



Surface Application of Wastewater – A Mass Balance Approach

by

Clifford B. Fedler

Texas Tech University

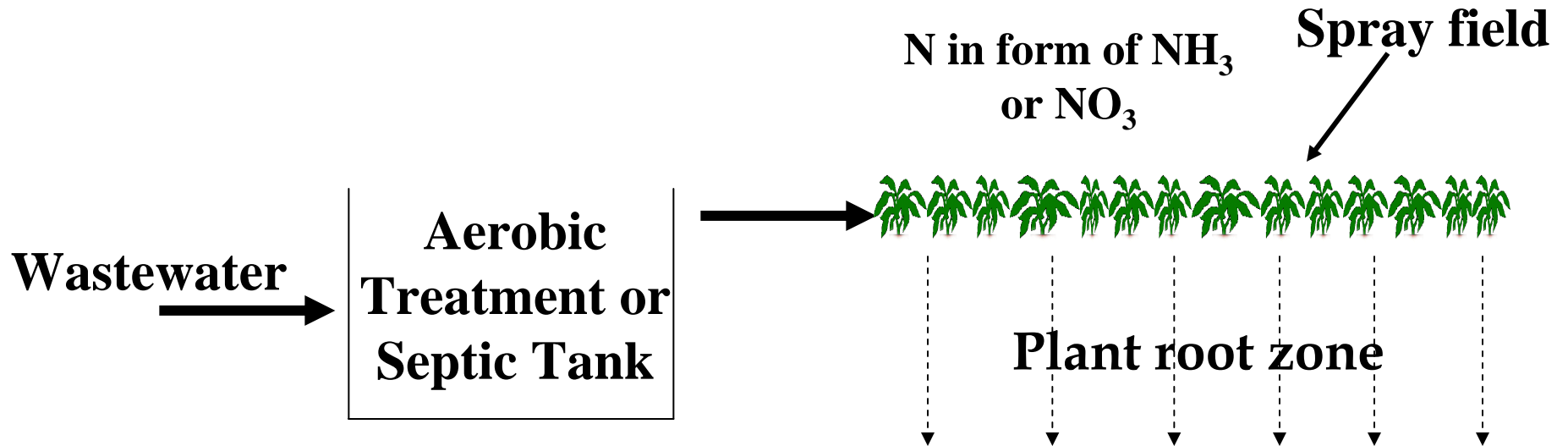
March 4, 2008

Clifford.fedler@ttu.edu



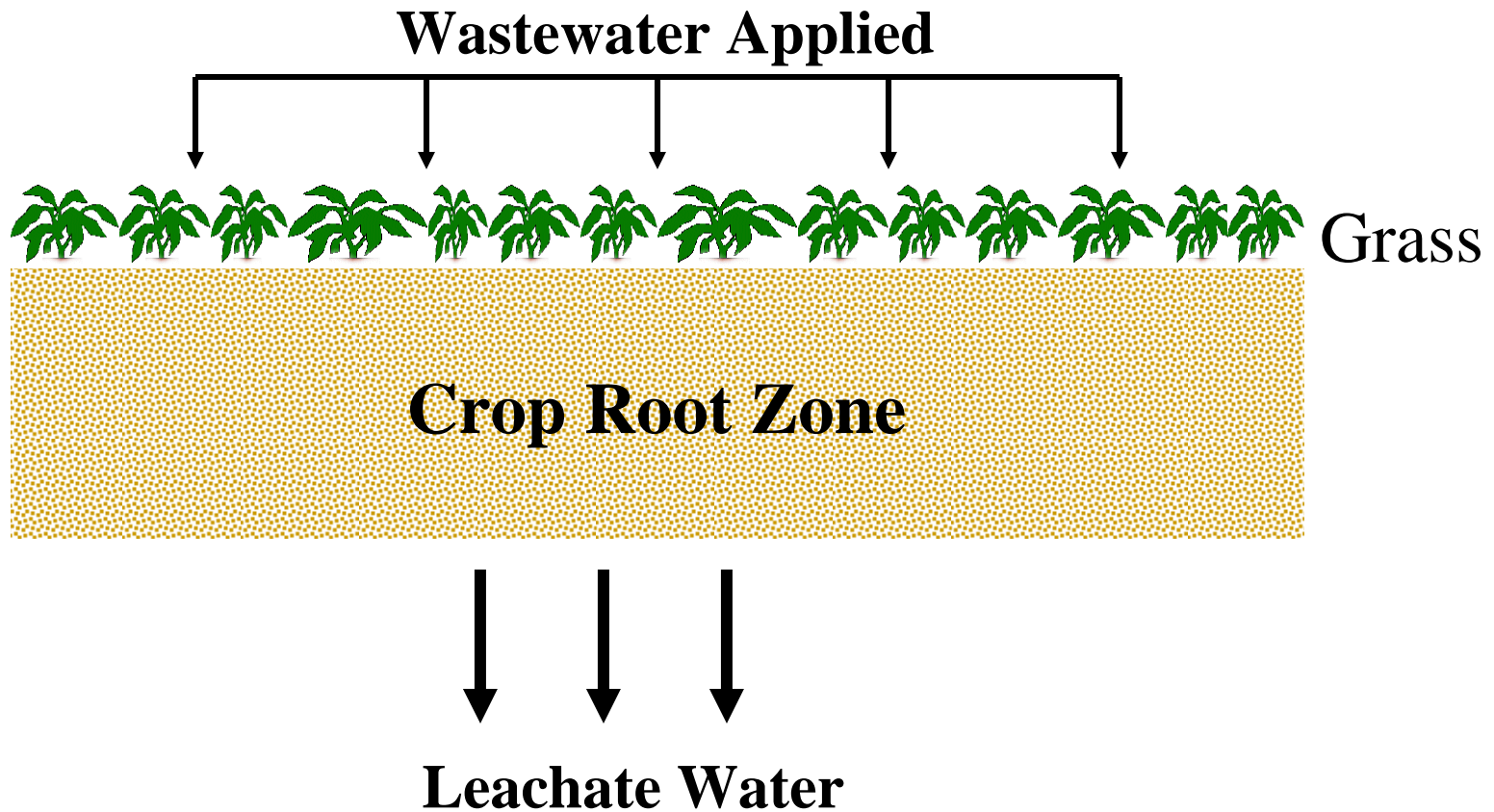


Basic System



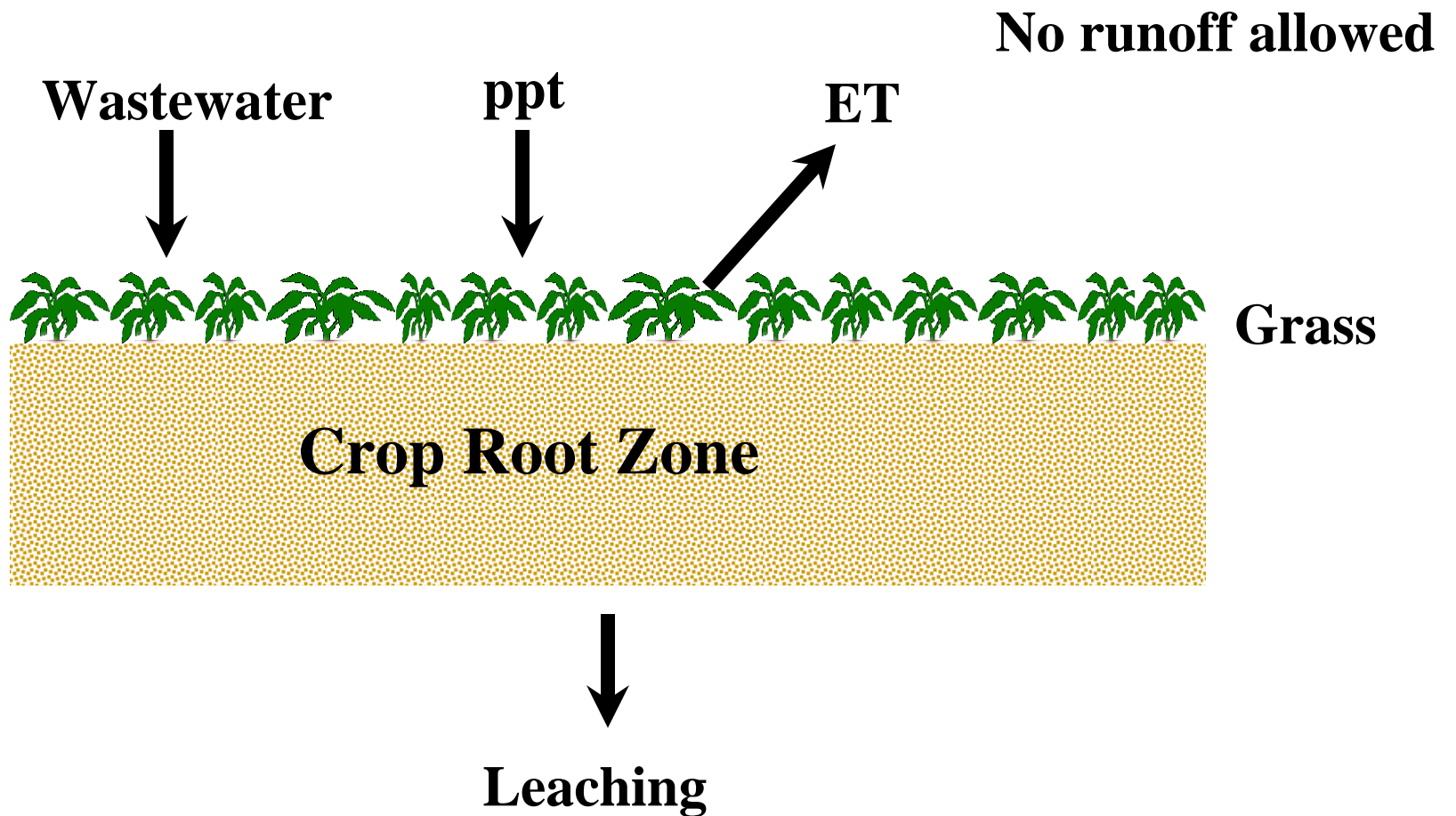


Surface Application System



Design Components

Water, Nitrogen & Salt Balance





What affects the Water Balance?

Wastewater application

Evapotranspiration (crop)

Precipitation

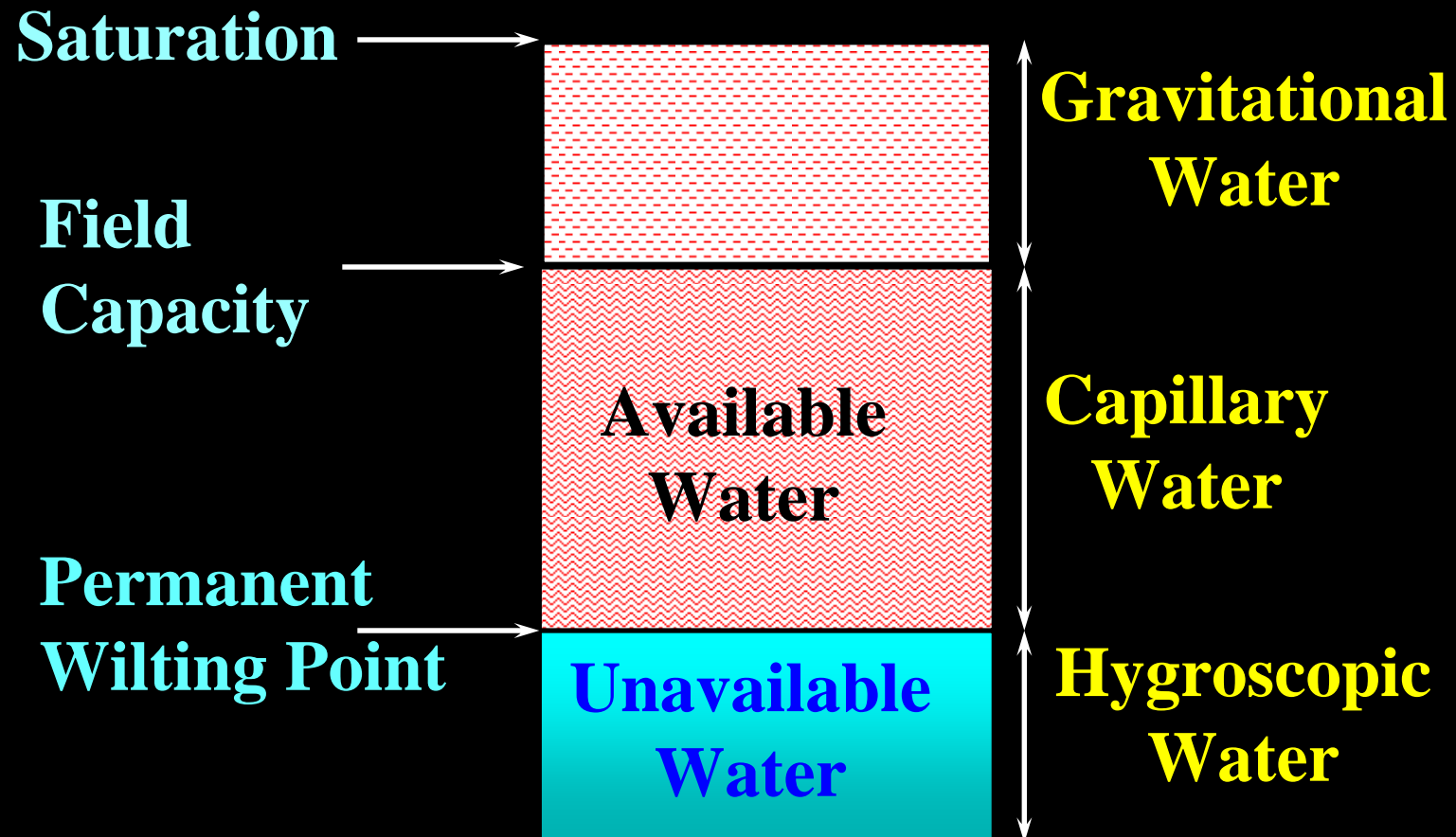
Soil water storage

Leaching

Runoff

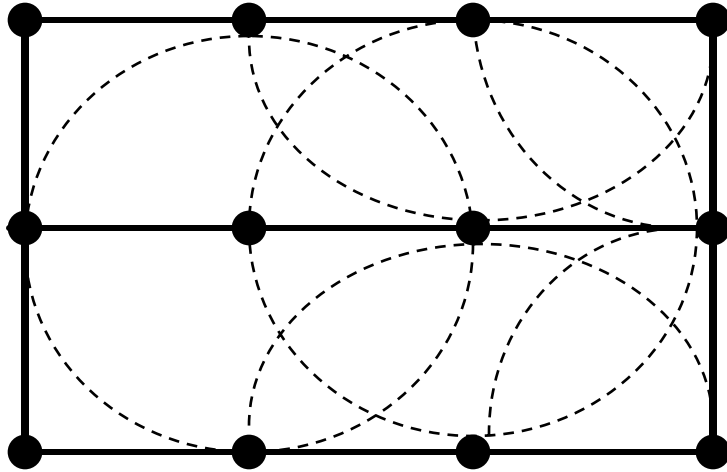


The Soil-Water System

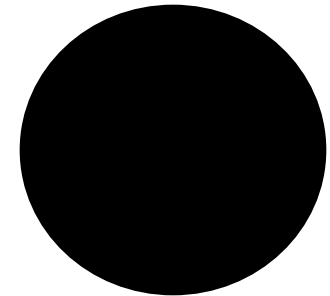
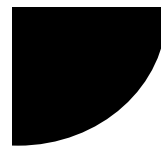
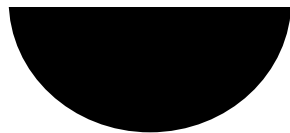
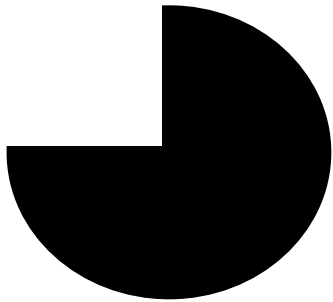
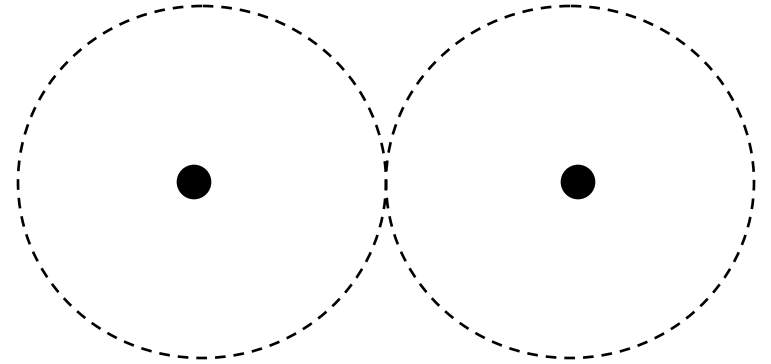




Use the Square Block Design With head-to-head overlap

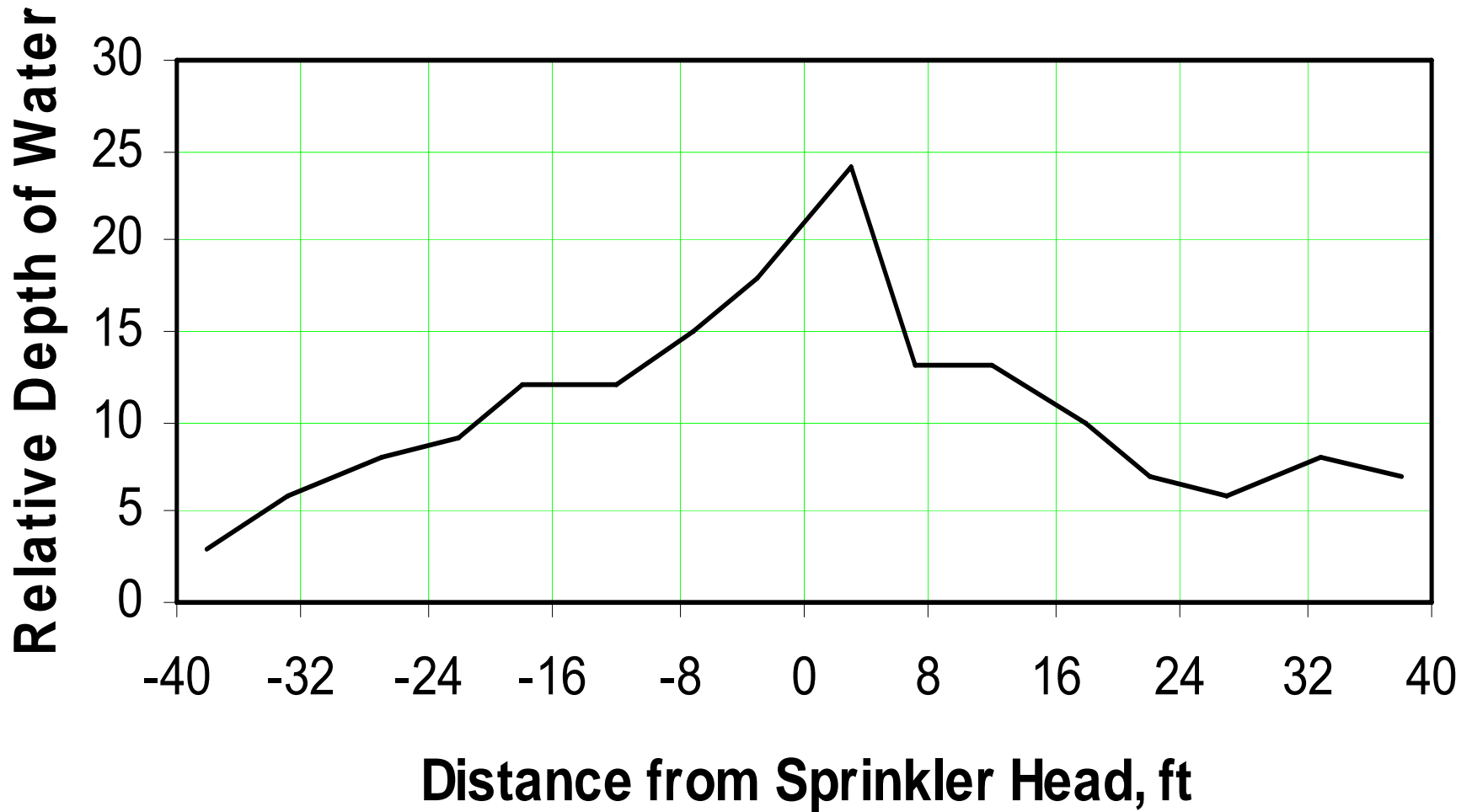


vs.

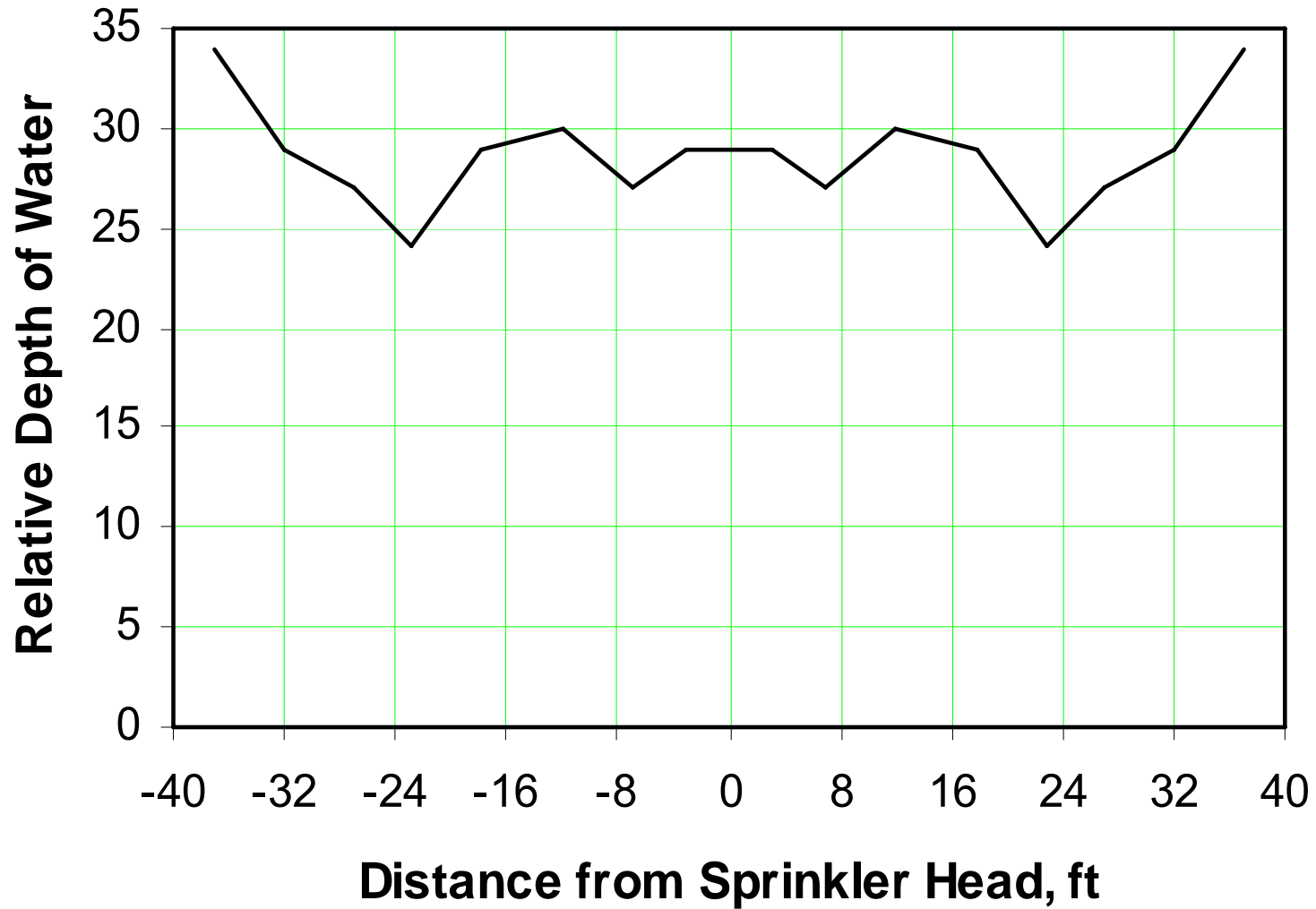


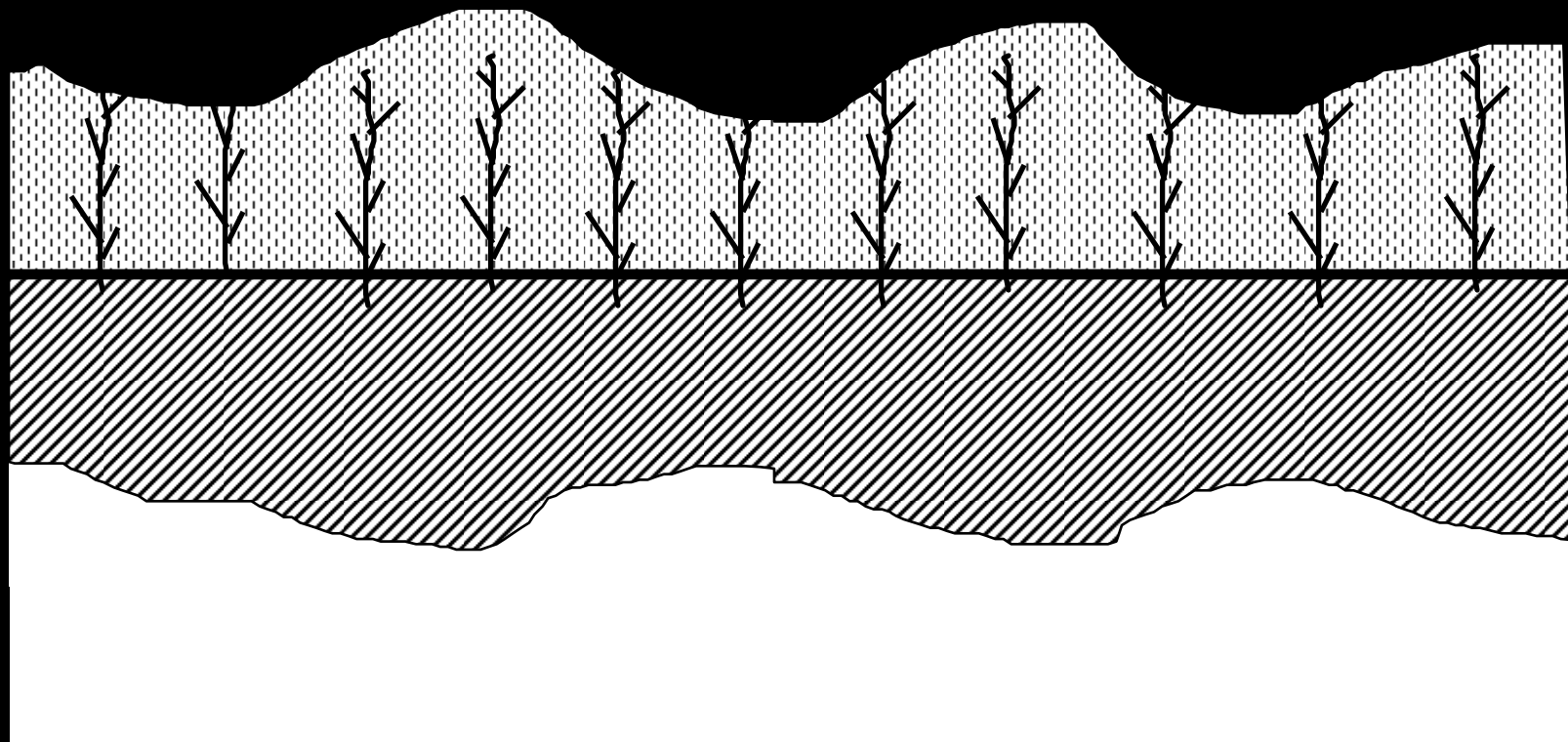


Single Sprinkler Pattern



Overlapping Sprinkler Pattern

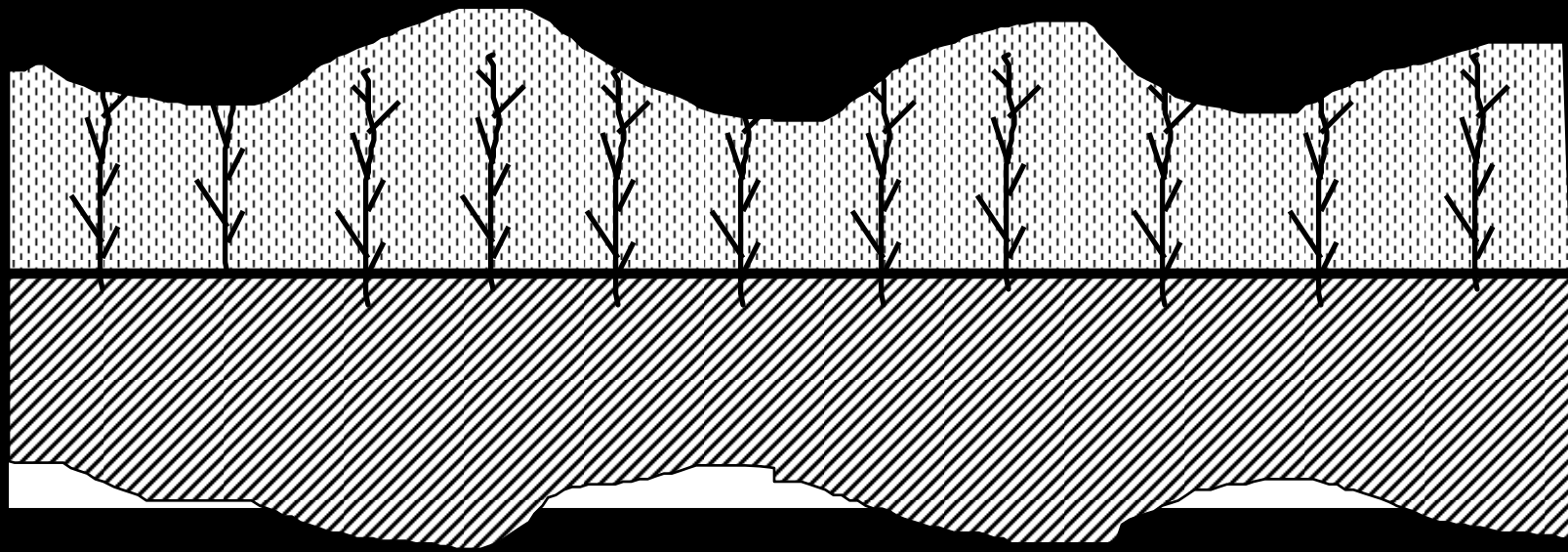




$E_a = 100\%$

$E_s = 50\%$

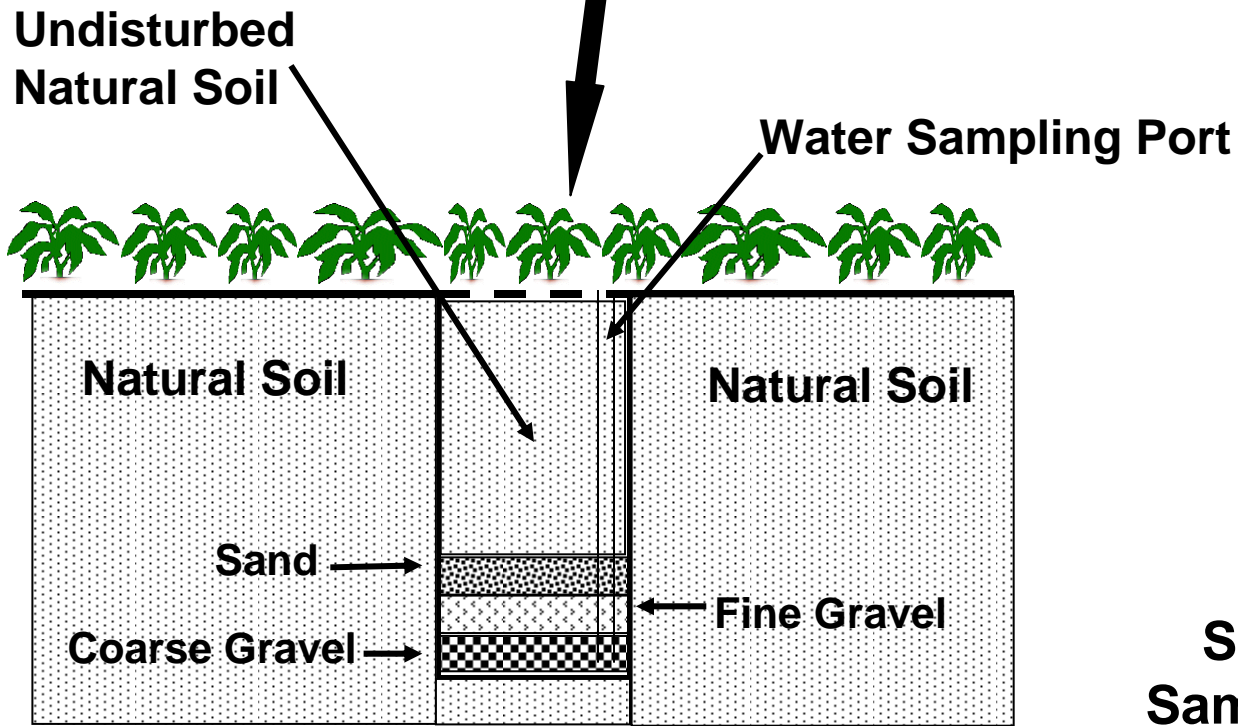
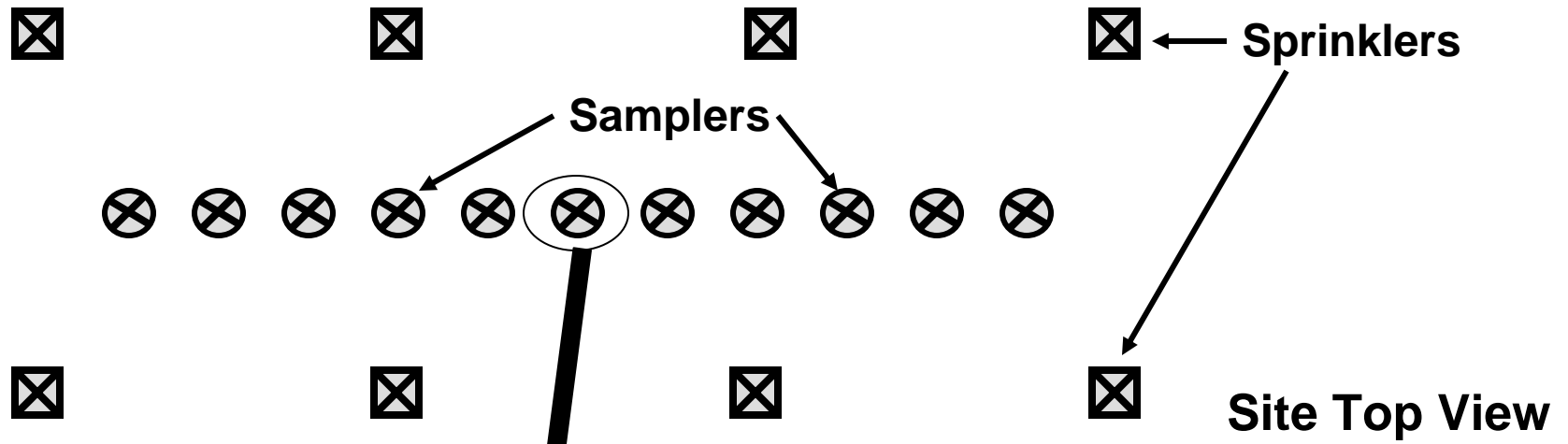
$UCC = 75\%$



$E_a = 90\%$

$E_s = 90\%$

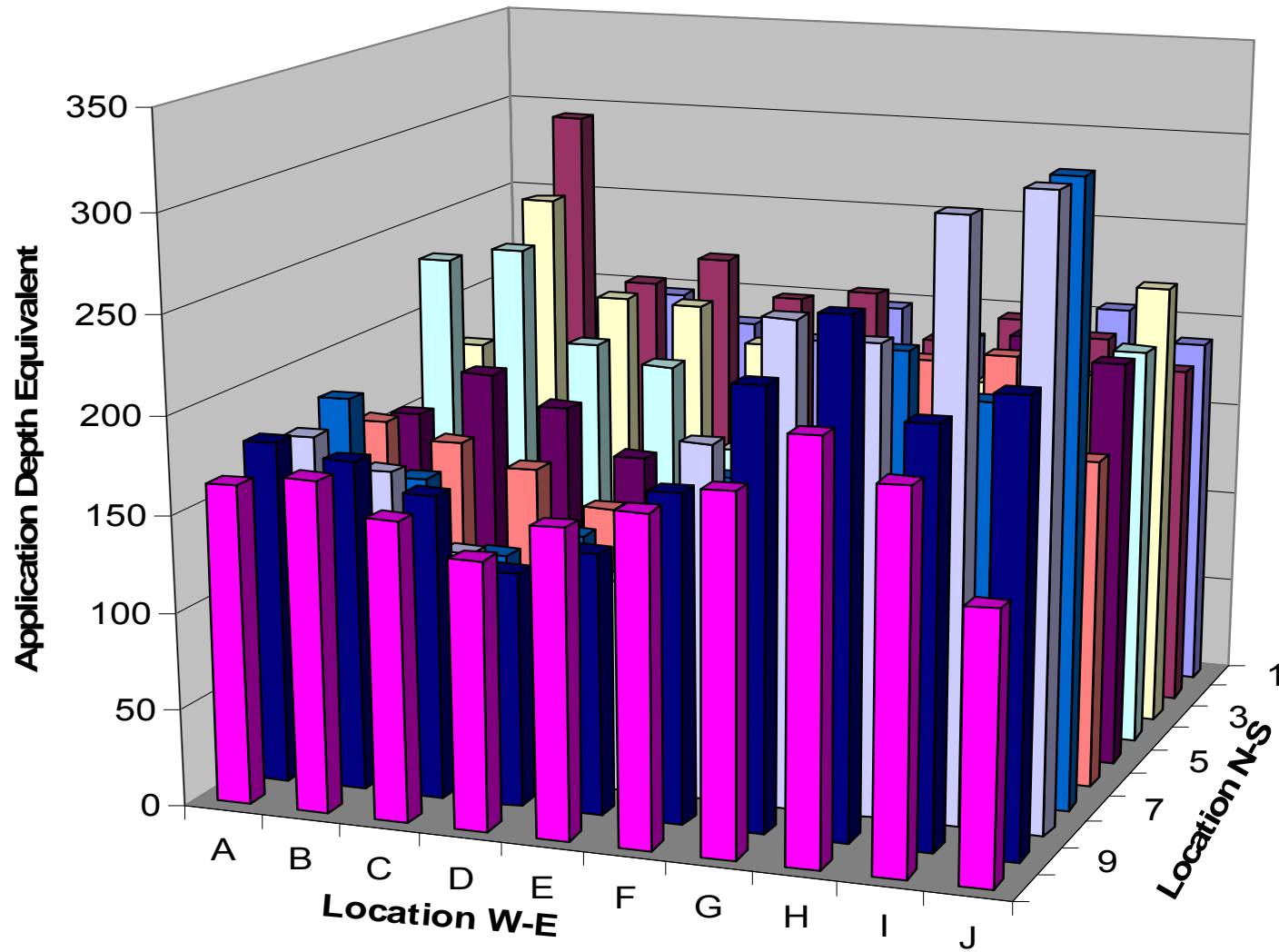
$UCC = 85\%$



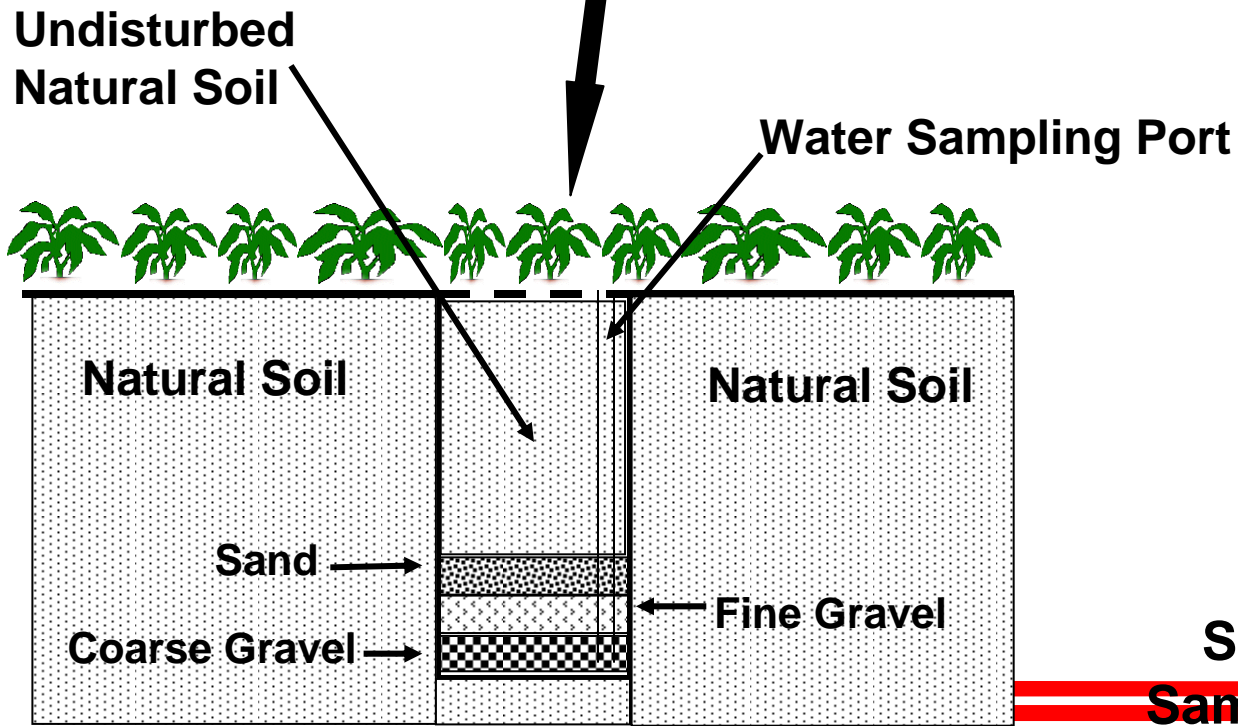
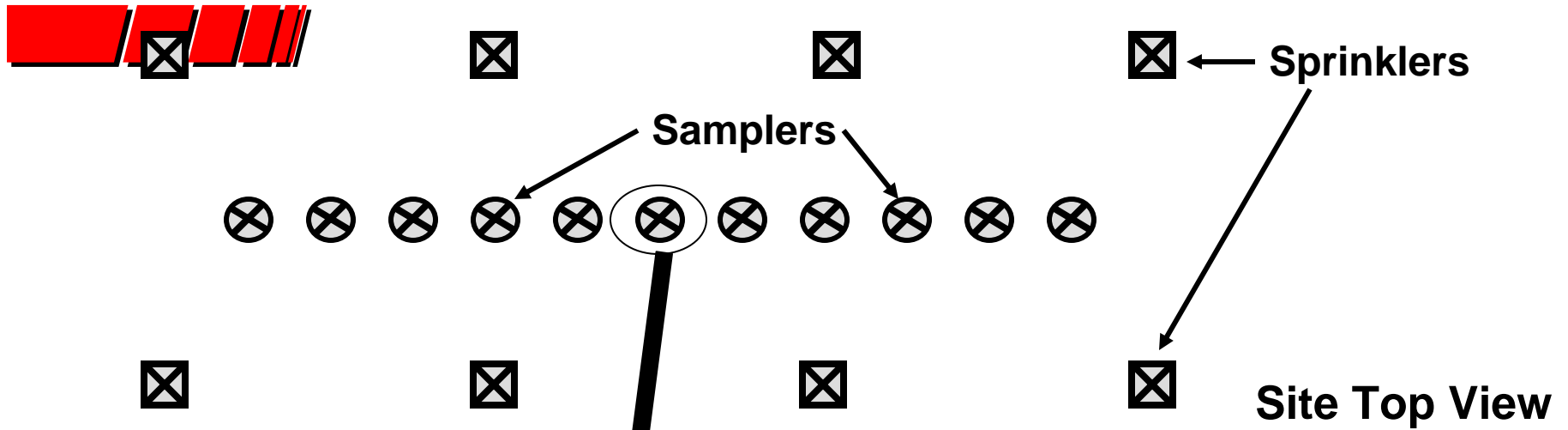


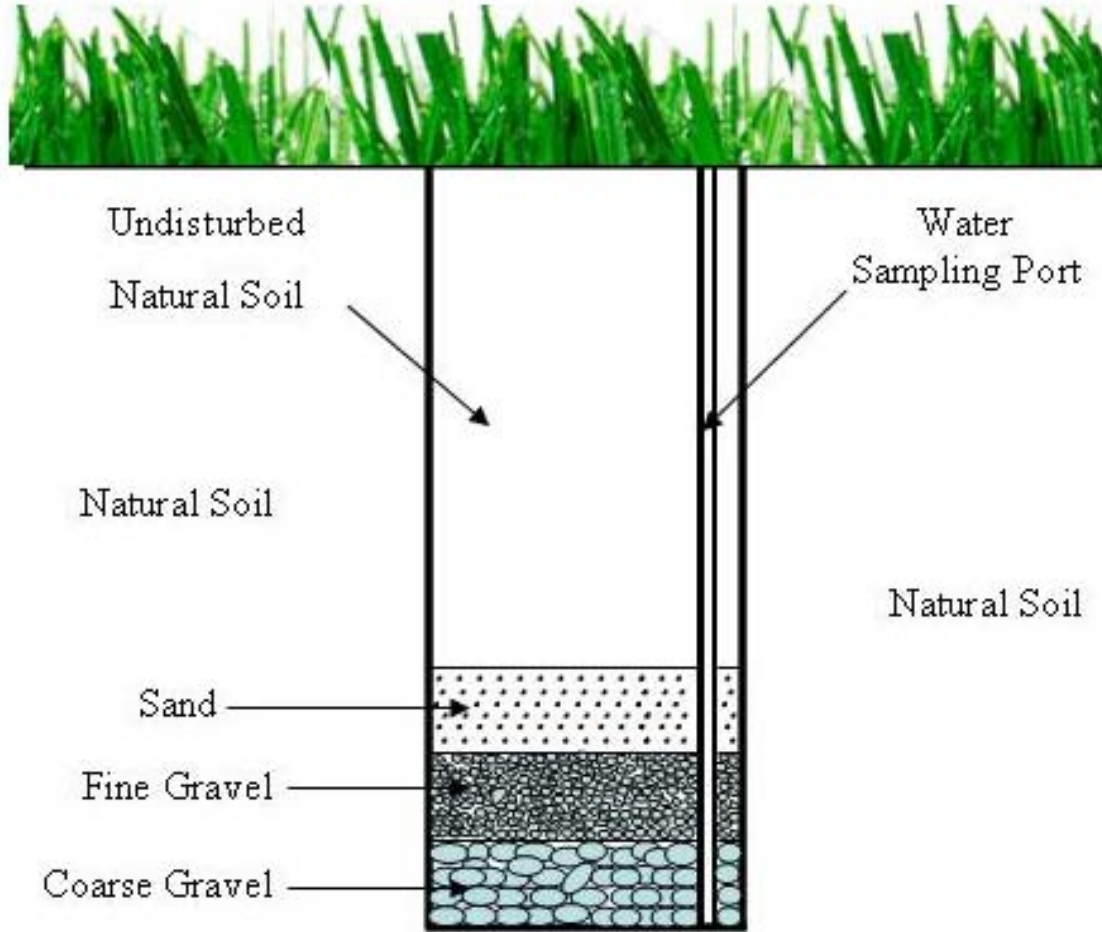


UCC



Seasonal UCC = 82%





1



2



3



4





The core is installed in the sampler.





Final shot of sampler immediately after installation







Sampler a short time after installation.





Duan and Rishu collecting water samples





**Midland soil sampler
installed at the TTU site**





Houston black clay soil sample



Wastewater

Water

Salt

Nitrogen

Water

Nitrogen



Water

Salt

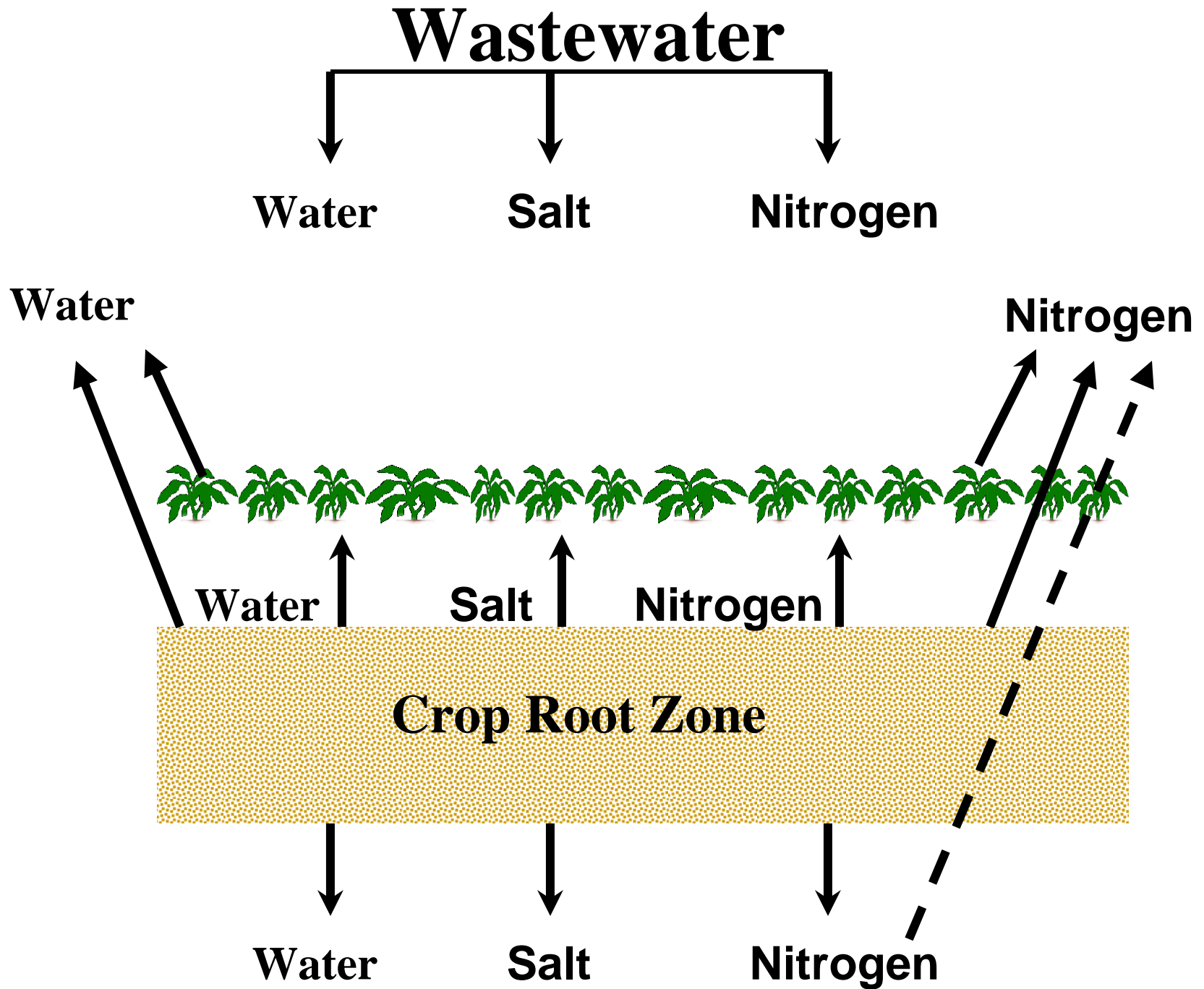
Nitrogen

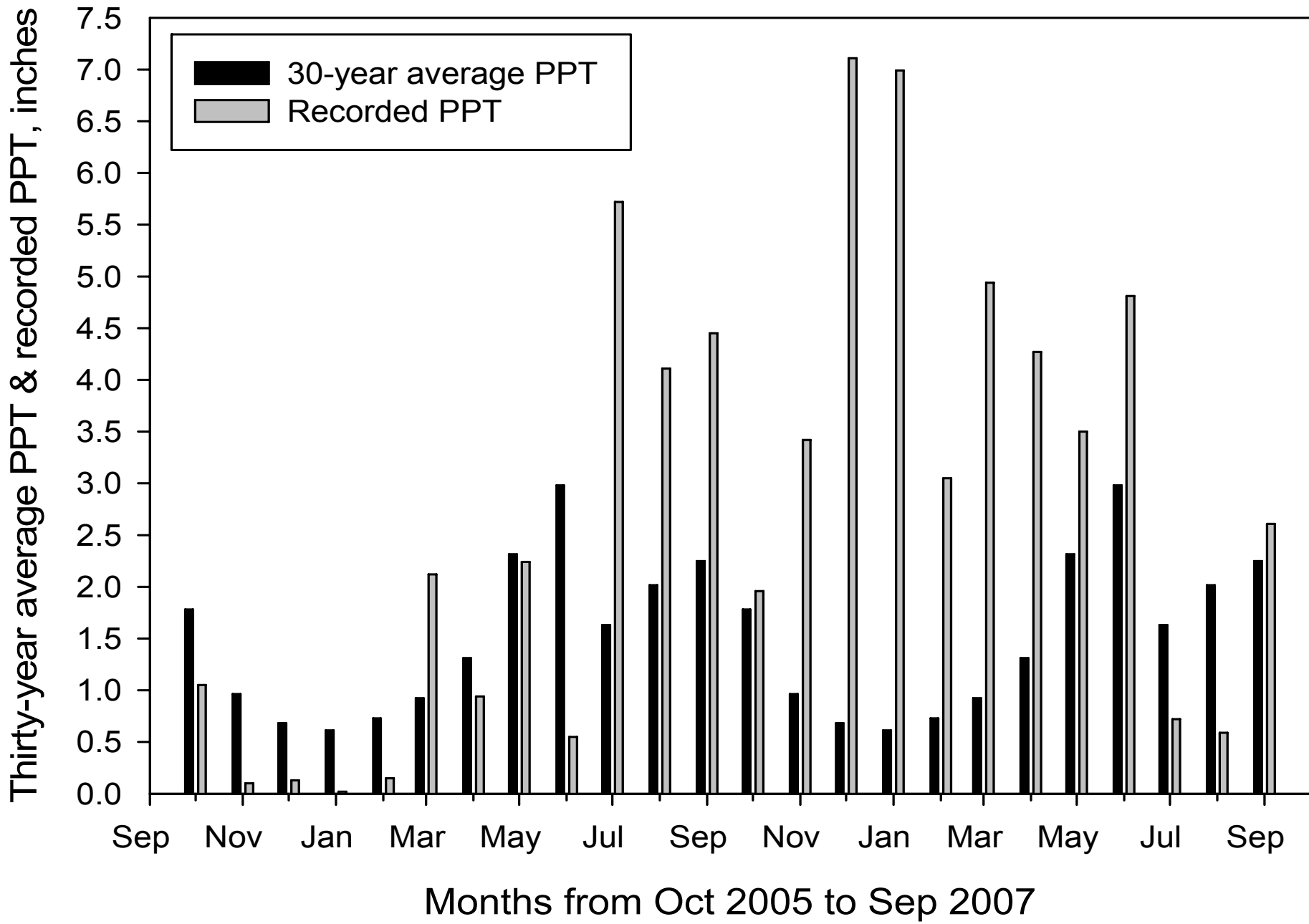
Crop Root Zone

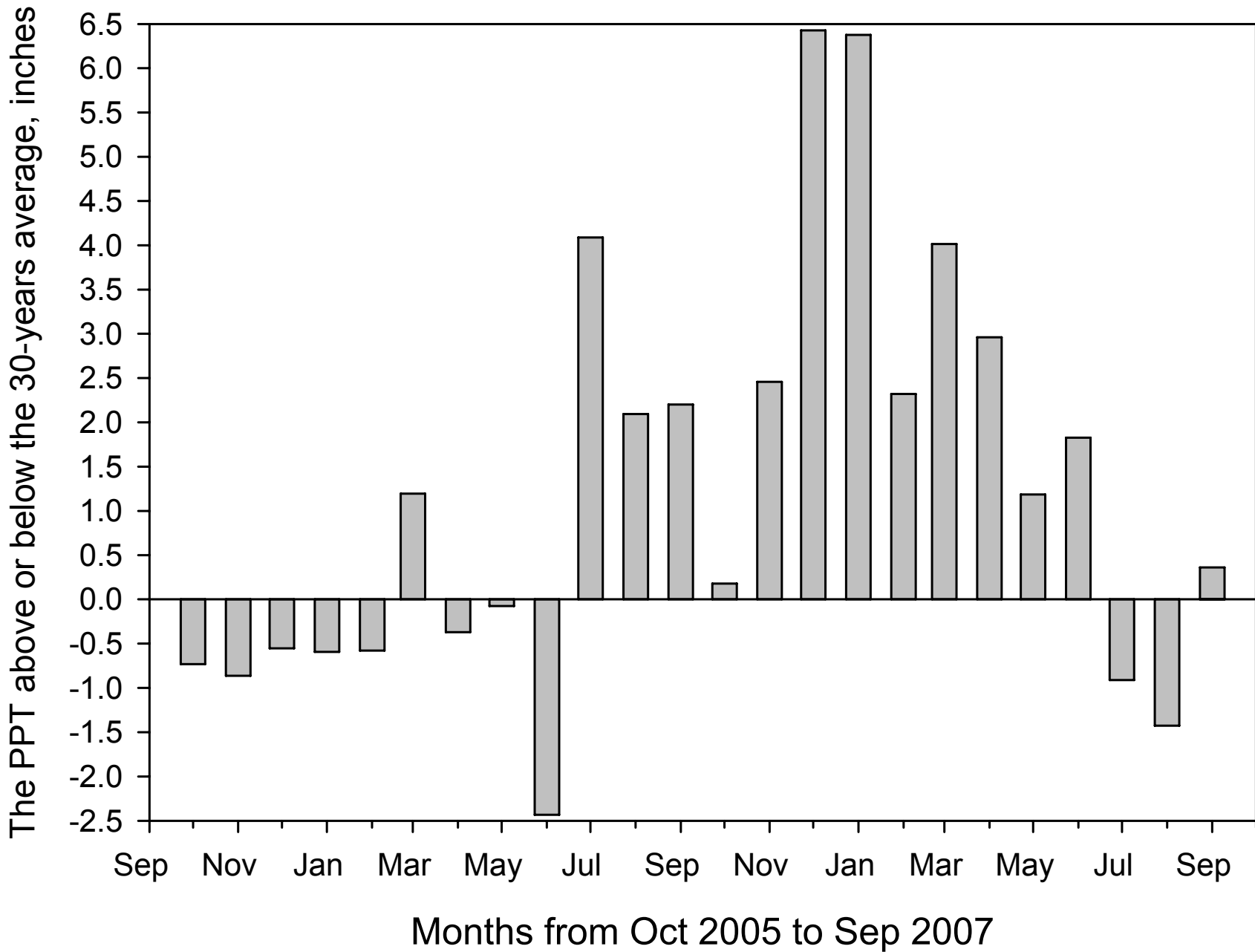
Water

Salt

Nitrogen

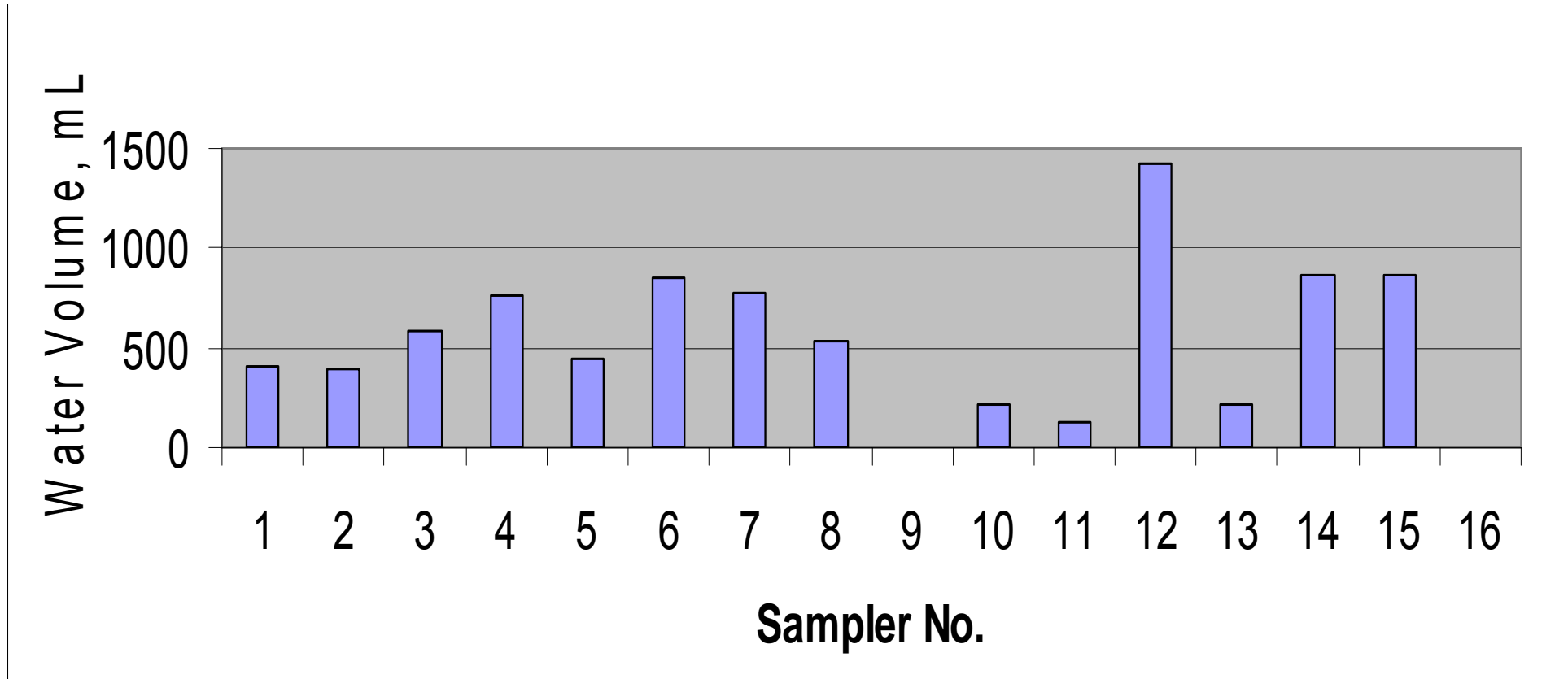






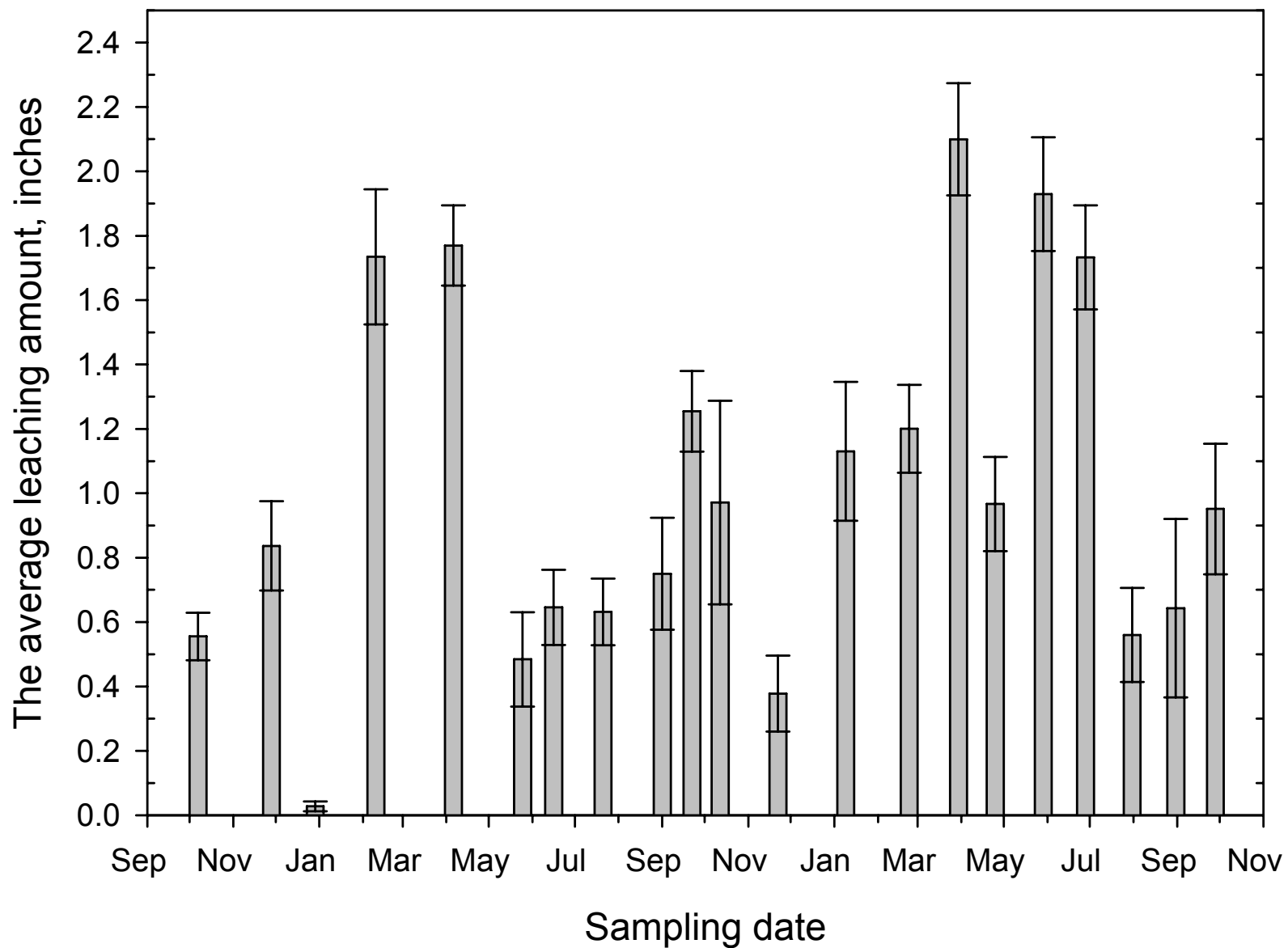


Spatial Change of Leach Water Volume in Leach Water

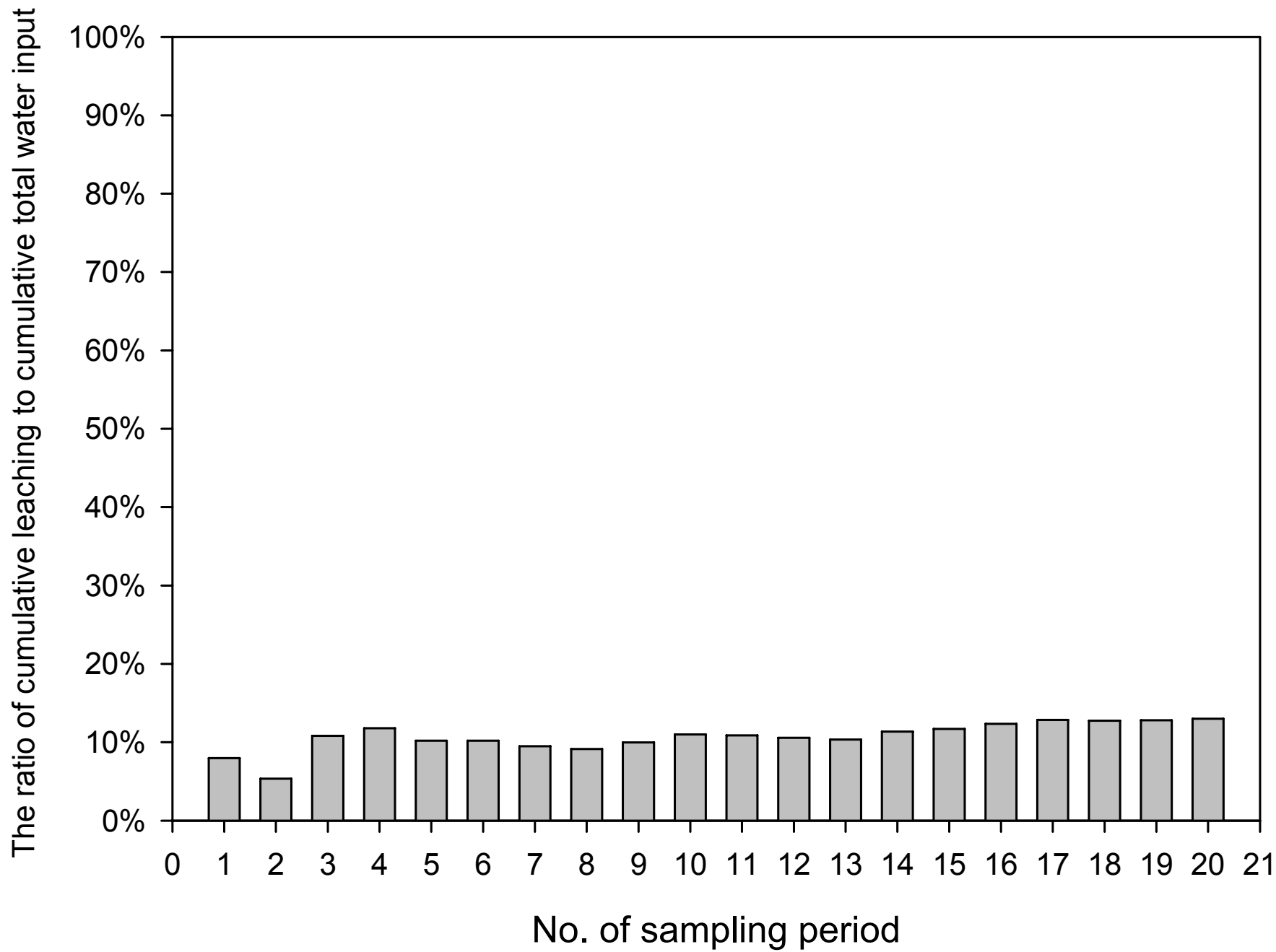


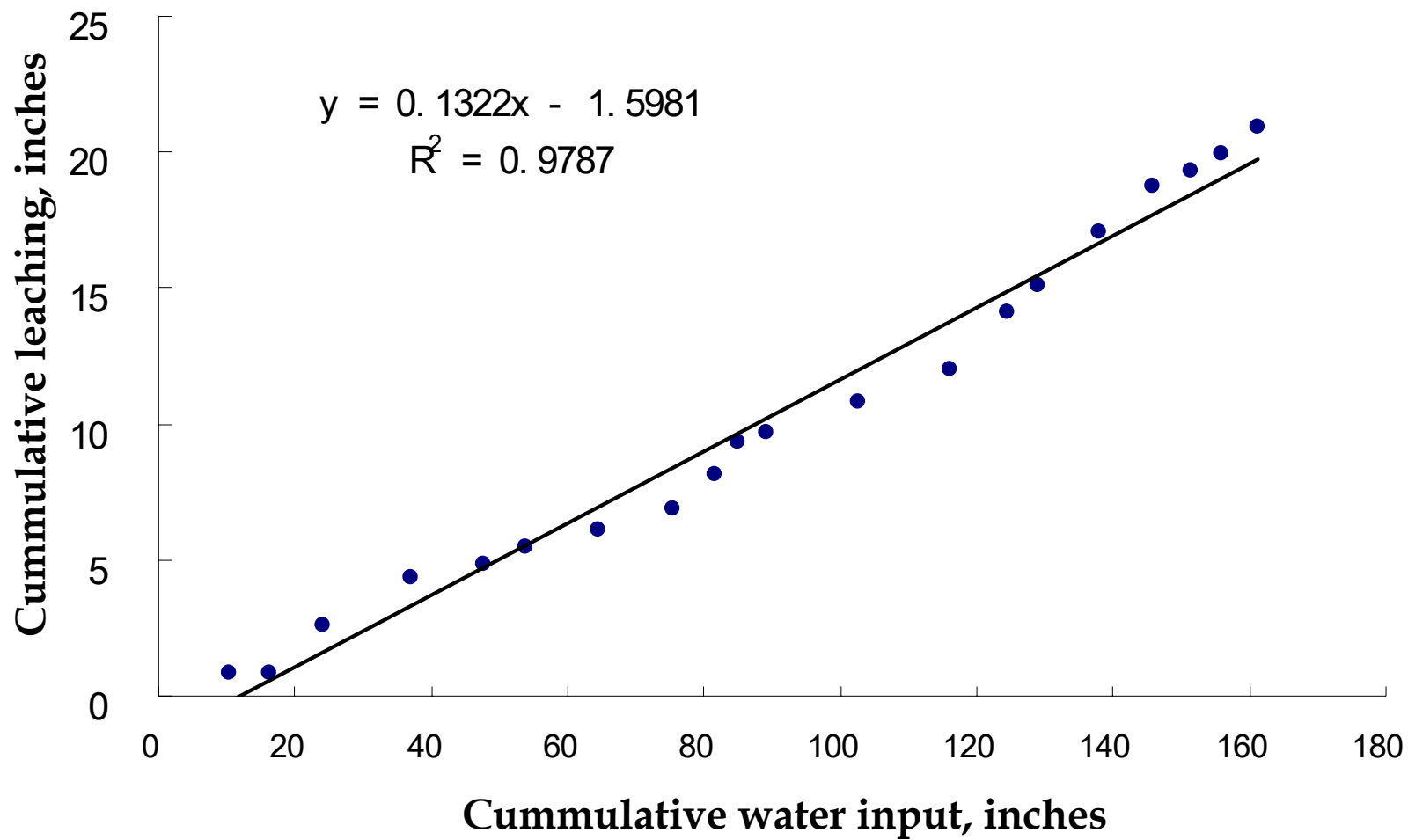
Irrigation+PPT=3603 mL between May 25th, 2006 to June 16th, 2006





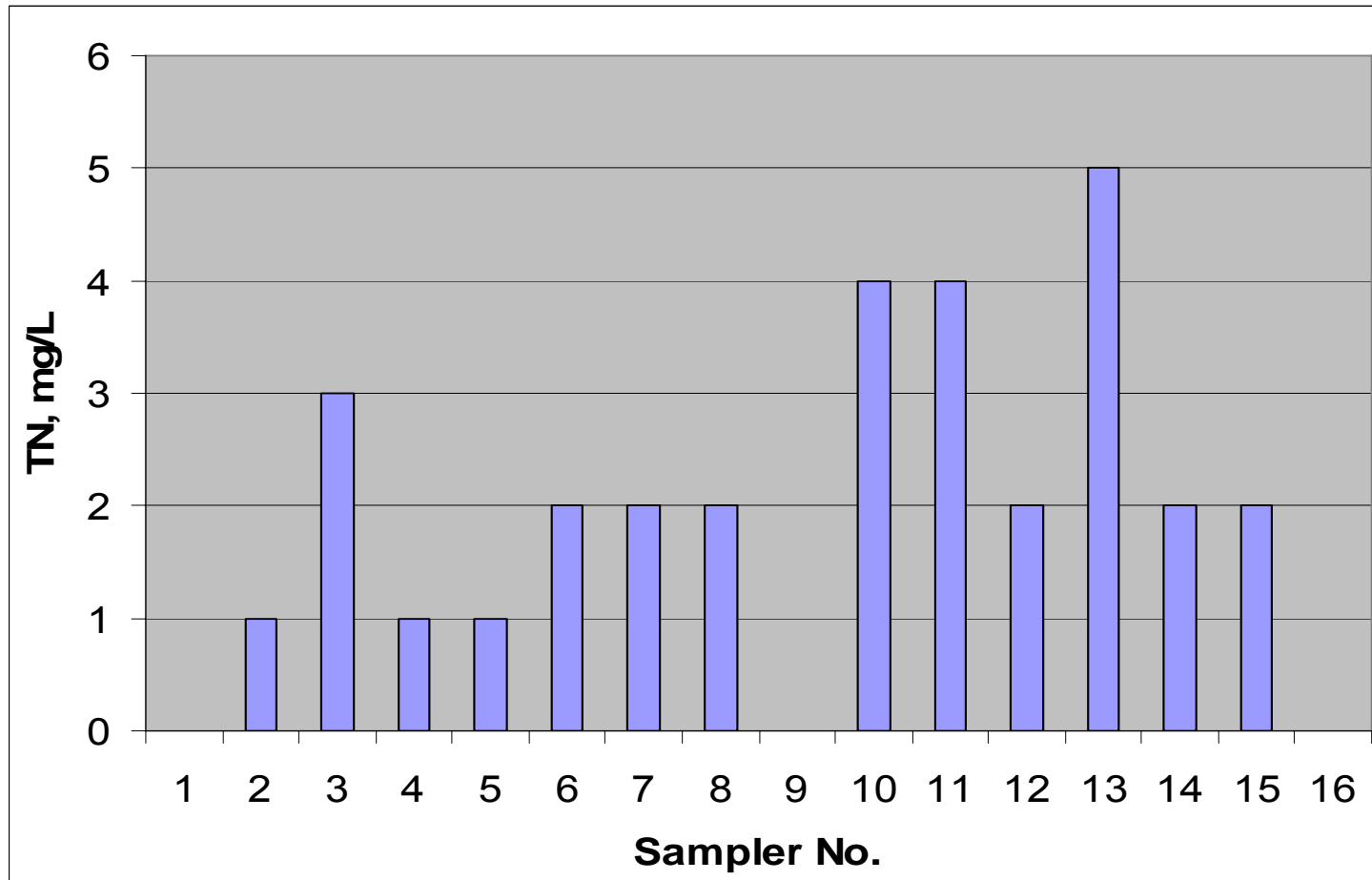
Average leaching for each sampling period from Oct 2005 to Sept 2007 \pm one standard error







Spatial Change in Total Nitrogen in Leach Water

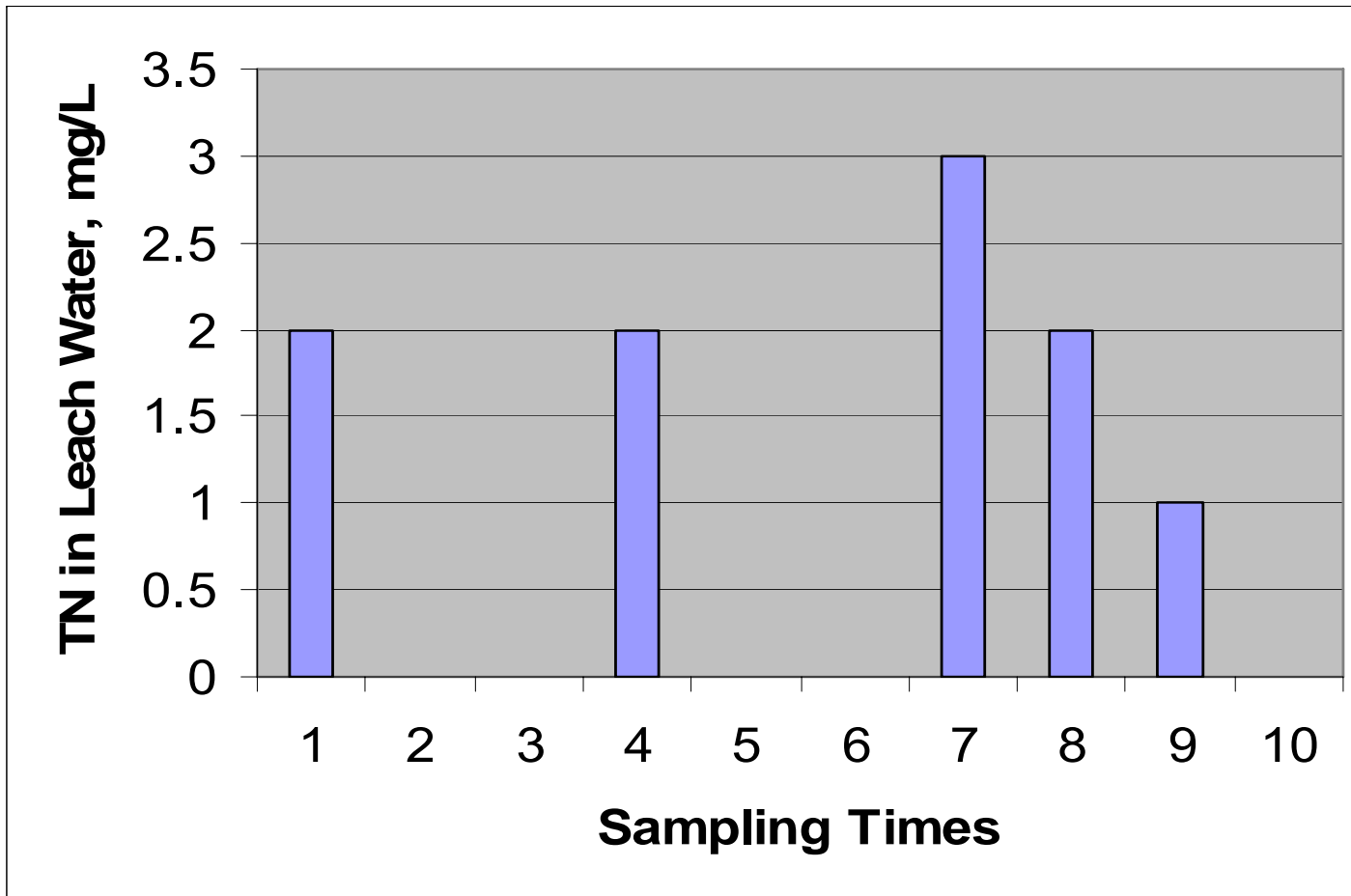


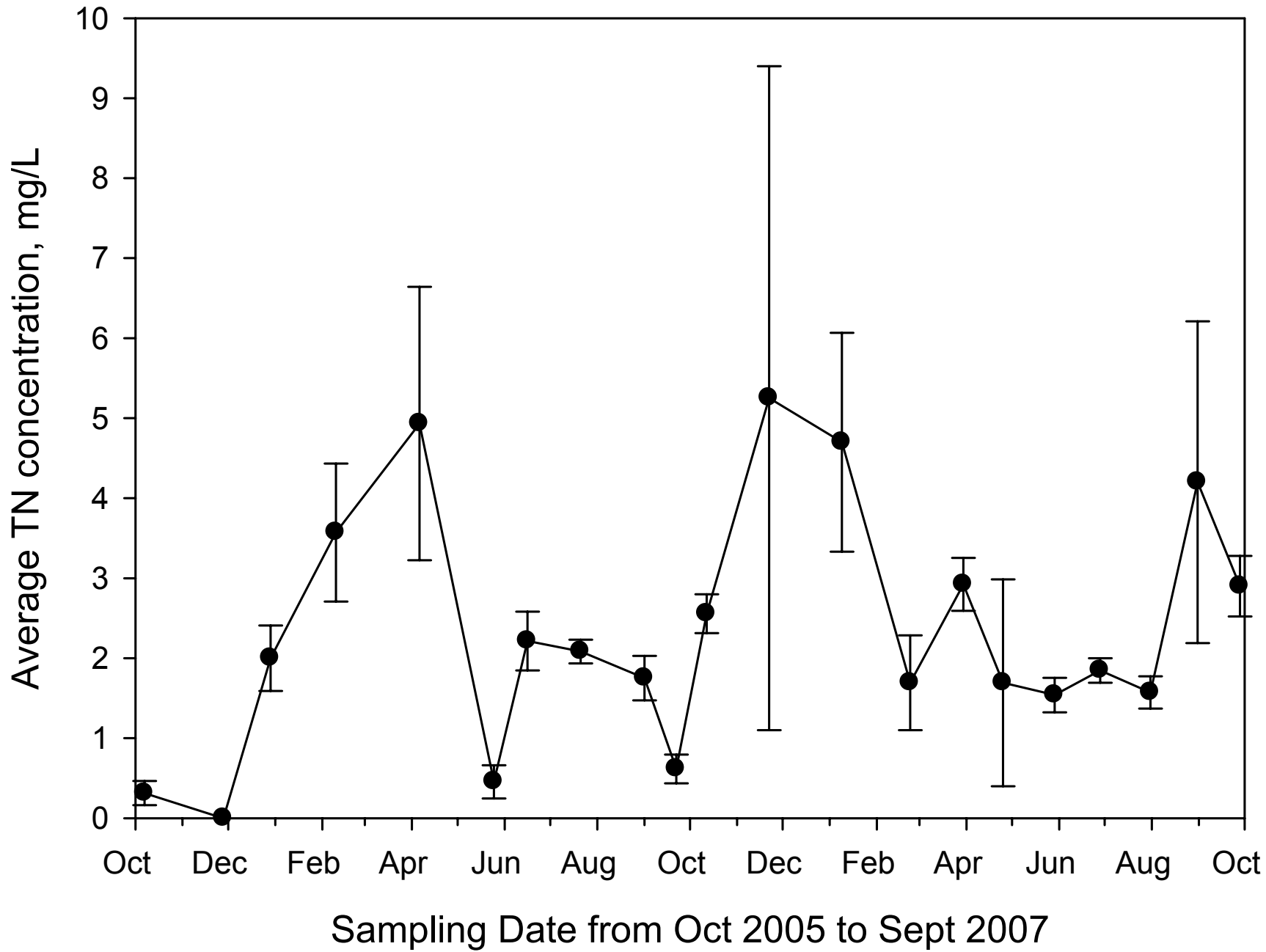
Average TN in Wastewater is 16.5 mg/L

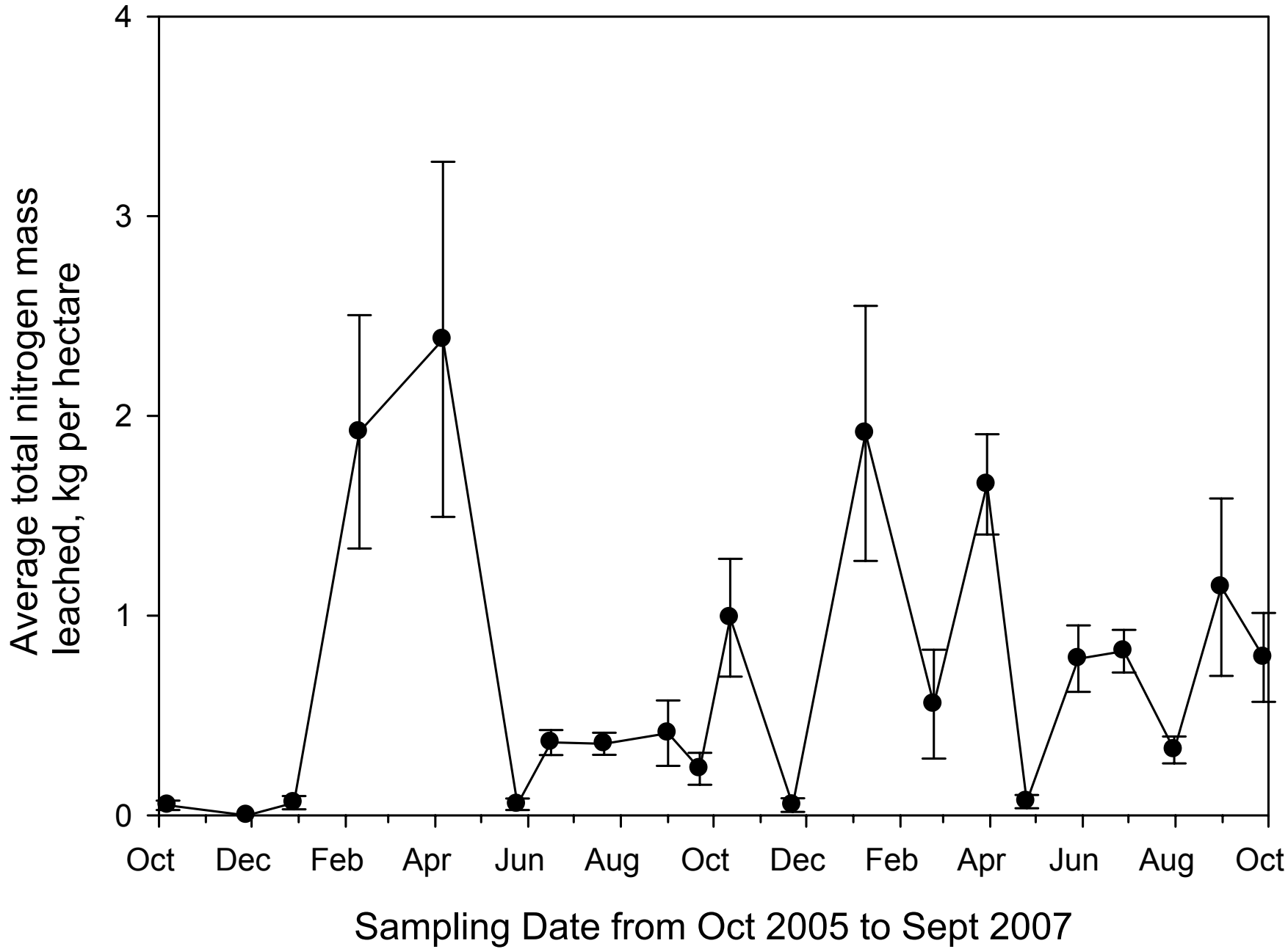


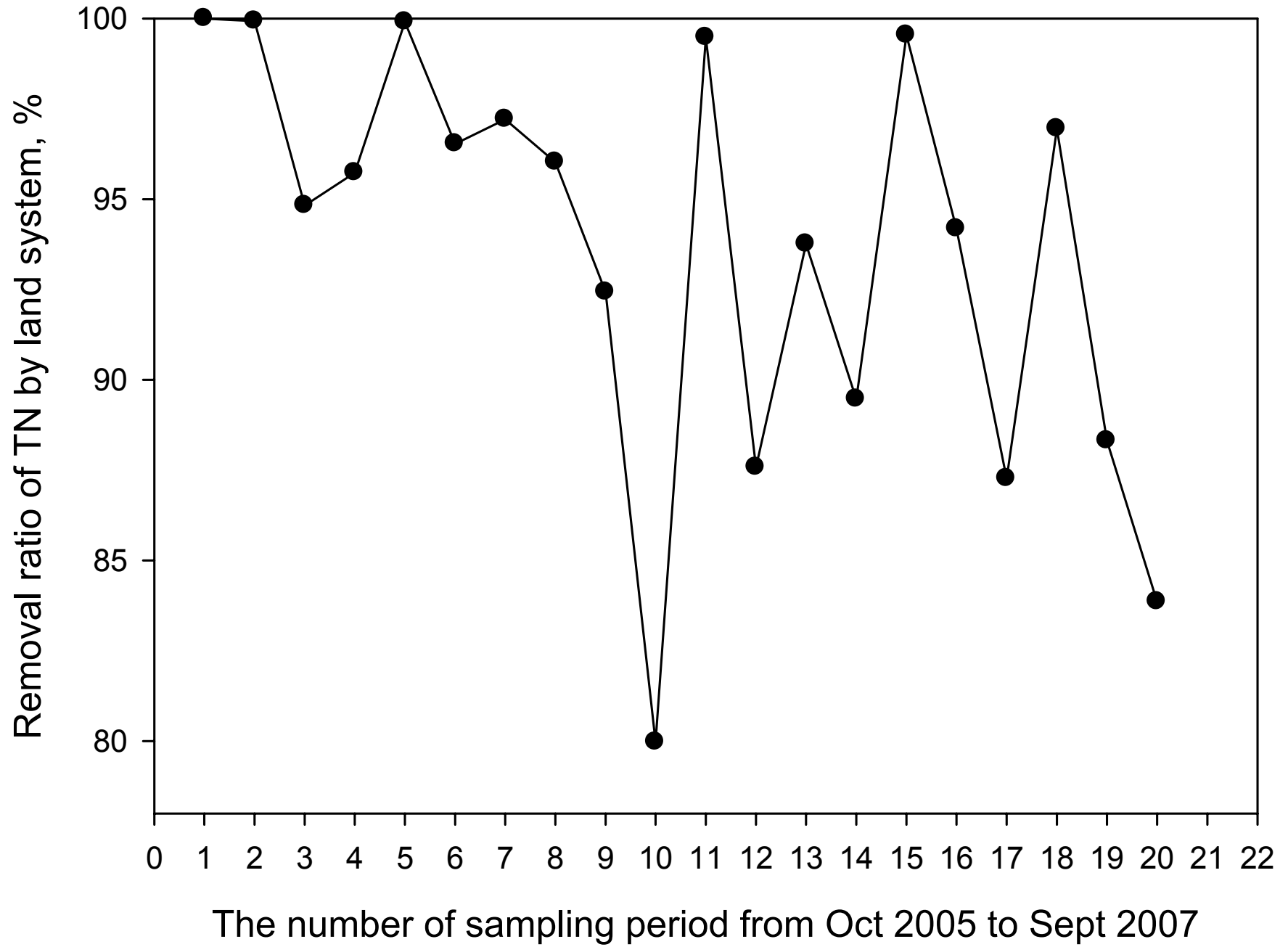


Temporal Change in Total Nitrogen in Leach Water



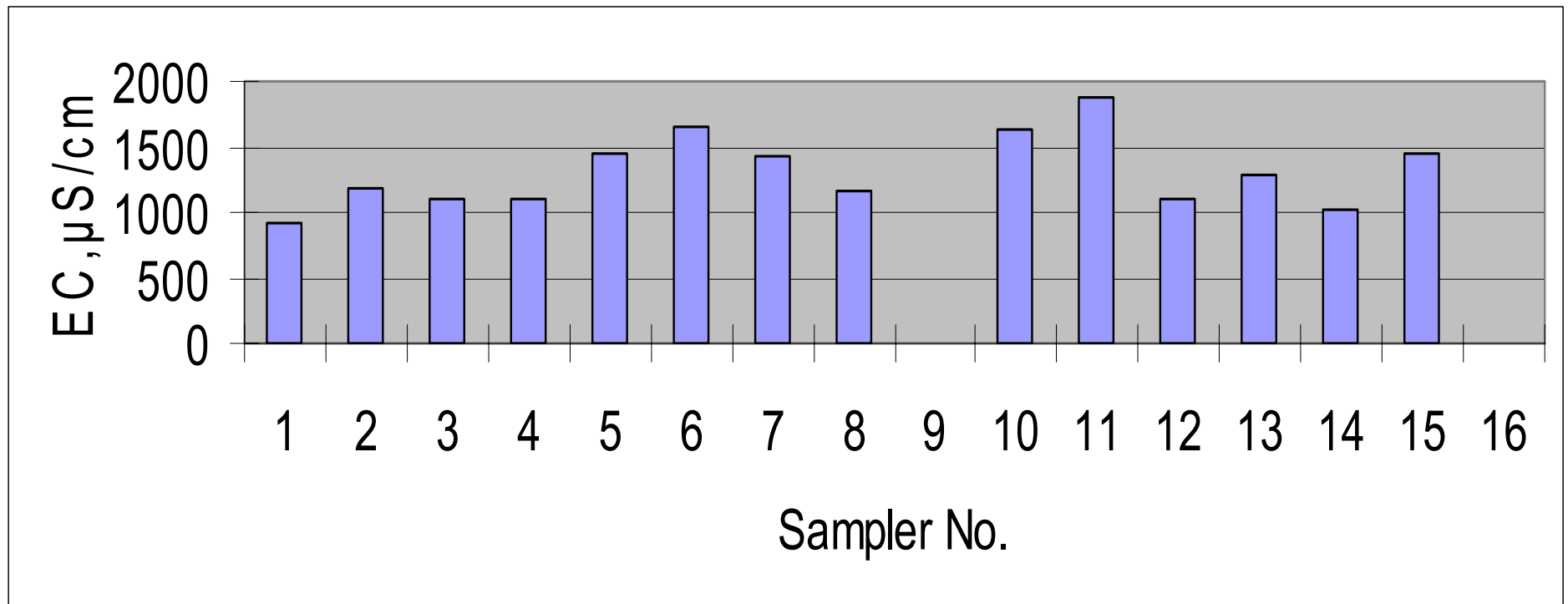








Spatial Change in Salinity in Leach Water



Average Salinity in Wastewater is 933.5 $\mu\text{S}/\text{cm}$

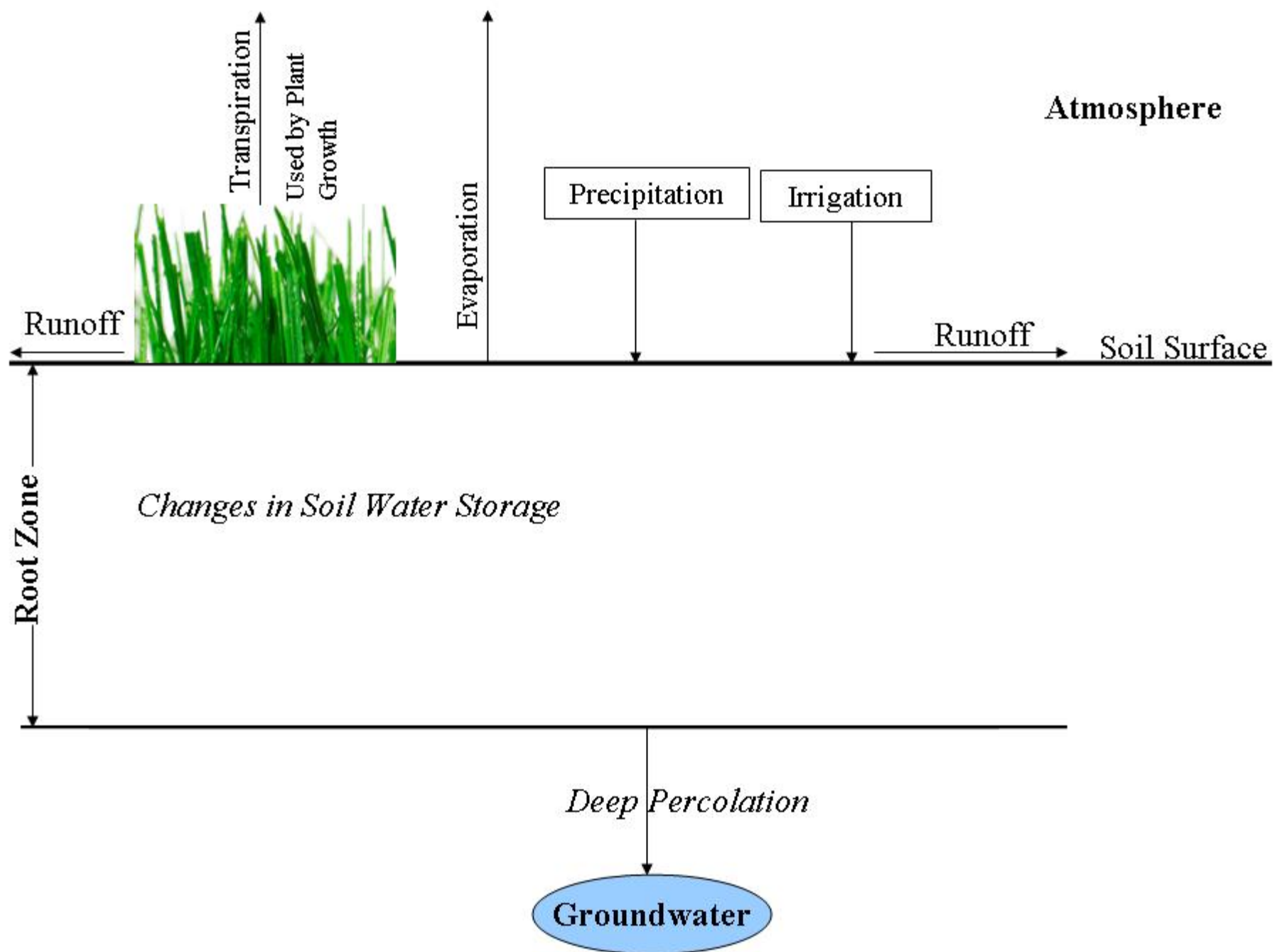




Accumulation of Salts

- **Upward movement of water**
 - high evaporative demand in arid and semi arid regions
 - insufficient rainfall to leach salts
- **Poor drainage**
 - salts must be leached from the root zone to prevent their accumulation





OSSF Surface Application System

Principle Design Parameters:

Evapotranspiration/Evaporation

Deep Percolation/Leaching

Soil Properties

water intake rate

soil water storage

Crop Selection

nutrient uptake/removal

active growth period

Wastewater Application

Runoff Control

Effect of PPCP's and bacteria movement

Thank you for your attention

