

In-situ capping of contaminated sediments

Method overview

Capping in-place (*in-situ*) is an internationally accepted technology for remediating contaminated sediments. It involves placing cap material overtop the sediment surface to create a new bottom and to meet certain performance objectives. Capping offers advantages and limitations compared to other remediation technologies, like dredging or natural recovery.

Two different types of capping are recognized: **isolation capping** and **thin-layer capping**. They differ in many ways, but mainly in terms of objectives for cap performance.

Isolation capping - performance objectives, design, materials and other factors

Performance objectives for isolation capping typically include:

- **Physical isolation** of bottom-dwelling organisms from contact with contaminated sediments.
- **Chemical isolation** of the cap's biological zone from contaminants moving up through the cap over time.
- **Stabilizing sediment** against erosion by natural and human-related forces.

Isolation caps are designed using the “layer-cake” concept. This concept involves including different material layers at pre-determined thicknesses to address one or more processes acting on or in the cap over time. These processes include:

- Bioturbation
- Erosion
- Chemical migration
- Consolidation
- Cap/sediment mixing during cap construction

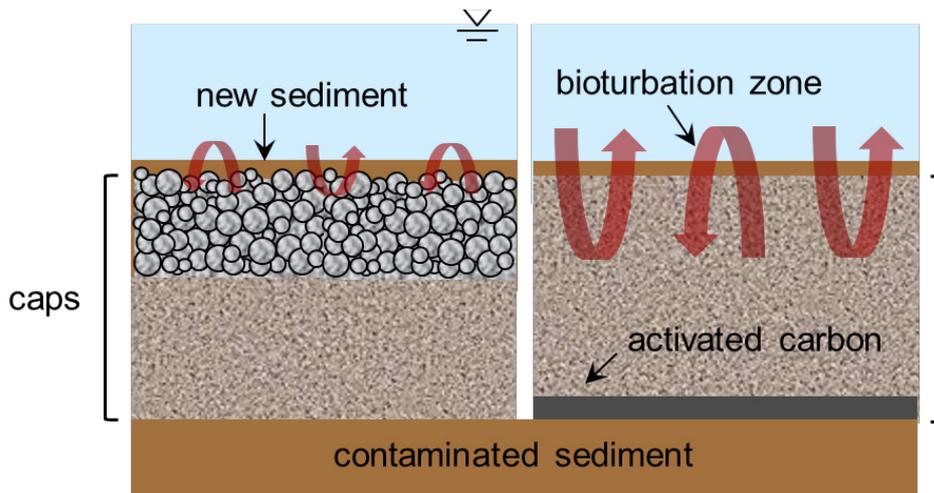
Various materials can be used in capping. They can either be non-reactive (conventional) or reactive in some way (active). Common active materials include strong sorbents, like activated carbon (AC) and organoclay. Active materials are often added into products that can easily be placed through water.



One type of conventional capping material, natural sand (source: SAO).



One type of active capping material, AC-amended BioBlok® (source: BioBlok Solutions AS).



not to scale

Examples of conventional (left) and active (right) isolation caps

Conventional isolation caps can meet performance objectives at many sites. However, active isolation caps are sometimes necessary or preferred based on site conditions, predicted superior performance and/or costs.

When designing and constructing conventional or active isolation caps, the possible influence of other factors should also be evaluated, including:

- Groundwater upwelling
- Sediment strength
- Slope stability
- Sediment gases

Thin-layer capping - performance objectives, design, materials and other factors

The main performance objective for thin-layer capping is to reduce - but not necessarily eliminate - biological exposure to sediment contaminants.

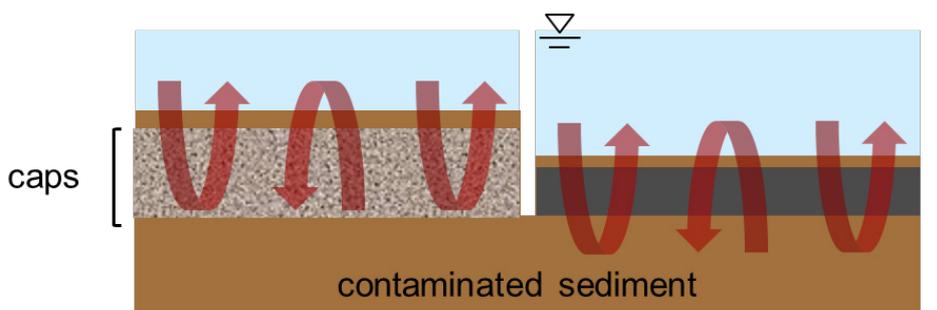
Parameters controlling design and thickness of thin-layer caps include:

- Type and reactivity of capping material
- Site-specific bioturbation depths
- Target level for reduced contaminant exposure.

Most materials used in isolation capping are also used in thin-layer capping. When using non-reactive materials like sand, layer thickness should at least equal the depth of the well-mixed bioturbation zone. When using strong sorbents like AC, layer thickness can be less than the well-mixed depth and still be protective.

As for isolation capping, other factors including groundwater upwelling, sediment strength, etc. also need to be considered when designing and constructing conventional or active thin-layer caps.

Conventional thin-layer capping is generally considered the same as the remedy of Enhanced Monitored Natural Recovery (EMNR), and active thin-layer capping the same as in-situ treatment.



not to scale

Examples of thin-layer caps. Conventional sand (left) and active AC (right).



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Examples of thin-layer caps. Conventional sand (left) and active AC (right) (photo sources provided).

Cap construction

Specific objectives should be met during construction of underwater sediment caps. These objectives include cap construction:

- In a controlled manner
- In a geotechnically stable manner
- Such that sediment re-suspension is minimized to the extent possible and practical.

Many different equipment-plus-placement-method combinations can be used for constructing sediment caps.



One approach to cap construction, i.e. a land-based, truck-mounted conveyor (source: AquaBlok, Ltd.).

Cap monitoring

Sediment capping projects involve two different types of monitoring for different purposes:

- Construction monitoring – to insure the cap is constructed as designed.
- Performance monitoring – to confirm the cap is functioning as intended over the long-term.

A wide variety of equipment and techniques are used to conduct construction and performance monitoring.

More information

See the entire SGI Publication 30 "In situ capping of contaminated sediments" and all of its associated documents at www.swedgeo.se