



Capabilities and Case Studies

Safe Neutralization of Explosives, Munitions and Munitions Constituents

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CEO/CTO



Presentation Outline

- Introduction to MuniRem Technology and Company
- MuniRem Reagent Case Studies
 - Chemical Warfare Materiel (CWM) Degradation
 - Remediation of OB/OD Sites
 - Soil and Groundwater Remediation
 - Demilitarization Support (Underwater & Land)
 - Equipment and Building Decontamination
 - Routine Maintenance of Energetics Facilities with MuniRem reagent
- Summary and Conclusion

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INTRODUCTION TO MUNIREM TECHNOLOGY

What is MuniRem Reagent?

- MuniRem is the commercial name for a University of Georgia Research Foundation patented technology
- MuniRem Technology is licensed exclusively to MuniRem Environmental, LLC
- It employs reduction chemistry to rapidly neutralize and destroy explosives and energetics in different media.
- The end product is non-hazardous.
- MuniRem reagent also degrades chemical warfare materiel (CWM) and stabilizes metals.



Advantages of MuniRem

Faster

Can destroy energetics hours compared to days/weeks for alternatives

Safer

Much reduced danger for the user. Alternative methods have resulted in fatalities

Lower Cost

Less equipment, less labor and less time to remediate means substantially lower total cost

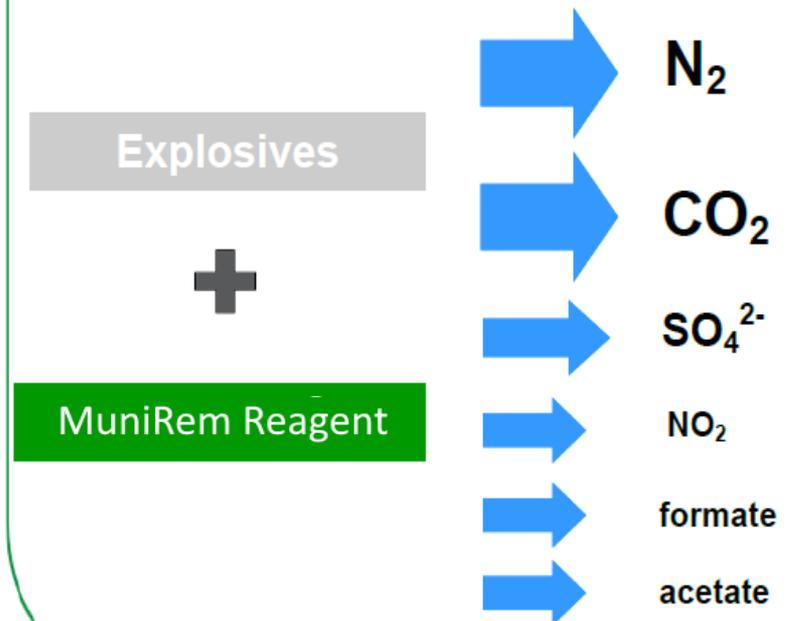
Types of Explosives and Metals Remediated and End Products

Effective in Neutralization and Remediation of



- Mustard (CWA)
- HMX / RDX / TNT
- DNTs / ADNTs
- NBs / NDMA
- Nitrocellulose Propellant
- PBX / PETN
- PCBs
- Lead Styphnate
- Lead Azide
- Picric Acid
- AN/TATP
- Comp A, B, & D
- Dynamite
- Reactive Aluminum
- As, Ba, Cd, Cr, Pb, Hg, U, etc.

Reliable Green Technology for Remediation of Explosives



MuniRem reagent is versatile in its ability to neutralize a variety of energetics

Effective Remediation of Heavy Metals

Reliable Green Technology for Remediation of Heavy Metals

Heavy metals



MuniRem Reagent



**Metal
Sulfide**



SO_4^{2-}

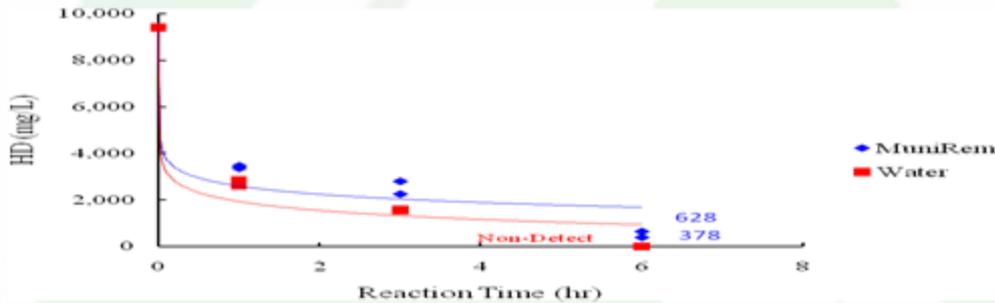


CHEMICAL DESTRUCTION OF CHEMICAL WARFARE MATERIEL (CWM)

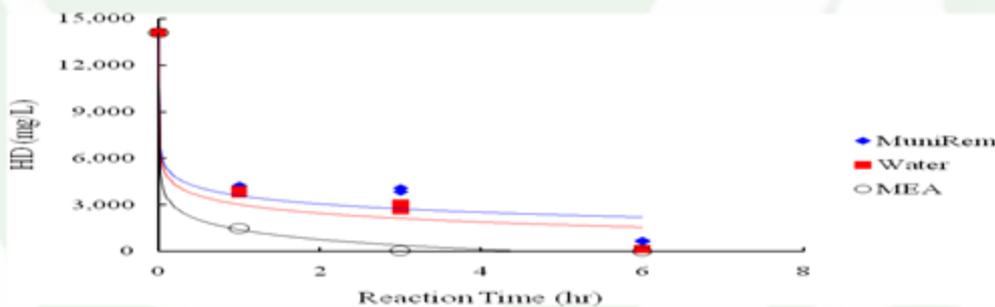
Contract #: W912PP-10-P-0034

Results presented are obtained from proof-of-concept test data for tests conducted at Non-Stockpile laboratory, Edgewood (2010)

Rate of Degradation of HD by MuniRem Reagent VS. Rate of Reversible Hydrolysis of HD by Water

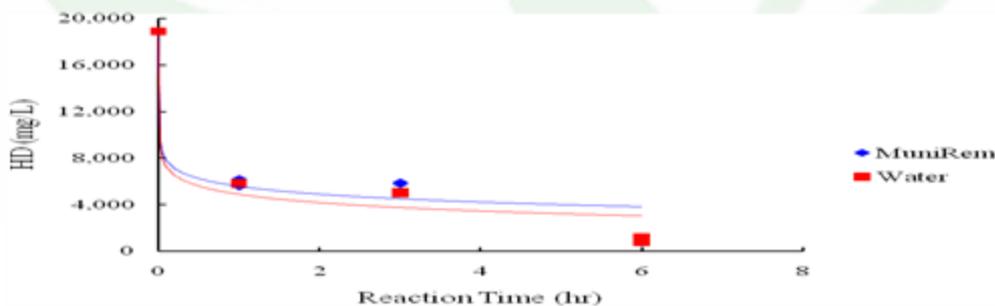


Initial = 40 uL (9,000 mg/L)



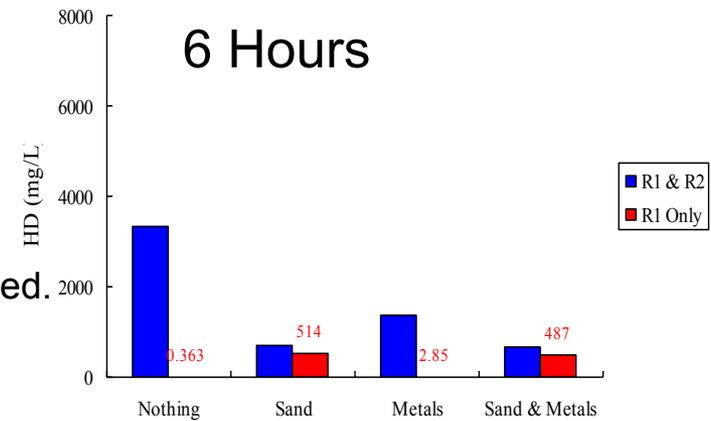
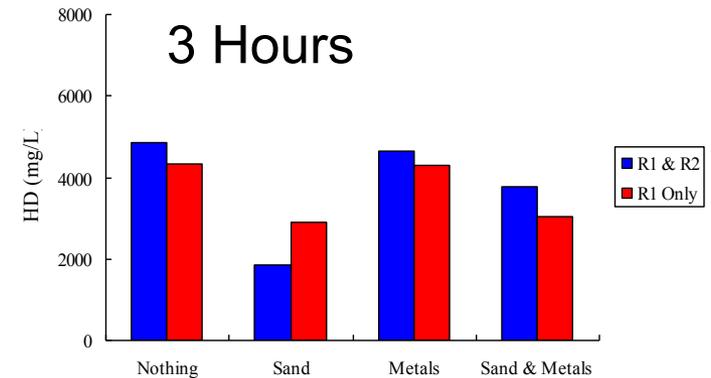
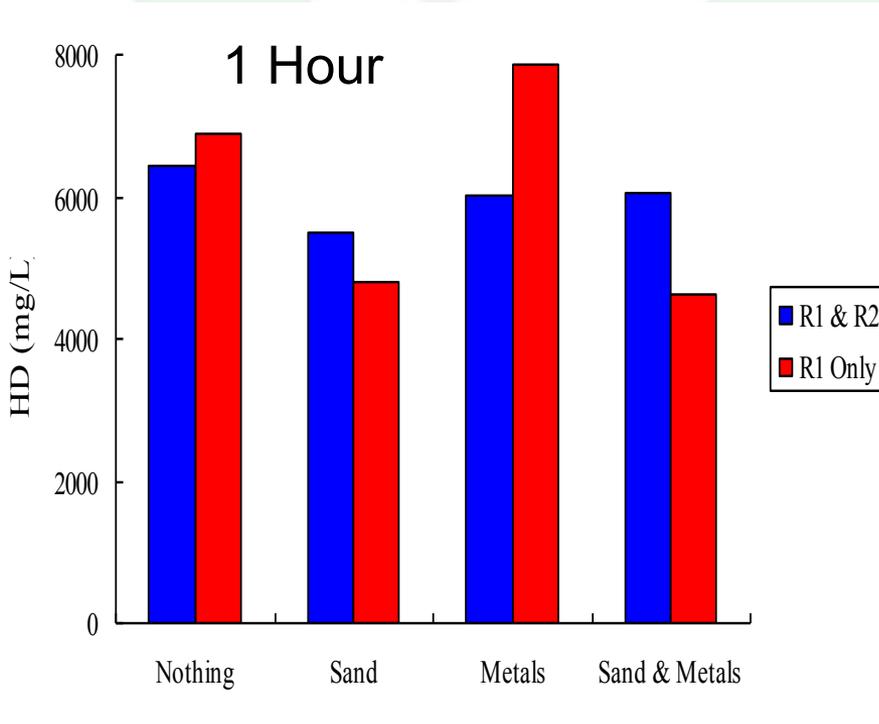
Initial = 60 uL (14,000 mg/L)

MEA forms Hazardous Waste



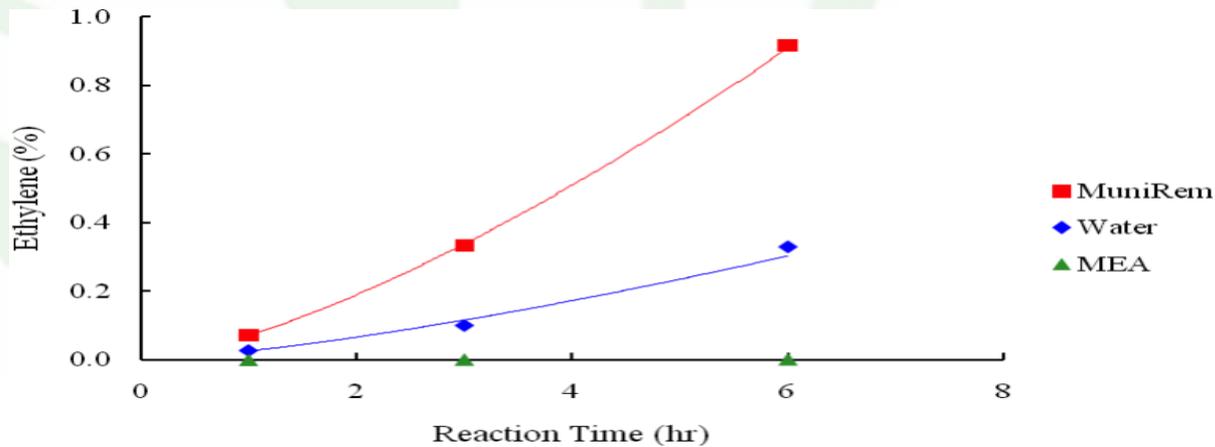
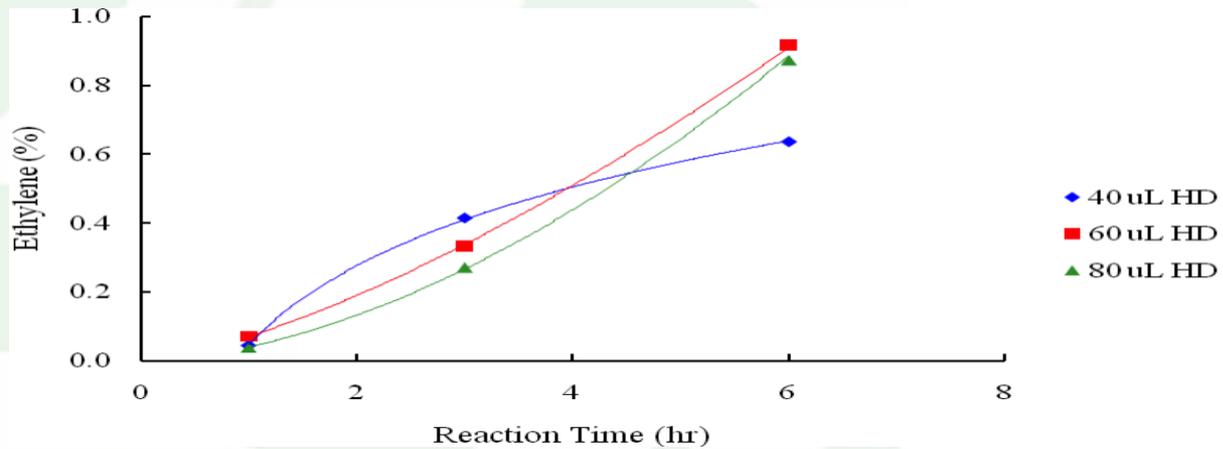
Initial = 80 uL (18,500 mg/L)

Neutralization of Mustard (HD) with MuniRem Reagent



Nothing = Homogeneous Solution of MuniRem; no solids added.
 Sand and Metal (Iron) was added to simulate reality
 Initial Concentration of Mustard = 18,500 mg/L
 Results for: 1 hour; 3 hours; **6 hours**

Evidence of Mustard (HD) Destruction by MuniRem Ethylene Production as a Function of Time





CWM/BWM Decontamination Methods

Old Methods

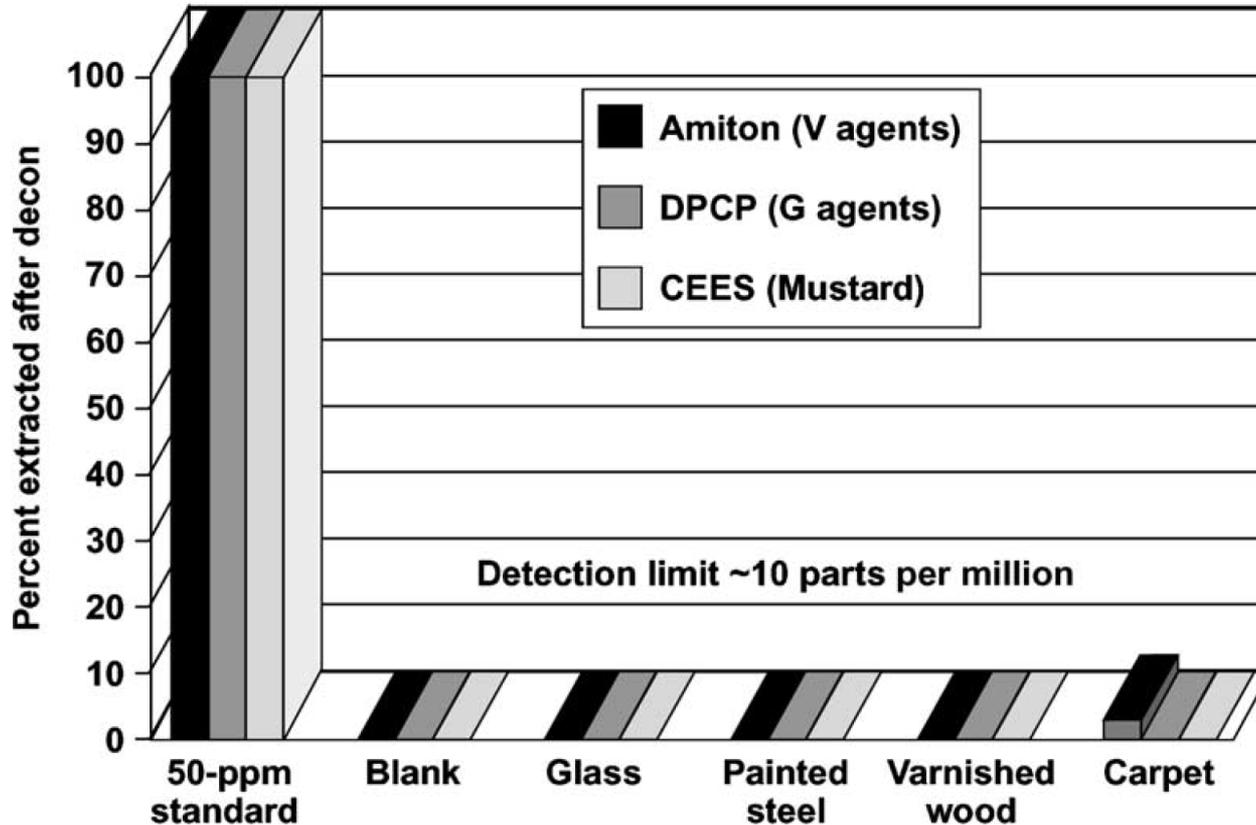
1. Chlorine bleach-based products
2. Highly caustic solutions

New Method

3. MuniRem Decontamination Gels – Formulated to minimize dispersal and run-off
 - Chemical Reduction Gel
 - Chemical Oxidation Gel

Percent of extracted CW agent from substrates after decontamination

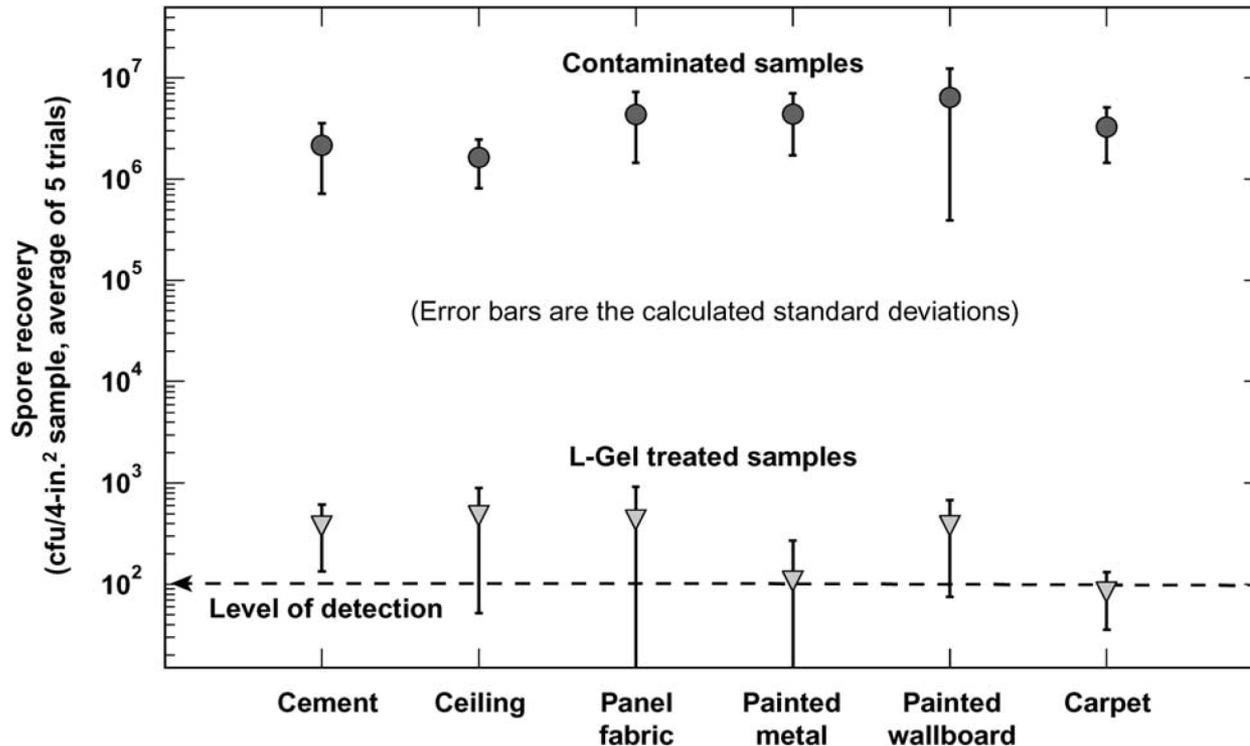
Using GC-MS detection methods (Lawrence Livermore National Laboratory Study)



Results of field tests on six materials contaminated with BG Spores

Chart shows spores before and after application of decontamination gel.

BG spores were reduced by an average of 99.988% by the decon gel.





Independent laboratory and field testing of LLNL Gel

- Field testing at the Military Technical Institute of Protection, Brno, the Czech Republic (October 1998);
- Lab testing at Edgewood Chemical Biological Forensic Analytical Center (ECBC), Aberdeen Proving Ground, MD (November 1999);
- Lab testing with thickened agents at the Defence Evaluation and Research Agency (DERA), Porton Down, UK (October 1999).



ON-SITE DEMILITARIZATION OF RECOVERED UNDERWATER MUNITIONS

MuniRem supports Savannah Harbor Expansion Project (SHEP)

Options for Recovery of Bomb Fillers (Bulk Energetics)

- Water jet
- Water saw
- Milling
- Cryogenic Breaching



Projectile Casings



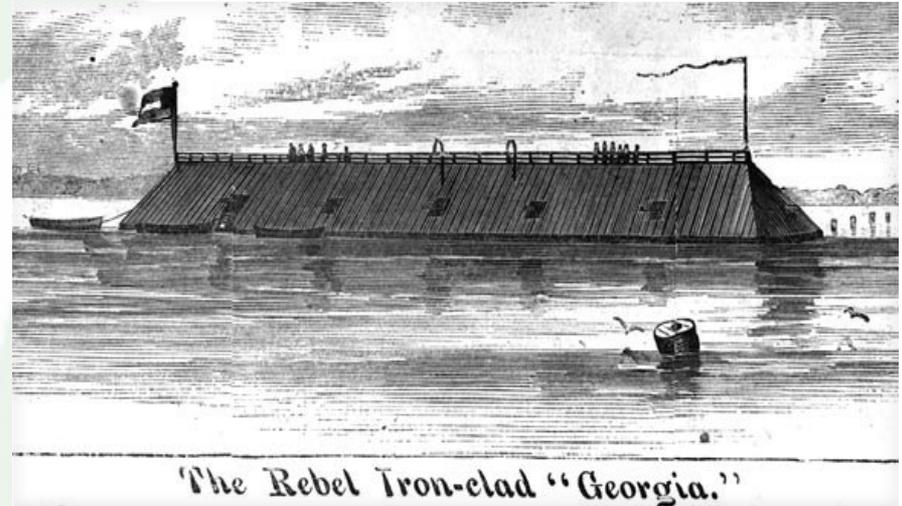
Breaching and Recovery of Bulk Energetics



Recovered Bulk Energetics

CSS Georgia Background

- Ironclad gunboat built for the Confederacy in 1862
- Completed Vessel was too heavy
- CSS Georgia spent her life as a floating battery in what is now the north edge of the Savannah Harbor navigation channel
- CSS Georgia scuttled by Confederate troops on December 24, 1864
- Recovery of CSS Georgia and its munitions was part of the Savannah Harbor Expansion Project



Munitions Recovered from Underwater Environment



Breaching of Recovered Projectiles

Total projectiles breached and neutralized = 170

Breaching throughput = 12 projectiles per hour



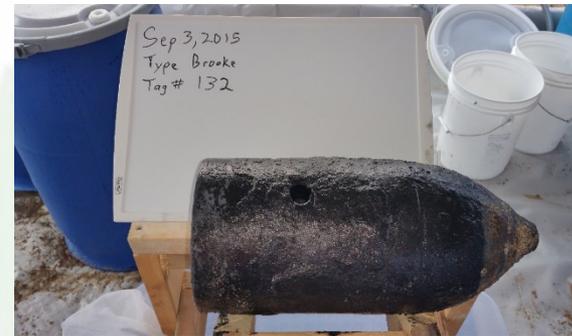
Neutralization of the Breached Munitions

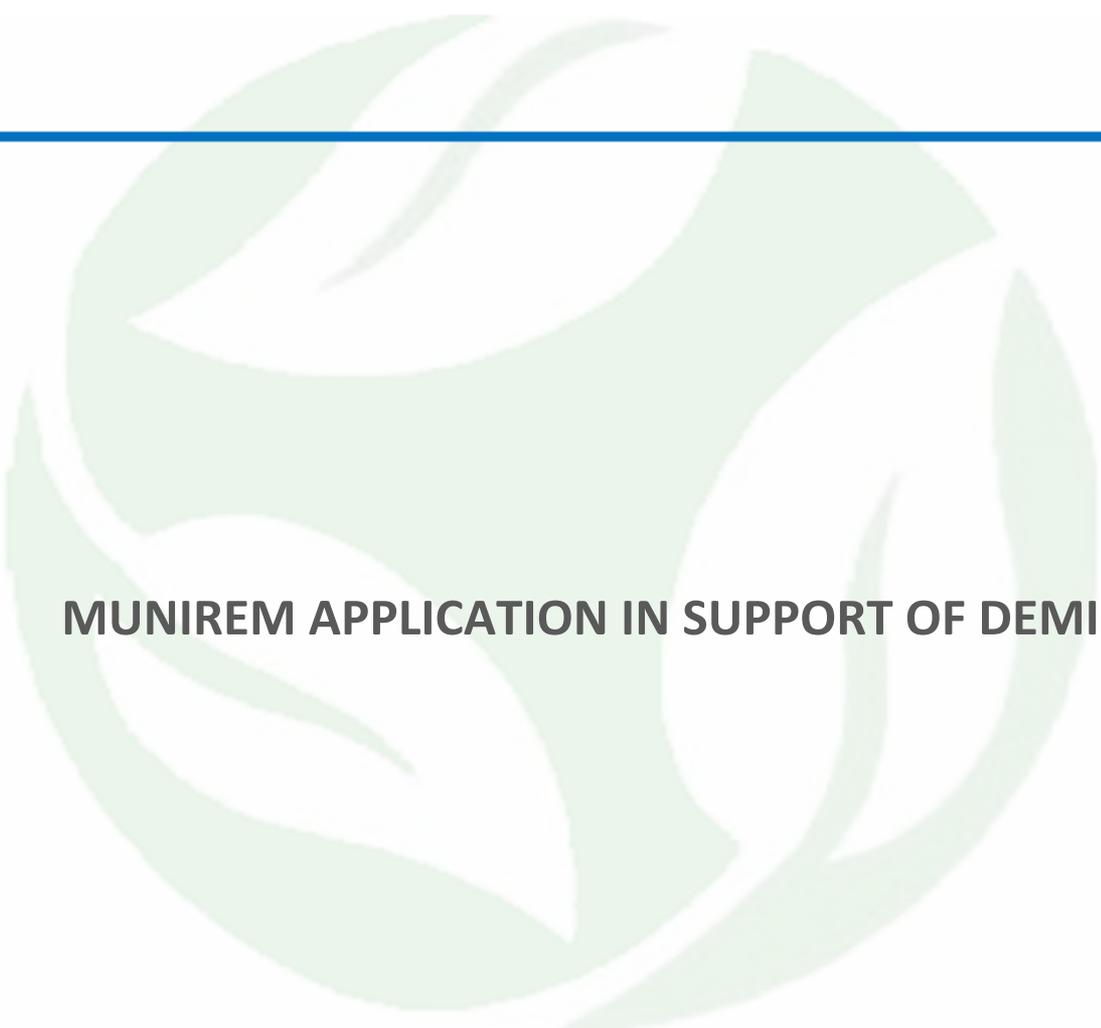
- After 150 years explosives still well preserved
- Explosives washout using MuniRem solution
- Explosives neutralized
- Fuzes safely removed and inerted
- Munitions certified by SUXOS as safe
- Characterization and disposal of non-hazardous waste



Summary – Underwater Munitions Demilitarization

- 170 Civil War munitions neutralized on-site in 2015
- Munitions transferred to U.S. Army Corps
- Munitions preserved for historical purposes
- No hazardous waste produced
- Largest on-site neutralization of recovered underwater Confederate munitions
- Follow up project November 2017



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MUNIREM APPLICATION IN SUPPORT OF DEMILITARIZATION

Thermal Vs. Non-thermal Decontamination

Thermal Decontamination



MuniRem Bath Decontamination

<p>Before Treatment</p> <p>Picric Crystals (yellow)</p> <p>Rusts (bright orange)</p>	<p>30-mins MuniRem® Bath</p>	<p>30-mins after MuniRem® Bath</p> <p>No visible traces of energetics</p> <p>Original bare metal surface (silvery)</p>
<p>Picric Crystals</p>	<p>30-mins MuniRem® Bath</p>	<p>Original bare metal surface (silvery)</p> <p>Rusts significantly reduced</p>
<p>MuniRem® Bath</p>	<p>30-mins MuniRem® Bath</p>	<p>Rusts dissolved from the bomb casing</p>

MuniRem Application at a Demilitarization Plant in SE Asia

Picric crystals (yellow)

Rust (bright orange)

30mins MuniRem® bath

No visible traces of energetics

Original bare metal surface

MuniRem® spray down

Picric crystals (yellow)

24 hours post-MuniRem®

Application of MuniRem to support demilitarization in SE Asia



Visible picric crystals on building surfaces (in bright yellow) before treatment.



Instant color change to reddish brown signifies neutralization reaction.



MuniRem® continues to breakdown the yellow picric crystals.



MuniRem®-treated area is left to air-dry.

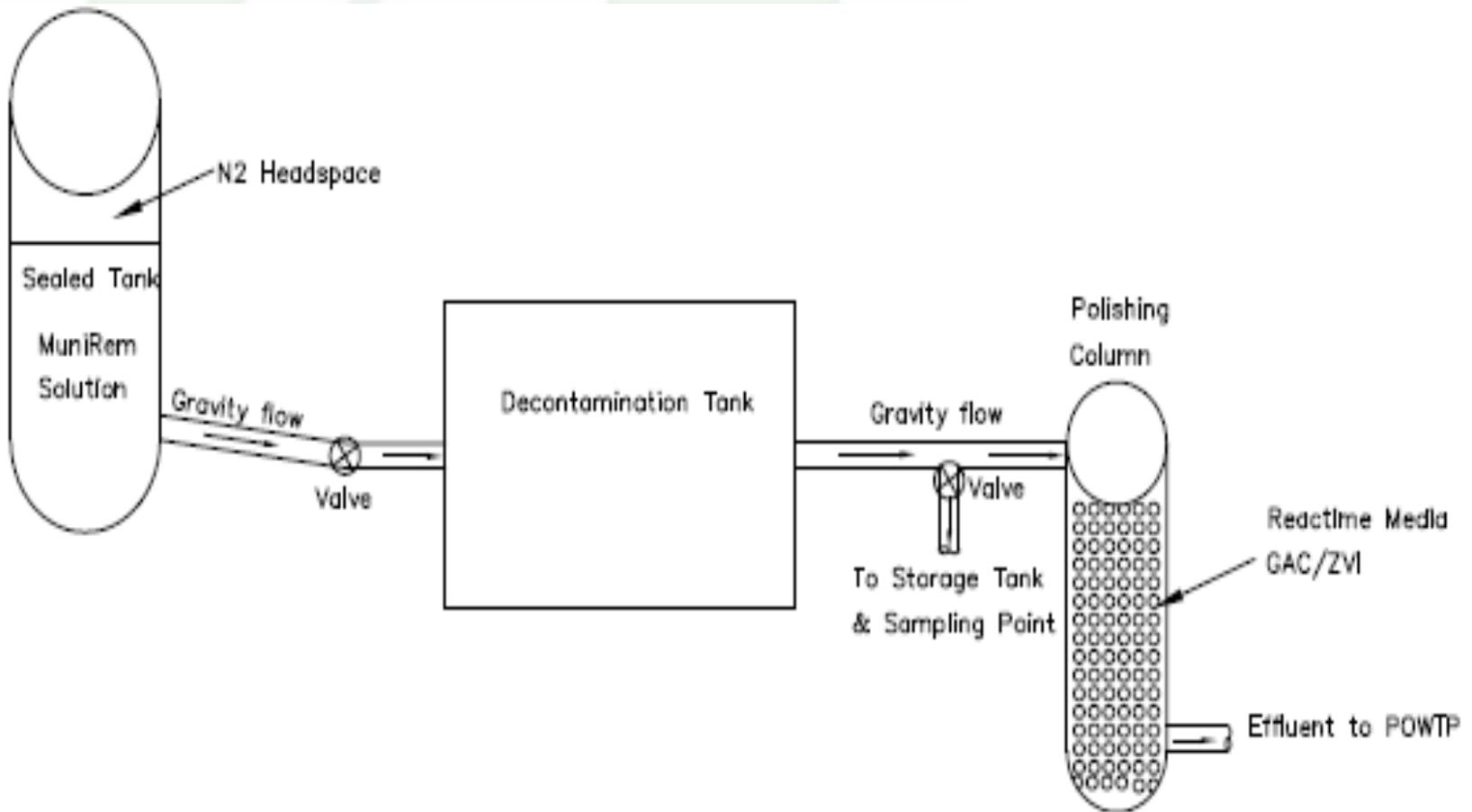


24 Hours Later
Visible and significant reduction of picric crystals.



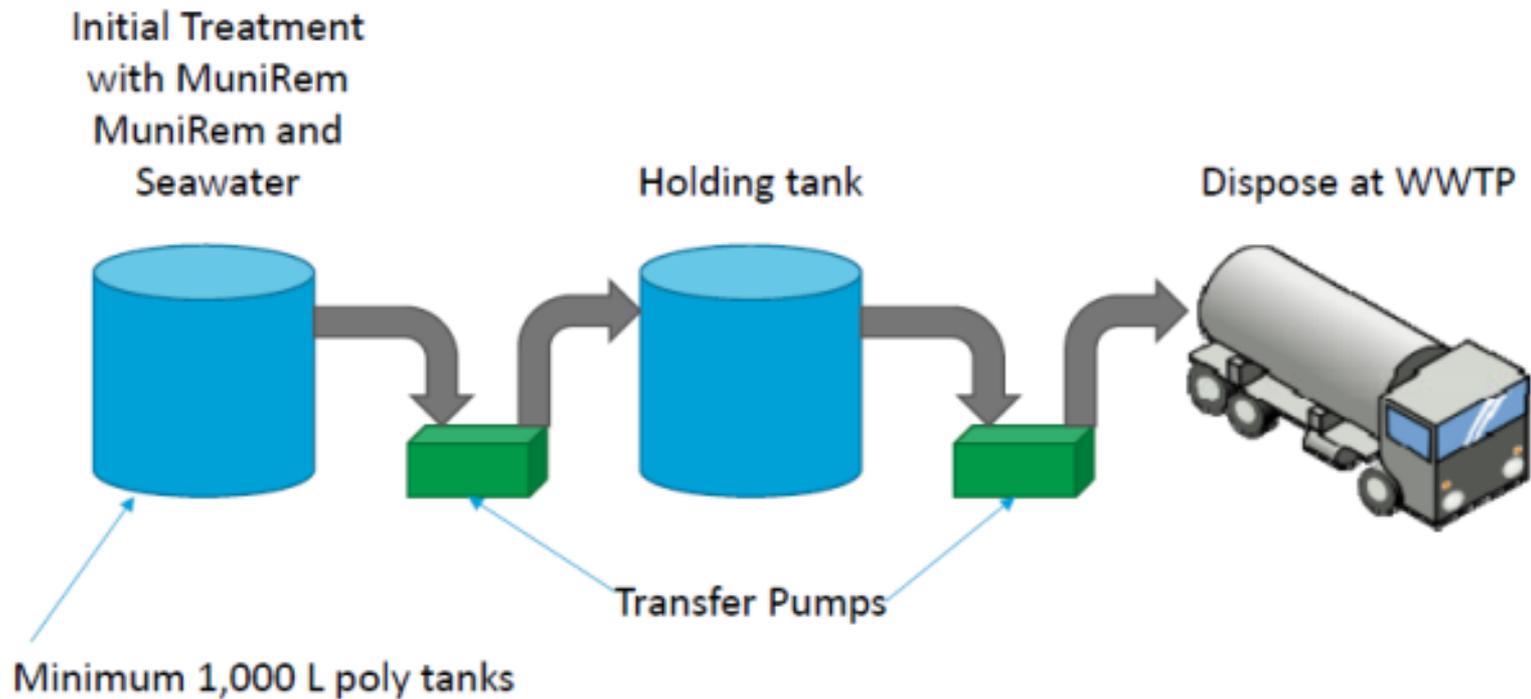
2 Weeks Later
No re-crystallization of picric acid.

Rapid Decontamination of Scrap and Accessed Sub-Munitions



Scale-up Option

Small Scale Demilitarization (Schematic)





CHEMICAL NEUTRALIZATION OF BULK EXPLOSIVES ABANDONED ON DEMILITARIZATION EQUIPMENT

Camp Minden, Louisiana

Abandoned Bulk Explosive Neutralization

- Melter/Flaker machine contained bulk H-6 (TNT, RDX, AL, Binder) explosives
- Large crystallized chunks of H-6 on equipment
- Wall surfaces and miscellaneous materials contaminated with explosives
- Lead paint chips mixed in with explosives



Small Footprint of MuniRem Solution Application



Explosives Neutralization Station Behind Building

MuniRem Solution Provided Safe Recovery of Crystallized Explosives

- Large H-6 chunks safely removed while spraying MuniRem solution
- Large explosive pieces transferred to neutralization reactor
- Neutralization of recovered explosives achieved rapidly in reaction tanks



Neutralization of Recovered Explosives



- 2,000 Lbs of H-6 explosives estimated as present on and in equipment
- >1000 lbs destroyed in place by spraying concentrated MuniRem solution
- >900 lbs recovered and neutralized on-site in reactor with MuniRem solution
- Sludge and wastewater characterized as non-hazardous waste



BUILDING 83 DECONTAMINATION AND DEMOLITION

Project Managed by Mr. Kevin Healy, Huntsville Support Center

Old Way vs New Way

Building Decon and Demolition – Old Method



Building Decon and Demolition – New Method



Building 83 LCAAP, MO





MuniRem application to decontaminate explosives on building exterior



MuniRem application to decontaminate explosives in building interior



Equipment decontamination using MuniRem solution



Explosive contaminated pipe before and after decontamination with MuniRem



Confirmation of MuniRem Pipe Decontamination using EXPRAY



Deconstruction of MuniRem Decontaminated Building





MuniRem Benefits at Building 83 LCAAP

- After about 20 years of waiting for a safe solution, MuniRem did the job.
- The MuniRem decontaminated building fixtures were characterized as MDAS (5X).
- MuniRem decontamination liquid penetrated the concrete floor cracks and neutralized the accumulated explosives.
- Thanks to the MuniRem solution, the project was completed ahead of schedule.

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MUNIREM APPLICATION AS A SOLUTION FOR OB/OD CONTAMINATION

MuniRem Application as a Solution for Munitions Constituents in OB/OD Trenches in SE Asia



Contaminated water
Before MuniRem® treatment



MuniRem® powder reacts
instantly with water...
5 secs after application



... to turn bright red:
oxidation is underway
10 secs after application

Faster lower cost solution for explosives contaminated soils, OB/OD ash, sludge, and spent activated carbon



MuniRem[®] mixed into contaminated soil



Water immediately activates the neutralization



24 hours after MuniRem[®]



2 weeks after MuniRem[®]

MuniRem Application to Remediate Munitions Constituents in OB/OD Soil at a Legacy Site – DRDC and DCC Canada

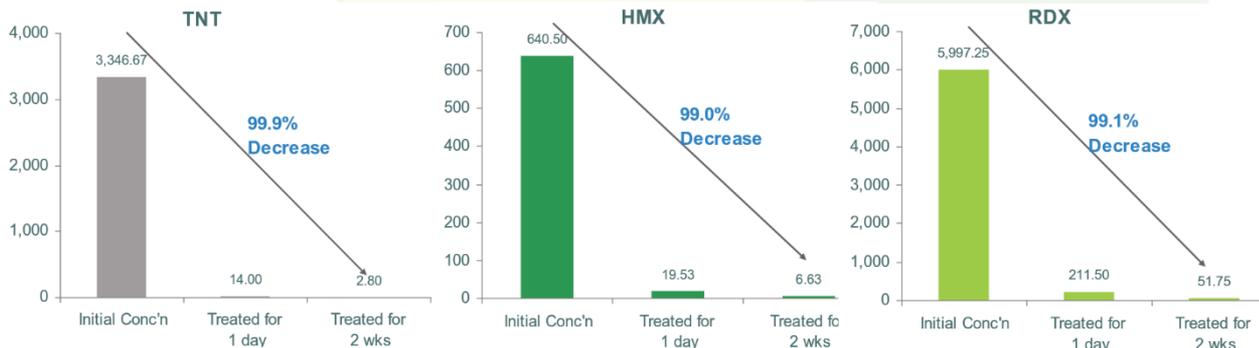


MuniRem Reagent at Ravenna Army Ammunitions Plant

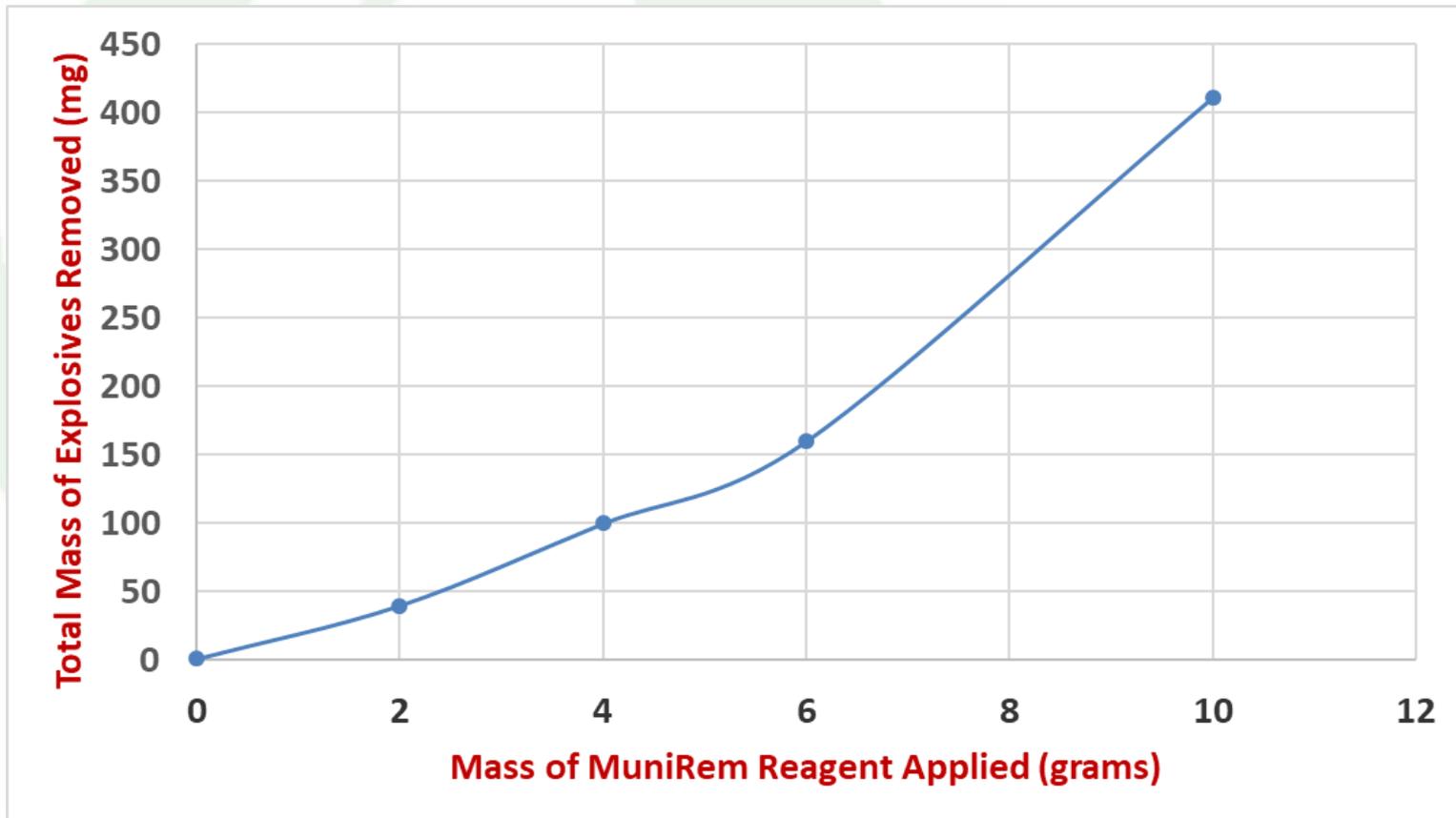
- Soil at Ravenna AAP was contaminated with TNT and other explosive compounds
 - EPA Methods 8330 A & B, TAL Metals & Products Analysis
- Demonstration details:
 - Dimension: 19ft by 45ft
 - Soil sample type: Silty-clay with rock
 - Targeted treatment depth: Top 2 feet
 - Explosives compounds of concern: TNT, HMX, RDX



Results for Rapid Remediation of Explosives Contaminated Soils



Optimization of MuniRem Reagent Dose for Remediation of Explosives in Soil





Groundwater Remediation DoD (AEC) Independent study



- Soil/Groundwater Applications
 - Energetics
 - Chlorinated compounds
 - Metals



**USE OF BENIGN CHEMICAL TREATMENT FOR
MUNITIONS CONSTITUENTS BREAKDOWN IN
VARIOUS MEDIA**

**Draft Field Protocol for the Application
of MuniRem to Remove Explosives from Groundwater**

December 2, 2014

Distribution D
Distribution authorized to Department of Defense and U.S. DoD contractors only.
(Critical Technology) (December 2, 2014)

Other requests for this document shall be referred to:
Office of the Assistant Secretary of the Army for
Installations, Energy and Environment (OASA[IE&E]) ESOH
5850 21st Street, Bldg 211, Second Floor
Fort Belvoir, VA 22060-5527

Contract No. W91ZLK-10-D-0005
Task No. 0825
CDRL No. A004

Submitted by
 *Concurrent Technologies Corporation*
100 CTC Drive
Johnstown, PA 15904



MUNIREM RATING AND SUMMARY



MuniRem Technology Rating

No.	Criteria	Rating
1	Maturity	Already applied at full scale to demilitarize discarded military munitions and neutralize bulk explosives Compliments other demilitarization technologies
2	Process Efficacy	Demonstrated and validated at bench, pilot and full scale
3	Process Throughput	10s to 100s pounds per hour. Determined by breaching and neutralization method
4	Process Safety	Very safe. Near instant neutralization of most energetics
5	Public & Regulatory Acceptance	Already approved on multiple State and Federal projects
6	Secondary Waste Issue	Not a concern
7	Destruction Verification Capacity	Available and Rapid. EXPRAY Test Kits and similar commercially available wet chemistry explosives sensors
8	Process Flexibility	Very scalable and adaptable. Easily transportable for on-site demilitarization. Fixed facility not a requirement for application

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MUNIREM IS A SAFE, WELL-PROVEN TECHNOLOGY THAT SHOULD BE PART OF EVERY PROJECT REQUIRING MUNITIONS DESTRUCTION

Our Clients

- Orbital ATK (Northrup Grumman)
- Austin Powder
- ORICA
- EMI Israel
- AEL Mining Services (South Africa)
- Multiple USDoD Army Ammunition Plants
- US Army Corps of Engineers
- US Marine Corps
- US General Service Administration
- Canadian Defense Forces
- General Dynamics
- CH2M (Jacobs)
- TETRA Tech
- PIKA International
- Donjon Marine
- EXPAL USA
- OTIE
- Concurrent Technologies Corporation
- Continental Motors International
- Dyno Noble



Thank you.

Feel free to contact me directly for any further information you need.

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