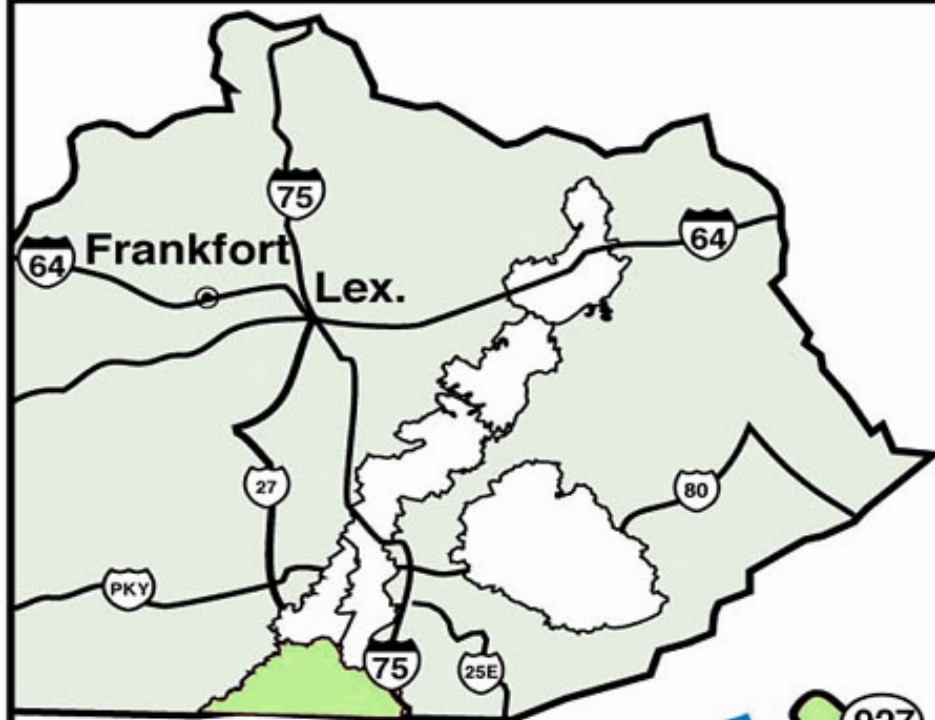
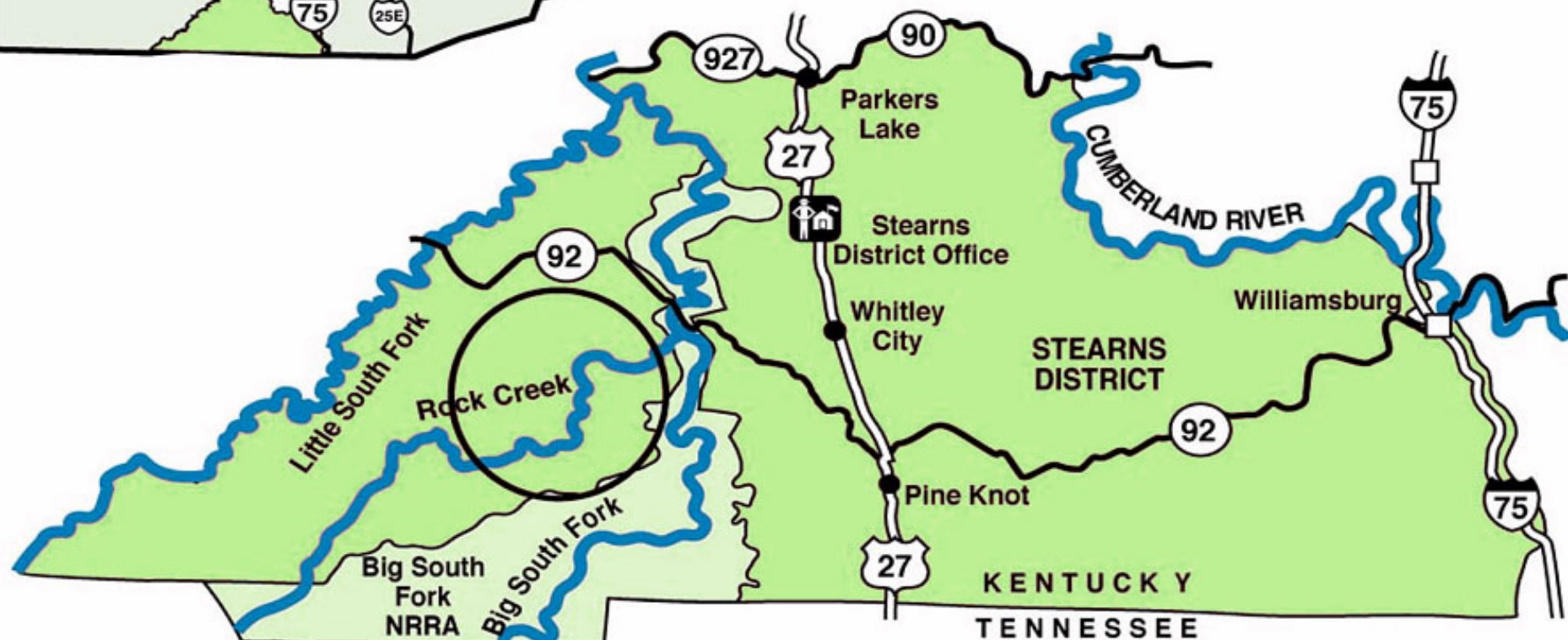


**Limestone Based Passive
Treatment of an Acid Mine
Drainage Impacted Watershed –
Rock Creek, Kentucky**



 **District Boundary
Daniel Boone
National Forest**

 **Big South Fork
National River and
Recreation Area**









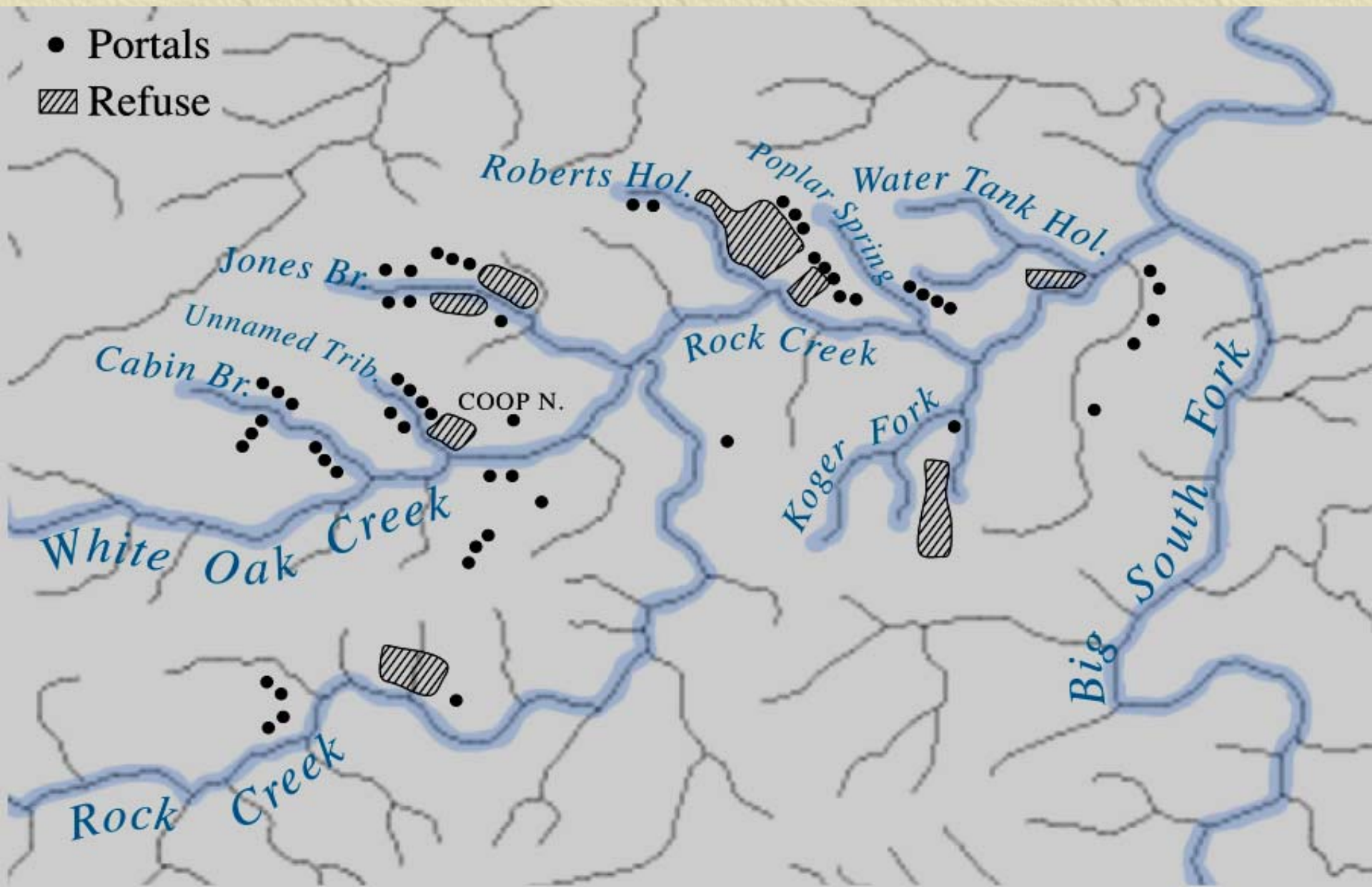






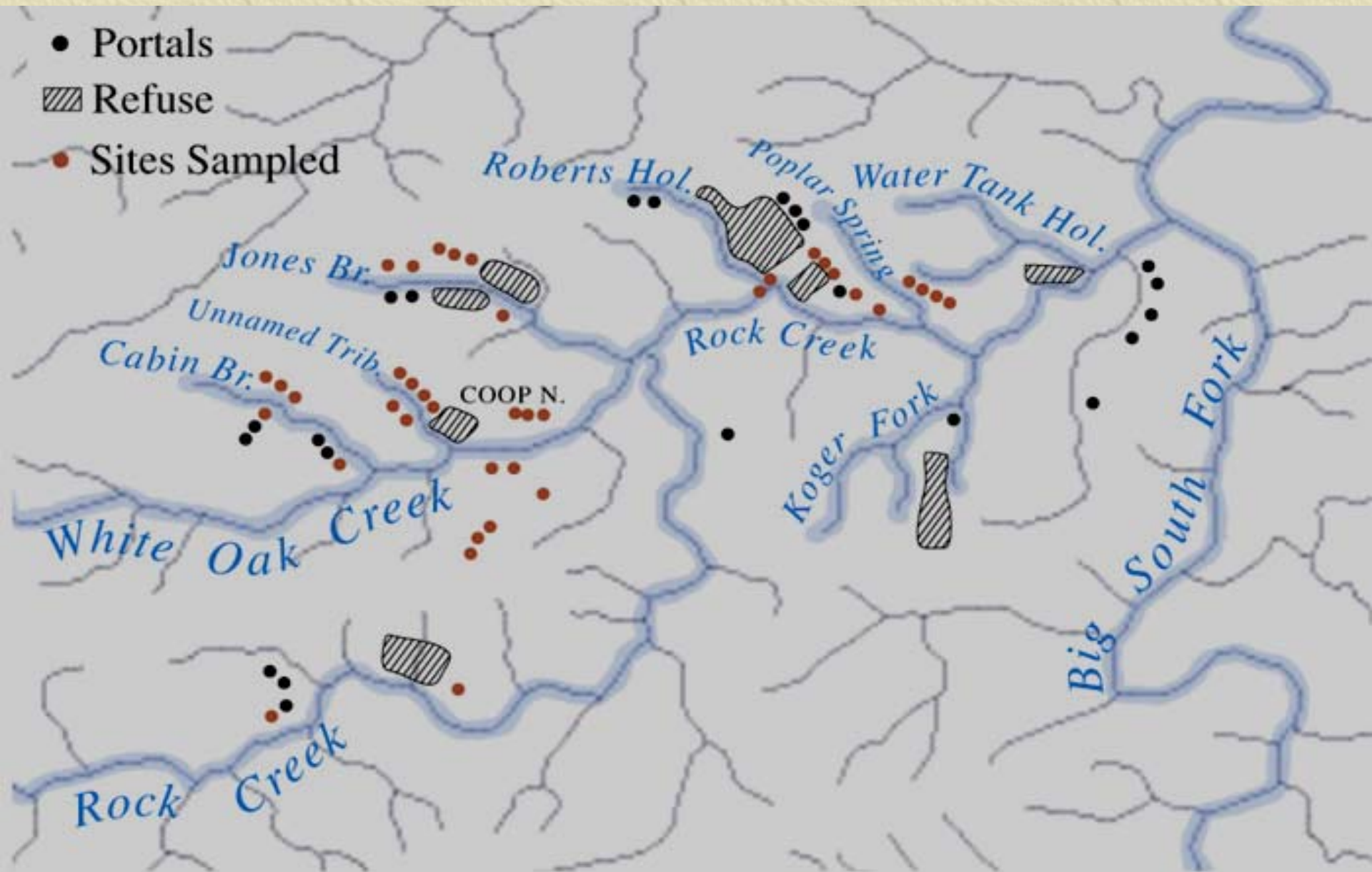


AMD Sources



Spring 1995
Portal Sampling
and Analysis

Sites Sampled

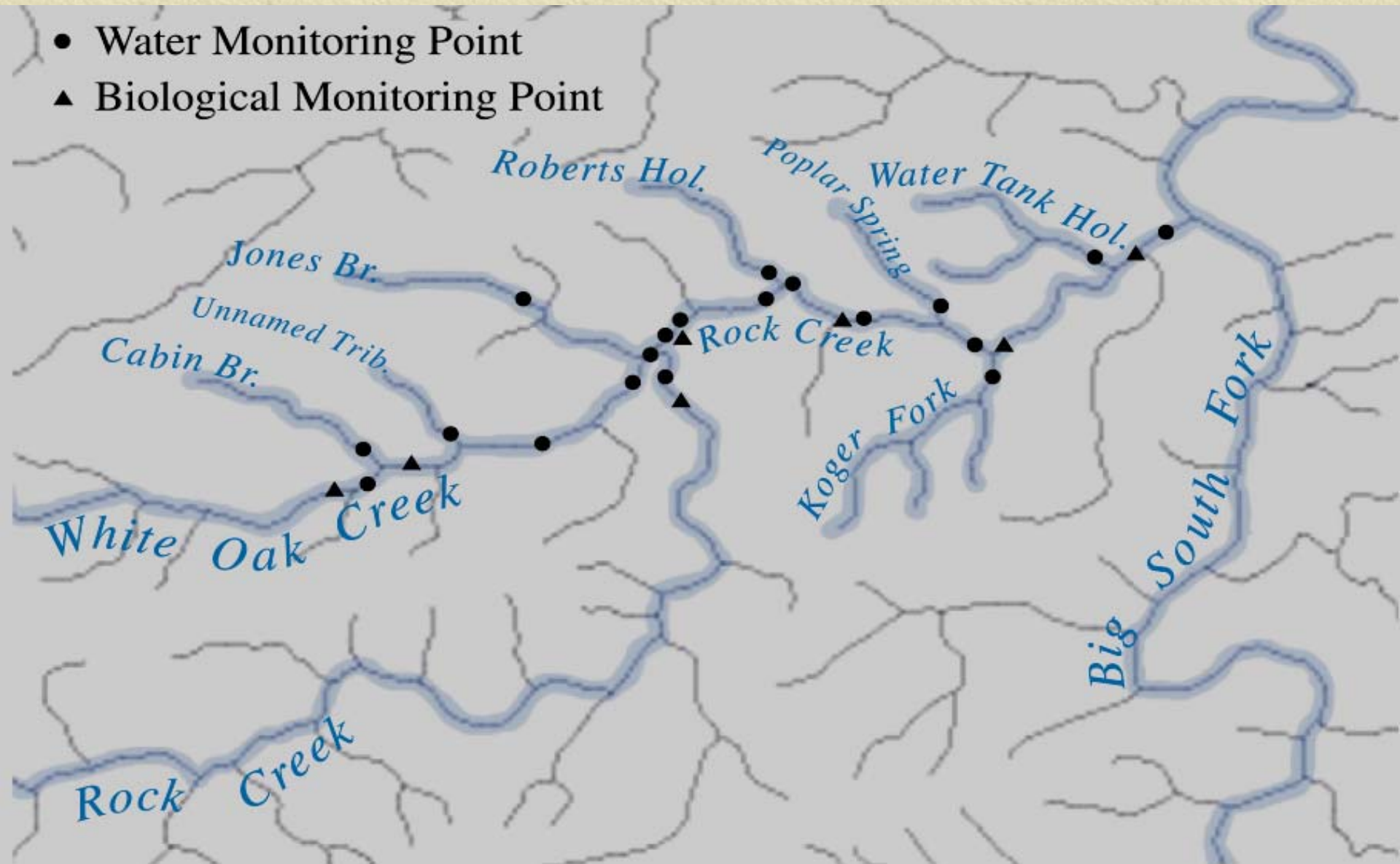


Rock Creek AMD Sites Characterized by

- ✦ Low pH
- ✦ High Acidity
- ✦ No Alkalinity
- ✦ High Iron Concentrations
- ✦ High Aluminum Concentrations

Monitoring Points

- Water Monitoring Point
- ▲ Biological Monitoring Point





Passive Treatment Suitability Analysis

- ✦ Anoxic Limestone Drain
- ✦ Open Limestone Channel
- ✦ Aerobic Wetland
- ✦ Anaerobic Wetland
- ✦ Vertical Flow Wetland

AMD Abatement Techniques Utilized

- ✦ Limestone Sand Dosing
- ✦ Refuse Removal and Treatment
- ✦ Open Limestone Channels
- ✦ Vertical Flow System

Rock Creek Project

AMD Abatement Methodology

- ✦ Treat AMD with limestone sand at rates based on acid loading calculations
- ✦ Utilize passive treatment and mine reclamation techniques as funding allows
- ✦ Reduce limestone sand dosing as sites are reclaimed and passive treatment systems are installed

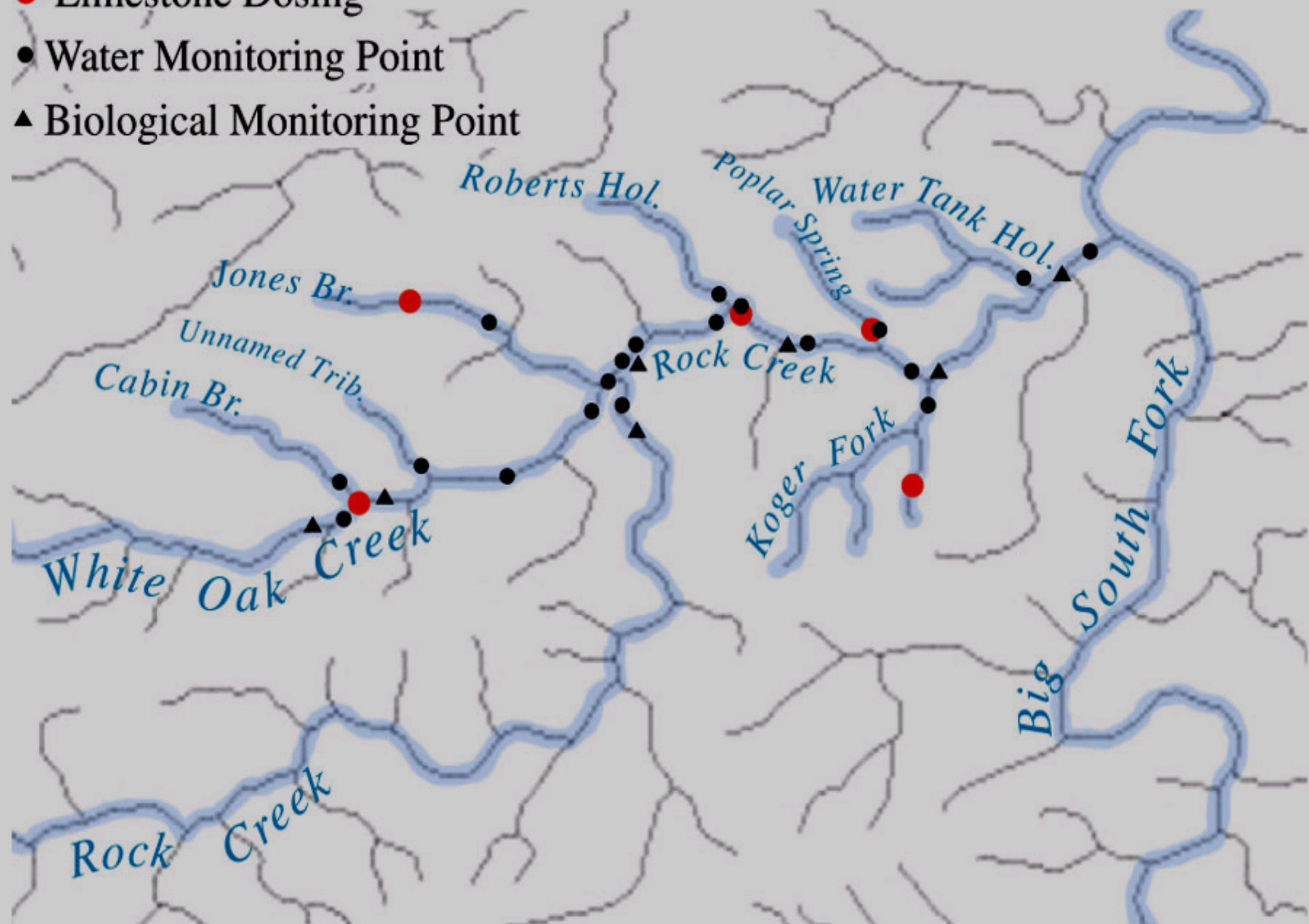
Project Construction



Limestone Sand Dosing

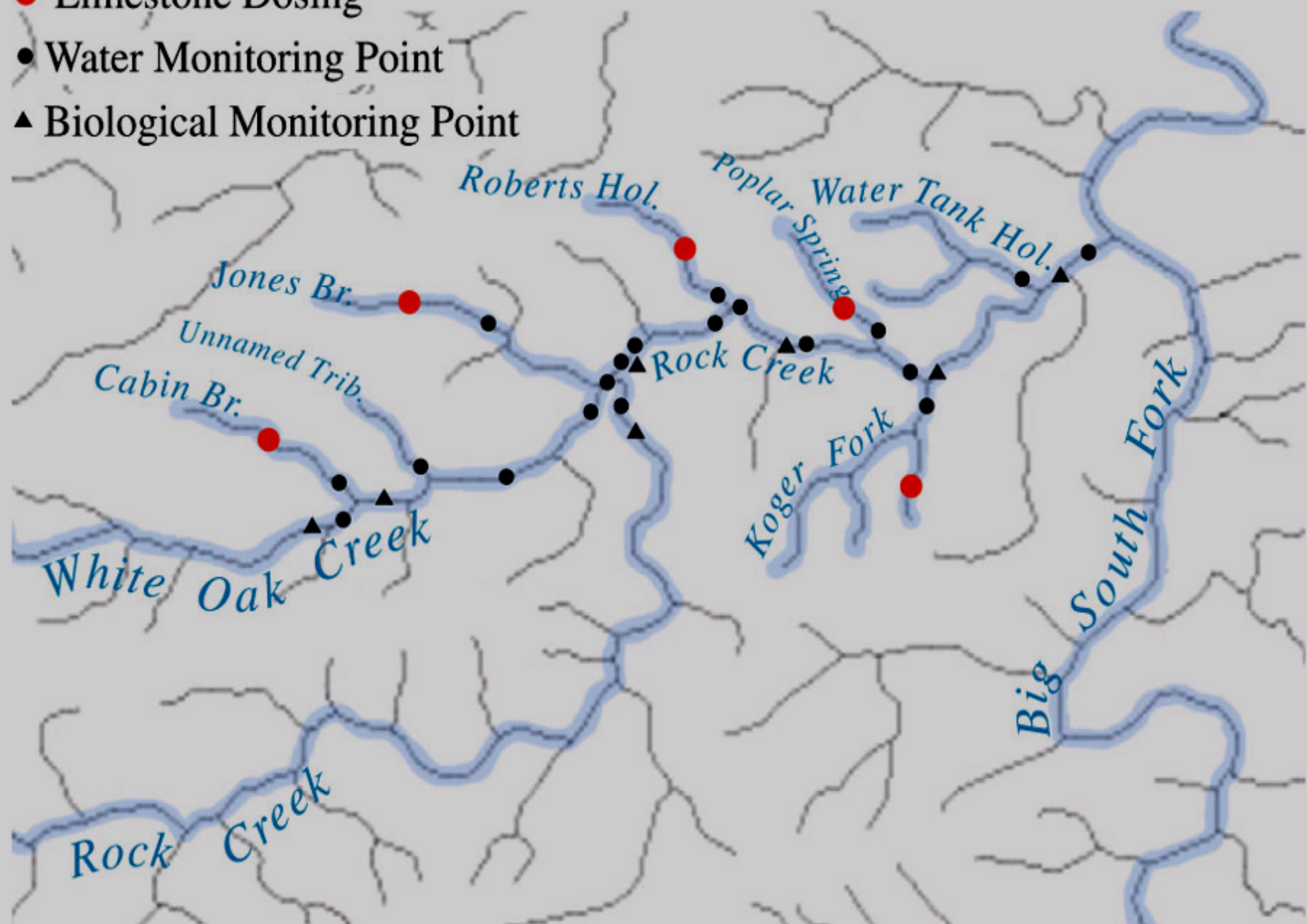


- Limestone Dosing
- Water Monitoring Point
- ▲ Biological Monitoring Point



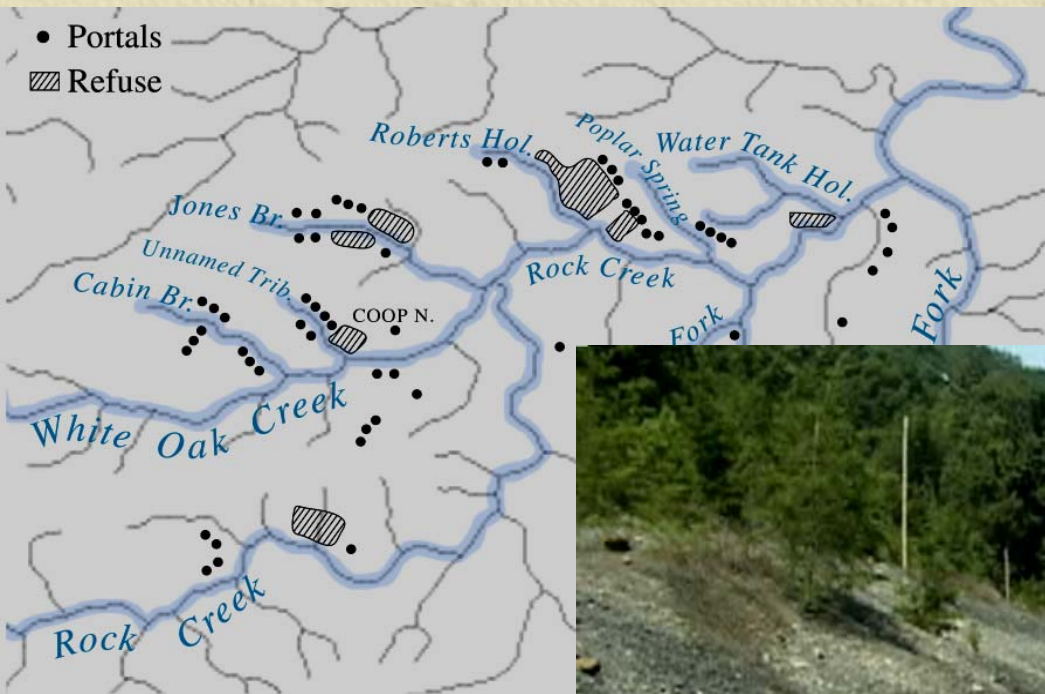


- Limestone Dosing
- Water Monitoring Point
- ▲ Biological Monitoring Point





Refuse Removal at Watertank Hollow















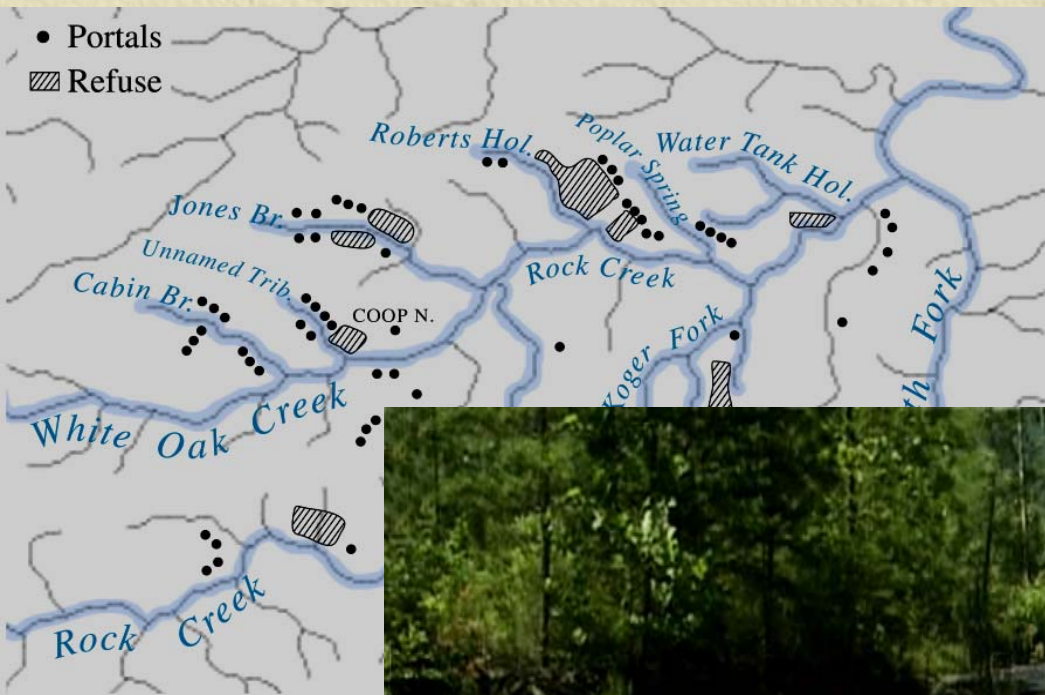


Water Tank Hollow Refuse Reclamation Results

RUSLE Analysis

- ✦ Sediment load into Rock creek reduced by 500 tons annually
- ✦ Acid load into Rock Creek reduced by over 80 tons annually

Refuse Removal at Paint Cliff





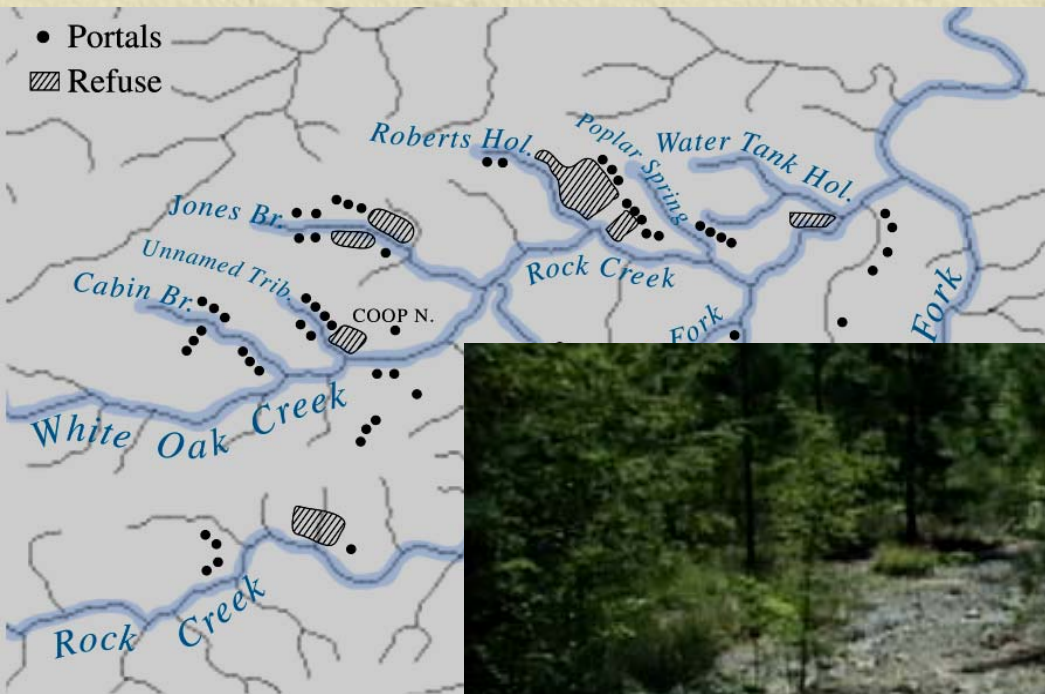








Roberts Hollow Fill Area





















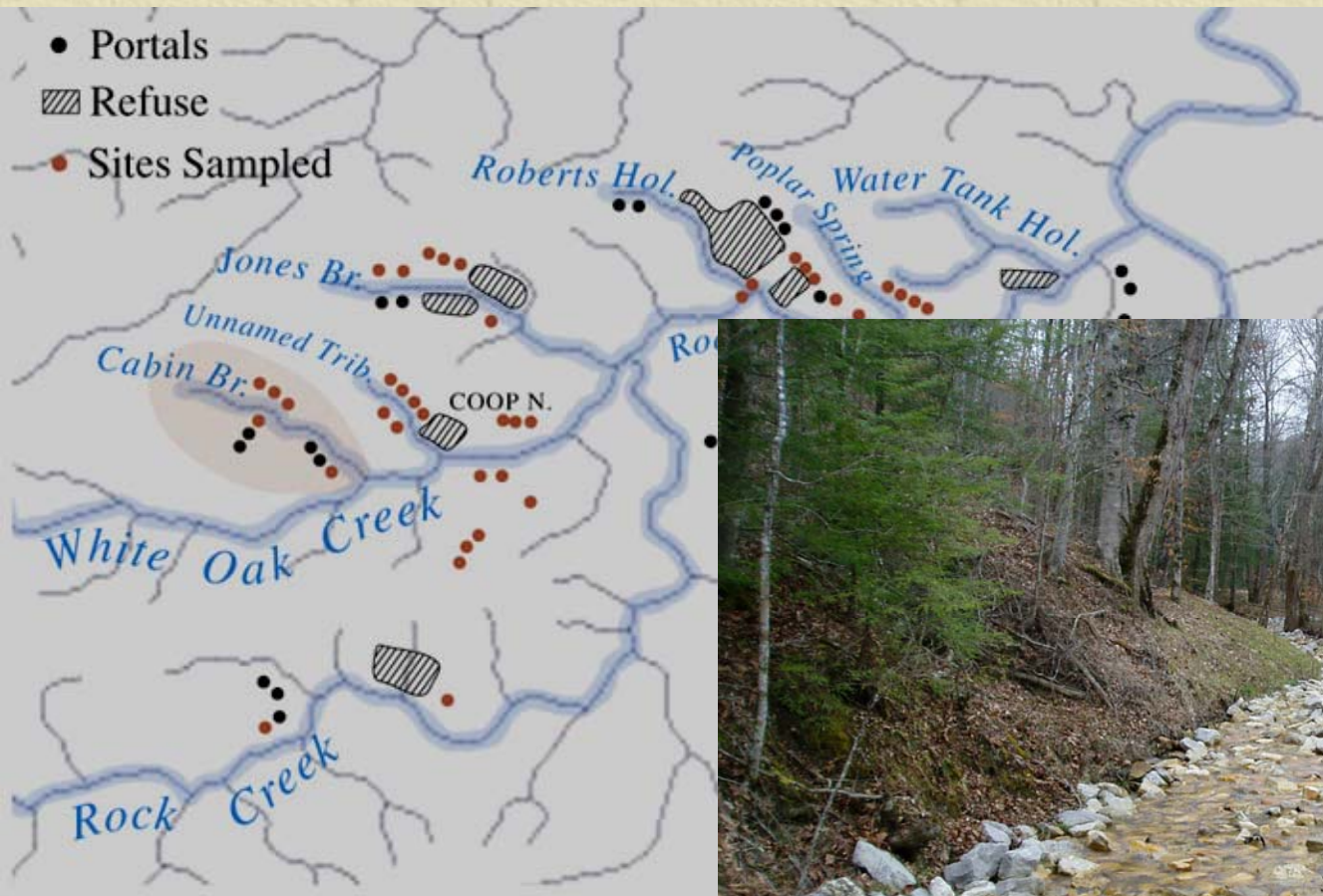


Open Limestone Channels





Cabin Branch







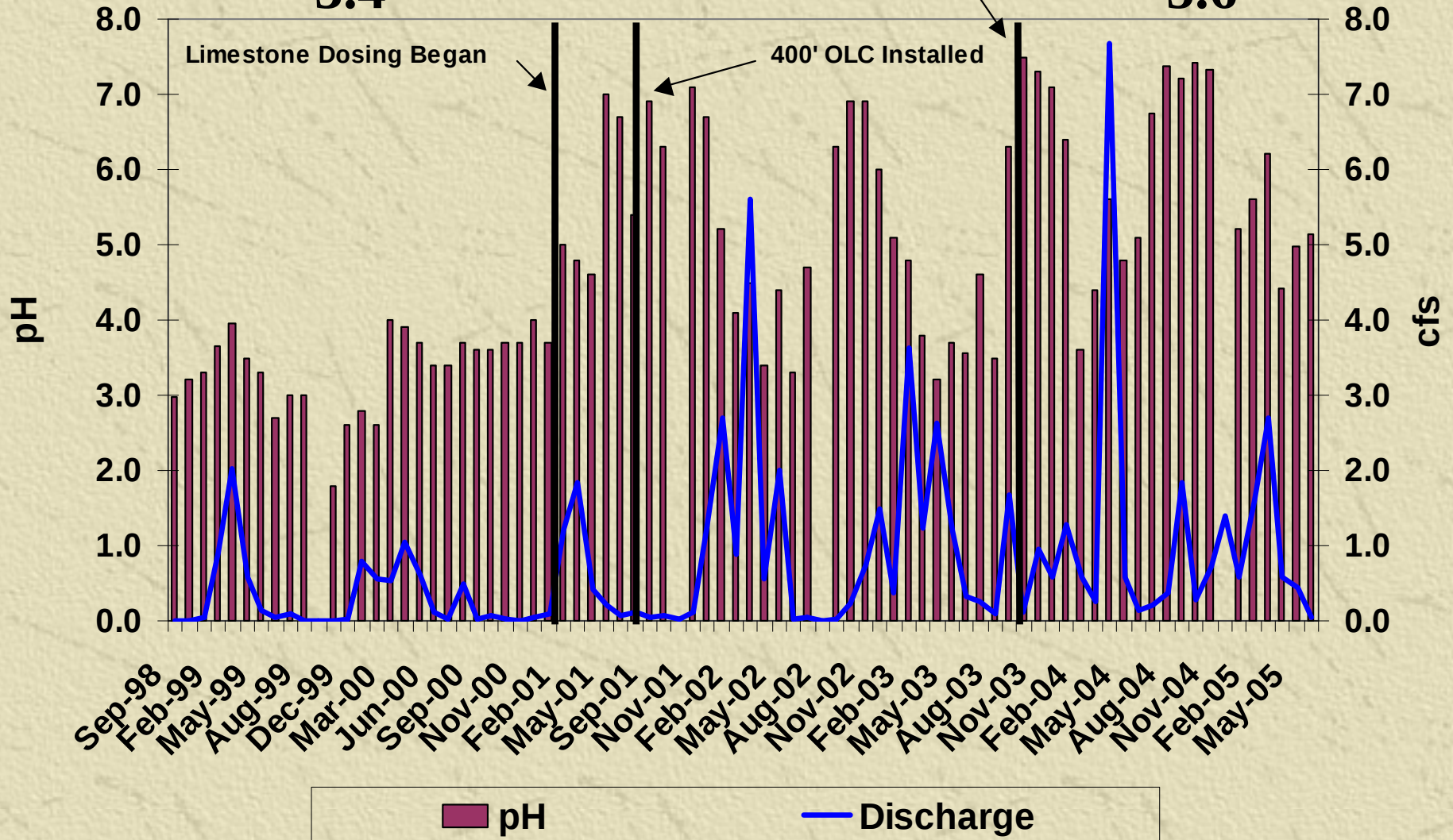


Cabin Branch pH

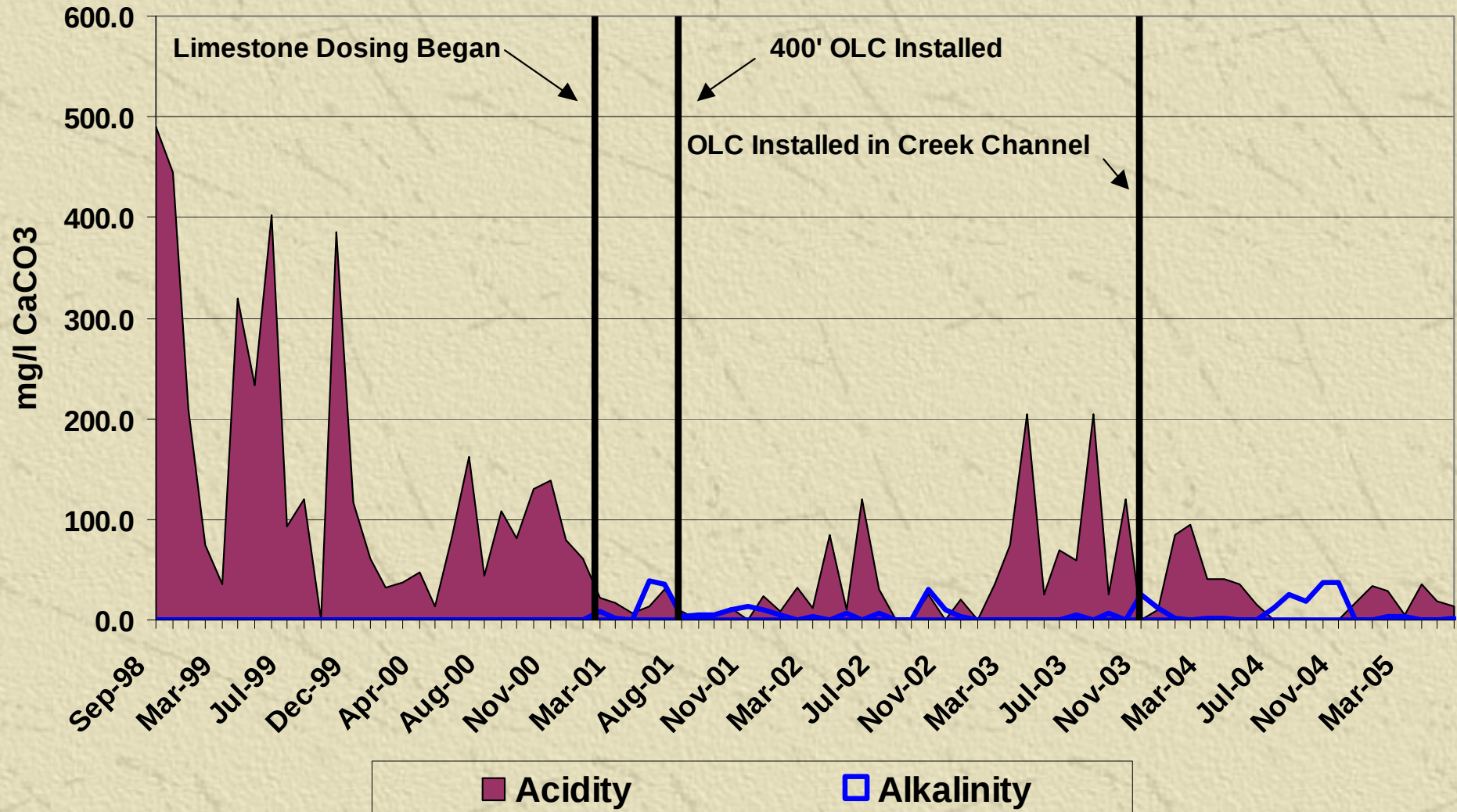
Median
3.4

Limestone Installed in Creek
Channel - Dosing Ends

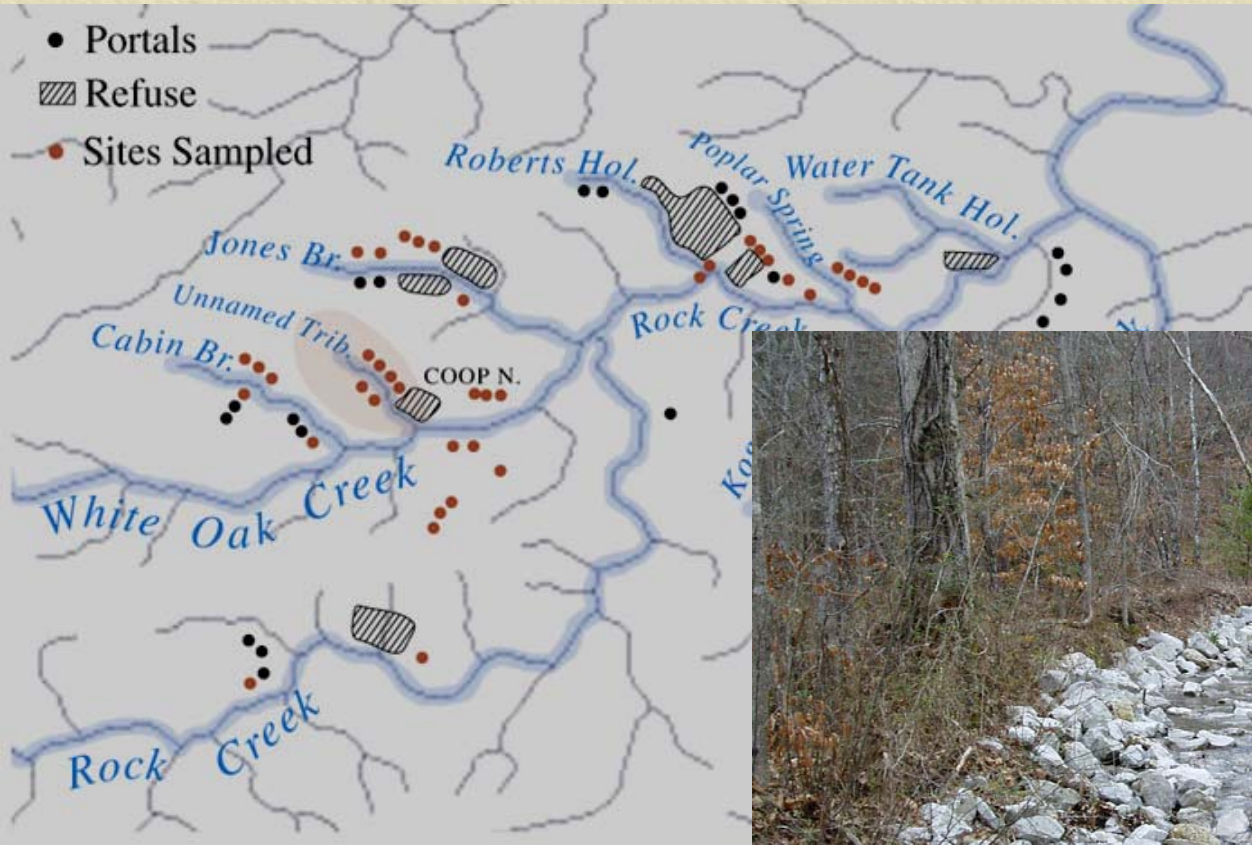
Median
5.6



Cabin Branch Acidity reduced 85%



Unnamed Tributary to White Oak Ck.



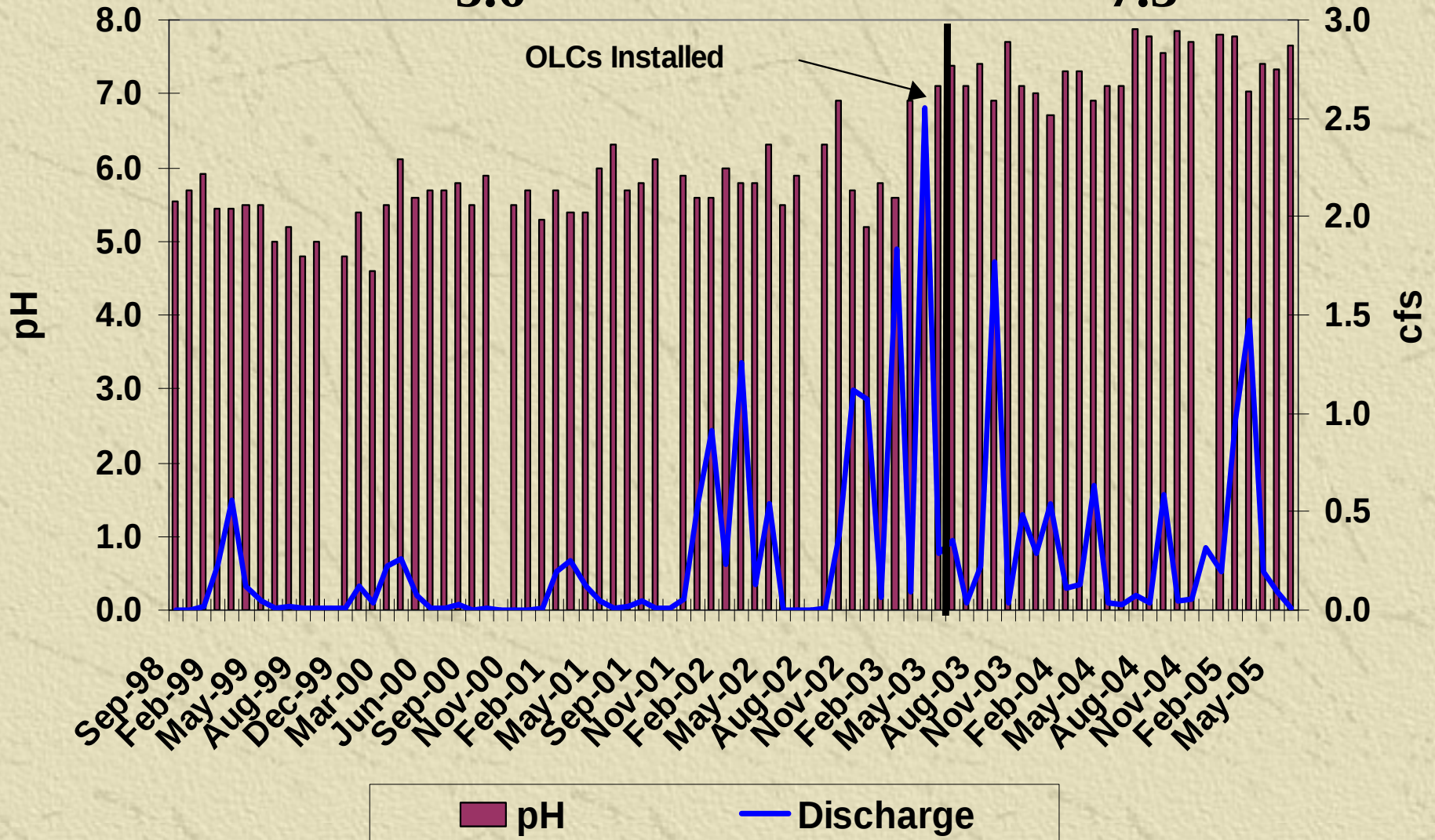
Unnamed Tributary pH

Median

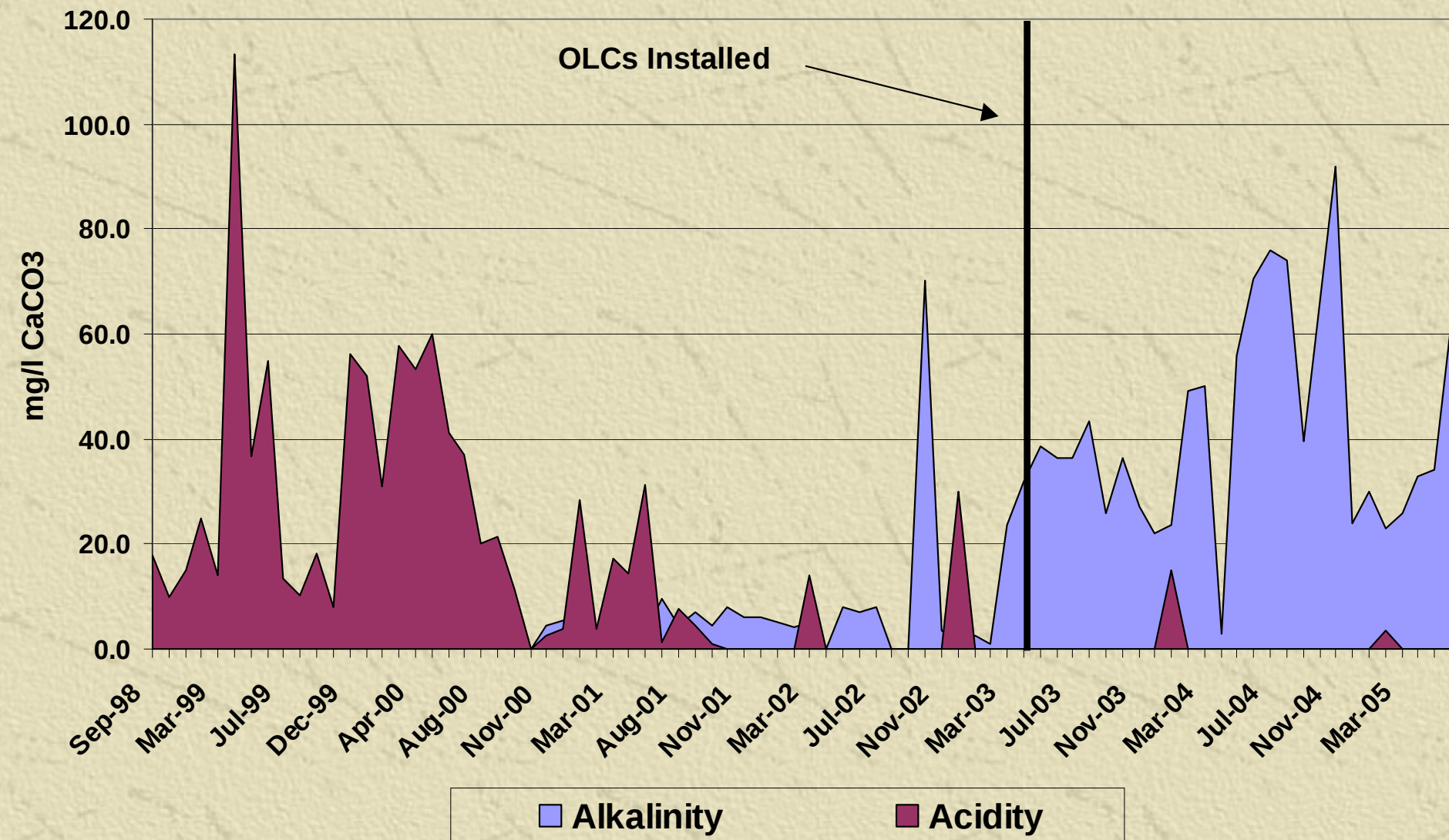
5.6

Median

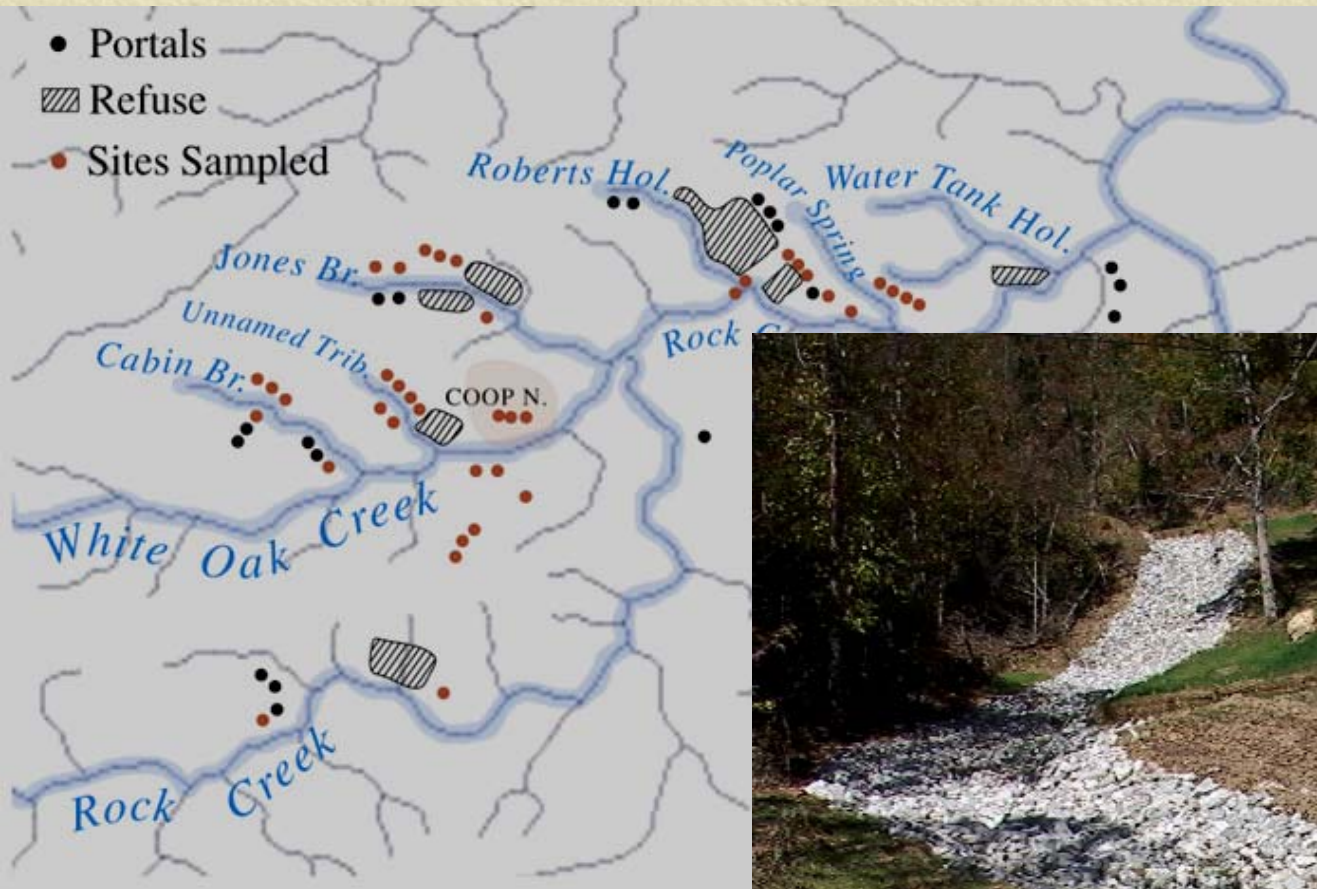
7.3



Unnamed Trib. Acidity reduced 95%



Cooperative North Portals





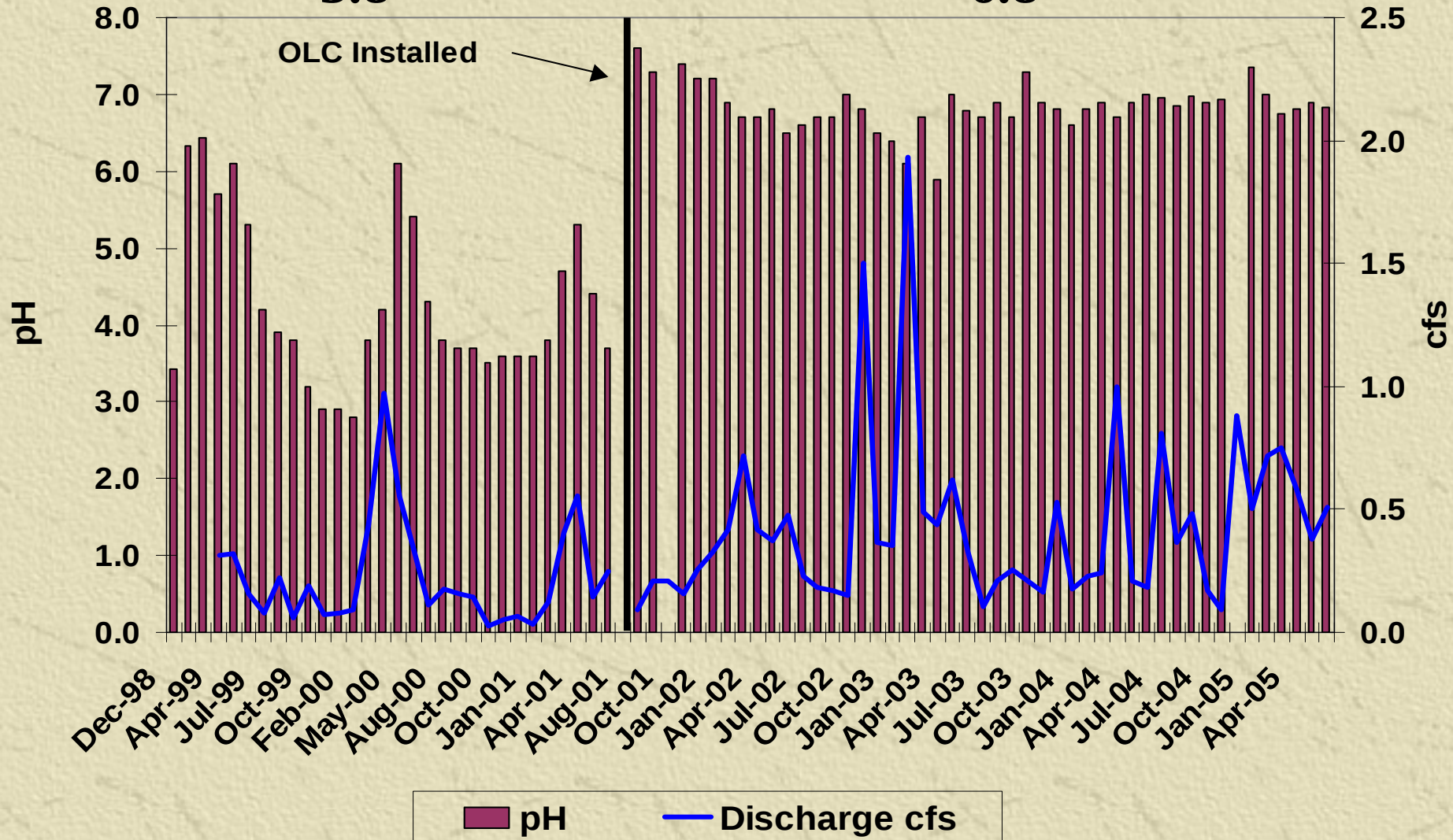
Cooperative North pH

Median

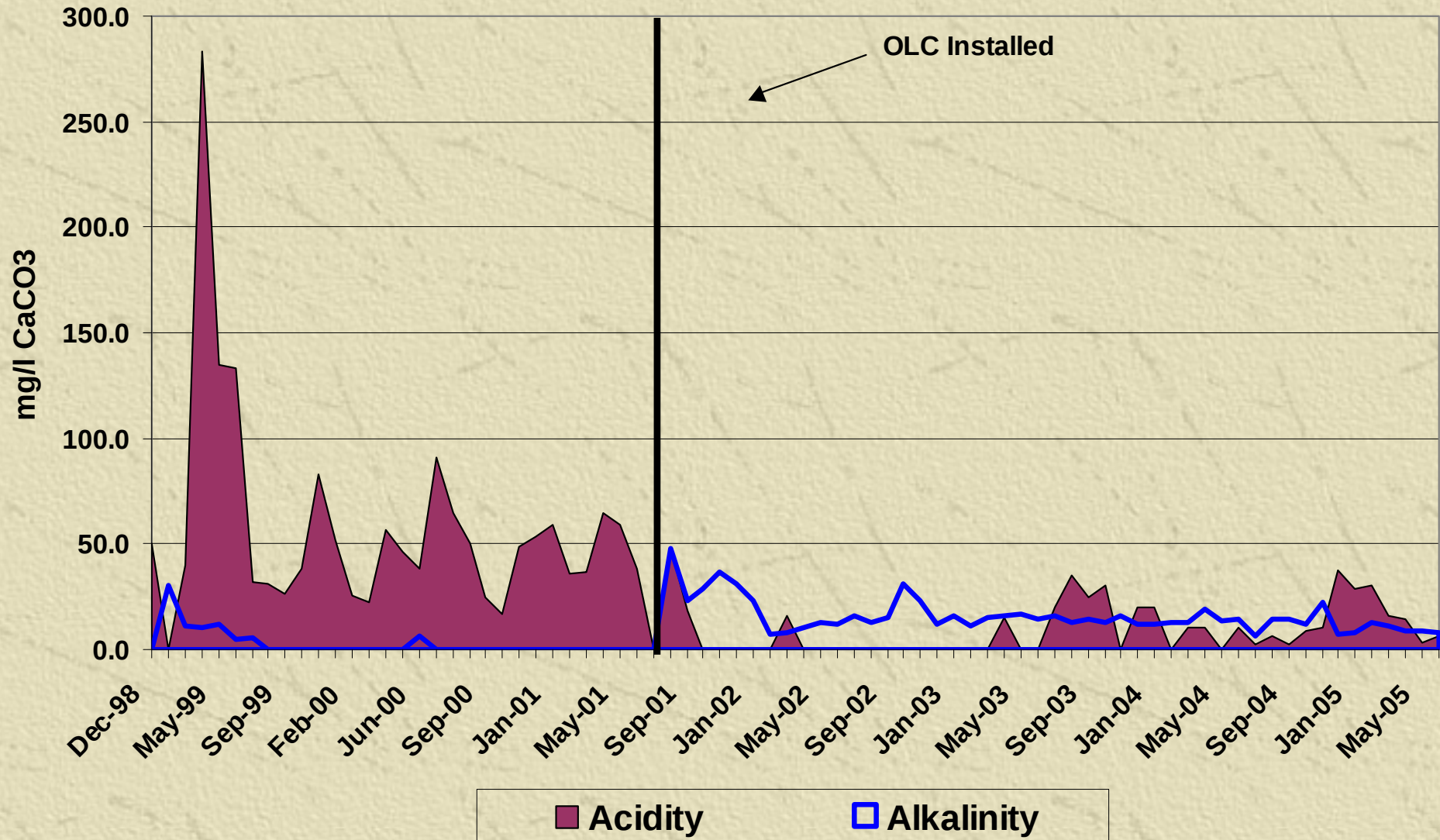
3.8

Median

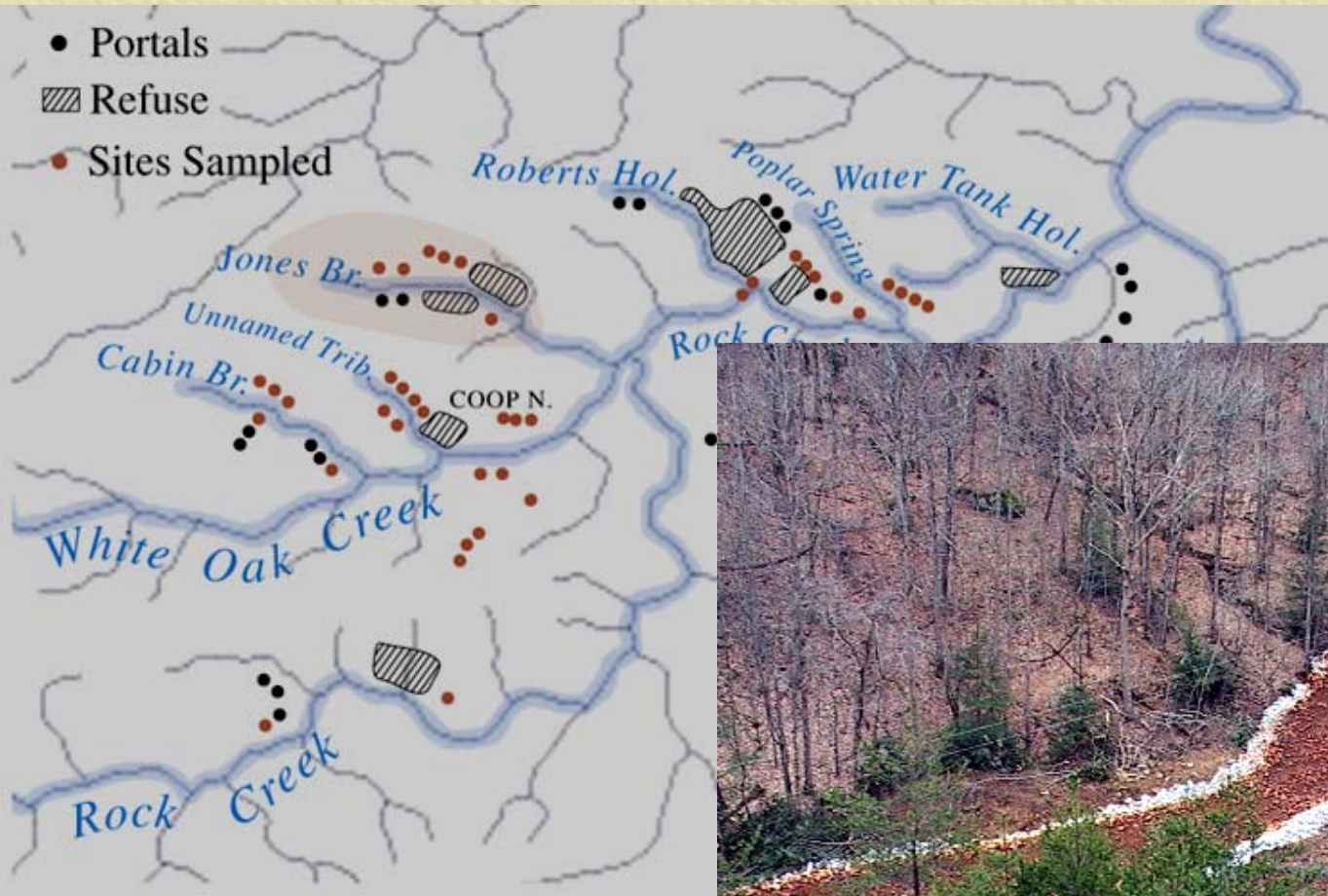
6.8



Coop North Acidity reduced 84%



Jones Branch







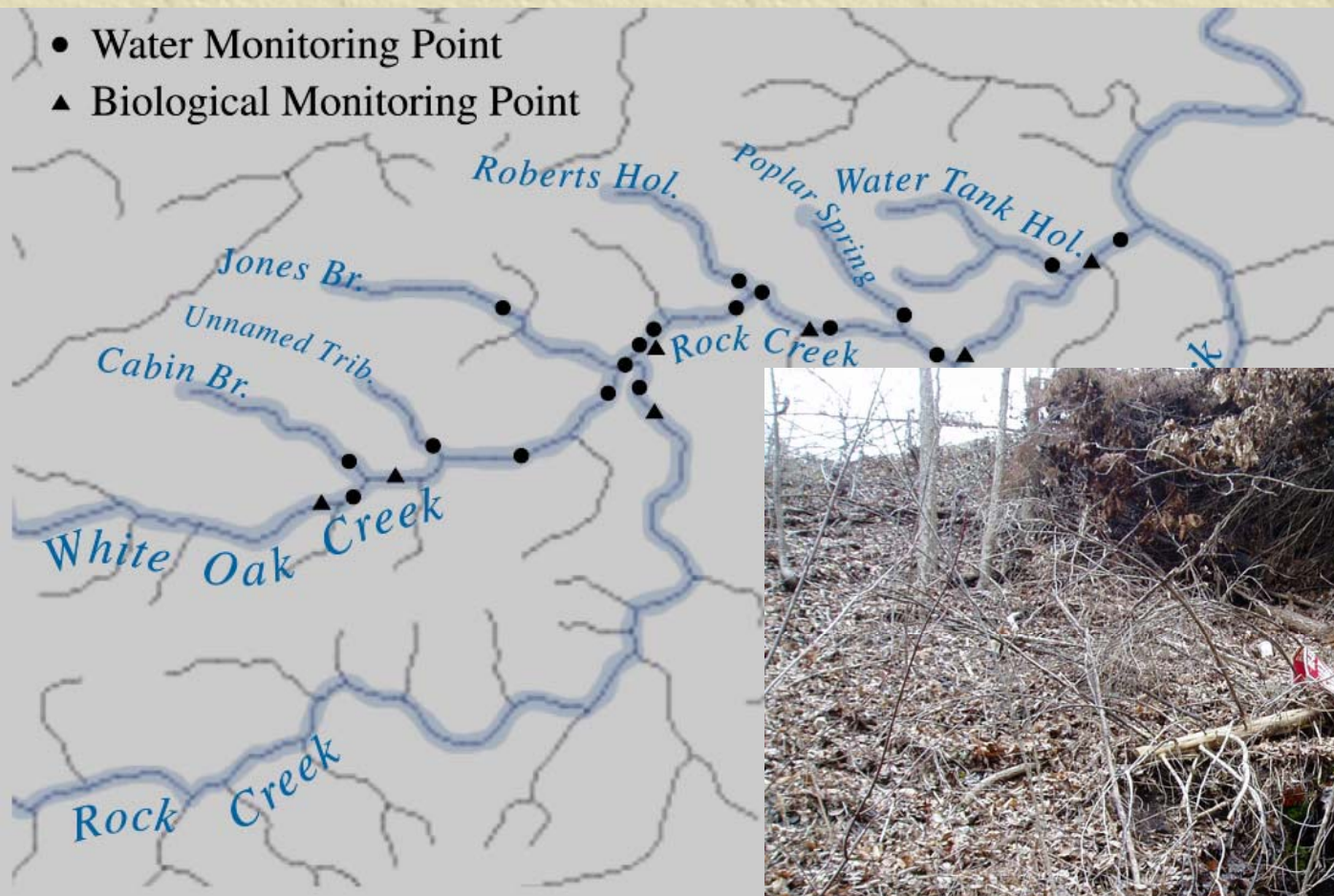








Jones Branch Spring



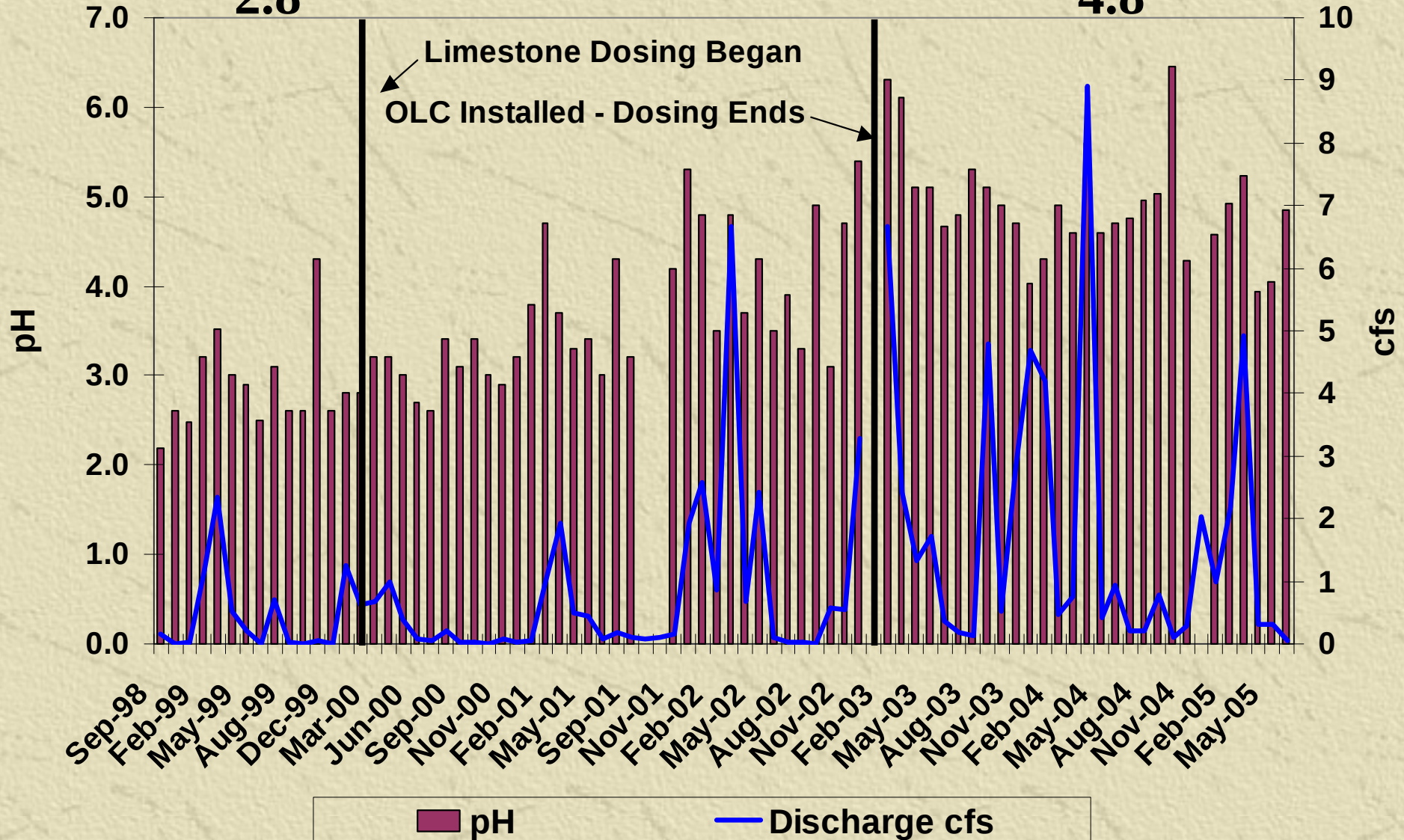
Jones Branch pH

Median

2.8

Median

4.8



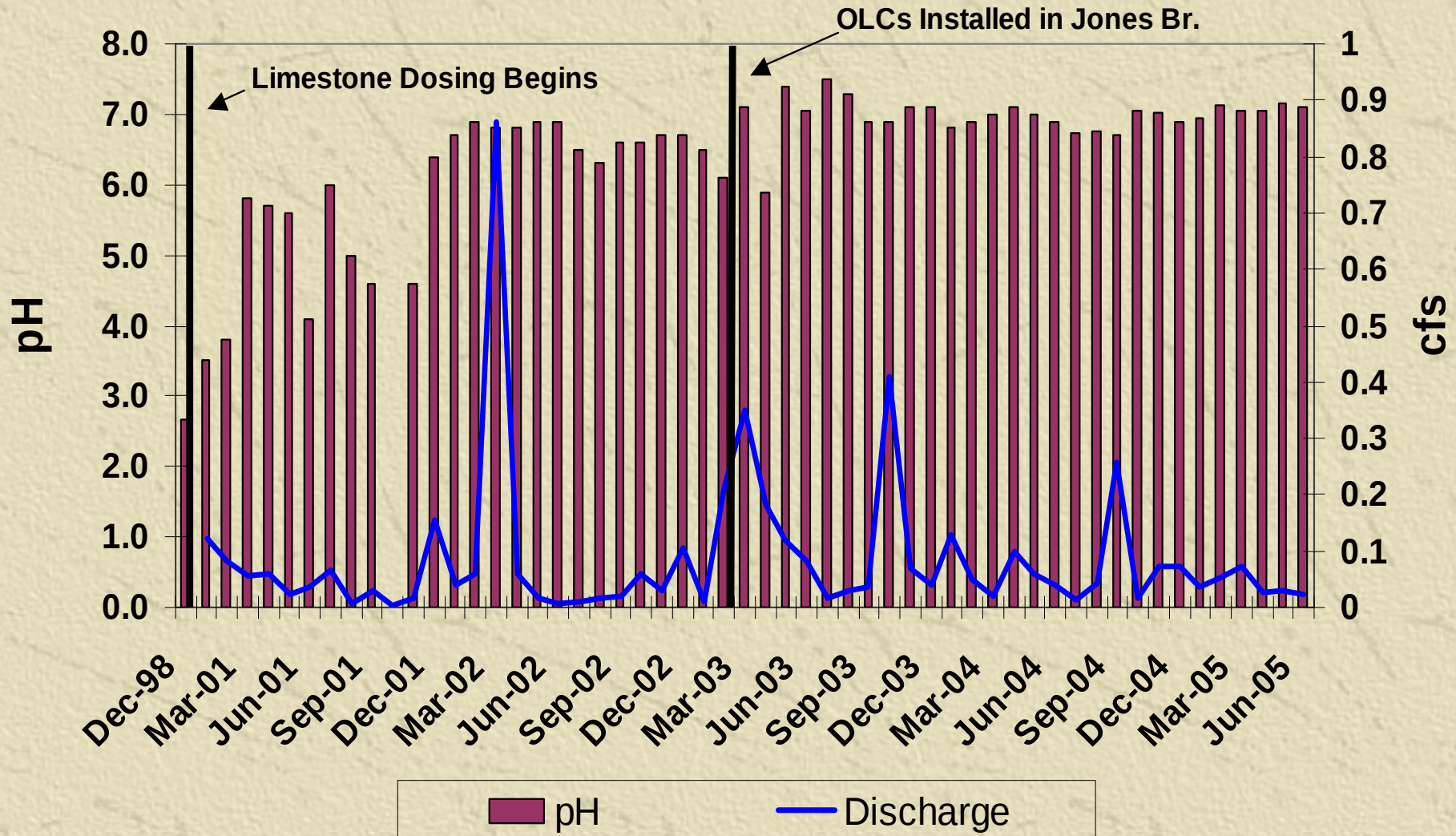
Jones Branch Spring pH

Before

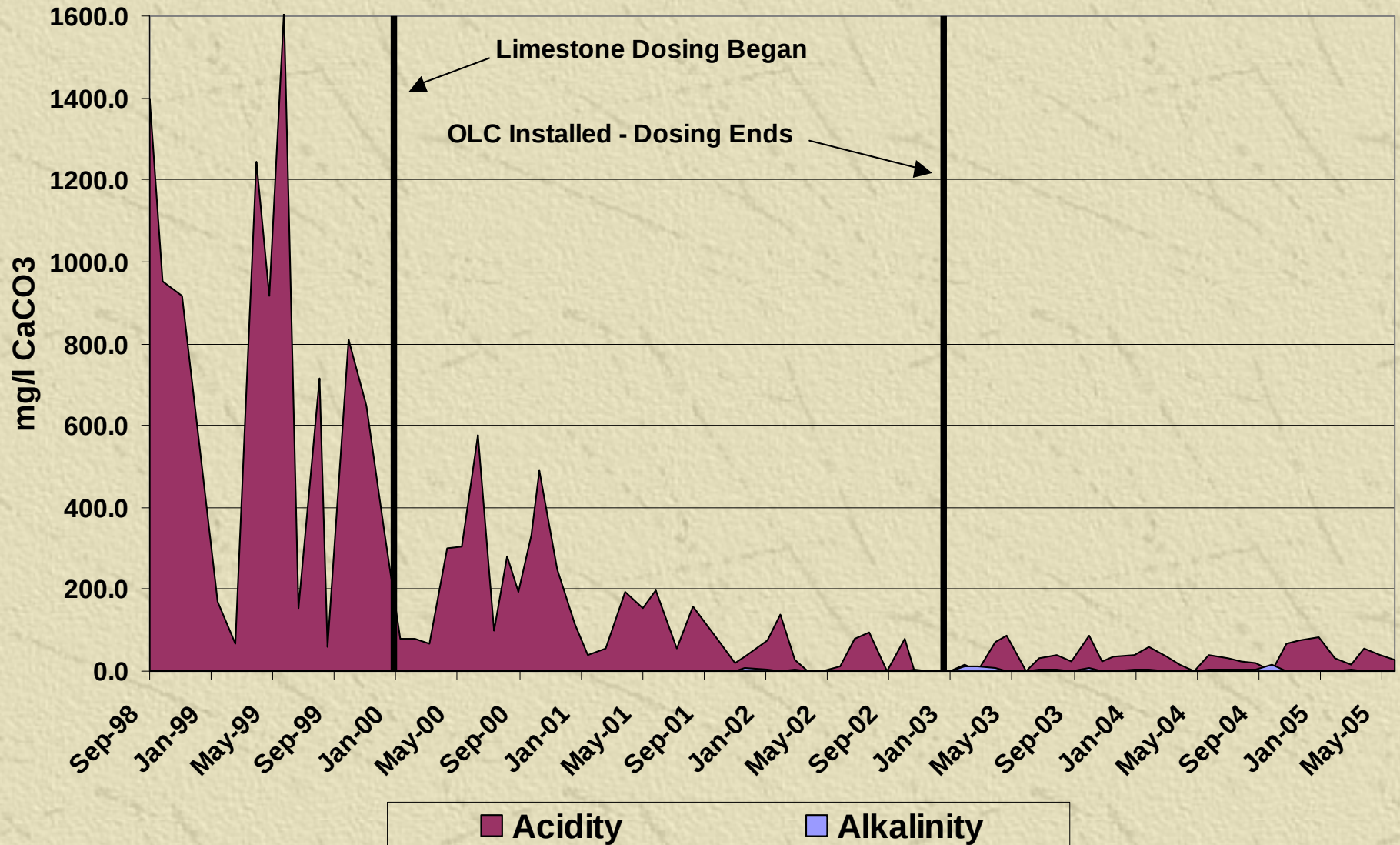
2.7

Median

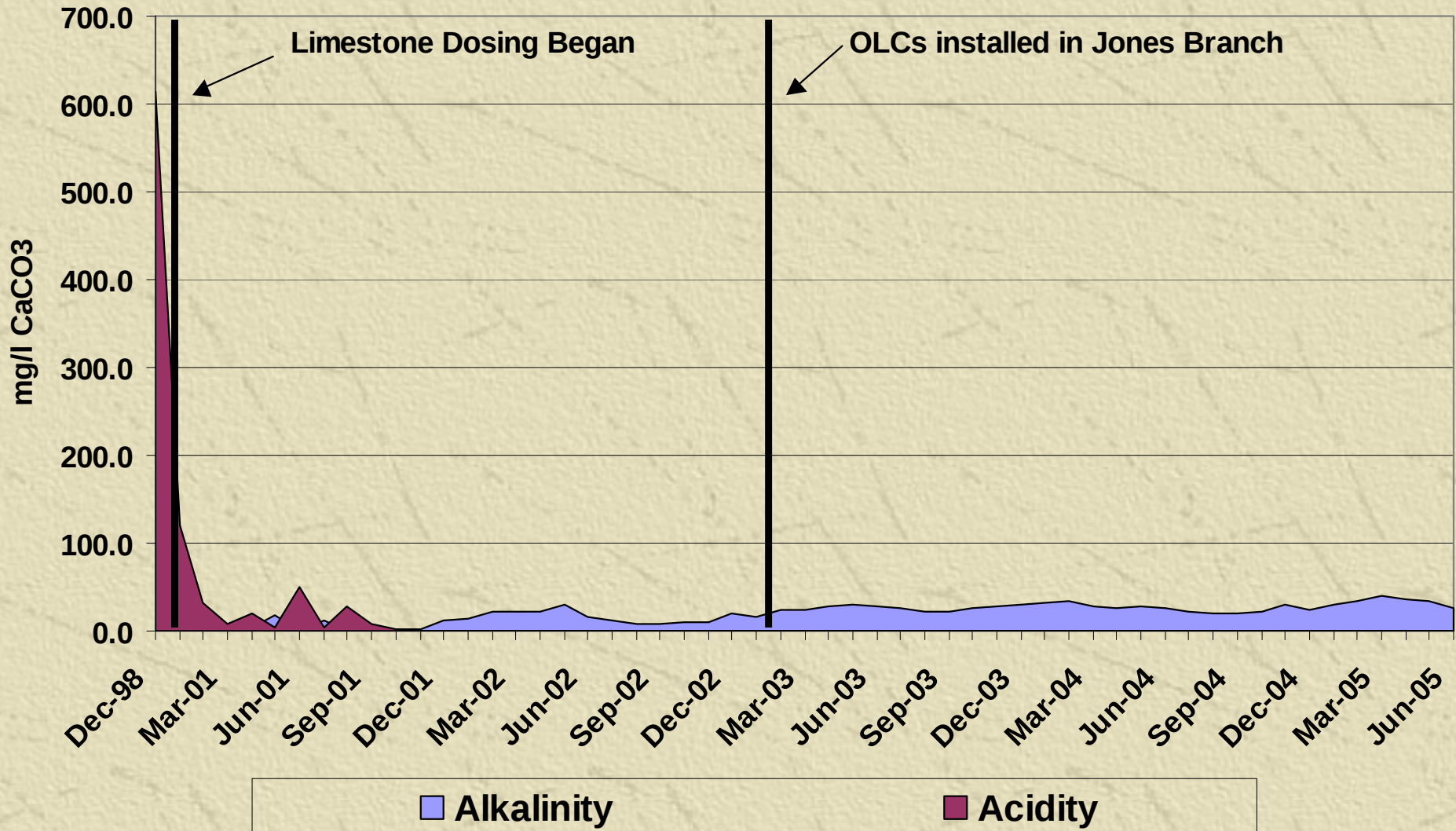
7.0



Jones Branch Acidity reduced 95%



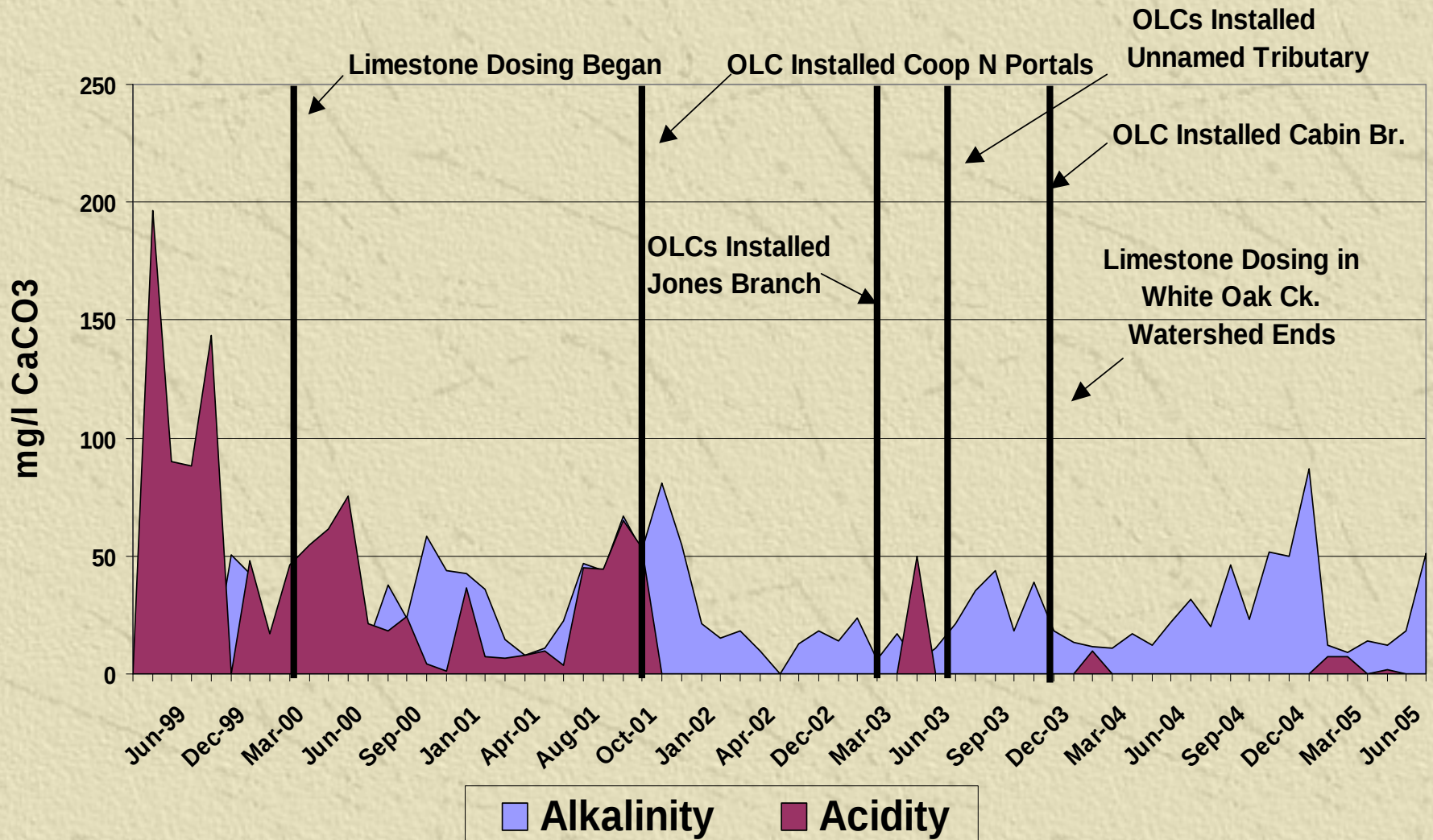
Jones Branch Spring Acidity



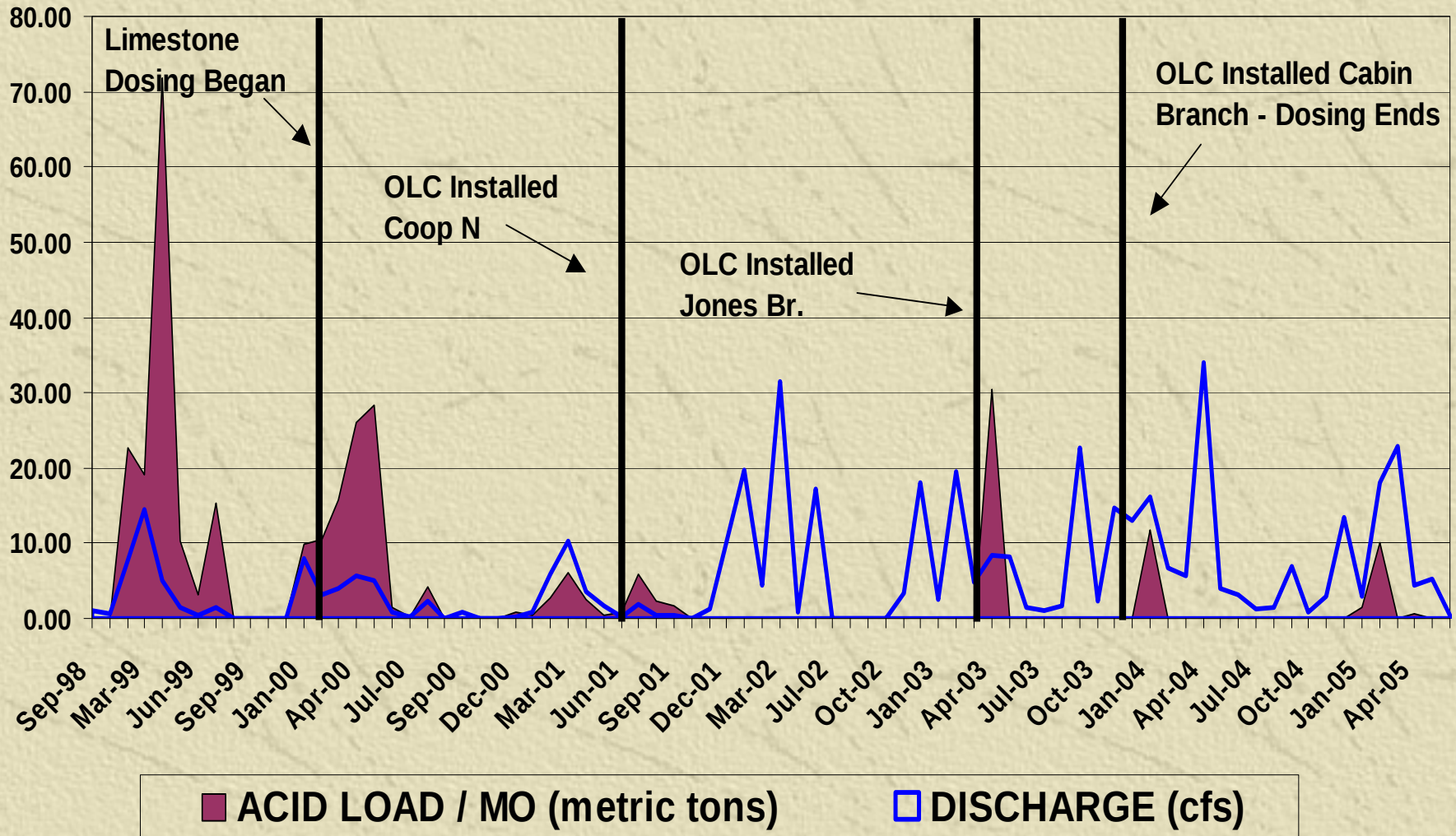
Open Limestone Channels Installed In White Oak Ck. Watershed

✦ Cabin Branch	4000 feet
✦ Unnamed Trib.	2000 feet
✦ Coop North Portal	500 feet
✦ Jones Branch	8000 feet

White Oak Ck. Acidity reduced 95%



White Oak Ck. Acid Load reduced 86%



Open Limestone Channels Installed Below White Oak Creek Watershed

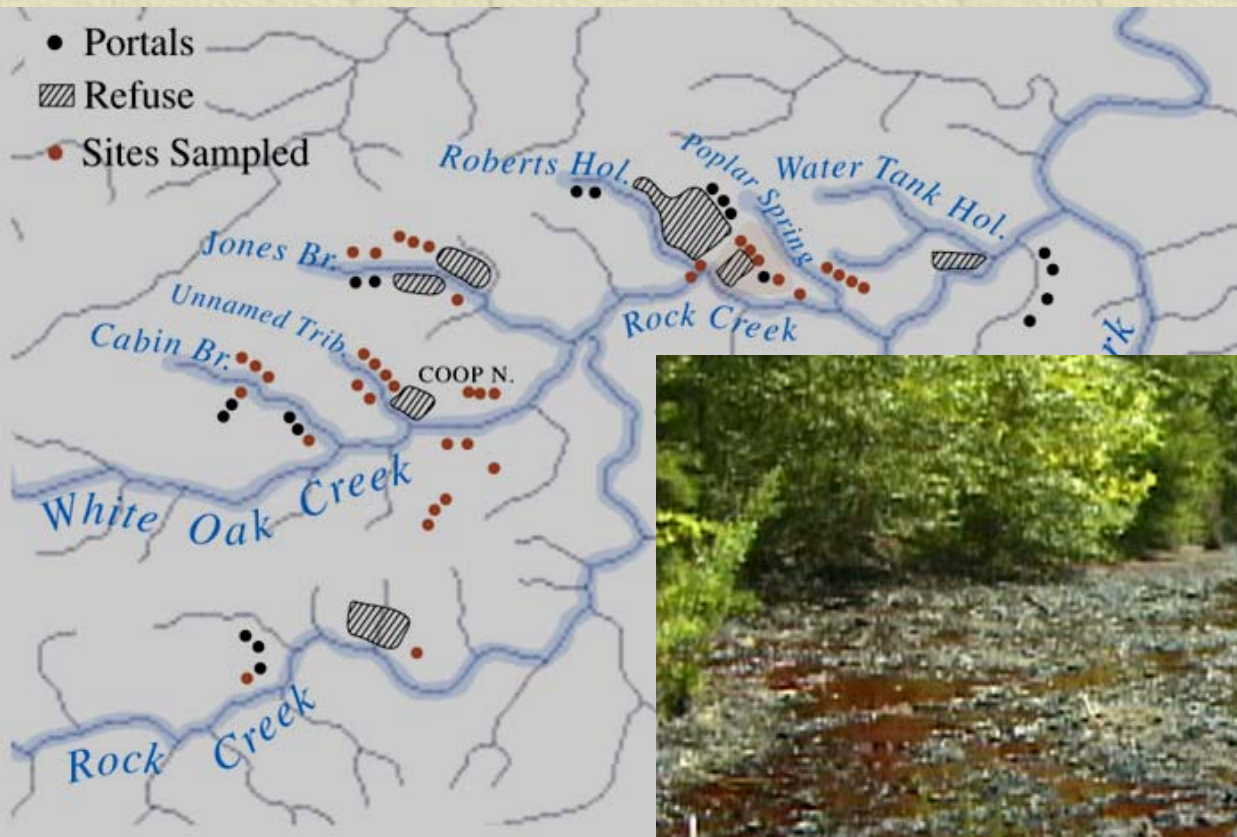
✦ Roberts Hollow 2500 feet

✦ Paint Cliff 2000 feet

✦ Poplar Spring 2500 feet

✦ Water Tank Hollow 800 feet

Paint Cliff Portals and Refuse



Monthly Mean before VFS

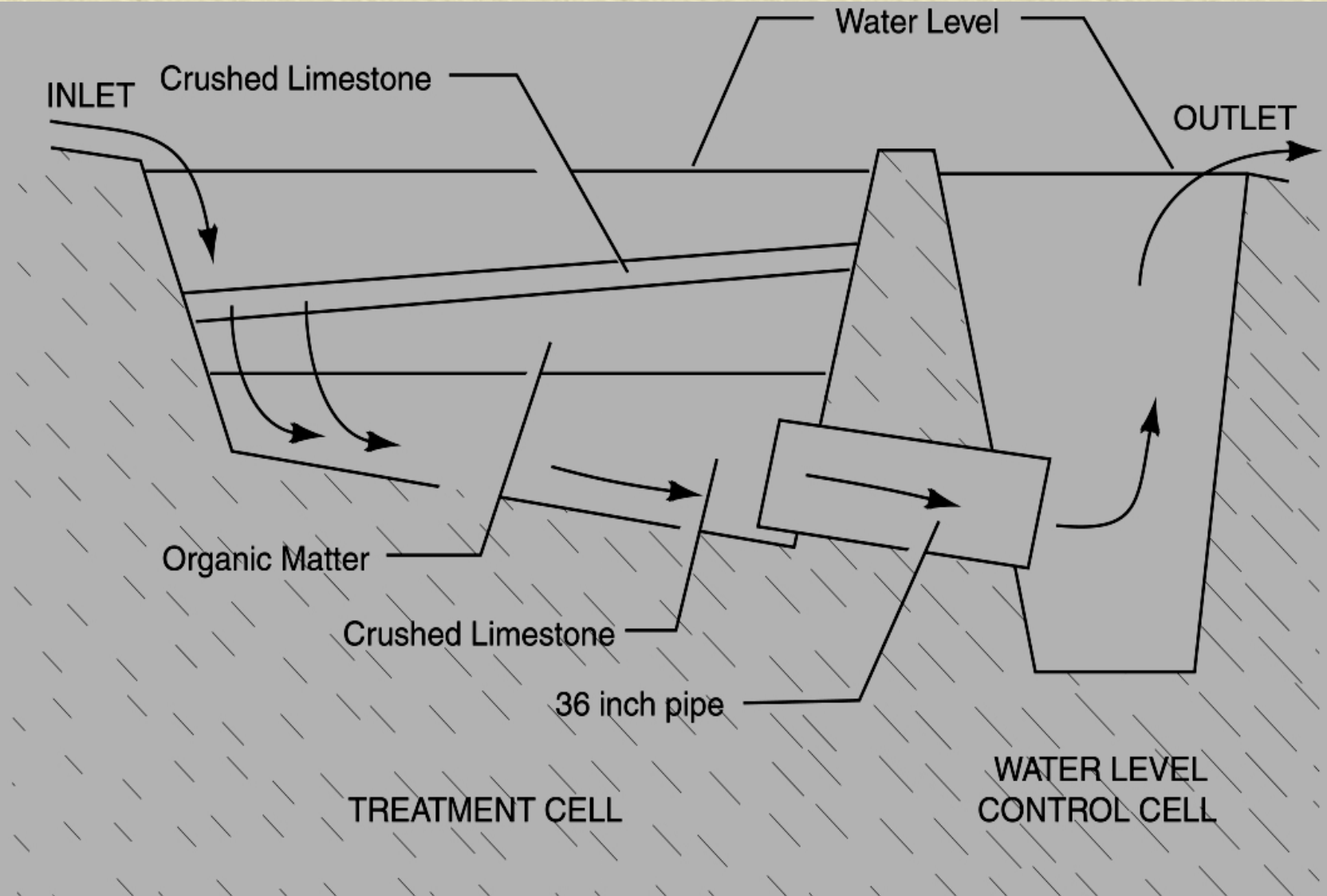
Acidity **811 mg/l**

Iron **135 mg/l**

Aluminum **35 mg/l**



Modified Vertical Flow System





Open Limestone
Channel

Water Level Control Cell

Treatment Cell

Sediment Basin

Open Limestone
Channel









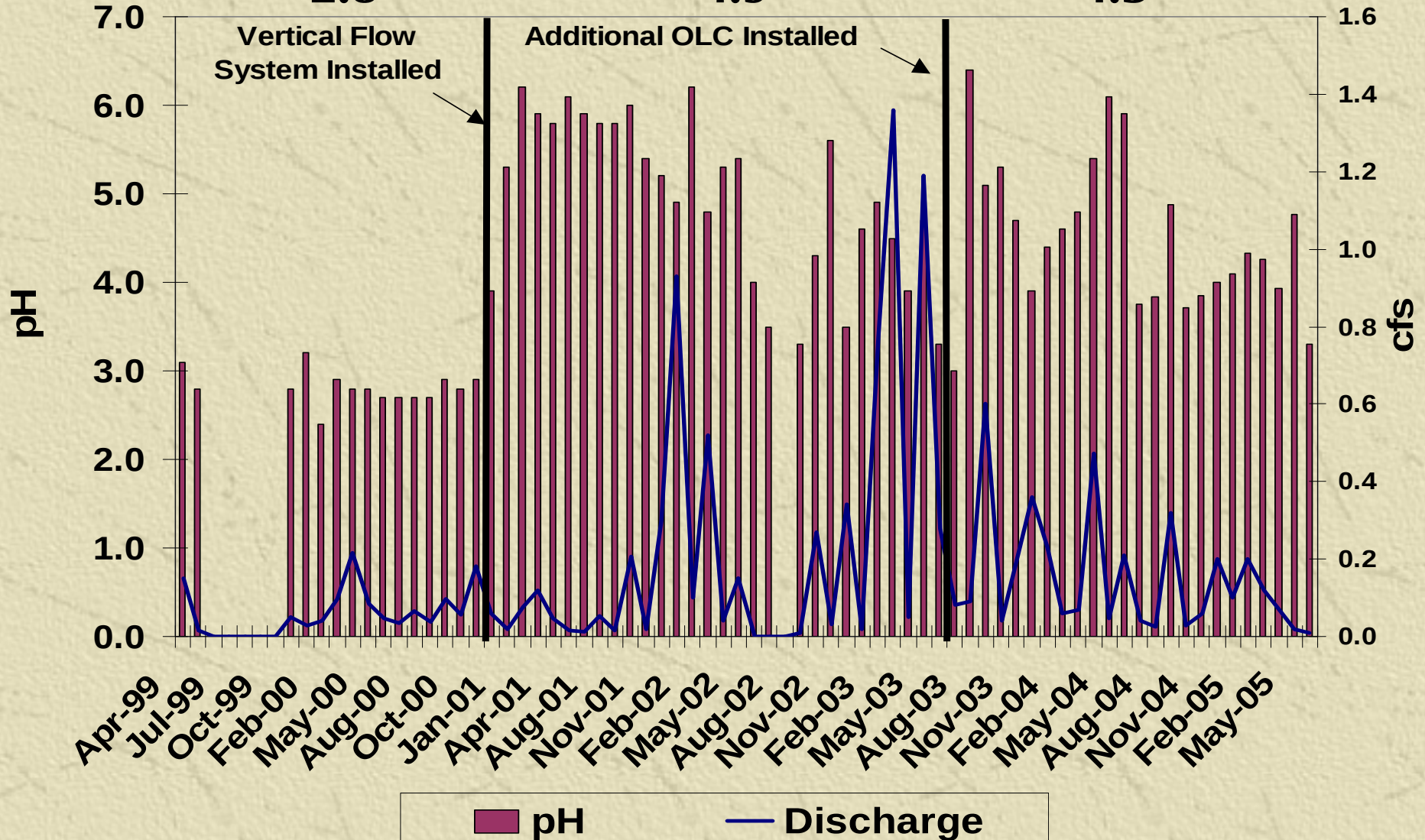


Paint Cliff pH

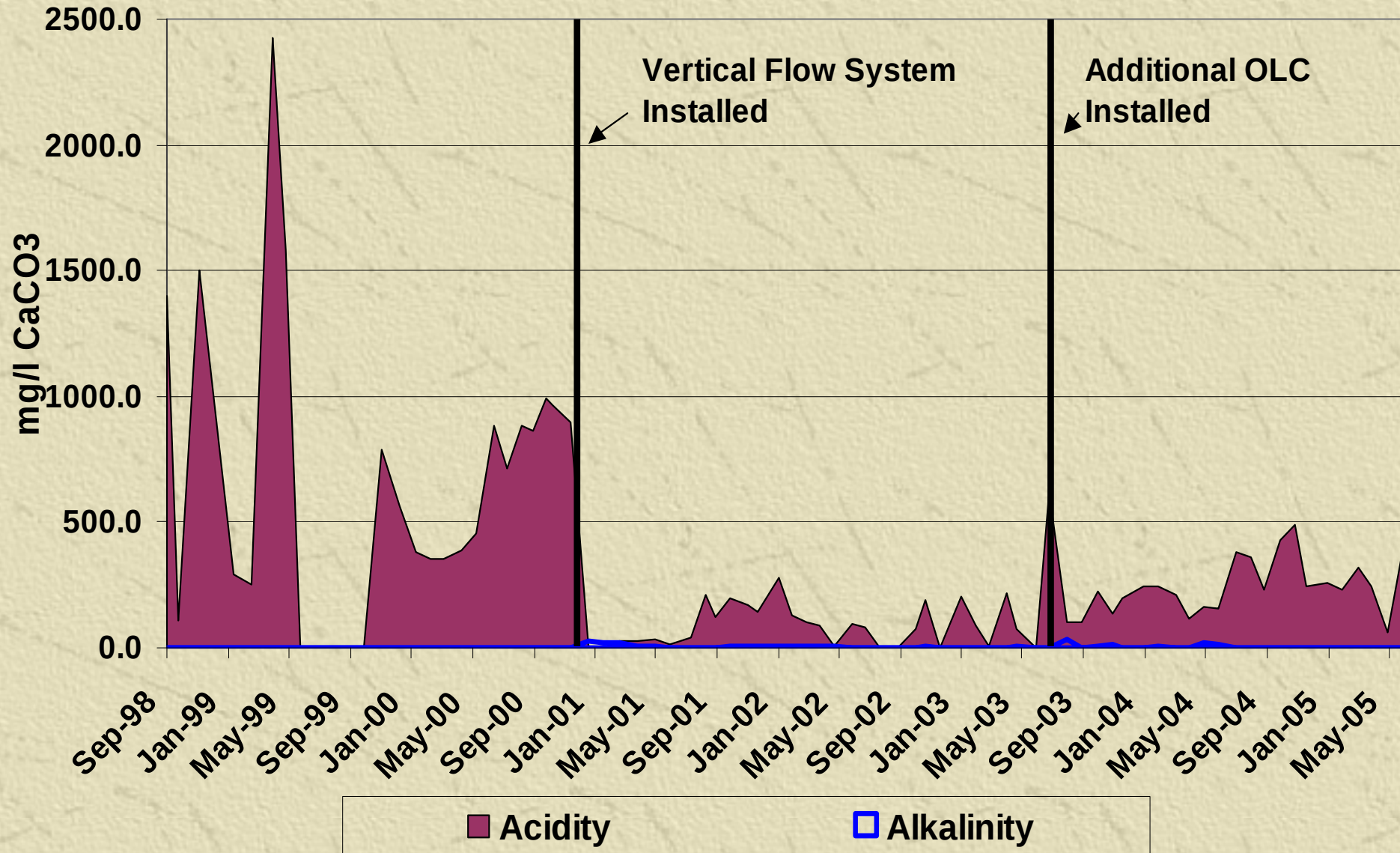
**Median
2.8**

**Median
4.9**

**Median
4.3**



Paint Cliff Acidity reduced 71%









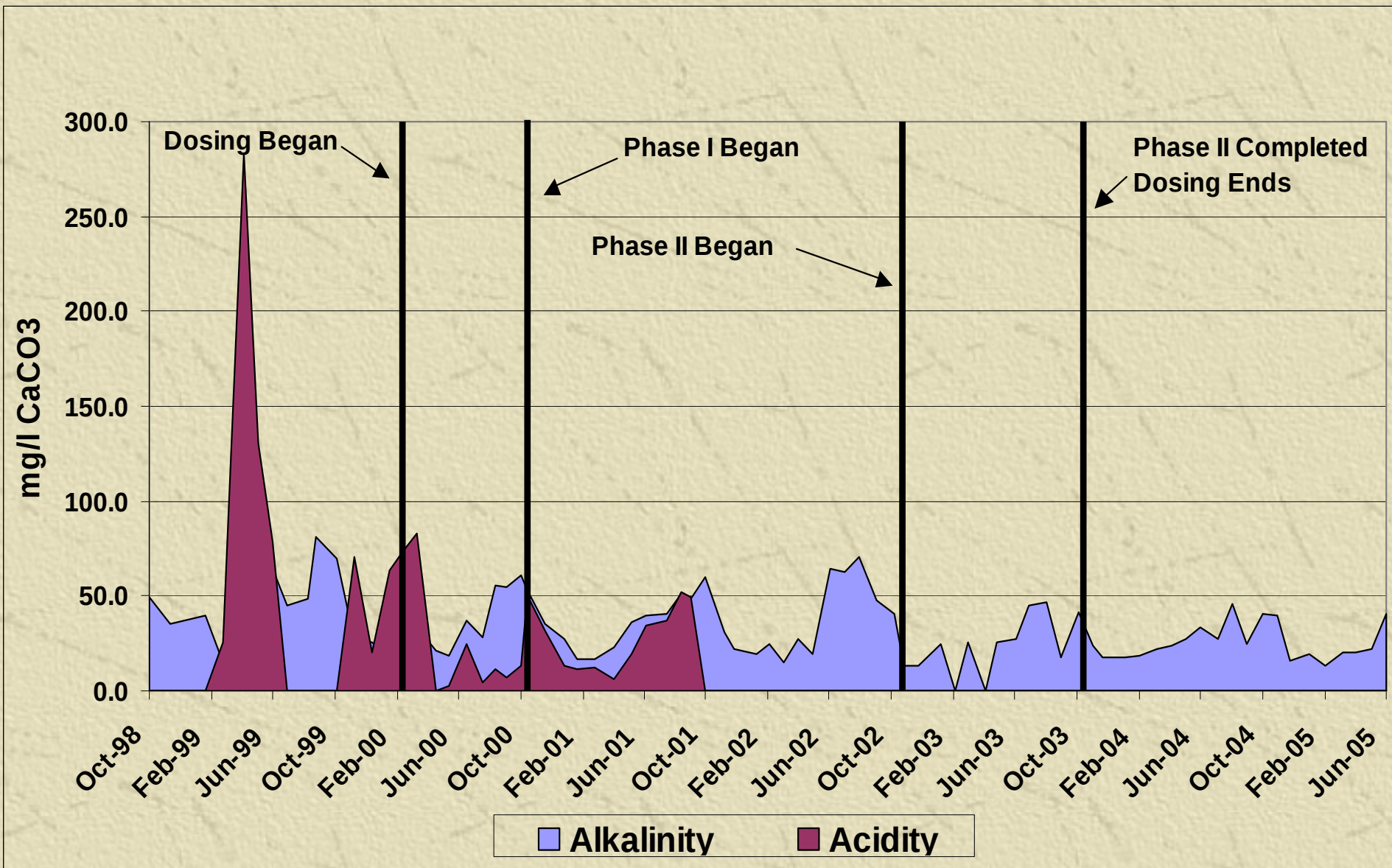




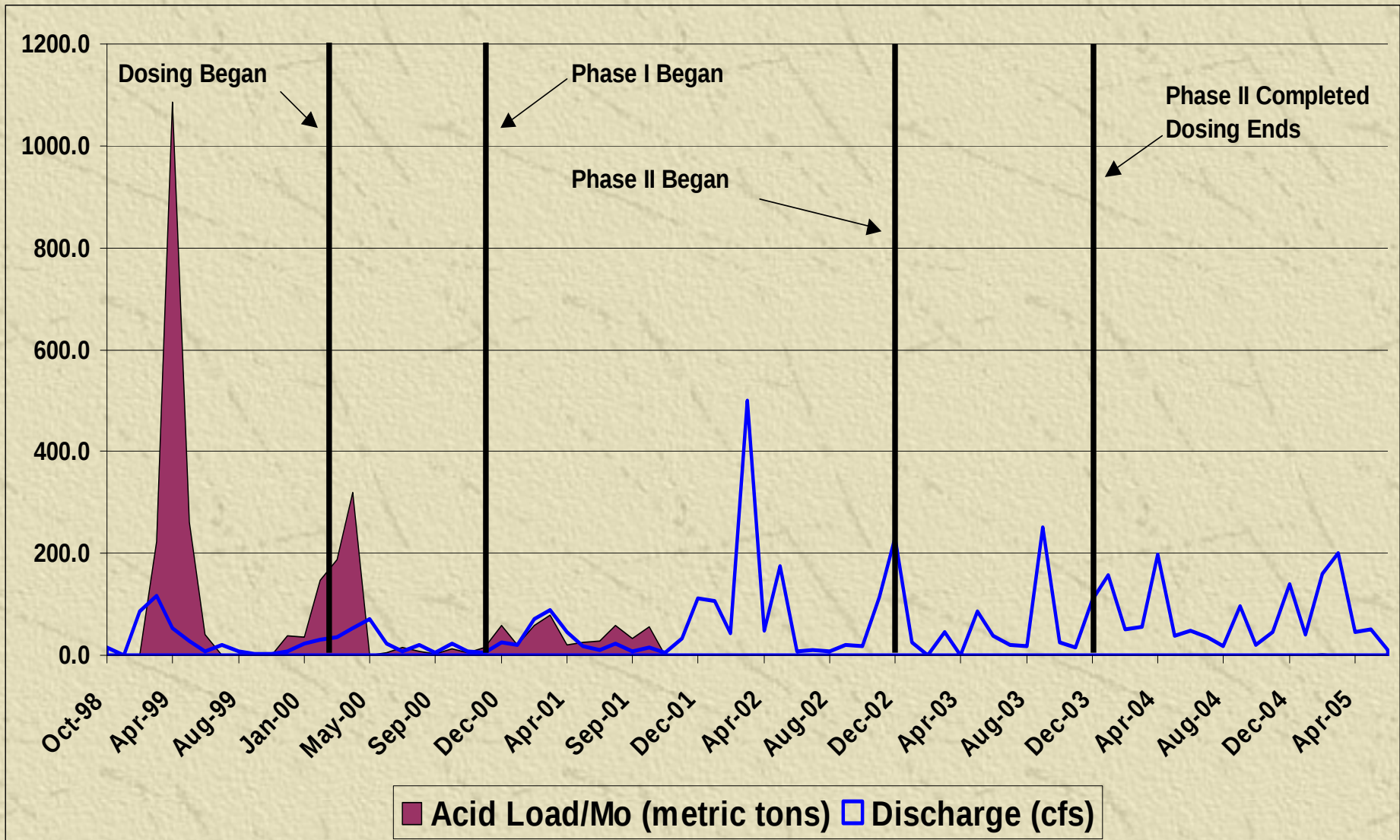
Paint Cliff VFS - July 2005

	INLET mg/l	OUTLET mg/l
ACIDITY	1531	470
CALCIUM	147	355
SULFATE	1540	1140
DISS. IRON	502	185
DISS. AL.	36	8

Rock Creek at Mouth



Rock Creek Acid Load at Mouth

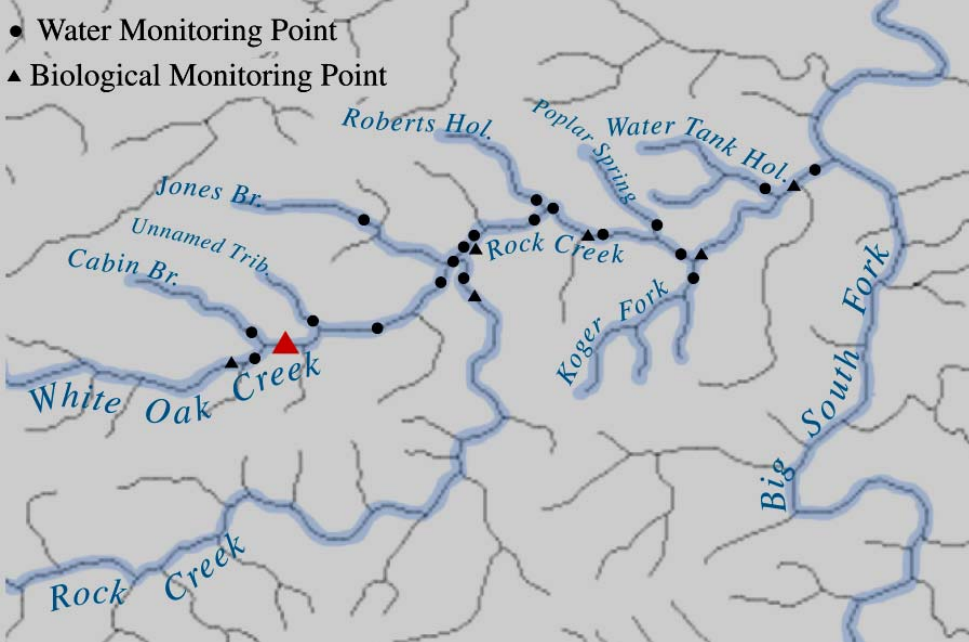


Biological Monitoring

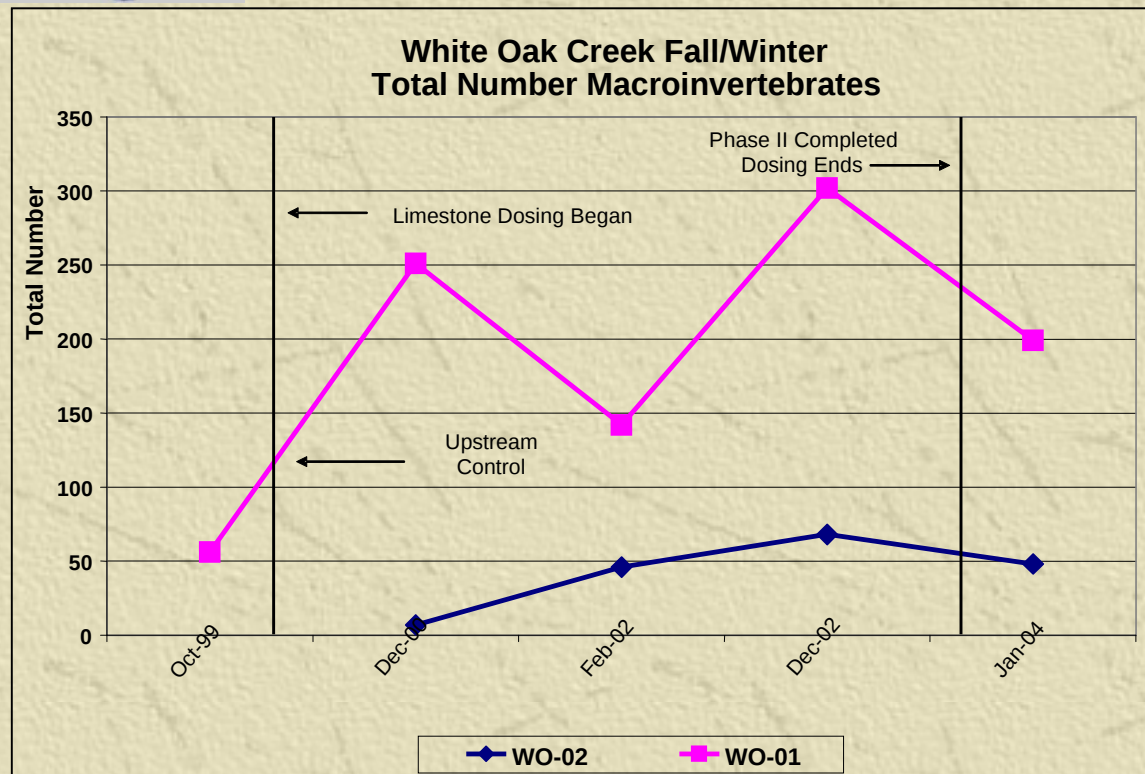


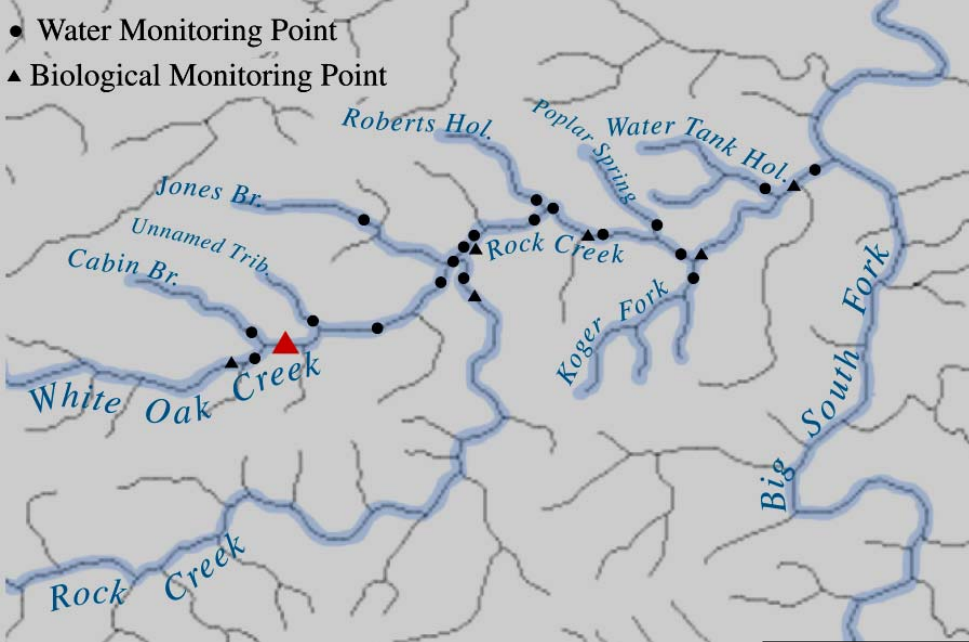
Macroinvertebrate Monitoring



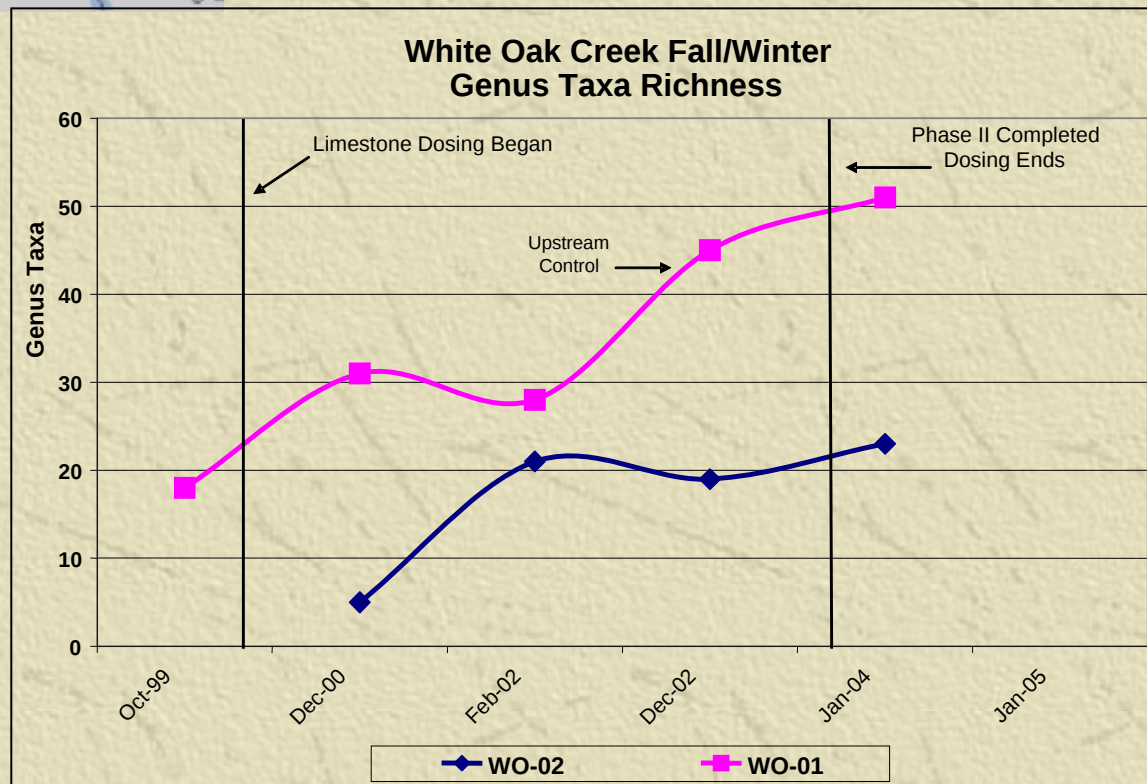


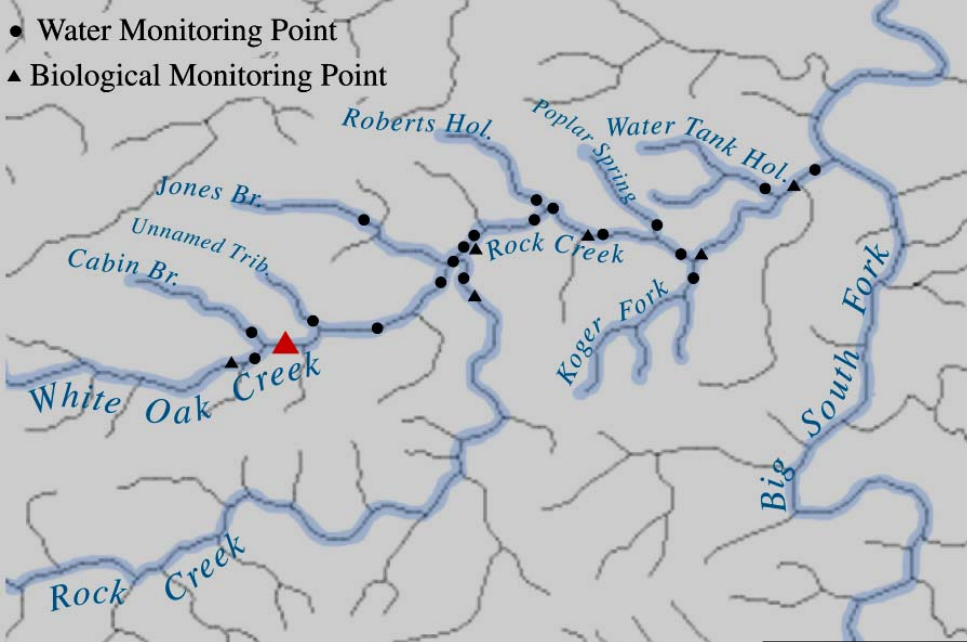
White Oak Creek Biomass



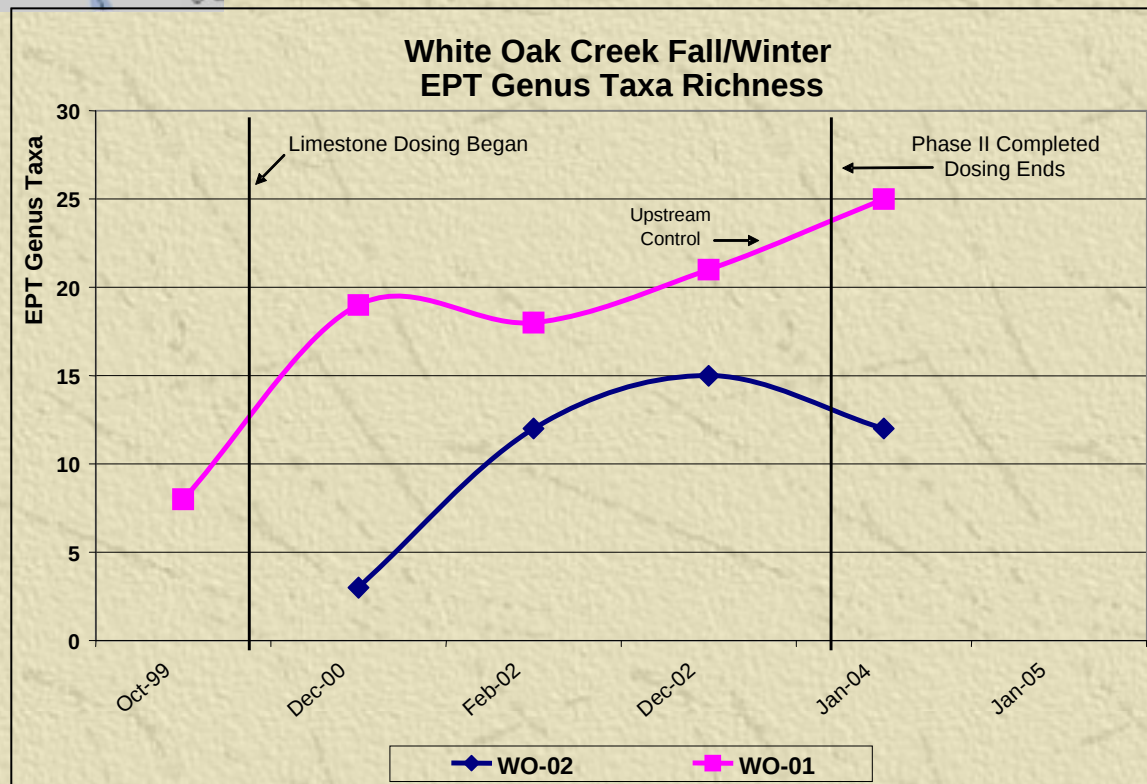


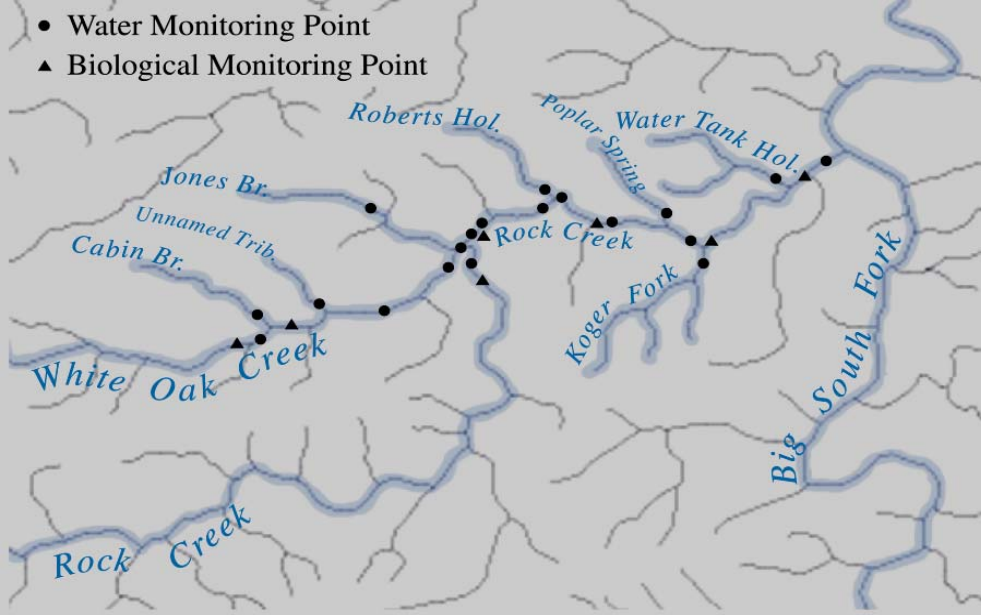
White Oak Creek Diversity



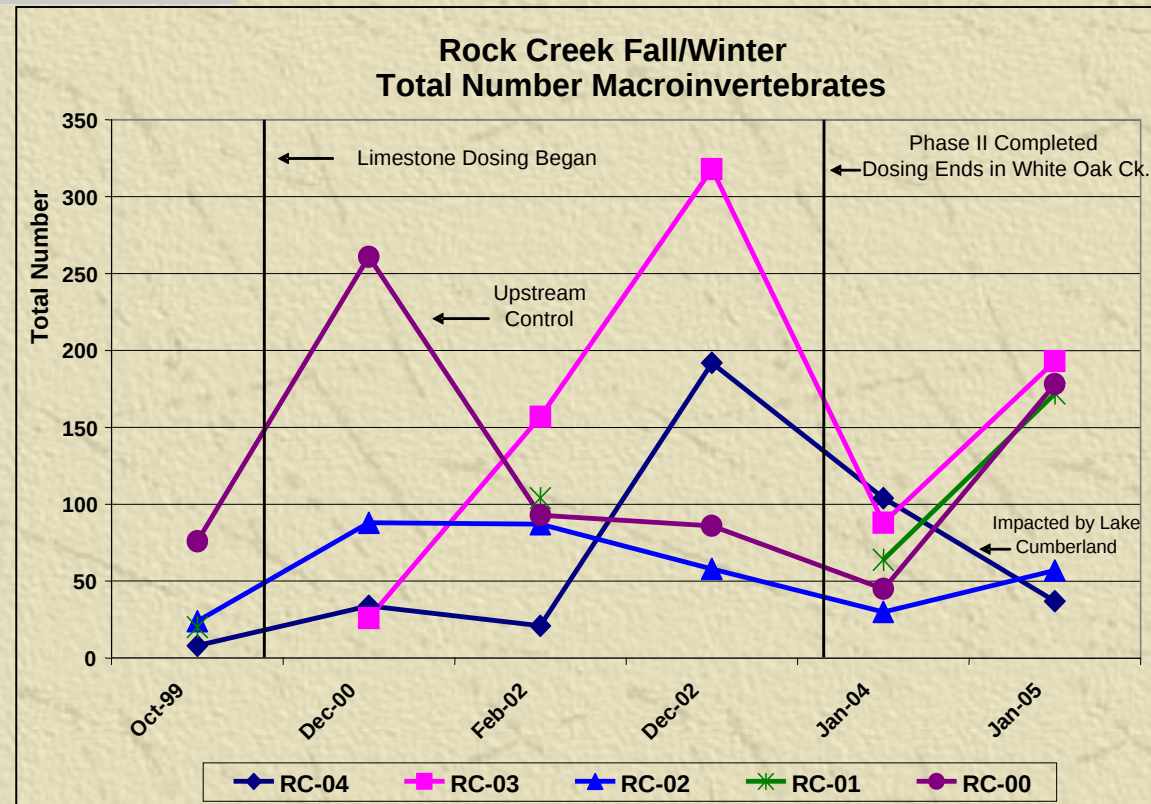


White Oak Creek Quality

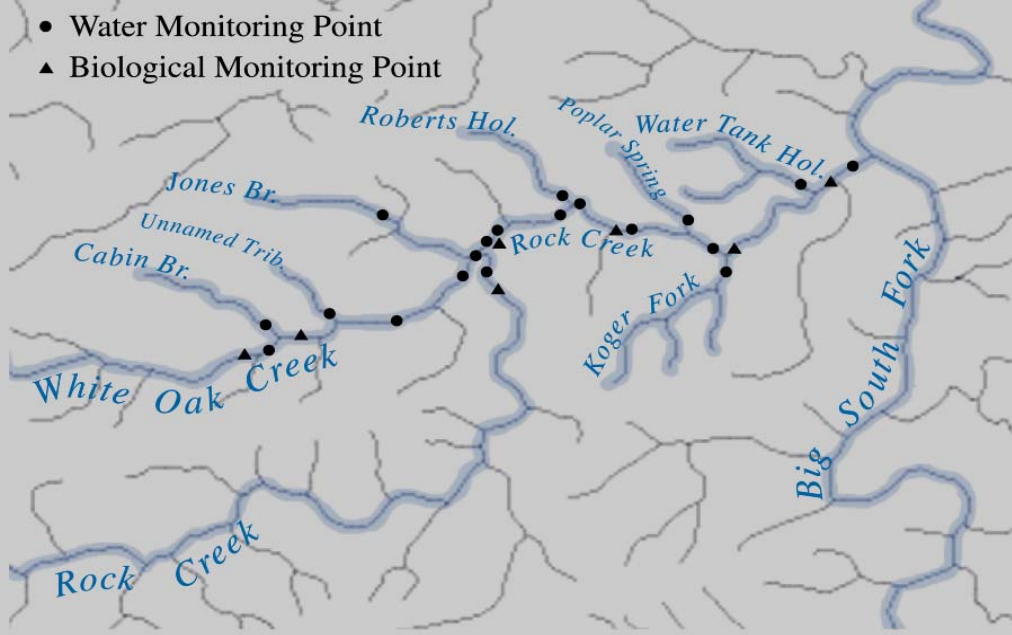




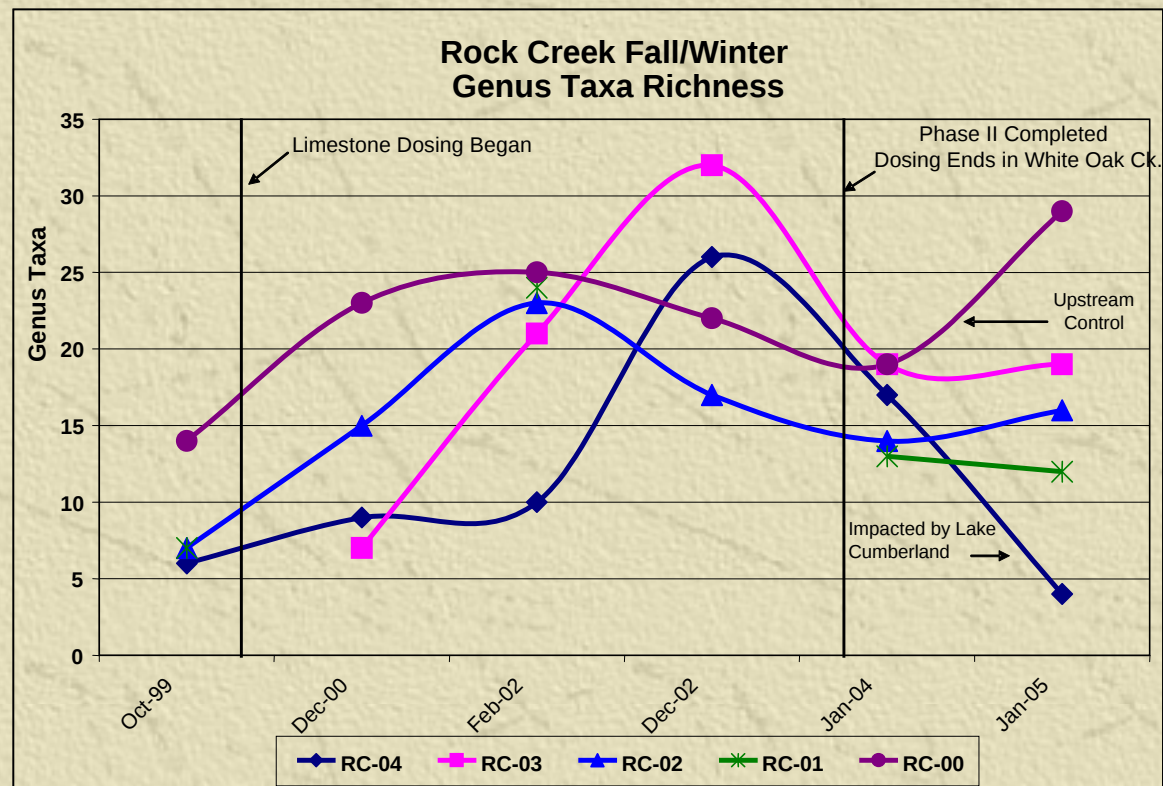
Rock Creek Biomass



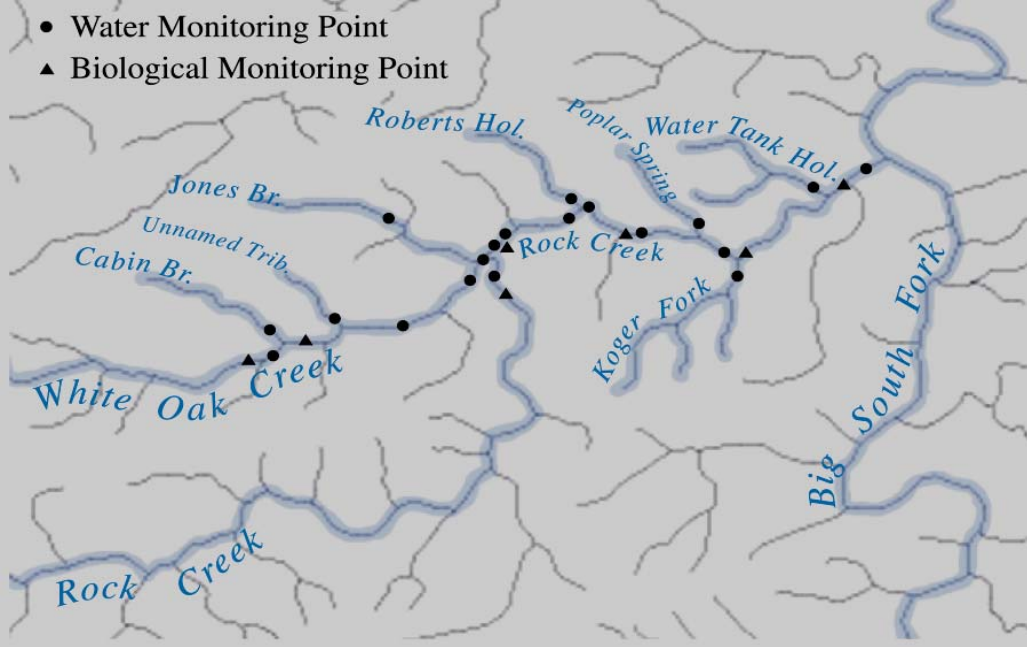
- Water Monitoring Point
- ▲ Biological Monitoring Point



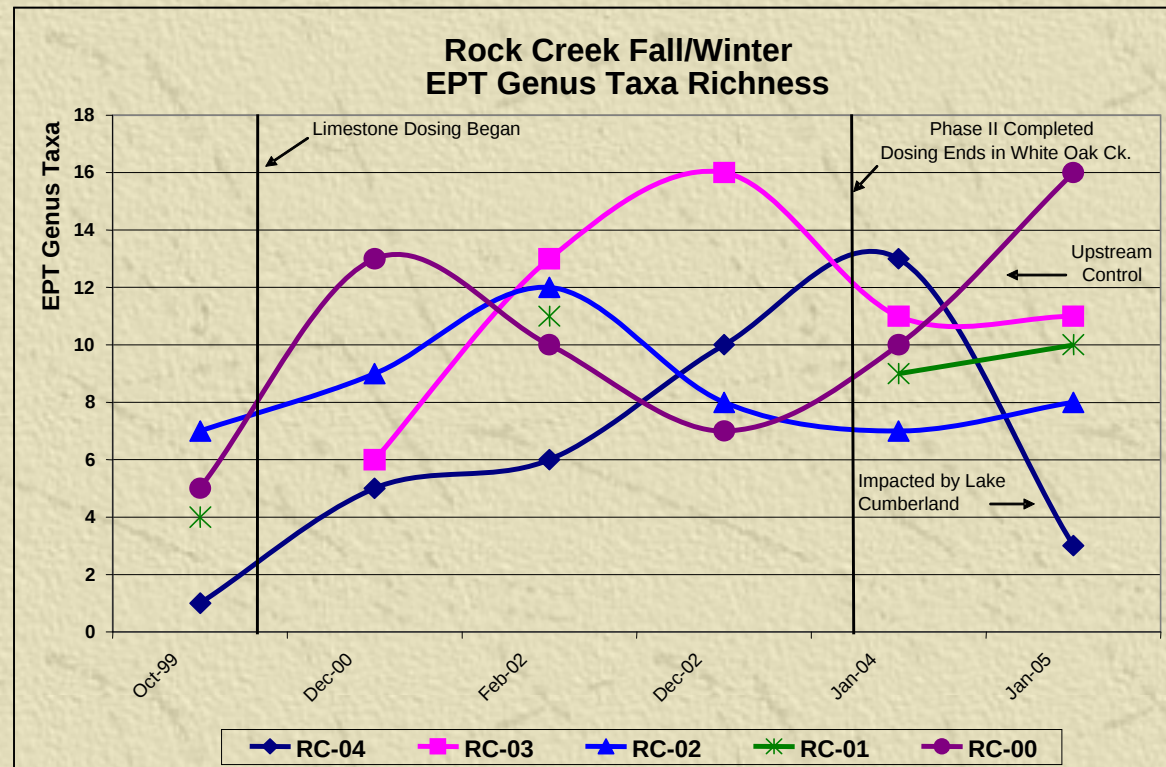
Rock Creek Diversity



- Water Monitoring Point
- ▲ Biological Monitoring Point



Rock Creek Quality

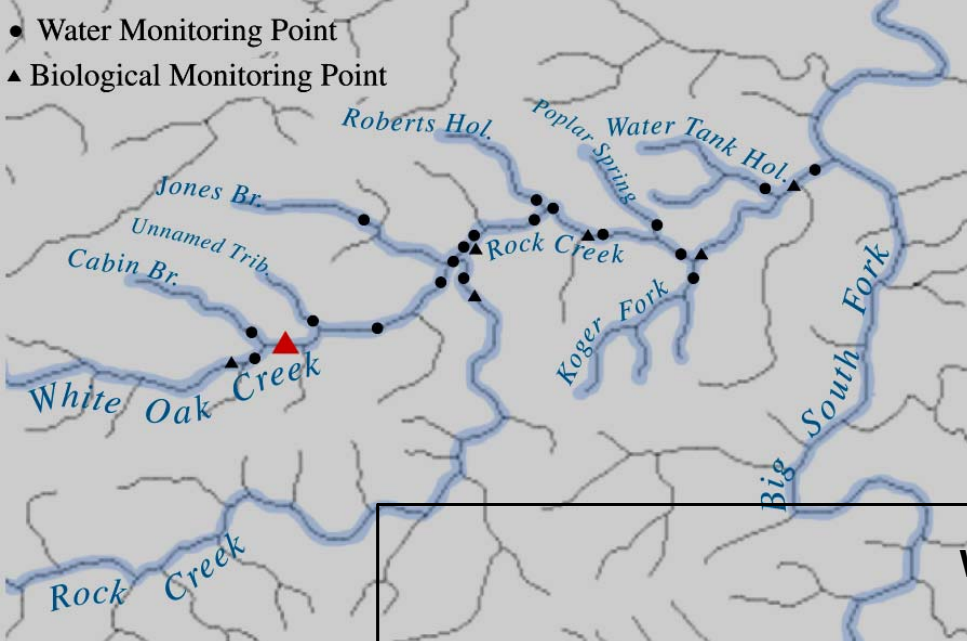


Fish Monitoring



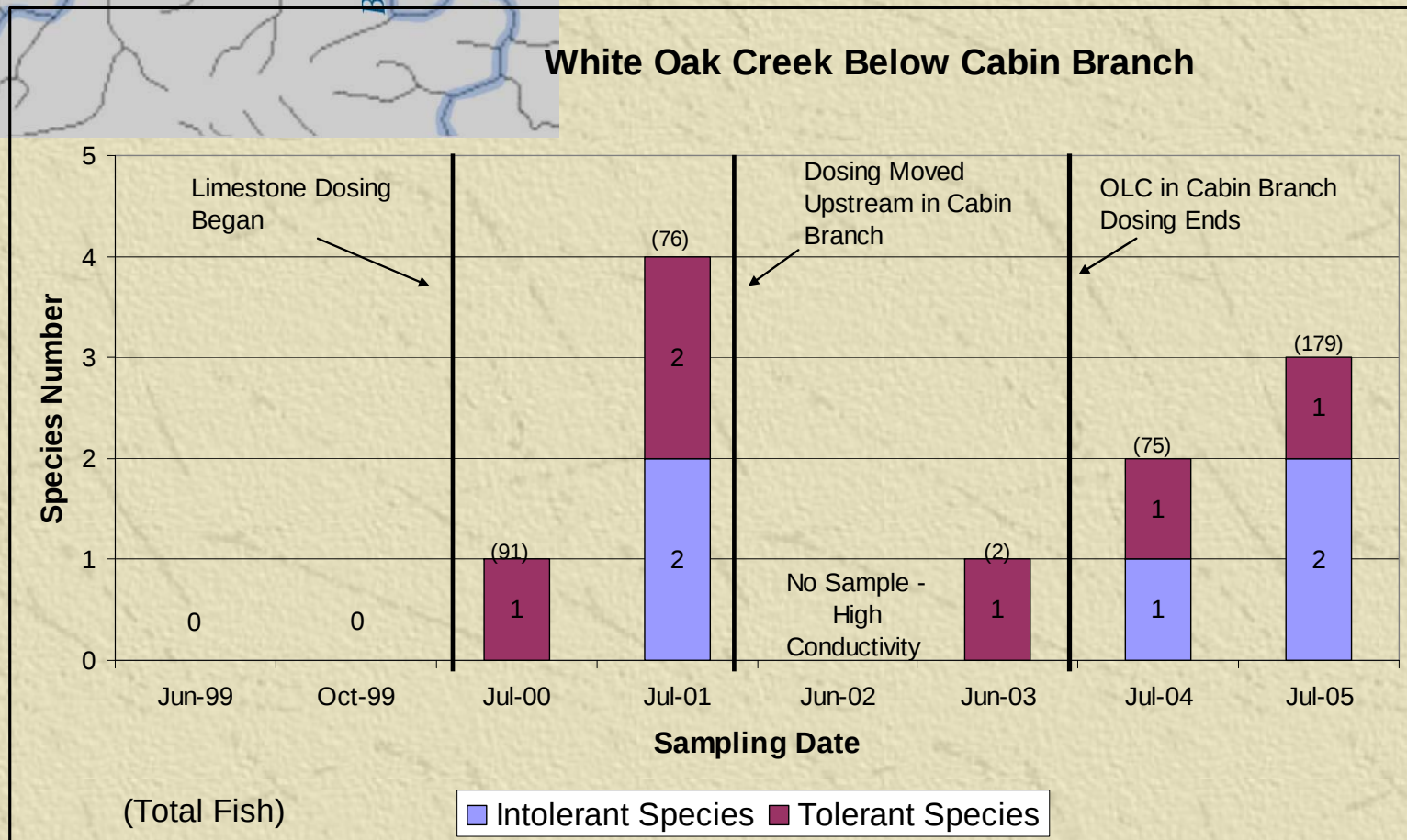


- Water Monitoring Point
- ▲ Biological Monitoring Point

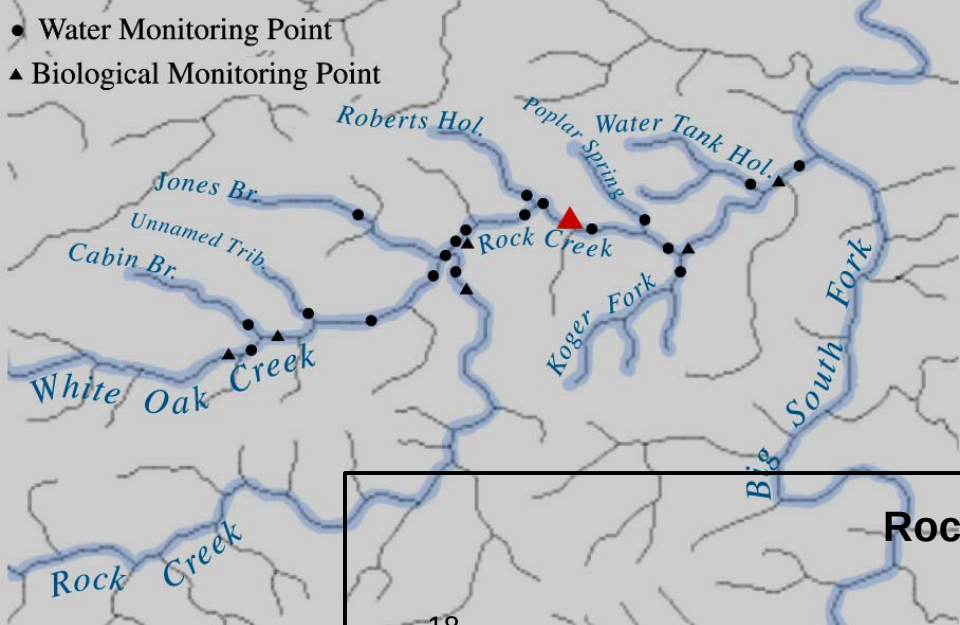


Fish Species

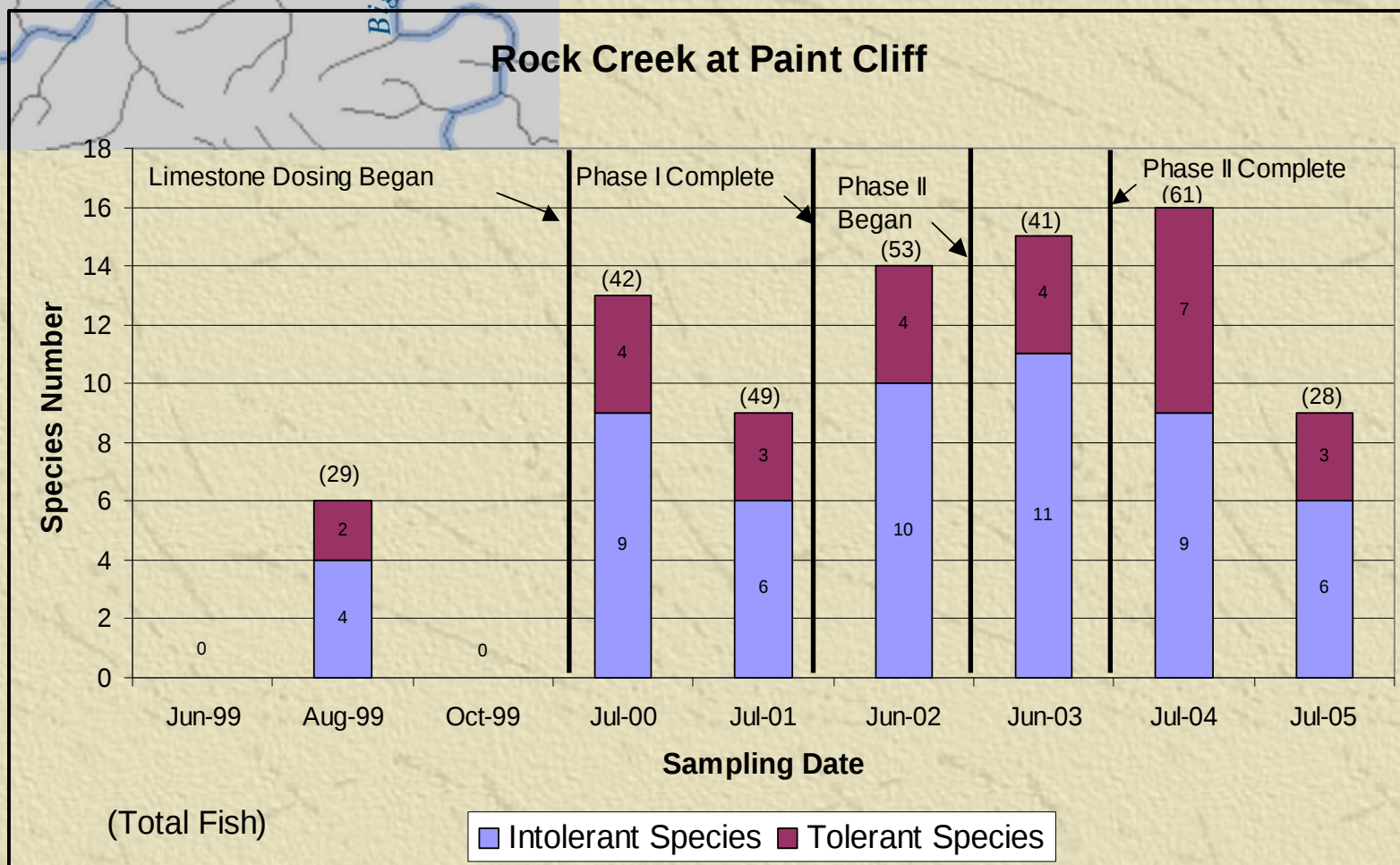
White Oak Creek Below Cabin Branch



- Water Monitoring Point
- ▲ Biological Monitoring Point



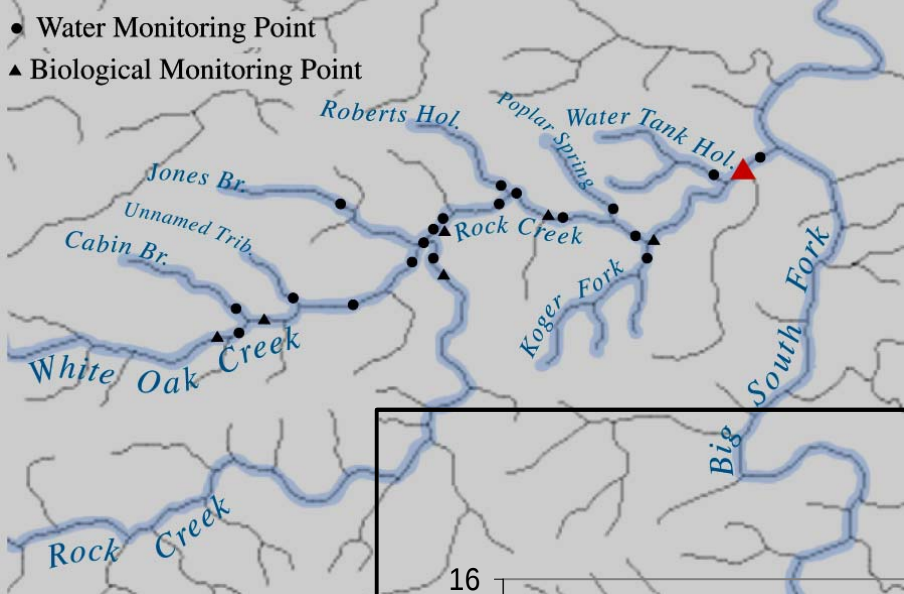
Fish Species



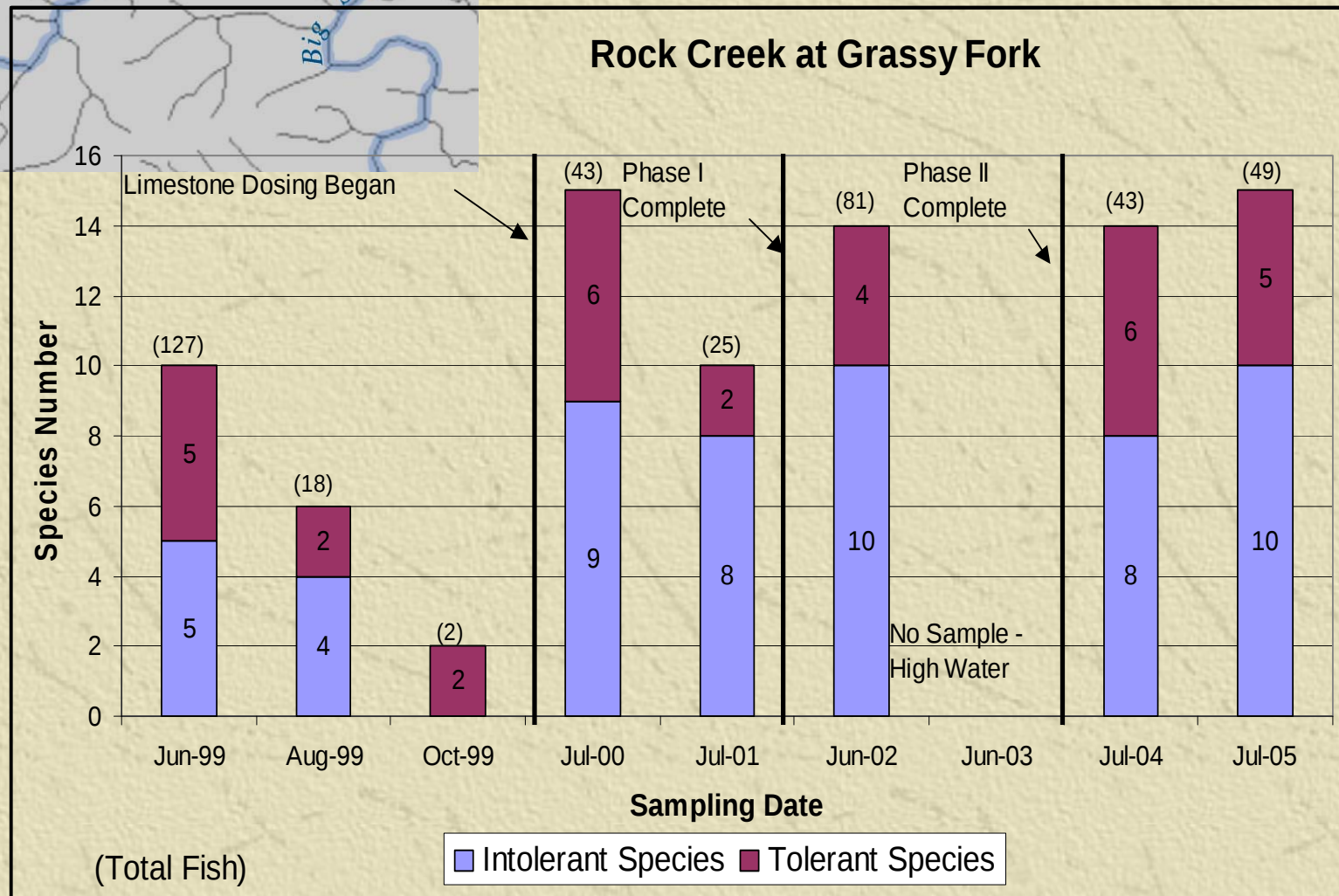




- Water Monitoring Point
- ▲ Biological Monitoring Point



Fish Species



Project Summary



80,000 Tons of Limestone Installed in Lower Rock Creek Watershed



20,000 feet of Limestone Channel Installed



Limestone Sand Dosing Ceased at 3 of 5 Sites after Phase II



Fish Populations are Increasing in Numbers and Diversity



Macroinvertebrate Populations are Increasing in Numbers and Diversity



Annual Acid Loading into
Big South Fork reduced from
1860 tons to zero



Total Construction Cost \$ 1,400,000

