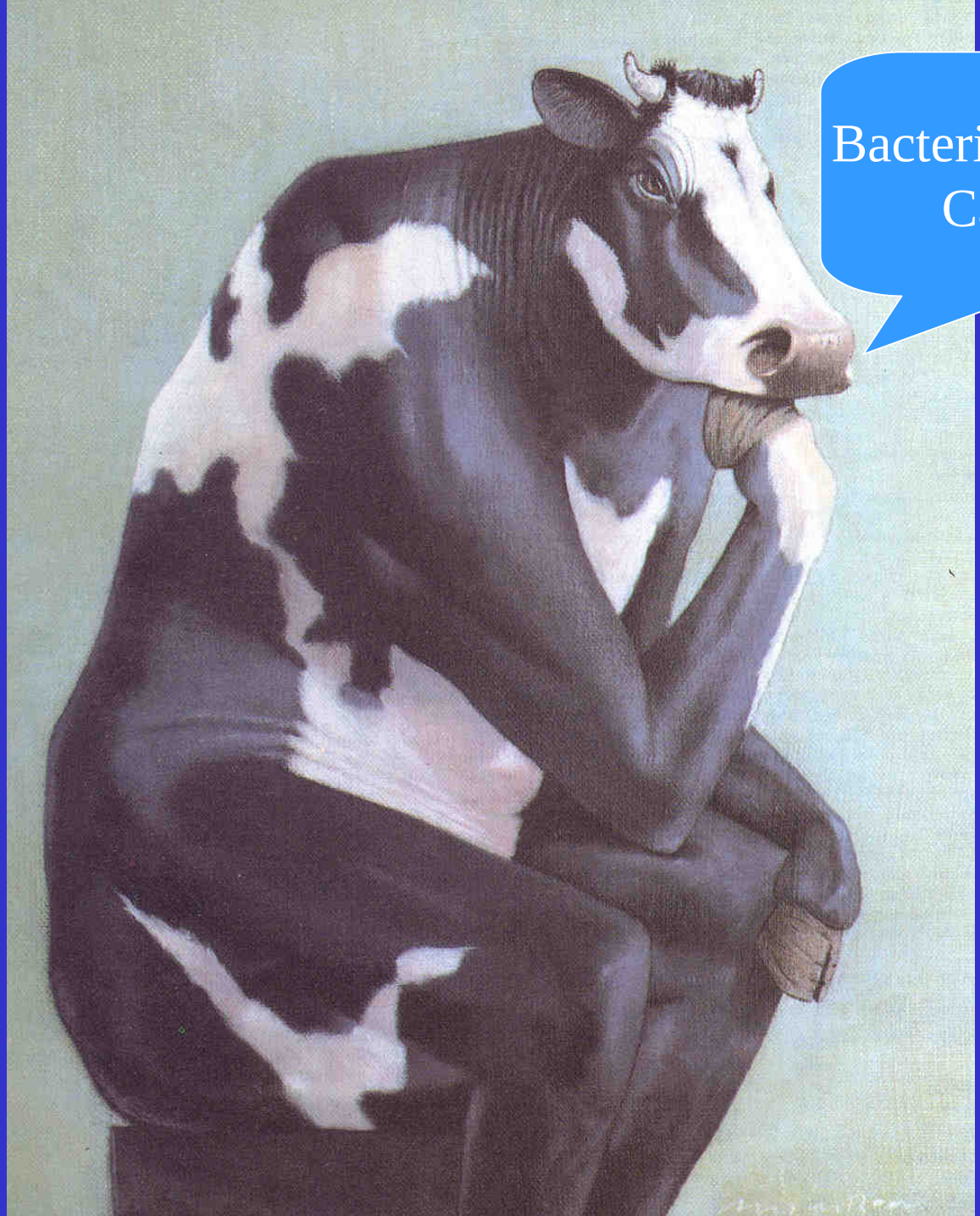

Bacteria and Nutrient
Case Study

Winter Application of Dairy Slurry

Evaluation of Nitrogen Use in a Native Pasture

Introduction

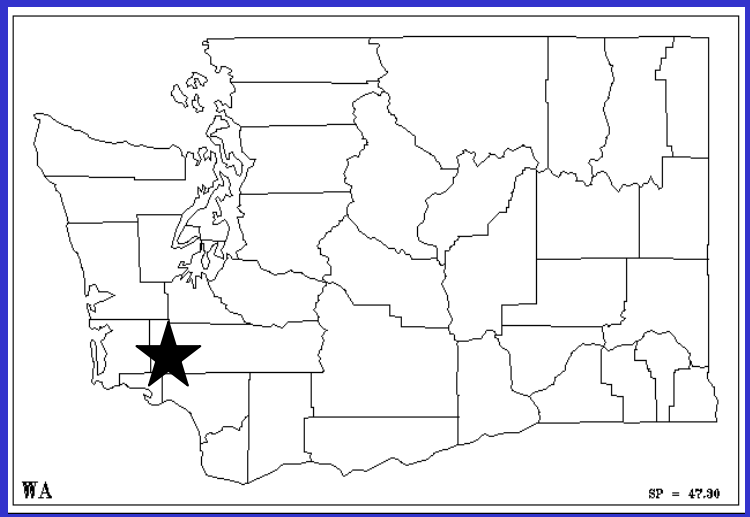
- WA Dairy Nutrient Management Act – 1998
  - All dairy operations were required to have a nutrient management plan by July 1, 2002
  - Plans had to be certified by December 31, 2003
- Requested to design a study for a dairy operation that did not have the suggested 6 months of storage
  - Manure storage facilities are expensive to build

Background

- Winter application of manure is discouraged
  - Increased risk of runoff
  - Perceived lack of nutrient uptake
- Few on-farm studies have been conducted to determine the actual environmental risks

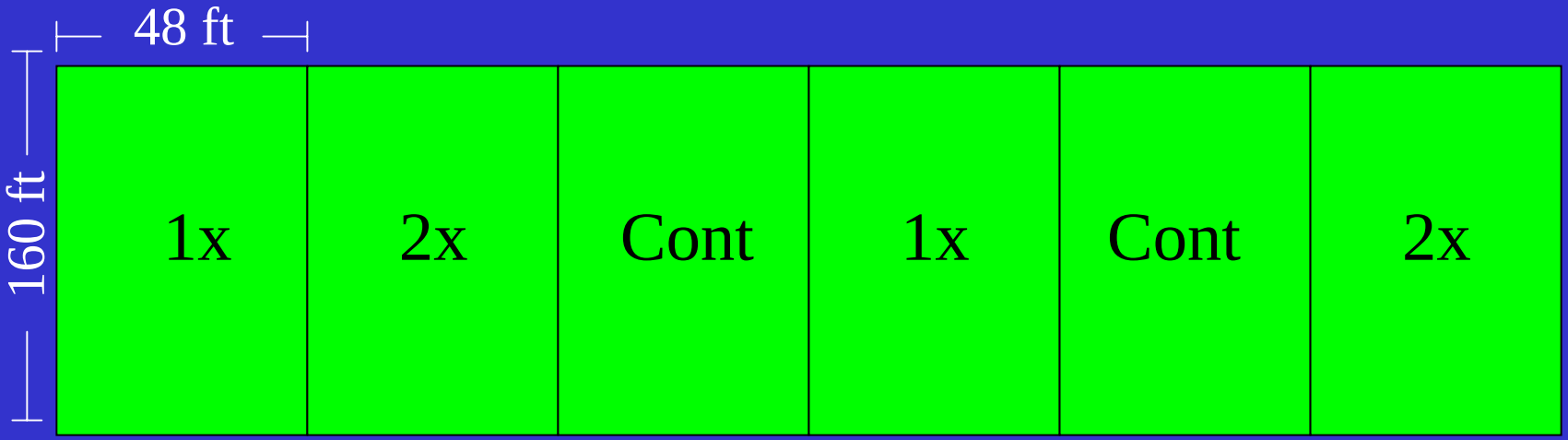
Background

- Transitional-organic, grazing based dairy
  - Located in southwestern Washington
  - Milk 60 Holstein cows
  - Relatively large land-base (200 acres)
  - Approximately 6 weeks of manure storage
  - Apply manure throughout the year



Materials and Methods

- Six plots were assigned in duplicate to one of 3 treatments
- Treatments
  - Control
  - 1x manure application rate
  - 2x manure application rate




Plots

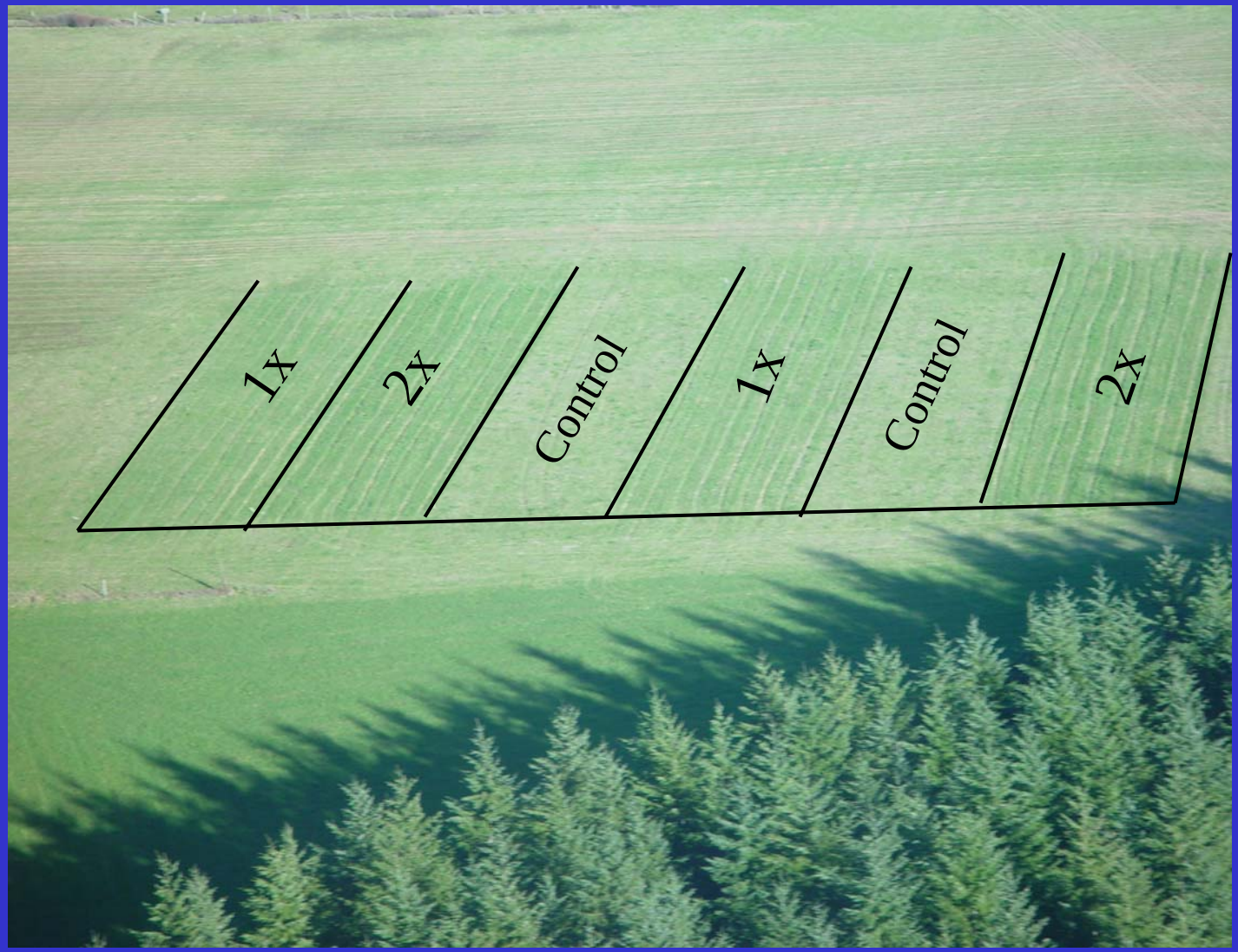
Manure Application

- Manure was applied 2 times per year
  - Winter - January
  - Summer - June
- Manure was surface applied with a splash-plate manure wagon
  - Each load was weighed and sampled
- Year 1 application rates
  - 1x plots – 112 lb N/acre
  - 2x plots – 200 lb N/acre

Materials and Methods

- Sample collection
  - 1 ft soil samples were taken once every 4 weeks
  - Grass clippings were taken once every 4 weeks
    - April through September
- Sample analyses
  - Grass
    - Dry matter, crude protein, and nitrate (NO_3^-)
  - Soils
    - NO_3^- and ammonium (NH_4^+)
  - Manure
    - Total nitrogen and NH_4^+

Evaluation of nitrogen use from winter manure application



Grass Dry Matter Yields

Item	control	1x	2x
	DM Yield, tons/ac		
Year 1	2.0	2.5	3.1
Year 2	1.8[b]	2.8[ab]	3.9[a]
Year 3	2.1[b]	4.0[ab]	5.4[a]

Soil Nitrate and Ammonium

Item	control	1x	2x	Yr Ave
NO_3-N, ppm				
Year 1	5.4	5.3	6.5	5.7
Year 2	4.9	5.6	6.0	5.5
Year 3	4.6	4.9	5.2	4.9

Winter Application of Dairy Slurry

Transport of Fecal Bacteria and Nutrients to Surface Water

Introduction

- Fecal coliform and *Escherichia coli* are bacteria of concern in surface waters
  - Indicators of fecal contamination
- Many rivers in Washington have TMDL standards for surface waters
  - Dairy farms are often listed as a source of fecal coliforms and *E. coli*

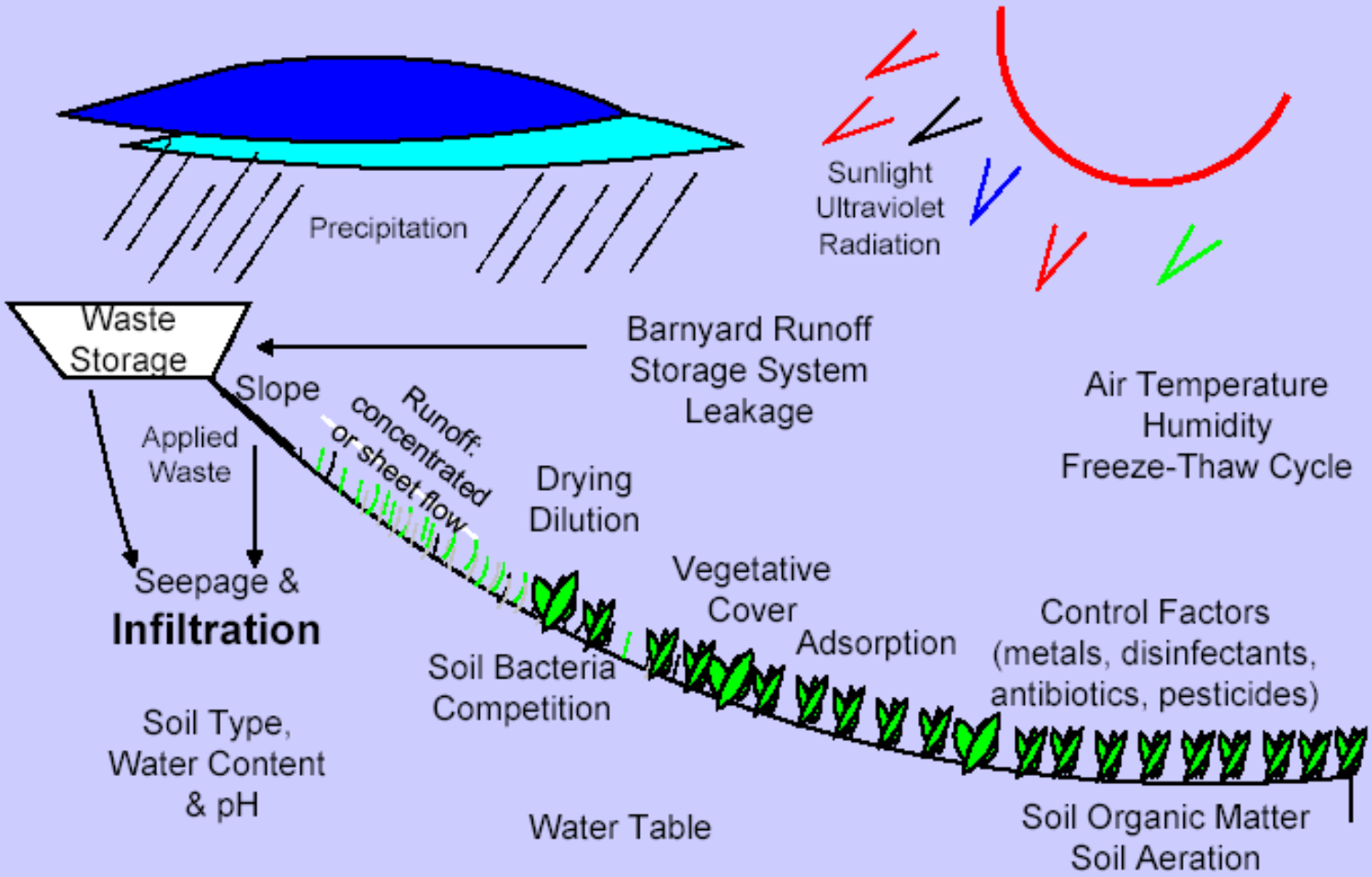
Introduction

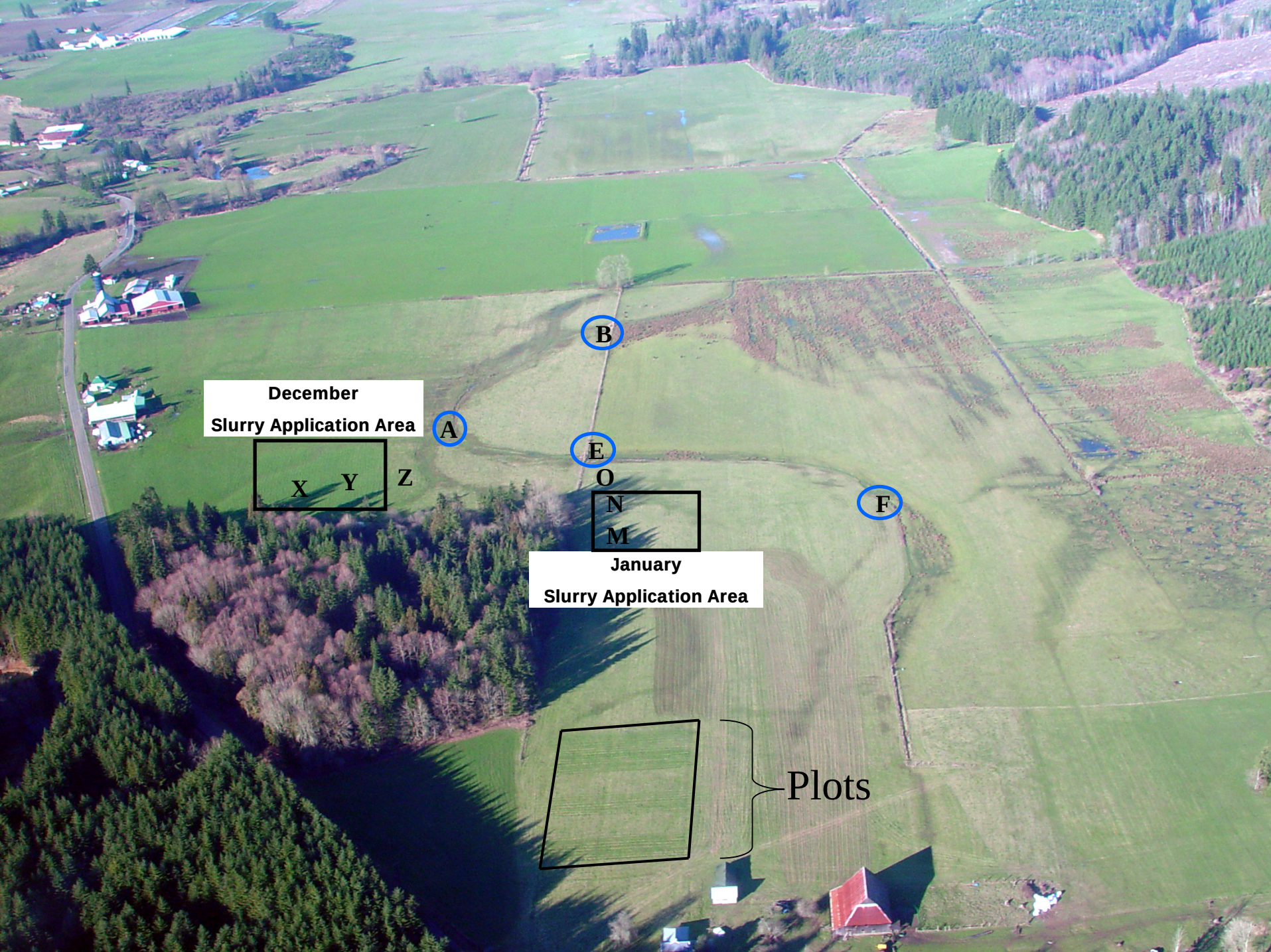
- Application of dairy slurry during winter months has been assumed to increase the risk of nutrient and bacterial contamination to the environment
- Evaluation of BMP are important to determine which practices adequately protect the environment while providing dairy operations alternative ways of managing manure and nutrients
- Few on-farm studies have been conducted to determine the actual environmental risks

Pathogens vs. Indicators

Microbial Indicator	Properties
Total coliforms (TC)	•originally believed to indicate the presence of fecal pollution •widely distributed in nature: soils, water, flora, fauna •contains members of *Escherichia*, *Citrobacyter Klebsiella* and *Enterobacter* identified by incubation at 35°C
Fecal coliforms (FC)	•subgroup of TC •coliforms that originate specifically from intestinal tracts of warm-blood animals •cultured by increasing the incubation temperature to 44.5°C •remains the predominant indicator used to assess bacterial pollution in watersheds
Escherichia coli *(E. coli)*	•member of the FC group •presence correlates with illness from swimming in both fresh and marine waters •has been shown epidemiologically to cause gastrointestinal symptoms •O157:H7 is a toxin-producing strain of this common bacterium

Factors Affecting the Viability Along Transport Pathways




December
Slurry Application Area
A
B
X
Y
Z
E
O
N
M
F
January
Slurry Application Area
Plots

Slurry Applications

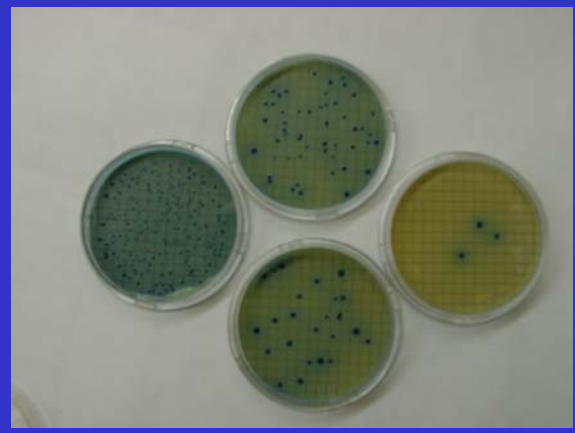
- December 12th application
  - 2.9 acres
  - 0.16 acre-inches
  - 4 to 5 times normal application area
- January 27th application
  - 1.2 acres
  - 0.18 acre-inches
  - 2 to 3 times normal application area

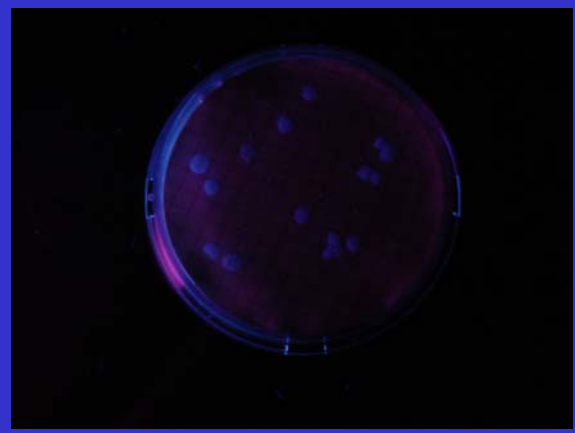
Soil Sampling

- Soil samples were taken from 2 plots in manure application area and 1 plot located in the buffer strip
  - Soil probe was 2.5 inches in diameter
  - Sampling depth of 1.5 inches
  - 3 cores were taken from each plot

Laboratory Procedures

- Water samples
  - Membrane filtration procedure
    - Fecal coliform
    - *E. coli*
- Soils
  - Samples were diluted with an equal amount of sterile buffered water
  - Placed in a stomacher for 1 min at 200 rpm
  - Membrane filtration technique for fecal coliform determination



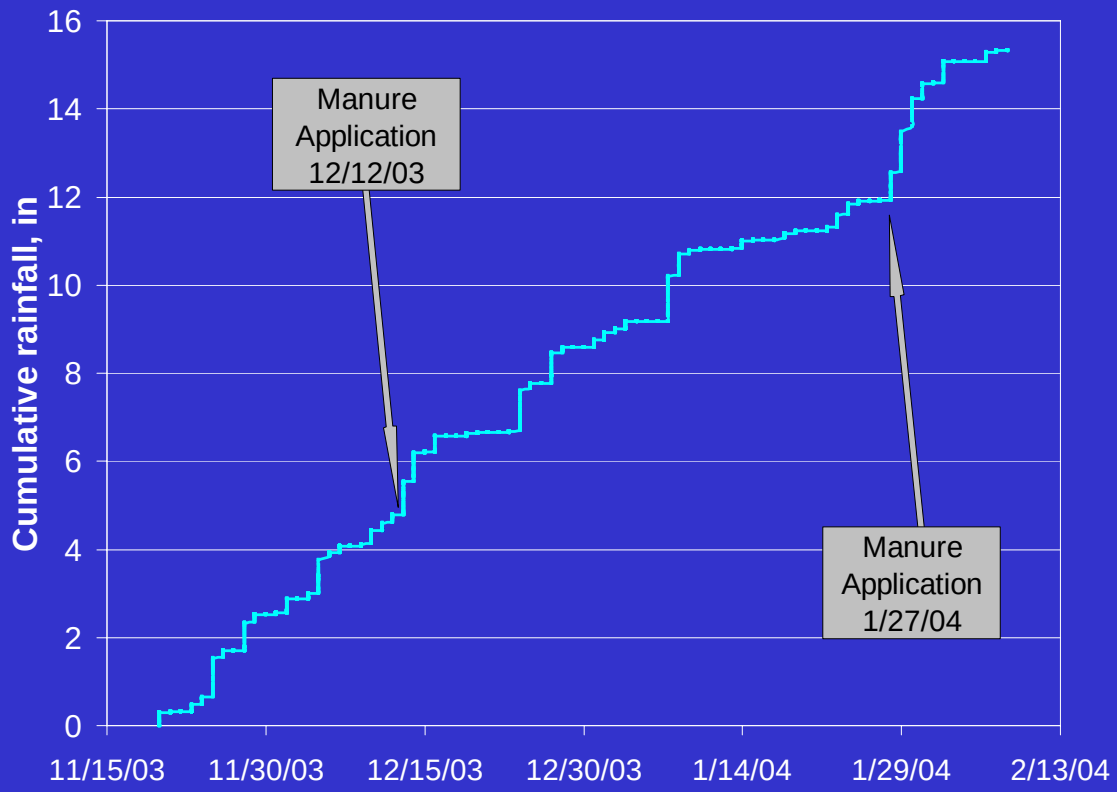


DNA Fingerprinting

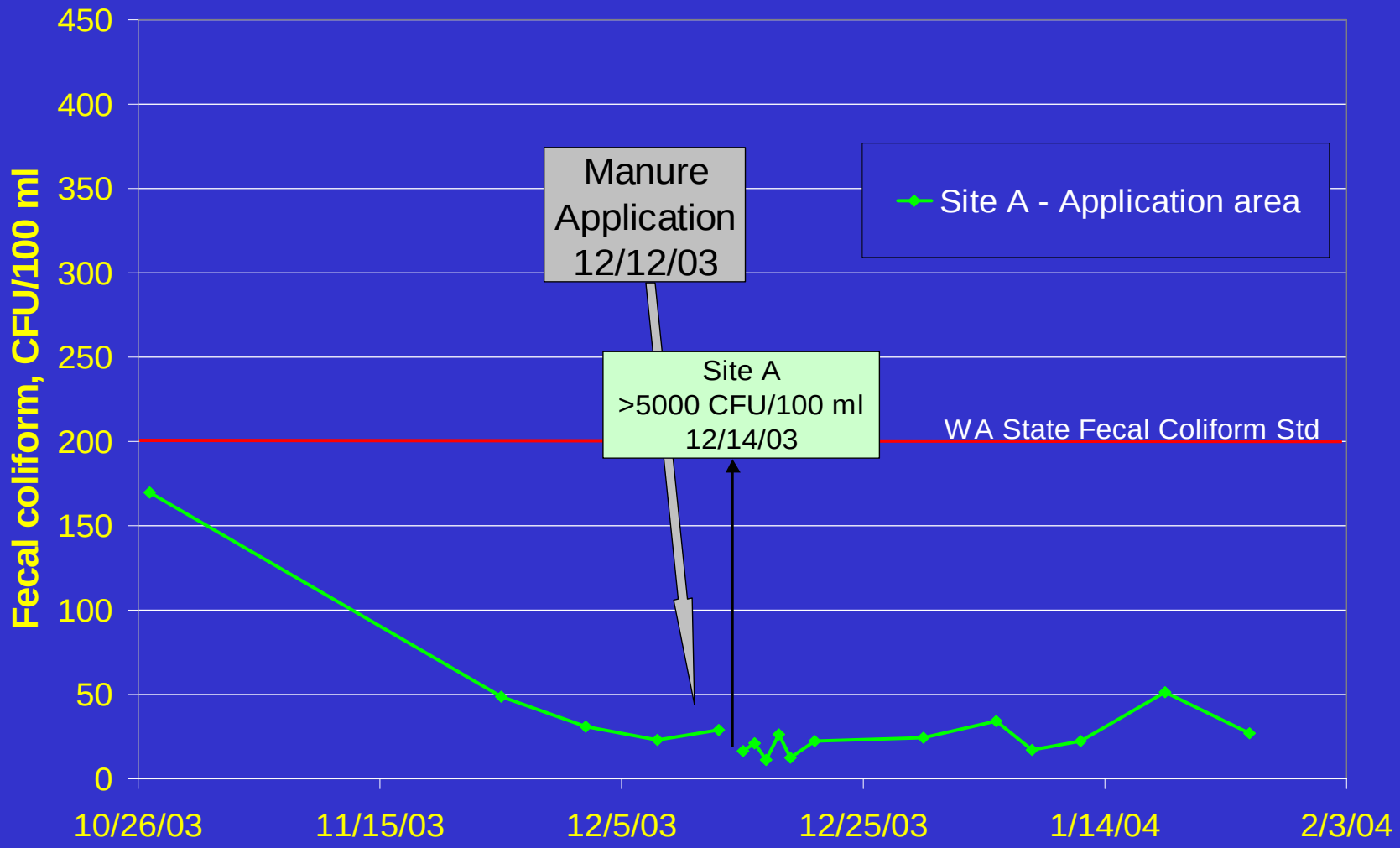
- Plates with *E. coli* were selected for DNA fingerprinting
  - Colonies from slurry application were used to establish background database
  - Plates taken from sites A, B, and D
  - 2 to 4 colonies per plate were selected for DNA ribotyping
  - Fingerprinting conducted by Institute of Environmental Health in Seattle

Rainfall

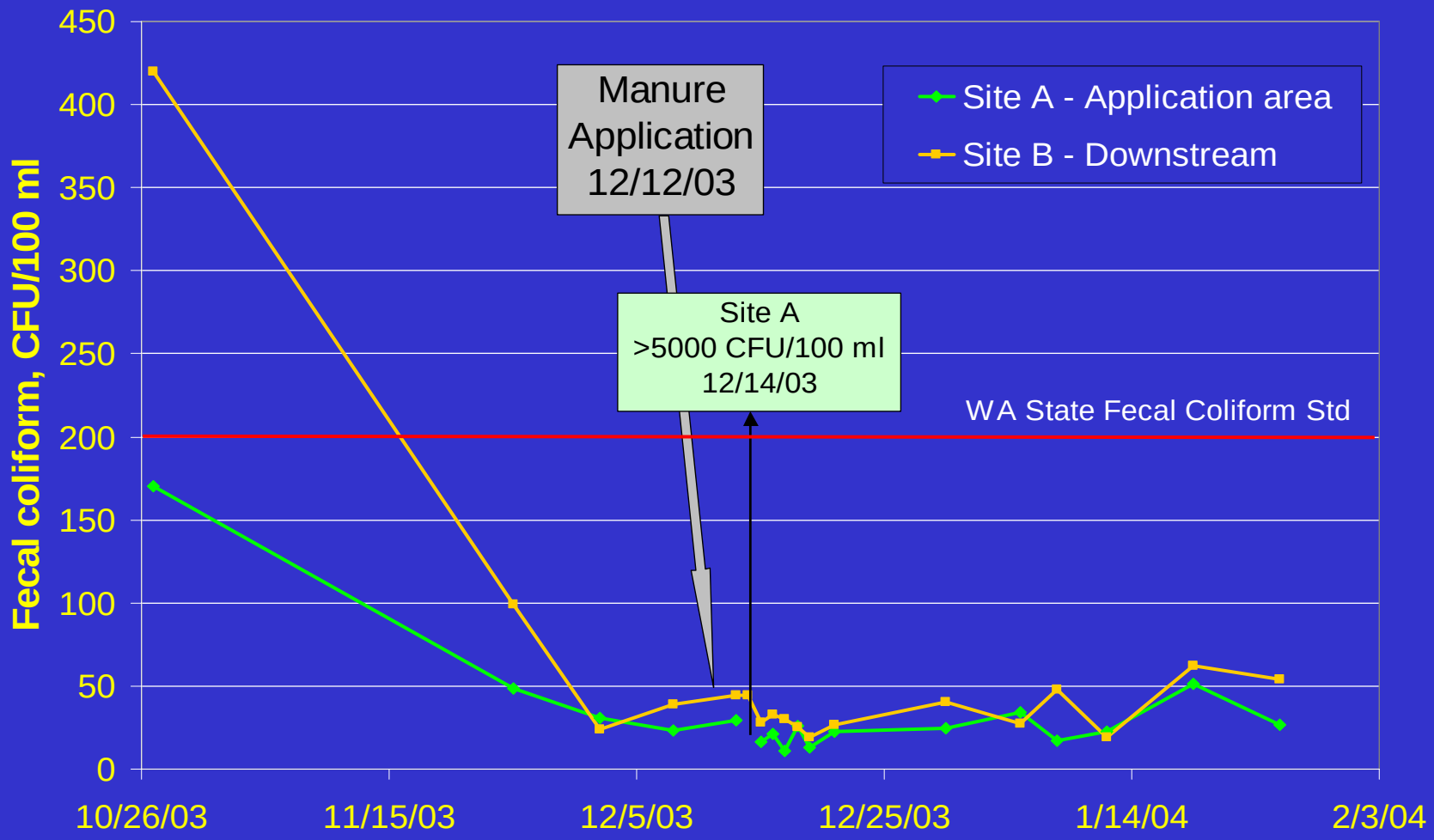
- December rainfall
  - 0.5 inches in 24 hrs
  - 1.1 inches in 48 hrs
  - 1.5 inches in 72 hrs



Water Fecal Coliform December Application



Water Fecal Coliform December Application

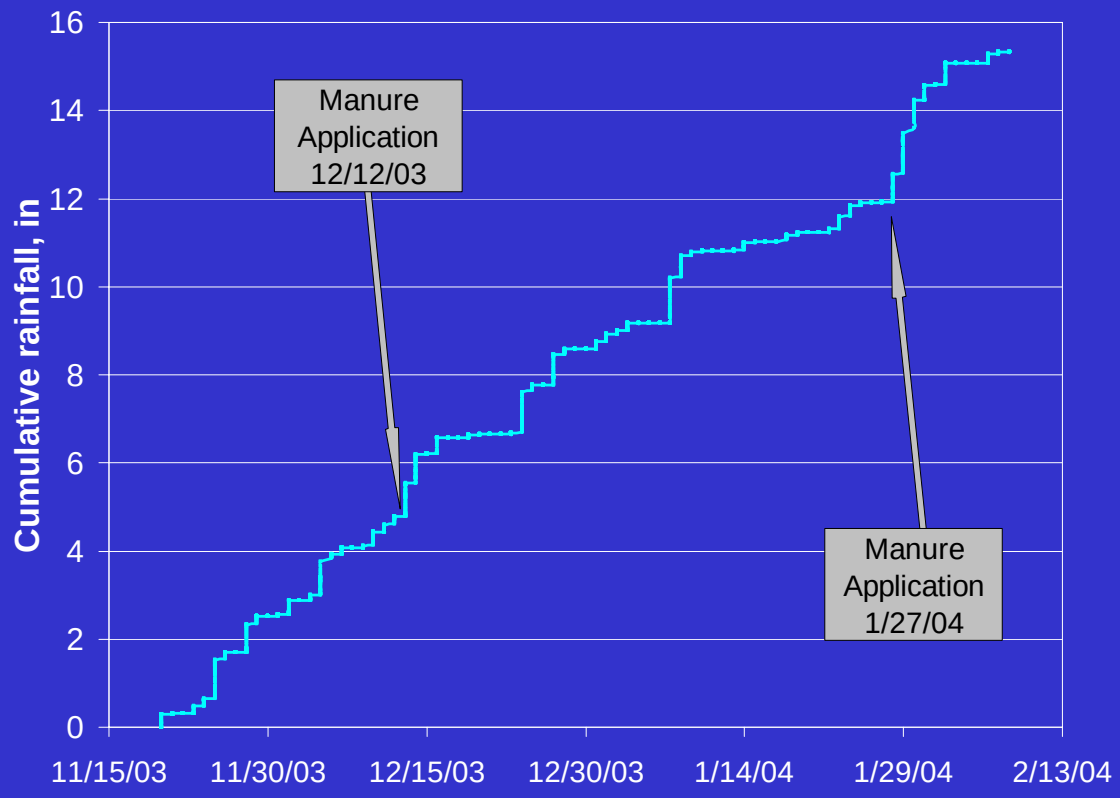


DNA Fingerprinting
December Application

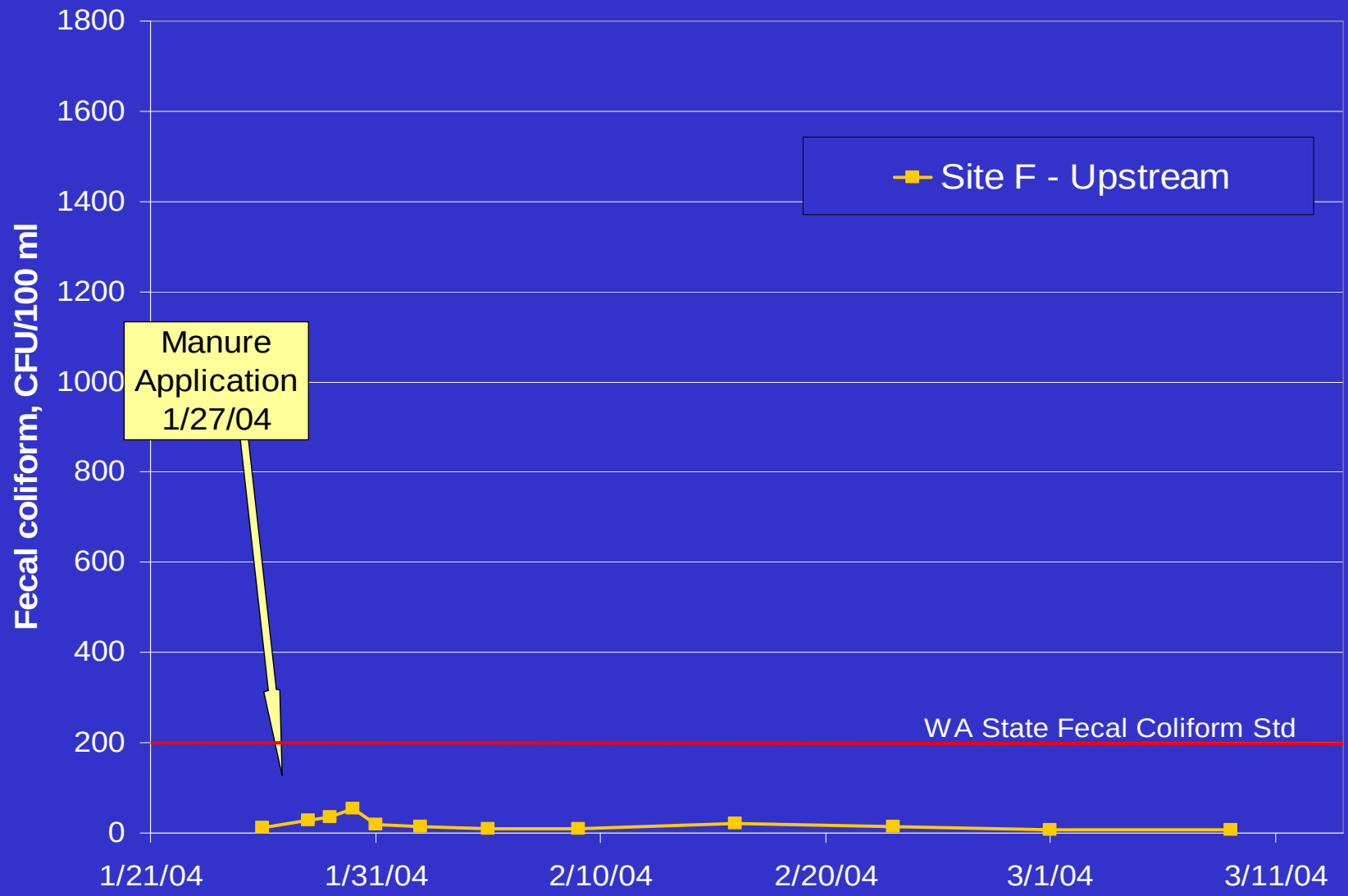
Site	# of isolates	# from cattle	% from cattle
A	9	9	100
B	22	18	82
D	13	8	62
Total	44	35	80

Rainfall

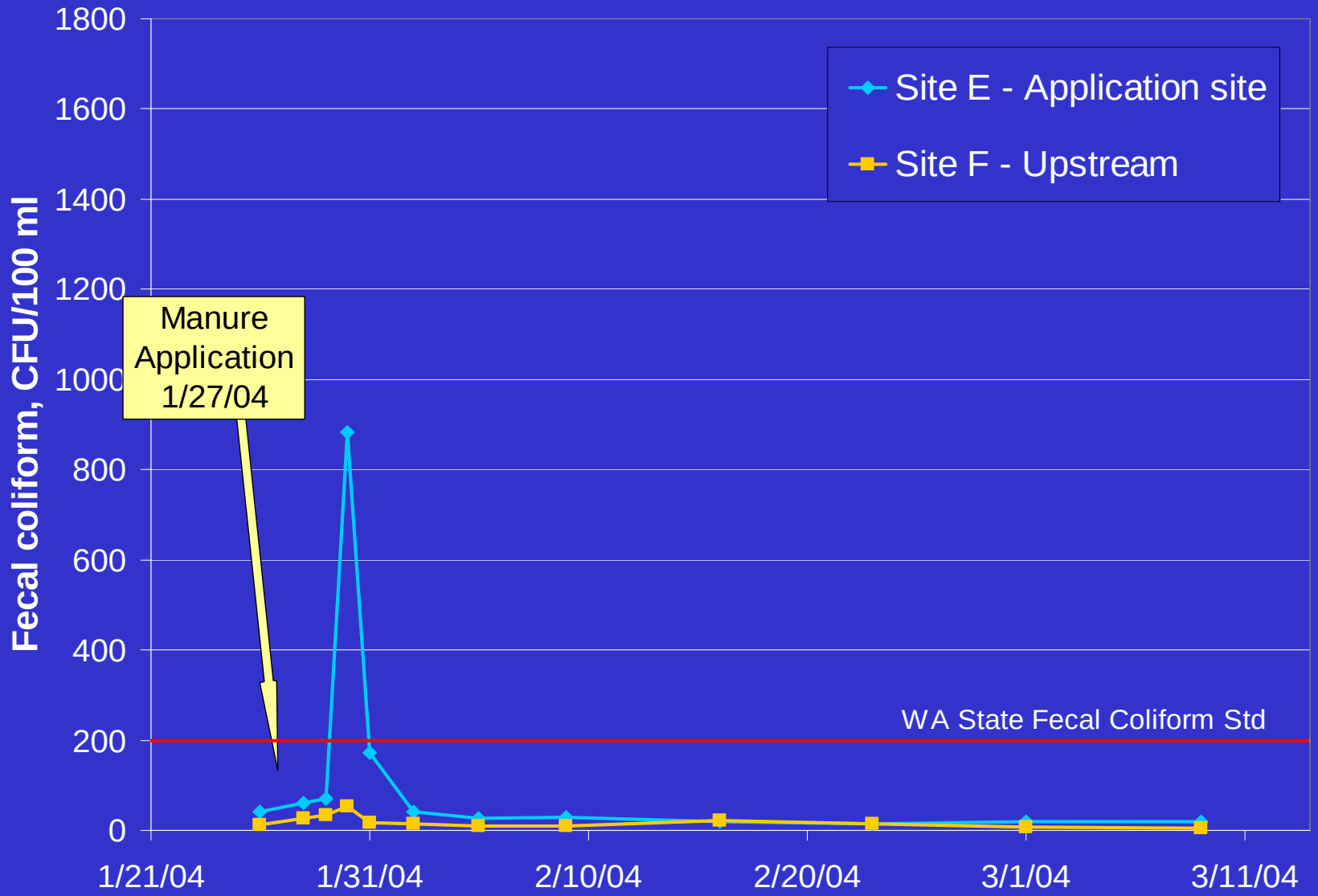
- December rainfall
  - 0.5 inches in 24 hrs
  - 1.1 inches in 48 hrs
  - 1.5 inches in 72 hrs
- January rainfall
  - 0.3 inches in 24 hrs
  - 1.1 inches in 48 hrs
  - 2.2 inches in 72 hrs



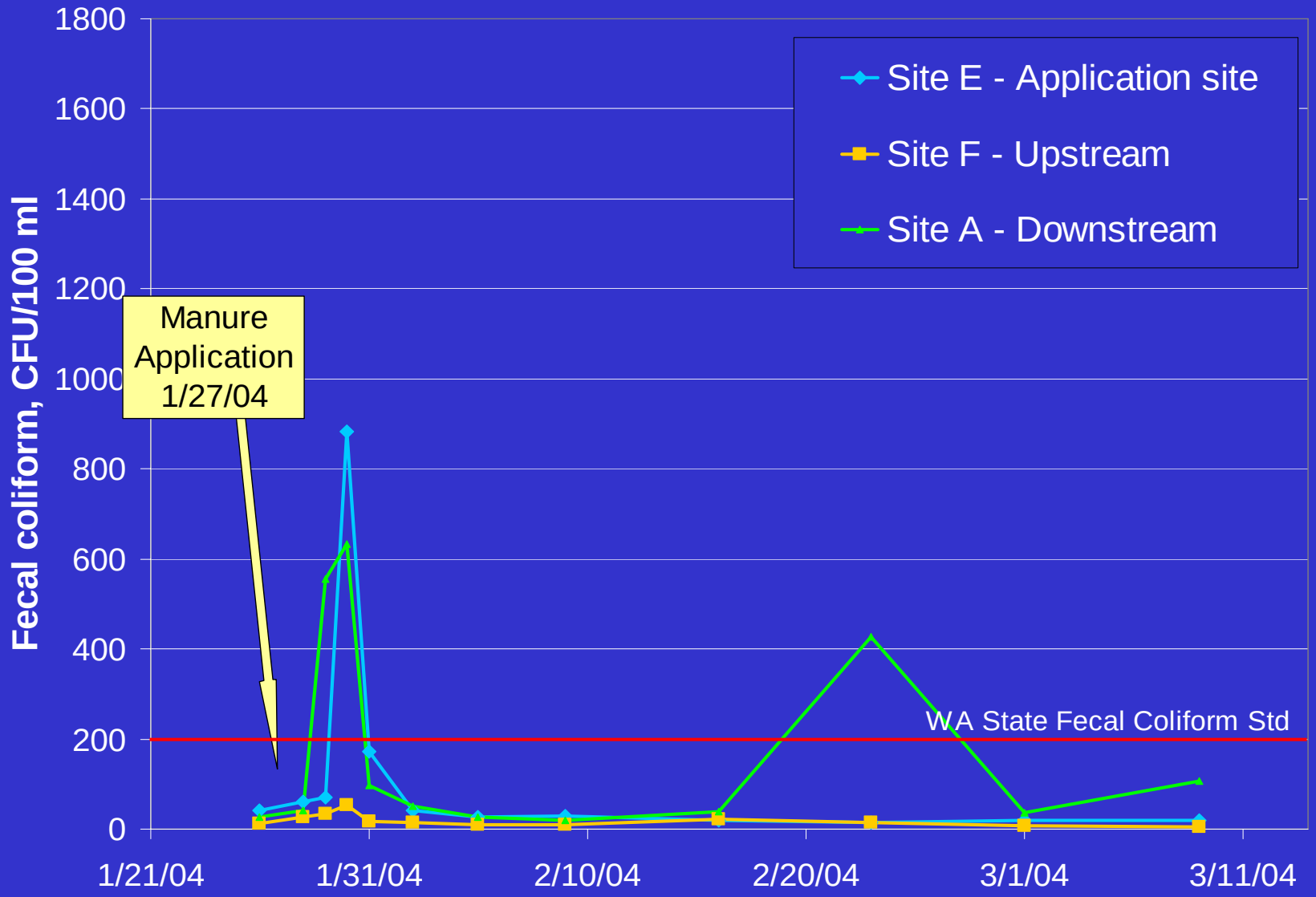
Water Fecal Coliform January Application



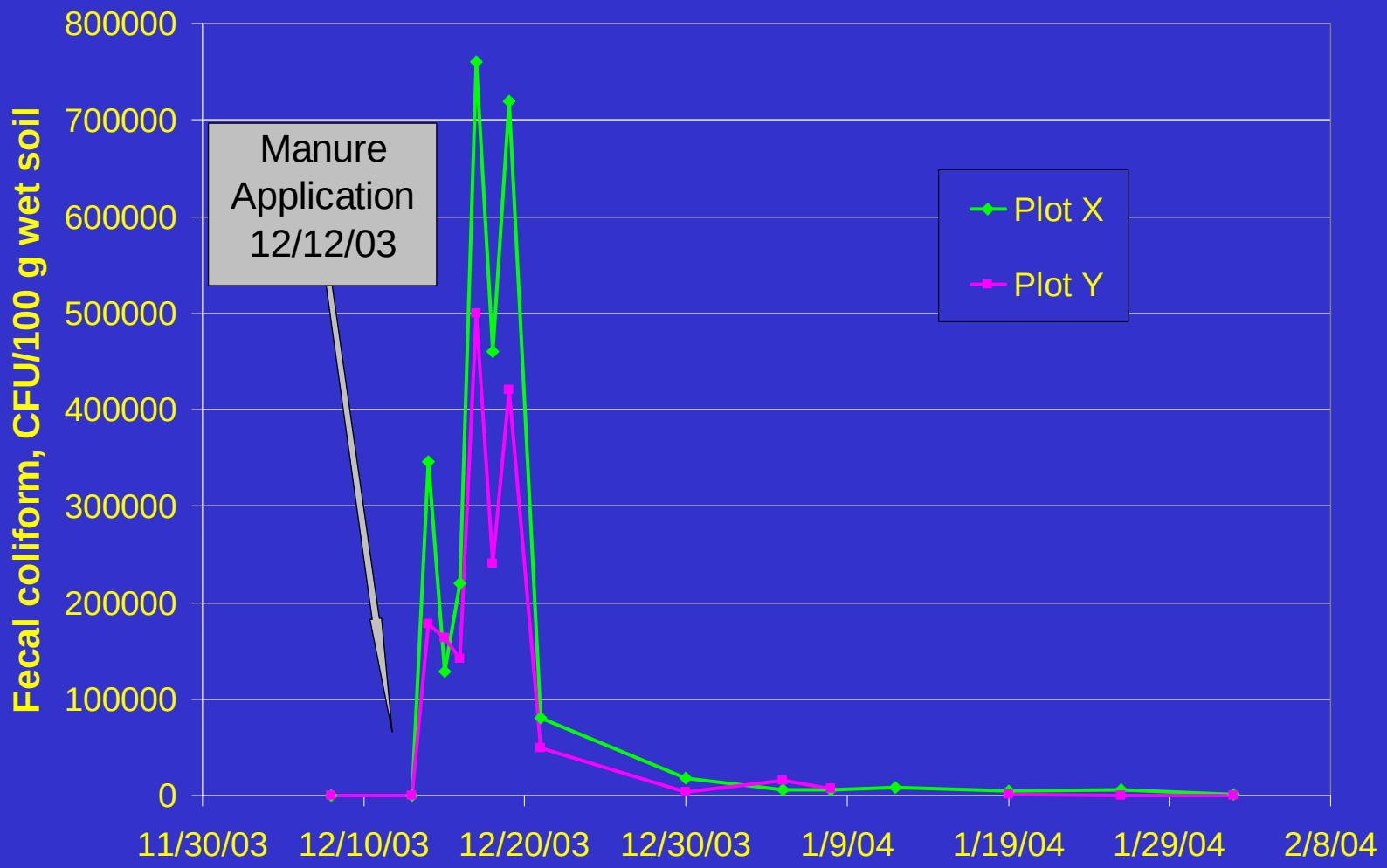
Water Fecal Coliform January Application



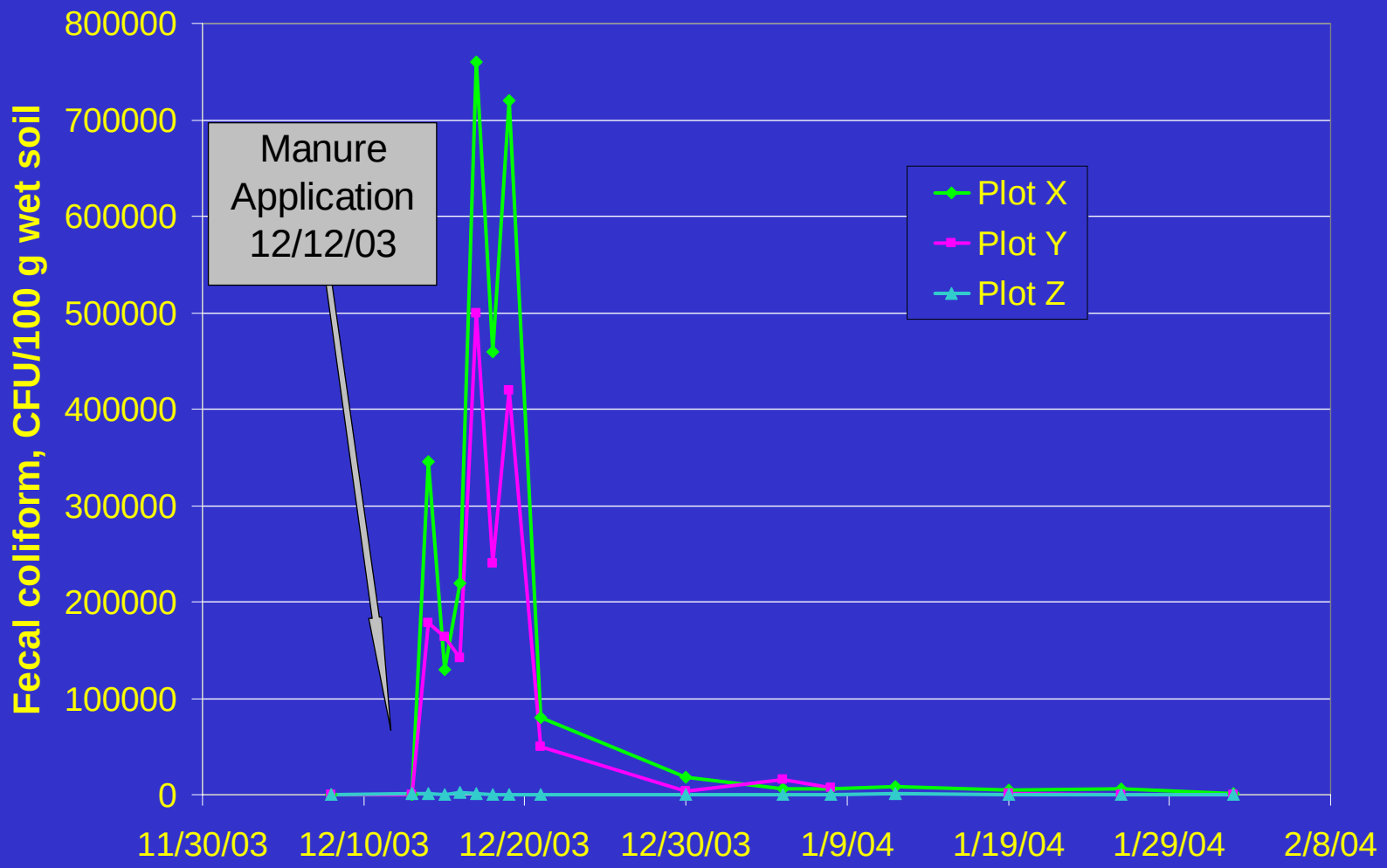
Water Fecal Coliform
January Application



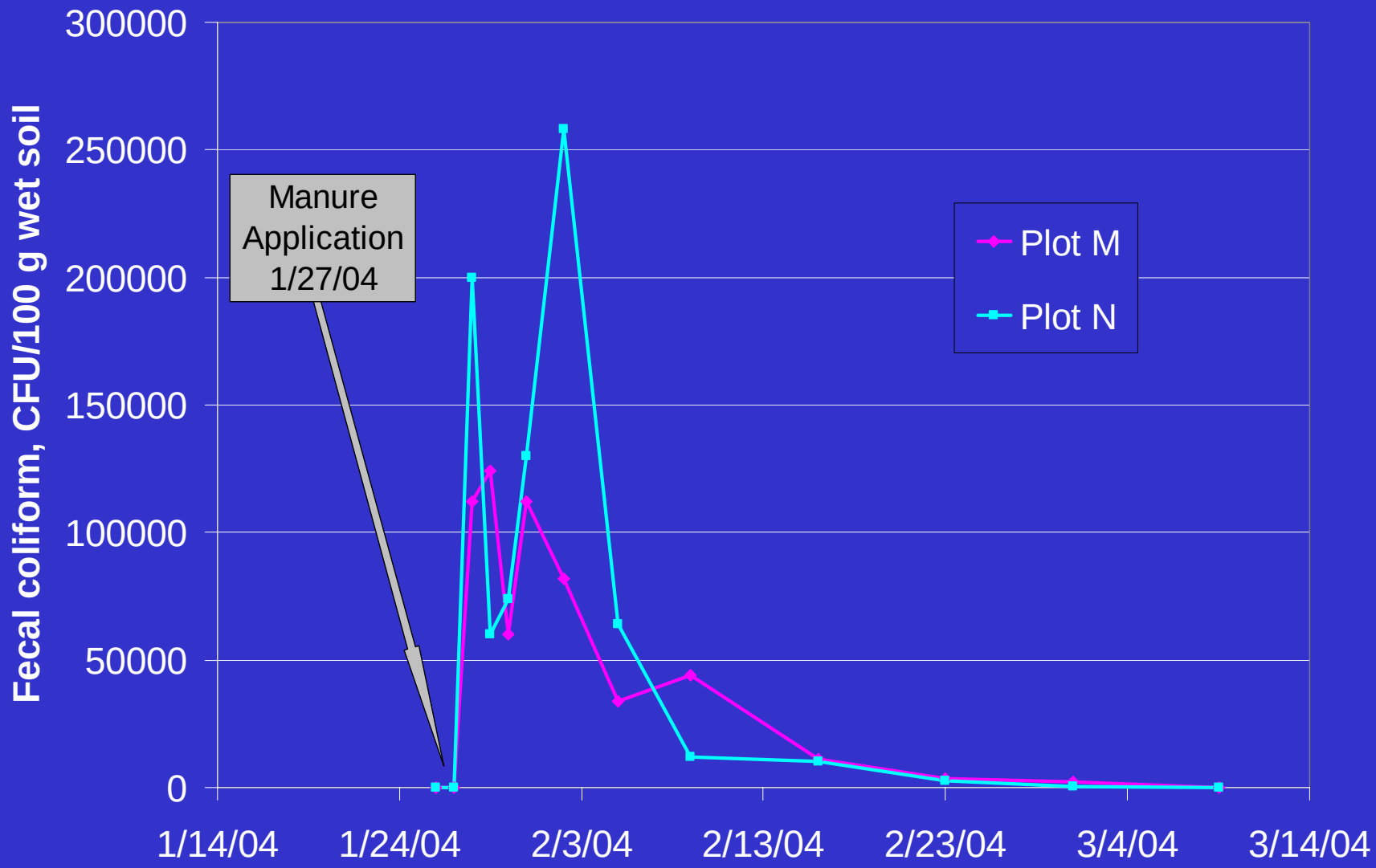
Soil Fecal Coliform December Application



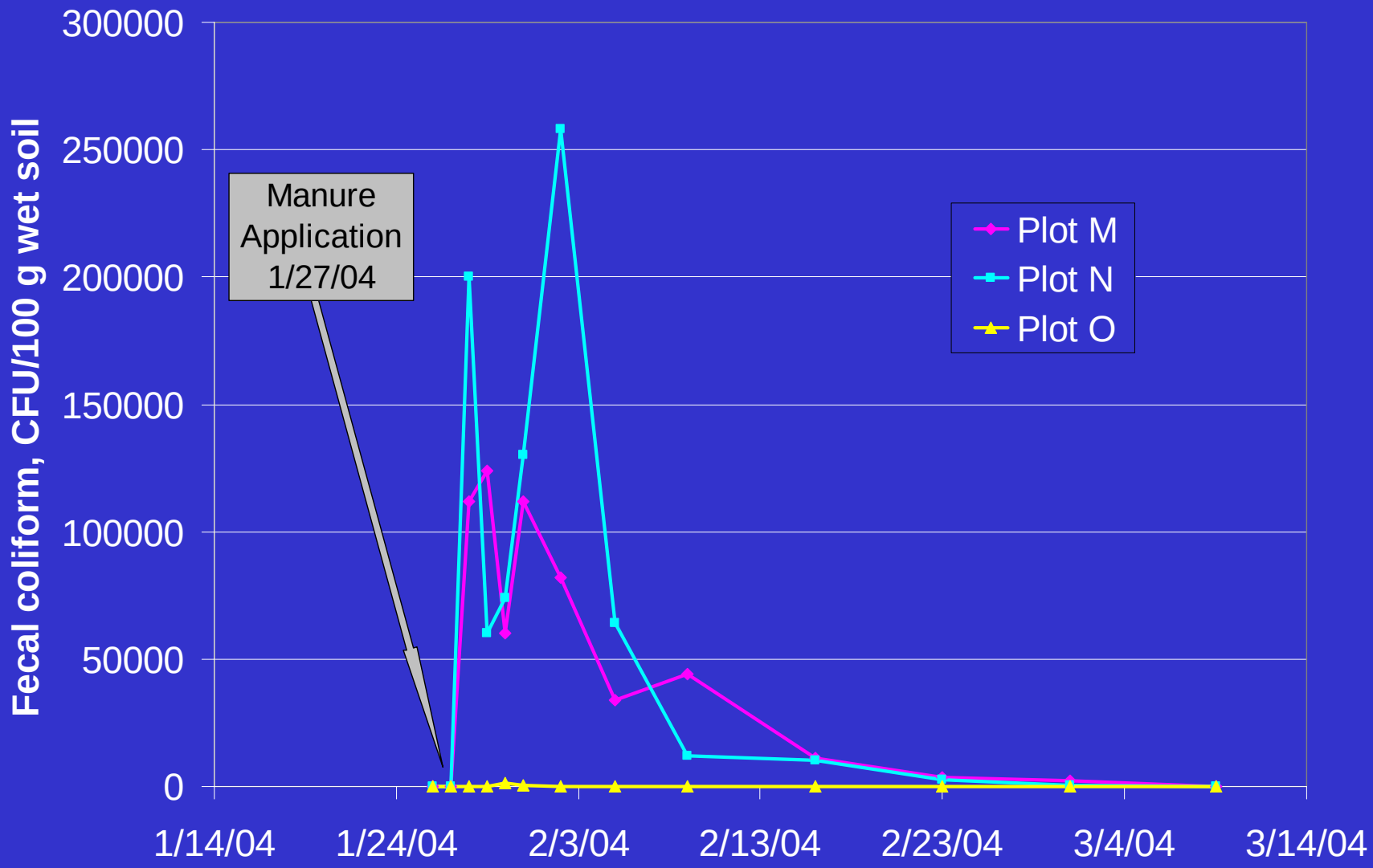
Soil Fecal Coliform December Application



Soil Fecal Coliform January Application



Soil Fecal Coliform January Application



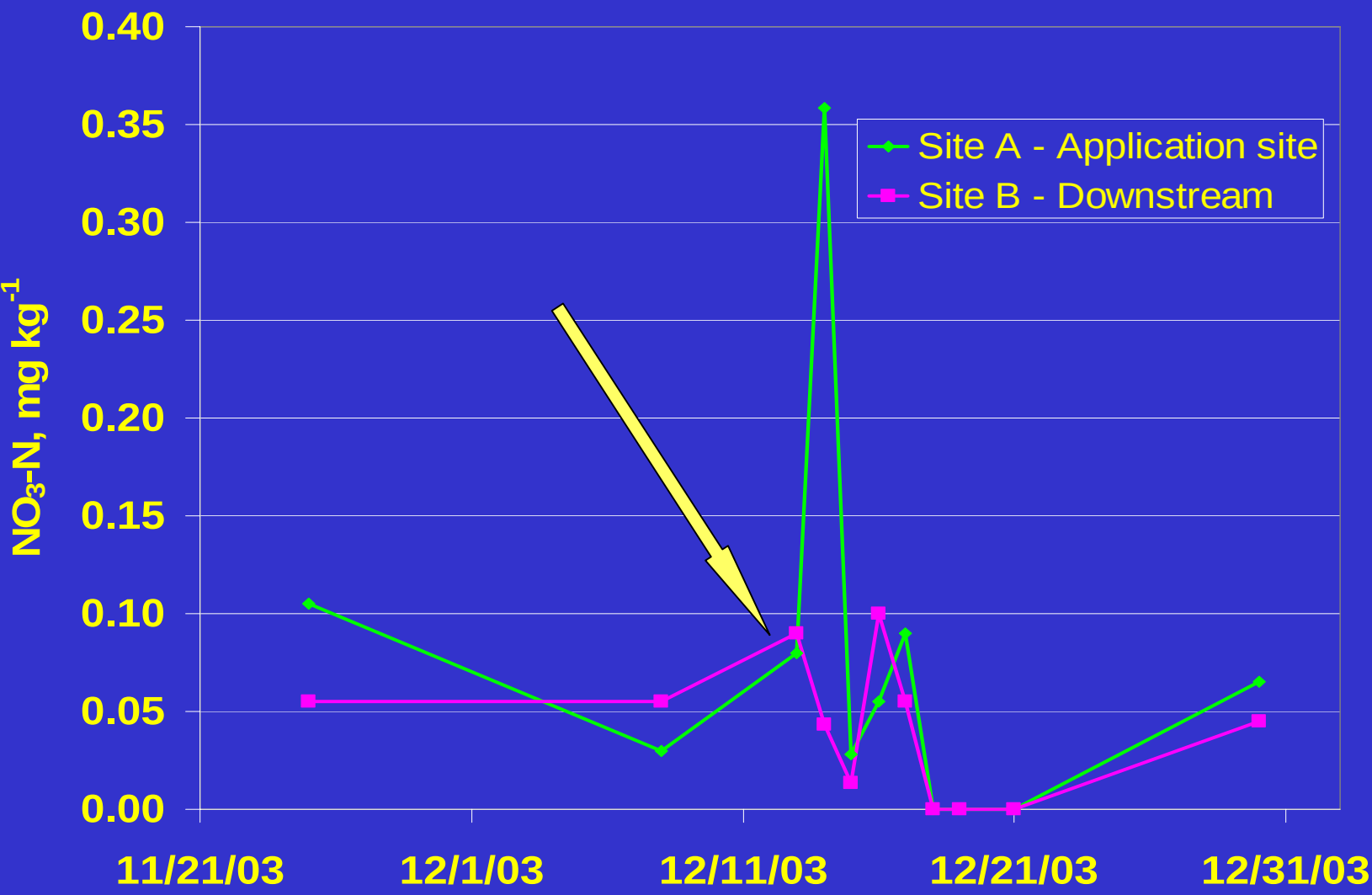
Winter Application of Dairy Slurry

Transport of Nitrogen and Phosphorus to Surface Water

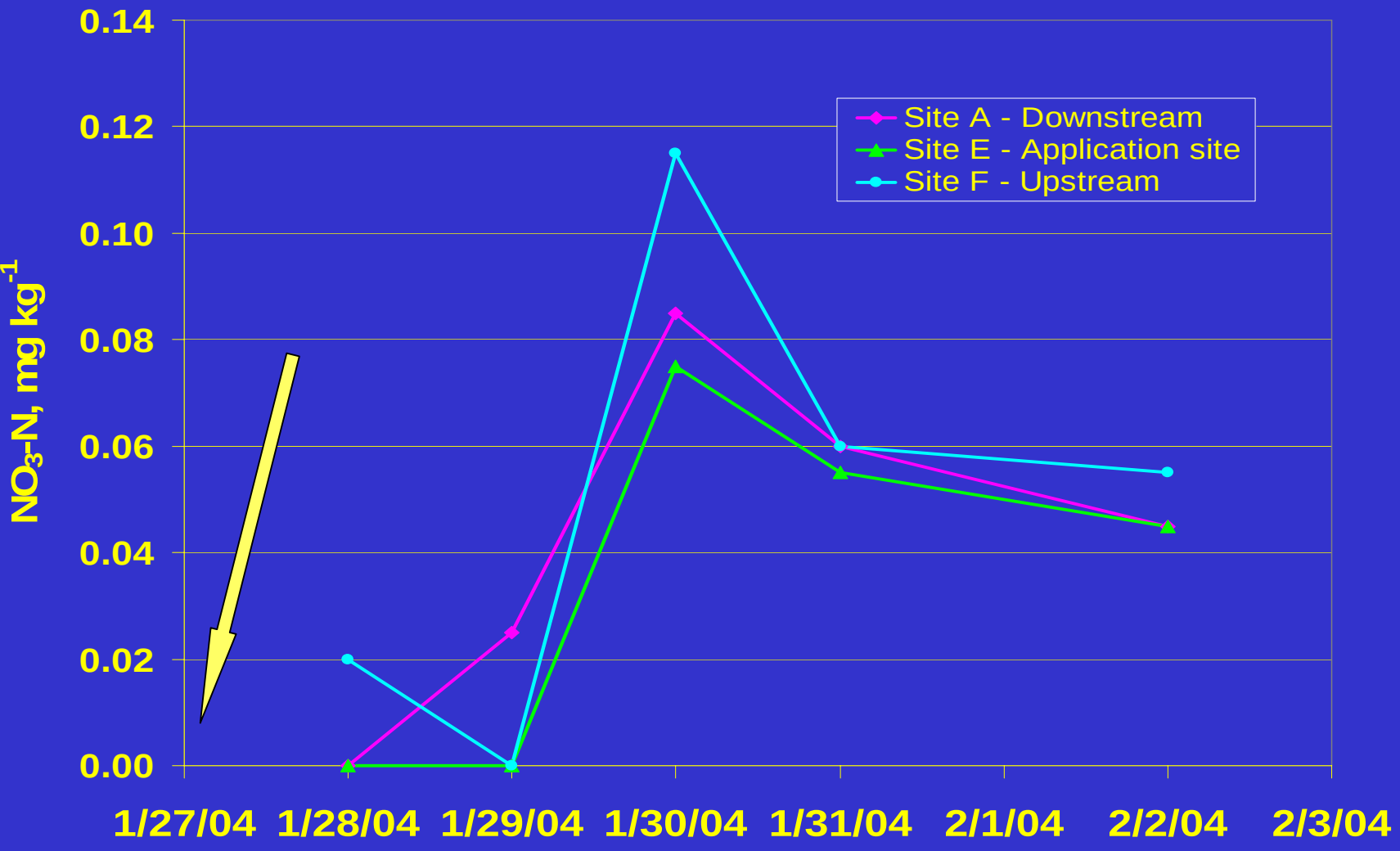
Nitrogen

NO_3-N & NH_4-N

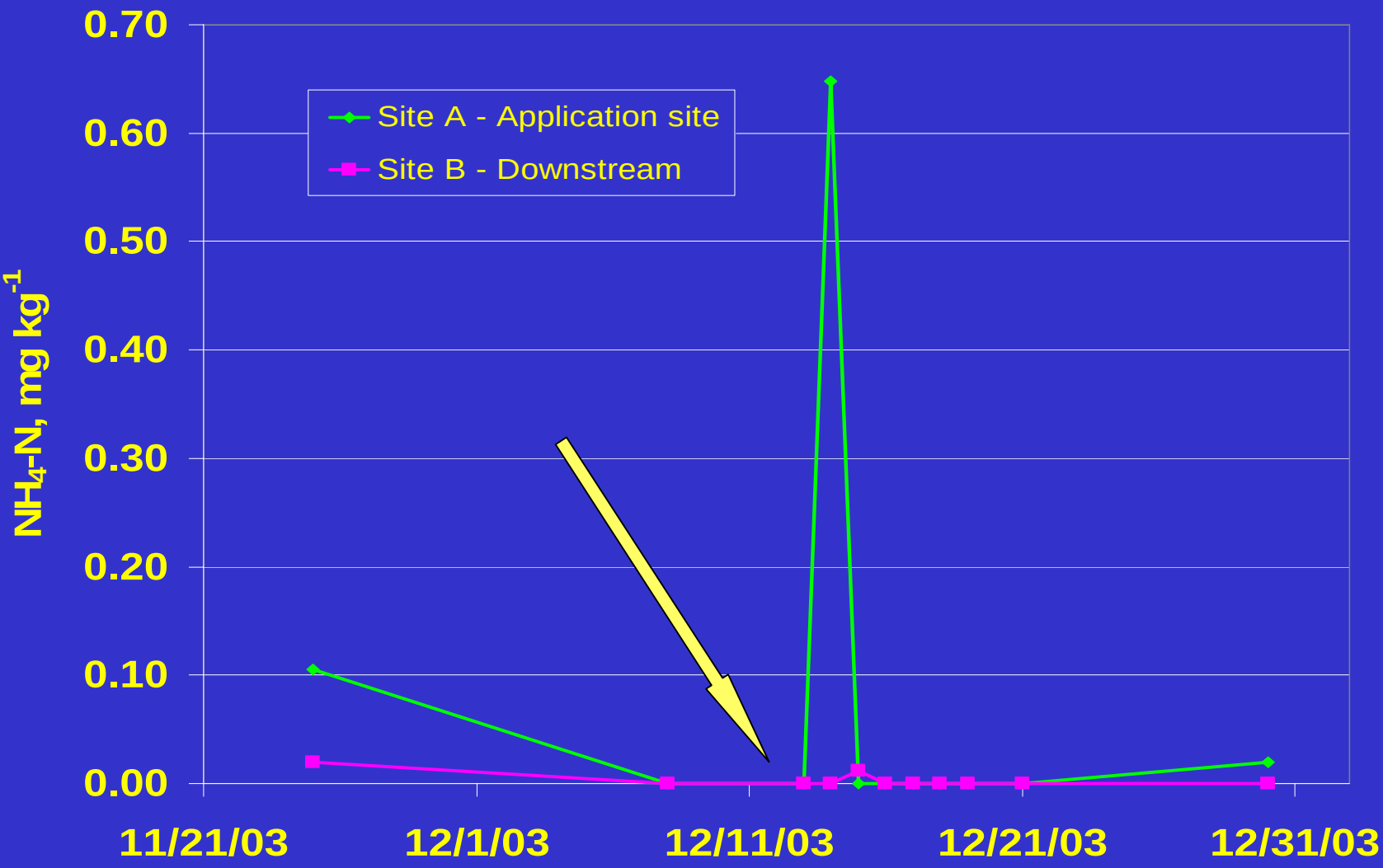
December Application
NO_3-N



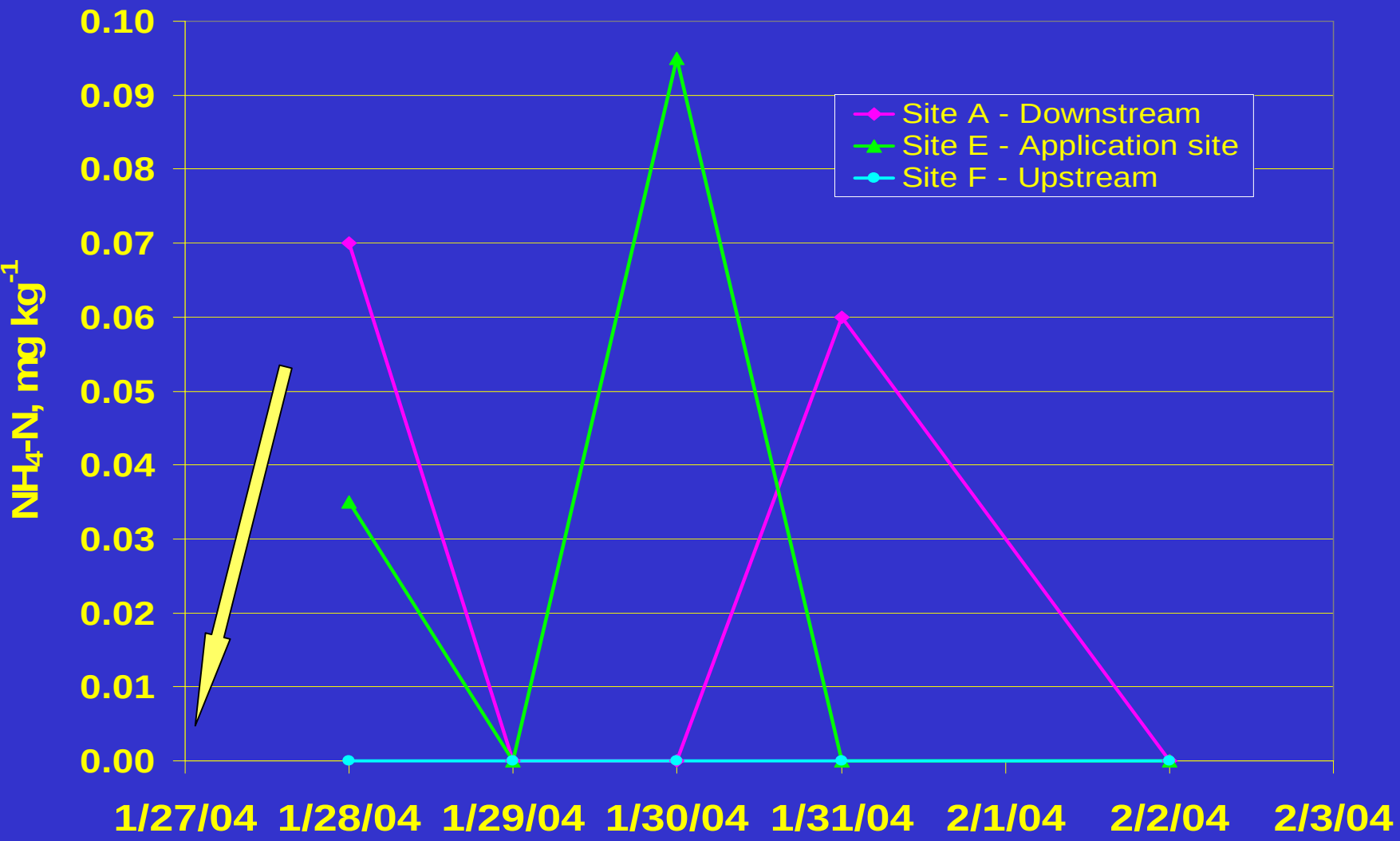
January Application
NO_3-N



December Application
NH_4-N



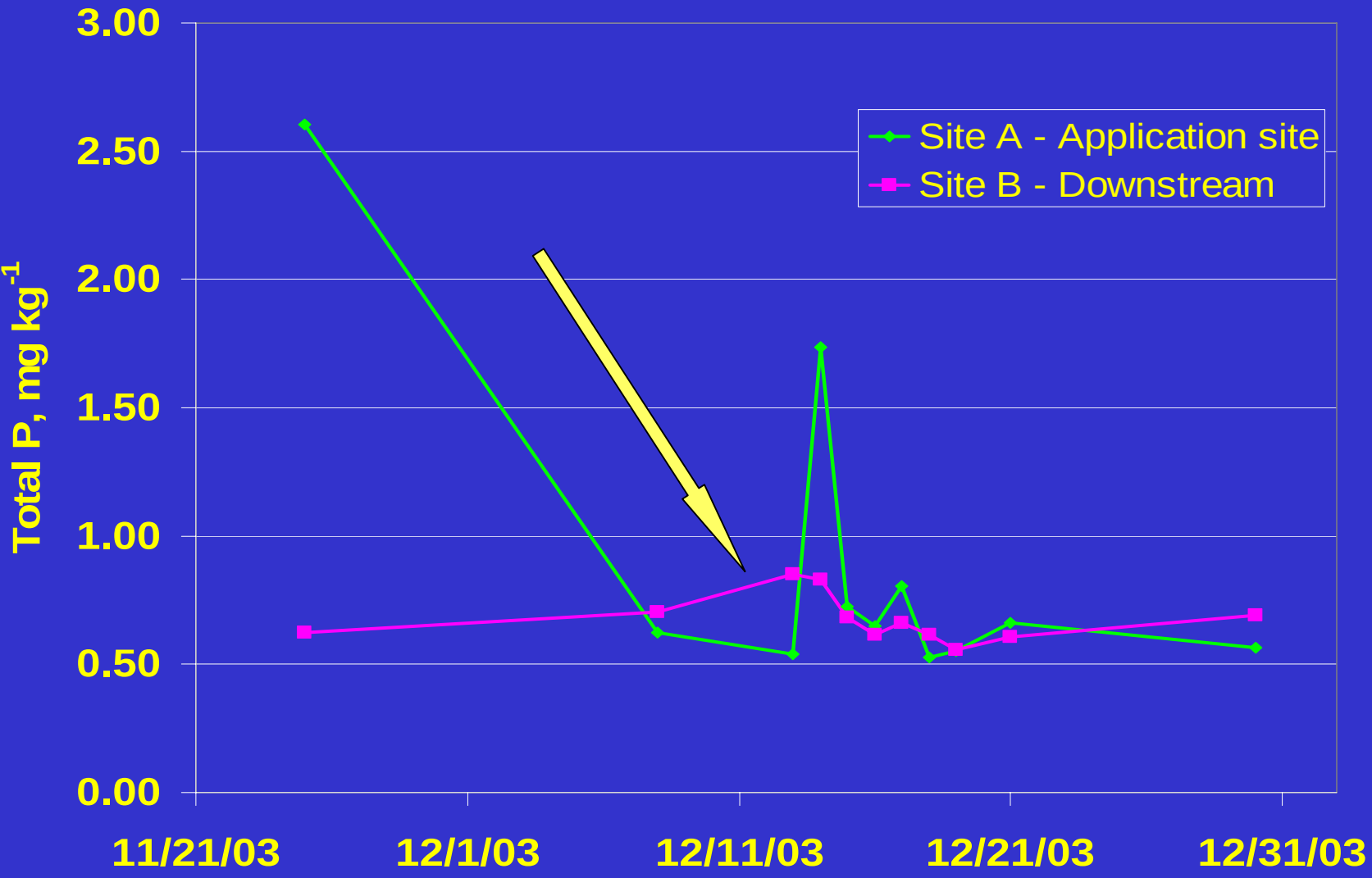
January Application
NH_4-N



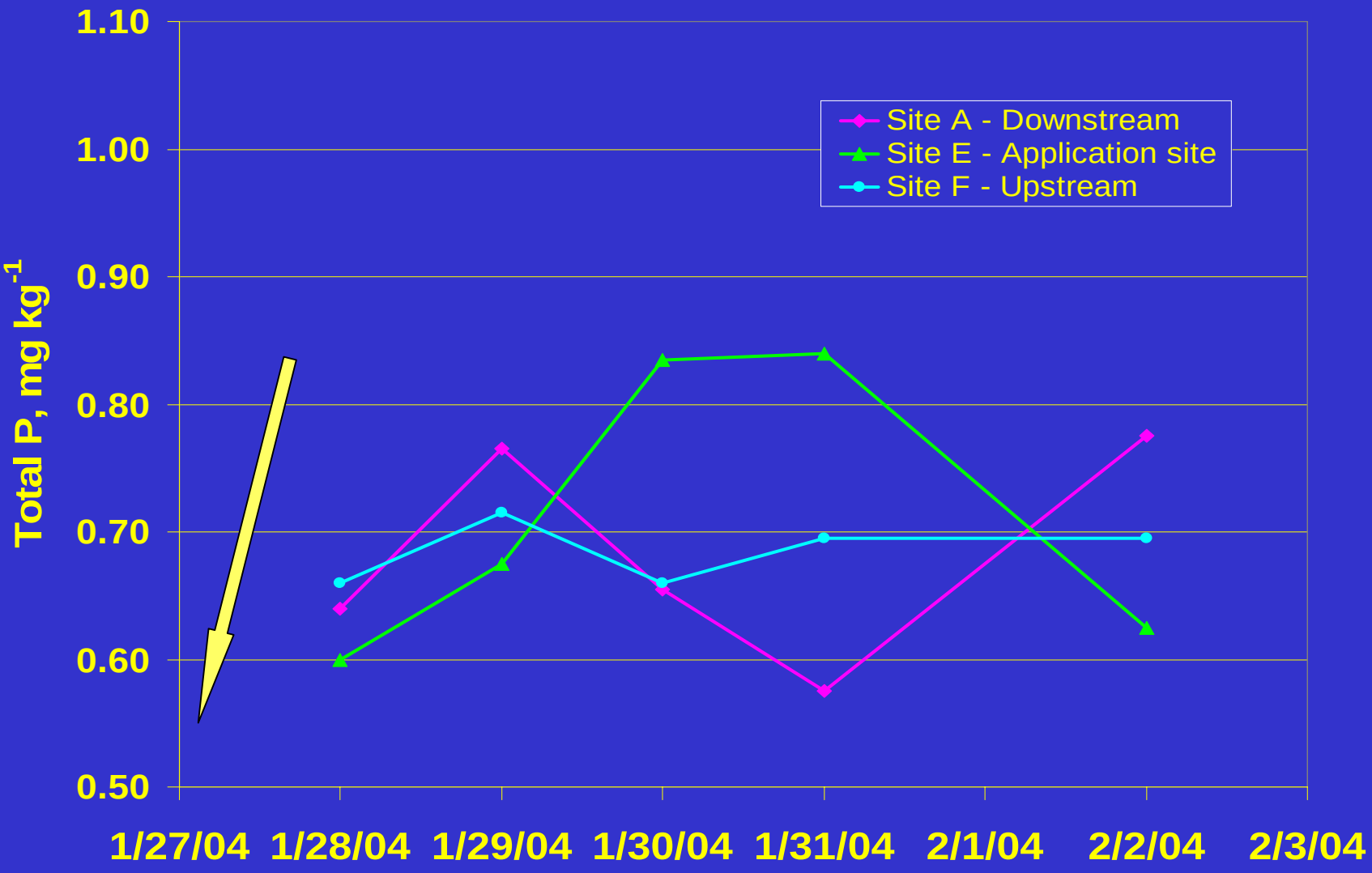
Phosphorus

Total P

December Application
Total P



January Application
Total P



Questions?