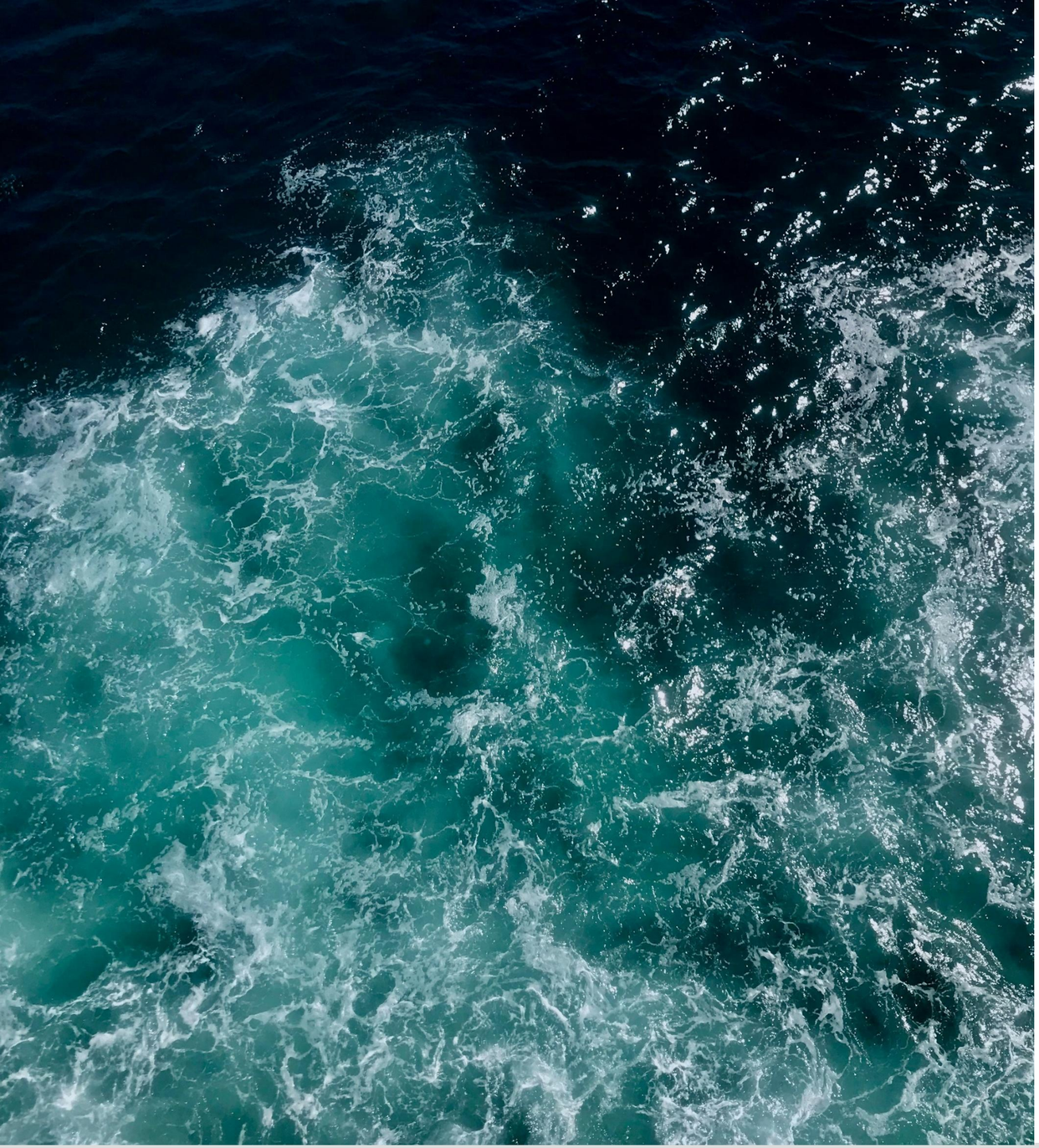
Transforming Mine Water Management

In-Situ, Autonomous, and ESG-Driven



About PMAP

- We offer a unique solution to overcome one of the most persistent challenges in the mining industry worldwide - the effective treatment of ARD
- Addressing two significant risks in mine wastewater treatment:
  - The transfer of contaminated water
  - The handling of dangerous hazardous reagents.

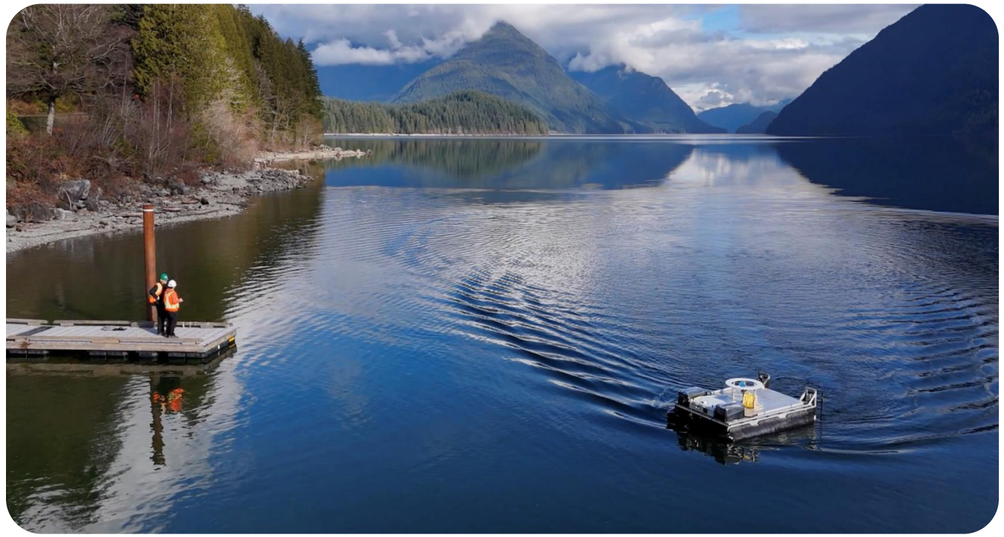
The Challenge in Mine Water Management

- ARD creates high operational costs, environmental risks, and regulatory pressure.
- Existing treatment systems rely on hazardous chemicals, large infrastructure, and heavy labor input.
- Unpredictable water chemistry and rising ESG scrutiny complicate compliance.

A Smarter Path Forward

- Tailings ponds become controlled, low-cost treatment zones through in-situ neutralization, metal recovery, and autonomous operation.
- Eliminate the need to move water, build heavy infrastructure, or handle toxic reagents.
- Align operations with sustainability targets—without compromising performance.

PMAP Technology



REAGENT

Patented framework for a slow-release non-hazardous neutralization reagent formula

DISPENSING

AI-powered dispensing vessel measures, monitors, adapts and dispenses reagents

Process Workflow

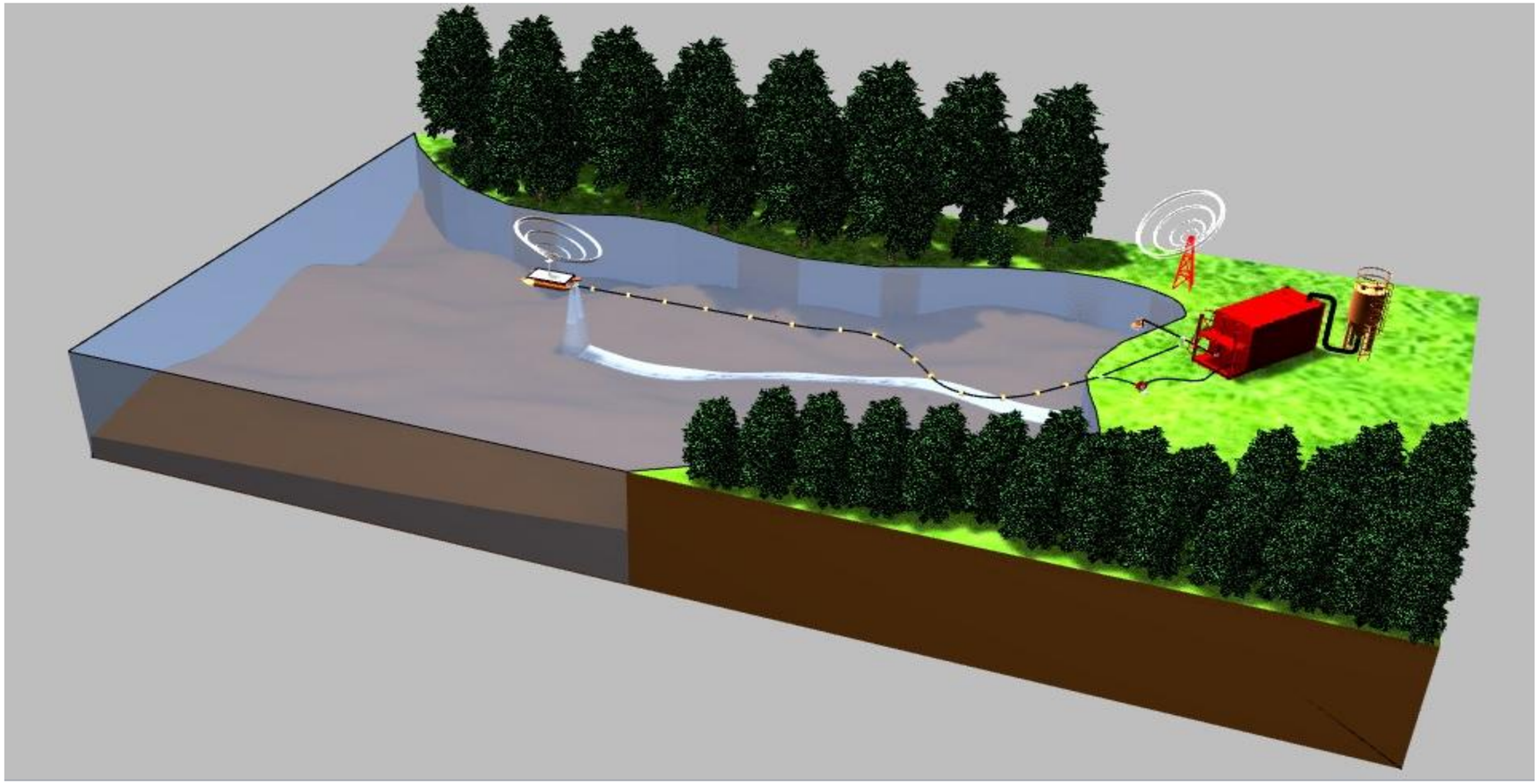
The four step PMAP process

Step 1:
Creating a Digital Map

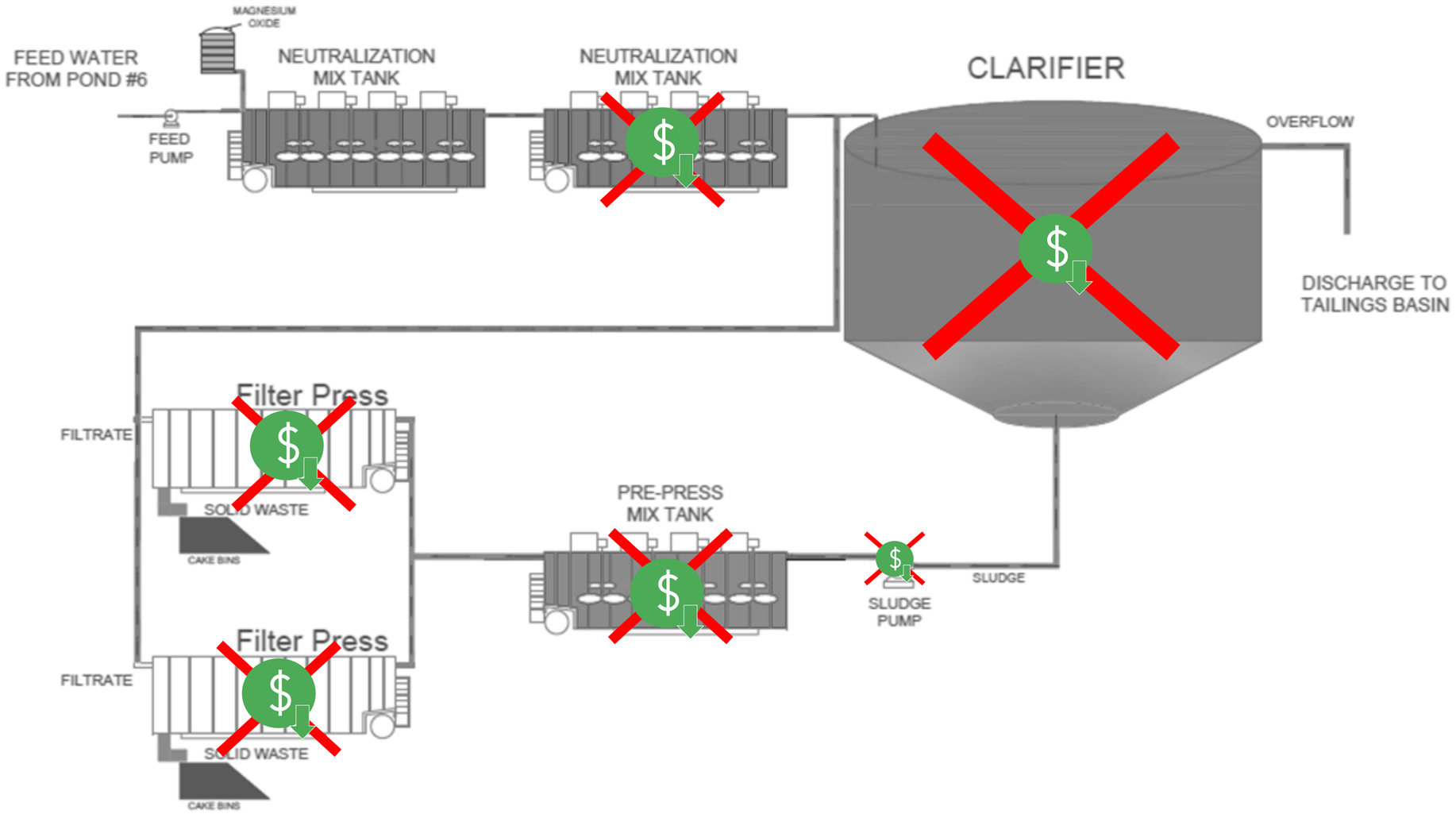
Step 2:
Custom Planning

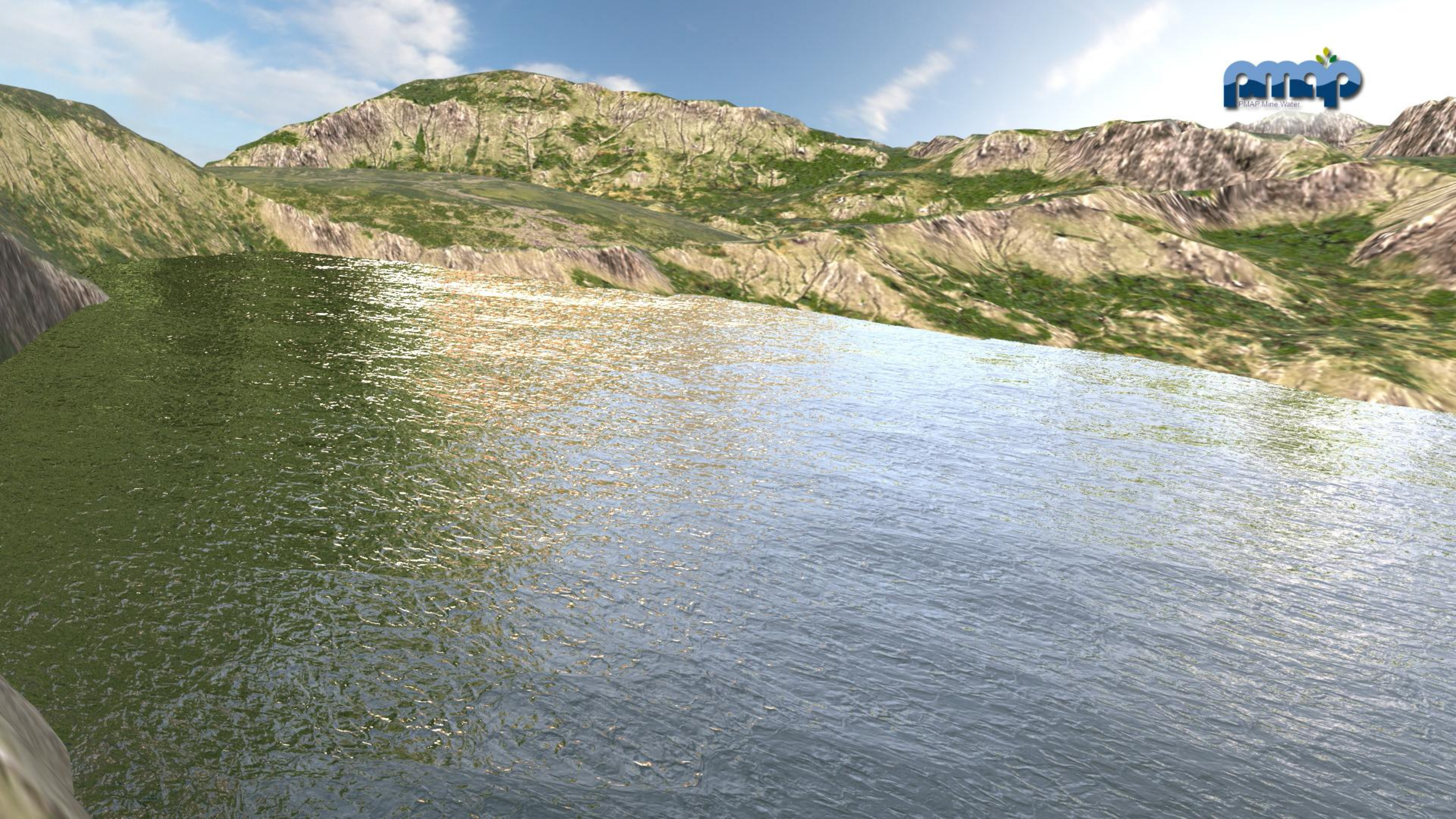
Step 3:
Slurry Preparation

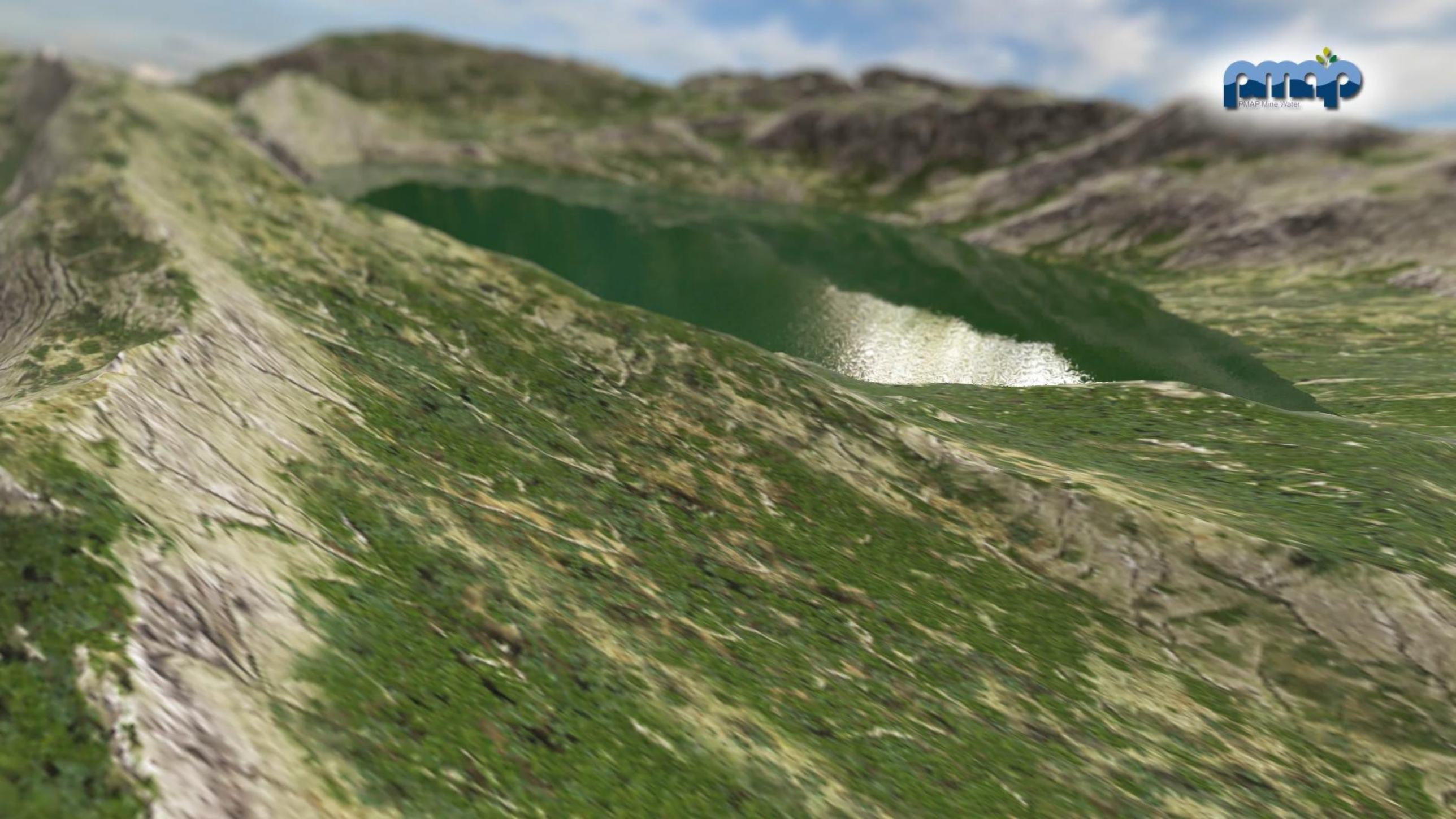
Step 1:
Slurry Injection



Up to 85% Reduction in Capital Costs




PMAP Mine Water


PMAP Mine Water

What This Means for Operations

Problem	PMAP-Enabled Outcome
Hazardous lime handling	Switch to non-toxic, MgO-based chemistry
High CAPEX/OPEX	Reduce up to 85% of capital costs and 30% of operational costs
Sludge volume & disposal	Minimize sludge, eliminate handling systems
ESG pressure	Unlock GHG, safety, and environmental gains
Lost metal value	Recover valuable metals onsite

Mine Water Challenges Addressed

Wastewater Treatment

- Handles extreme pH (as low as 1.5)
- Achieves pH neutralization without post-adjustment
- Controls gypsum scaling via MgO-based formulation

Water Monitoring

- Autonomous vertical sampling (depth-resolved)
- Real-time conductivity, pH, ORP, temperature, etc.
- Sediment accumulation mapped in 3D

Engineering Constraints

- Works with no major infrastructure
- Does not require pumps, clarifiers, filter presses
- Fits brownfield workflows as pretreatment or retrofit

Metal Recovery

- Nickel: 90–95% recovery from high-acid water
- Sludge metal content >10% for metals

Technology That Adapts to Site Needs

Four capabilities that drive measurable results

In-situ chemical treatment

- Tailored MgO formulation effective at pH < 2
- Eliminates gypsum scaling by avoiding calcium sulfates
- Slow-release reaction supports process control over 24–72 hours
- No post-treatment pH adjustment required in most scenarios

Unmanned autonomous vessels

- Operates in shallow or deep tailings ponds (0.5m–10m)
- Fully autonomous routes using GPS
- Obstacle-avoidance via lidar and front-facing camera
- Safe operations with >2 km communication range and fail-safe return

Real-Time Monitoring & Bathymetry

- Sensors capture pH, conductivity, ORP, temperature at multiple depths
- 3D sediment maps built using high-resolution sonar
- Supports seasonal trends, dredging, and regulatory reporting
- Sediment cores recovered with automated winch

Modular Integration & Scalability

- No need for clarifiers, filter presses, or pumps
- Modular configuration for ponds from 20,000 to 150,000 m^3
- Integrates as stand-alone or pretreatment to lime
- Complies with CCME effluent benchmarks, customizable to permits

Comparison Snapshot

Traditional Active Lime Treatment Compared to PMAP

Feature	Traditional (Lime)	PMAP
Chemical handling	Hazardous	Non-toxic
Reagent cost	Low per ton, high in use	Smart use, lower total
Sludge	High	Low
Capital required	High	Minimal
ESG profile	Weak	Strong

Deployment Models

New mine sites

Eliminate traditional treatment builds

Active mines

Retrofit metal recovery or cost-cutting overlay

Legacy sites

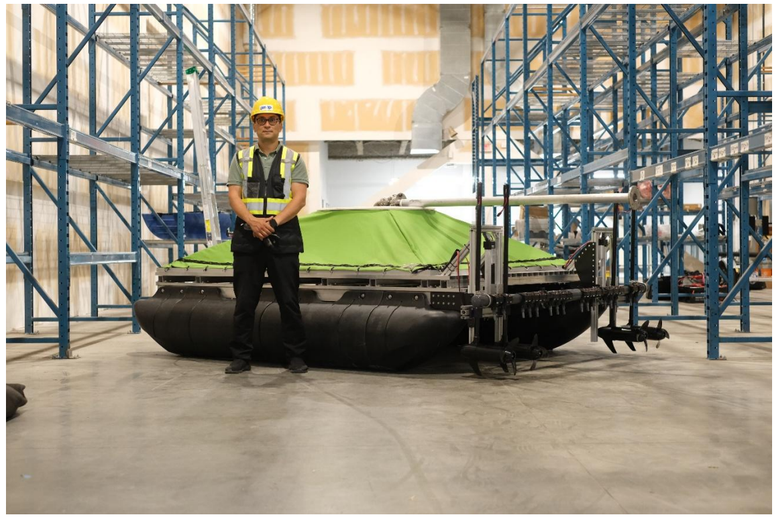
Compliant closure support, reclamation tools

Field Ready Tools

The PMAP Fleet of Unmanned Boats

S.M.A.R.T

Surveying, Mapping, Analysing and Reagent Transmission



P.R.O.B.E

Point Reaching Operational Bathymetric Explorer

S.P.O.R.T

Small Prototype Operations Robotic Tool

ESG and Economic Advantages

- 90% less GHG emissions
- No sludge handling infrastructure
- Non-hazardous reagent use
- Smart reagent consumption
- Minimal operator exposure
- Higher nickel/copper recovery

Case Studies

3 Alternative Approaches for a Tailing Pond

- Volume of water: 50,000 m3
- Initial conditions:
  - pH level: 1.9
  - Nickel: 8000 mg/liter
  - Copper: 3000 mg/liter
- Target: neutralized and release with Nickel at lower than 50 mg/lit
- Three scenarios:
  1. Conventional lime process
  2. MgO used with lime facility
  3. PMAP formula and method

Approach #1

Conventional lime process

- **Benefits:**
  - Neutralization achieved and contamination removed
  - Estimated cost: 7.5 M CAD
  - Previous experience and controllable process
  - Utilizing previous investment in lime preparation facilities
- **Disadvantages:**
  - Low concentration of Nickel in sludge (%2-4)
  - Unable to recover Nickel due to low concentration
  - High energy use for active water treatment
  - No additional revenue
  - Safety challenges, high labor needs, environmental issues

Alternative #2

MgO used with lime facility

- **Benefits:**
  - Neutralization achieved and contamination removed
  - Estimated cost: 7.5 M CAD
  - Recovered Nickel from sludge
  - Extra revenue from metal recovery: 13 M CAD
- **Disadvantages:**
  - Uncontrollable process
  - (Since pH indicator can’t be used for control)
  - Overuse of reagent
  - Rigid solid formed in clarifier:
  - Hence, clarifier removed and replaced with filter press
  - Replacement of gypsum with unutilized MgO & other solids

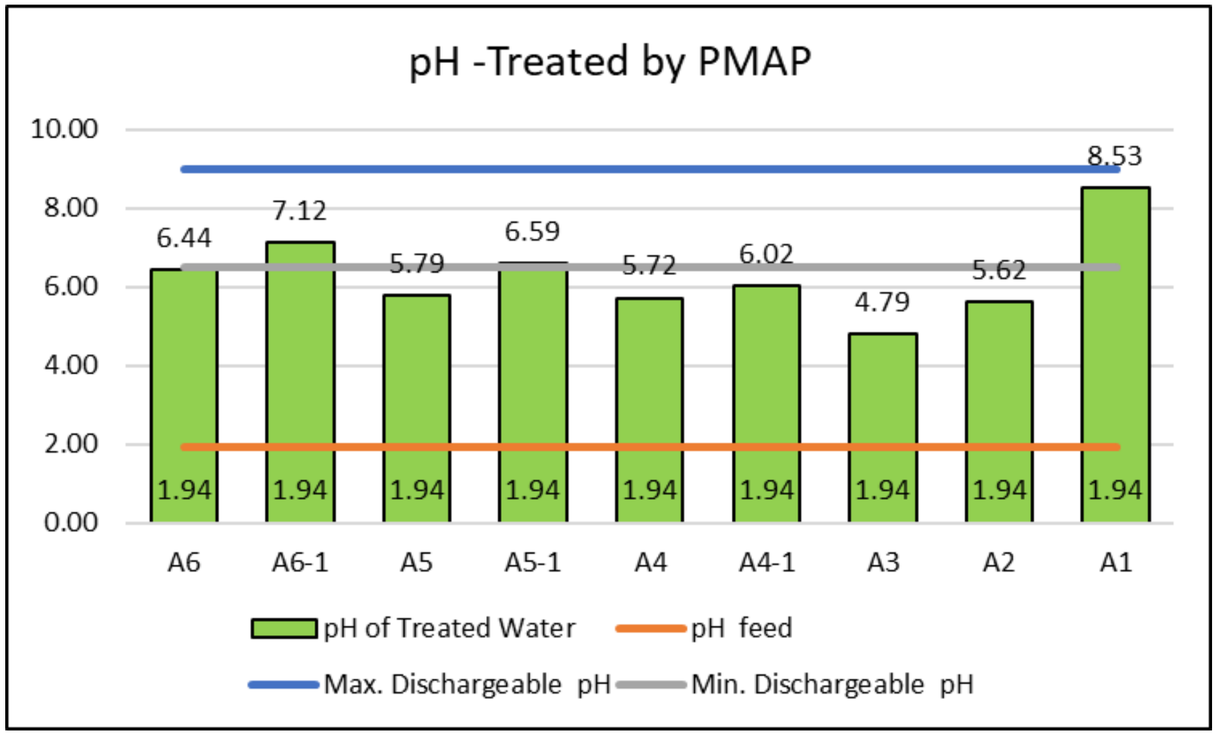
Alternative #3

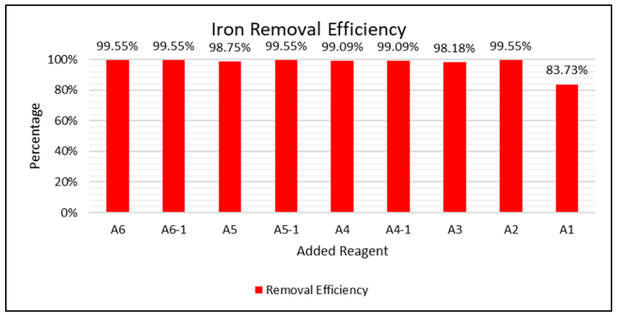
PMAP formula and Method

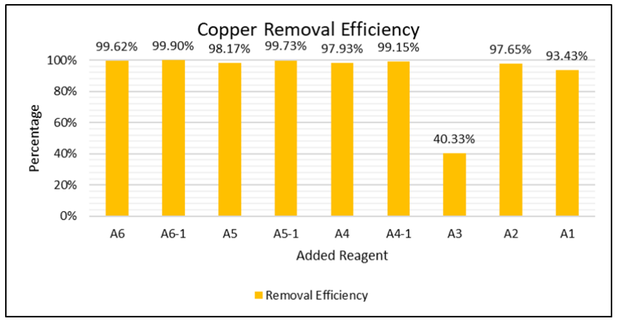
- **Benefits:**
  - Neutralization achieved and contamination removed
  - Estimated cost: less than 5.5 M CAD
  - Recovered Nickel from sludge
  - Extra revenue from metal recovery: 13 M CAD
  - Significant boost of ESG indicators: Safety, GHG emissions, Environmental safety, reduced operational costs
- **Disadvantages:**
  - Dissolved magnesium and sulfate in water
  - Required retention time

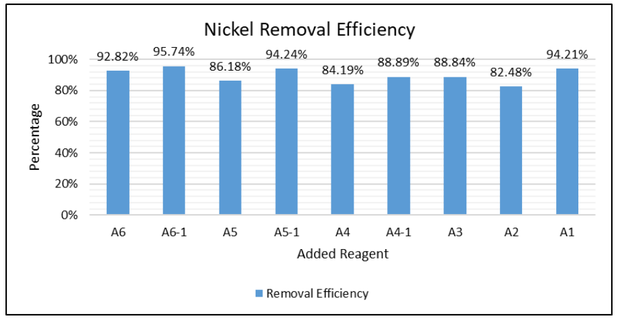
Sample of PMAP Outcome: Metal removal & pH control

- Efficient Iron, Copper, and Nickel removal









Results of treating site sample with acidic water (pH=1.94) containing different dosages of PMAP reagent. The pH of treated water won't be higher than 9 either at optimum dosage (A6-1) or at 2.5-time excessive reagent consumption (A1).

How can we help?

Send us a water sample for a complimentary analysis

Download a sample report here

For more information:

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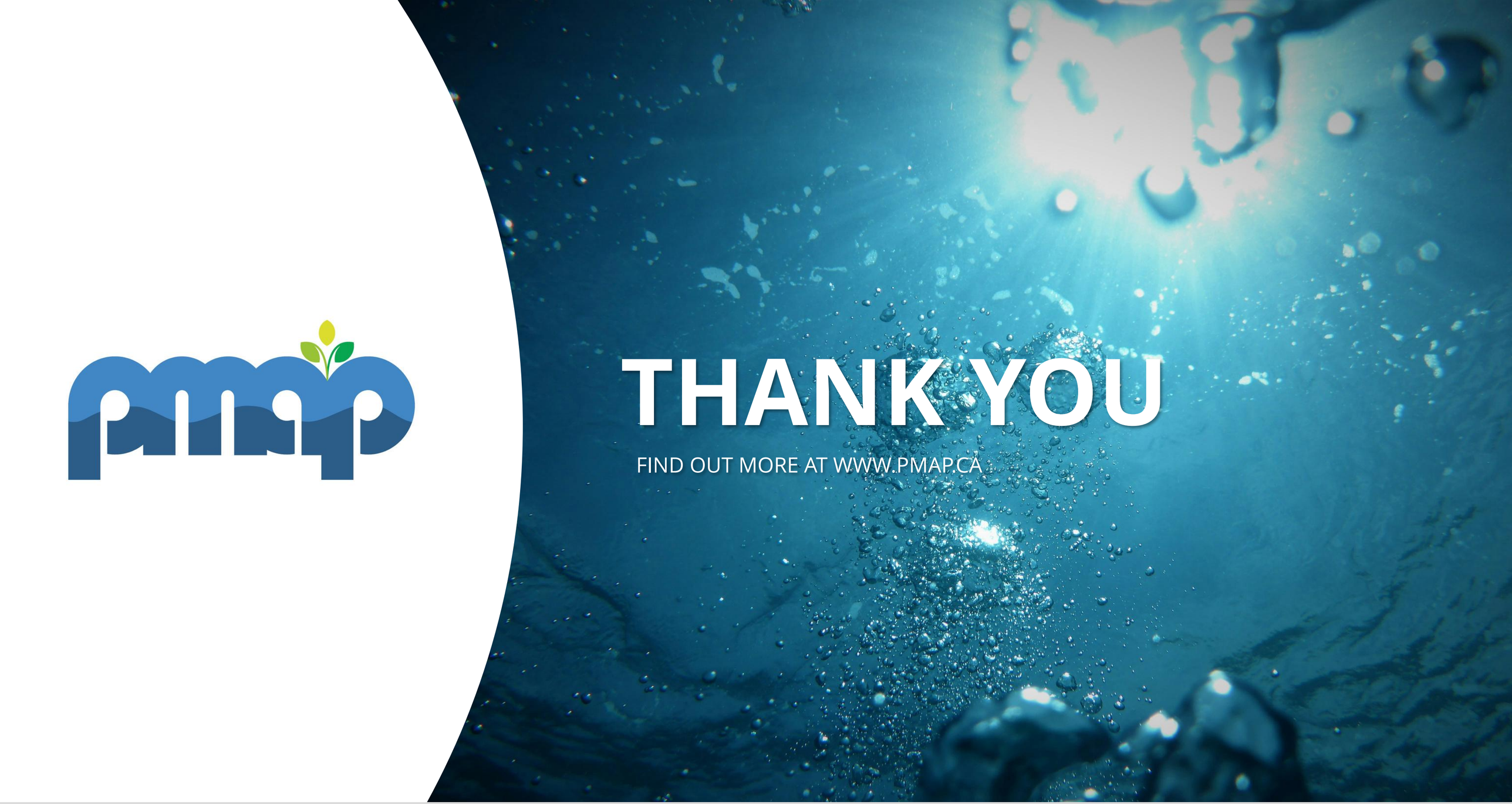

THANK YOU

FIND OUT MORE AT WWW.PMAP.CA