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Using Compost to Improve Water Quality

David Crohn
University of California, Riverside

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Freeway Complex Fire, Nov. 2008

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Official Report: Freeway Complex Fire

FREEWAY COMPLEX

Freeway Complex Incident Information:	
Last Updated:	November 19, 2008 6:00 pm FINAL
Date/Time Started:	November 15, 2008 9:07 am
Administrative Unit:	CAL FIRE / Orange County Fire Authority / Corona City Fire / City of Anaheim / Chino Valley Fire / City of Brea / Los Angeles County Fire / CHP
County:	Orange County/Riverside County
Location:	Between Corona, Chino Hills, Yorba Linda, Brea & Anaheim
Acres Burned:	**30,305**
Containment	30,305 acres - 100% contained
Structures Destroyed:	314 residence, 4 commercial and 43 outbuildings
Cause:	Under investigation
Cooperating Agencies:	CAL FIRE, Orange County Fire Authority, Corona Fire, Anahiem City Fire, Chino Valley Fire, CHP, CDCR and CCC.
Total Fire Personnel:	1,633
Engines:	156
Fire crews:	48
Dozers:	4
Water tenders:	5
Costs to date:	$16.1 million
Conditions:	The Freeway Complex is made up of the Freeway Fire and the Landfill Fire. CAL FIRE Incident Command Team #6 has transitioned into unified command.

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K-rail

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Facing slopes in Temecula, CA

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Experimental Site

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Controlled burn

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After the burn

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Riverside Station 1 Fire Crew

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Installed Slope

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Collection Basin

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It's wet out here…

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Four captured events (mm)

- December 15, 2009, following a 12.5 mm storm that fell over 48 hours
- January 19, 2010, following a 32 mm storm that fell over 36 hours
- January 21, 2010, following a 39 mm storm that fell over 36 hours
- January 23, 2010, following a 49 mm storm that fell over 36 hours

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After the first rains…

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Randomized Complete Block Plot Design

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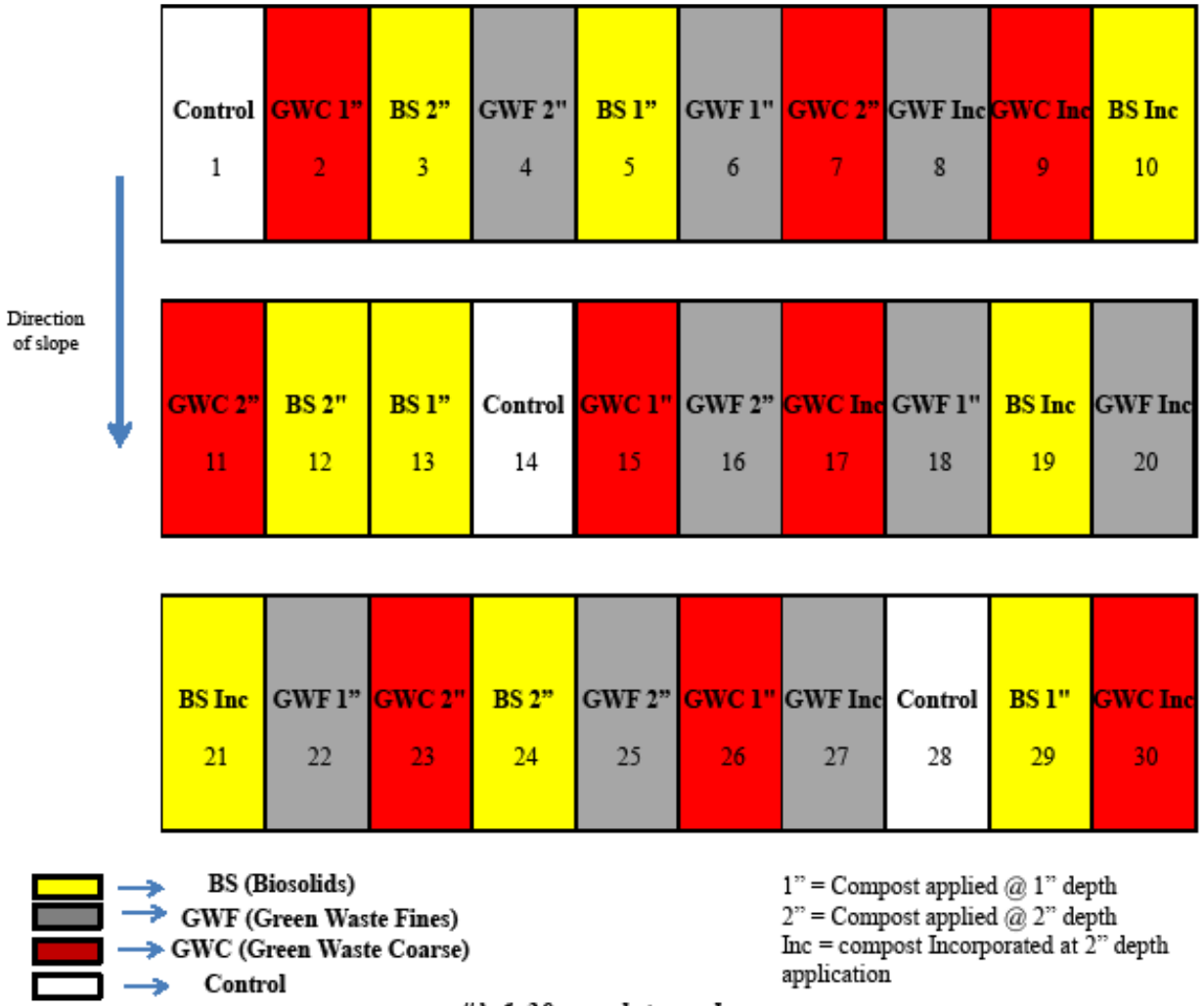

Materials

- Greenwaste compost fines
- Greenwaste compost overs
- Biosolids compost
- No compost

Rates

- 1 inch
- 2 inches
- 2 inches incorporated

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3:1 slope

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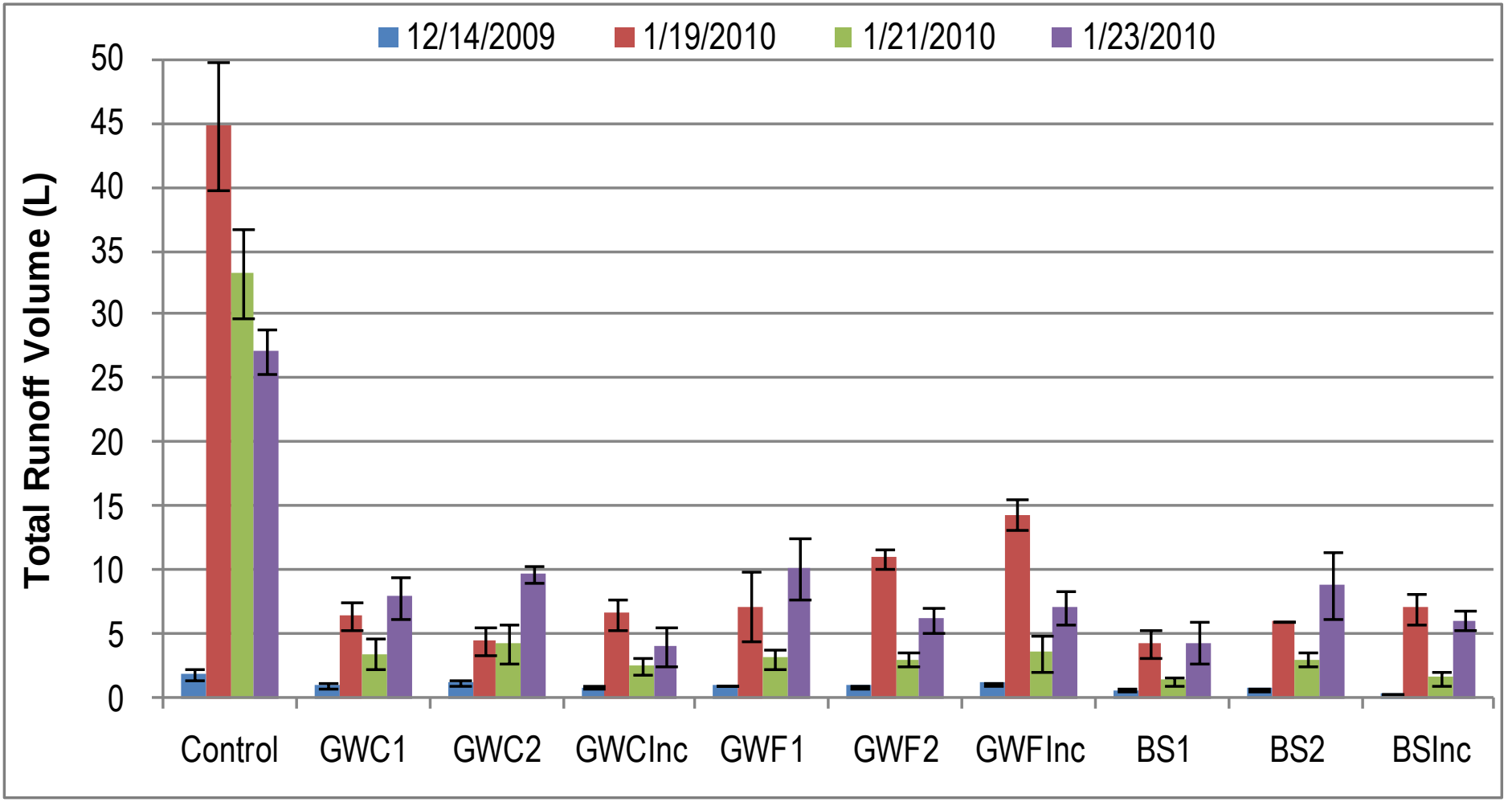
Total Runoff Volume



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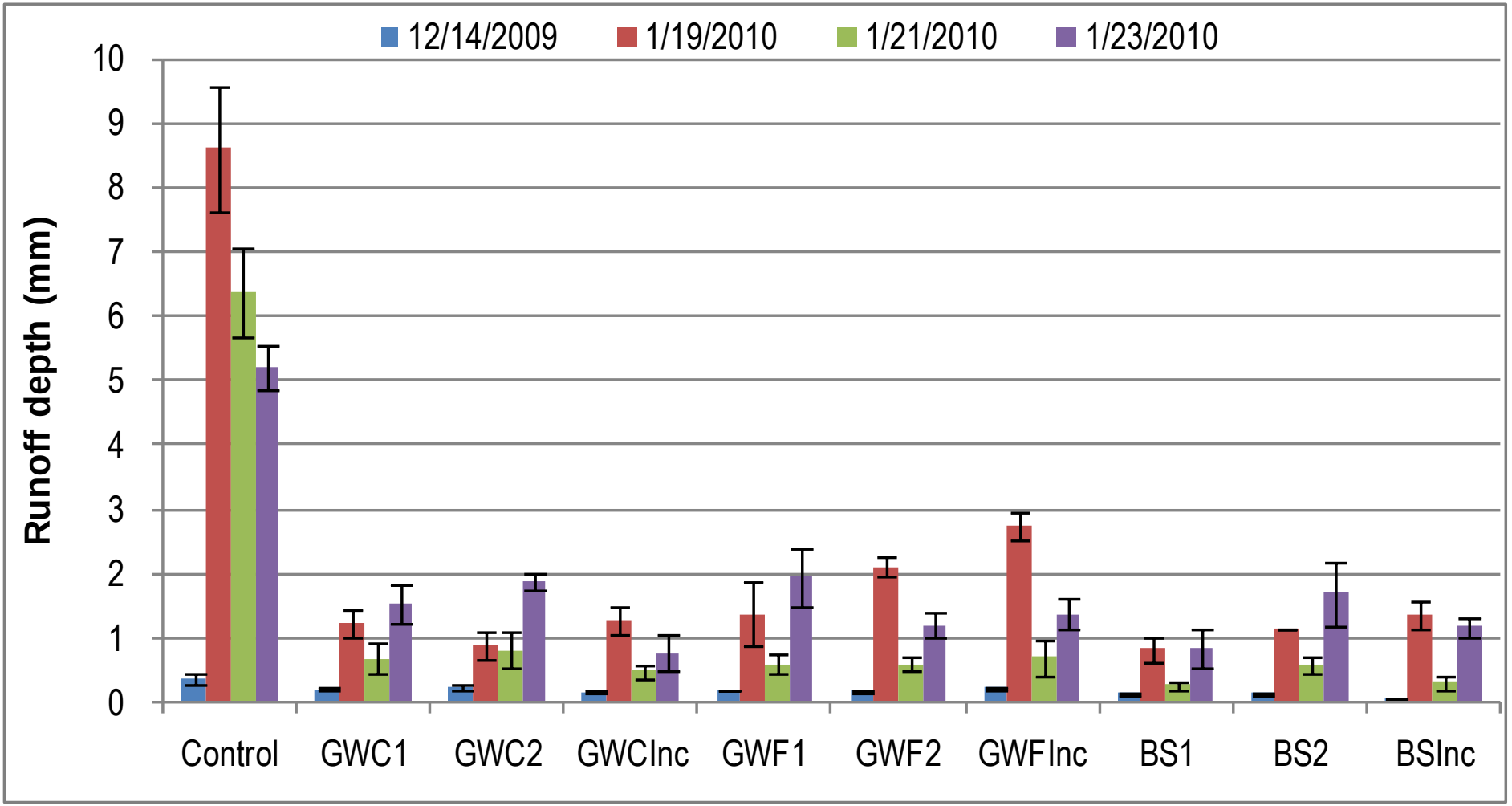
Total Runoff Depth



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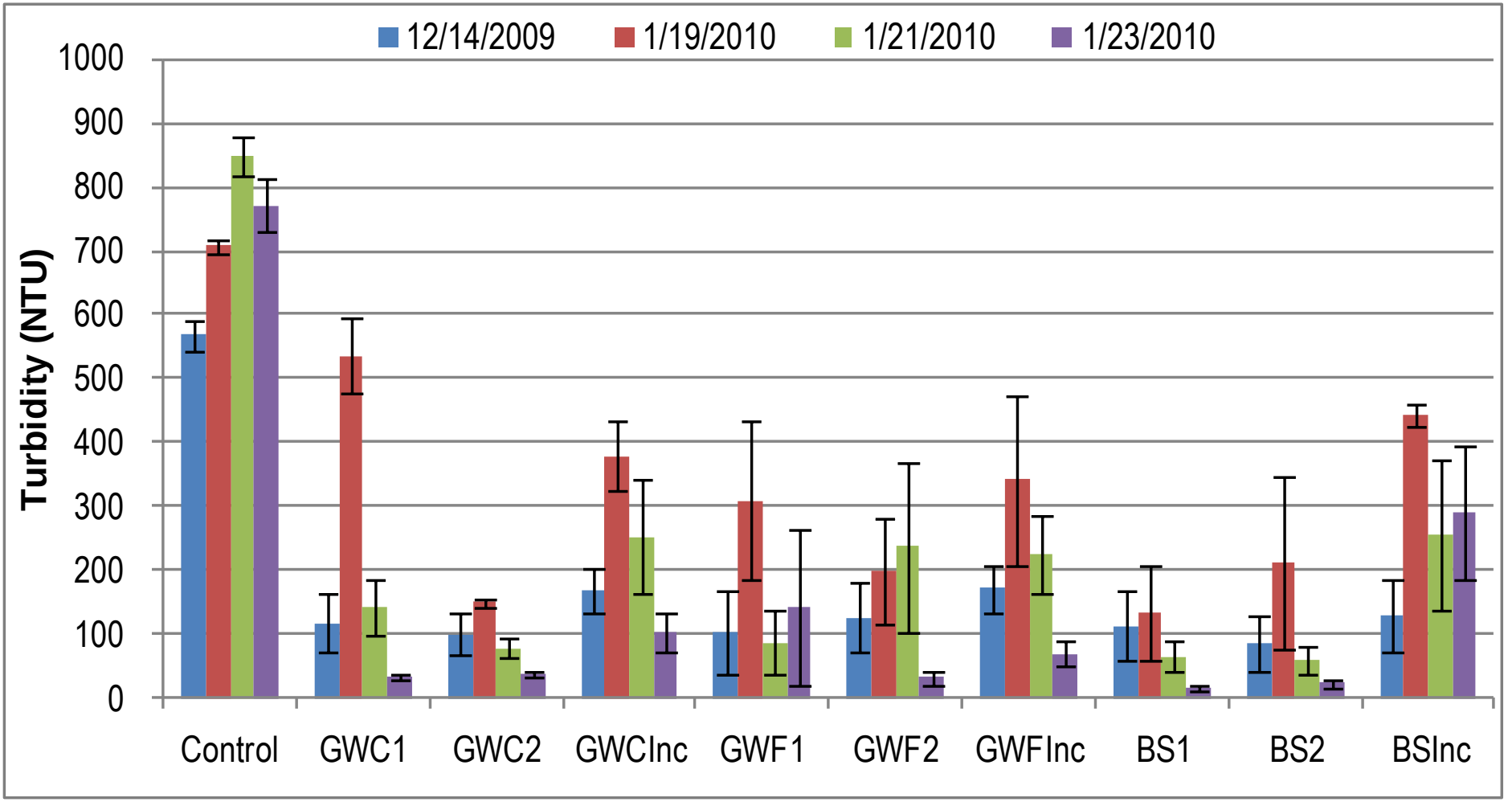
Turbidity



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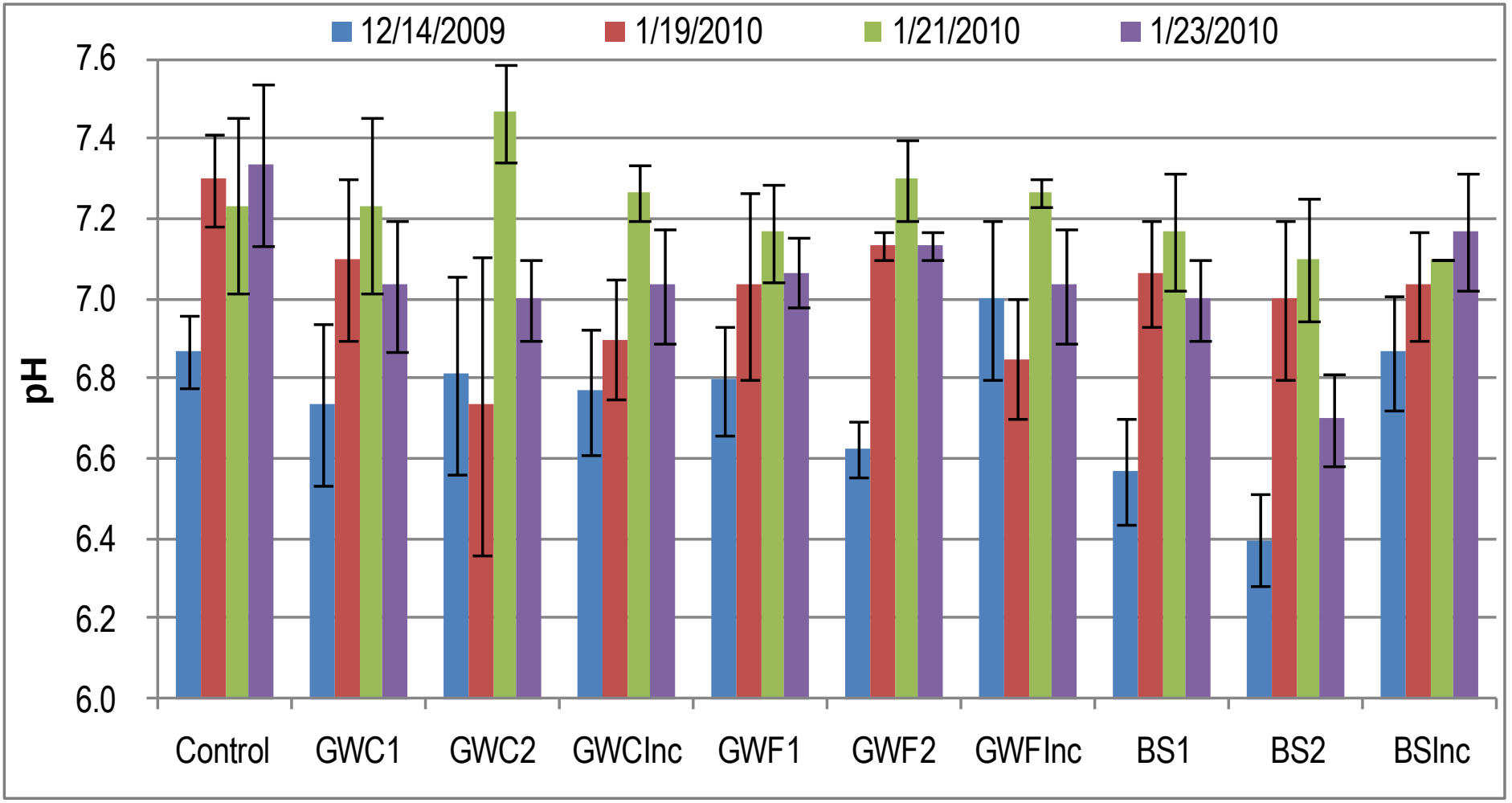
pH



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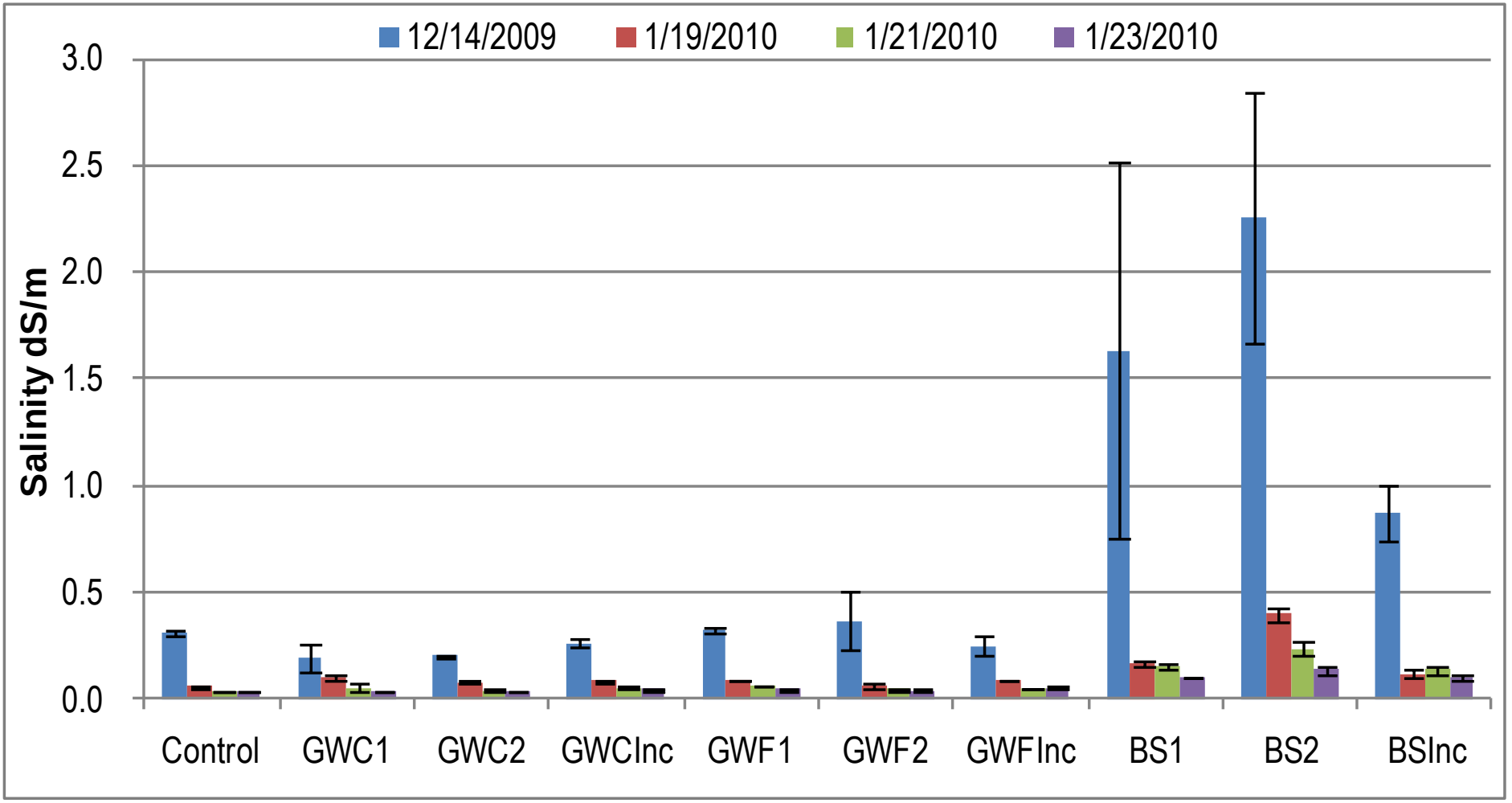
Salinity



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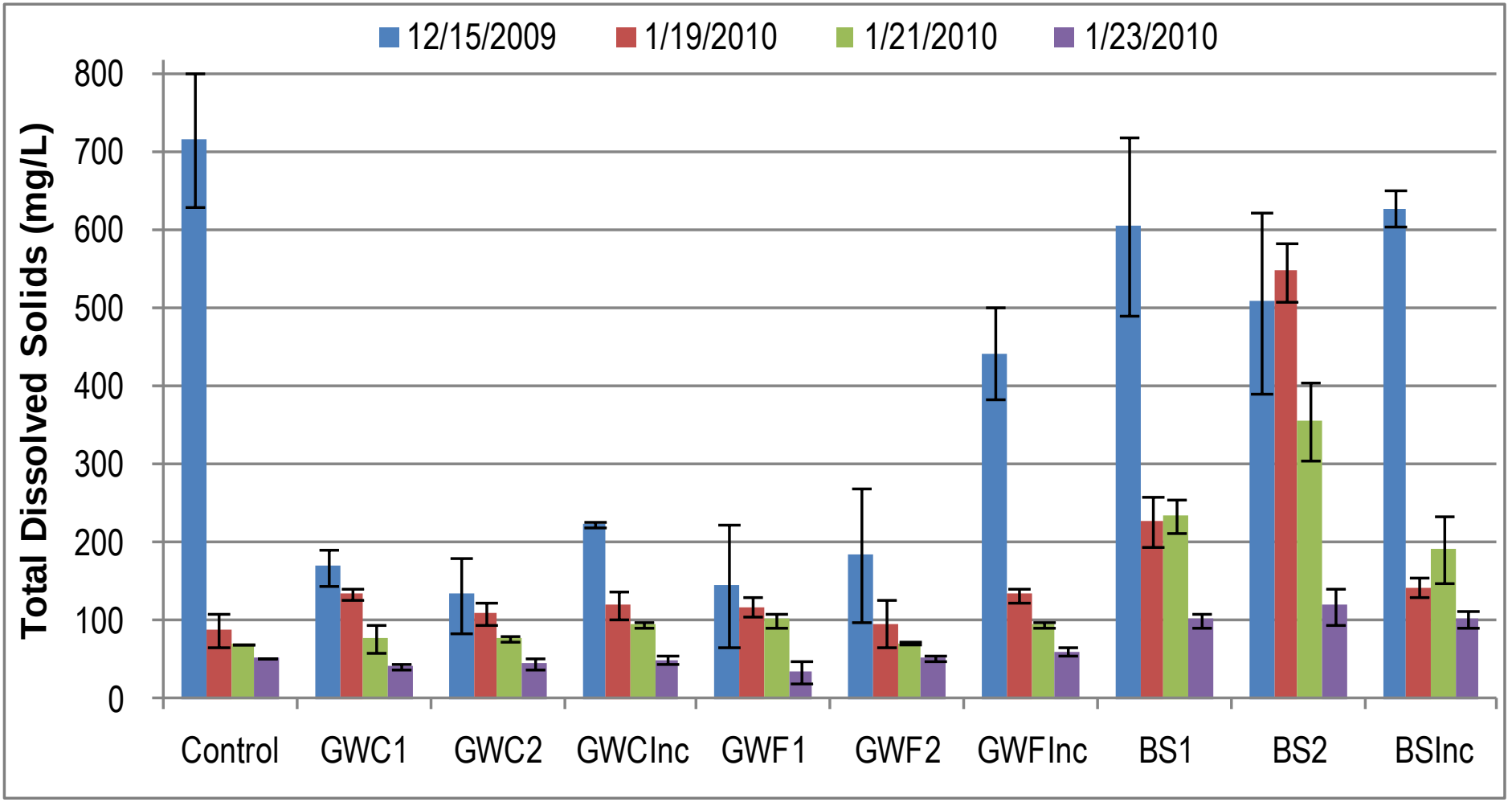
Total Dissolved Solids



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Concentration

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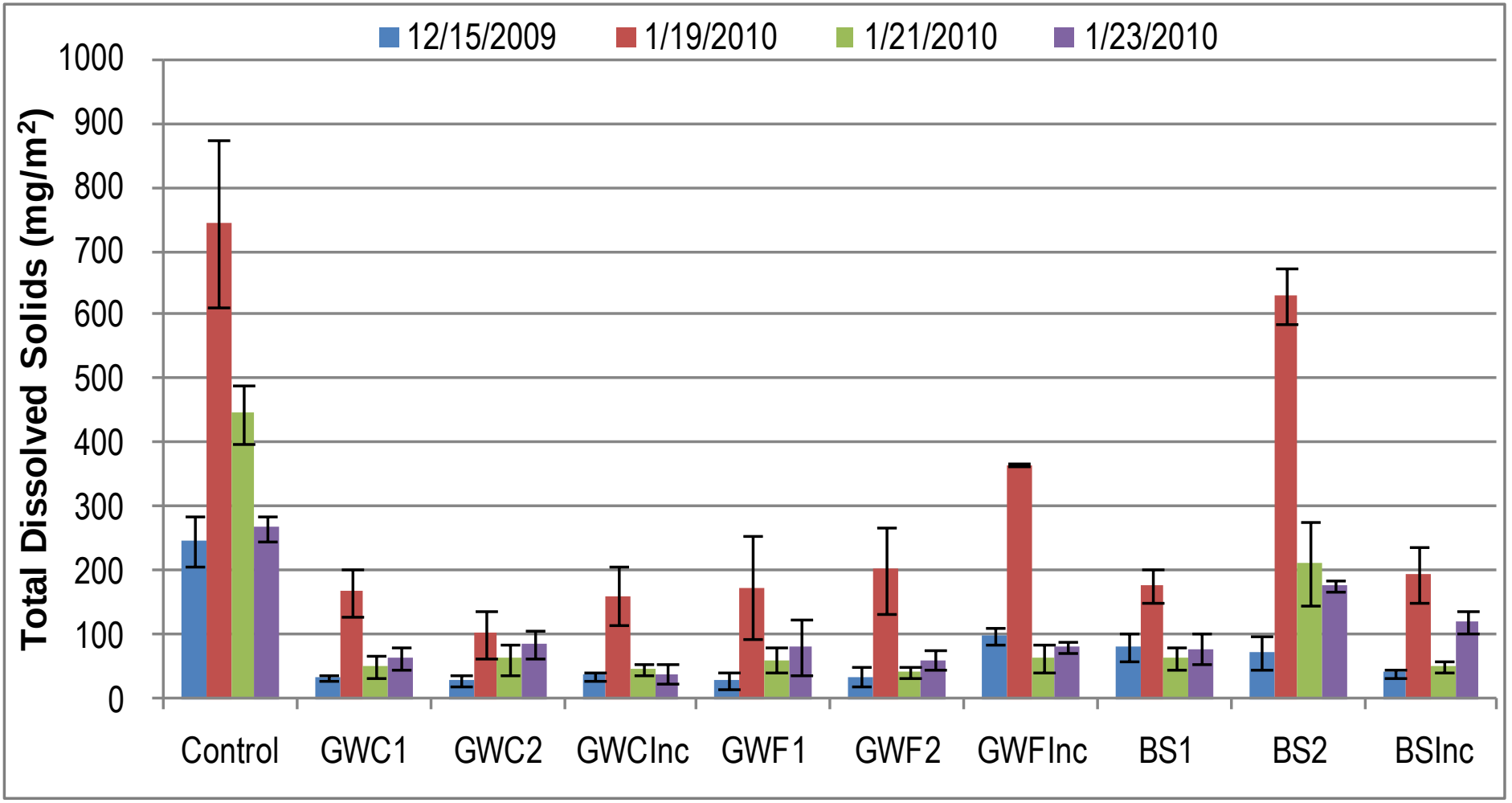
Total Dissolved Solids



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Exported Mass

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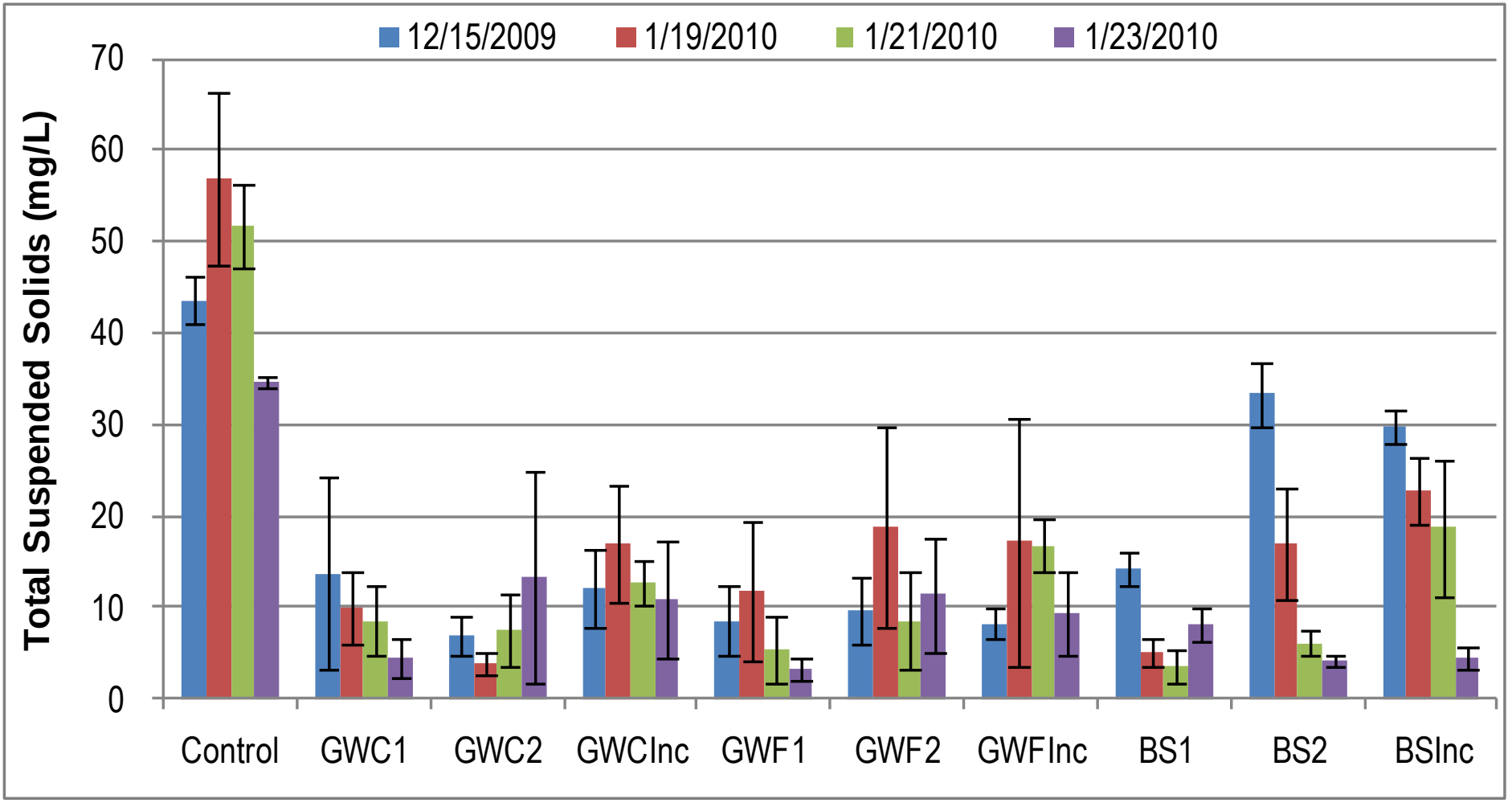
Total Suspended Solids



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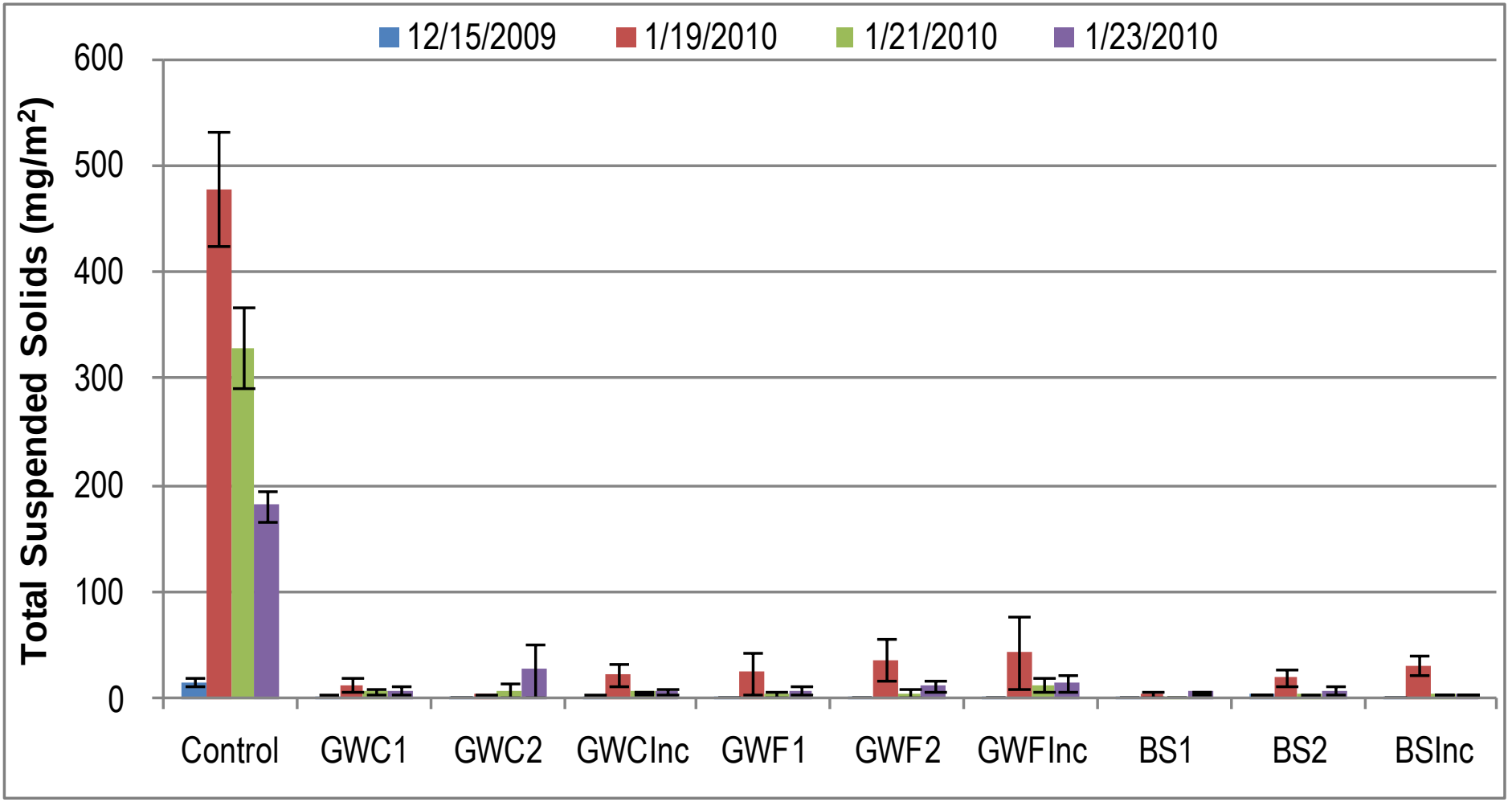
Total Suspended Solids



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Exported Mass

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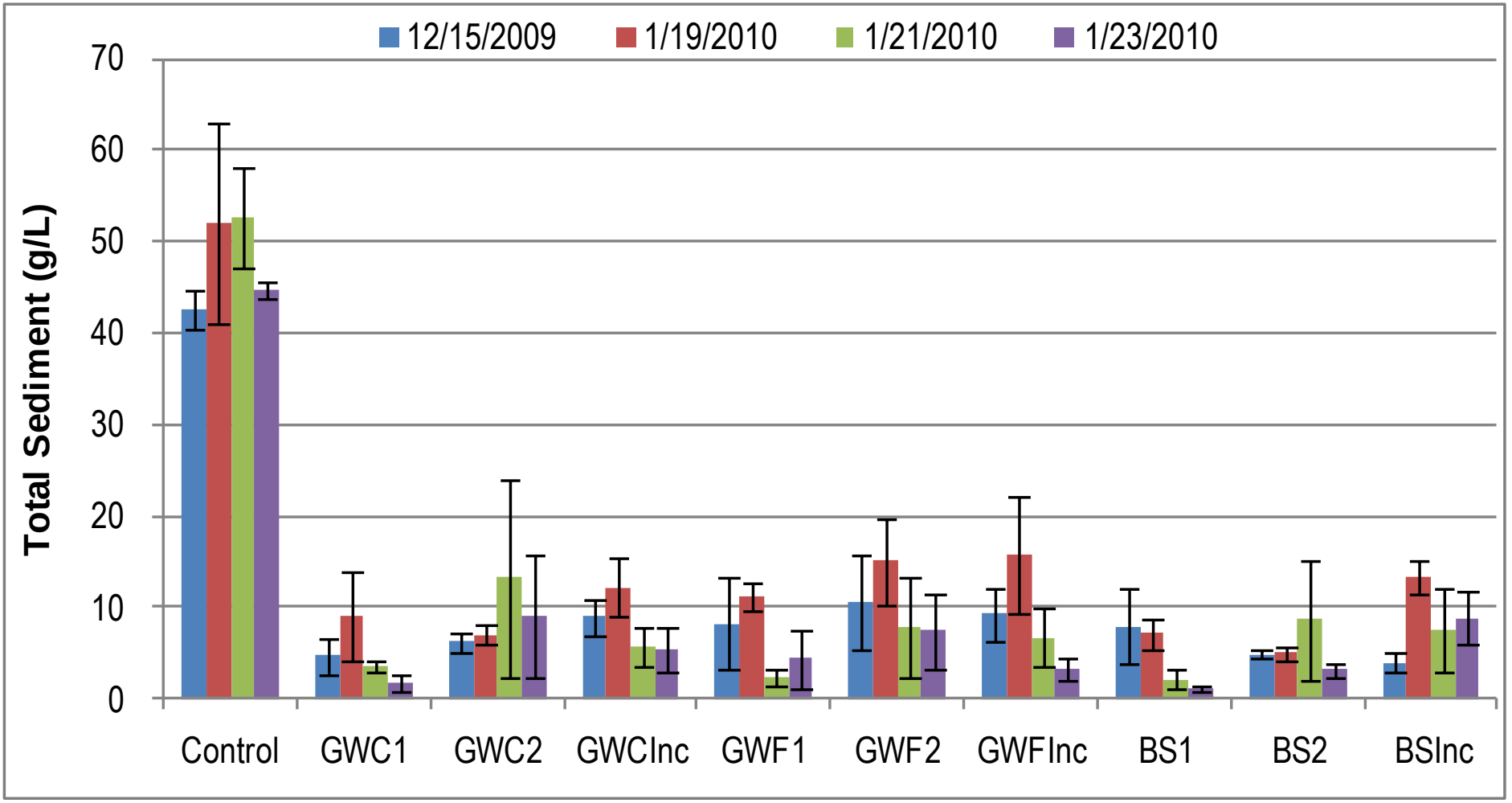
Total Solids



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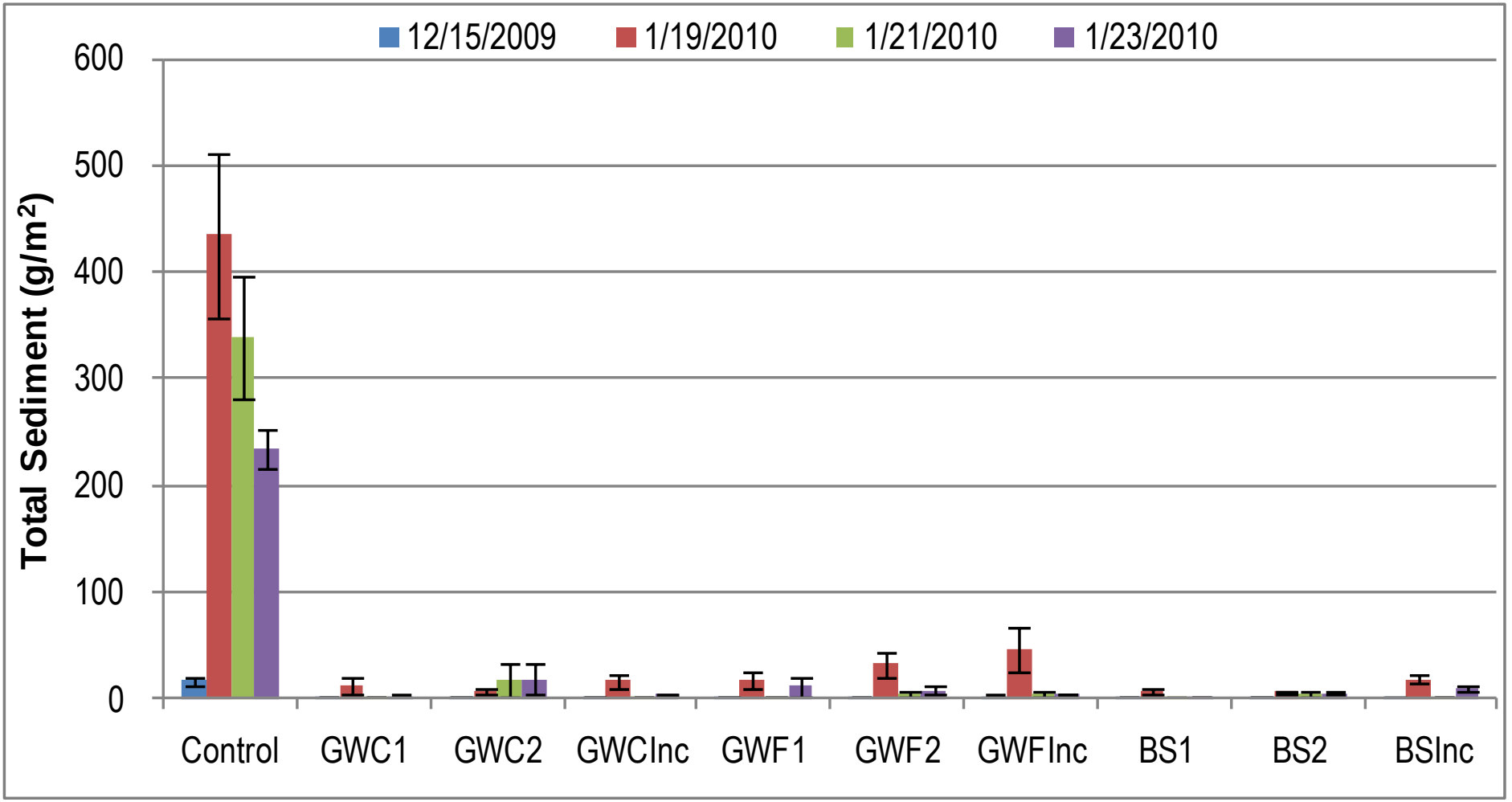
Total Solids



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Exported Mass

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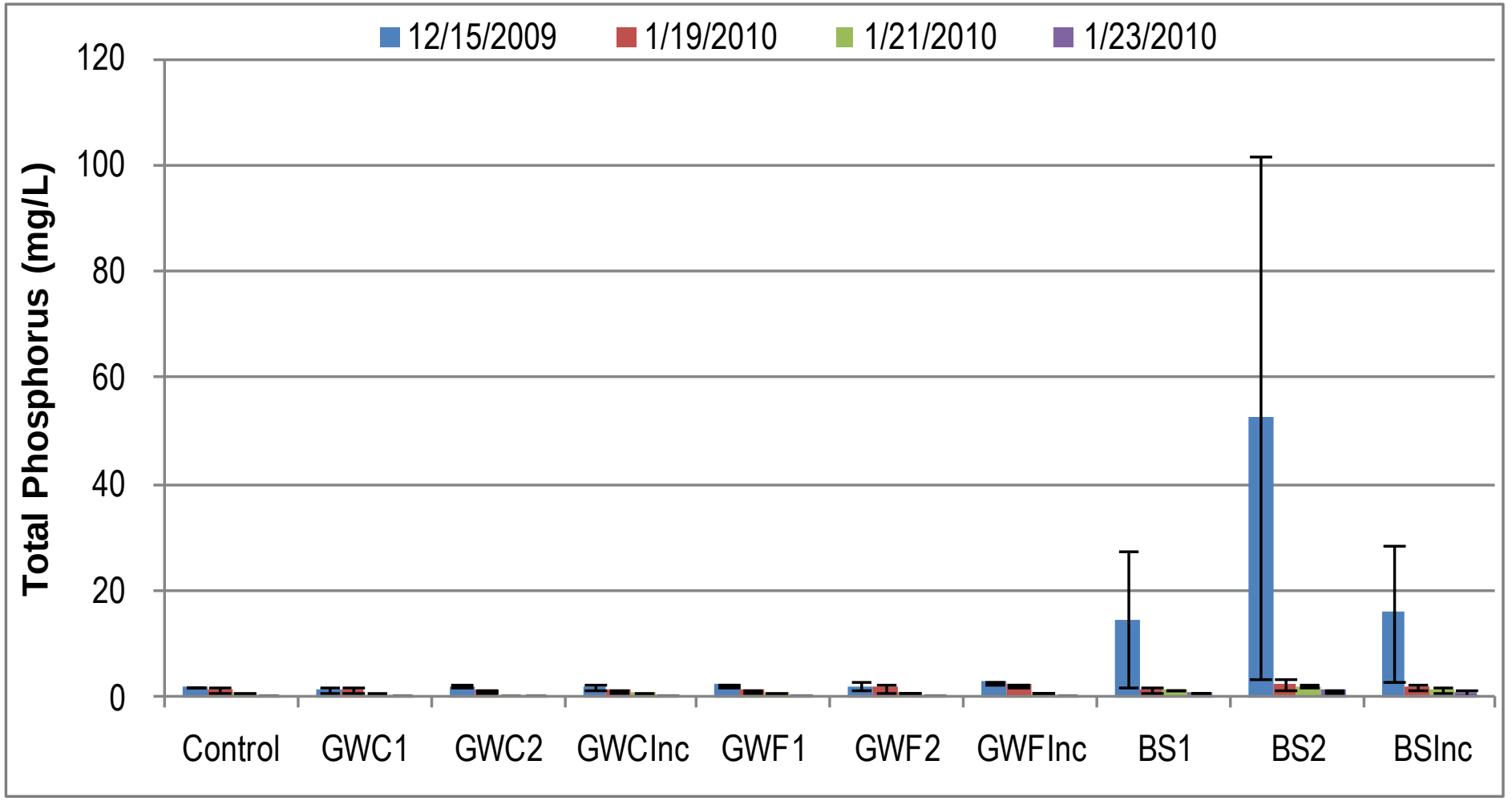
Total Phosphorus



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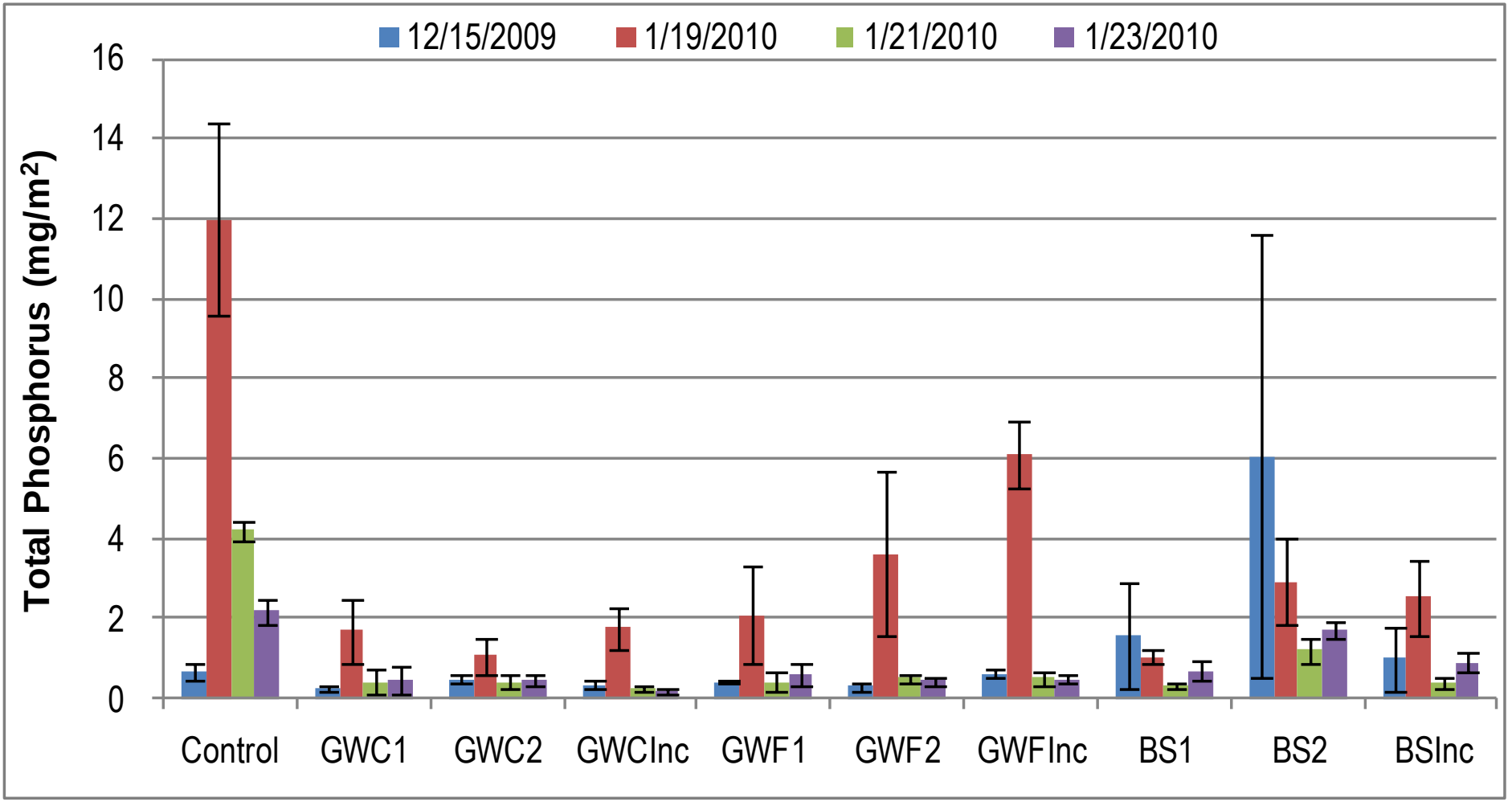
Total Phosphorus



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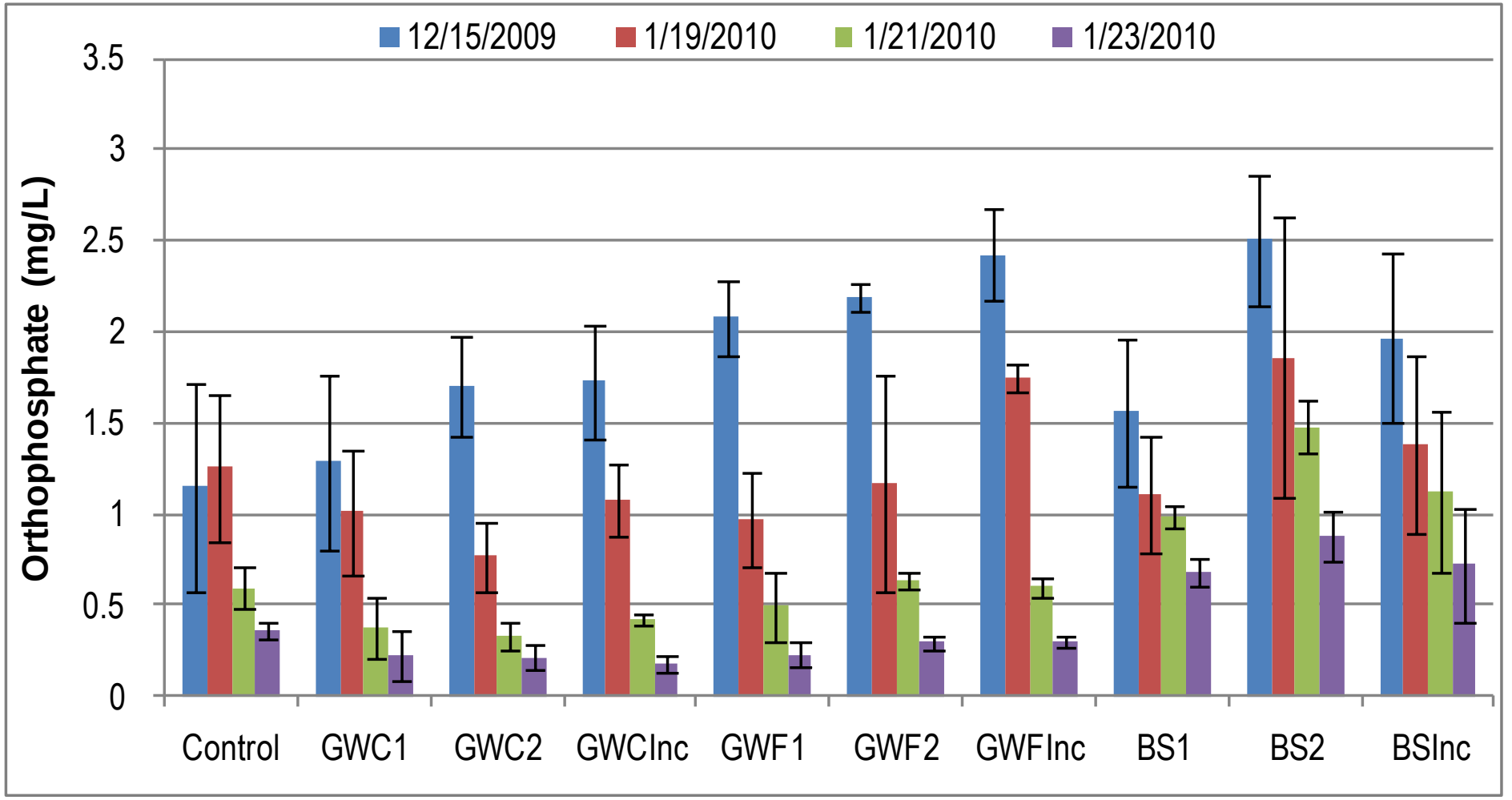
Orthophosphate



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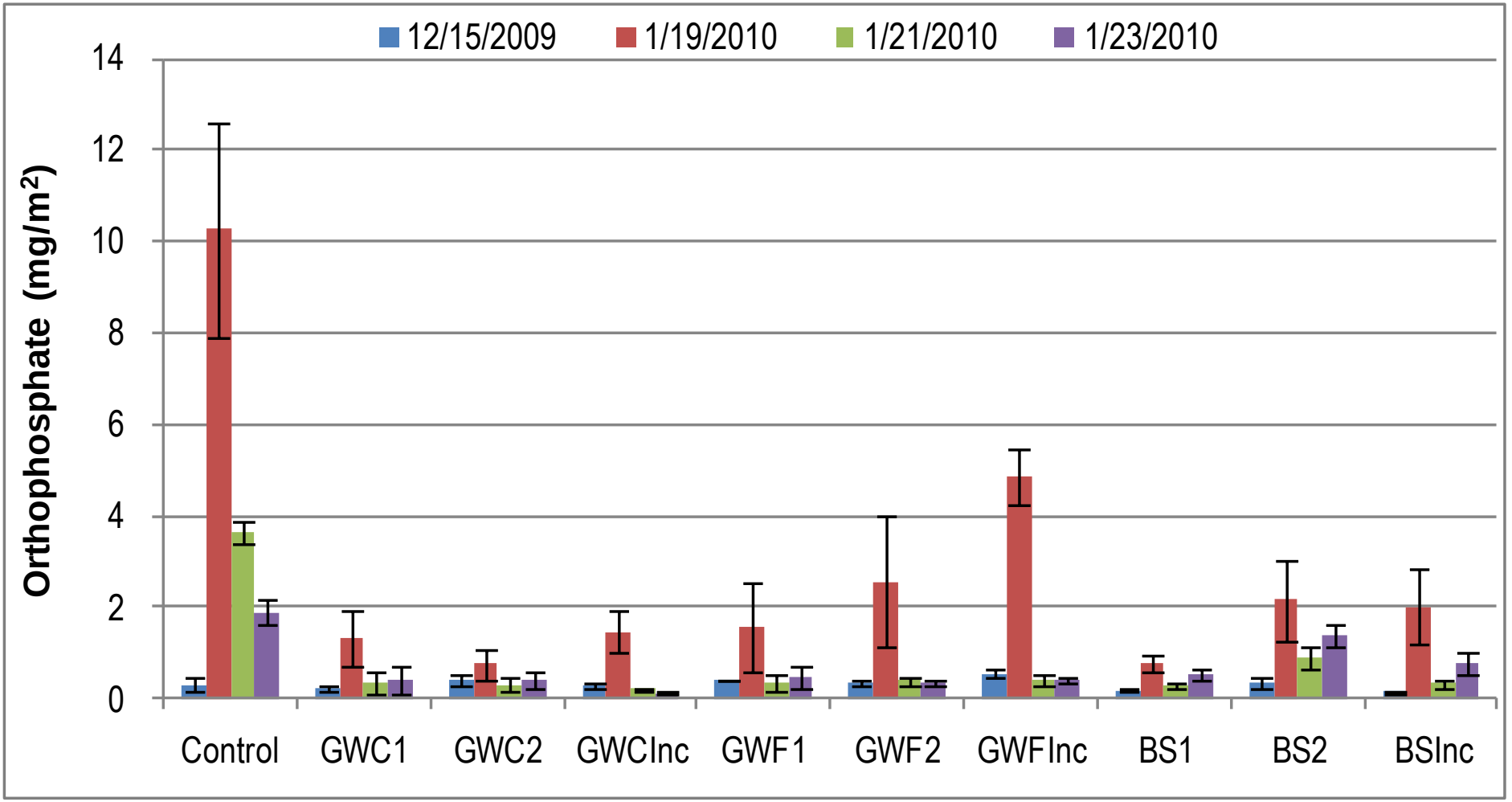
Orthophosphate



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Exported Mass

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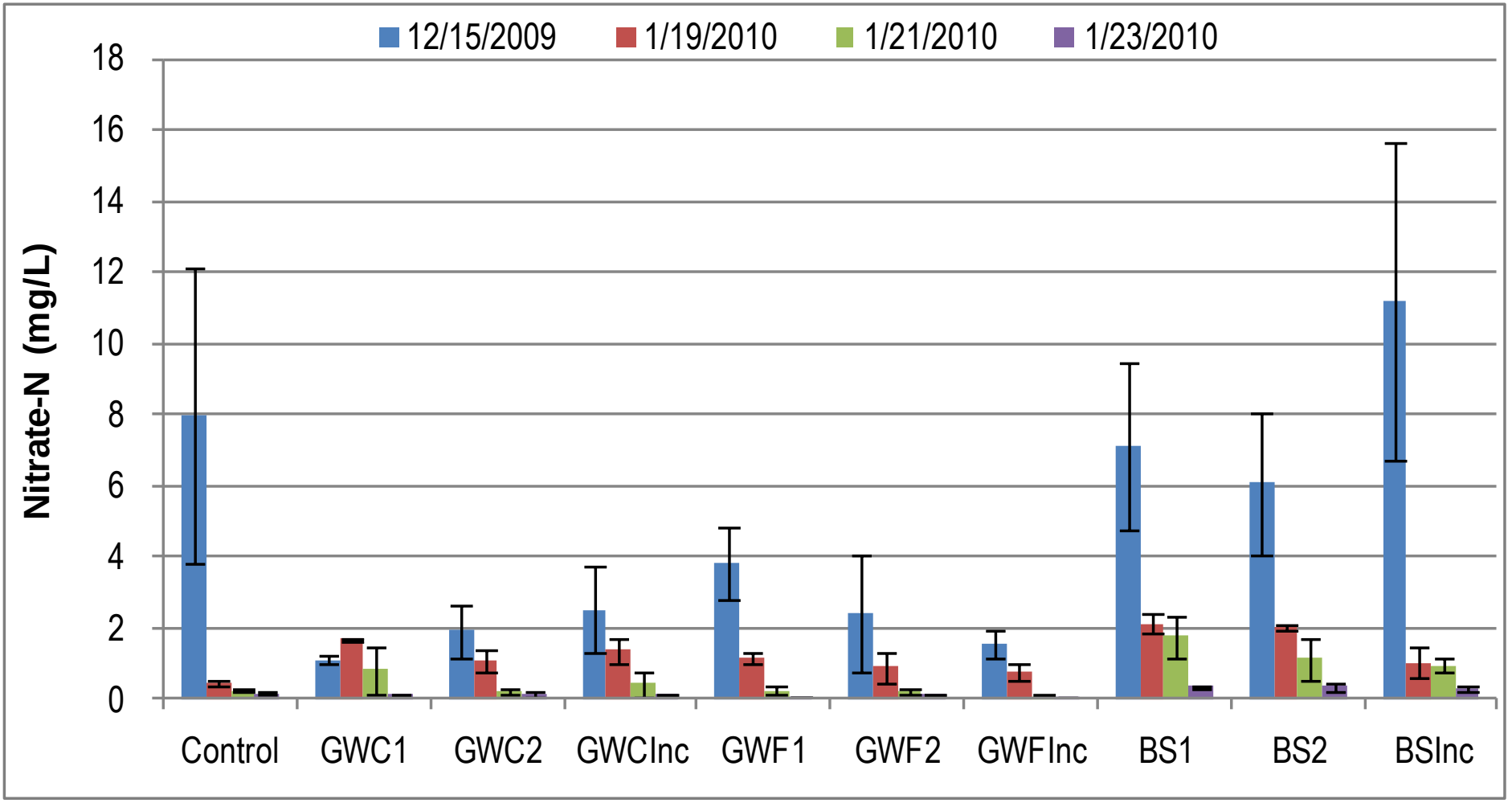
Nitrate-nitrogen



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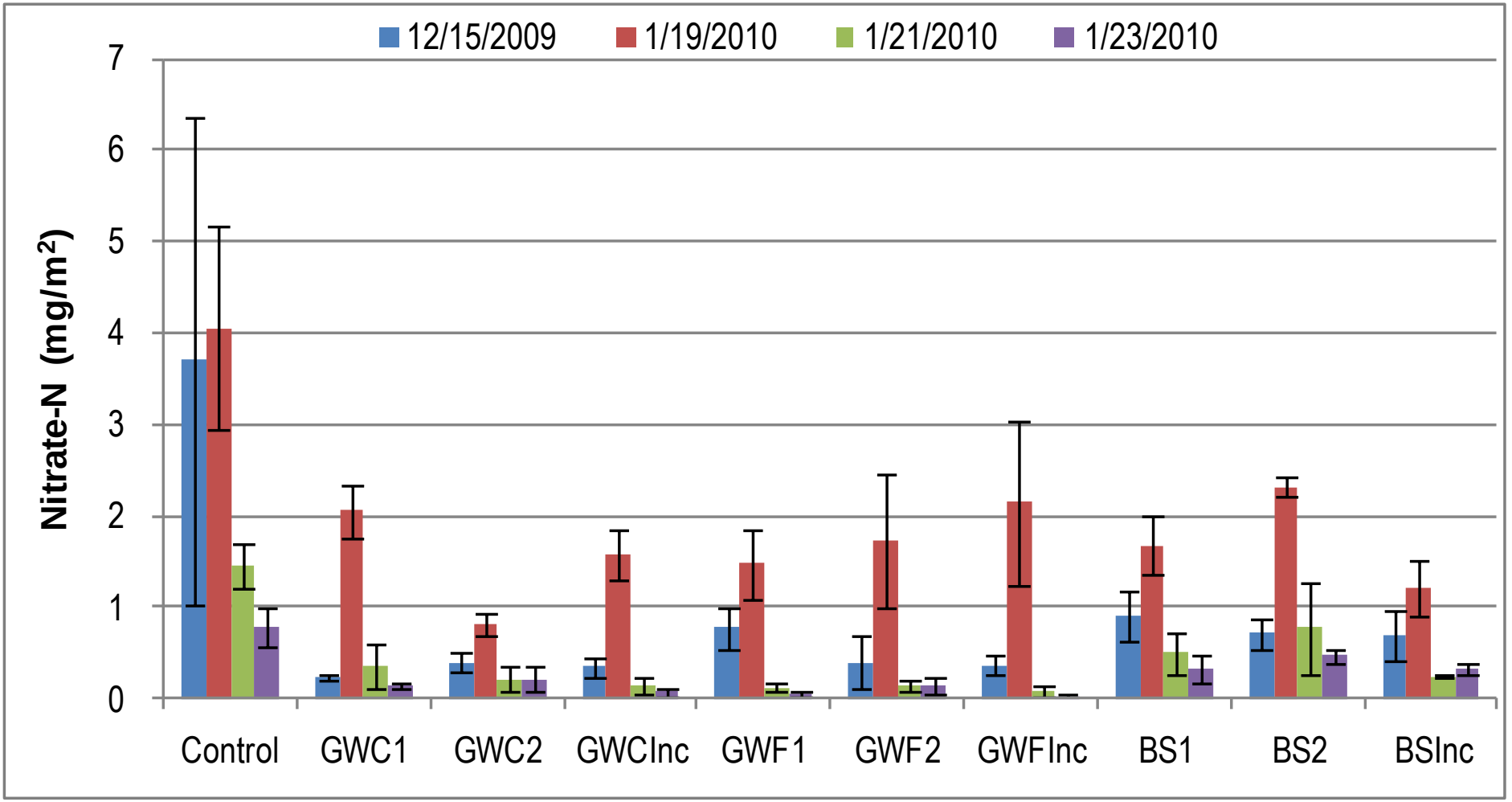
Nitrate-nitrogen



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Exported Mass

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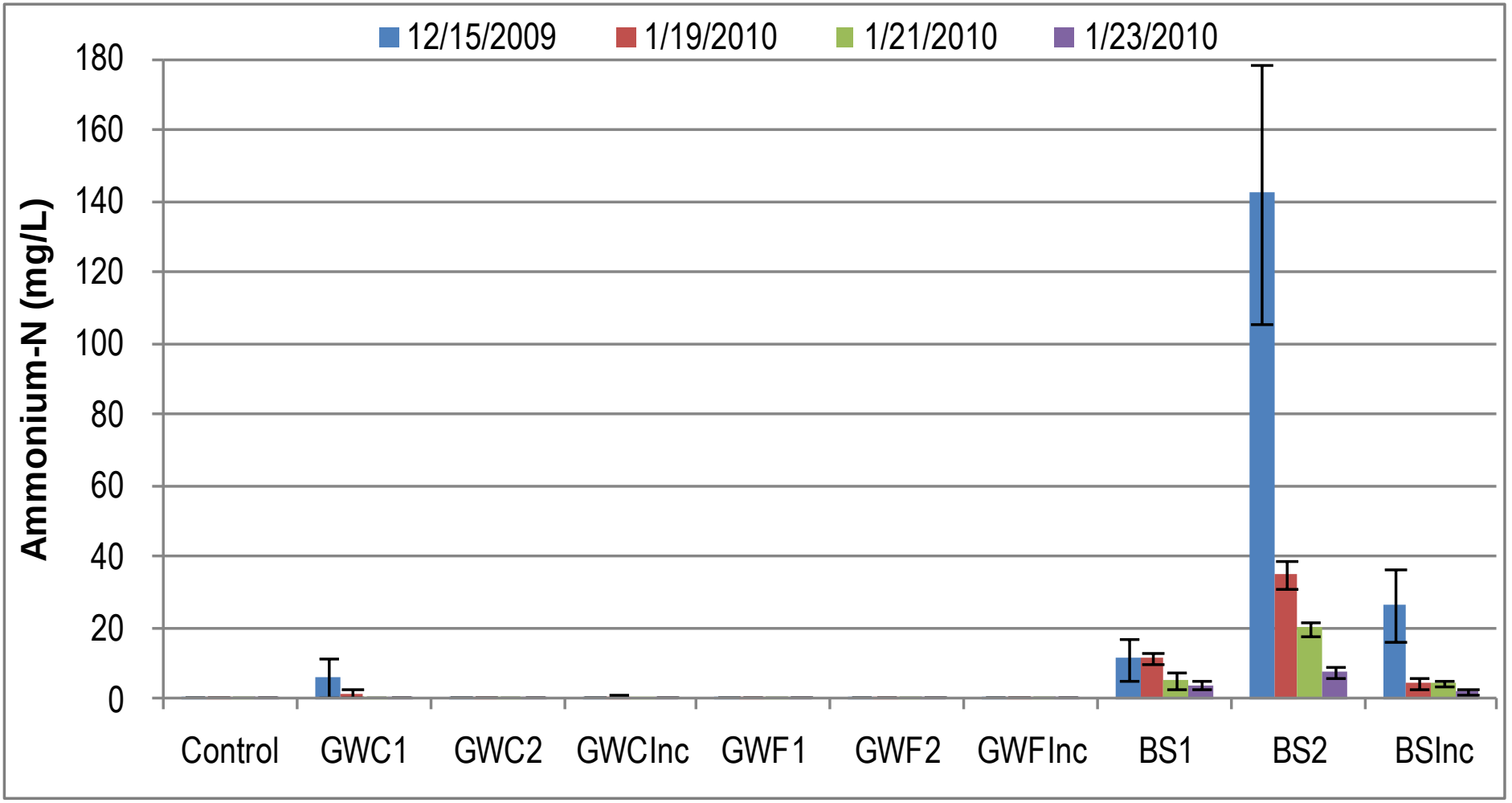
Ammonium-nitrogen



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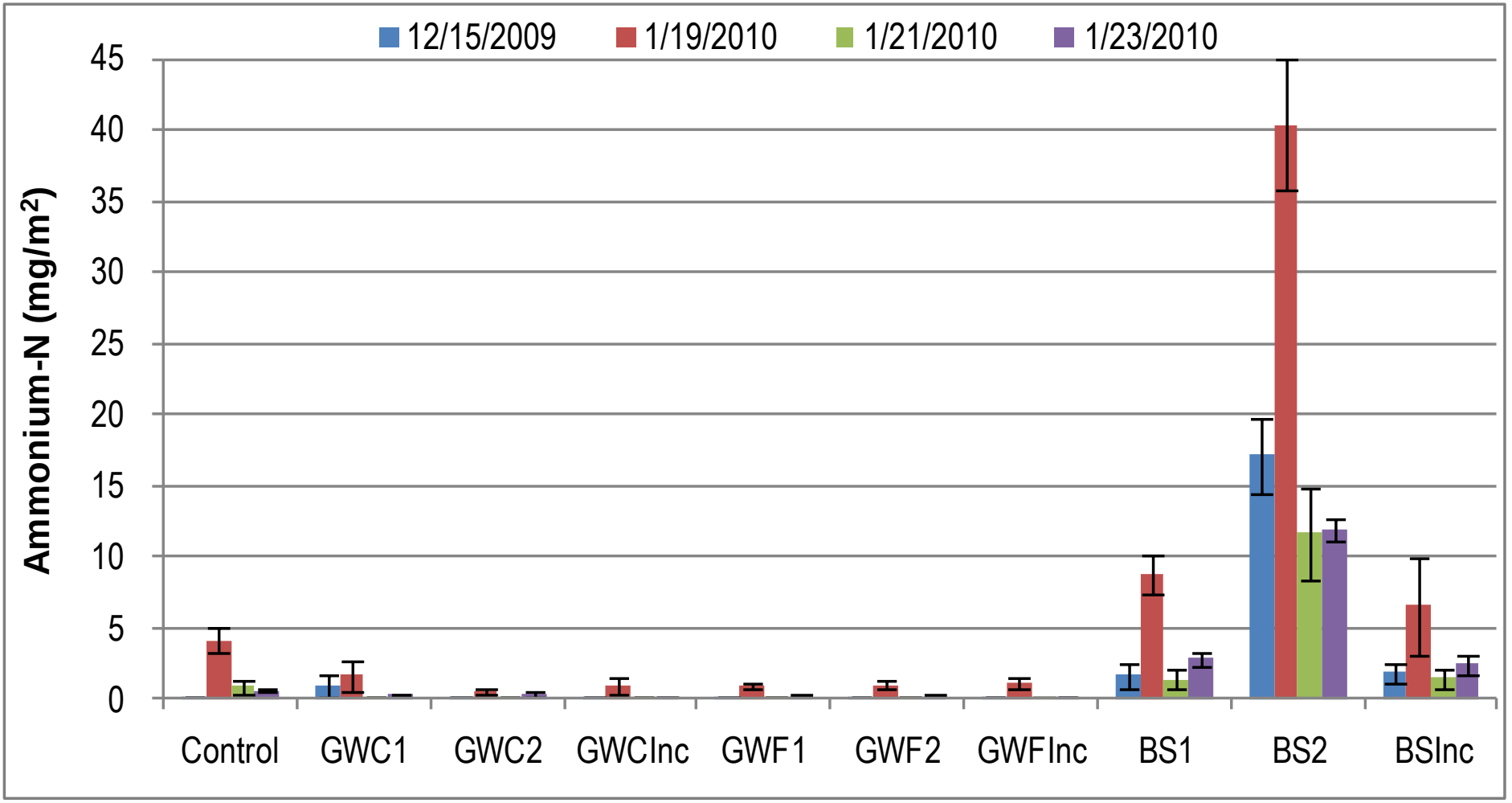
Ammonium-nitrogen



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Exported Mass

Metals

- Lead, and mercury were not detected during the study.
- Arsenic and selenium were detected rarely.
- Copper, molybdenum, nickel, and zinc were all present, though at low levels.
- Cadmium and chromium were initially present, though not always observed, particularly in runoff from the biosolids co-compost mulch plots.
- By the last two storms, concentrations were generally below detection limits, although BS2, with its higher sediment losses, did register more detectable values.
- As expected, biosolids co-composts yielded more metals than either of the greenwaste composts.

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Photo: Simon Wong Engineering

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Seed Mixes

- Seed Mix 1
  - Bromus carinatus "Cucamonga" (Cucamonga Brome)
  - Trifolium tridentatum (Tomcat Clover)
  - Vulpia microstachys (Small Fescue)
- Seed Mix 2
  - Artemisia californica (California Sagebrush)
  - Atriplex canescens (Four-wing Saltbrush)
  - Baccharis sarothroides (Broom Baccharis)
  - Encelia actonii (Acton Bush Encelia)
  - Eriogonum fasciculatum (Hairy Yerba Santa)
  - Eriogonum fasciculatum (California Buckwheat)
  - Eriophyllum confertiflorum (Golden Yarrow)
  - Eschscholzia californica (California Poppy)
  - Isomeris arborea (Bladderpod)
  - Lasthenia glabrata (Goldfields)
  - Lotus scoparius (Deerweed)
  - Lupinus succulentus (Arroyo Lupine)
  - Salvia apiana (White Sage)
  - Salvia mellifera (Black Sage)
  - Vulpia microstachys (Small Fescue)

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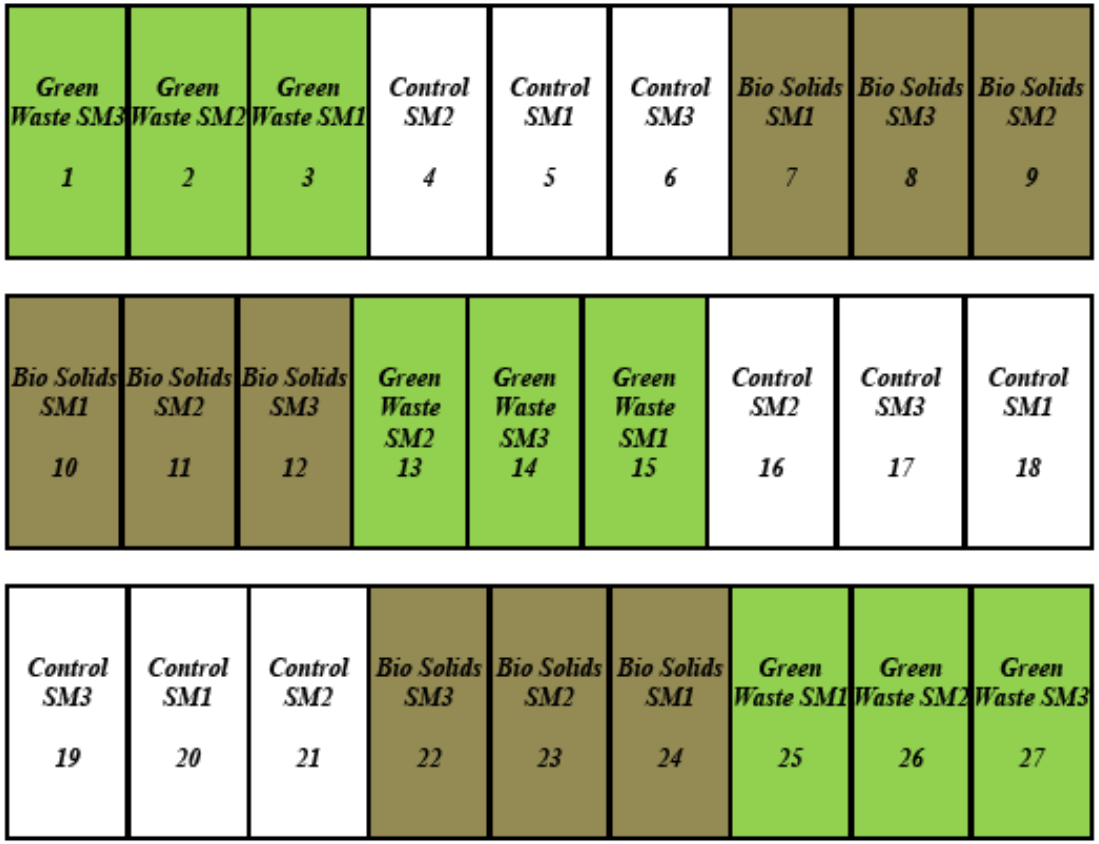
Split-Plot Design Layout



SM1- Seed Mix type-1
SM2- Seed Mix type-2
SM3- Seed Mix type-3 (no actual seed mix)

Materials

- Greenwaste compost
- Biosolids compost
- No compost

Rate

- 1 inch

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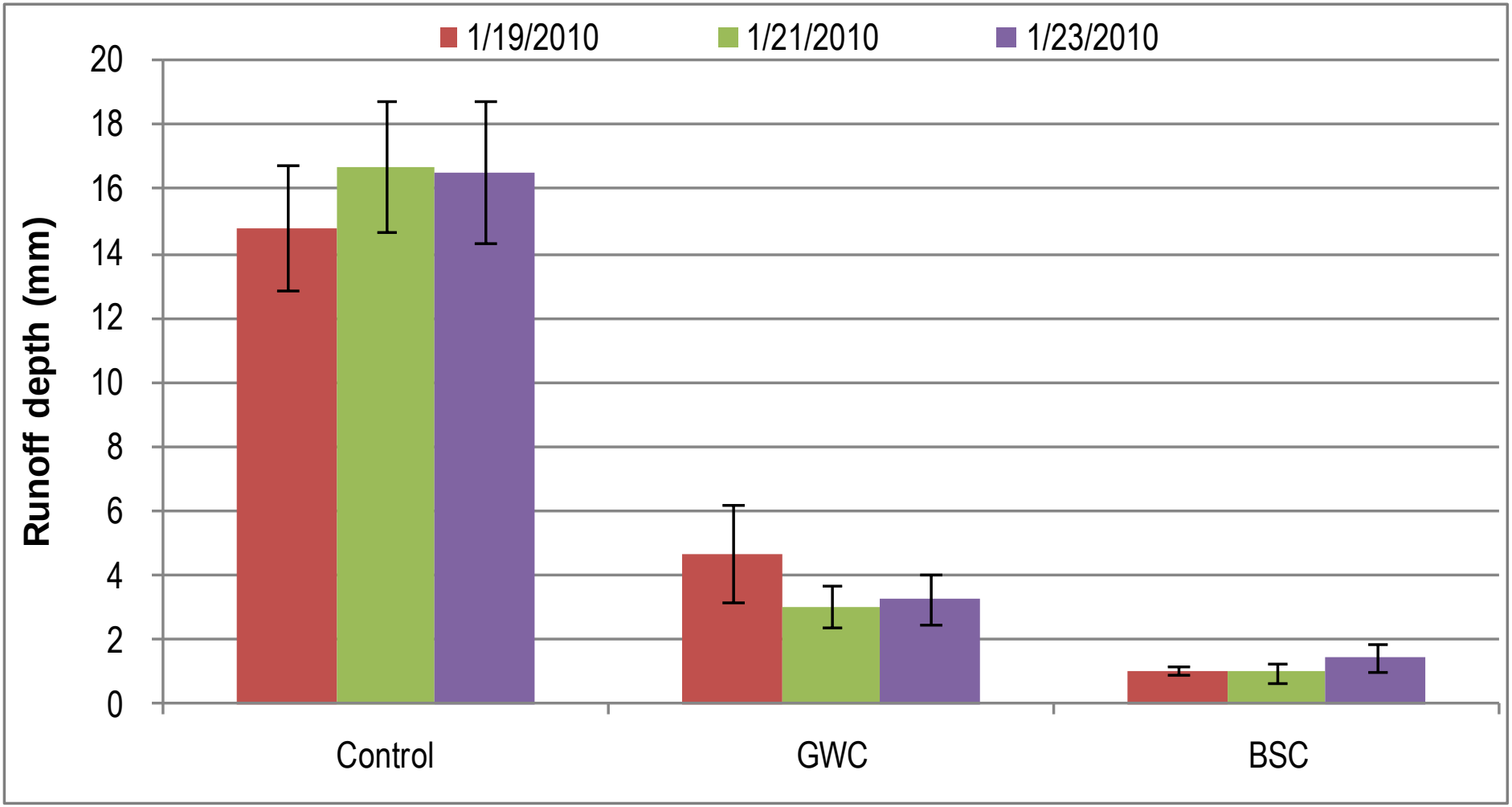
Total Runoff Depth



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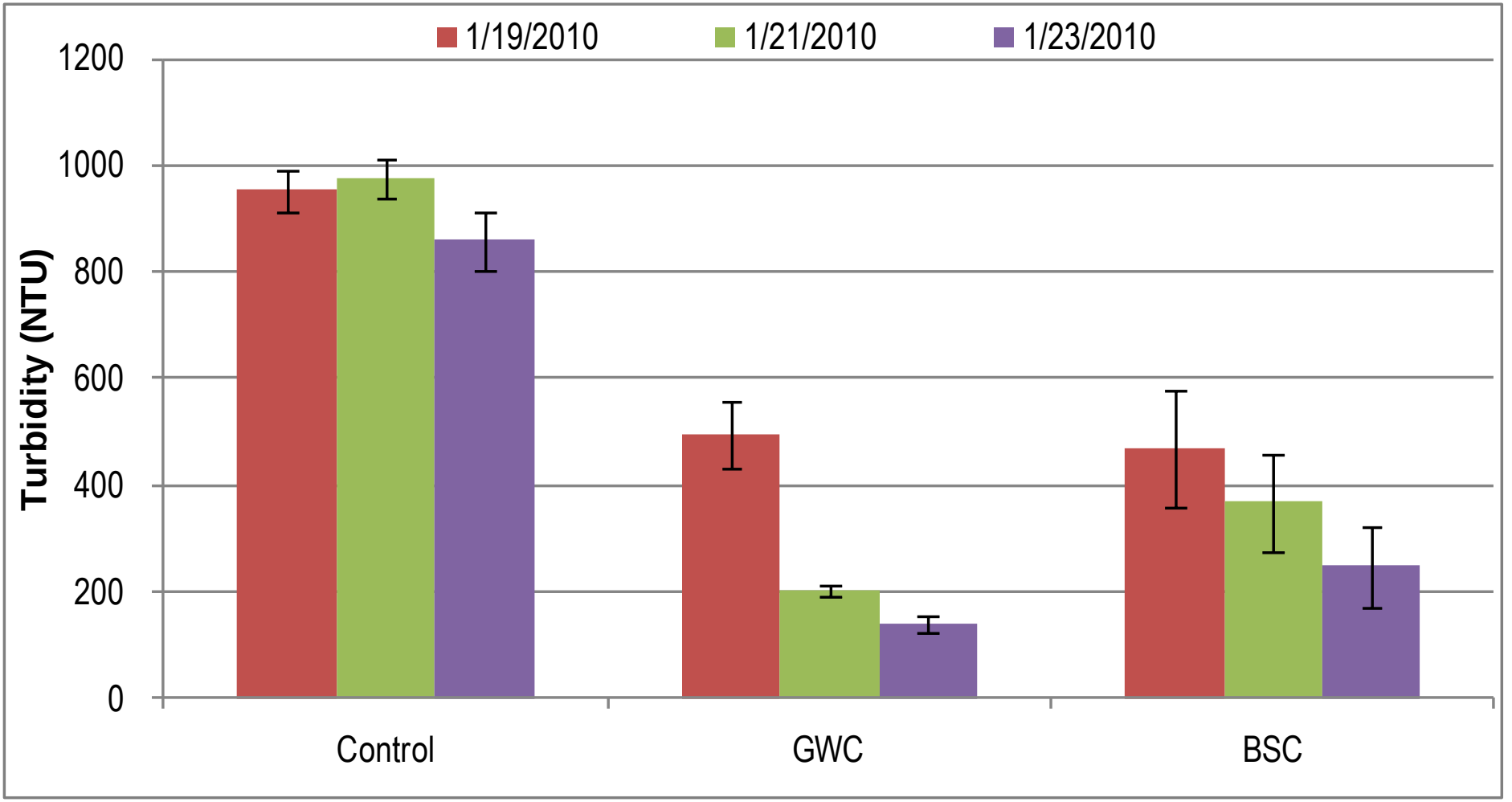
Turbidity



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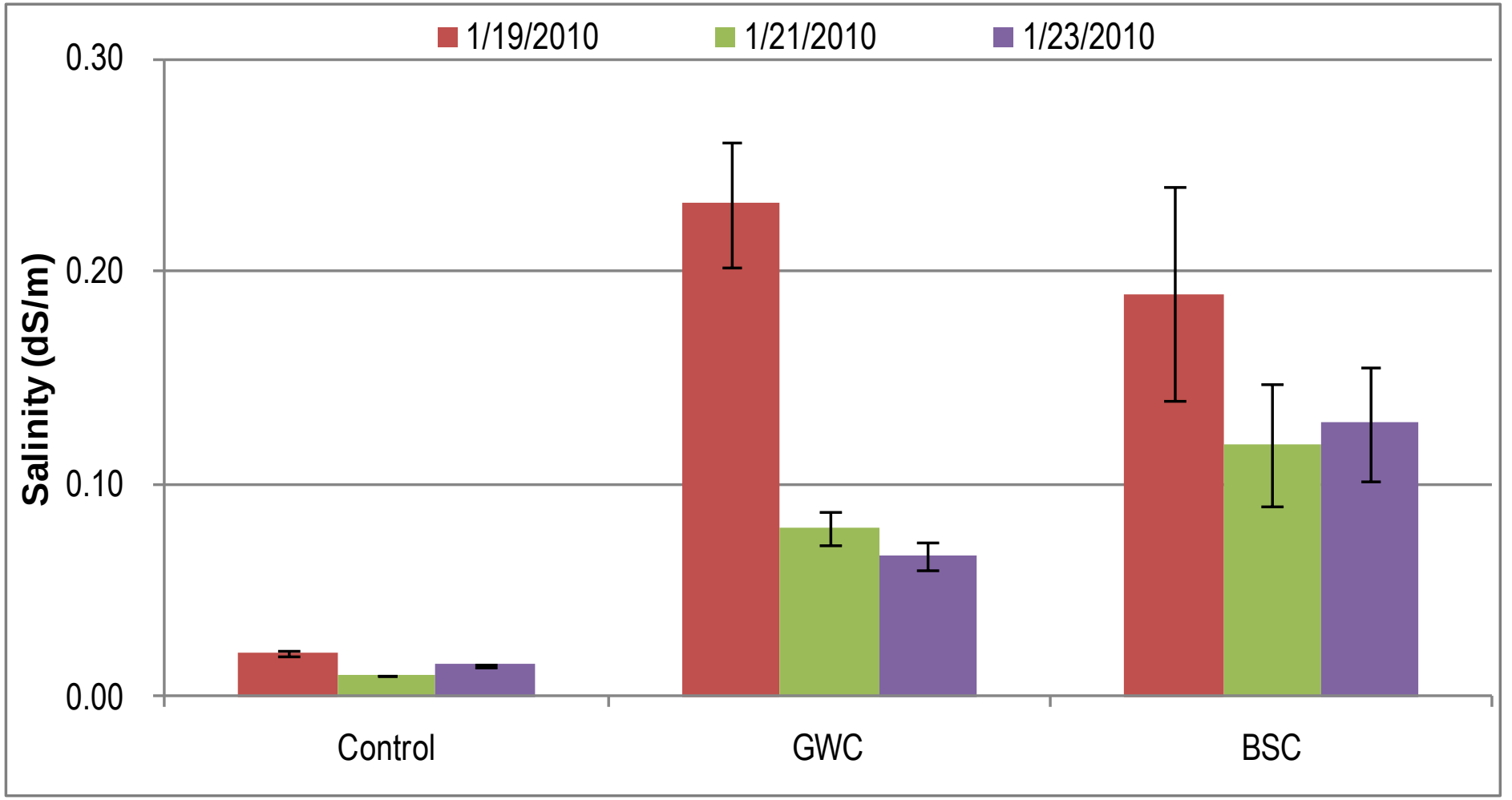
Salinity



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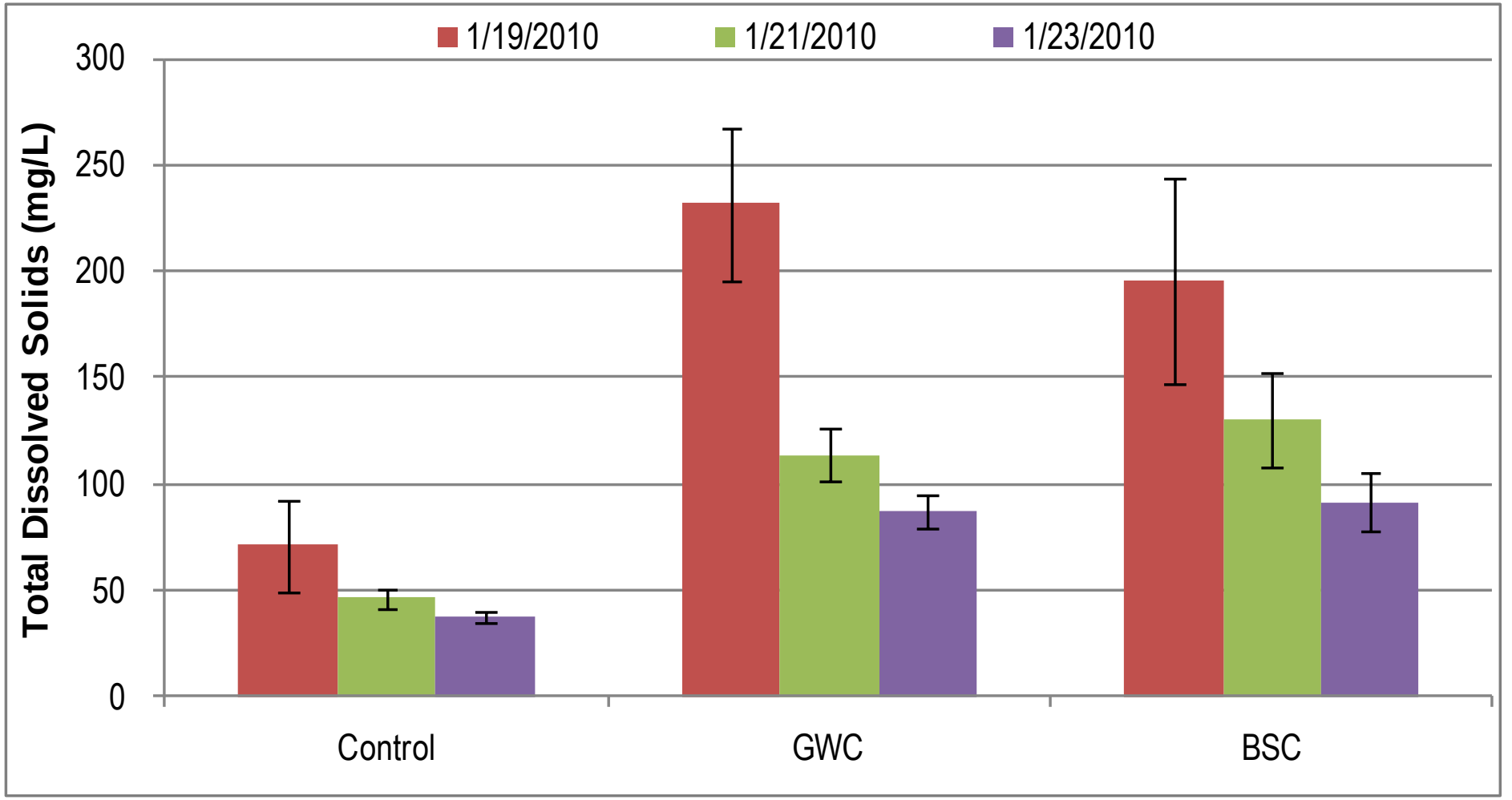
Total Dissolved Solids



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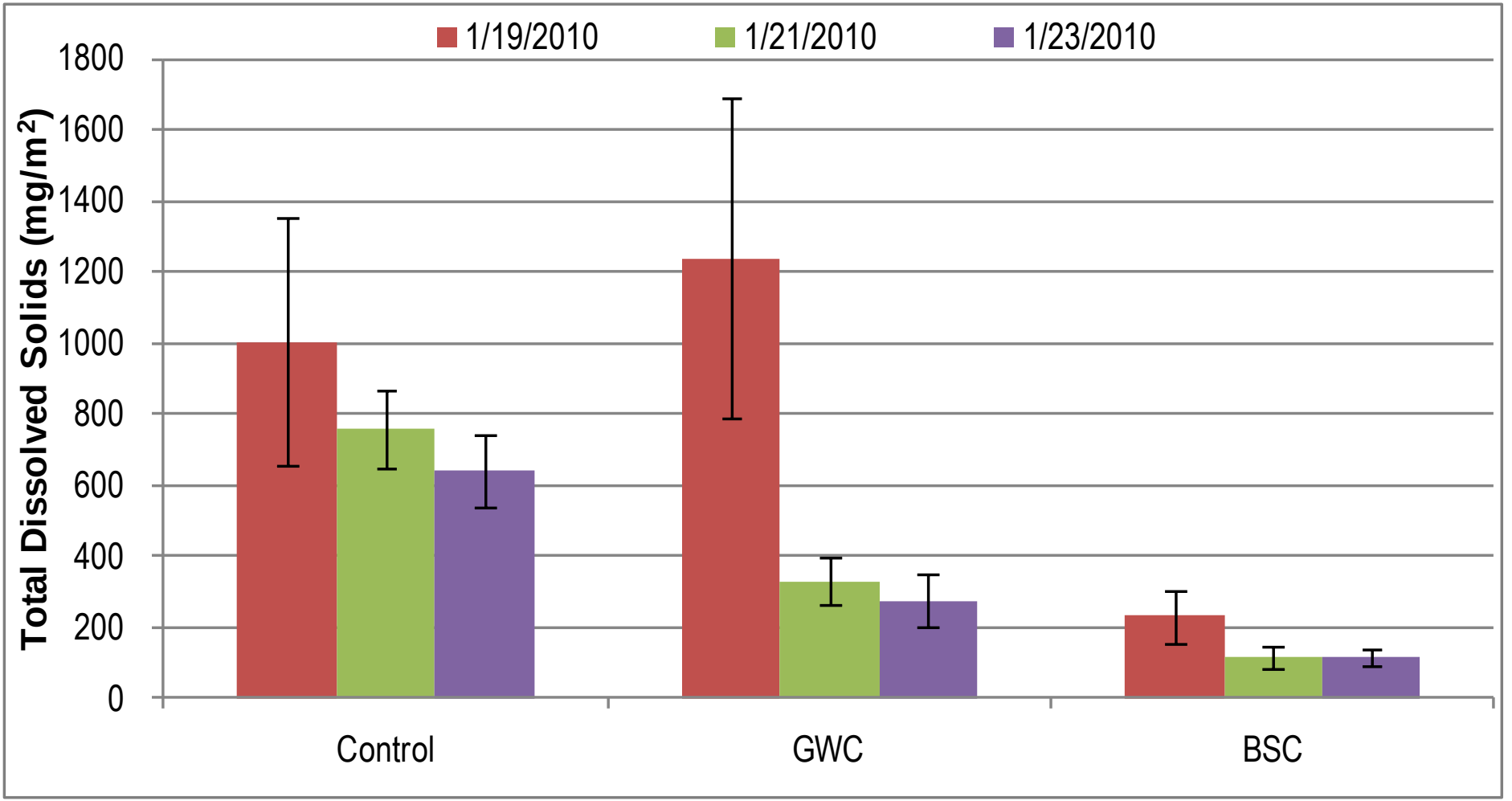
Total Dissolved Solids



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Exported Mass

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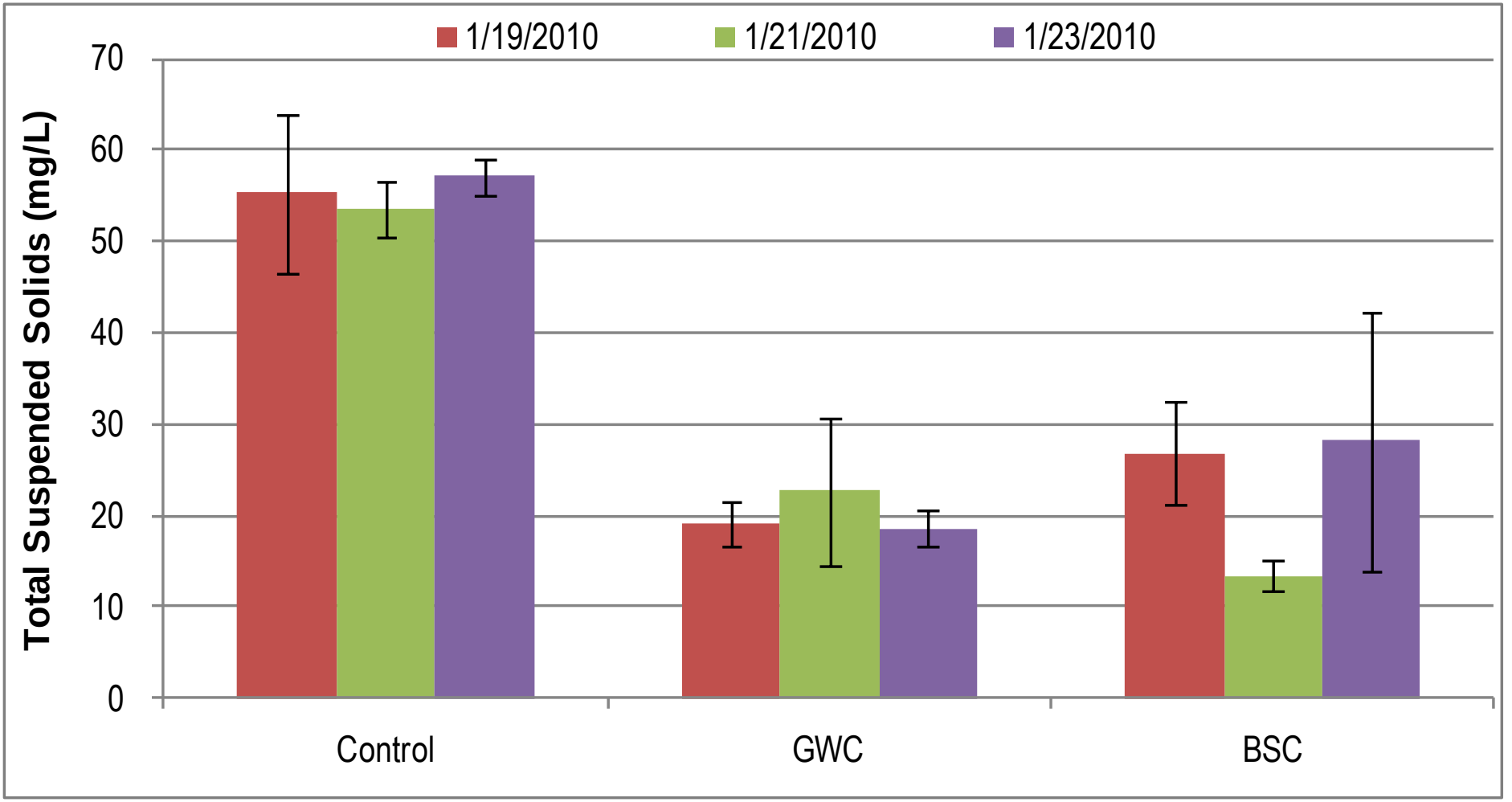
Total Suspended Solids



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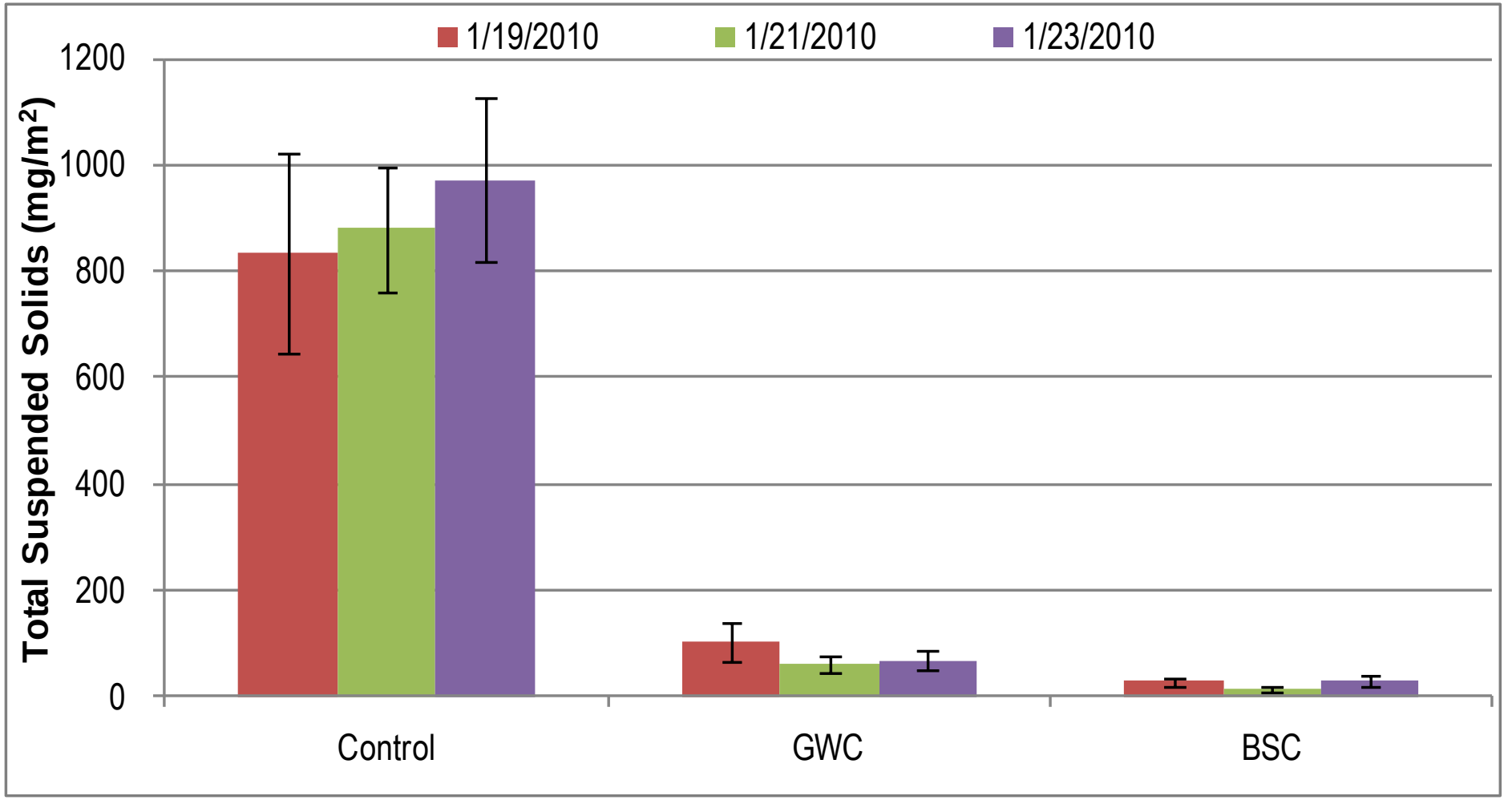
Total Suspended Solids



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Exported Mass

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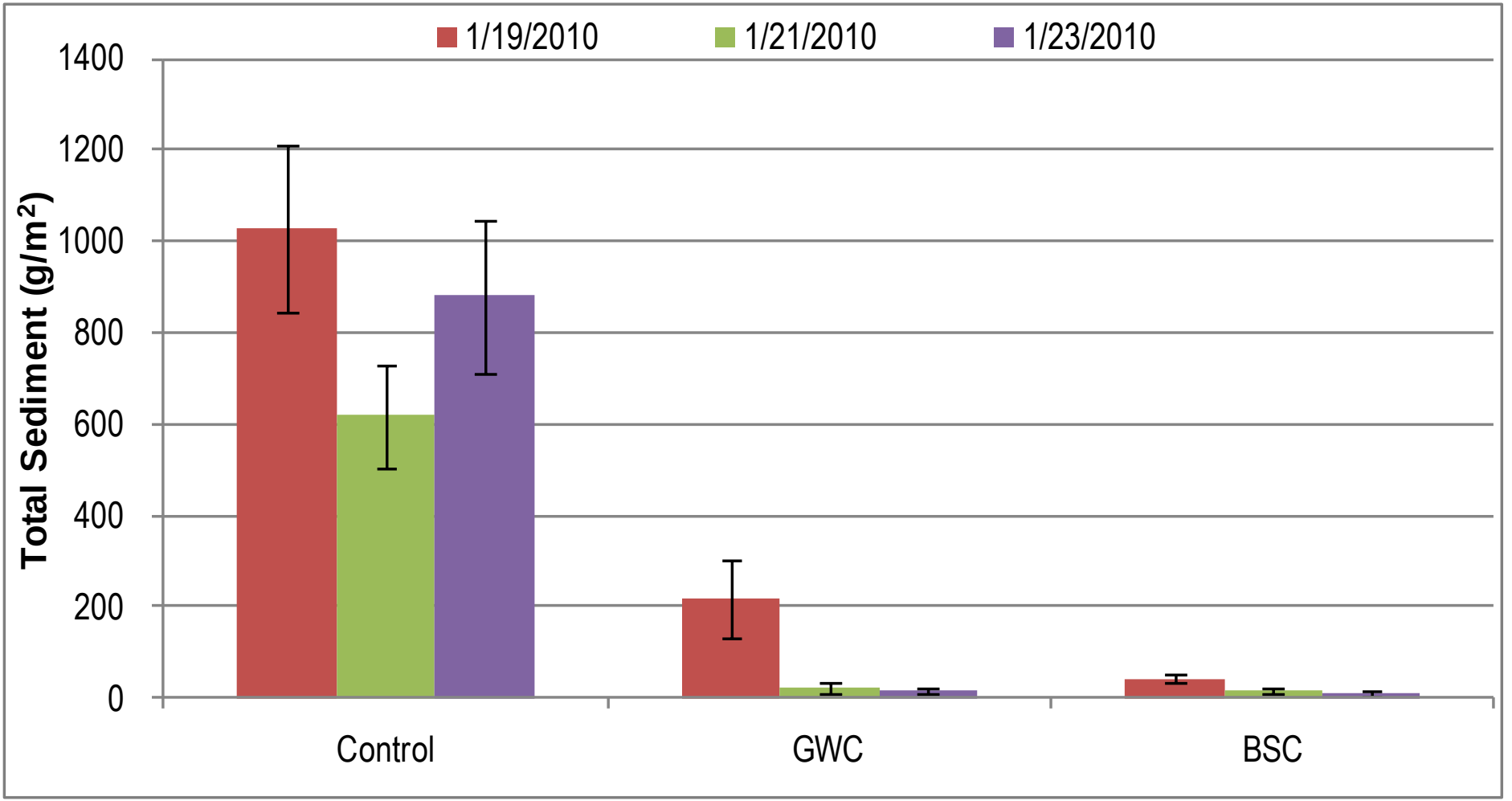
Total Solids



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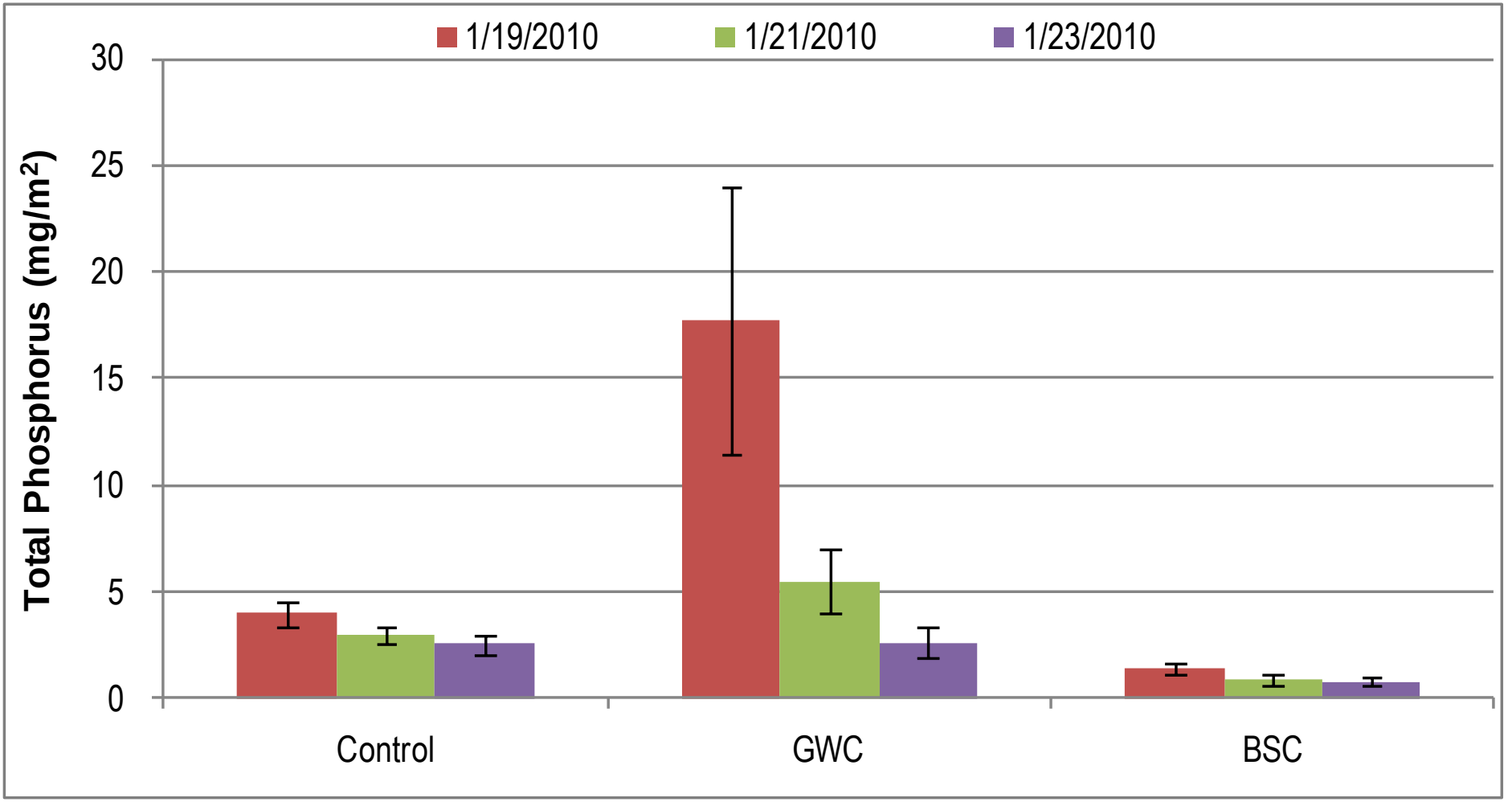
Total Phosphorus



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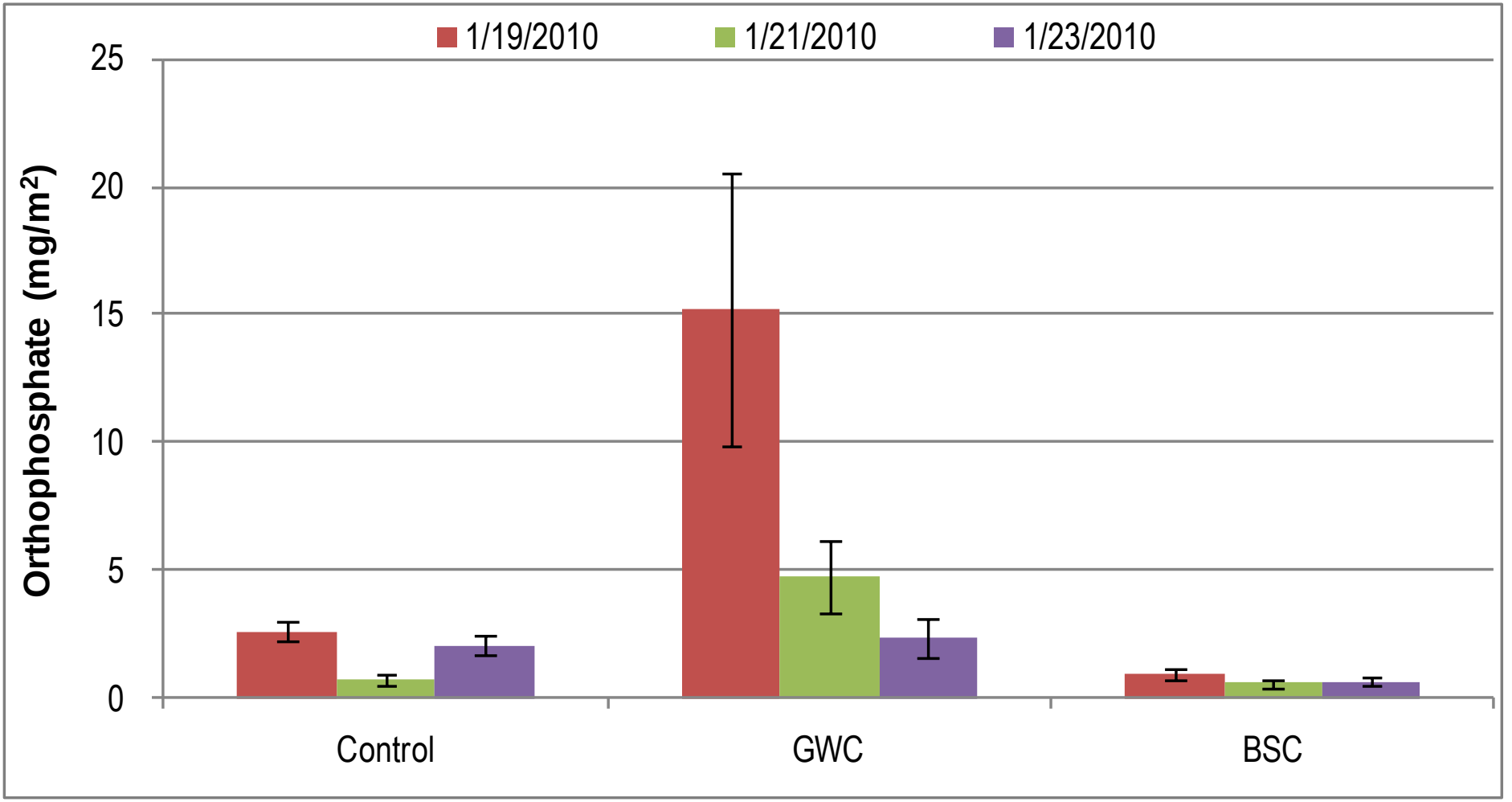
Orthophosphate



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Exported Mass

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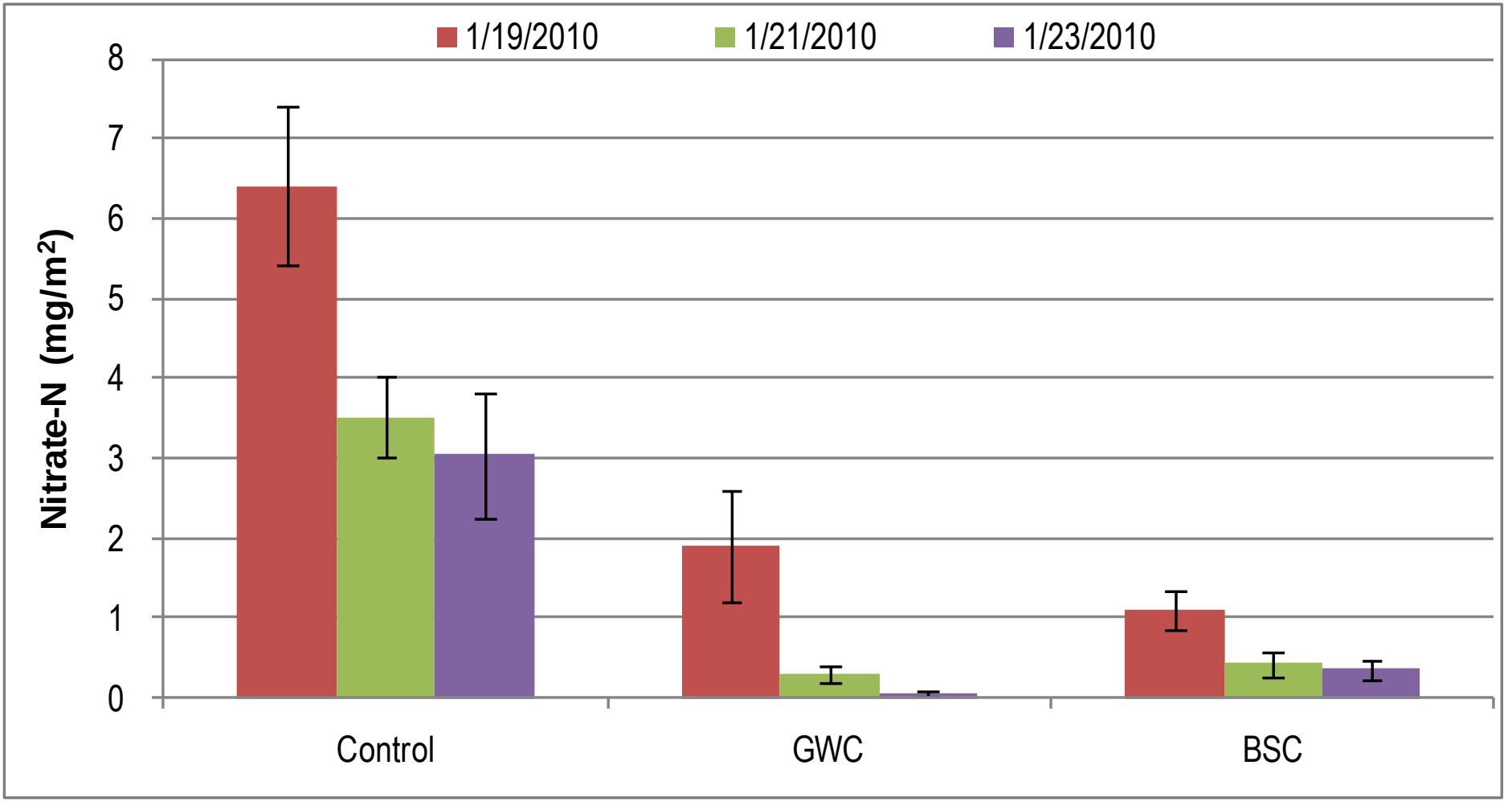
Nitrate-nitrogen



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Exported Mass

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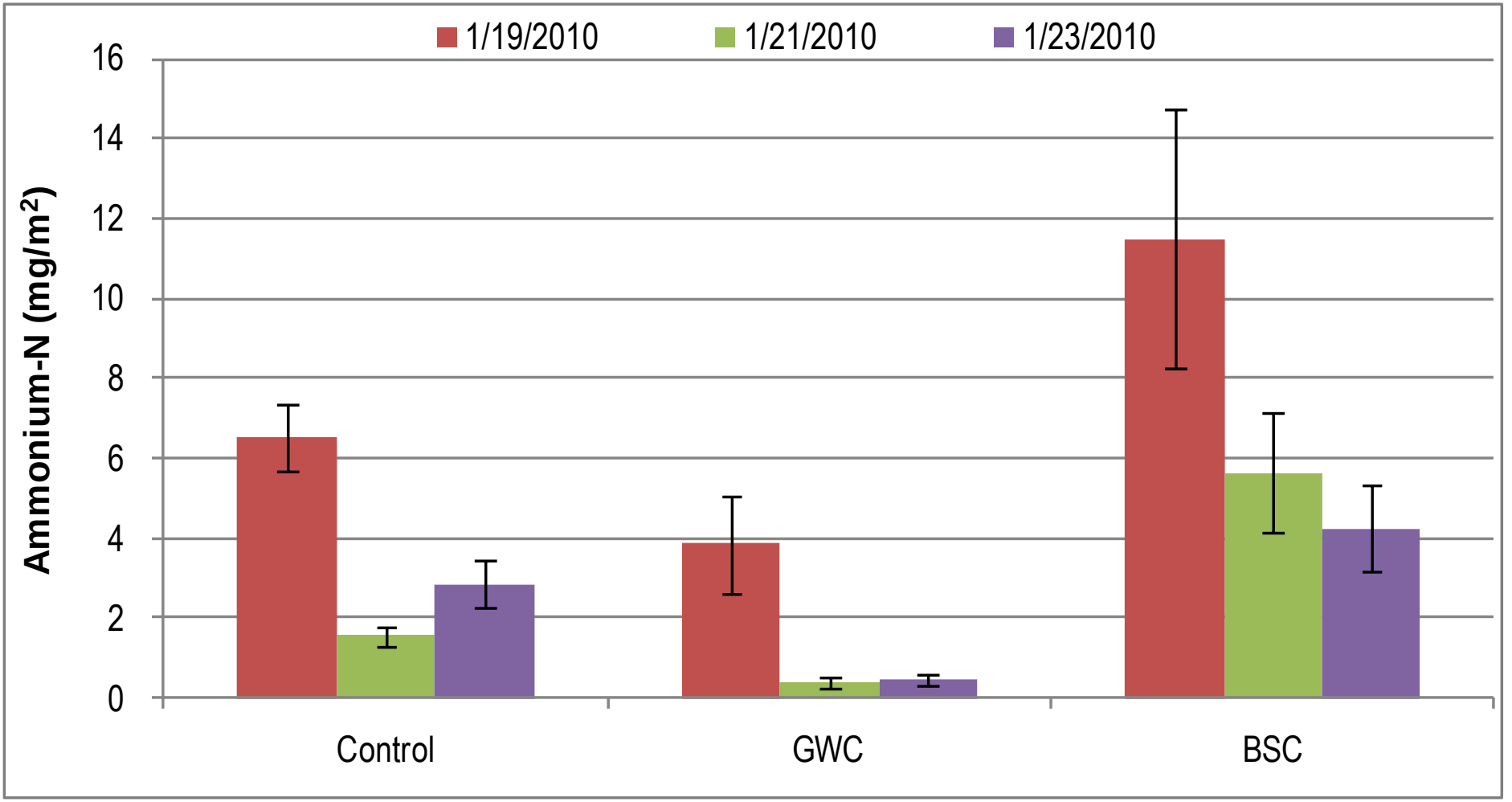
Ammonium-nitrogen



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Vegetation

Andrew Sanders
March 26, 2010

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Composting BMPs for Water Quality

David Crohn
University of California, Riverside

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Composting BMPs

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Composting BMPs

- **Key Concepts**
  - Pollutants move out of piles with water
  - Control the water and you control the pollutants
  - Compost can hold a considerable amount of water
  - BMPs take advantage of this water holding property
- **Strategy**
  1. Develop test for the potential ***water holding capacity*** of composts
  2. Evaluate movement of water through a pile during a precipitation event using a ***column study***
  3. Evaluate strategies for encouraging water ***infiltration***
  4. Develop a ***management procedure*** for composters to reduce water losses from their piles.

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1. Water Holding Capacity

Difference between compost moisture at "field capacity" and the compost moisture in the pile.

$$Wet\ basis\ moisture\ content = \frac{Bag\ mass\ with\ moist\ compost\ (g) - Bag\ mass\ with\ dry\ compost\ (g)}{Bag\ mass\ with\ moist\ compost\ (g) - Empty\ bag\ mass\ (g)}$$

2. Column Study

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Packing

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1.3 inches per hour

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Data Collection

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Covering

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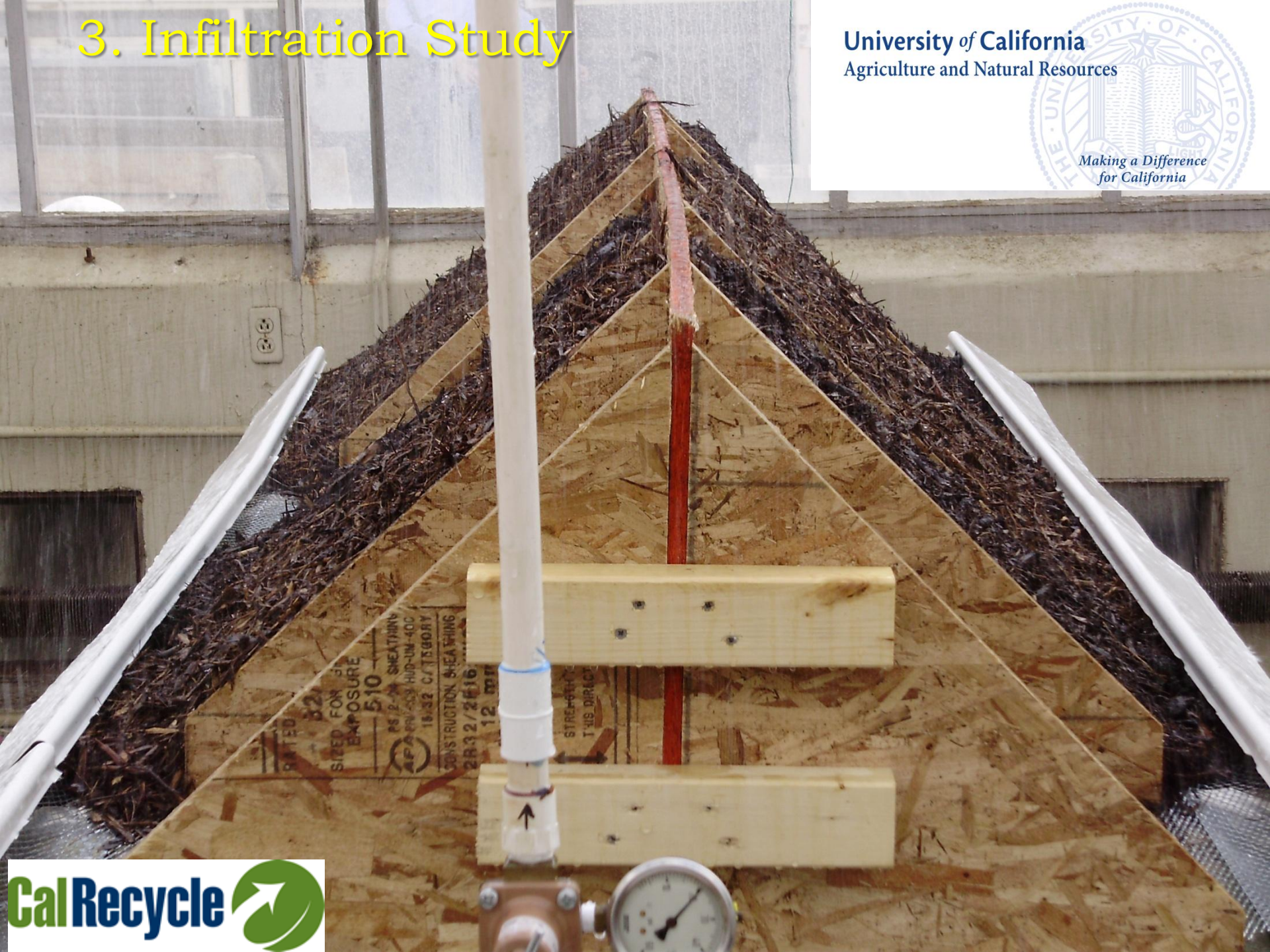
Efficiency factors

	Mean	*Std. Error*
	Greenwaste Compost	
Day 1	1.26	0.08
Day 7	0.93	0.21
Day 14	0.82	0.12
	Biosolids Co-compost	
Day 1	0.97	0.12
Day 7	0.39	0.06
Day 14	1.14	0.11
	Combined Data	
All Composts	0.92	0.12
No outlier	**1.03**	**0.08**

3. Infiltration Study



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Bin Construction

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Bin Construction

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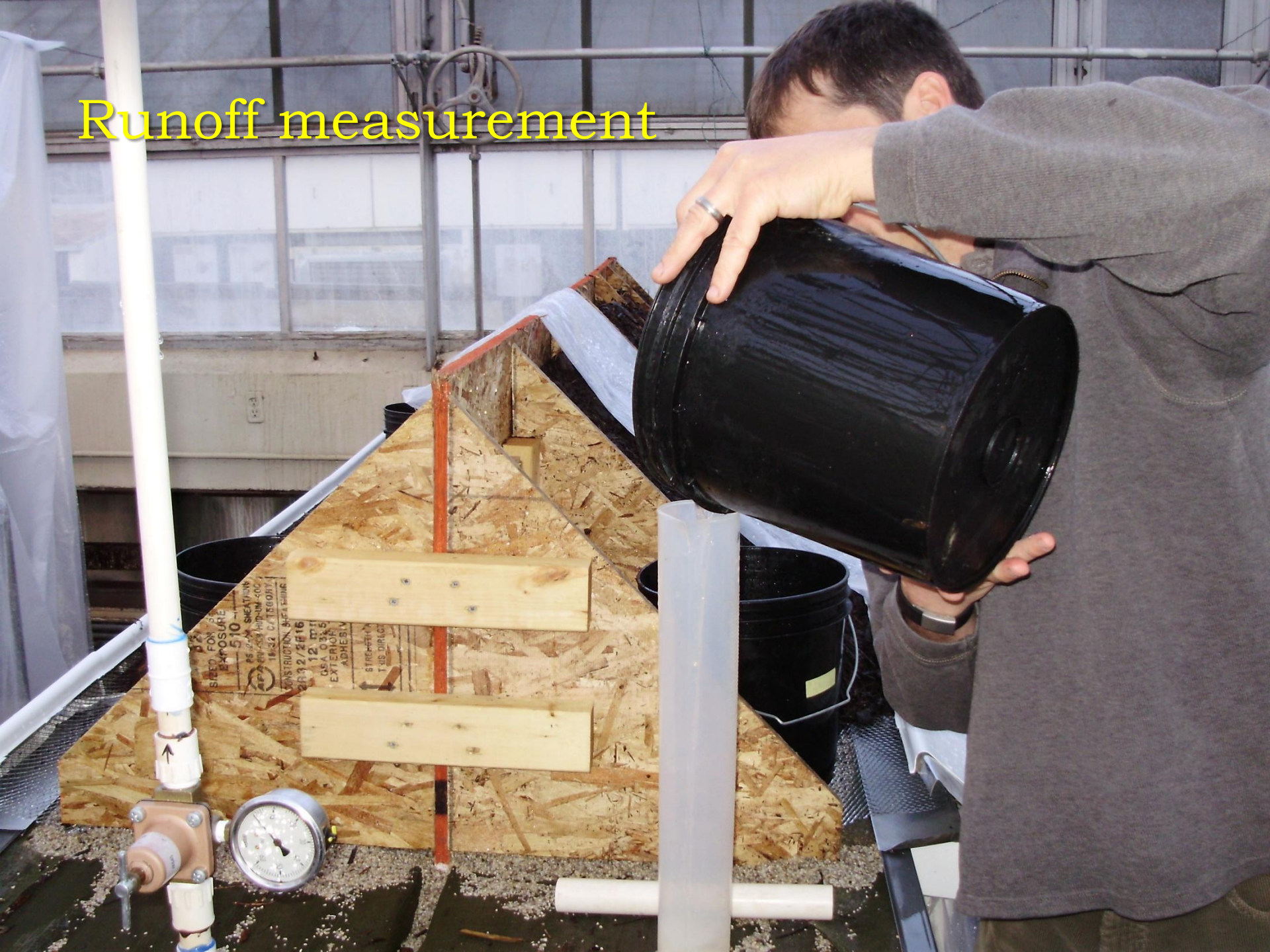
Runoff measurement

Treatments

- Sloped compost
  - fresh material installed to fill bin
  - covered with 1 cm oven dry compost
  - Also turned
- Flat compost
  - fresh material installed to approximately 17 cm
  - covered with 1 cm oven dry compost
  - flat area extended to natural angle of repose
- Surfactant
  - fresh material was installed to fill the bin
  - Covered with 1 cm oven dry
  - 1 Tb *E*-Z Wet Soil Penetrant 26 was dissolved in 500 mL water an applied as a pressurized aerosol to each bin
- Three 30 minute high intensity (~4 in/hr) rain events for each treatment

Flat topped piles

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Resulting runoff fractions

	Sloped Surface	Flat Surface	Surfactant
	Greenwaste compost, dry on top		
Control	0.109±0.006a	0.115±0.001a	0.122±0.014a
Day 1	0.254±0.050a	0.138±0.009a	0.100±0.023b
Day 7	0.247±0.044a	0.138±0.019ab	0.102±0.037b
Day 14	0.123±0.029a	0.080±0.002a	0.084±0.063a
	Greenwaste compost, over 1.5 hrs		
Control	0.114±0.008a	0.114±0.001a	0.119±0.013a
Day 1	0.202±0.057a	0.132±0.012a	0.106±0.020a
Day 7	0.137±0.016a	0.131±0.024a	0.110±0.023a
Day 14	0.081±0.028a	0.084±0.017a	0.091±0.050a
	Greenwaste compost, turned		
Control	0.113±0.098a	0.101±0.004a	
Day 1	0.092±0.029a	0.133±0.004a	
Day 7	0.059±0.046a	0.103±0.026a	
Day 14	0.055±0.050a	0.084±0.054a	
	Biosolids co-compost, dry on top		
Control	0.158±0.013a	0.132±0.016a	0.134±0.015a
Day 1	0.133±0.005a	0.117±0.007a	0.157±0.003b
Day 7	0.154±0.009a	0.116±0.011b	0.184±0.008c
Day 14	0.107±0.020a	0.115±0.014a	0.100±0.016a
	Biosolids compost, total		
Control	0.155±0.007a	0.136±0.020a	
Day 1	0.153±0.009a	0.137±0.008a	
Day 7	0.178±0.015a	0.136±0.005a	
Day 14	0.108±0.017a	0.112±0.018a	

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Red is very similar to the controls indicating little or no runoff

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Management procedure

- Can use "field capacity" and pile moisture measures to estimate water holding capacity
- Find inches of compost/inch of rain and use this storage
- Additional moisture may slow air movement
- Infiltration was not really a problem, but
  - Dry greenwaste compost benefits from surfactant, less important for moist compost.
  - A flat top likely encourages infiltration, even though we did not "prove" this due to variability. Larger-scale studies might.
  - Turning did not assist in infiltration, though in the field this may be a way to moisten the surface

(Not Real Ivory)

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Design tool

	Wet Weight (g)	Dry Weight (g)	Moisture Content	Pick one: Greenwaste Compost	Pick one: Biosolids Co-compost
Field Capacity:	300	100	67%		
Compost Moisture:	200	90	55%	○ Day 1	○ Day 1
Compost Bulk Density:	1200	lb/yd^3		○ Day 7	○ Day 7
Storage Capacity:	**5.2 inches compost/inch rain**			○ Day 14	◉ Day 14
Efficiency 92%		Efficiency Level:		○ Average ○ Stricter	◉ Strictest

White regions indicate required information.

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Conclusions

- Composts effectively reduced the mass export of pollutants from fire damaged and construction damaged soils
- 1 inch was better than either 2 inches or 2 inches incorporated
- Compost piles can hold considerable water and the amount is largely predictable
  - Water may slow air movement
  - Density influence has not been studied