Microvi

Redefining Chromium Remediation: Biological Precision, Real-World Results

National Institute of Environmental Health Sciences (NIEHS) Virtual Technology Fair

August 27, 2025

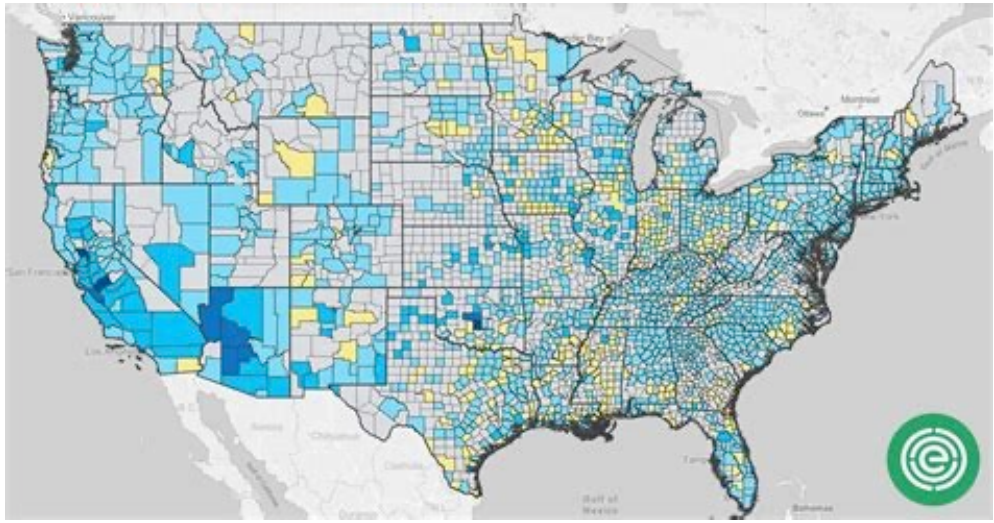
The Nationwide Chromium Crisis: Ubiquitous Contamination

Regulatory Information

- Federal MCL (total chromium): 50 µg/L
- California (2024): First Cr(VI) MCL = 10 µg/L
- Public Health Goal (PHG): 0.02 µg/L (OEHHA, 2011)
- Utilities must adopt best-available technologies with full life-cycle and waste cost evaluations

Treatment Options

- **Chemical:** Coagulation/filtration or stannous chloride reduction
- **Physical:** Strong- or weak-base anion exchange
- **Biological:** Harness microbes to reduce toxic Cr(VI) into stable Cr(III)

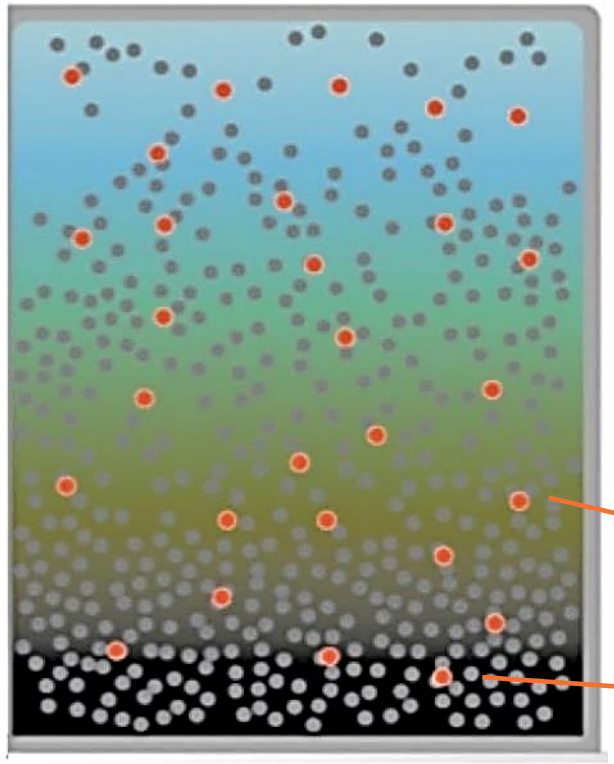


According to the Environmental Working Group (EWG), in tests conducted from 2012 to 2017, hexavalent chromium was detected in the tap water of more than 247 million Americans, spanning every U.S. state.

MicroNiche Engineering Uses Targeted Organisms

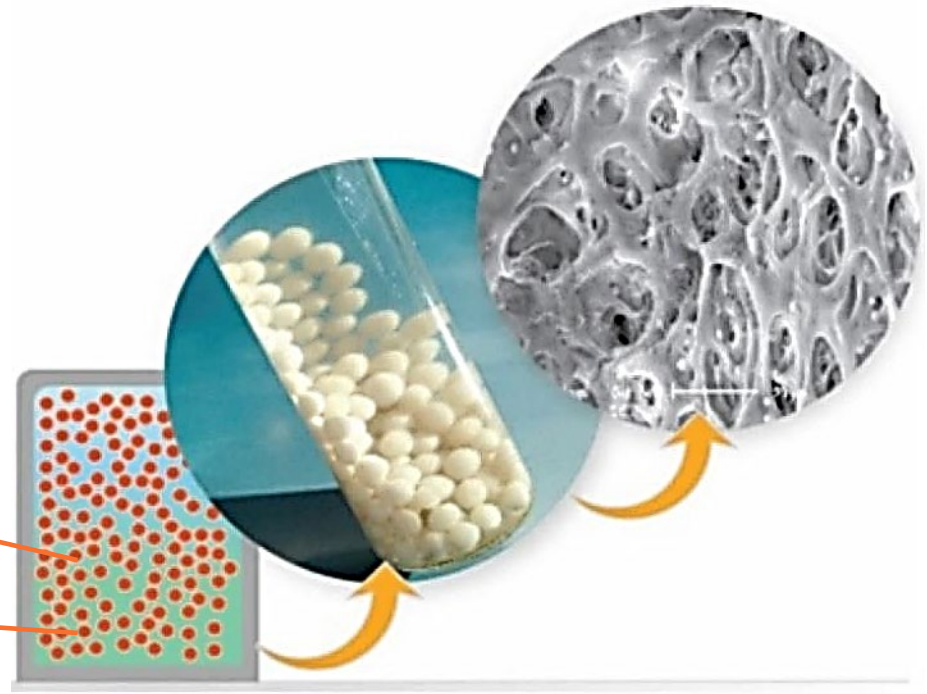
The fastest growing organisms are not necessarily the most fit, metabolically active, or useful for industrial bioprocesses

Traditional Biological Treatment



Microvi Biocatalytic Treatment

- Utilizes only the most active, effective microbes (●) in combinatorially engineered microenvironments



NSF-61 certified for drinking water — proven safe, scalable, and effective

Project Objectives: Optimizing MB-CR™ Performance

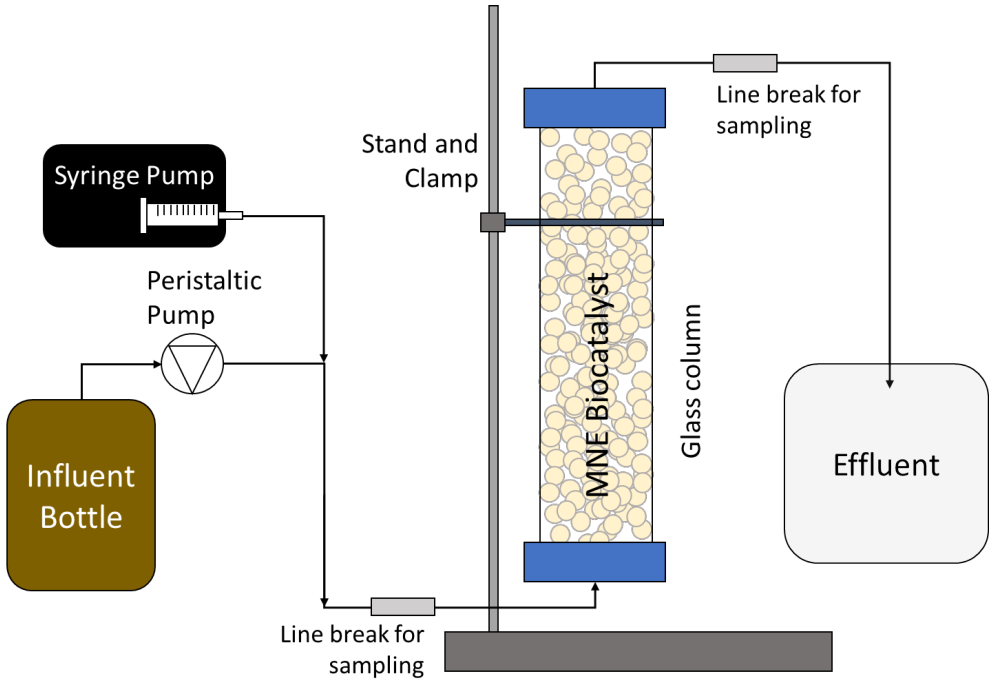
Demonstrate Cr(VI) reduction by MNE biocatalyst in batch reactors and track mass balance of chromium

Evaluate Cr(VI) reduction by MNE biocatalyst in Continuous-flow packed bed reactors (PBRs)

- Optimize Cr(VI) removal: Compare carbon sources, hydraulic retention time (HRT)
- Evaluate conditions with and without nitrate
- Improve measurement technique using a new spectroscopic approach

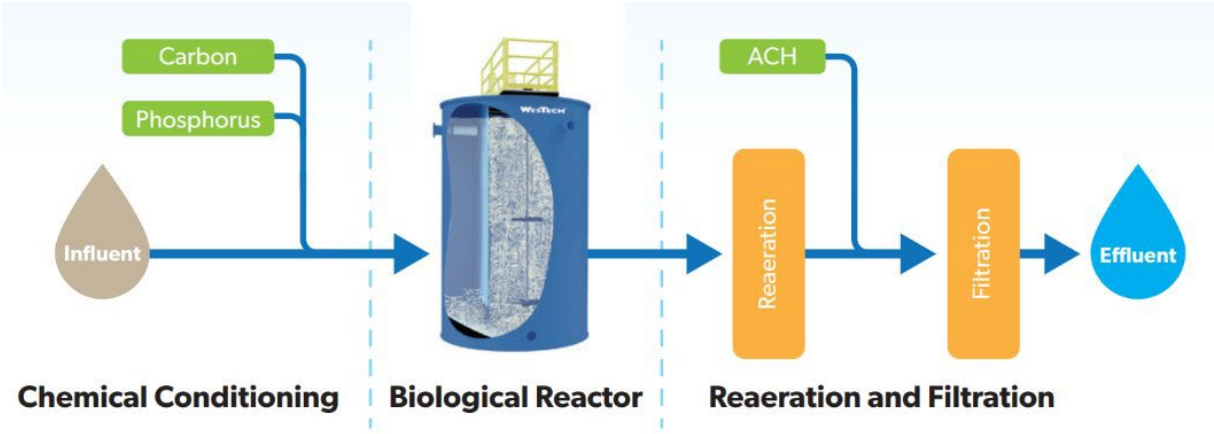
Perform Cr(VI) sampling at full-scale system designed for nitrate-N treatment in groundwater

Biocatalyst Reactors: From Lab Studies to Full-Scale Systems



Bench-scale configuration

- Document removal of Cr(VI) under continuous-flow using packed bed reactors (PBRs).
  - Compare sodium lactate (SL) to acetic acid (AA)
  - Used spectroscopic methods to measure Cr(VI)



Large-scale configuration

- Perform routine steady-state sampling for two large-scale reactors
  - Microvi nitrate treatment plant which also has trace amounts of hexavalent chromium.
  - Used EPA 218.6 methods (J-flagged if [Cr(VI)] < 1 µg/L).

Validating MB-CR™ with Ondavia

Working Together

- Since 2015, Microvi and Ondavia have partnered to integrate advanced monitoring with innovative biotreatment, strengthening validation and deployment of MB-CR™.

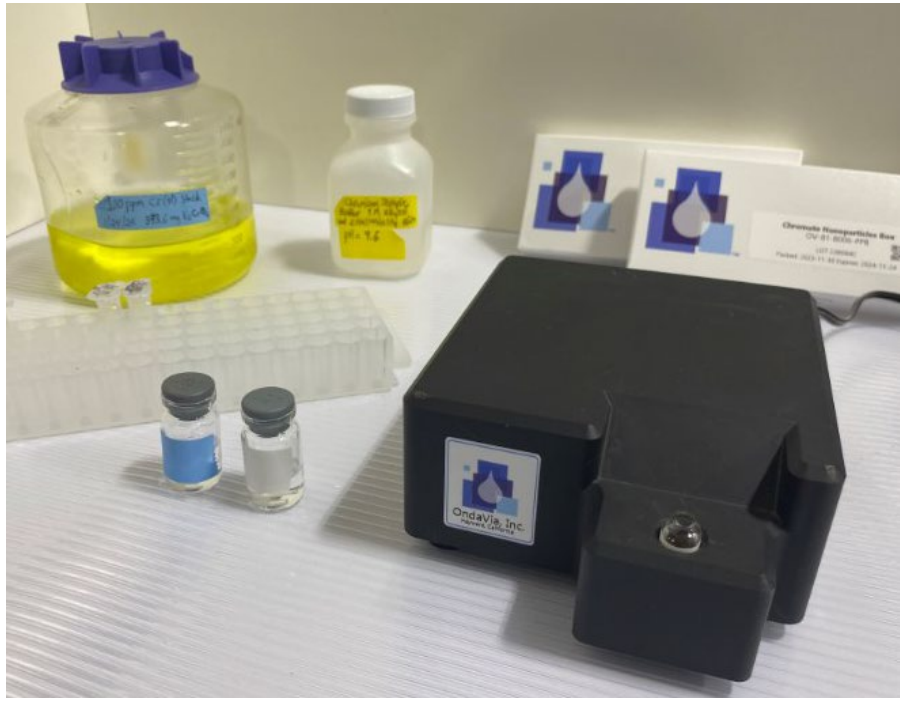
Samples Analyzed for NIEHS Project

- Over 100 samples processed as part of NIEHS-funded projects, enabling robust performance validation and accurate measurement of chromium removal across diverse conditions.

Value of Collaboration

- Delivers faster validation of treatment efficacy.
- More than $5,000 in direct savings through shared resources, faster testing turnaround, and streamlined workflows — lowering project costs and accelerating results.

Working Together	Number of samples analyzed for NIEHS project	Cost savings realized
Since 2015	100+	$5000+

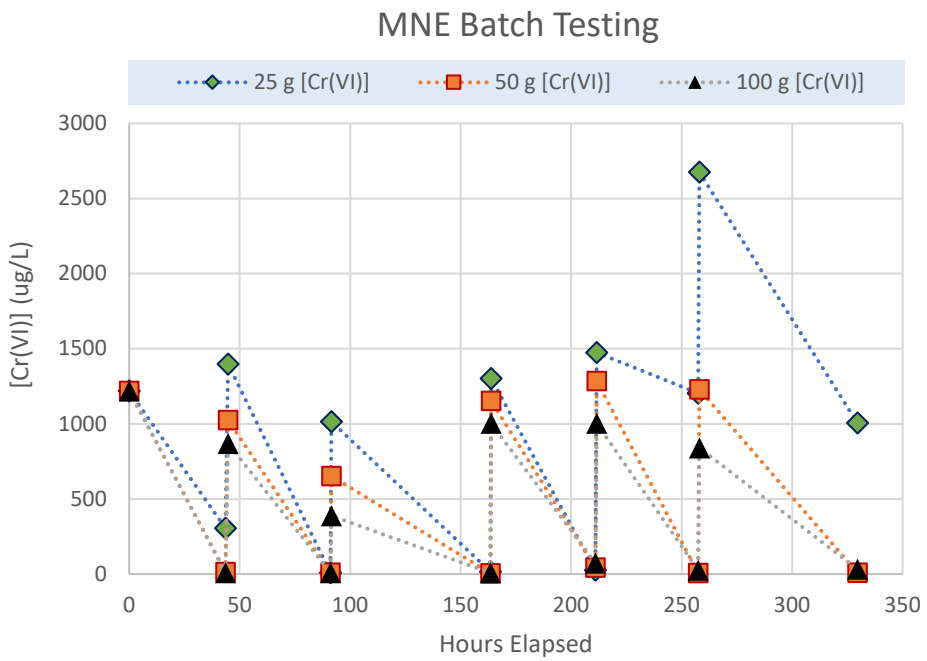


Performing Cr(VI) measurements with Opal™

MNE Biocatalyst Achieves >99% Cr(VI) Reduction

MNE Biocatalyst Reduction of Cr(VI)

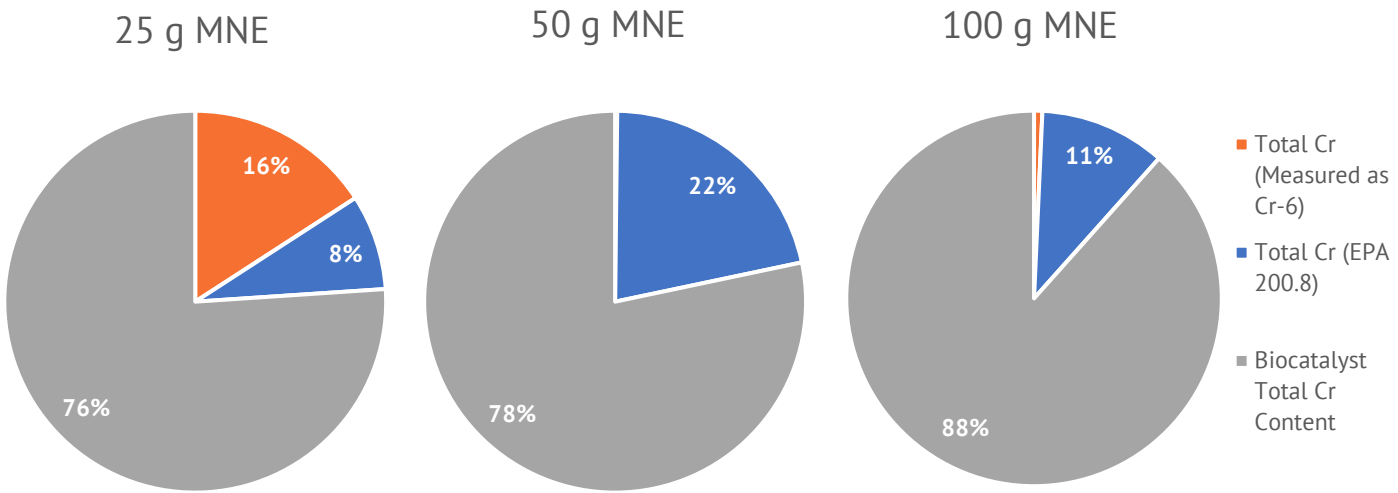
- MNE biocatalyst subjected to repeated 1200 µg/L Cr(VI) spikes



- Total mass Cr(VI) added to each reactor was 1050 ± 8 µg
- Corresponding controls showed no reduction of Cr(VI) and increased [Cr(VI)] after each spike

Mass Balance Results

- Results of chromium mass balance are shown below:

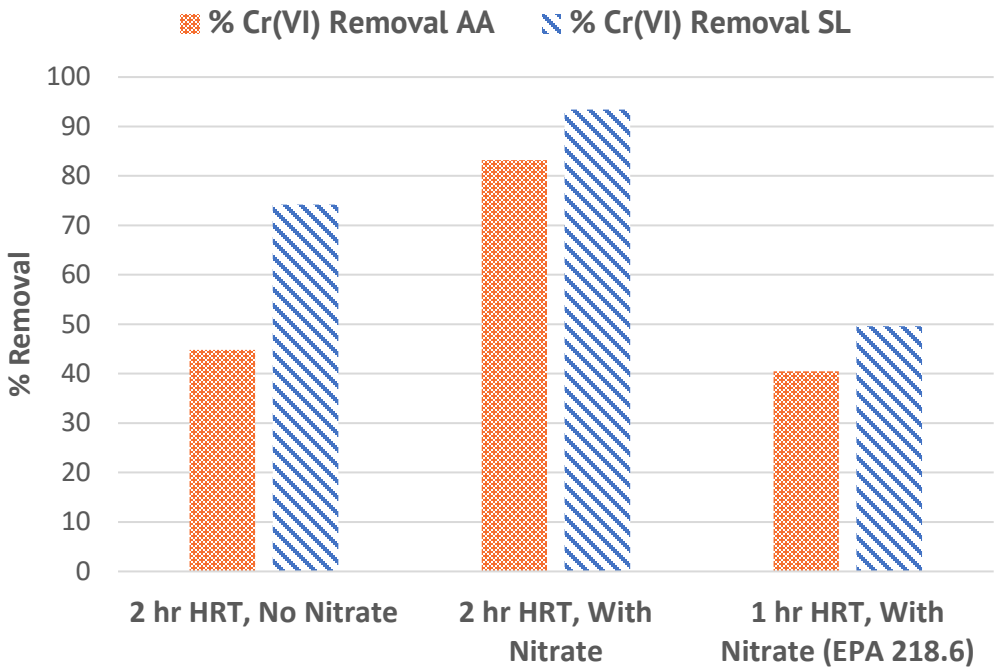


- Aqueous fraction of Total Cr ranged from 11-24%
- Inferred that biocatalyst retained 76-88% of total Cr
- A significant fraction of Total Cr was detected in the aqueous medium by EPA 200.8, showing that residual Cr(III) would be present in the treated water.

Process Optimization: Carbon Selection & Retention Time

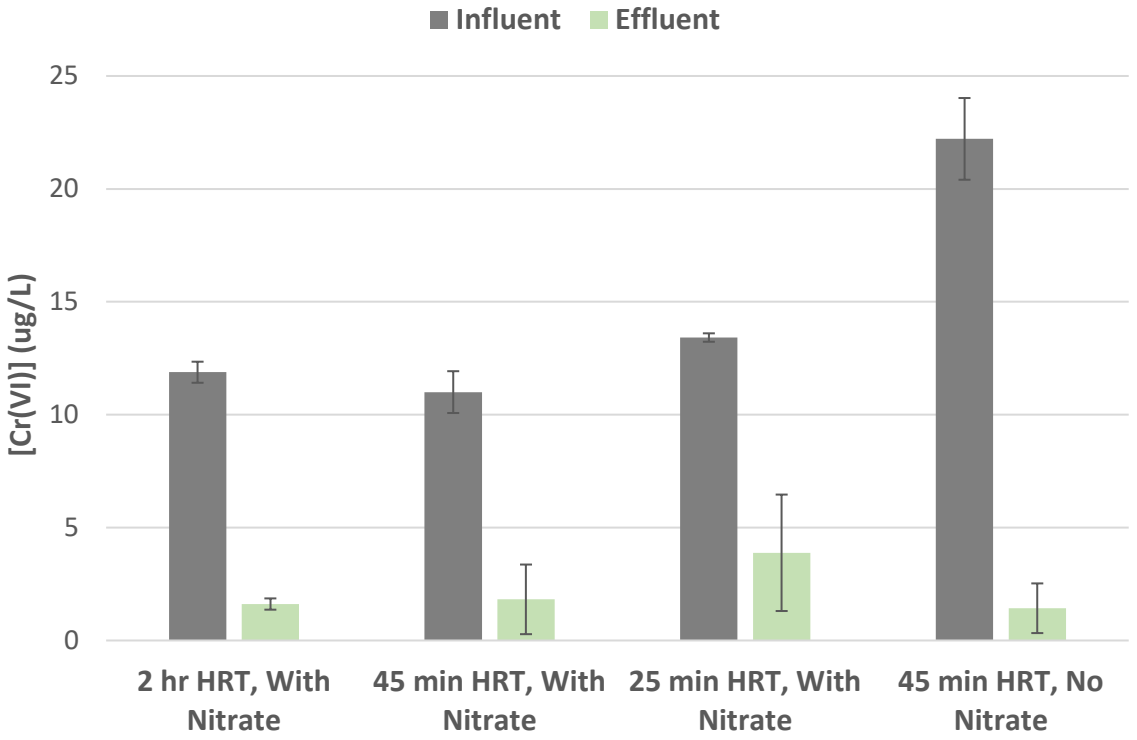
Comparison of Carbon Sources

- Packed bed columns under steady-state conditions with influent [Cr(VI)] of 25 µg/L



- SL indicated improved performance but isn't certified for drinking water treatment
- EPA results for Cr(VI) (n = 4) yielded similar performance for acetic acid (AA) and sodium lactate (SL)

Optimization with Acetic acid

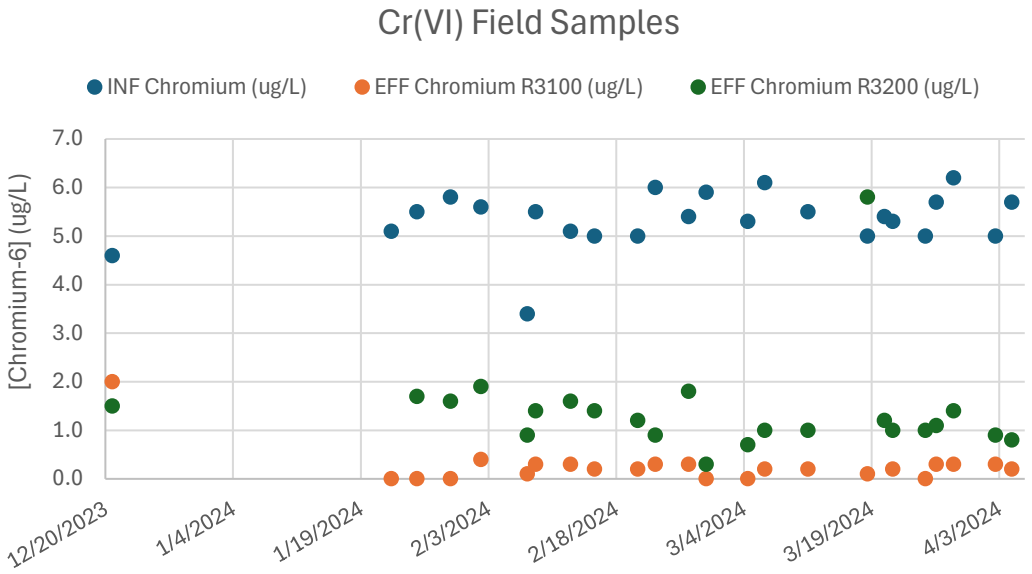


- Packed bed column with acetic acid (AA); measured Cr(VI) using Opal analyzer
- All conditions indicated that a 10 µg/L MCL could be achieved

Proven Performance in Large-Scale Systems

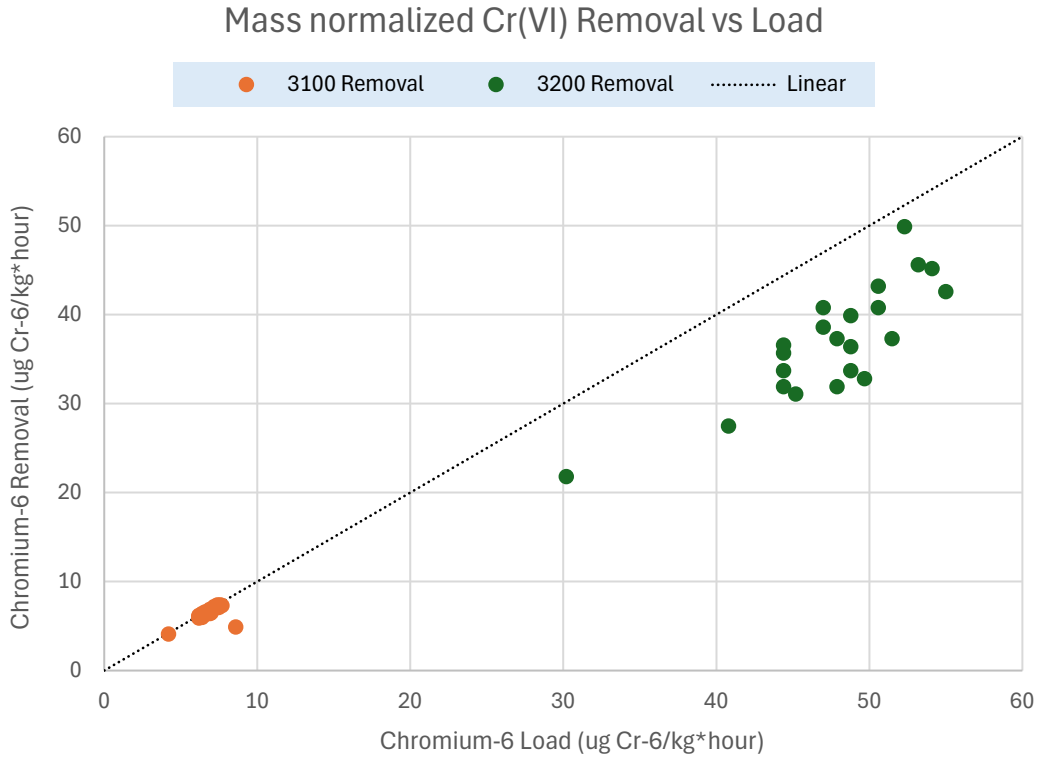
Large-scale system

- Groundwater containing 5 µg/L of Cr(VI) and 5 mg-N/L of nitrate



- Within continuous-stirred tank reactors, MNE biocatalyst performing nitrate treatment demonstrate effective reduction of Cr(VI)
  - Many samples below the reporting limit

Performance Results



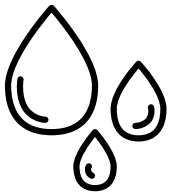
- Microvi's MNE technology demonstrates consistent removal performance under two different loading scenarios
- Future directions: Test higher Cr(VI) load conditions

Conclusions: MB-CR™ Proven from Lab to Field

Lab Studies

- Simple, effective process for Cr(VI) removal
- Biocatalysts achieve consistent reduction in batch & continuous-flow tests
- Majority of Cr retained safely within biocatalyst
- Quantitative measurement possible down to 1 ppb

Biocatalysts can consistently deliver hexavalent chromium treatment to meet upcoming MCL



Large-scale Water Treatment

- 90+ days of continuous operation with consistent removal
- Groundwater tests confirm <1 µg/L effluent
- Simultaneous nitrate removal demonstrated
- Ready to meet upcoming Cr(VI) MCL compliance

MB-CR™: Validated across scales, ready for real-world adoption

Microvi

Thank you

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Grant Information	**NIEHS will fill this in for you:** **Fatemeh Shirazi, Biological Reductive Immobilization of Hexavalent Chromium using Biocatalyst Composites, Microvi Biotech Inc., 5R44ES031495, Project Link: https://reporter.nih.gov/project-details/10707077**
Presenter	Ameen Razavi and Fatemeh Shirazi
Technology Name and Description	MB-CR ("Microvi Biotech – Chromium" Technology) A biocatalytic treatment technology that harnesses Microvi's proprietary MicroNiche Engineering™ platform to biologically reduce toxic hexavalent chromium [Cr(VI)] into its stable and less harmful trivalent form [Cr(III)]. Unlike conventional physico-chemical methods, the system employs immobilized microbial catalysts in a plug-and-play modular design, delivering sustainable, chemical-free, and cost-effective remediation.
Innovation	MB-CR is the first biological chromium treatment system that eliminates the need for added chemicals or sludge handling, offering a cleaner and more sustainable solution than conventional methods. Its modular, plug-and-play design makes it highly adaptable to a wide range of water qualities and treatment scales, from small systems to large industrial operations. Technoeconomic assessments indicate cost savings of 30–50% compared to prevailing technologies. MB-CR is protected under Microvi's global IP portfolio, with 17 issued and pending patents based on its proprietary MicroNiche Engineering™ platform.
Contaminant and Media	MB-CR targets hexavalent chromium [Cr(VI)] in groundwater and drinking water. Pilot studies achieved effluent levels of <5 – 7 µg/L Cr(VI) and 1 – 2 µg/L total chromium. The system delivers reliable treatment within standard hydraulic retention times (≈1 hour), produces minimal sludge, and has few limitations aside from site-specific water chemistry and chlorine use
Technology Readiness Level	MB-CR is currently at TRL 6 (Pilot Scale System), with successful performance demonstrated in continuous-flow lab and field pilot reactors treating groundwater and drinking water sources. Based on ongoing pilot testing and partnerships with utilities, initial market availability is anticipated within 1–3 years, with full commercial deployment expected shortly thereafter
Site Work	MB-CR has been pilot-tested with Sunny Slope Water Company (SSWC), California, treating groundwater contaminated with Cr(VI).
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