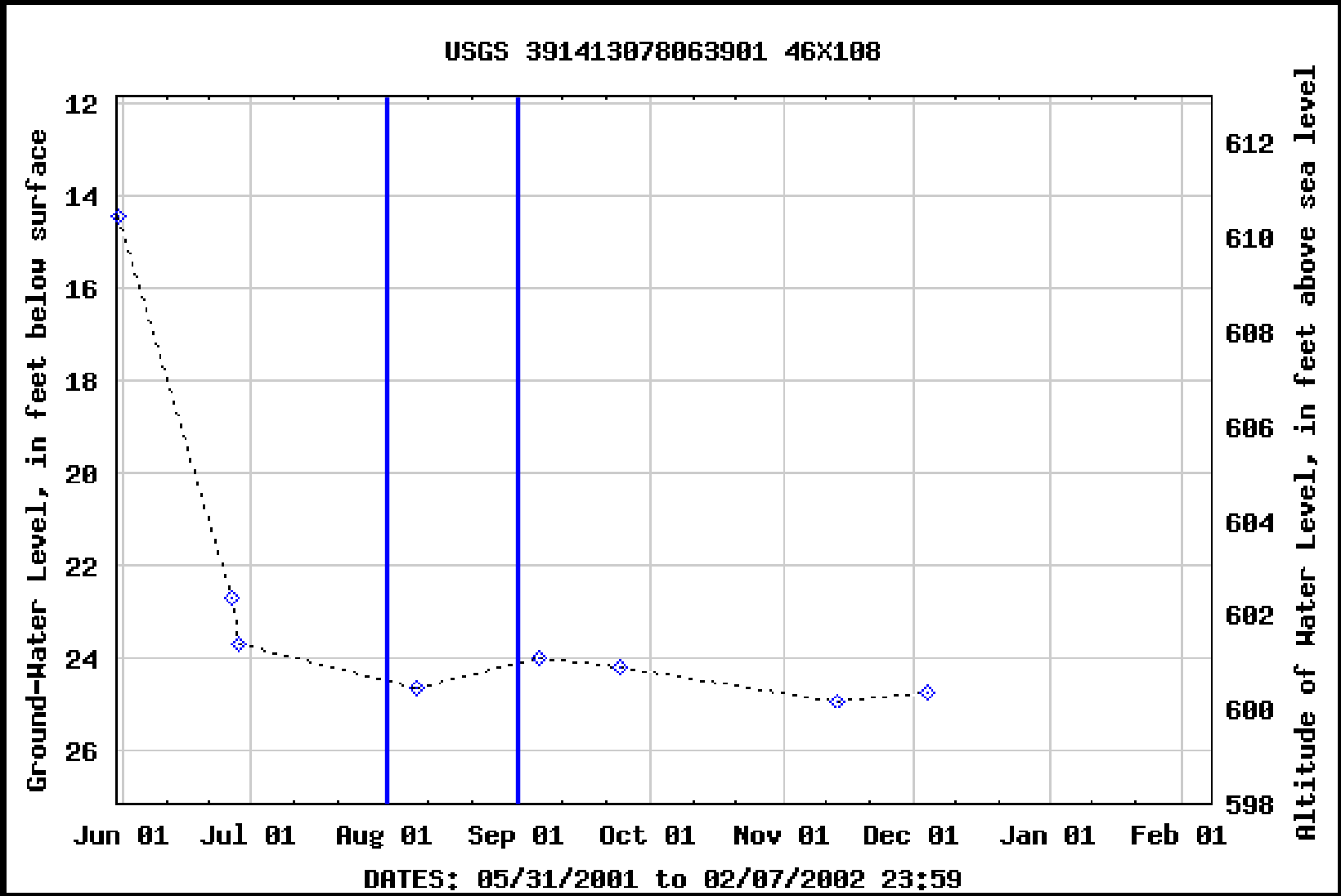
Continuous Ground-Water Levels *(Hydrographs)*



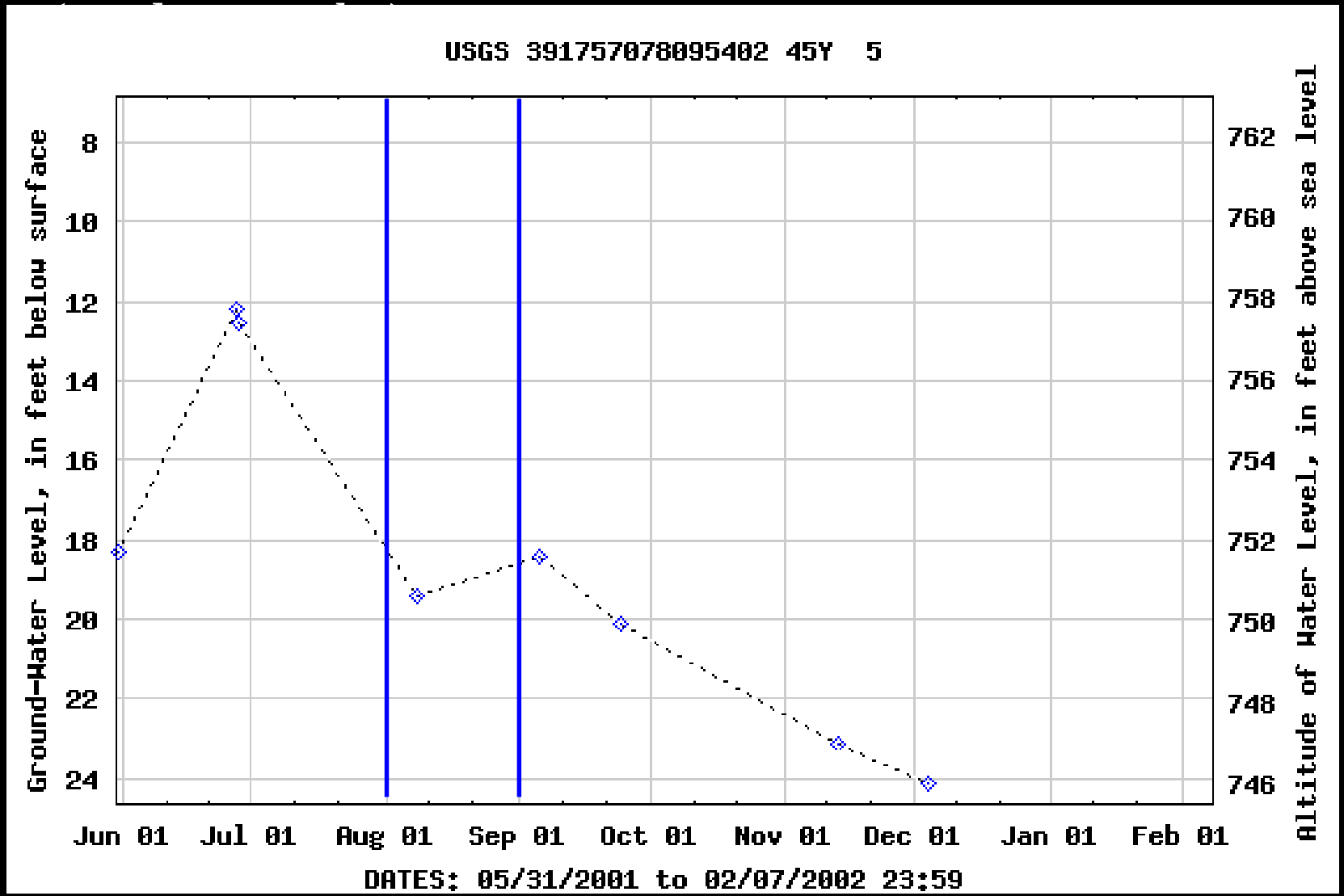
Instantaneous Ground-Water Levels



Instantaneous Ground-Water Levels



Instantaneous Ground-Water Levels



Surface-Water Discharge Data

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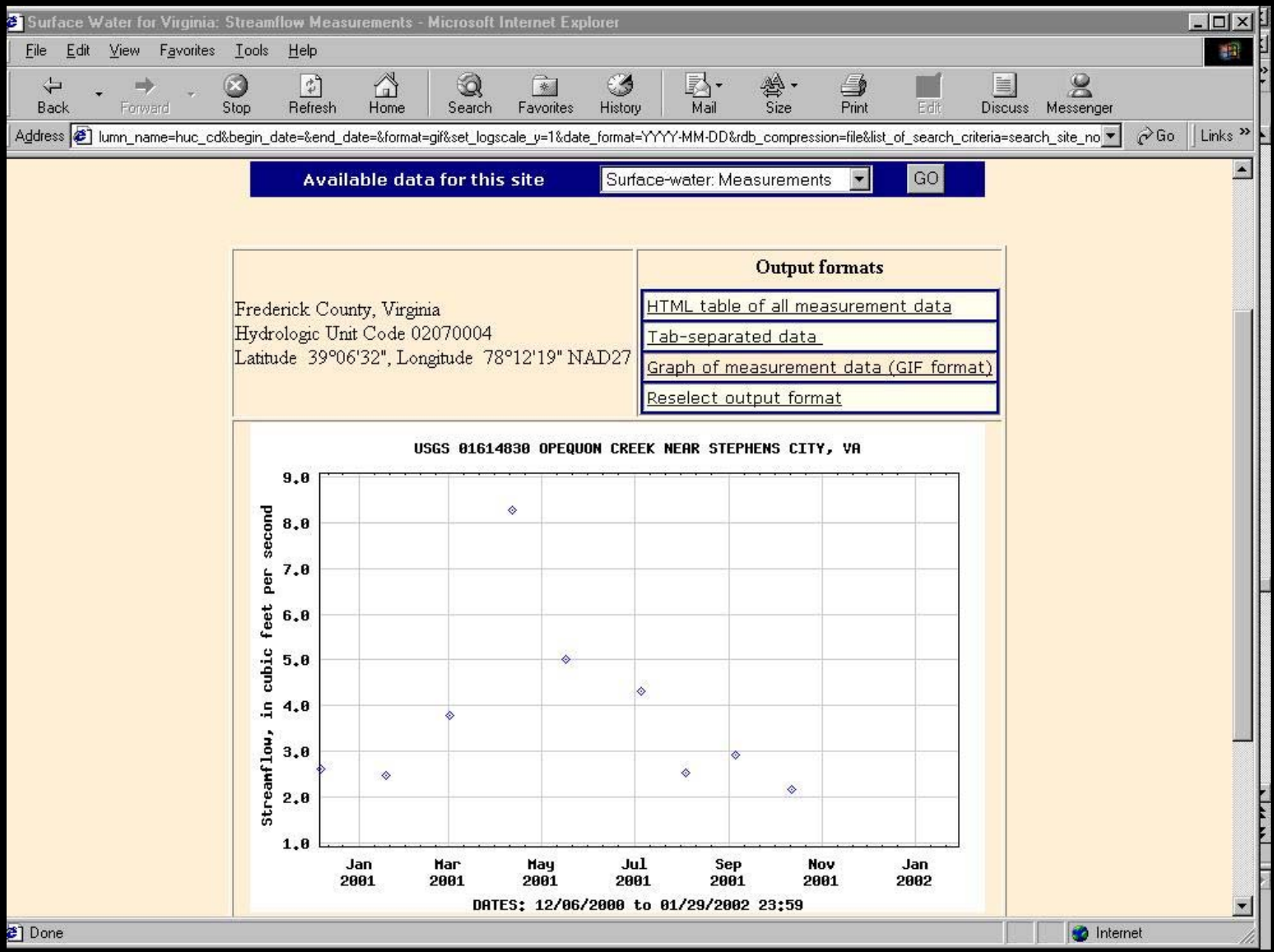
Surface-Water Discharge Data



USGS

WELL 6
CLARKE COUNTY

390348078035501 **Local number: 46W175**

LOCATION.--Lat 39`03'48", long 78`03'55", Hydrologic Unit 02070007, 1.5 mi east of the intersection of U.S. Highways 17/50 and 340 at Blandy Experimental Farm. Owner: University of Virginia.

AQUIFER.--Conococheague Limestone of Middle Cambrian age.

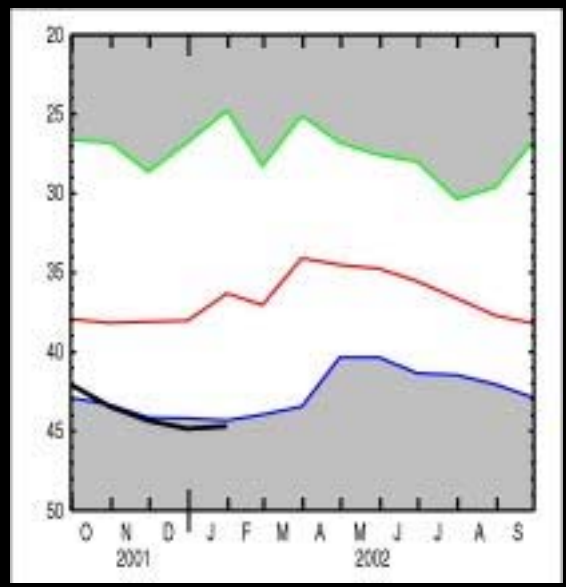
WELL CHARACTERISTICS.--Drilled unused water well, diameter 6 in., depth 80.4 ft, cased to 24 ft, open hole 24 to 80.4 ft.

INSTRUMENTATION.--Electronic data logger 60-minute record interval. Prior to February 28, 2000, digital recorder 60-minute punch.

DATUM.--Elevation of land-surface datum is 600 ft above sea level, from topographic map. Measuring point: Top of casing, 3.7 ft above land-surface datum.

REMARKS.--Missing record due to recorder malfunction.

PERIOD OF RECORD.--July 1987 to current year.



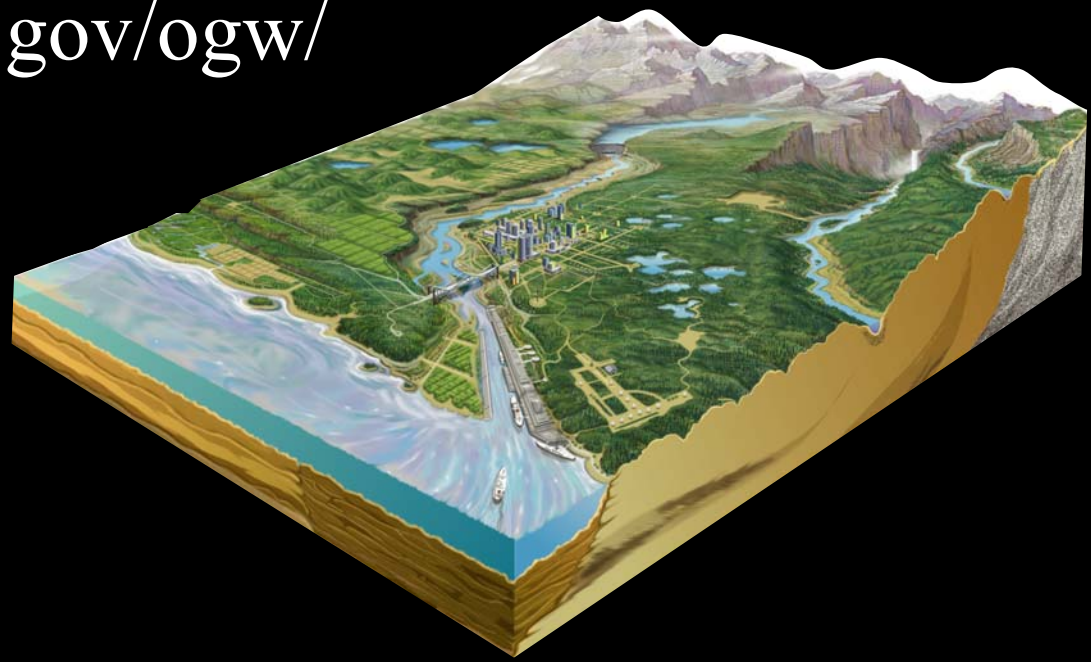
Web Links

- USGS, WRD, Virginia District

http://va.water.usgs.gov/

- USGS, WRD, Office of Ground Water

http://water.usgs.gov/ogw/



Contact information

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