

The image features five vertical glass tubes, each containing a different amount of a reddish-brown liquid. The tubes are arranged in a row and are set against a background of a forest and mountains. The text is overlaid on the left side of the image.

**Yost Brothers, LLC**  
Anacortes, WA

**Blue Q Labs, LLC**  
Lebanon, OR

**We want to fully emerge from the technology proof-of-concept phase and are in need of critical mass and seeking resources to achieve technology acceptance and commercialization**

# Problems Solved

1. Neutralize acidic pH in water without adding hydroxide
2. Remove hazardous metals/radionuclide substances from water without adding chemicals (e.g., Zn to  $\ll 0.1$  mg/L)
3. Reduce mass of solid residuals (45-65% less than lime)
4. Metal leachability from solids, sludges, tailings, sediments, etc. (because of short/long-term exposure to acid rain, acid mine/acid rock drainage, mine pool, acidic leachate, and watershed drainage fluids)

# The Technology(ies)

1. **Advanced Neutralization (AN)**: Acidity/Metals in Mine Drainage
2. **MBT**: Leachable Heavy Metals/Radionuclides in Solids

**Combined**: A Solution for AM/ARD at active/legacy mine sites

# Our Team is Seeking:

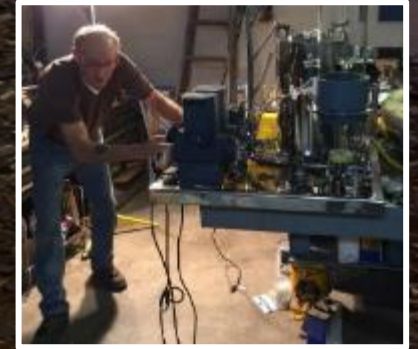
- 1. A new member (Colorado-based)**
- 2. Grant/funds to fully emerge from Proof-of-Concept**
- 3. Technology Emergence - Field Pilot Program:**
  - a. AN and AN combined with MBT at 20-100 gpm on AMD (4-6 week run-time), and with;**
  - b. In-Mine Placement of MBT Treated Solids (partially funded)**

Karl W. Yost  
Yost Brothers, LLC  
Anacortes, WA

- See EXPO Bios
- See LinkedIn (very dated)
- Directed/Managed >\$300 mm in site remediation/cleanup
- Over 60 NPL Site project cleanups (Region 5, 10, and across country)
- 2 Technologies emerged from former USEPA SITE Program to commercialized business sectors (MAECTITE and MatCon)

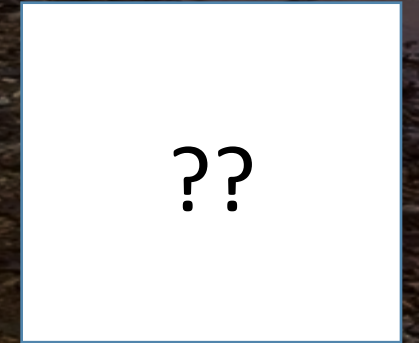


Rick Alexander  
Blue Q Labs, LLC  
Lebanon, OR



- Over 40+ years in fabrication, construction, and design/development
- Developed from concept through world-wide commercialization, a test unit to evaluate levels of formaldehyde in particle and chip board for mill site use. Eliminated 6-8 weeks of product curing time allowing for safe accelerated product release from point of manufacture to retail. Major cost savings throughout industry by streamlining just-in-time inventory management

## New Team Member Colorado USA

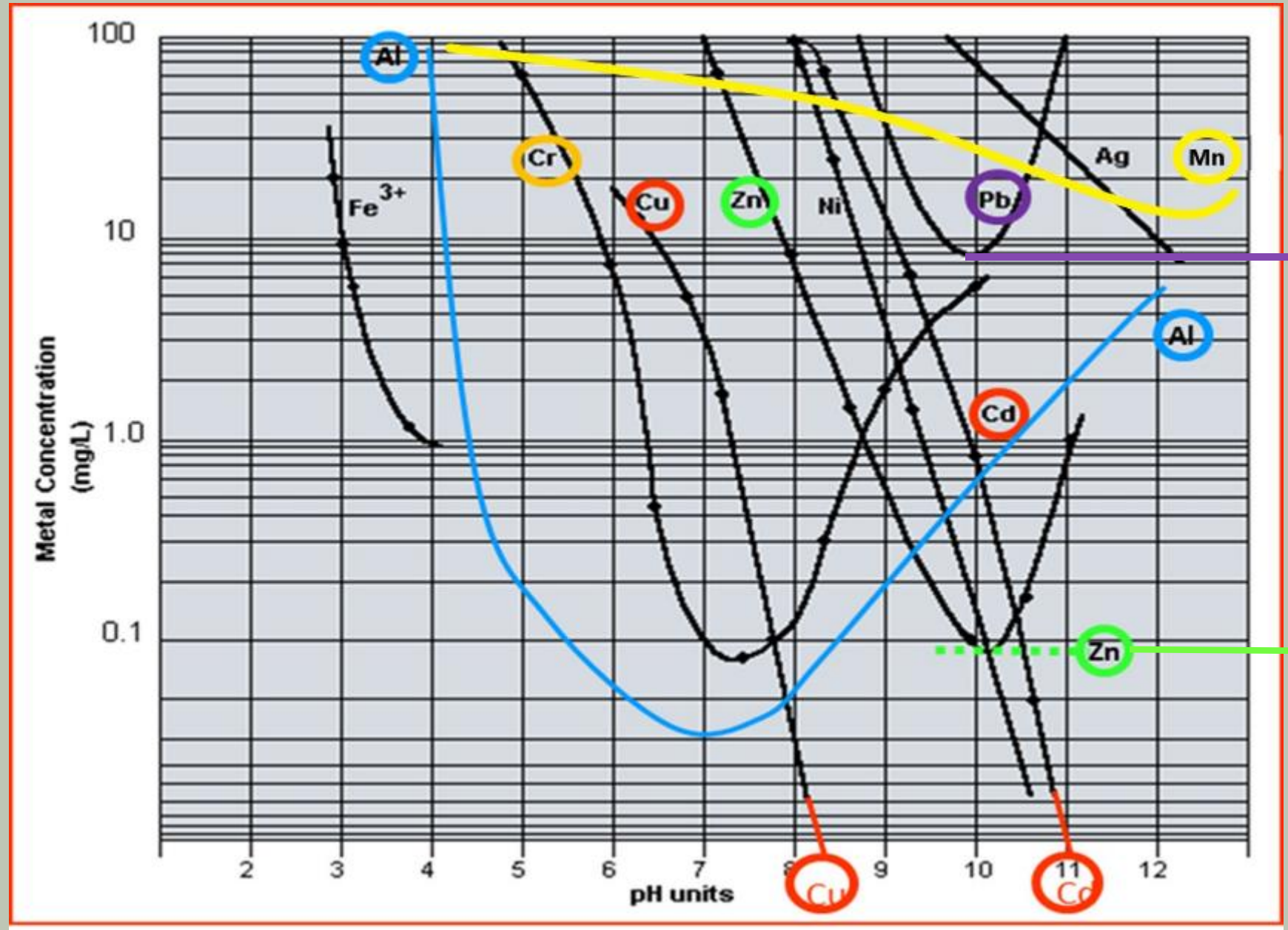
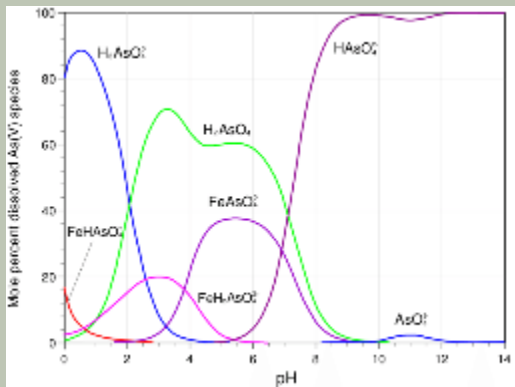


- Market Survey and Review
- Customer Identification and Industry Diligence
- Business Solution Sanity Check
- Grant Applications/Technical Writing
- Business Development
- Company Management Involvement

# “The Silo” Metallic Hydroxide Precipitation Curves (R-OH<sup>-</sup>)

- Multiple pH Points needed for maximized heavy metal precipitation from AMD Fluids
- Hydroxide Instability due to contact with Acidity

Arsenic





# Comparison of R-Hydroxide Solubility Products (Ksp)

vs.

# Ksp Values for R-MBT Anions

<u>Metal</u>	<u>Quicklime</u> <u>Ksp</u> <u>R-Hydroxide</u>	<u>MBT</u> <u>Ksp</u> <u>R-MBT</u>	<u>Comment</u>
Aluminum	$3 \times 10^{-34}$	$9.8 \times 10^{-21}$	amphoteric
Arsenic	soluble	N/A	oxidation state
Cadmium	$5.3 \times 10^{-15}$	$2.53 \times 10^{-33}$	
Cobalt	$1.1 \times 10^{-15}$	$2.05 \times 10^{-35}$	
Copper	$1.6 \times 10^{-19}$	$8 \times 10^{-37}$	
Iron (II)	$4.9 \times 10^{-17}$	$3.6 \times 10^{-41}$	oxidation state
Iron (III)	$2.79 \times 10^{-39}$	$1 \times 10^{-88}$	
Lead	$1.43 \times 10^{-20}$	$7.9 \times 10^{-43}$	amphoteric
Manganese	$2.1 \times 10^{-13}$	$1 \times 10^{-22}$	oxidation state
Mercury	$3.1 \times 10^{-26}$	$2 \times 10^{-53}$	oxidation state
Nickel	$5.5 \times 10^{-16}$	$4.74 \times 10^{-32}$	
Zinc	$4.1 \times 10^{-17}$	$1.0 \times 10^{-32}$	amphoteric

**NOTES:**

- 1) Amphoteric properties and valence state of metal ions are critical to solubility
- 2) Ksp values are nominal, but typically accepted in the literature
- 3) Quicklime can be substituted with any hydroxide contributing source or pozzolanic alkaline reagent

# Advanced Neutralization - AN (Water)

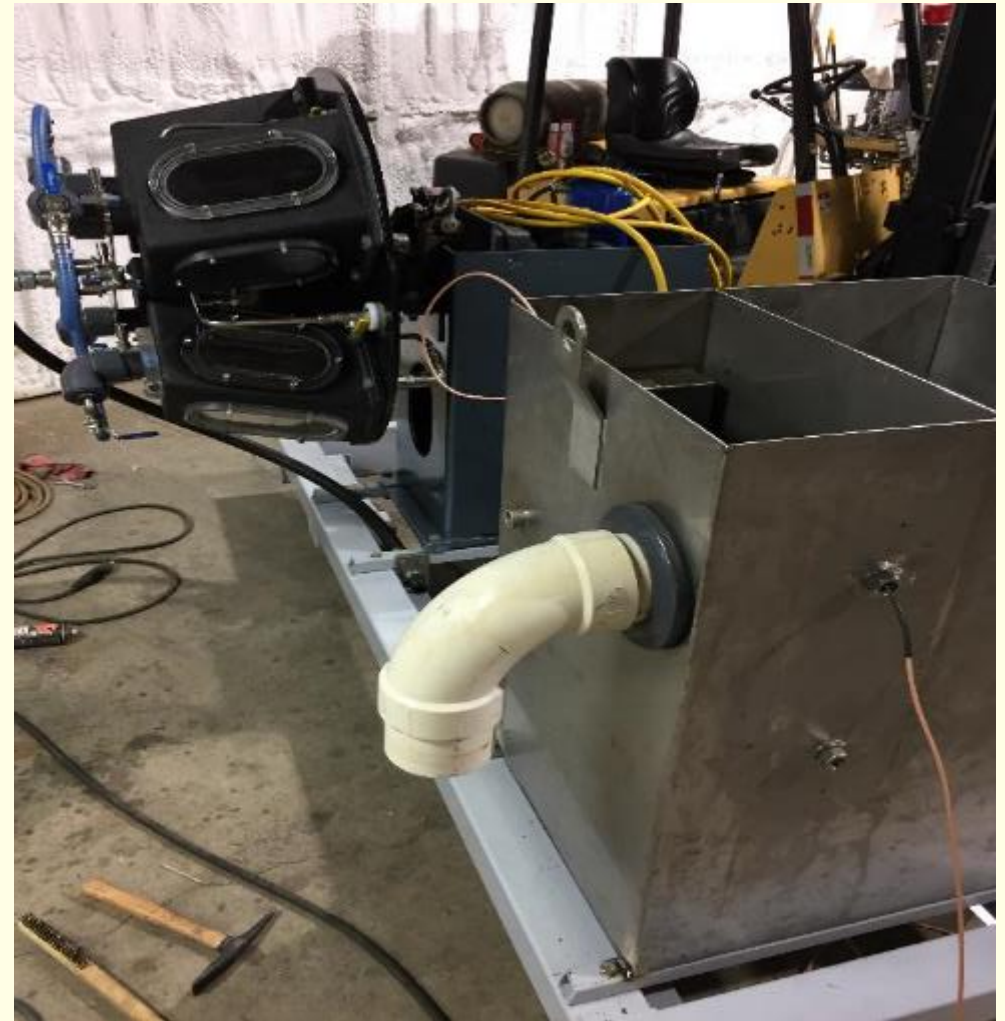
- Treats acidity & removes heavy metals (total and dissolved)
- Electric power to an array of combined components.
- Uses constituents in water to manufacture needed chemical reactants, including hydroxide and metallic oxides (that precipitate)
- Lower cost than conventional HDS and lime/lime-polymer mine water treatment.
- Compatible with MBT and other solid treatment/dewatering technologies
- Patents Pending

# Advanced Neutralization – Engineering

## Scale



1-5 gpm



5-20 gpm

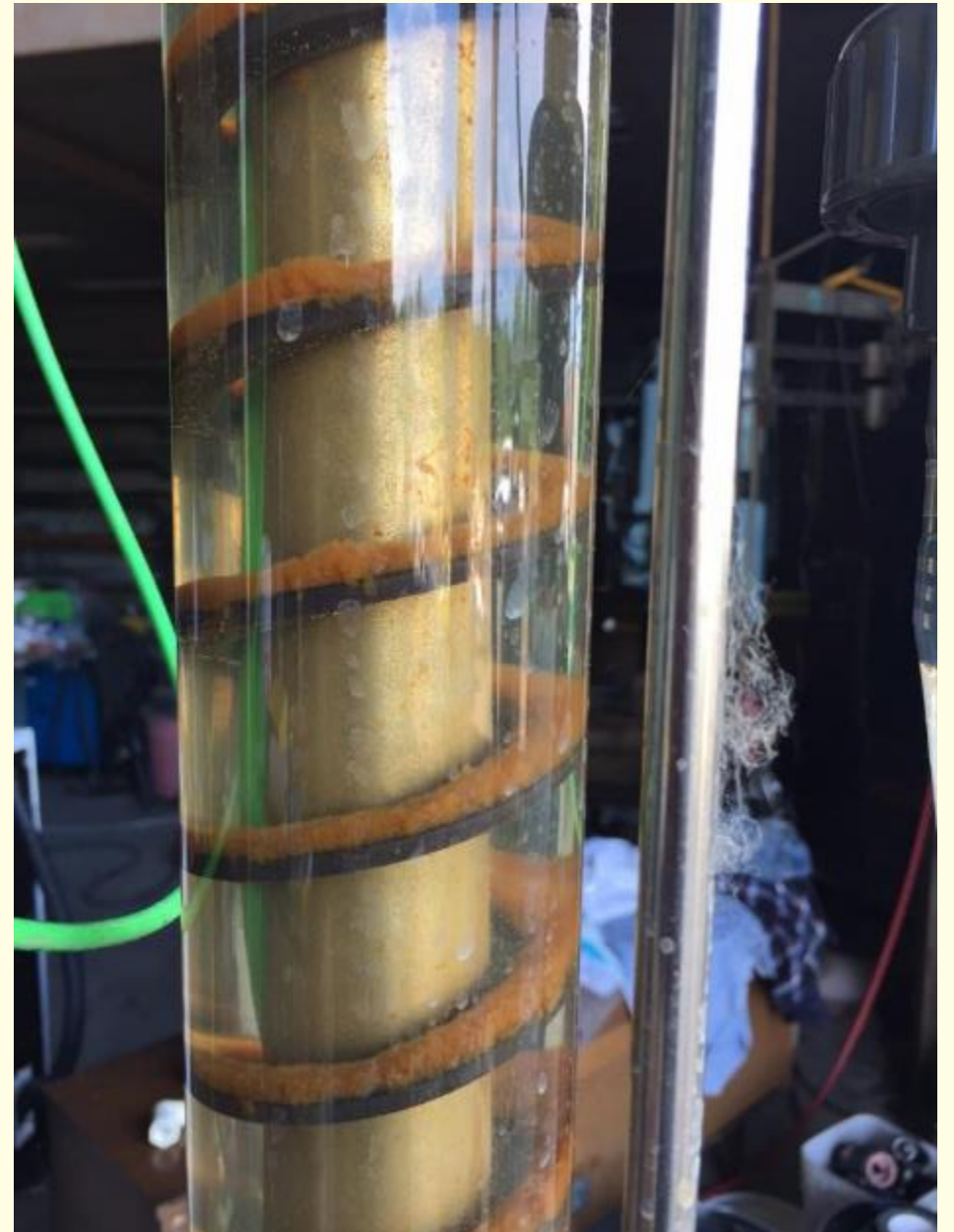
# MBT: Leachable Heavy Metals in Solids

HMR Solutions, LLC Brooklyn, NY

- Treatment of leachable heavy metals in soil, sediments, paste, tailings, slurries, water treatment residuals, and other solid waste
- MBT Reagent supplier
- Technical/operational support provider
- Treatability/Optimization Studies
- Technology patents pending (advancements on MBS since EPA SITE evaluation in late 1990's)

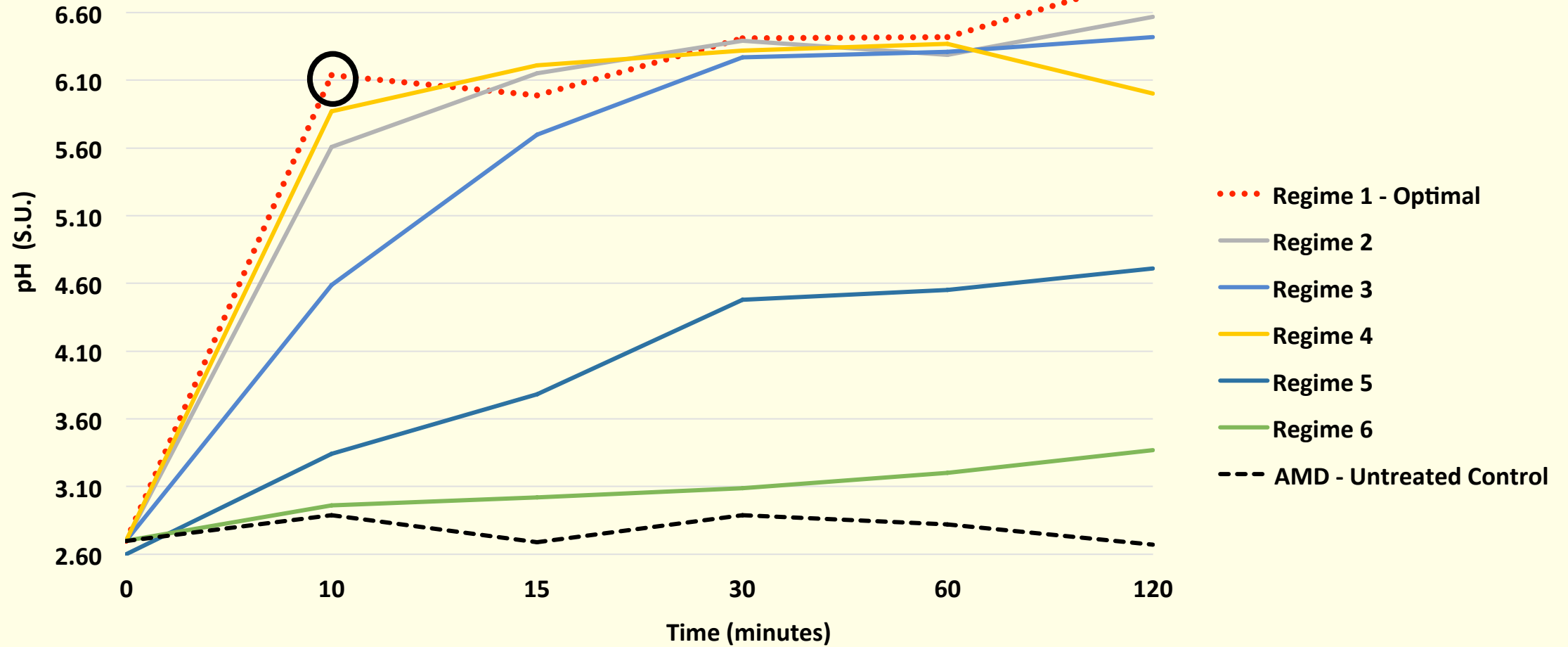
# Studies and Field Trials

- Success Mine, Wallace ID
- Bunker Hill Mining & Metallurgical Complex NPL Site, Kellogg/Smelterville, ID
  - Russel Tunnel
  - Reid Tunnel
  - Kellogg Tunnel
  - Jig Tailings, South Fork of the CDA River
- **Bonita Peak Mining District NPL Site, CO**
  - **Mogul Mine, Gladstone CO**
  - **Cement Creek, Gladstone CO**
  - **American Tunnel, Gladstone CO**
  - **Gold King Mine, Gladstone CO**
- Summitville Mine, Summitville, CO



# AMD - AN (Advanced Neutralization) Process

## Stage 1 In-Water OH<sup>-</sup> Mfg.: pH v. Time



# Bunker Mine/Kellogg Tunnel, Kellogg ID

Active Mine – AMD



# Bunker Mine/Kellogg Tunnel, Kellogg ID

Issues: pH, Heavy Metals

Technologies: AN

Unresolved: **Sulfate removal**, Mn, Zn



Parameter	Units	Untreated	AN - Treated	
			R-1	R-2
Aluminum, dissolved	mg/L	1.23	0.476	0.05
Aluminum, total	mg/L	1.27	0.893	0.19
Arsenic, dissolved	mg/L	<0.025	<0.0030	0.0004 J
Arsenic, total	mg/L	0.040	<0.0030	0.0004 J
Cadmium, dissolved	mg/L	0.0753	0.0500	0.020
Cadmium, total	mg/L	0.0750	0.0492	0.021
Calcium, total	mg/L	207	NT	197
Copper, dissolved	mg/L	0.059	0.00993	0.0018 J
Copper, total	mg/L	0.0600	0.0107	0.0014 J
Iron, dissolved	mg/L	18.8	36.8	1.98
Iron, total	mg/L	88.6	44.9	1.98
Lead Dissolved	mg/L	0.558	<0.00300	0.00027 J
Lead, total	mg/L	0.607	0.00539	0.00086
Magnesium, total	mg/L	113	NT	74.7
Manganese, dissolved	mg/L	68.2	61.0	46.66
Manganese, total	mg/L	68.8	60.5	48.04
Nickel, dissolved	mg/L	0.0615	0.162	0.024
Nickel, total	mg/L	0.059	0.165	0.025
Sulfate	mg/L	1430	NT	858
Zinc, dissolved	mg/L	40.3	14.5	2.197
Zinc, total	mg/L	50.2	15.1	2.296
pH	S.U.	2.34	6.74	7.54

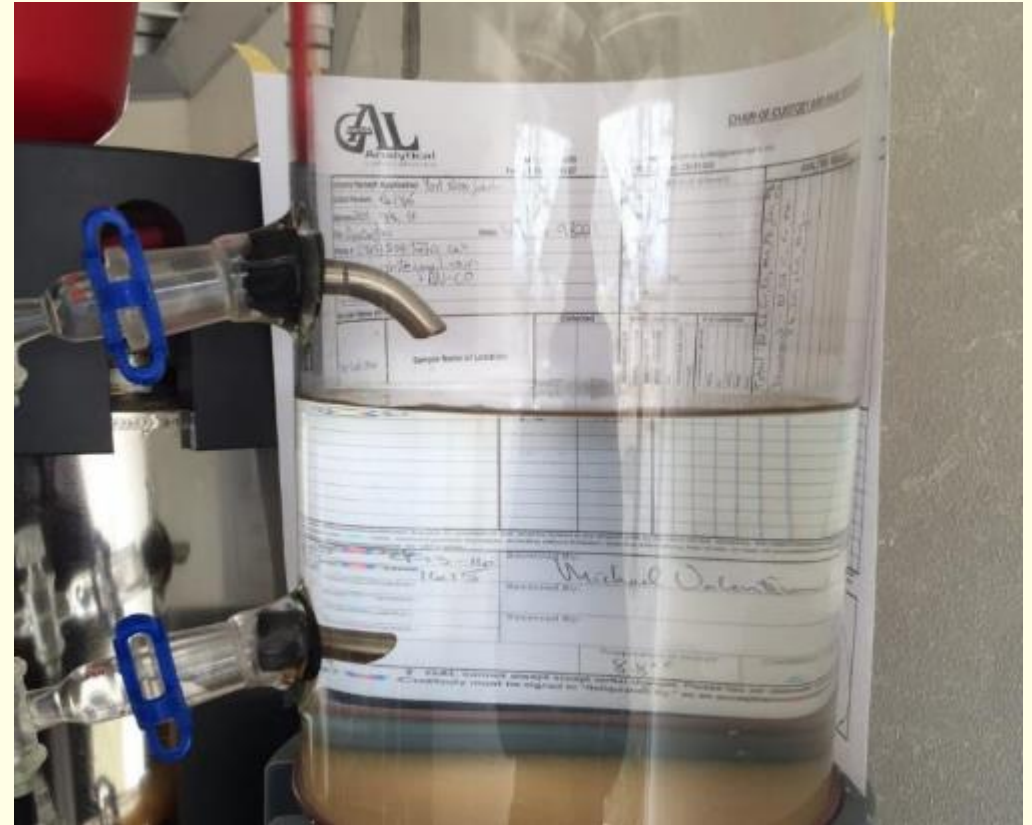


# Cement Creek Drainage Basin, Gladstone CO

August 2015



AN Solids Maturation



GKM – AN Clarified Effluent

# AN vs. Lime Treatment – Mogul Mine AMD

## August 17, 2015 Sample Collection Dissolved Metals

<u>Parameter</u>	<u>Units</u>	<u>Untreated</u>	<u>Lime Treated</u>		<u>AN Treated</u>
			pH 7.86 S.U.	pH 10.34 S.U.	
<b>Aluminum</b>	<b>mg/L</b>	<b>3.5</b>	0.05	<b>0.17</b>	<b>0.06</b>
Arsenic	mg/L	<0.0025	0.0004 J	0.0003 J	<b>0.0002 J</b>
<b>Cadmium</b>	<b>mg/L</b>	<b>0.054</b>	<b>0.031</b>	<0.00025	<b>0.000125 J</b>
Chromium	mg/L	N/A	<0.001	<0.001	<b>N/A</b>
<b>Copper</b>	<b>mg/L</b>	<b>0.0187</b>	0.002	0.0007 J	<b>0.0013 J</b>
Iron	mg/L	25.5	<0.050	<0.050	<b>0.03 J</b>
Lead	mg/L	0.251	0.00016 J	<0.0005	<b>0.00016 J</b>
<b>Manganese</b>	<b>mg/L</b>	<b>28.1</b>	<b>22.10</b>	<b>6.80</b>	<b>0.30</b>
<b>Nickel</b>	<b>mg/L</b>	<b>0.016</b>	<b>0.017</b>	0.007	<b>0.009</b>
Silver	mg/L	0.00006 J	<0.0002	<0.0002	<b>&lt;0.00001</b>
<b>Zinc</b>	<b>mg/L</b>	<b>32.1</b>	<b>8.740</b>	0.022	<b>0.019</b>
<b>pH</b>	<b>S.U.</b>	<b>3.46</b>	7.86	<b>10.34</b>	<b>6.48/7.52</b>

### NOTES:

- 1) Lime treated samples w/calcium hydroxide to pH indicated.
- 2) pH measured in field/treatability laboratory
- 3) No filtration in treatment. Samples settled 2 hrs.
- 4) Untreated sample data by Green Analytical Laboratory, Durango, CO
- 5) Treated sample data by Edge Analytical, Inc., Burlington, WA

Lime  
Treated



AN  
Treated



# AN Solids Settling Times

Left to Right:

2 minutes

5 minutes

7 minutes

10 minutes



30 minutes

9.86 gallons of Mogul Mine AMD → 86.7 g of AN solids (air dried to damp paste)

# Gold King Mine, Gladstone CO

April 13, 2016 – USEPA Settling Pond/Lime/Polymer and Solids Dewatering System



# Gold King Mine Field Trial (October 2018)



# Gold King Mine

Gladstone, CO

Legacy Site – Mine Drainage

Issues: pH, Heavy Metals

Technologies: AN

Unresolved: Sulfate, Sulfide, Sulfur



## AN Treatability Results Gold King Mine AMD

April 12-15, 2016

AMD Parameter	Units	Untreated	AN Treated			
			R-1	R-1A	R-2	R-3
Aluminum, total	mg/L	13.9	1.43	1.39	DGap	DGap
Aluminum, dissolved	mg/L	8.94	<0.500	<0.500	DGap	DGap
Arsenic, total	mg/L	53*	NT	NT	0.0004 J	0.00035 J
Arsenic, dissolved	mg/L	62*	NT	NT	0.0005	0.00036 J
Calcium, total	mg/L	367	342	340	143.8	102.2
Calcium, dissolved	mg/L	371	335	302	151.2	90.8
Cadmium, total	mg/L	0.0379	0.0285	0.0017	0.0012	<0.00025
Cadmium, dissolved	mg/L	0.0384	0.0302	0.0014	0.0009	<0.00025
Copper, total	mg/L	2.96	0.114	<0.0100	0.008	0.002
Copper, dissolved	mg/L	2.69	0.109	<0.0100	0.0016 J	0.0013 J
Iron, total	mg/L	58.5	5.58	<0.500	23.54	2.05
Iron, dissolved	mg/L	43.8	4.28	<0.500	0.03 J	0.007 J
Lead, total	mg/L	0.0193	<0.0050	<0.0050	0.00017 J	0.0017
Lead Dissolved	mg/L	0.0086	<0.0050	<0.0050	<0.0005	<0.0005
Magnesium, total	mg/L	17.7	16.4	13.4	7.4	2.8
Magnesium, dissolved	mg/L	17.4	16.3	12.1	7.7	2.5
Manganese, total	mg/L	21.5	18.2	5.53	7.762	0.303
Manganese, dissolved	mg/L	20.0	18.6	5.44	4.631	0.012
Sulfate	mg/L	1685*	983	811	NT	NT
Sulfide, total	mg/L	NT	NT	NT	<0.05	NT
Sulfur, total	mg/L	NT	NT	NT	157	153
Sulfur, dissolved	mg/L	NT	NT	NT	167	166
Zinc, total	mg/L	21.5	5.54	<0.100	0.038	0.019
Zinc, dissolved	mg/L	10.1	5.69	<0.100	0.0074	0.001 J
pH	S.U.	5.2	5.75	7.66	6.62	7.24
pH	S.U.	3.28*				

\* Historic average

# MBT (Solids)

- Renders heavy metals and radionuclides in solids non-leachable and stable long-term to landfill leachate, acid rain, AMD, and other acidic fluids
- Regulated hazardous metal substances under CERCLA
- Applicable to slurries, pastes, sediments, tailings, soil, and solids
- Treated material suitable for disposal/management in/near acidic fluid
- Liquid, slurry, and solid reagent forms
- Commercially available from HMR Solutions, Inc.

# Gold King Mine (GKM) Acid Mine Drainage (AMD)

## Gladstone, Colorado

Bonita Peak Mining District (BPMD) NPL Site  
 Field Trials - October 24-30, 2017

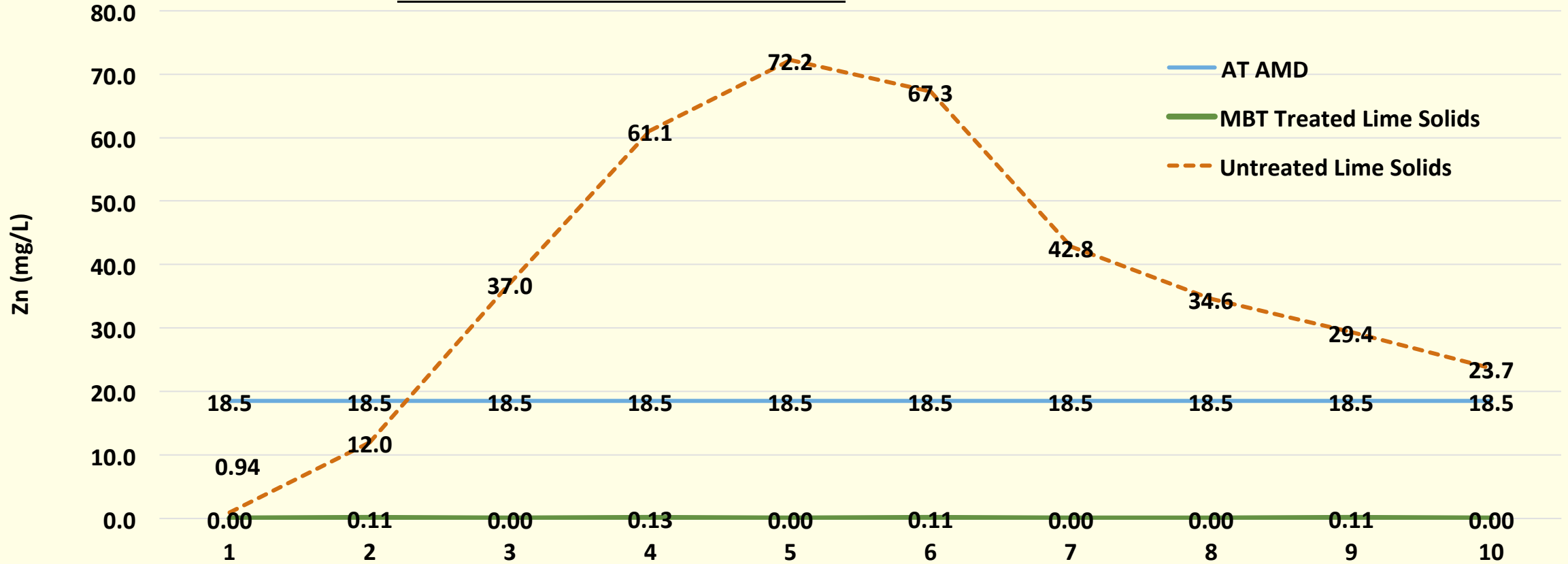
<u>BASELINE - Untreated Matrix</u>	<u>pH</u>	<u>Al</u>	<u>Fe</u>	<u>Cd</u>	<u>Co</u>	<u>Cu</u>	<u>Pb</u>	<u>Mn</u>	<u>Ni</u>	<u>Zn</u>
Cement Creek Water (mg/L - Metals as Totals)	3.94	4.32	29.1	0.0122	NT	0.084	0.0233	20.9	NT	6.3
American Tunnel AMD (mg/L - Metals as Totals)	3.02	4.61	101	<0.0050	0.148	0.0201	0.0196	44.9	0.0862	18.5
Untreated GKM Lime Solids (mg/Kg - Metals as Totals)	8.29	60,100	246,000	175	146	13,100	64	22,600	103	39,200



**GOLD KING MINE - FIELD TRIAL DATA (October 2018)**

**Zn Leachability** via USEPA Method 1320 (Modified Multiple Extraction Procedure)

**American Tunnel Extraction Fluid: MBT vs. Untreated GKM Lime Solids**

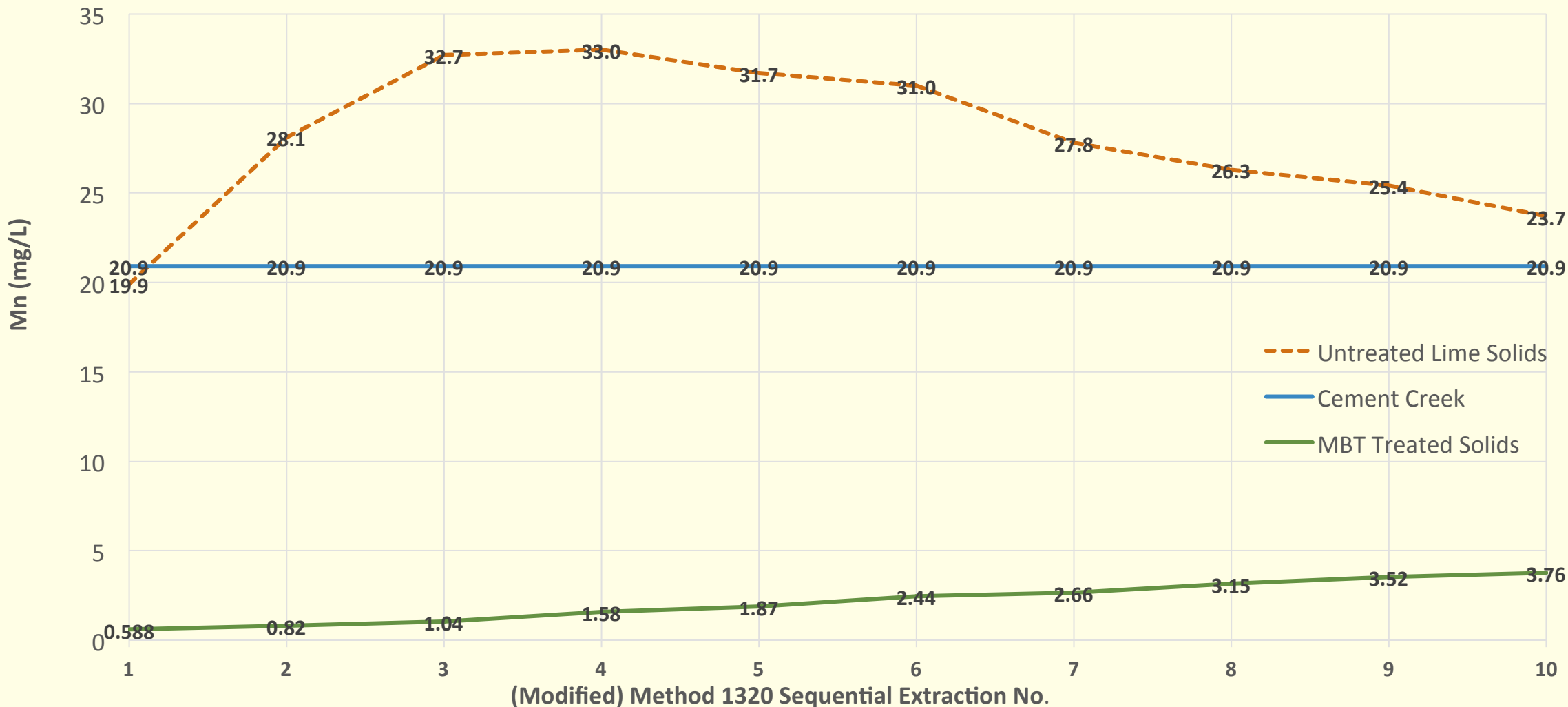


(Modified) Method 1320 Sequential Extraction No.

# GOLD KING MINE - FIELD TRIAL DATA (October 2017)

**Mn Leachability** via USEPA Method 1320 (Modified- Multiple Extraction Procedure)

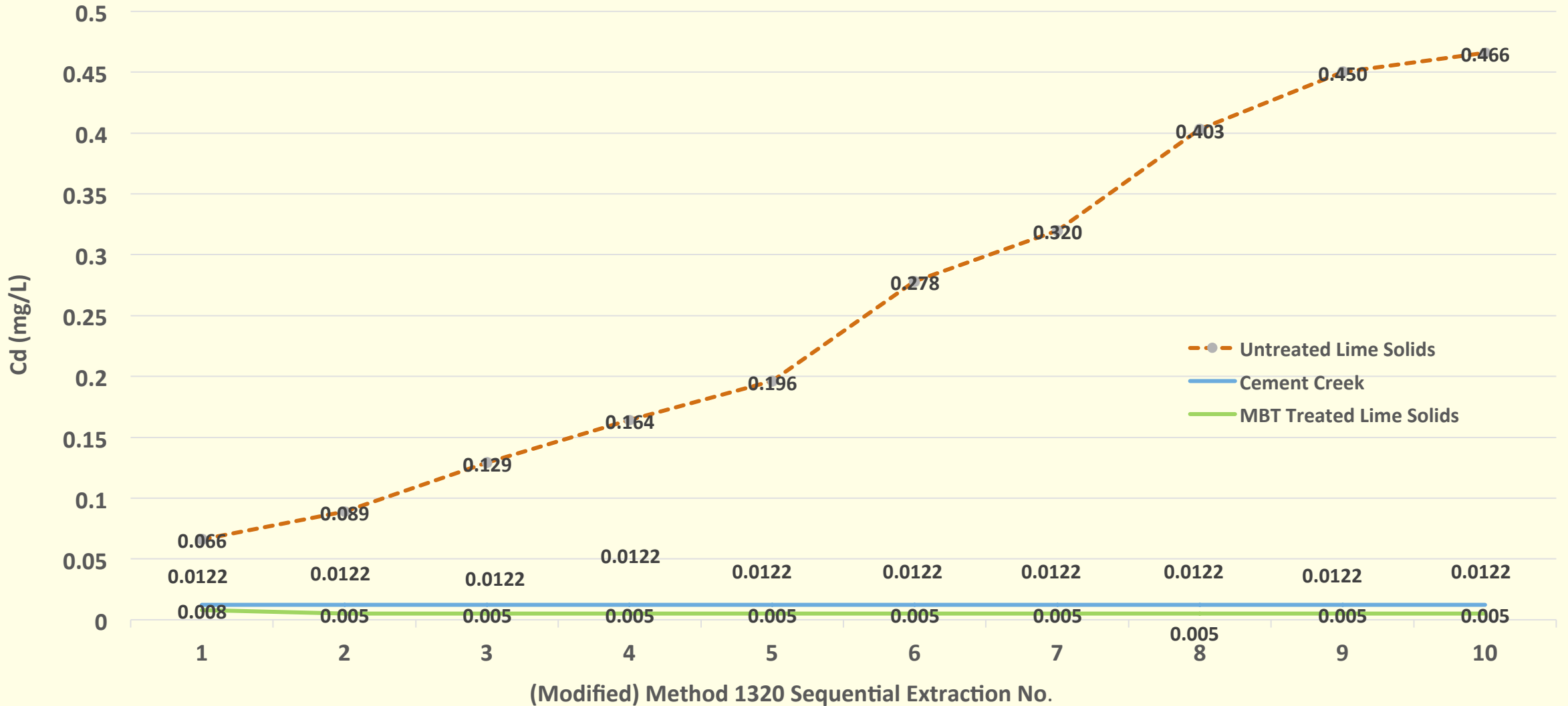
Cement Creek Extraction Fluid: MBT Treated vs. Untreated GKM Lime Solids



# GOLD KING MINE - FIELD TRIAL DATA (OCTOBER 2018)

**Cd Leachability** via USEPA Method 1320 (Modified - Multiple Extraction Procedure)

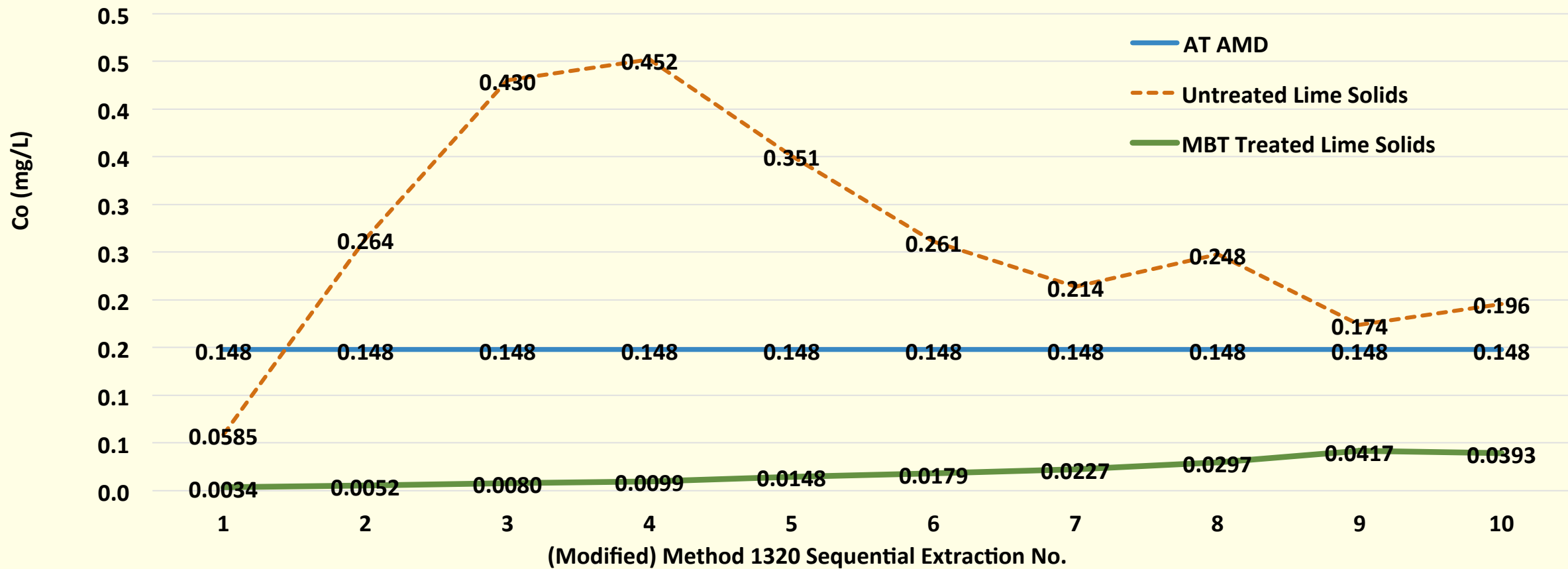
Cement Creek Extraction Fluid: MBT Treated vs. Untreated GKM Lime Solids



GOLD KING MINE - FIELD TRIAL DATA (October 2018)

# Co Leachability via USEPA Method 1320 (Modified Multiple Extraction Procedure)

## American Tunnel Extraction Fluid: MBT vs. Untreated GKM Lime Solids



# BENEFITS and ADVANTAGES

- No alkaline reagents or polymers
- Remote site locations
- Low labor, limited expendables
- Sized for in-mine setup/operations, e.g., shipping container or smaller housing
- Generates 60-75% less solids than conventional lime/polymer systems
- Powerable by penstock/turbine “bolt-on” to treatment plant discharge with potential for excess power sale to the grid



# Our Team is Seeking:

- 1. A new member (Colorado-based)**
- 2. Grant/funds to fully emerge from Proof-of-Concept**
- 3. Technology Emergence: AN technology**
  - a. Field pilot program (4-6 weeks) for AN and AN combined with MBT at 20-100 gpm on AMD**
  - b. In-Mine Placement of MBT Treated Solids (partially funded)**

# QUESTIONS?

Karl Yost  
Yost Brothers, LLC  
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(425) 508-3230

Rick Alexander  
Blue Q Labs, LLC  
Blueqlabs@gmail.com  
(541) 974-5850



# INTERESTED CUSTOMERS

- Regulatory Agencies/Land Managers
- Mining/Metal “Workings”/Manufacturing Companies
- Well field services/Injection well fluid disposal companies
- Solution-oriented engineering firms (US and Canada)
- Savvy remediation/environmental construction contractors



# Desirable Add-on Options:

## 1. AN:

- a. hydropower & power management
- b. Speciated metal recovery

## 2. In-mine Work:

- a. processing of AMD and solids
- b. dewatering & disposition of MBT treated solids

## 3. Expanded analytical testing

## 4. Mineralogical evaluation of MBT treated solids

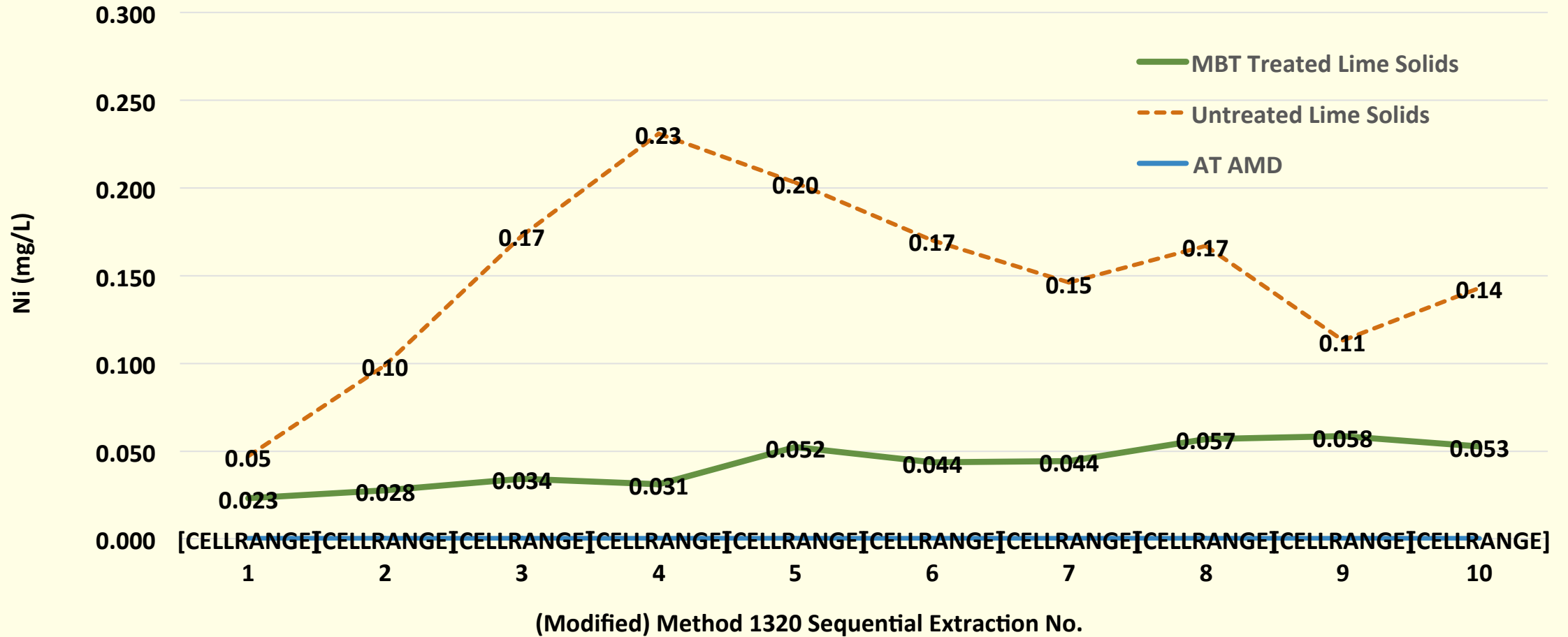
# MBT - INVESTING OPPORTUNITIES

Contact HMR Solutions, Inc.

# GOLD KING MINE - FIELD TRIAL DATA (October 2018)

## **Ni Leachability** via USEPA Method 1320 (Modified Multiple Extraction Procedure)

American Tunnel Extraction Fluid: MBT vs. Untreated GKM Lime Solids



# CONTACT INFORMATION

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# **AN - CURRENT STATUS for Acidity and Heavy Metals Treatment in AMD**

- 1) Full-scale in 3-4 months for up to 20-30 gpm
- 2) Onsite Pilot Trial needed for 4-6 week duration to gather data for upscaling to 100+ gpm system for full-scale deployment in 9-12 months
- 3) Ready for incorporation of AN residual solids dewatering and MBT processing at AMD influent flow rate of 15-20 gpm
- 4) Require guidance for effluent water quality parameter limitations

# CURRENT STATUS – MBT for Metals in Solids

- 1) Ready to go full-scale in 3-4 weeks from a Notice-to-Proceed under fixed and unit price line-item contract terms
- 2) Production rate range of up to 75-150+ tons per hour
- 3) Untreated stockpile to treated stockpile or slurry or untreated slurry to treated slurry
- 4) Mobilization – Setup/Startup – Processing  
Decon/tear-down – Demobilization
- 5) Process control testing
- 6) Validation/confirmation of treatment by Others

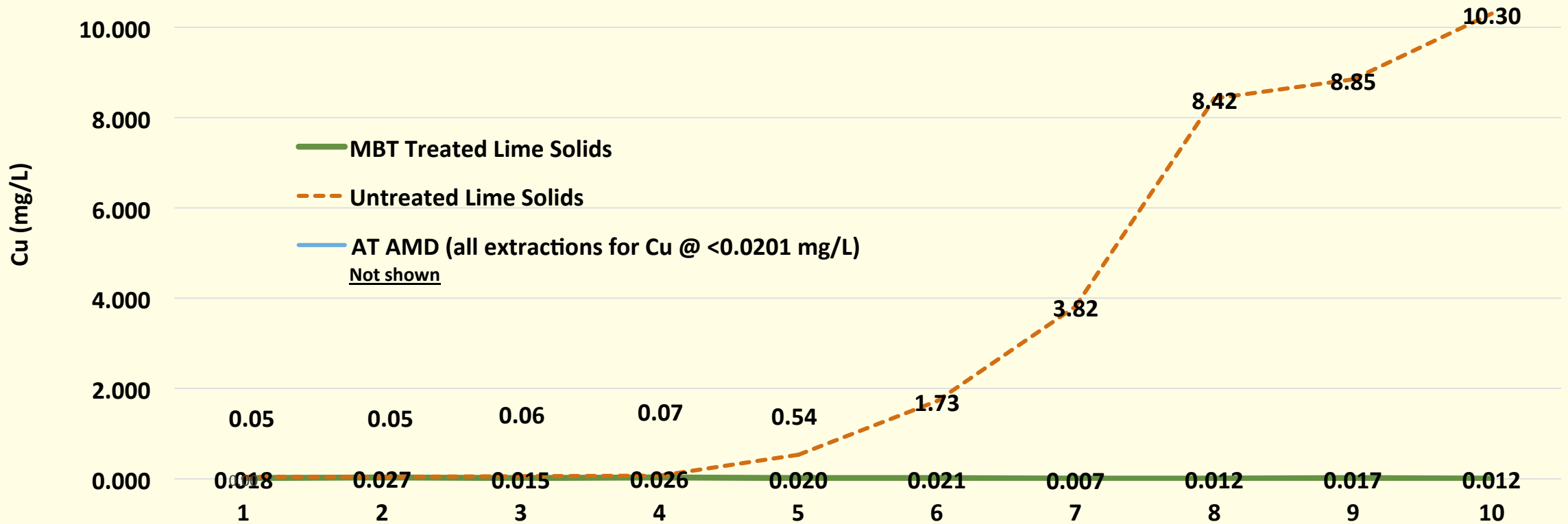
# BENEFITS and ADVANTAGES

## Frac Water - Backflow and Produced

- Minimizes energy and pressure requirements for deep injection well disposal of spent fluids
- High potential to allow re-sale and reuse of spent water not previously possible
- Treated water suitable for future make-down
- Compact and Portable

GOLD KING MINE - FIELD TRIAL DATA (October 2018)

**Cu Leachability** via USEPA Method 1320 (Modified Multiple Extraction Procedure)  
American Tunnel Extraction Fluid: MBT vs. Untreated GKM Lime Solids



(Modified) Method 1320 Sequential Extraction No.

Yost Brothers, LLC -- HMR Solutions, Inc., Brooklyn, NY -- Blue Q Labs, LLC