Winter irrigation of reclaimed wastewater onsite – will pollutants run off?

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Soil is the best onsite wastewater treatment technology

Why?

Discharging Systems

- BOD5
- TSS
- Ammonia
- *E. coli*

Why?

Soils

- BOD5
- TSS
- Ammonia
- *E. coli*
- Total Nitrogen
- Total Phosphorus
- “Emerging Pollutants”

Total Nitrogen

- Leaches in soil
- Plant uptake
- Denitrification

Total Phosphorus

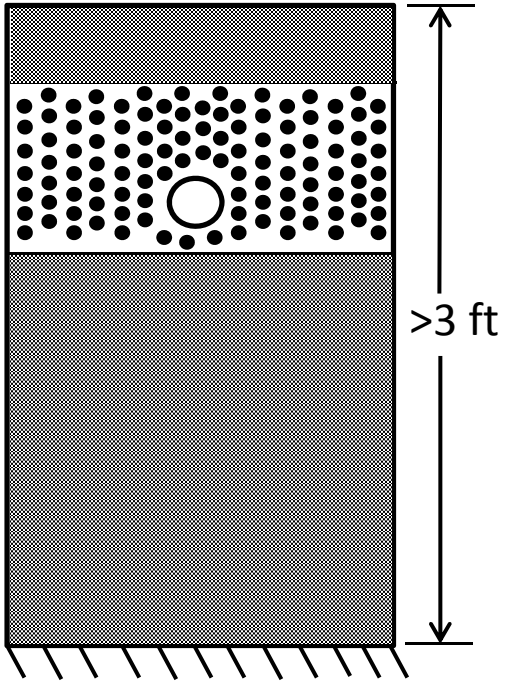
- Plant uptake
- Soil chemistry

“Emerging Pollutants”

- Example – Pharmaceuticals
- Binding with soil humic material
- Microbial degradation

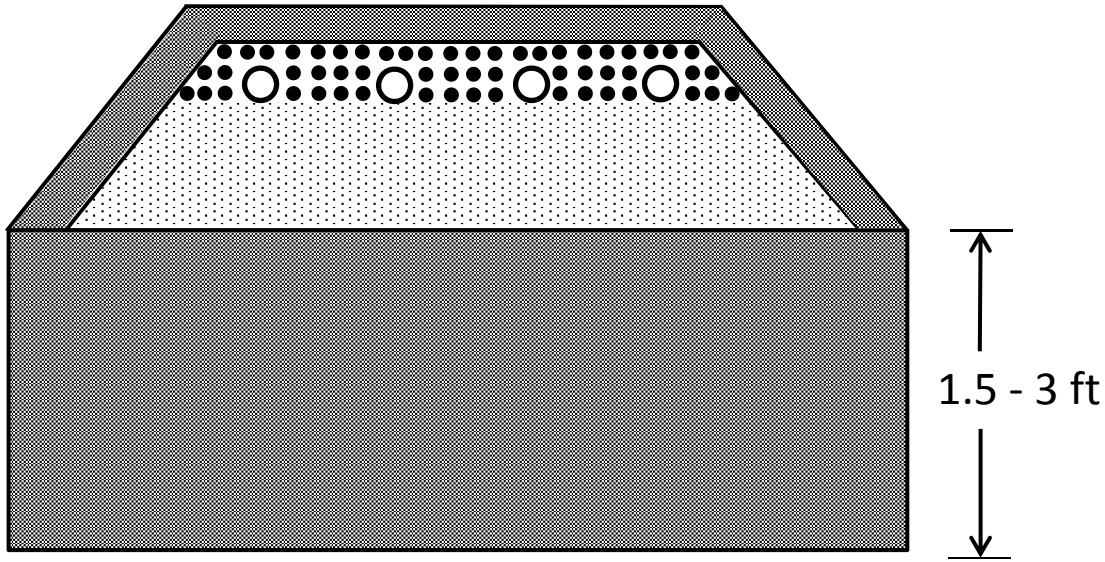
Onsite Wastewater Treatment

Leach Field



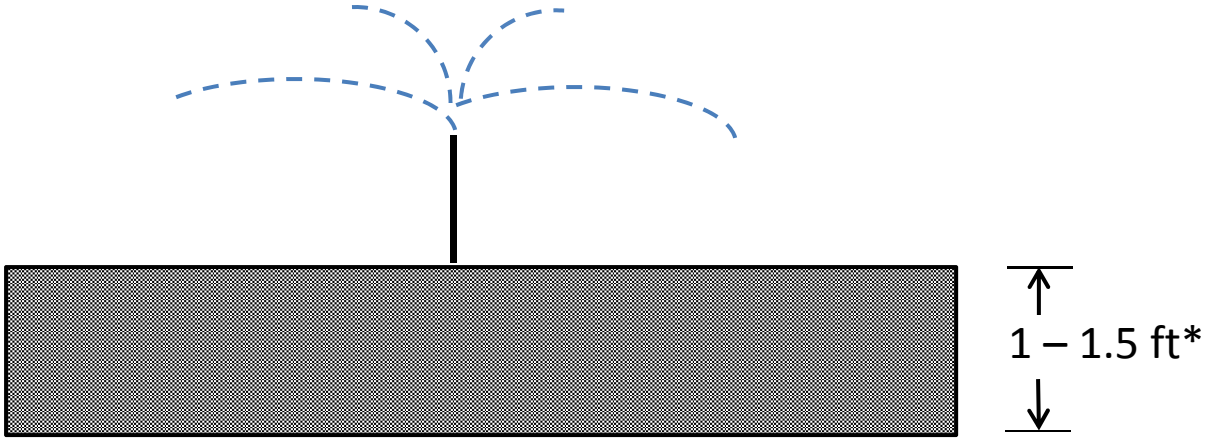
~16% of Ohio soils

Mound System



~31% of Ohio soils

Special Device Approval - Surface Irrigation



~22% of Ohio soils

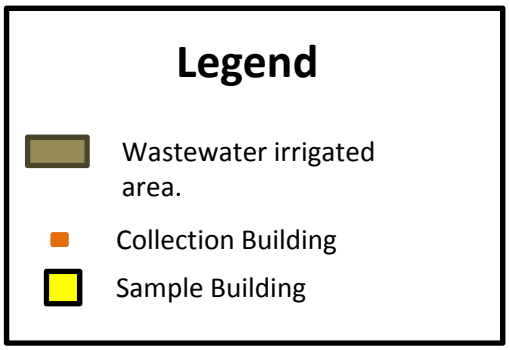
*6 in. for special device approval

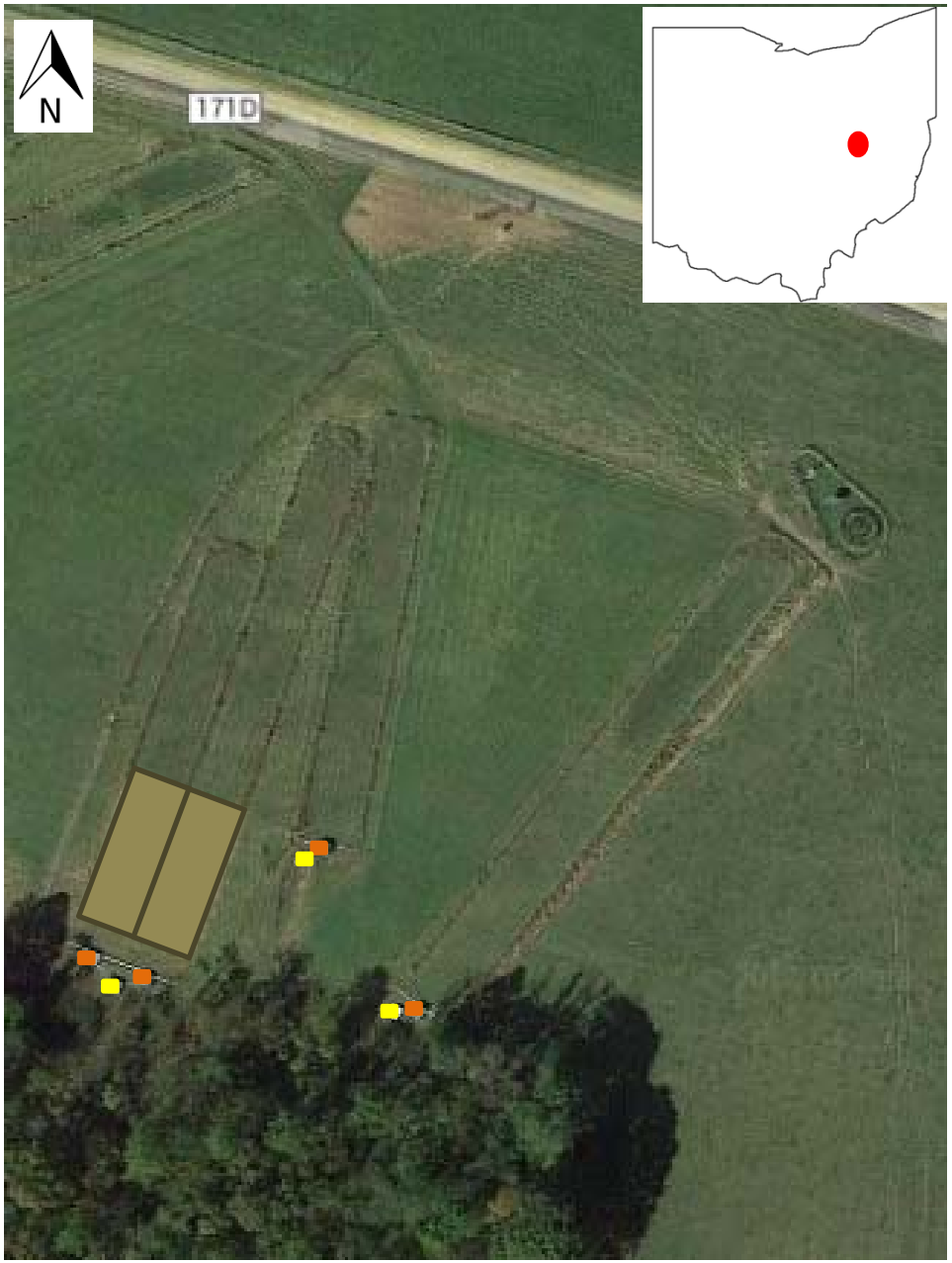
Not a new technology

- Penn State http://www.opp.psu.edu/services/about-opp/divisions/ee/util/wastewater-services
- Vermont


Winter?
Runoff quality from reclaimed wastewater irrigation in freezing conditions

METHODS
Yard sized plots






A)


B)

Irrigation System

- 360 gal of artificial wastewater every other day

- 0.5 inches on 3000 ft^2

Artificial Wastewater

Manure + Tap Water + Soluble Nutrients

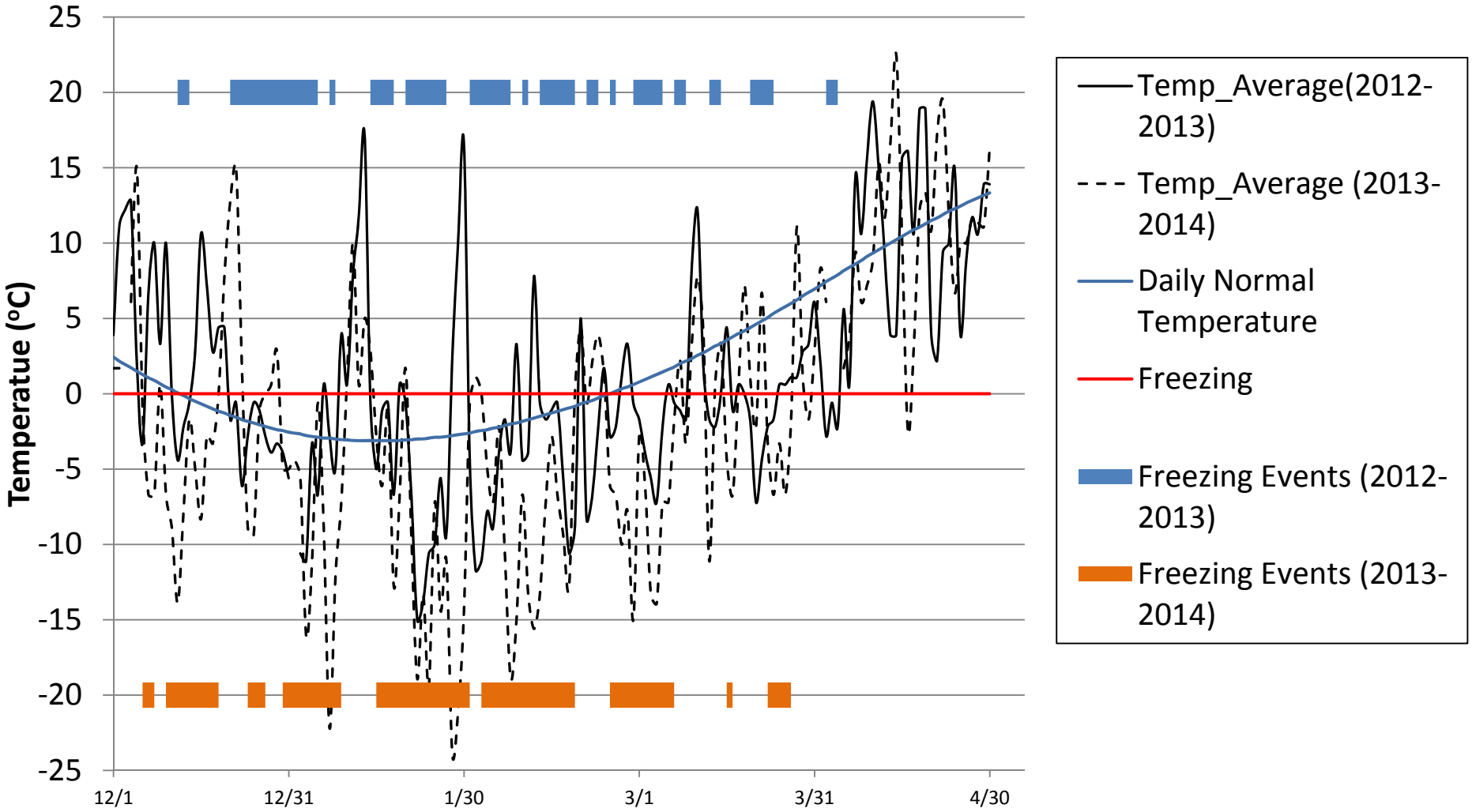
Type	BOD5	Filterable residue	NH3-N	E. *coli*	Total-N as N	Total-P as P
Target	>10*	>30*	>3.0*	>523*	15	5

*Based on NPDES discharge limits
All units in mg/L except E. coli which are in CFU/100 mL

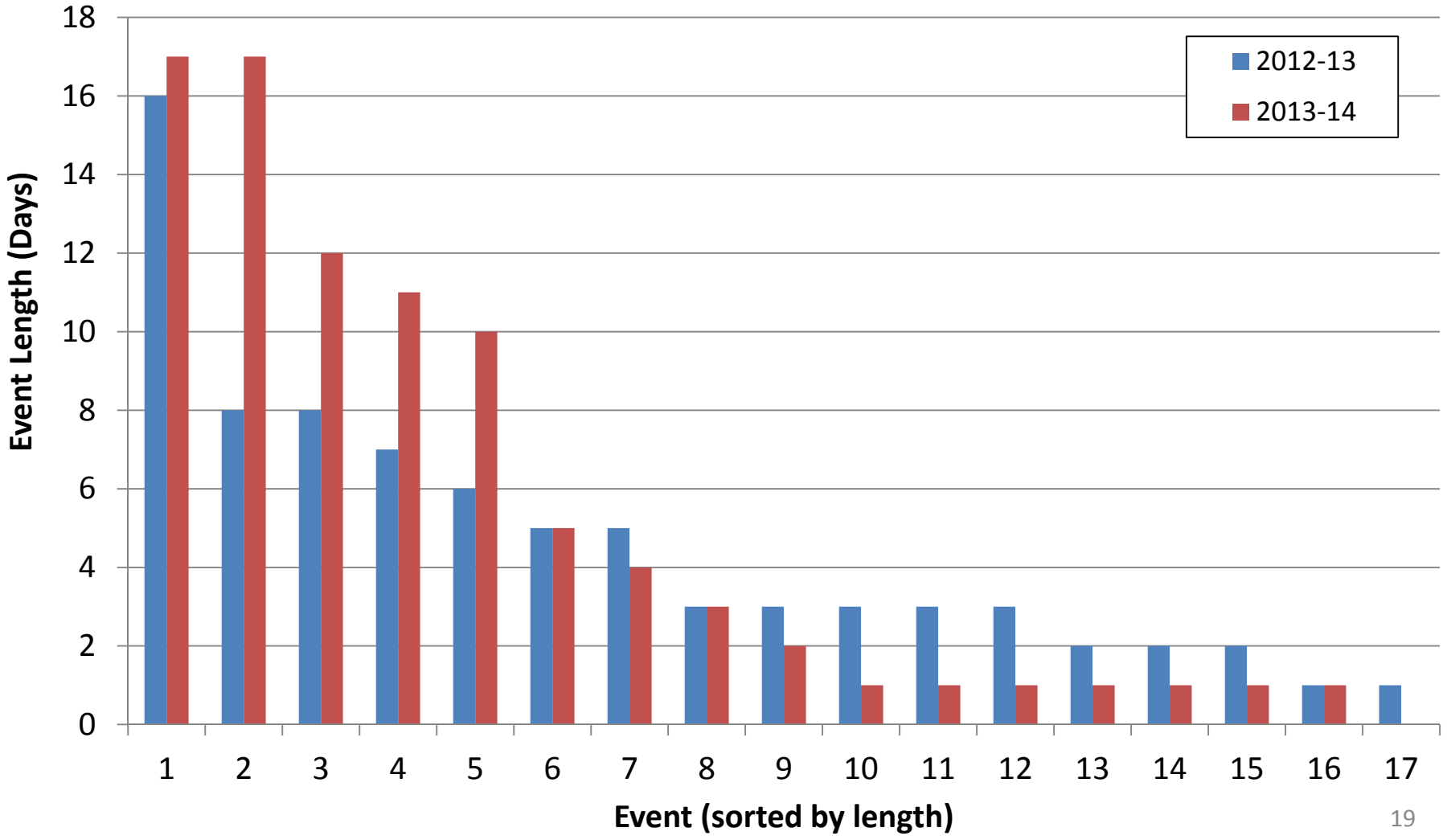
Weather Conditions

From: http://www.ncdc.noaa.gov/crn/

Air Temp for 2 Winters



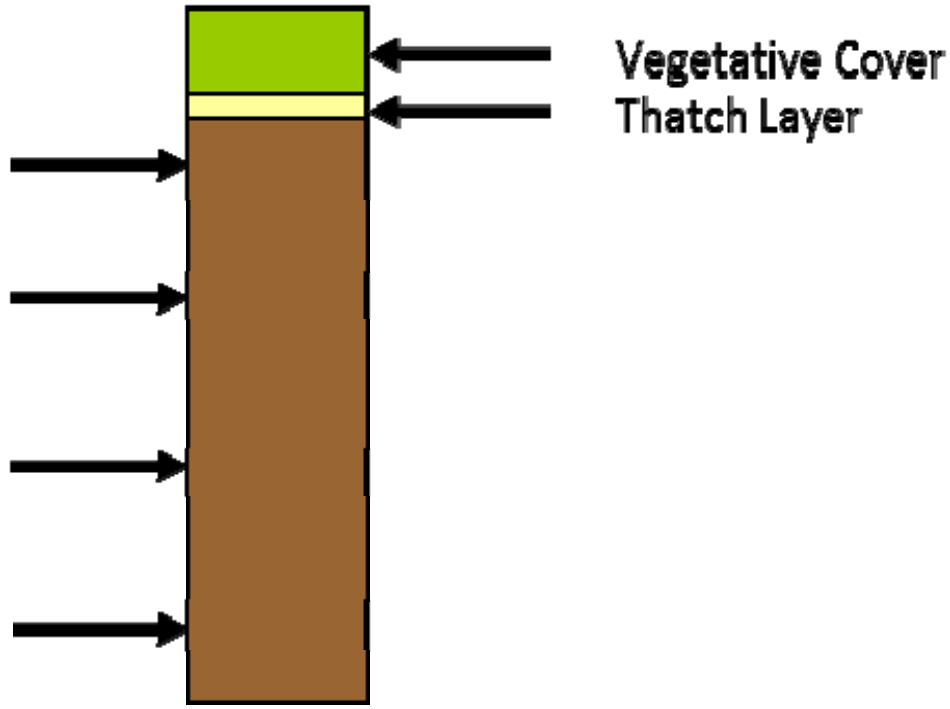
Freezing Air Temp Duration

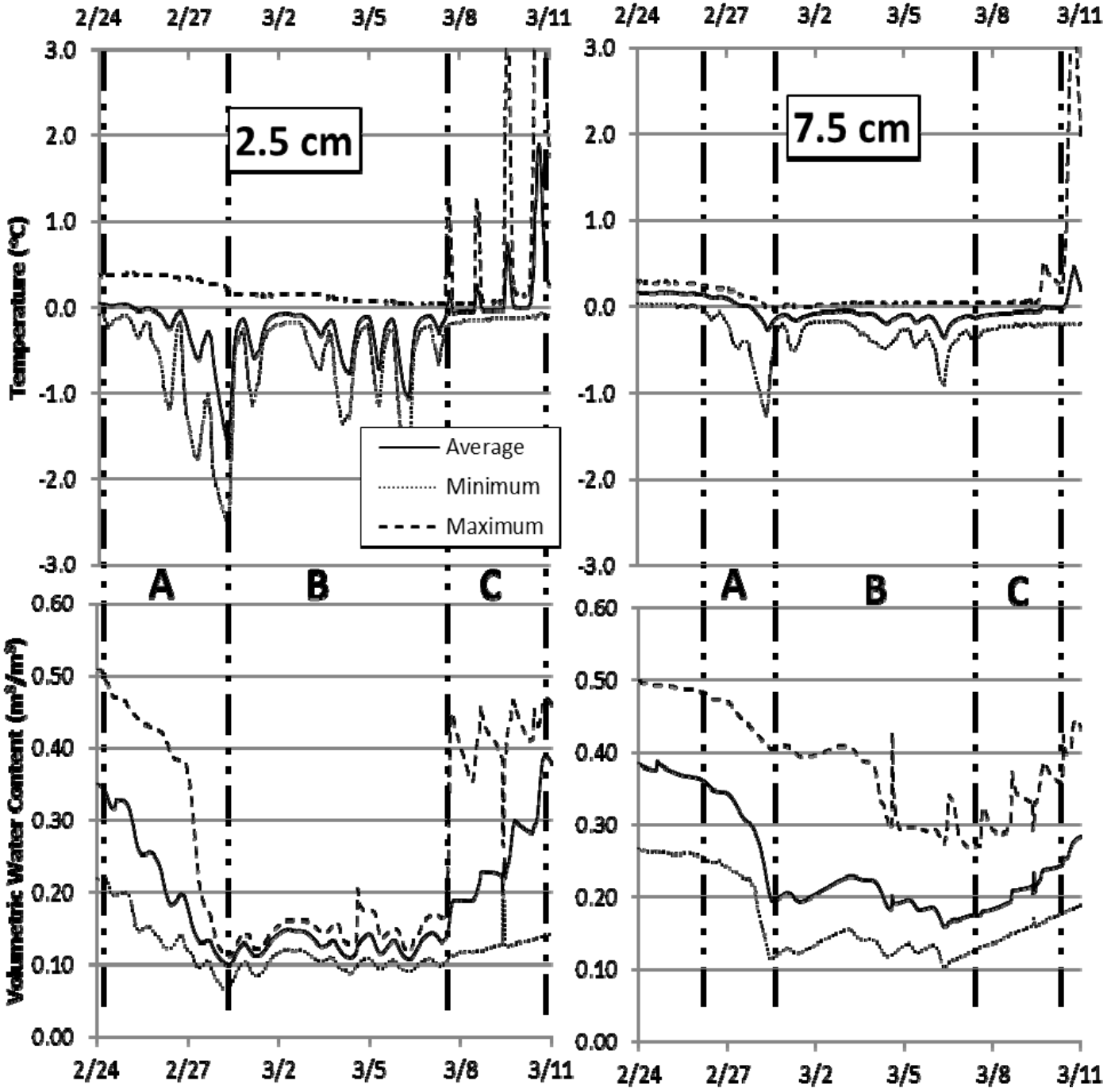


Soil Freezing

Temperature & Moisture

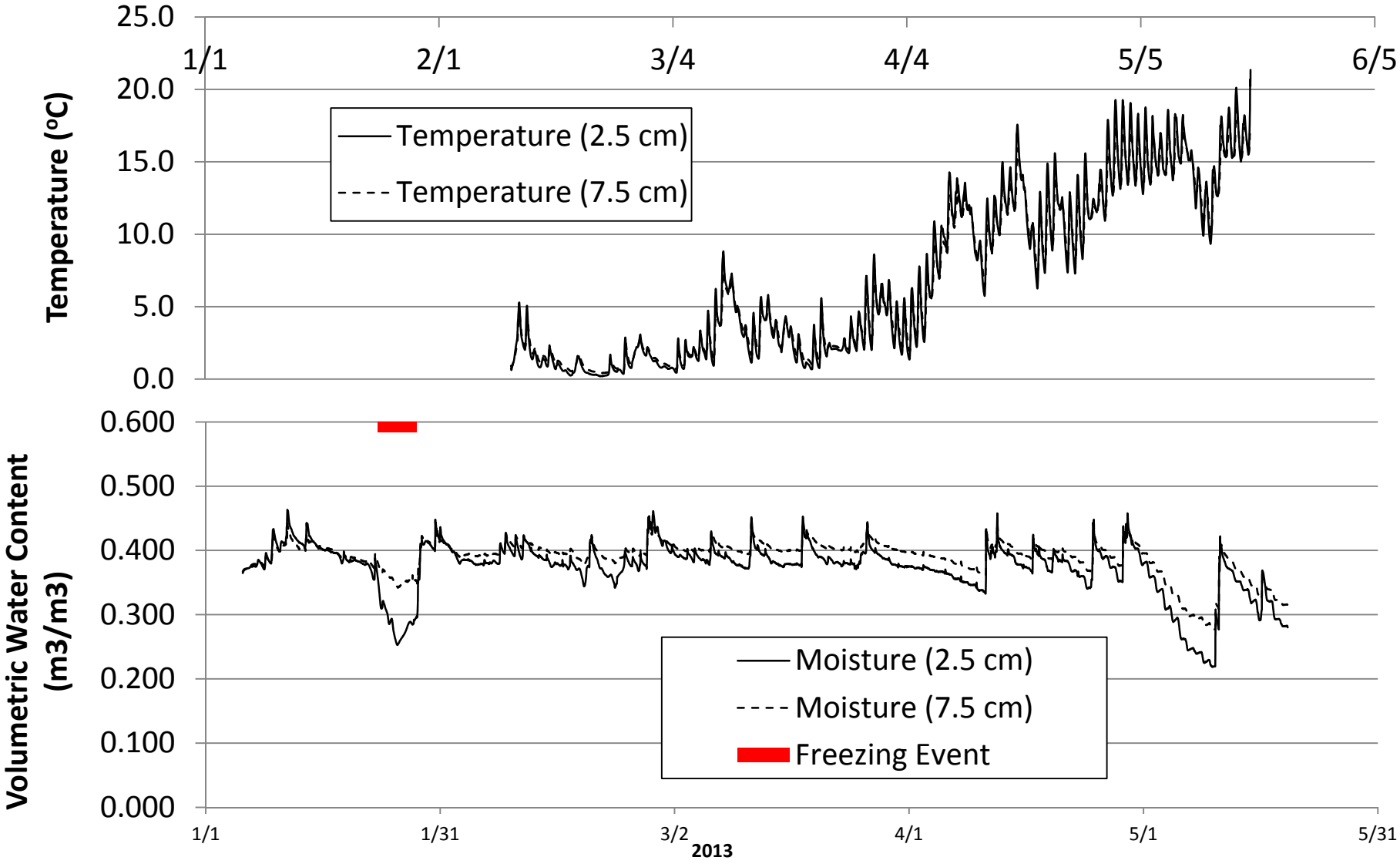
Temperature



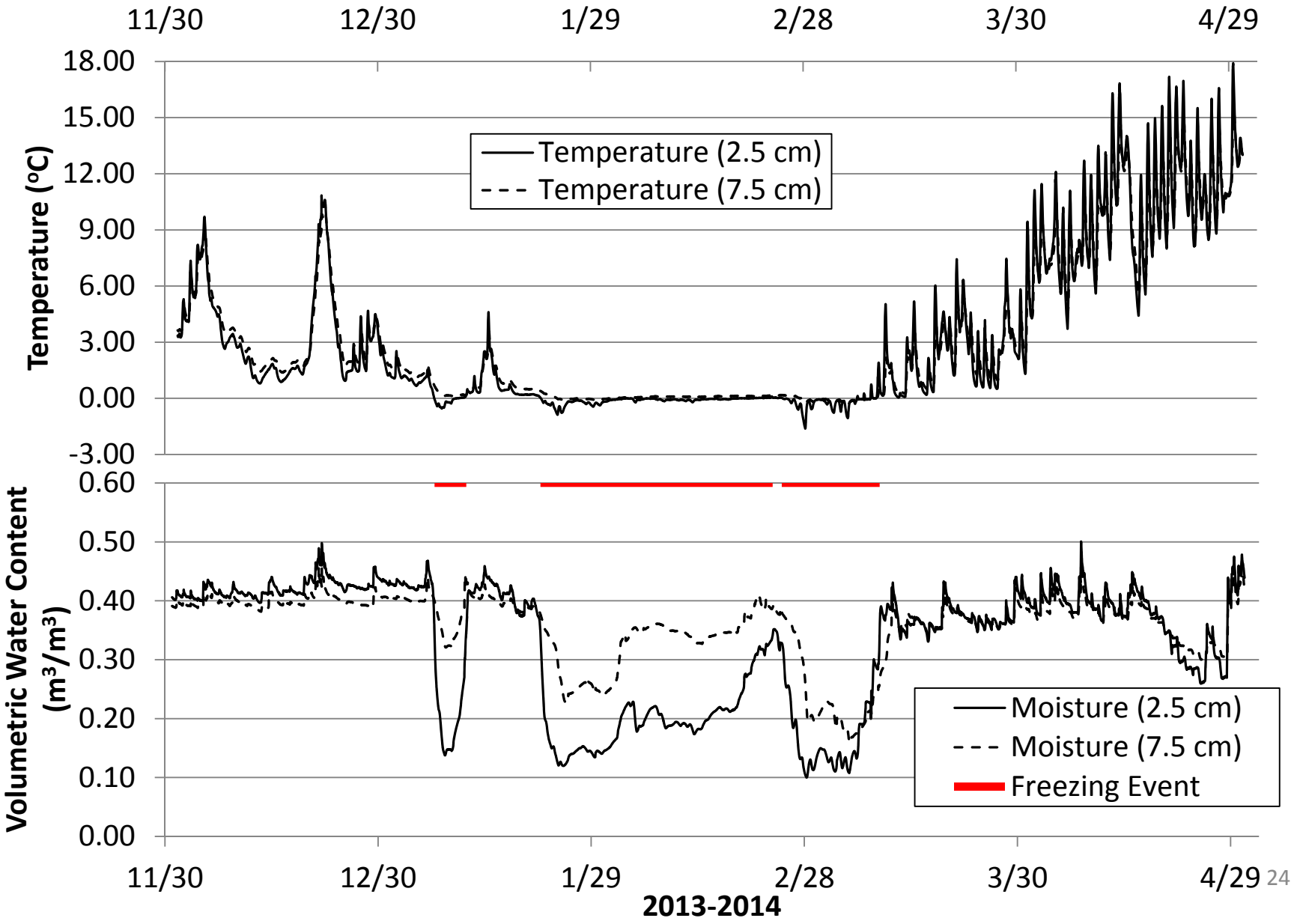

2/24
2/27
3/2
3/5
3/8
3/11
2.5 cm
7.5 cm
Temperature (°C)
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
Average
Minimum
Maximum
A
B
C
Volumetric Water Content (m³/m³)
0.60
0.50
0.40
0.30
0.20
0.10
0.00

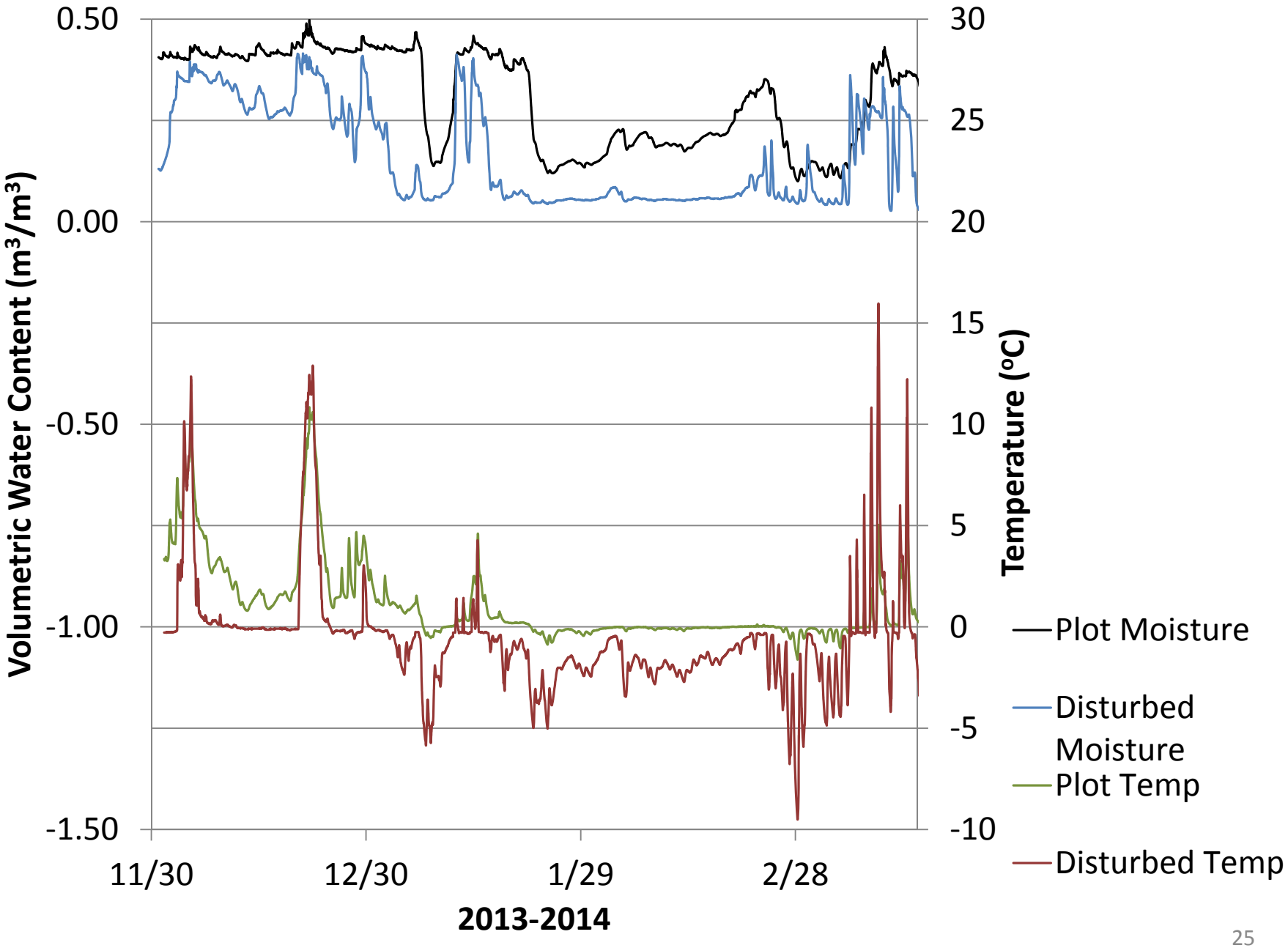
Isothermal Conditions

Soil froze 1 time January 2013 – May 2013



Soil froze 3 times for Dec 2013 – April 2014




0.50
0.00
-0.50
-1.00
-1.50
Volumetric Water Content (m³/m³)
30
25
20
15
10
5
0
-5
-10
Temperature (°C)
11/30
12/30
1/29
2/28
2013-2014
Plot Moisture
Disturbed Moisture
Plot Temp
Disturbed Temp

What happened to the irrigated water in freezing weather?

Runoff

Normal Winter (2013): One Runoff Event

Cold Winter (2014): Eleven Runoff Events

Runoff Water Quality

Parameters Sampled:

- Suspended Solids
- BOD_5
- NH_3-N
- *E. coli*
- NO_3-N
- Total-N
- PO_4-P
- Total-P

BOD_5

Sample	BOD_5 (mg/L)	# of samples
Wastewater Plot	5.9	12
Control Plot	8.5	11
Wastewater	16.0	3

*Not Significant

Effluent Standard for Discharging systems: 15 mg/L

Total Suspended Solids (TSS)

Sample	TSS (mg/L)	# of Samples
Wastewater Plot	149	12
Control Plot	356	13
Wastewater	102	3

*Not Significant

Effluent Standard for Discharging systems: 30mg/L

E. coli

Sample	*E. Coli* (CFU/100 mL)	# of Samples
Wastewater Plot	23	7
Control Plot	19	11
Wastewater	>10,000	3

*Not Significant

Effluent Standard for Discharging systems: 523 CFU/100mL

Nitrogen

Sample	Total-N	NH_3-N	NO_3-N	# of Samples
	mg/L			
Wastewater Plot	3.56	1.94	3.74	12
Control Plot	1.52	0.89	0.68	13
Wastewater	8.58	3.43	3.26	3

*All Results Significant

Effluent Standard for Discharging systems: 3.0 mg/L NH_3-N

Phosphorus

Sample	Total-P	PO_4-P	# of Samples
	mg/L		
Wastewater Plot	1.39	1.15	12
Control Plot	0.88	0.53	13
Wastewater	3.69	3.61	3

*All Results Significant

Air temp/Soil temp

- Freezing air temperatures do not always result in soil freezing

Frozen soil/runoff

- Normal winter – 1 runoff event
- Very cold winter
  - long duration soil freezing
  - 11 runoff events

Runoff Quality

- No difference between wastewater irrigated plot compared to control plot
  - BOD_5
  - TSS
  - *E Coli*

Runoff Quality

- Ammonia
  - Higher off wastewater plot
  - Lower than irrigated effluent

Runoff Quality

- Total-N, NO_3-N, Total-P and PO_4-P
  - Higher off wastewater plot
  - Lower than irrigated effluent

Will pollutants runoff?

- Of the regulated pollutants,
  - BOD_5, TSS and *E coli* - no
  - ammonia showed a difference in runoff compared to a control

Will Pollutants Runoff?

- During a severe winter,
  - Runoff occurred 7% of days
  - The alternative? …….discharge every day

Can we irrigate anywhere?

- Disturbed soils
  - NO

Problems I encountered

- Freezing in hydro-mechanical zone valve
  - Valves were drained

Problems I encountered

- Rotational problems in sprinklers

Problems I encountered

- Low solids an absolute necessity.
  - Clogged nozzles will not drain

Questions?

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