Management of munitions constituents in soil using alkaline hydrolysis: a practical guide.

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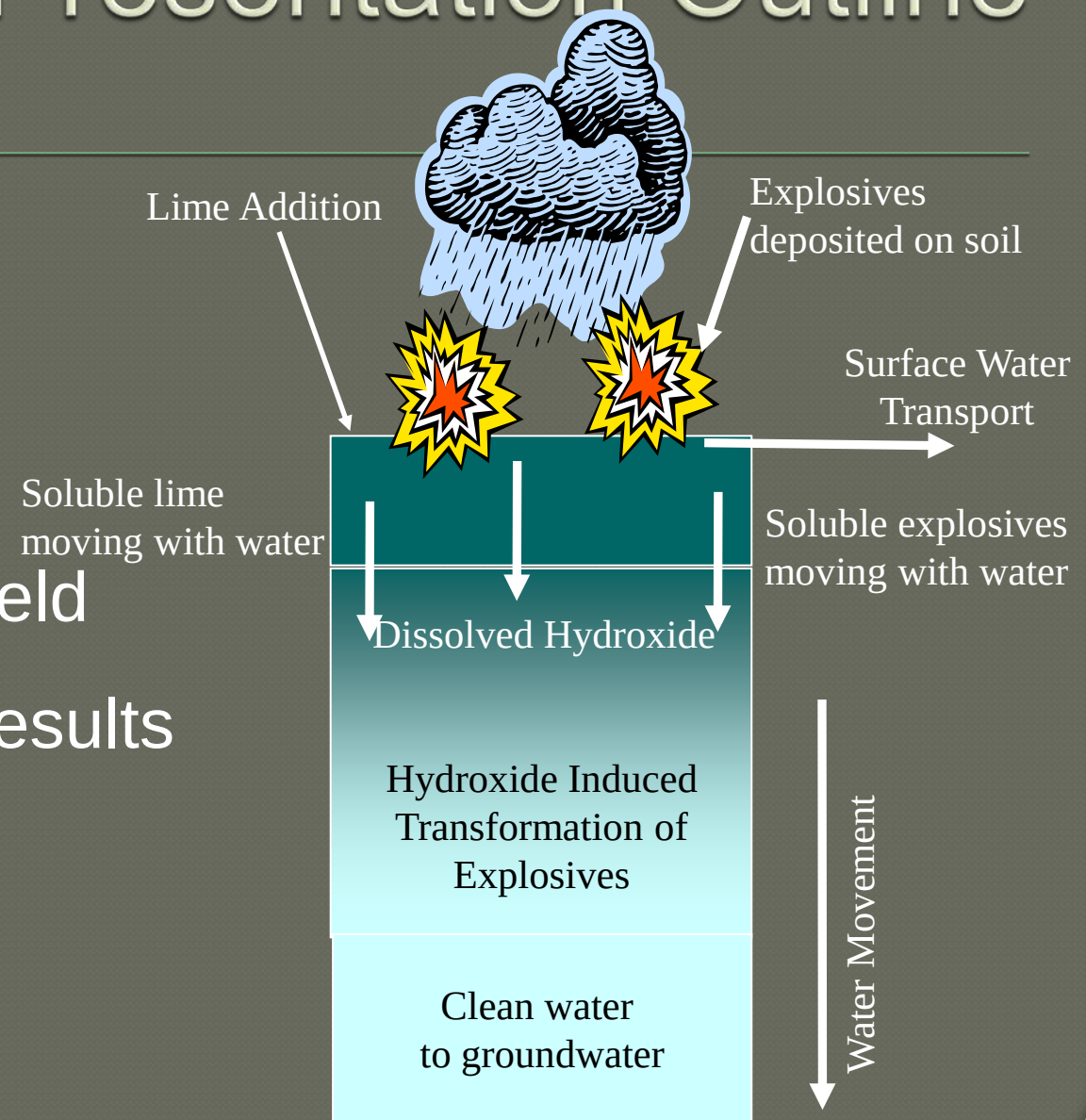
Presentation Outline

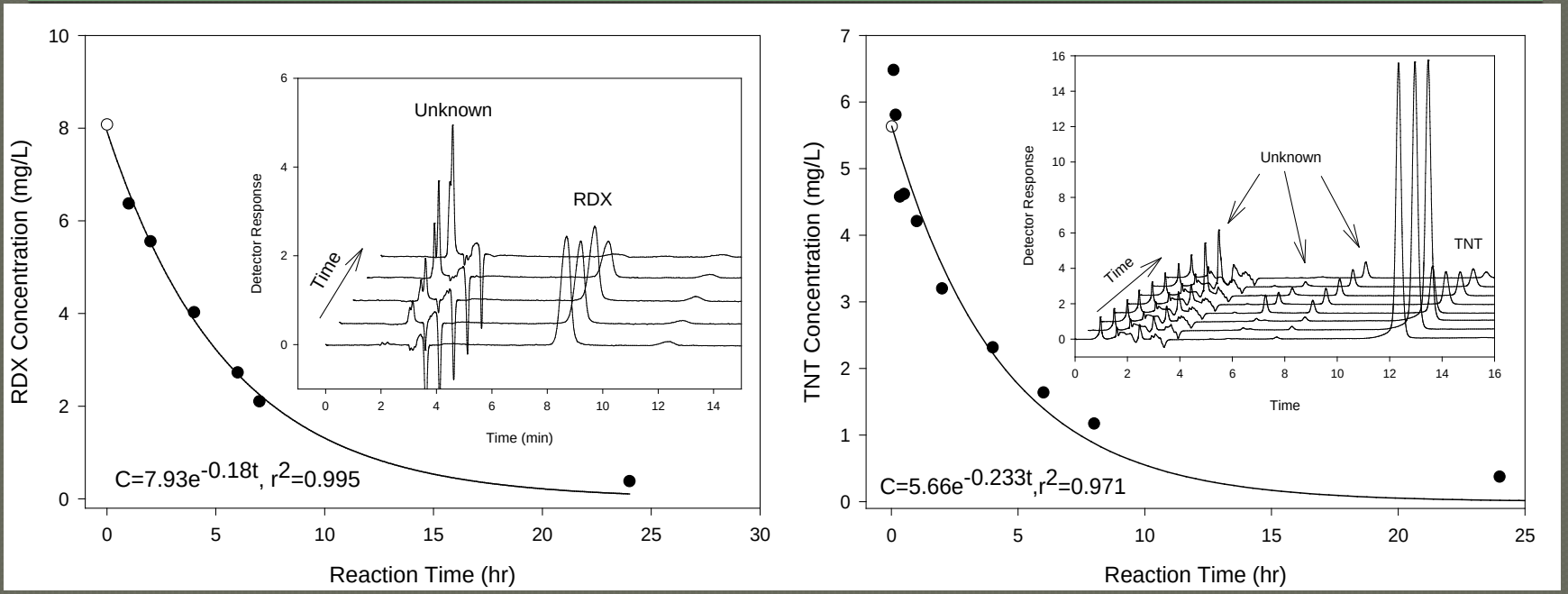
- Concept
- Advantages and disadvantages
- Laboratory and field demonstrations results
- Lime dosage
- Summary
- References



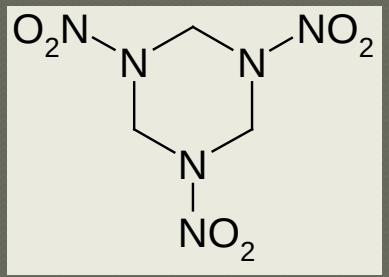
Advantages/ Disadvantages

- Advantages of using this approach:
  - *In-situ* treatment of munitions constituents
  - Incorporate lime into normal range activities
  - Reduce munitions constituents migration off range
  - Stabilize metals and transform explosives residues
  - Low cost approach (<$2,000/acre/year)
  - Lime is readily available
  - Reduce potential future liability associated with migrating munitions constituents and source zone contamination
- Disadvantages
  - Amount of lime needed varies with soil type and weather conditions
  - Need to evaluate range soil characteristics
  - Application method will vary with site conditions, usage.

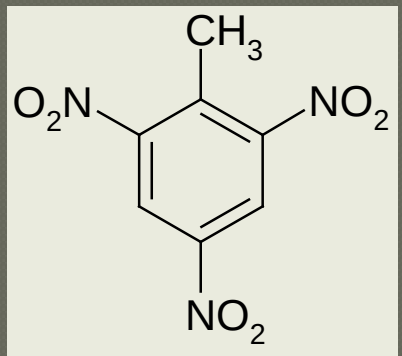
Laboratory results



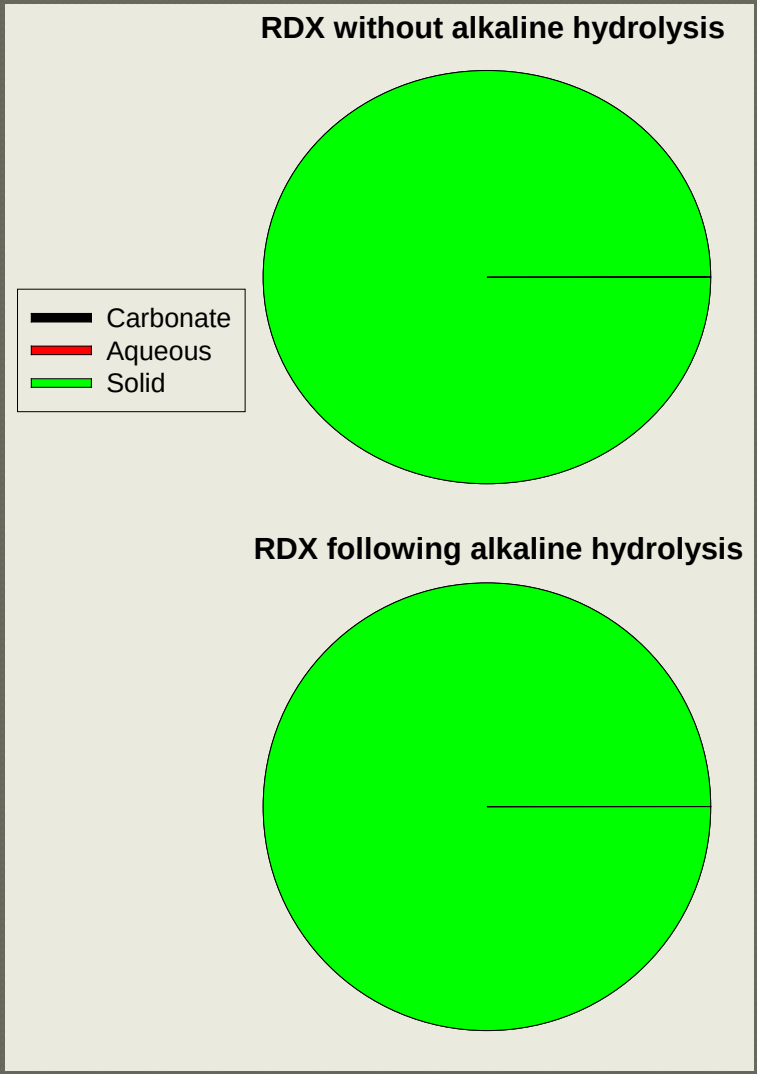
- **RDX**
- **Aqueous**
- **pH=12**
- **Half Life ≈ 5 hrs**



- **TNT**
- **Aqueous**
- **pH=11.5**
- **Half Life < 2 hrs**



Bio-mineralization of RDX base-hydrolysis products



The degradation of RDX base induced transformation products continues via both anaerobic and aerobic degradation

<u>≥75%</u> aerobic mineralization obtained in ^{14}C labeled study after a few weeks

Bench-scale Mesocosms

- Types of lime tested
  - Hydrated lime ($Ca(OH)_2$)
  - Quicklime (CaO)
  - Class C fly ash
  - Caustic solutions
- Application methods
  - Till or no till
  - Acid rain

Benches holding soil-filled pots are on the upper level and the leachate collection and secondary containment system are on the lower level.

Field demonstrations

- Blow in place facility- Redstone Arsenal, Huntsville, AL
- Hand grenade range- Fort Jackson, S.C.
- Open detonation facility- Aberdeen Proving Grounds, N.J.

Blow-in-place site after treatment with 227 kg of hydrated lime.

Blow-in-place application

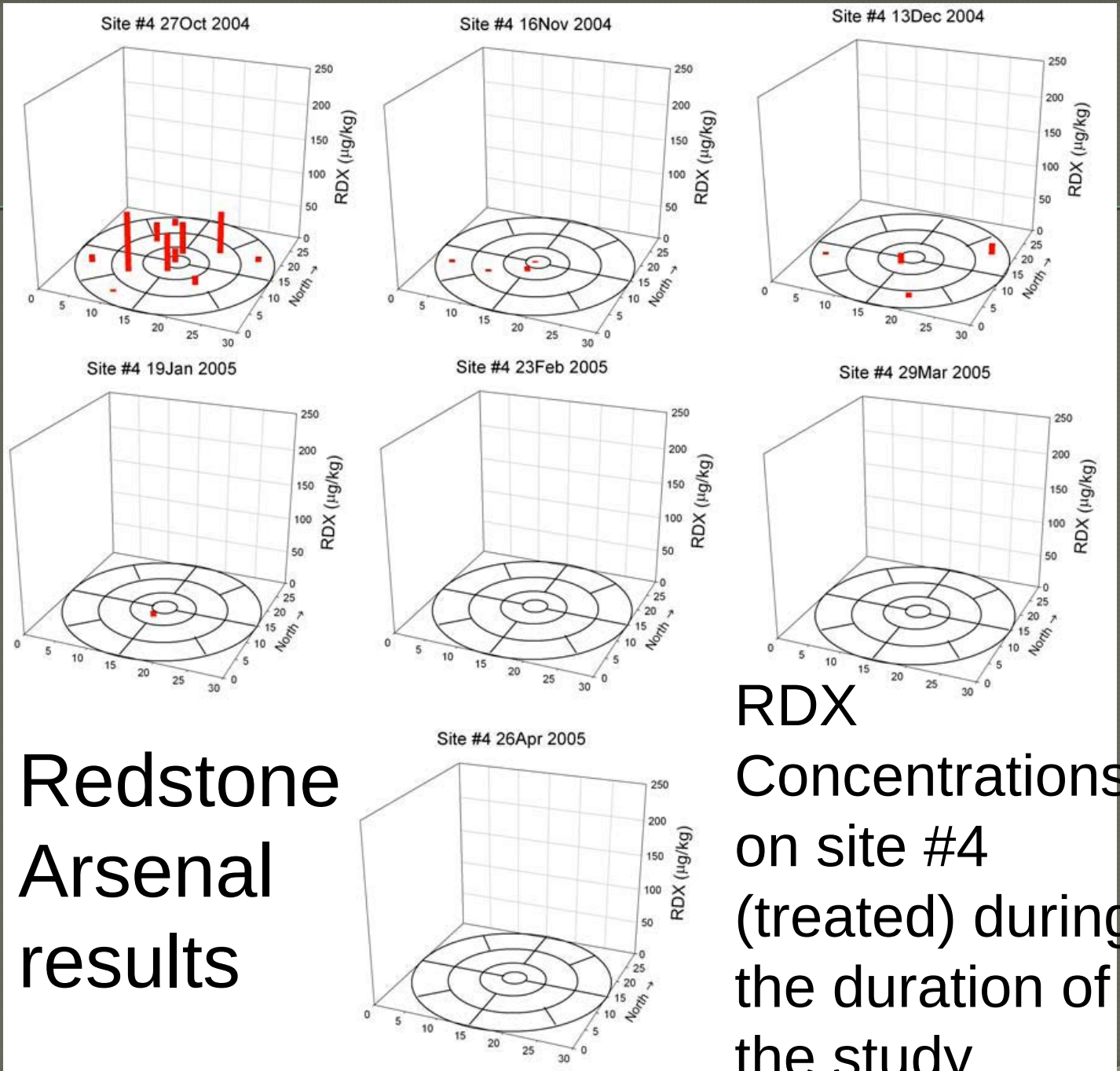
High calcium hydrated lime was applied with a 5 ft drop spreader pulled behind an ATV. 227 kg lime was applied across a 30 m by 30 m area centered on the crater. Lime was applied manually in the craters.

Blow in place- sampling

Mortar round prepared for blow-in-place operations

Soil sampling with tool

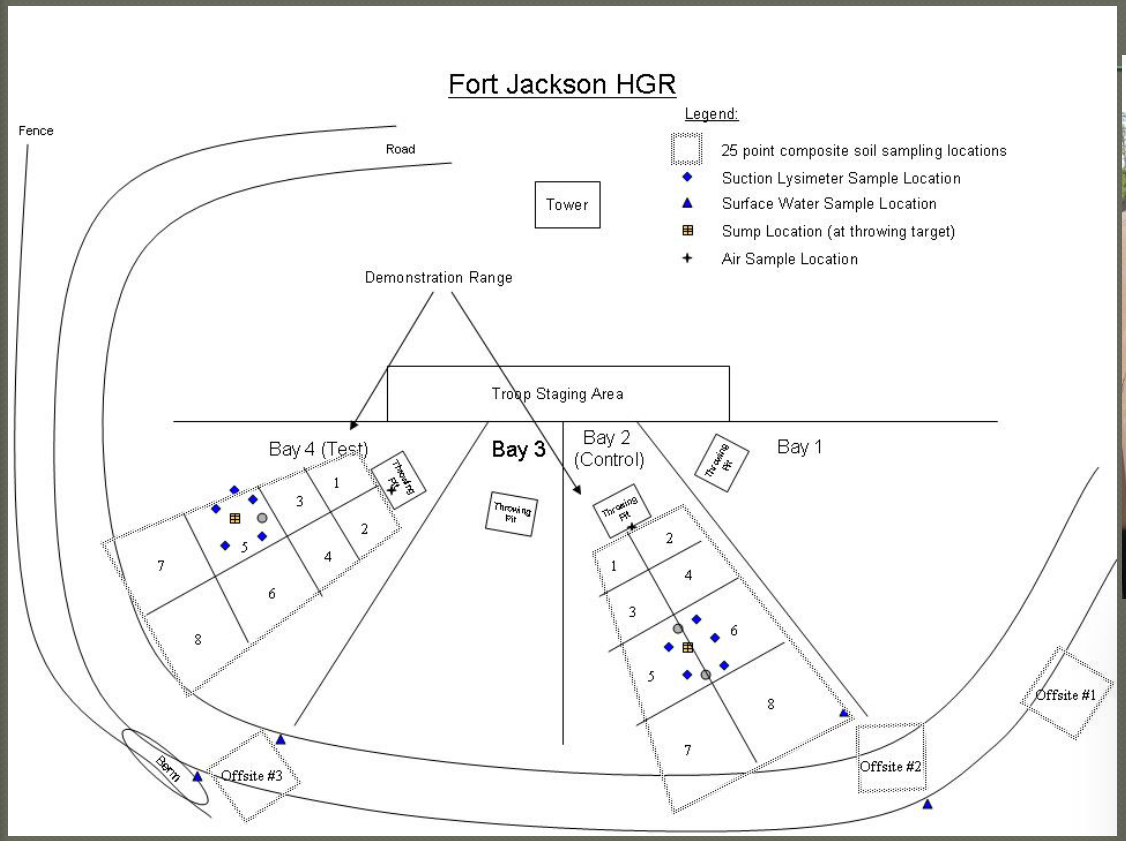
Pushing soil core out of the tool.



Redstone Arsenal results

RDX Concentrations on site #4 (treated) during the duration of the study

Hand grenade range- Ft Jackson



Surface water sampler

Schematic (not to scale) of Fort Jackson Hand Grenade Range; Bay 2 was the control and Bay 4 was the test bay (or limed).

Ft Jackson hand grenade range application method

Lime was spread with an ATV pulling a spreader. The lime was then disked into the soil. Level D PPE is recommended for personnel during application.

Fort Jackson Hand Grenade Range (HGR) Results

Sampling Date	Bay 4 (Limed) Average RDX Conc. (ppm)			Rain Between Sample Events (inches)	Post Lime % Soil Moisture
	Pre Lime	Post Lime	% Change		
Apr 06	4.21	<1.75[1]	>58%	0.12	2.21
Oct 06	0.42	<0.08	>59%	3.2	6.36
Jan 07	<0.09	<0.10	No Change	0	6.83

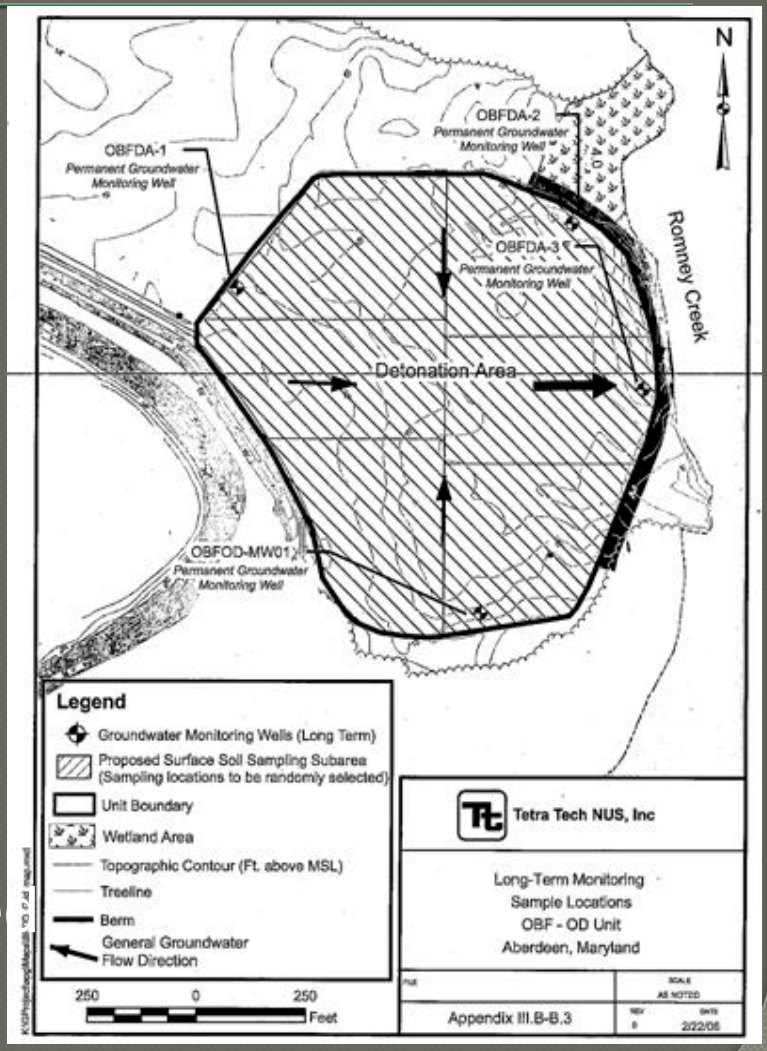
1 Report limit (0.02 ppm) used in calculations where '<' present.

Application was accomplished in about 4 hours.
Approximate cost of $400 per bay/application.

Open detonation facility Aberdeen Proving Grounds, NJ

Site characteristics:

- ✓ Active range
- ✓ Accessible year round
- ✓ Shallow depth to groundwater.
- ✓ Sufficient soil explosives concentrations
- ✓ APG provides on-site UXO support
- ✓ There were no known environmental drivers that limite the technology use.



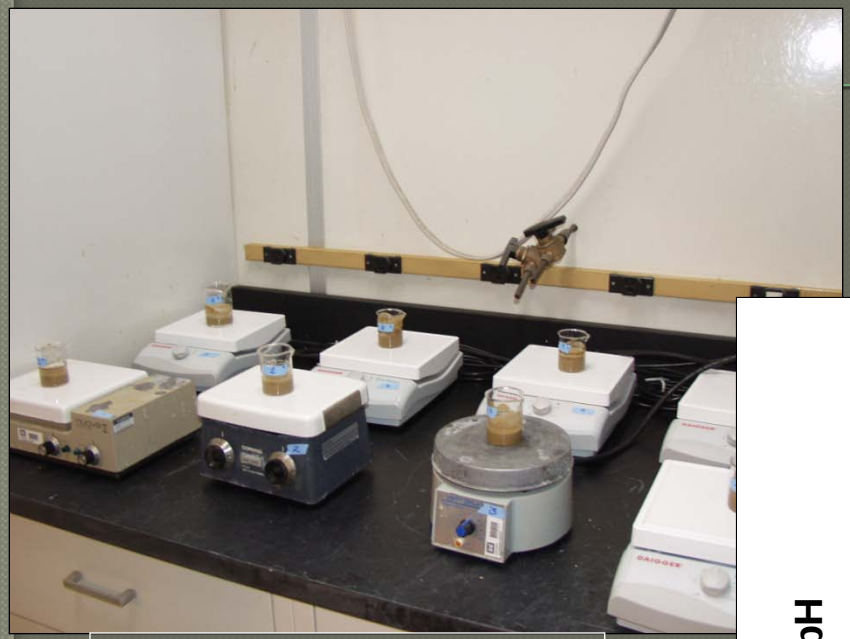
OD facility- application method

The most effective application method was to place bags of lime around the soil mound. The detonation mixed the lime. RAC 3 was recommended for this operation.

OD facility- APG Results

- Explosives concentrations were reduced to non-detect values in pore, surface, and ground water and soil.
- Most metals were stabilized.
- Invertebrate population was not affected.
- Surface water pH was neutral at perimeter.
- Cost assessment depends on site specific conditions.

Lime dosage determination

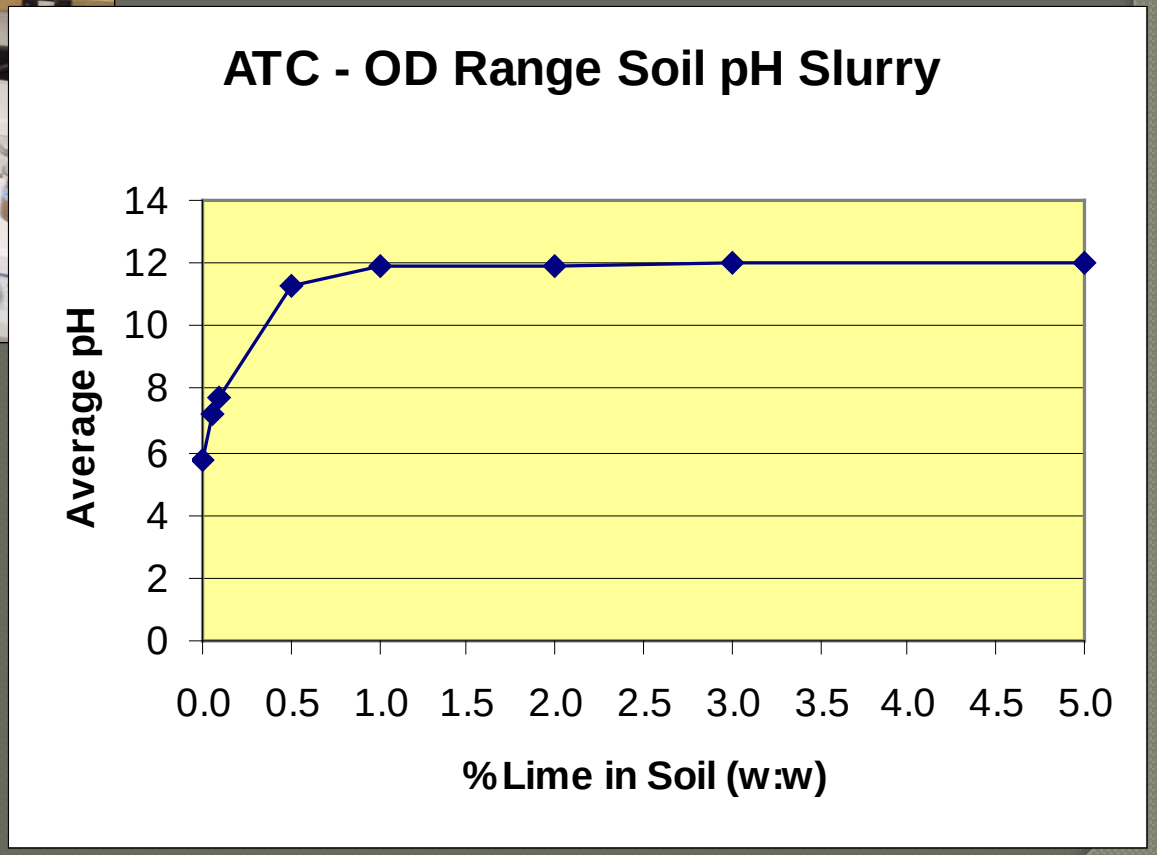


Soil Slurries

- 1:1 (w:w) ratio soil to water
- Add varied amounts hydrated lime to establish curve.

Soil pH Slurry

0.5% (w:w) lime needed to elevate pH above 11.5



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In summary

- ✓Alkaline hydrolysis can be used for different types of facilities:
  - ✓Small arms firing ranges
  - ✓Hand grenade ranges
  - ✓Demilitarization of munitions- BiP, OD
- ✓Effective
- ✓Reasonable costs using readily available equipment
- ✓Application does not interfere with training activities
- ✓Immobilize metals associated with common munitions.

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Questions ?

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