Protocols for mCDR Monitoring, Reporting, and Verification

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NASEM mCDR Standing Committee
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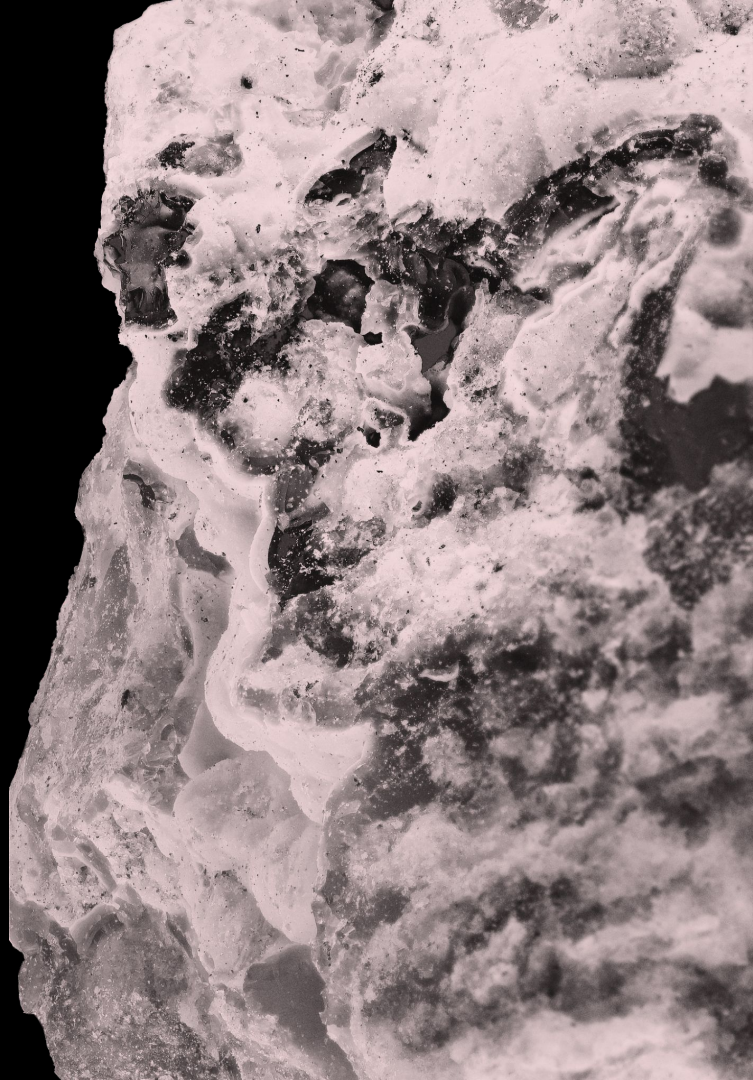
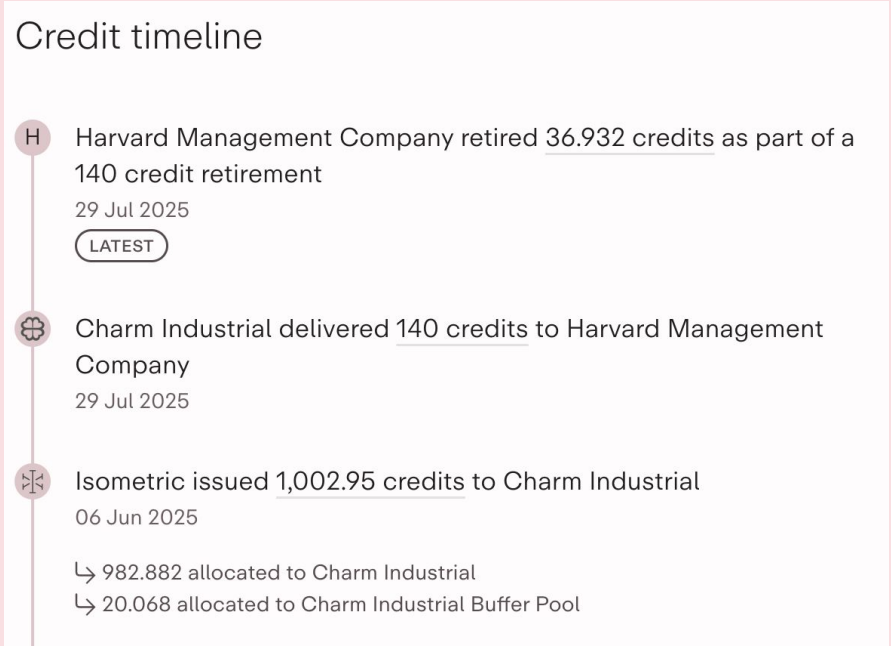


What is a registry?

A public ledger that tracks credit:

- Issuance
- Ownership
- Retirement

Where 1 credit represents 1 tCO_2e removed that has been **verified**



How is a credit verified?

M

Monitoring

The ability to accurately measure, monitor and model baseline and CO_2 removal activities to quantify net CDR.

R

Reporting

The process of reliably and transparently providing data related to CO_2 removals in a format that is accessible and verifiable.

V

Verification

The auditing of methodologies, project data and removal claims by independent third parties, demonstrating scientific rigor and accuracy in removals.

Standard setting: MRV protocol development

v1.0 | Certified

Electrolytic Seawater Mineralization

This protocol outlines the MRV and best practices for high-quality carbon removal in electrolytic seawater mineralization.

v1.0 | Pending certification

Direct Ocean Capture and Storage

This protocol outlines the MRV and best practices for high-quality carbon removal of CO2 from the atmosphere via Direct Ocean Capture and Storage.

v1.0 | Certified

Ocean Alkalinity Enhancement from Coastal Outfalls

This protocol outlines the MRV and best practices for high-quality carbon removal in ocean alkalinity enhancement.

v1.0 | Certified

Wastewater Alkalinity Enhancement

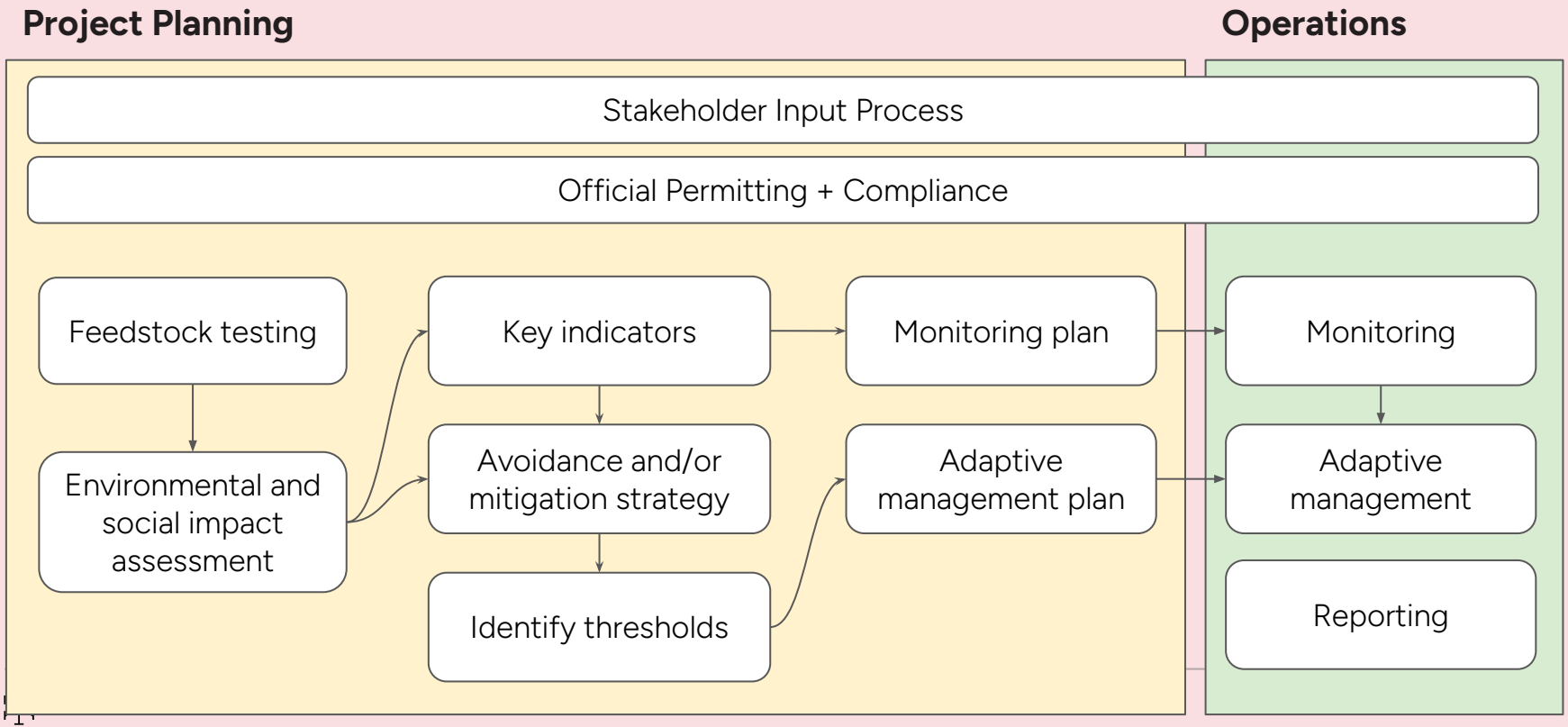
This protocol outlines the MRV and best practices for high quality carbon removal in wastewater alkalinity enhancement projects.

v1.0 | Certified

River Alkalinity Enhancement

This protocol outlines the MRV and best practices for high-quality carbon removal in river alkalinity enhancement.

Environmental and social safeguarding



Net CDR quantification approach

$$CO_2e_{Removal} = CO_2e_{Stored} - CO_2e_{Counterfactual} - CO_2e_{...}$$

The amount of credits we generate for a given removal activity

The amount of carbon dioxide which is durably stored as a result of the project

The amount of carbon dioxide which would have been durably stored without the project existing

The amount of carbon dioxide emissions associated with the project

E.g. OAE:

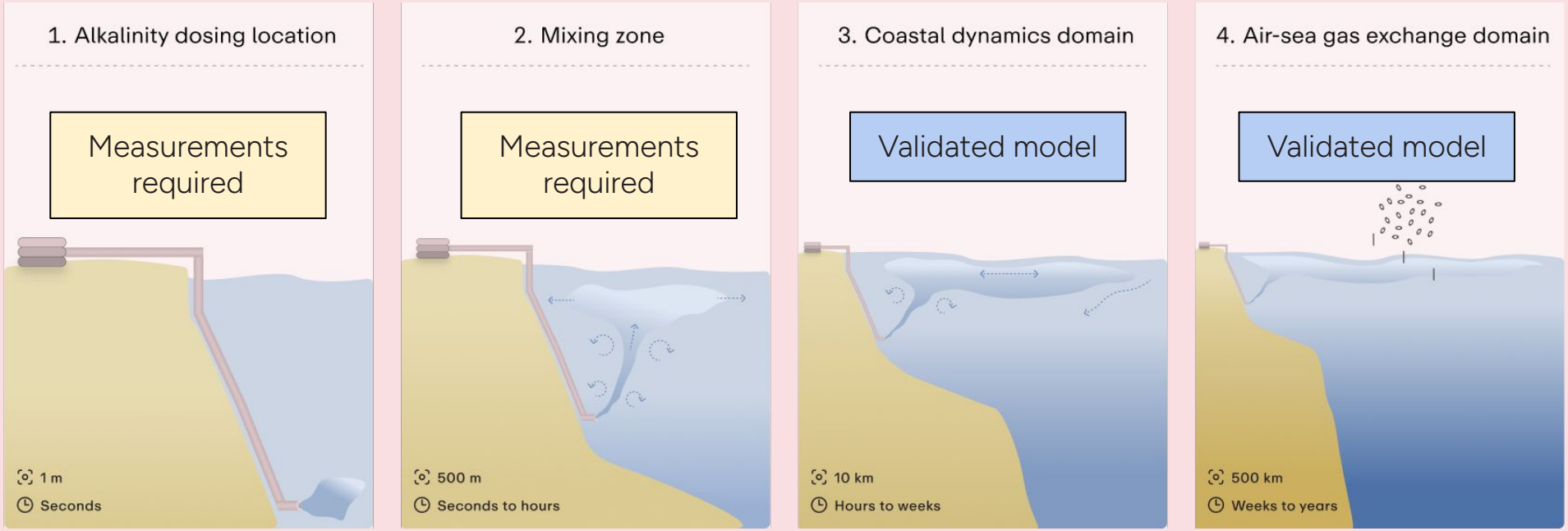
$$CO_2e_{Removal} = \Delta CO_2e_{AirSeaFlux} - CO_2e_{Emissions}$$

Quantification of air-sea CO_2 flux

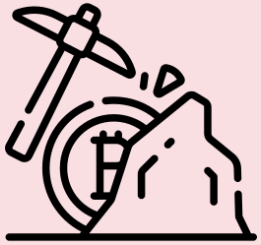
Step 1: Outfall measurements

Step 2: Alkalinity upscaling and losses

Step 3: Air-sea gas exchange



Project emissions



Feedstock production + transport

Site operations + monitoring

Personnel transportation + accommodation

Project establishment + closure

Standardized emissions-accounting modules:

v1.2 | Certified

Energy Use Accounting

This module describes how energy-related emissions must be calculated so that they can be subtracted in the net CO_2e removal calculation.

v1.1 | Certified

Transportation Emissions Accounting

This module describes how transportation-related emissions must be calculated so that they can be subtracted in the net CO_2e removal calculation.

v1.0 | Certified

Embodied Emissions Accounting

This module describes how embodied emissions related to equipment and material manufacture must be calculated so that they can be subtracted in the net CO_2e removal calculation.

Uncertainty quantification

Sequestration	
Mass of feedstock dosed	±0.25%
Feedstock alkalinity content	±4.33%
Interannual variability in near-field model	±7.26%
Interannual variability in far-field model	±19.25%
Air-sea CO_2 flux parameterization	±6.51%

Emissions	
Feedstock production	±3.46%
Feedstock transport	±9.96%
Personnel transportation & accommodation	±7.35%
Project establishment	±6.25%
End-of-life	±5.62%
Operations and monitoring	±1.18%

Uncertainty quantification

Sequestration	
Mass of feedstock dosed	±0.25%
Air-sea CO_2 flux parameterization	±6.51%

Emissions	
Feedstock production	±3.46%
Operations and monitoring	±1.18%

$$CO_2e_{Removal\ uncertainty} = \Delta CO_2e_{AirSeaFlux} - CO_2e_{Emissions} -$$

$$625.6\ tCO_2 = 881.8\ tCO_2 - 151.3\ tCO_2e - 104.8\ tCO_2$$

MRV roadmap

Short term

🔍Uncover real-world MRV challenges from initial deployments and verification

🔁Evolving protocols based on those learnings

Medium term

🧪Project level MRV enables research + experimentation

🚥Protocols begin to stabilize for more mature pathways

🚀Suppliers, registries and verifiers consistently improving efficiency of what is required

Long term

⚖️ Protocols and tooling are standardized and regularly updated based on new research.

⚡Verification is accessible, efficient, automated.

2 years **5 years** **7 years**

continually sharing experiences with broader community to drive science & tech innovation

Summary

1. Advancements in protocol development since the 2022 NASEM Report
    a. Lays foundation for transparent data reporting and verification
    b. Puts mCDR on a level playing field with terrestrial CDR with standardized emissions accounting
2. Current protocols are V1.0 – will continue to evolve based on new research
    a. MRV today will be very different from MRV at scale

To learn more

- *registry.isometric.com → read protocols & explore removal data from projects*
- *isometric.com/science-network-members → stay up to date on protocol developments and consultations*