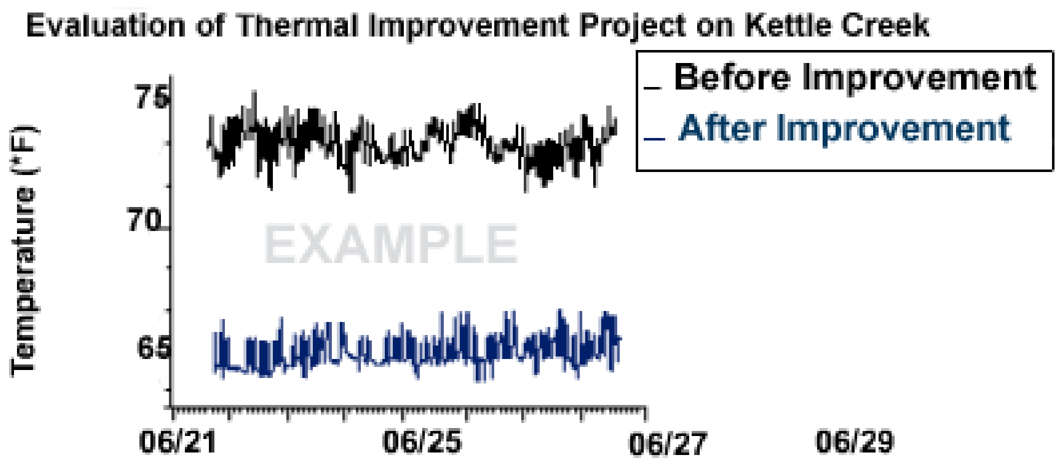


Example graphs that could be produced from HOBO temperature loggers

APPENDIX H
THERMAL ASSESSMENT

Average yearly nutrient and sediment loading on Kettle Creek (1976-1985)			
Subwatershed	lbs/acre/ year N	lbs/acre/ year P	lbs/acre/year Sediment
Billings Branch	0.71	0.06	0.08
Cross Fork	2.05	0.2	0.37
Germania Branch	3.83	0.22	0.37
Hammersley Fork	1.55	0.16	0.27
Little Kettle	4.46	0.37	0.7
Long Run	3.53	0.24	0.27
Sliders Branch	2.52	0.17	0.28
Two Mile Run	2.3	0.21	0.38

APPENDIX I
NPS POLLUTION

Methods used in the development of non-point pollution models

GWLF Background

The Generalized Watershed Loading Function (GWLF) model is a combined distributed/ lumped parameter watershed model based on land use/land cover source area characteristics. The GWLF models surface runoff using the Soil Conservation Service-Curve Number approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE). A sediment delivery ratio based on watershed size and transport capacity estimation based on average daily runoff is then applied to the calculated erosion to determine sediment yield. Streamflow consists of runoff and discharge from groundwater. The latter is obtained from a lumped parameter watershed water balance. Daily water balances are calculated for unsaturated and shallow saturated zones. Daily evapotranspiration is given by the product of a cover factor and potential evapotranspiration. The latter is estimated as a function of daylight hours, saturated water vapor pressure and daily temperature. The yield in any month is proportional to the total transport capacity of daily runoff during the month. Dissolved and solid-phase nitrogen and phosphorus in streamflow is derived from point sources, groundwater, rural runoff and urban runoff. Rural nutrient loads are transported in surface runoff and groundwater from numerous source areas. Dissolved loads from each source are obtained by multiplying runoff by dissolved concentrations. Nutrient loads from septic systems are calculated by estimating the per capita daily load from each type of system and the number of people in the watershed served by septic systems.

The ArcView version of the GWLF model was developed at Penn State and provides a user-friendly interface based on GIS technology and available data layers. The AVGWLF was used to model NPS sources on the Kettle Creek watershed.

Point source discharges can also be included in the model but are not applicable to Kettle Creek.

See Haith and others 1992 for additional information regarding this model.

The table above illustrates the average area loading values per year (1976-1985) as determined from the GWLF model. Subwatersheds selected for the modeling exercise had at least some agricultural or residential land-use characteristics. Billings Branch was selected as a reference watershed with predominately forest-land cover.

Water Quality Network Site Derived Area-Loading Estimation

Nutrient exports from the watershed were also modeled using the historic water quality data monitored by the US EPA at the Westport stream gage. Due to the location of this site below the Alvin Bush Reservoir only nitrogen was modeled.

A regression relationship was developed to predict the concentration of total nitrogen (mg/

l) from the daily stream flow (cfs). Mean daily flow data is then used to predict total nitrogen loads by day, month or year. These total load values divided by area above the gage provides an area loading rate that is comparable to the GWLF model. The following equation was obtained to predict concentration of total nitrogen from flow. Discharge values were square root transformed to improve the model.

Total N (mg/l) = 0.118289 + 3.05E-02 [Discharge(cfs)]- 3.65E-04 [Discharge (cfs)2] (R2 = .378 p = <.0001)

Some of the unpredicted variability in the model may be due to flow regulation by the Alvin Bush reservoir, but the area loading rate developed from the model was comparable with rates derived from the GWLF. (See page 180, for more on GWLF).

Dirt and Gravel Road Sediment Delivery Probability

Dirt and gravel roads are potentially contributing to excessive sediment loading on the Kettle Creek watershed. An ArcView-based model was developed in order to prioritize subwatersheds for road improvement options. The model examined all dirt and gravel roads within 30 meters of the stream as potential contributors of sediment. Township, state and other roads were included in the model. Forest management roads (i.e. skid roads, revegetated haul roads) were not included in the model. Roads within this 30m zone were converted to grid coverage and examined in relation to slope classes derived from the 30m digital elevation model of Kettle Creek. Slope classes were used as a measure of the probability of sediment delivery to a stream channel. Roads located on slopes greater than 40% were indicated as having a high probability of sediment delivery to the channel, 10-40% as moderate probability and roads on slopes less than 10% were listed as low probability. Additionally, roads that crossed streams were analyzed based on the slope of the road at the stream crossing. Road crossings of streams have the greatest potential for sediment delivery to the channel. The same slope classes were used to determine a probability of sediment delivery to the channel. Locations of crossings and road surfaces were ground-truthed in limited locations on the watershed for verification.

The actual delivery of sediment to the channel is based on a variety of factors that could not be included in the model and may affect the accuracy of the probability values, including ditch relief spacing, obstructions to flow below the road and others. It was our goal to provide an analysis that would begin to identify the potential delivery of sediment from dirt and gravel roads at the subwatershed scale. Site-specific problem sites in the watershed have been ground verified on township roads by the Dirt and Gravel Road program. These sites can now be viewed within the greater context of all dirt and gravel road sediment pollution potential at the subwatershed scale. Site-specific identification of problem areas can begin on non-township roads based on the locations identified in the potential sediment delivery model.

Subwatershed Sediment Impacts Ranking

A simple index was established for the sub-watersheds of Kettle Creek to determine the relative impacts of dirt and gravel road runoff to receiving streams. The index was based on the length of road segments with the potential for sediment delivery within each sub-watershed, the number of road crossings per subwatershed, the likelihood of runoff reaching a Class A trout stream and the location of the subwatershed in relation to naturally reproducing wild trout streams. Wild trout are particularly susceptible to siltation and road improvement projects should be identified in relation to these streams. High scores from the index indicate a greater likelihood and impact of sediment runoff from dirt and gravel roads.

Each of the parameters in the index received a score based on the relative importance as defined by the Kettle Creek Team. Road crossings, proximity to trout streams and the potential for sediment delivery were scored by importance in that order. These scores were then multiplied to receive a final ranking.

Roads that cross streams within subwatersheds were given scores based on the probability of sediment delivery at the site. Road crossings, as with other sections of road, were given relative probabilities of sediment delivery based on the slope of the landform in the vicinity of the road. Steeper slopes were given a higher score. This score was then multiplied by the number of road crossings. The PFBC trout stream classification provided a basis for scoring the subwatershed's streams. If streams were Class A or had the potential to be high quality wild trout streams they were given a higher score. Class D streams received a lower score. "Location in the watershed" was scored based on the class of the mainstem that the subwatershed drained into. If these downstream reaches had potential for wild trout reproduction the score was higher. This parameter was intended to account for the potential downstream affects of sediment delivery from the subwatershed and the connectivity of streams to other wild trout streams. High, moderate and low probability of sediment delivery was determined based on the sediment delivery model. The percent of roads within subwatersheds with the probability of sediment delivery to streams received scores proportional to the percent of stream length influenced by those road segments.

References:

Haith, Douglas A., Ross Mandel, Ray Shyan Wu. 1992. Generalized Watershed Loading Functions Version 2. Department of Agricultural and Biological Engineering, Cornell University.

Roads Prioritization Index

Stream	Road Sediment Production /Stream Length	High Potential	Moderate Potential	Low Potential	Stream Class	Location in Watershed	Road Crossings Low	Road Crossings Moderate	Ranking Score
Cross Fork	10.5%	0.1%	5.7%	4.6%	4.0	0.5	15.0	17.0	49.33
Upper Kettle Creek	15.5%	0.1%	8.3%	7.1%	4.0	2.0	6.0	8.0	23.91
Two Mile Run	36.9%	0.0%	15.1%	21.8%	4.0	0.5	12.0	5.0	23.04
Little Kettle Creek	9.0%	0.0%	5.4%	3.7%	2.0	1.0	7.0	7.0	21.29
Germania Branch	18.1%	0.0%	5.5%	12.6%	4.0	2.0	11.0	4.0	20.89
Hammersley Fork	2.5%	0.0%	1.7%	0.8%	4.0	0.5	2.0	3.0	8.08
Beaverdam Run	9.6%	0.3%	6.5%	2.8%	4.0	0.5	3.0	2.0	7.33
Trout Run	7.8%	0.5%	6.8%	0.6%	4.0	0.5	0.0	3.0	6.31
Hevner Run	4.5%	0.0%	3.0%	1.5%	4.0	0.5	0.0	2.0	4.15
Spicewood Run	17.7%	0.0%	16.7%	1.0%	4.0	0.5	1.0	1.0	3.69
Sliders Branch	5.2%	0.0%	1.6%	3.6%	4.0	2.0	1.0	1.0	3.55
Long Run	1.7%	0.0%	0.0%	1.7%	4.0	1.0	2.0	0.0	2.07
Walters Run	5.2%	0.0%	1.3%	3.9%	4.0	0.5	1.0	0.0	1.13
Billings Branch	0.0%	0.0%	0.0%	0.0%	4.0	2.0	0.0	0.0	0.00

This table shows the input data for the road prioritization index by subwatershed.

APPENDIX J
FUNDING SOURCES

Potential Funding Sources for Watershed Restoration and Protection

AMD Funding

Federal Abandoned Mine Land Reclamation Trust Fund: The Trust Fund was established by the federal Surface Mining Control and Reclamation Act (SMCRA). US Office of Surface Mining (OSM)

The Appalachian Clean Streams Initiative (ACSI) is a broad-based program to eliminate acid drainage from coal mines. The program was initiated by the US Office of Surface Mining (OSM) and the US E.P.A. Region 3

Rural Abandoned Mine Program(RAMP) is authorized by section 406 of the Surface Mining Control and Reclamation Act of 1977, as amended by the Abandoned Mine Reclamation Act of 1991. Eligibility: Individuals, groups, or units of government who own or control the surface or water rights of abandoned coal land or lands, and water affected by coal mining practices before August 3, 1977. These areas are not eligible if: (1) There is continuing reclamation responsibility on the part of the mine operator or the State; (2) the lands are in Federal ownerships; and (3) the surface rights are under easement or lease to be remained. (Source: http://www.cfda.gov/static/10910.asp).

Potential Funding Sources for Watershed Protection

Federal Watershed Protection Funding Sources (organized according to topic)

Agriculture

U.S. Department of Agriculture
Conservation Reserve Program (CRP)(FSA)

Environmental Quality Incentives Program (EQUIP)(NRCS)

Coastal Waters

(Kettle Creek is a part of the Cheasapeake Bay Watershed)

U.S. Environmental Protection Agency
Chesapeake Bay Program Grants (CBP)

Chesapeake Bay Small Watershed Grants (CBP)

Disaster Prevention and Relief

Federal Emergency Management Agency
Flood Mitigation Assistance Program

Hazard Mitigation Grant Program

Project Impact Grant Program

U.S. Army Corps of Engineers
Flood Hazard Mitigation and Riverine Ecosystem Restoration Program (Challenge 21) (USACE)

U.S. Department of Agriculture
Emergency Conservation Program (FSA)

U.S. Environmental Protection Agency
Superfund Technical Assistance Grants for Citizen Groups at Priority Site (OERR)

Economic Development

U.S. Department of Agriculture
Water and Waste Disposal Systems for Rural Communities (RUS)

U.S. Department of Commerce
Public Works and Development Facilities Program (EDA)

U.S. Department of Housing and Urban Development

Community Development Block Grant Program (CPD)

U.S. Environmental Protection Agency
Sustainable Development Challenge Grants (OA)

Education and Research

Corporation for National Service
Learn and Serve America Program

U.S. Department of Agriculture
Sustainable Agriculture Research and Education (CSREES)

Water Quality Special Research Grants Program (CSREES)

U.S. Environmental Protection Agency
Environmental Education Grants Program (OEE)

Science to Achieve Results (ORD)

Environmental Justice

U.S. Environmental Protection Agency
Environmental Justice Grants to Small Community Groups (OEJ)

Environmental Justice Through Pollution Prevention Grants Program (OEJ)

Forestry

U.S. Department of Agriculture
Cooperative Forestry Assistance Programs (FS)

Forestry Incentives Program (NRCS)

Mining

U.S. Department of the Interior
Abandoned Mine Land Reclamation Program (OSM)

Monitoring

U.S. Environmental Protection Agency
Environmental Monitoring for Public Access and Community Tracking (OEI)

Pollution Prevention and Control

Small Business Administration

Pollution Control Loans

U.S. Department of the Interior
Clean Vessel Act Grant Program (FWS)

U.S. Environmental Protection Agency

Chemical Emergency Preparedness and Prevention Technical Assistance Grants (CEPPO)

Pesticide Environmental Stewardship Grants (OPPTS)

Pollution Prevention Incentives for States (OPPTS)

Watershed and Drinking Water Source Protection

U.S. Department of Agriculture
Watershed Protection and Flood Prevention Program (NRCS)

U.S. Department of Transportation
Transportation Equity Act for the 21st Century Funding Programs (FHWA)

U.S. Department of the Interior
Land and Water Conservation Fund Grants to States (NPS)

U.S. Environmental Protection Agency

Capitalization Grants for Clean Water State Revolving Fund (OWM)

Nonpoint Source Implementation Grants (319 Program) (OWOW)

Water Quality Cooperative Agreements (OWM)

Watershed Assistance Grants (OWOW)

Wetlands

U.S. Department of Agriculture
Wetlands Reserve Program (NRCS)

U.S. Department of the Interior
North American Wetlands Conservation Act Grants Program (FWS)

U.S. Environmental Protection Agency
Five-Star Restoration Program (OWOW)

Wetlands Program Development Grants (OWOW)

Wildlife

National Fish and Wildlife Foundation
Bring Back the Natives Grant Program

U.S. Department of Agriculture
Wildlife Habitat Incentives Program (NRCS)

U.S. Department of Commerce
Community-Based Restoration Program (NOAA)

Fisheries Development and Utilization Research and Development Grants and Cooperative Agreements Program (NOAA)

U.S. Department of the Interior
Partners for Fish and Wildlife Program (FWS)

Wildlife Conservation and Appreciation Program (FWS)

Source
http://www.epa.gov/owow/watershed/wacademy/fund/sources.html

ATMOSPHERIC DEPOSITION METHODS

Episodic Acidification Sampling For Detailed Study

• Materials needed: clean water sampling bottles, access to stream hydrograph, flow meter, measuring tape.

• Three water samples are used to determine this. One sample is taken before the peak of the storm, one sample is taken at the peak of the storm, and the final sample is taken after the peak of the storm. To do this, much more than three samples are taken because it will not be known at what time the peak of the rain event occurs until after the rain event is over. In order to ensure that a sample is taken before, during, and after the peak of the storm, a water sample, flow, and depth measurements are taken every 6 hours during the entire storm length.

• The water sample is then analyzed for pH. Only three samples (before, during, and after peak) are needed for this analysis.

• Note: to determine which three samples are used, flow and depth measurements need to be graphed. The graph will look similar to the figure on the following page.

• If the pH becomes more acidic during the peak rain events, acidic deposition is affecting the watershed and may potentially cause problems with stream biota and general water quality in the future.

Episodic Acidification Sampling For Volunteers

• Materials needed: pH meter

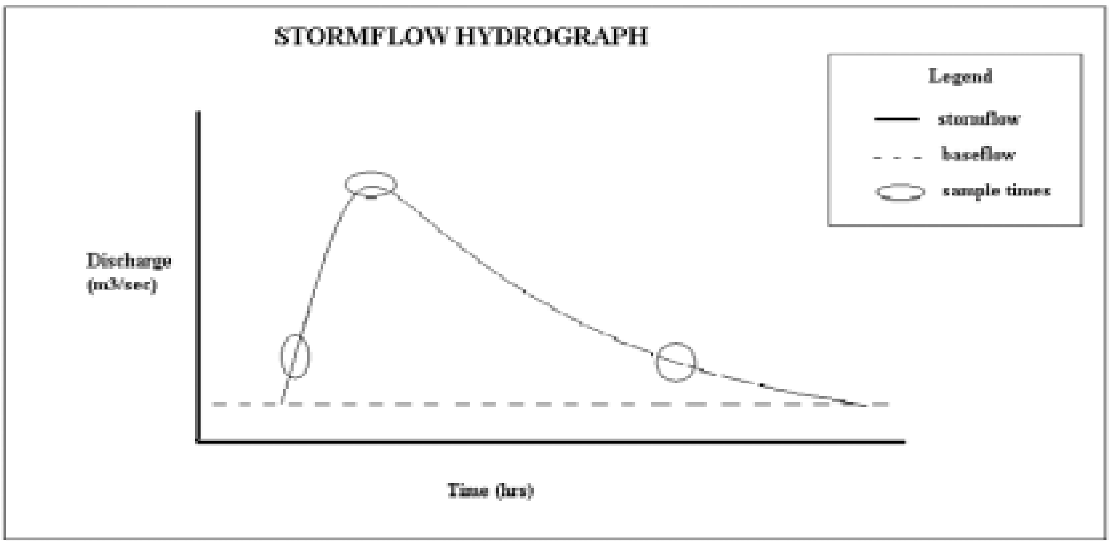
• Three pH readings are needed. One reading is taken before the peak of the storm, one reading is taken close to the peak of the storm, and the final pH reading is taken after the peak of the storm. Note: these samples do not have to be taken at exact times in the storm, estimations of high and low flow can be used to indicate the "peak", before, and after the peak of the storm.

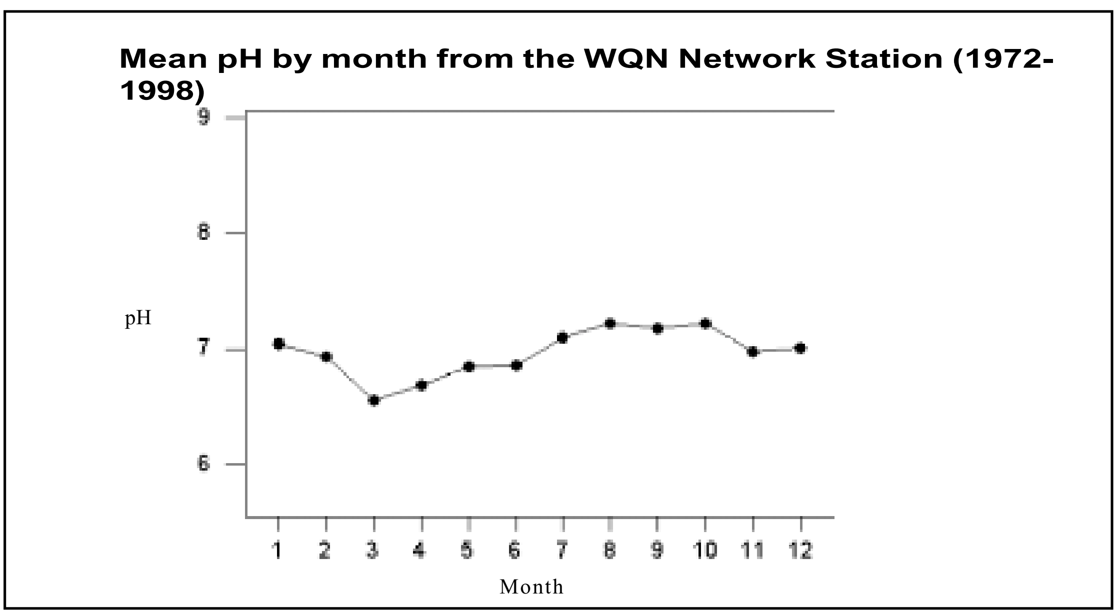
• Sample hydrograph of estimated times of pH reading are located on the graphs on the following page.

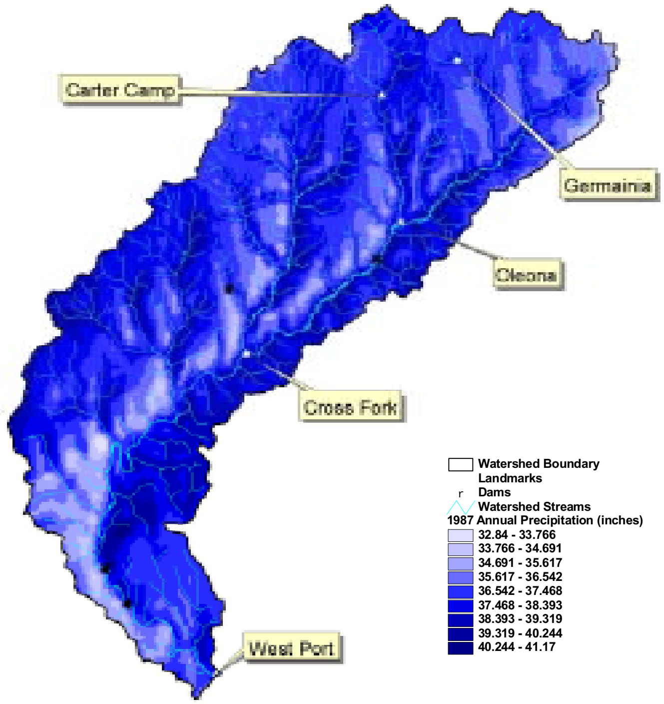
• If the pH becomes more acidic during the peak rain events, acidic deposition is affecting the watershed and may potentially cause problems with stream biota and general water quality in the future.

APPENDIX K
ATMOSPHERIC DEPOSITION

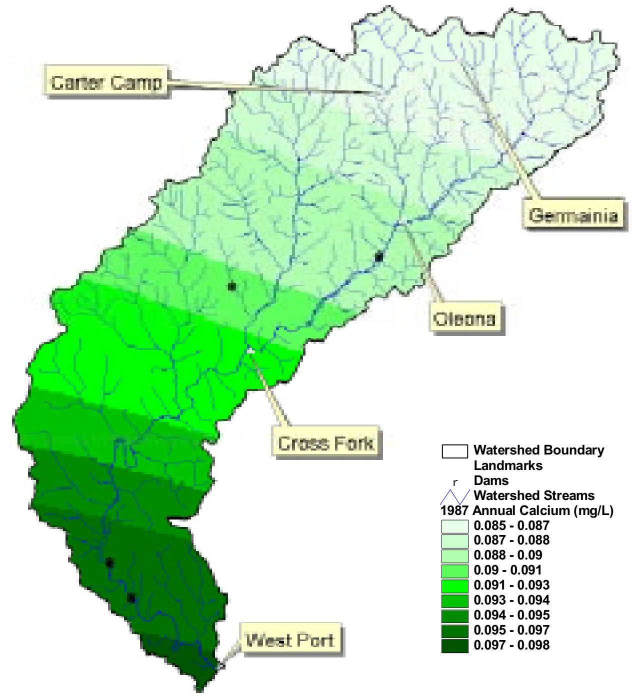
SUGGESTED EPISODIC ACIDIFICATION SAMPLING TIMES



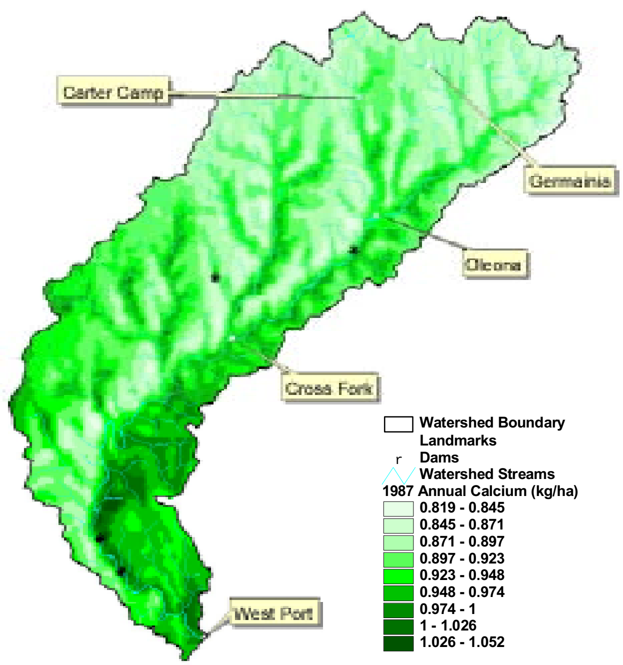




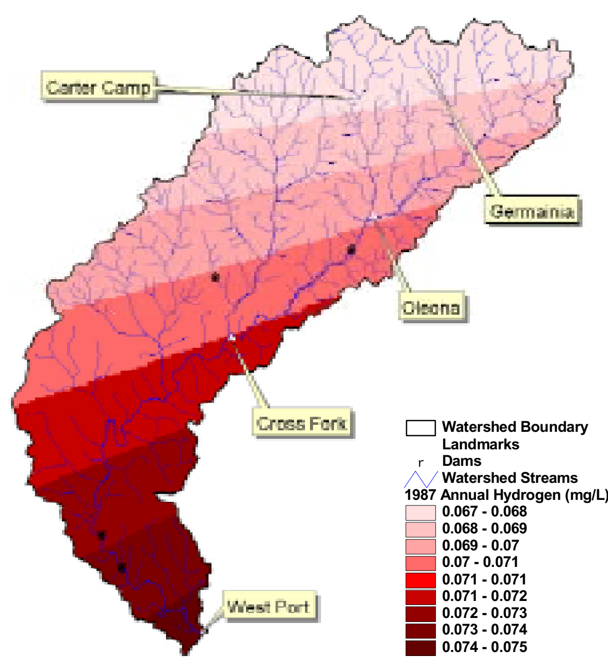
1987 Precipitation in the Kettle Creek Watershed



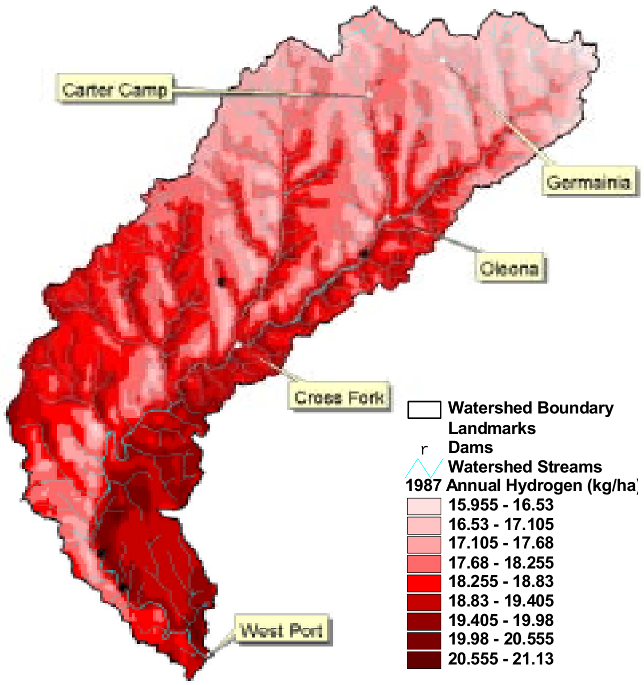
1987 Calcium Concentration in the Kettle Creek Watershed



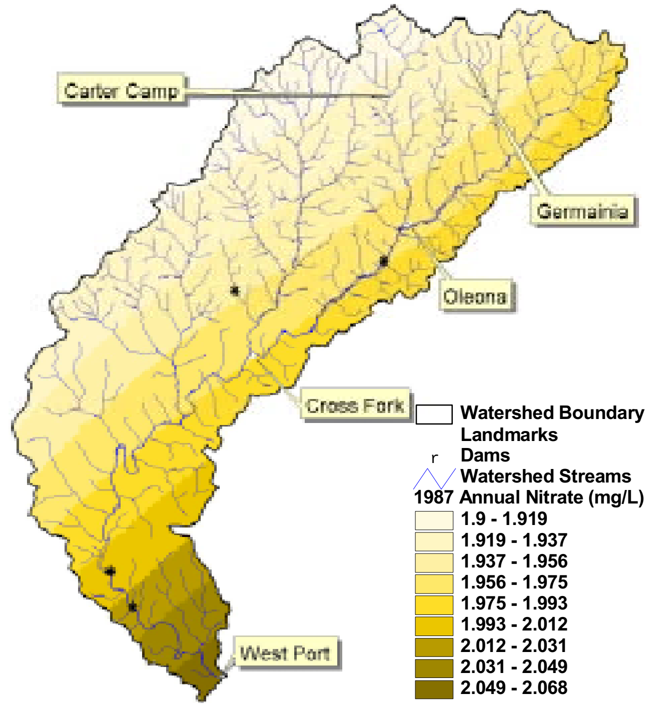
1987 Calcium Deposition in the Kettle Creek Watershed



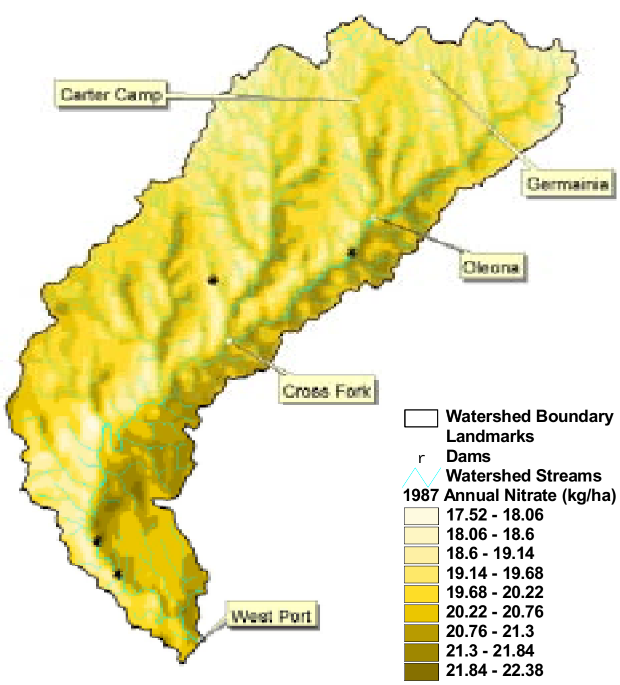
1987 Hydrogen Concentration in the Kettle Creek Watershed



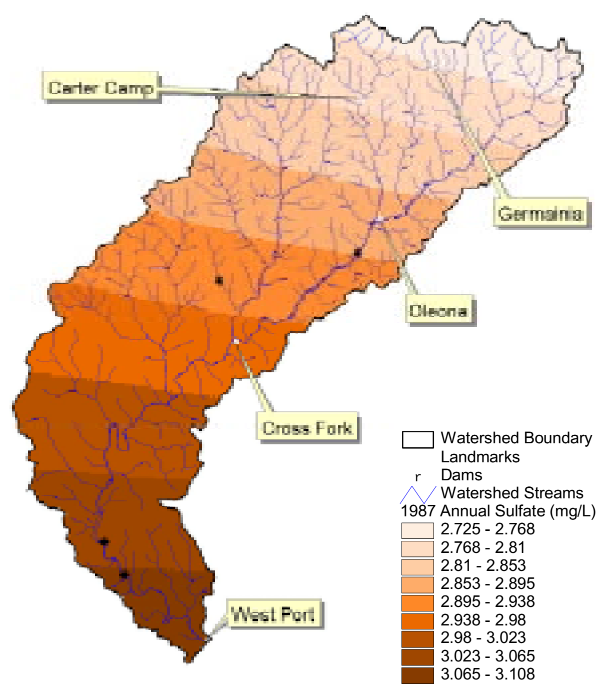
1987 Hydrogen Deposition in the Kettle Creek Watershed



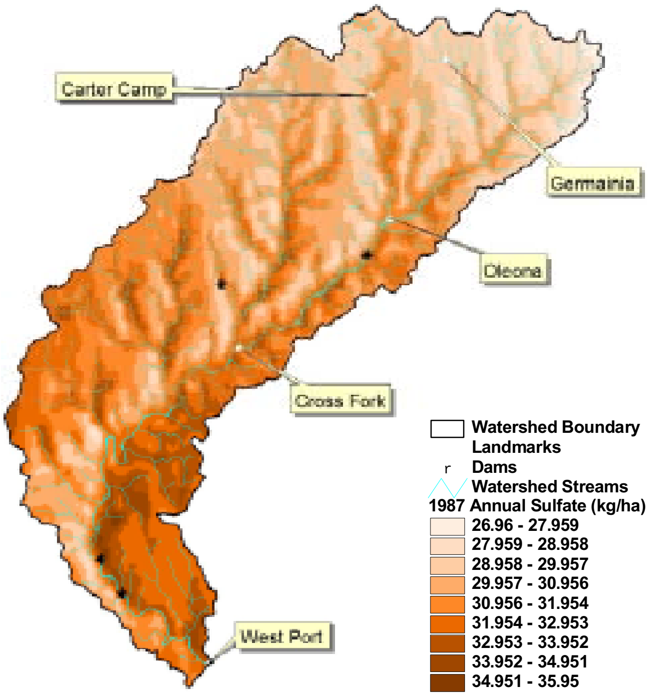
1987 Nitrate Concentration in the Kettle Creek Watershed



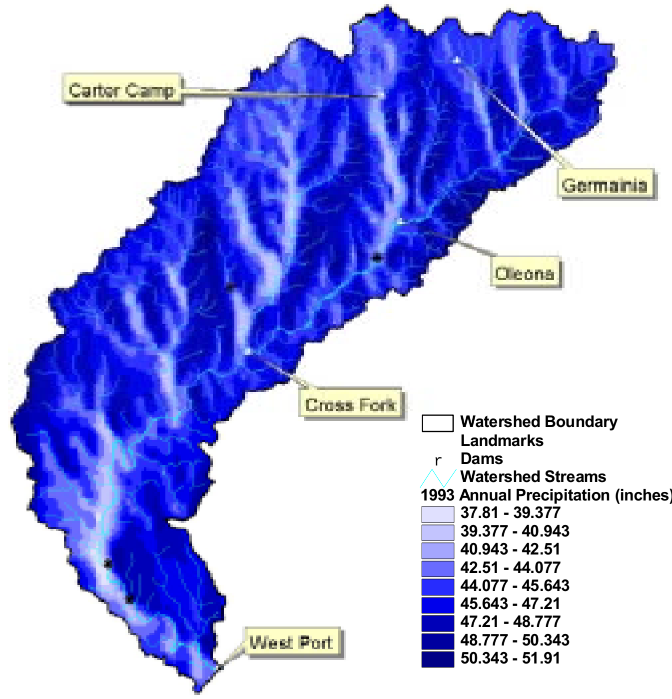
1987 Nitrate Deposition in the Kettle Creek Watershed



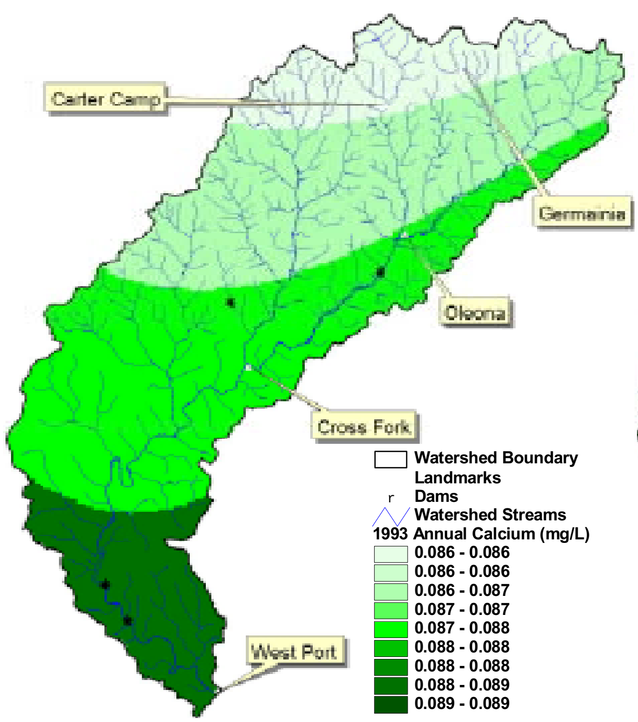
1987 Sulfate Concentration in the Kettle Creek Watershed



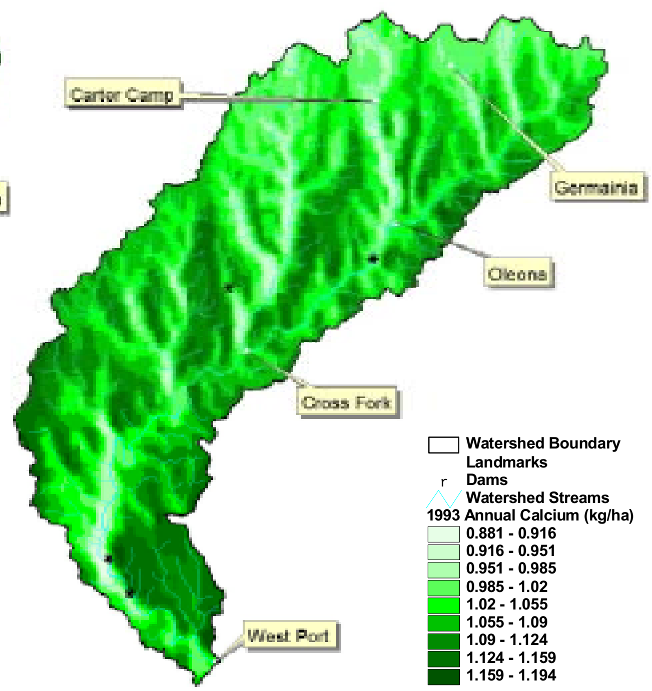
1987 Sulfate Deposition in the Kettle Creek Watershed



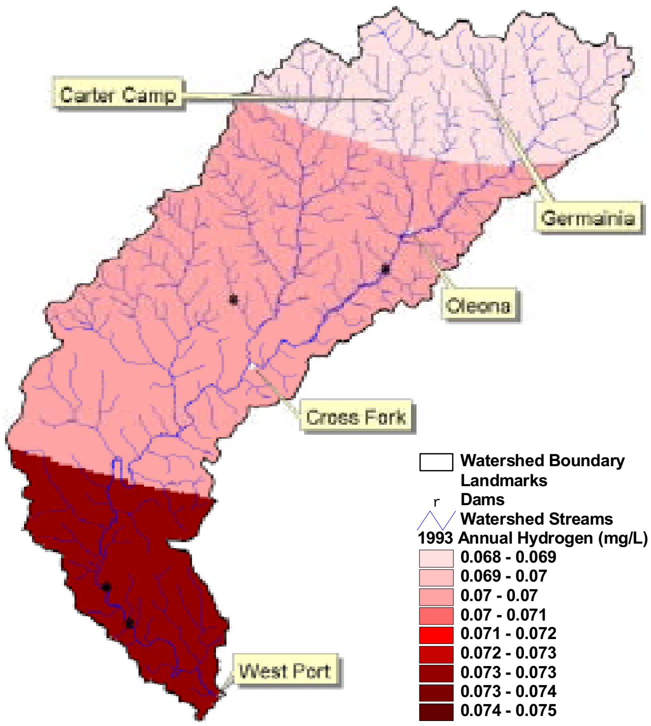
1993 Preciptation in the Kettle Creek Watershed



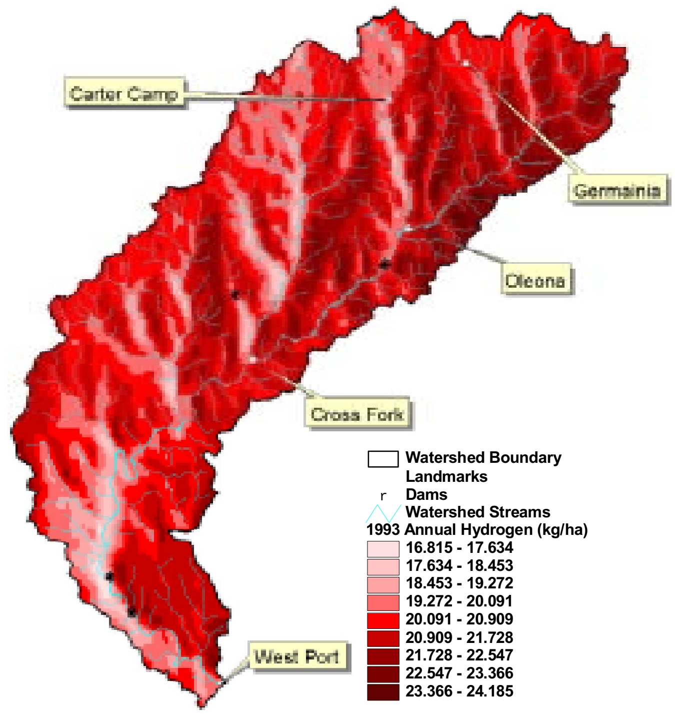
1993 Calcium Concentration in the Kettle Creek Watershed



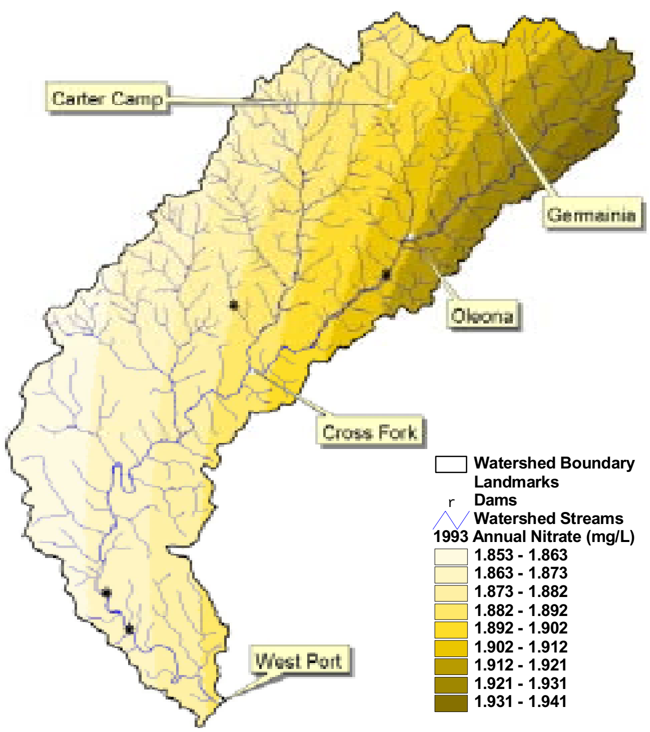
1993 Calcium Deposition in the Kettle Creek Watershed



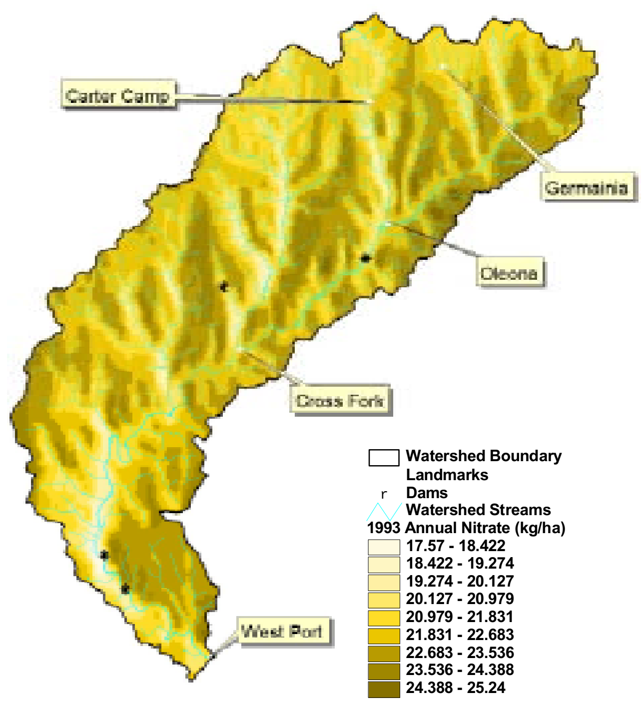
1993 Hydrogen Concentration in the Kettle Creek Watershed



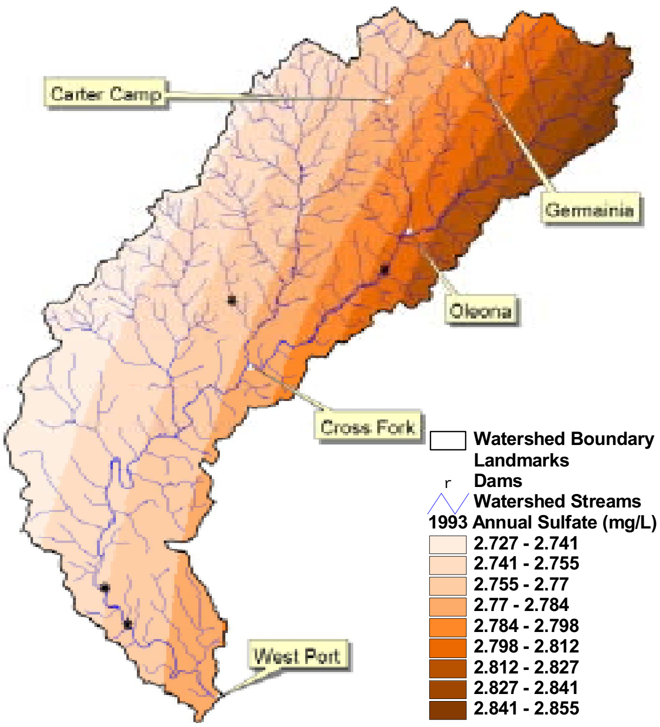
1993 Hydrogen Deposition in the Kettle Creek Watershed



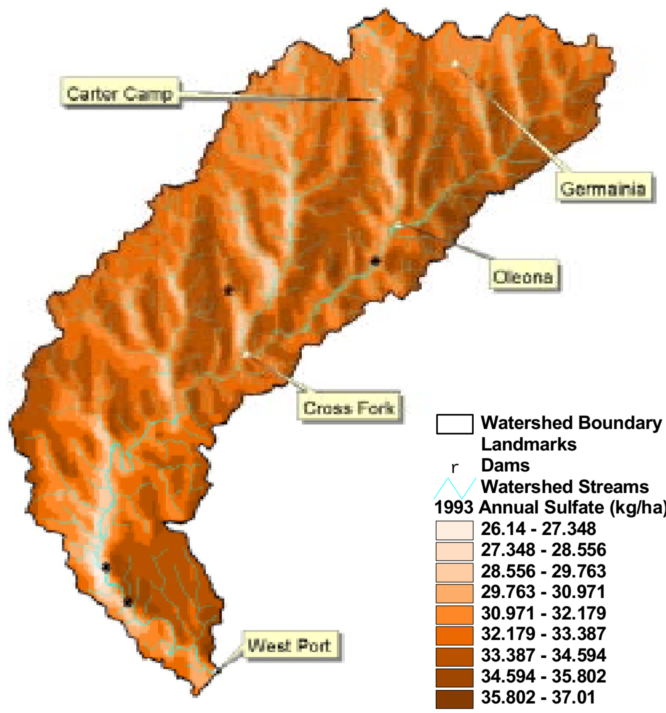
1993 Hydrogen Concentration in the Kettle Creek Watershed



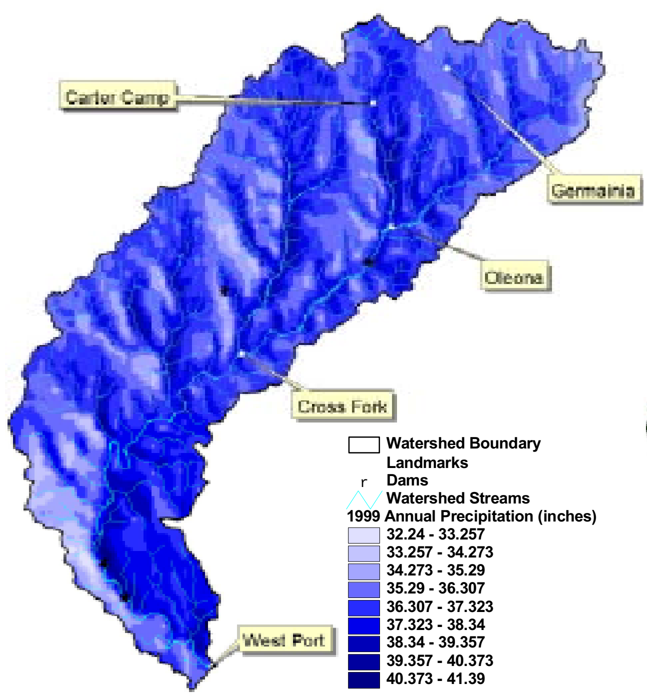
1993 Hydrogen Deposition in the Kettle Creek Watershed



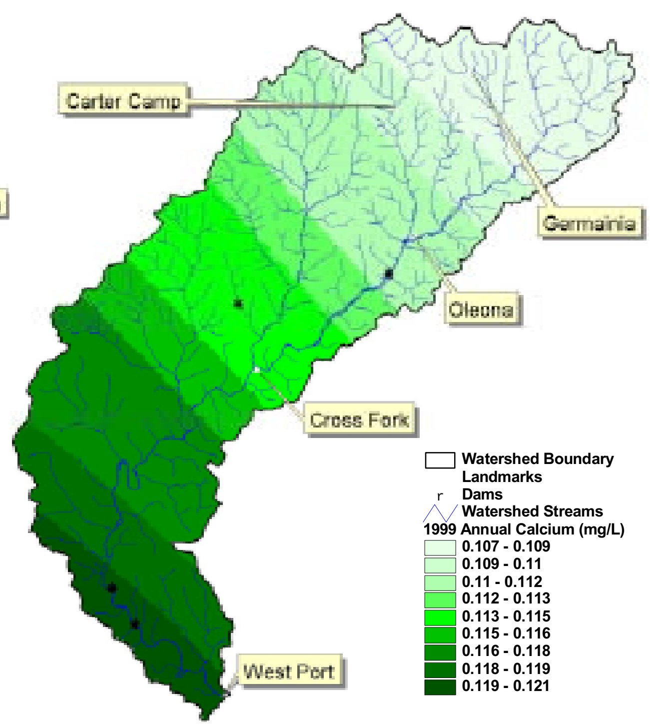
1993 Sulfate Concentration in the Kettle Creek Watershed



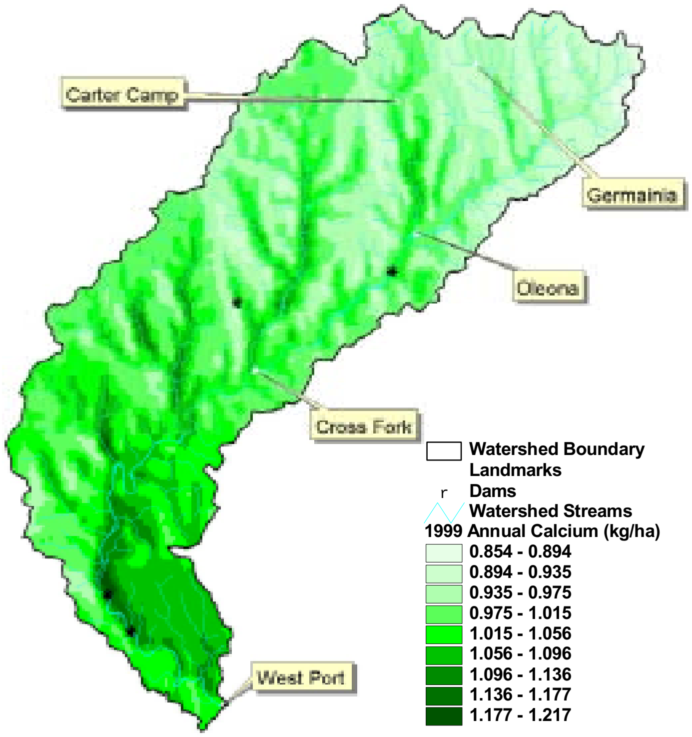
1993 Sulfate Deposition in the Kettle Creek Watershed



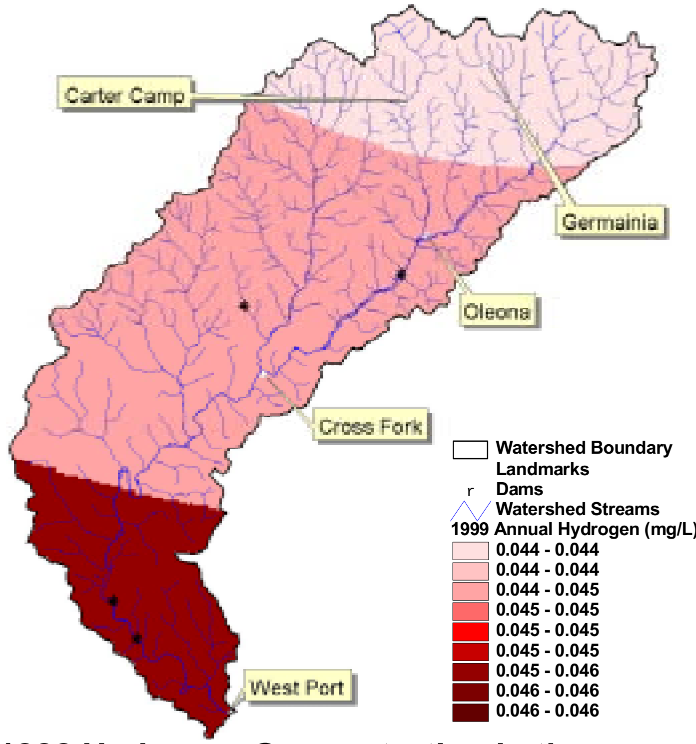
1999 Precipitation in the Kettle Creek Watershed



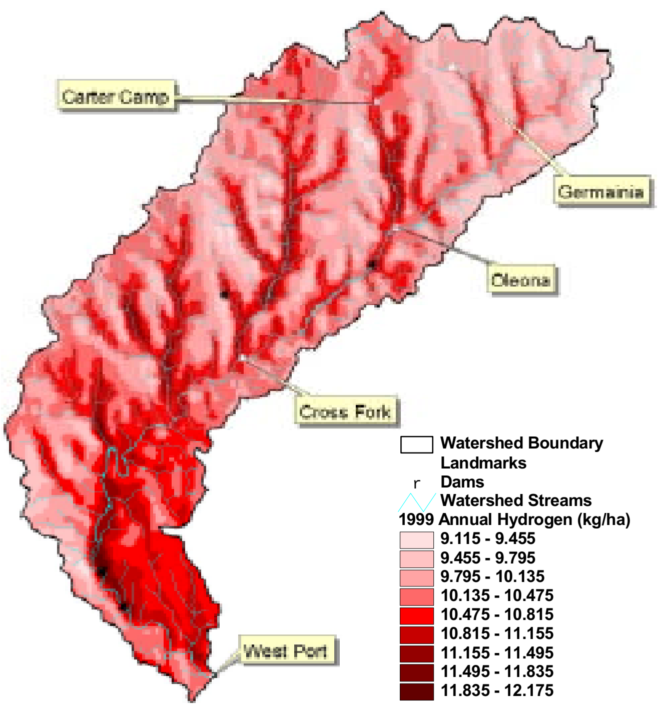
1999 Calcium Concentration in the Kettle Creek Watershed



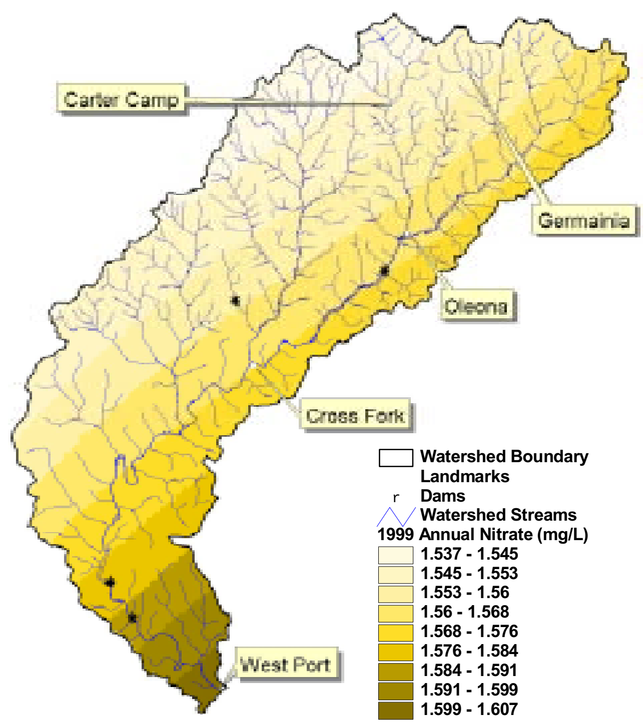
1999 Calcium Deposition in the Kettle Creek Watershed



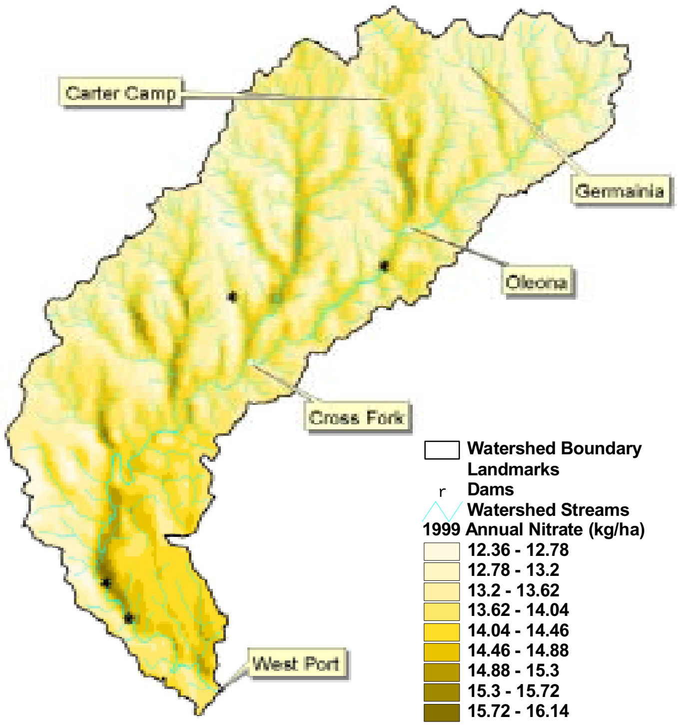
1999 Hydrogen Concentration in the Kettle Creek Watershed



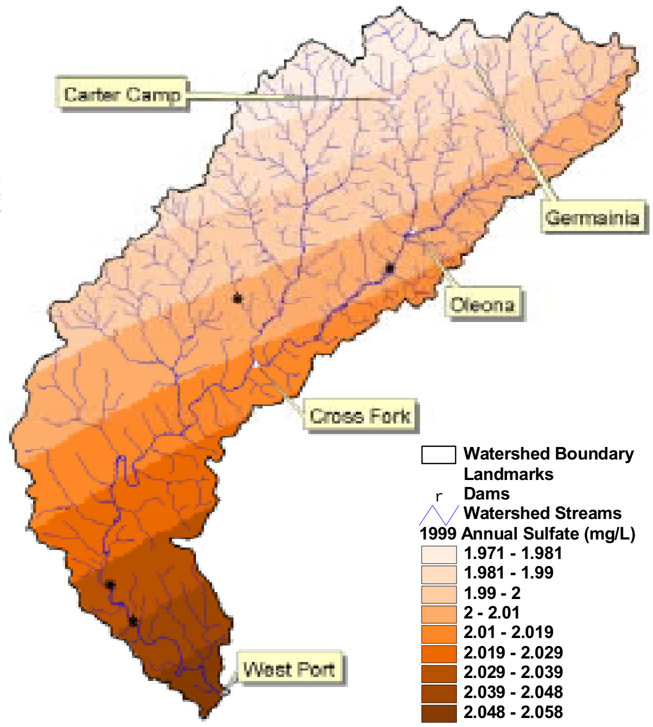
1999 Hydrogen Deposition in the Kettle Creek Watershed



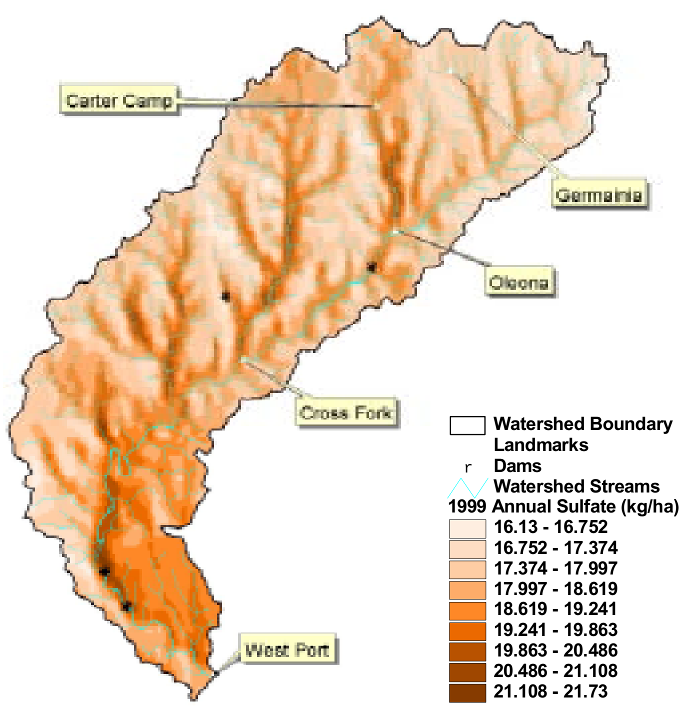
1999 Nitrate Concentration in the Kettle Creek Watershed



1999 Nitrate Deposition in the Kettle Creek Watershed



1999 Sulfate Concentration in the Kettle Creek Watershed



1999 Sulfate Deposition in the Kettle Creek Watershed