Accessing Reduction of Nonpoint Source Phosphorous Runoff From Land Application of Biosolids Treated With Water Treatment Residuals

Project # FY 07-200

Project Leaders

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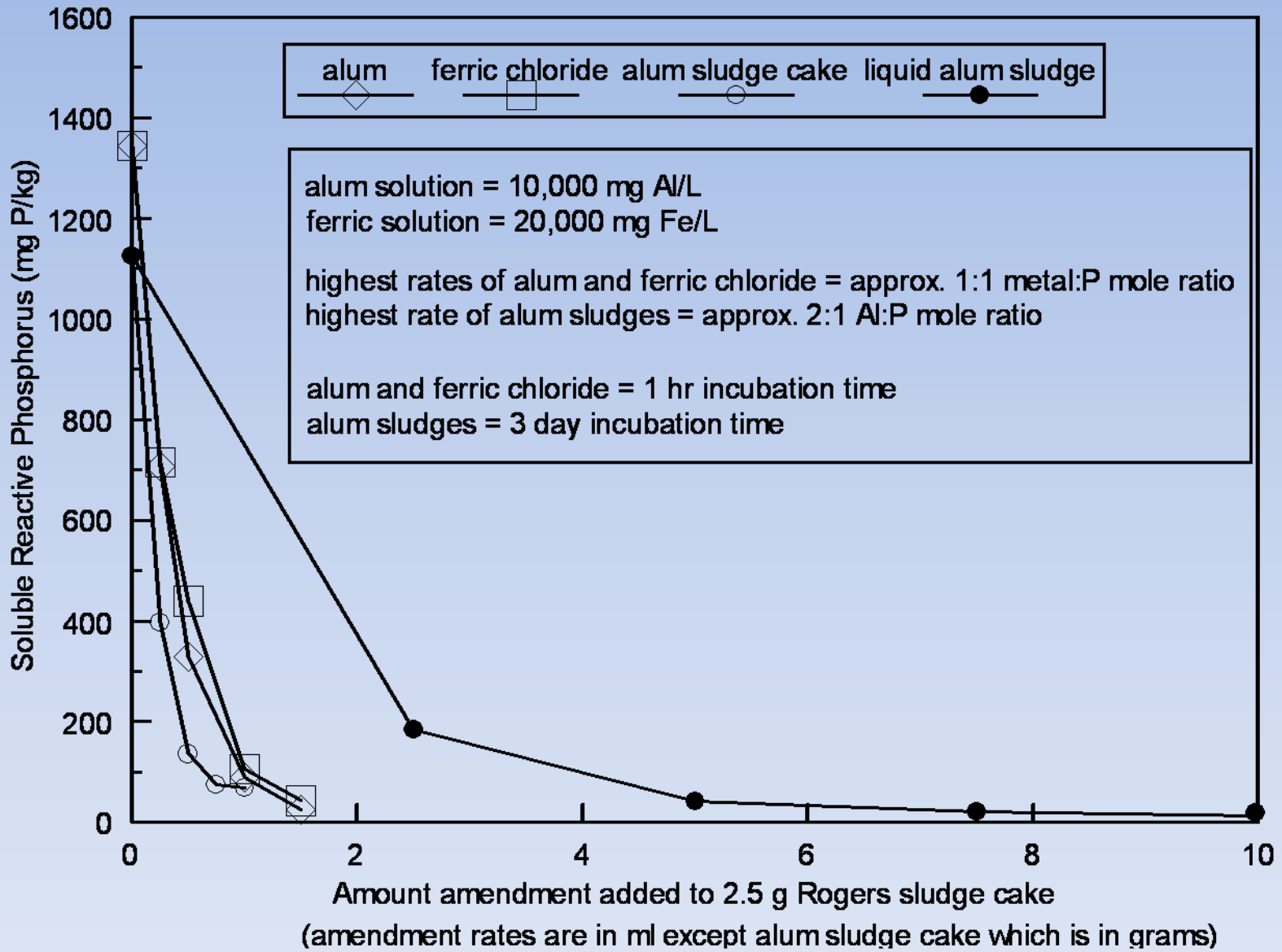
Background

- Non-point source Phosphorus
  - Problematic as considered the limiting element in eutrophication
  - 80-90% of phosphorus in runoff water from land fertilized with animal manures or biosolids is dissolved reactive phosphorus
  - Reactive phosphorus is readily available for uptake by algae and other nuisance growth

Background

- Protective rates for nutrient applications in nutrient surplus areas
  - Forced area WWTPs to landfill instead of land application
- Phosphorus Index development for biosolids
  - Alum sludge from water treatment facilities evaluated for effects on P solubility
  - Alum sludge currently being landfilled


alum
ferric chloride
alum sludge cake
liquid alum sludge
alum solution = 10,000 mg Al/L
ferric solution = 20,000 mg Fe/L
highest rates of alum and ferric chloride = approx. 1:1 metal:P mole ratio
highest rate of alum sludges = approx. 2:1 Al:P mole ratio
alum and ferric chloride = 1 hr incubation time
alum sludges = 3 day incubation time
Soluble Reactive Phosphorus (mg P/kg)
1600
1400
1200
1000
800
600
400
200
0
0
2
4
6
8
10
Amount amendment added to 2.5 g Rogers sludge cake
(amendment rates are in ml except alum sludge cake which is in grams)

Background

- Laboratory tests indicated that both liquid and dewatered alum sludge can reduce soluble P in biosolids
- Preliminary small scale studies indicated a reduction of soluble P in runoff of approximately 50%

Research Goals/Objectives

- The purpose of this project is to demonstrate the efficacy, cost-effectiveness, practicality and sustainability of treating biosolids (sewage sludge) with water treatment residuals (alum sludge) for land application and reduction of NPS phosphorus in runoff.

Research Goals/Objectives

- Determine optimum dosage rates for both liquid and dewatered alum sludge
- Determine the limits of soluble P reduction
- Determine the effects on forage production
- Evaluate potential savings to infrastructure

Methods

- Small plot rainfall - runoff simulations
  - Samples taken prior to fertilization (background)
  - Biosolid – alum sludge mixtures applied
  - Rainfall simulation (2” per hour storm)
  - Samples taken and analyzed
  - Process repeated on same plots after
    - 1 week
    - 3 weeks
    - 9 weeks

Methods

- Watershed level demonstrations
  - Three watersheds constructed
    - Hydrologically isolated
    - Flumes and automatic samplers installed
  - Background sampling performed
  - Biosolids alone applied to one watershed
  - Biosolids and “optimum” rate of alum sludge applied to one watershed
  - No application of any substance to third

Methods

- Watershed Level Demonstrations
  - In the event of runoff generating rainfall events
    - Runoff volumes measured
    - Samples taken for analysis
    - Forage growth periodically evaluated

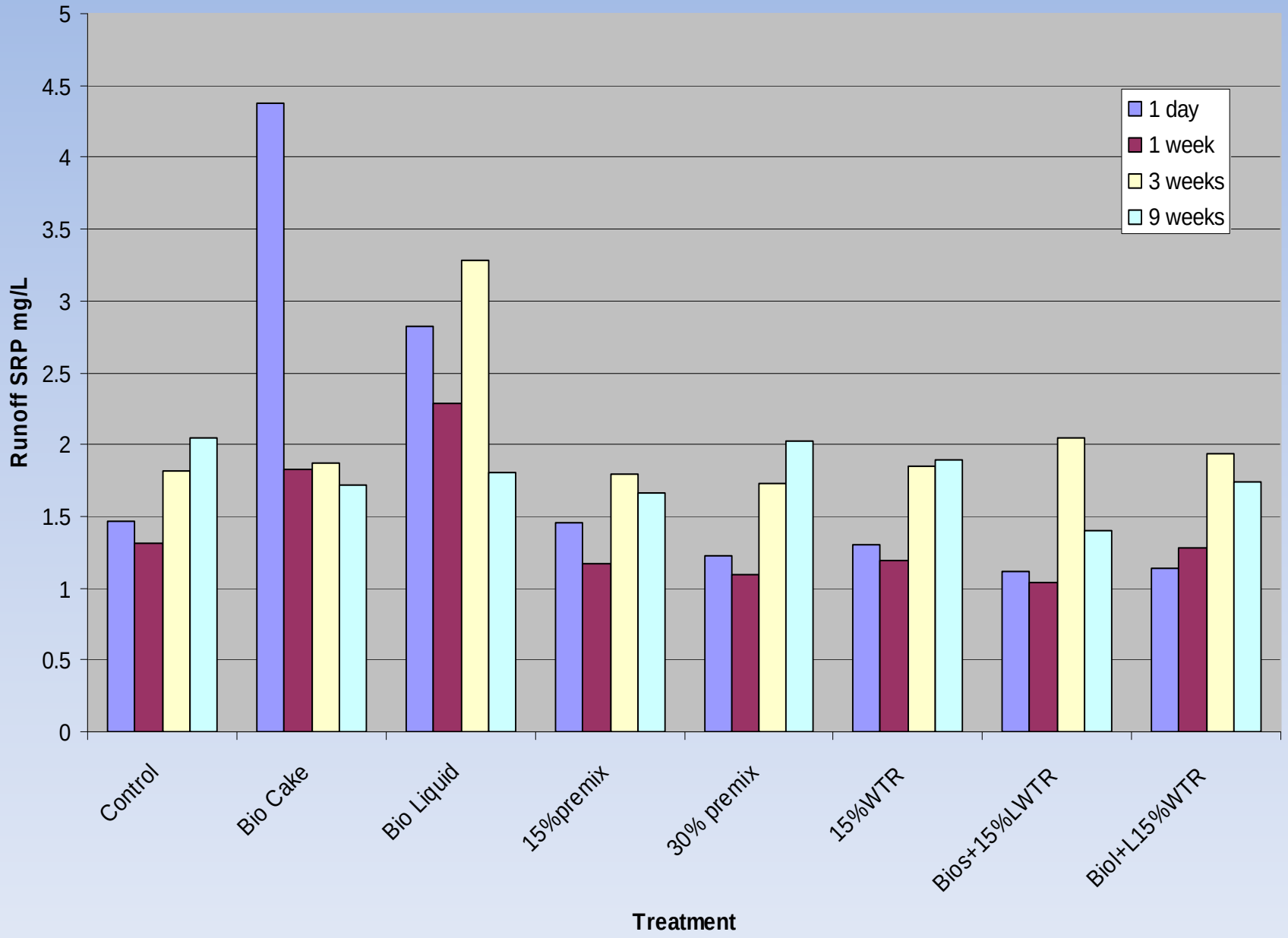
Work Plan and Progress

- Develop QAPP and receive approval
  - November 2007 – January 2008
  - Final approval by EPA February, 2008

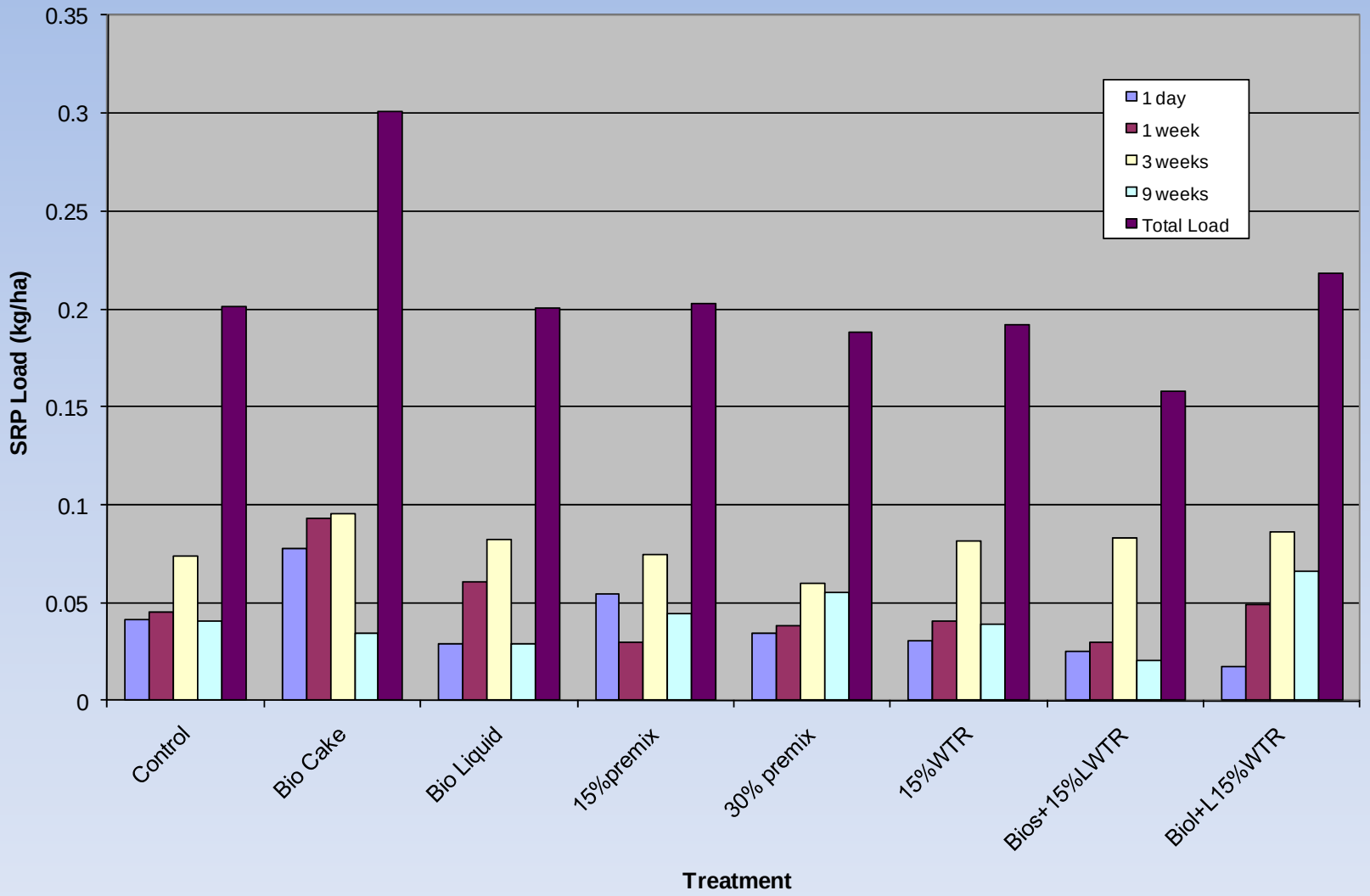
Work Plan and Progress

- Conduct rainfall simulation studies
  - April 2008 – August 2008
    - Delayed by unseasonably rainy spring and summer
    - Started simulations first week of August 2008
    - Completed September 2008
- Sample soils and runoff from simulations
  - Completed September 2008

Rainfall Simulation Data



Rainfall Simulation Data



P, Al, Fe content of treatments
(mg kg^{-1})

Treatment	Soluble P	Total P	Total Al	Total Fe
Biosolid Cake	1983	ADL	16298	ADL
Liquid Biosolid	4616	21258	8945	9437
Biosolid Cake + 15% Al-WTR (premixed ~3 weeks before app.)	155	19755	ADL	ADL
Biosolid Cake + 30% Al-WTR (premixed ~3 weeks before app.)	128	13917	ADL	ADL
Biosolid Cake + 15% Al-WTR (premixed 1 day before app.)	76	20675	ADL	ADL
Biosolid Cake + 15% Liquid Al-WTR	84	22030	46424	ADL
Liquid Biosolid + 15% Liquid Al-WTR	96	24438	44113	13698

ADL = Above detection limits

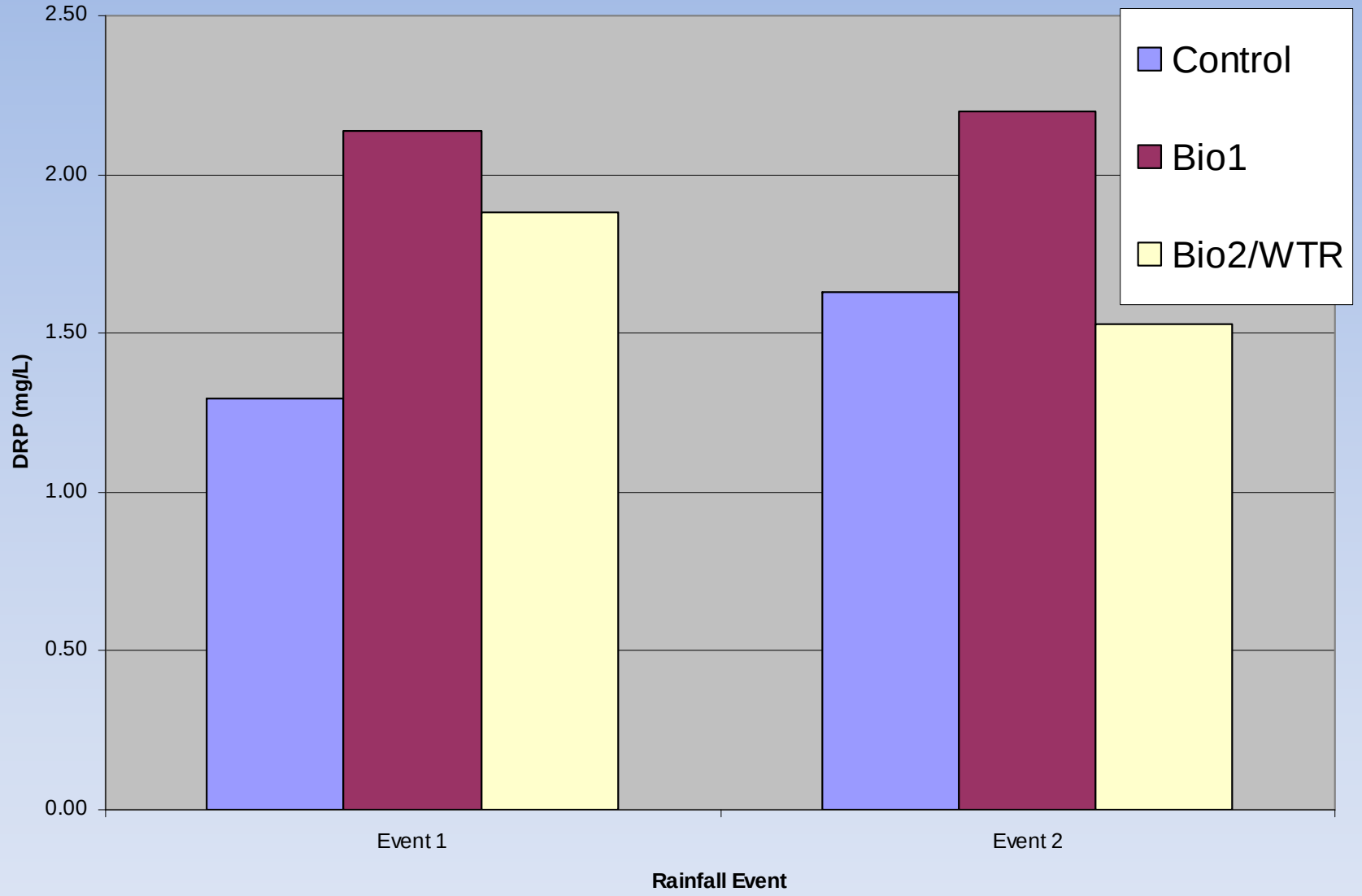
Work Plan and Progress

- Construct watersheds for field scale studies
  - February 2008 – May 2008
    - Delayed by unseasonably rainy spring and early summer months
    - Earthwork completed in early June
    - Samplers and flumes acquired and installed in July
    - Soil samples for background and background runoff samples taken.
    - Runoff sampling in progress
    - Limited runoff generating rainfall events to date

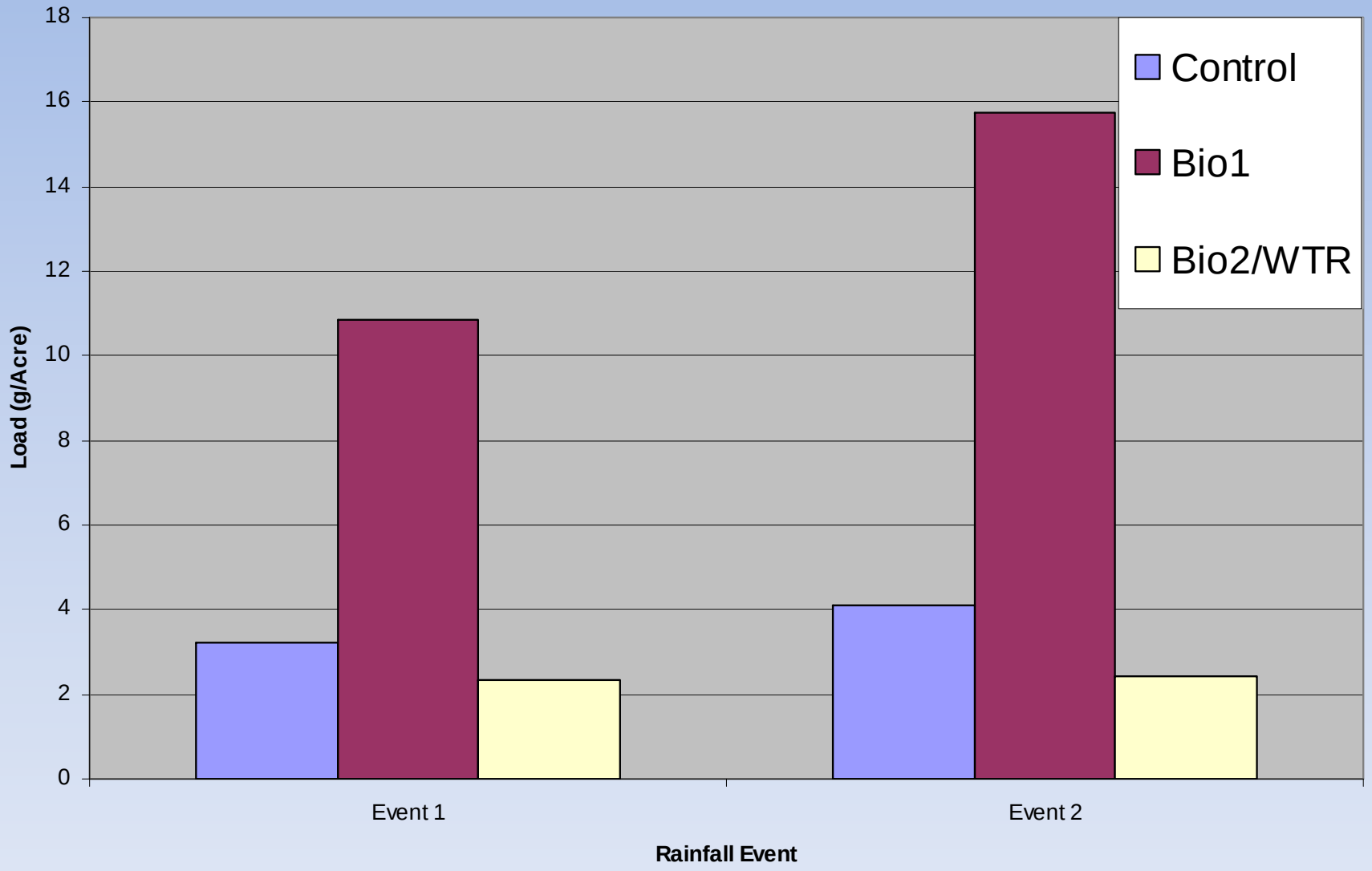
Work Plan and Progress

- Determined optimum application rate (~15% WTR by weight)
- Applied biosolids and biosolid-alum sludge mix December 1, 2008
- Sampling of runoff ongoing
- Abstracts and oral presentations at SWAWWA, AWRA and IAHR conferences
- Reporting requirements satisfied to date

Field Scale DRP



DRP Load


18
16
14
12
10
8
6
4
2
0
Load (g/Acre)
Control
Bio1
Bio2/WTR
Event 1
Event 2
Rainfall Event

Work Plan and Progress

- To Do List
  - Continue watershed/field scale studies including sampling and analysis
  - Cost analyses
  - Technology transfer
  - Reporting as required
  - Final report due in May 2010

Challenges

- Mother Nature
  - Unseasonably wet weather in 2008 put us around a month or two behind schedule (temporarily)
  - Relatively dry in fall, winter and spring, limited runoff events thus few field scale samples to date
- No other critical issues to date
- This project is going smoothly thanks to continued assistance and support from:

Kudos & Thanks

- Sue Filat-Alami
- Jeff Hall
- Philip Moore
- Jason de Koff
- Phillip's crew and lab
- Mo Shafii @ADEQ
- Duyen Tran @ OMI
- Beaver Water

QUESTIONS ????