Subaqueous capping remediation with activated carbon geocomposite in Sydney/Australia

GEOANZ #1 ADVANCES IN GEOSYNTHETICS

7–9 JUNE 2022 | BRISBANE CONVENTION & EXHIBITION CENTRE

Subaqueous capping remediation with activated carbon geocomposite in Sydney/Australia

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Contaminants in waterbodies

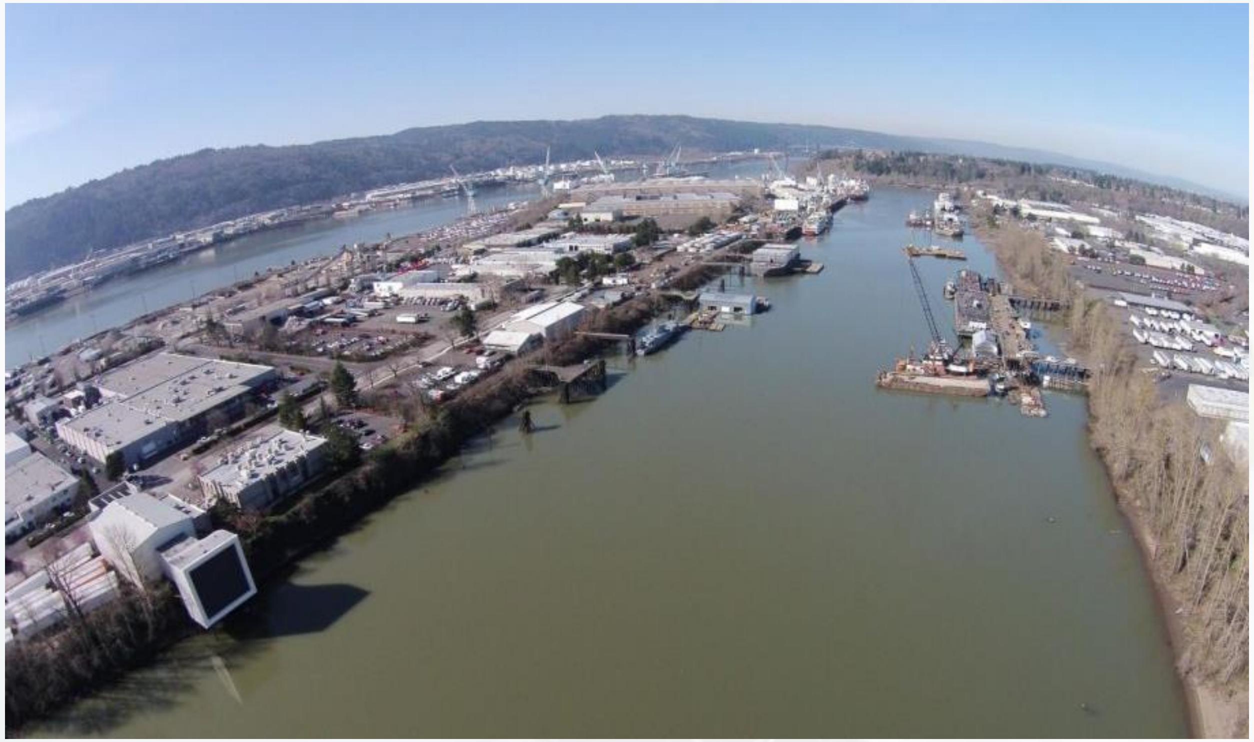
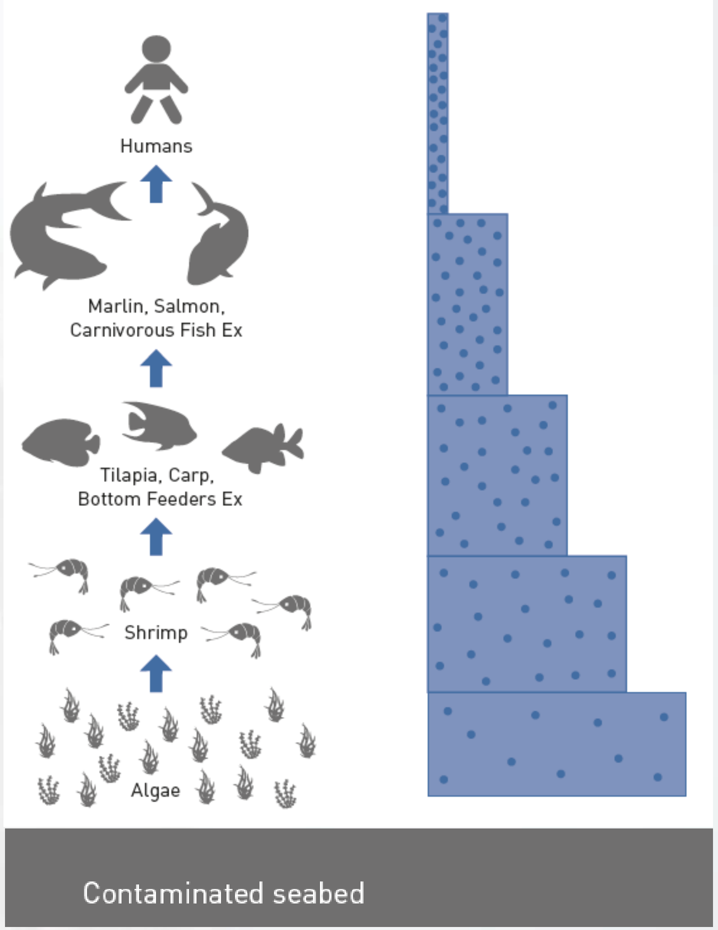


Photo of Portland Harbour (OR), USA



Bioaccumulation along the food chain

Sediment Remediation Options

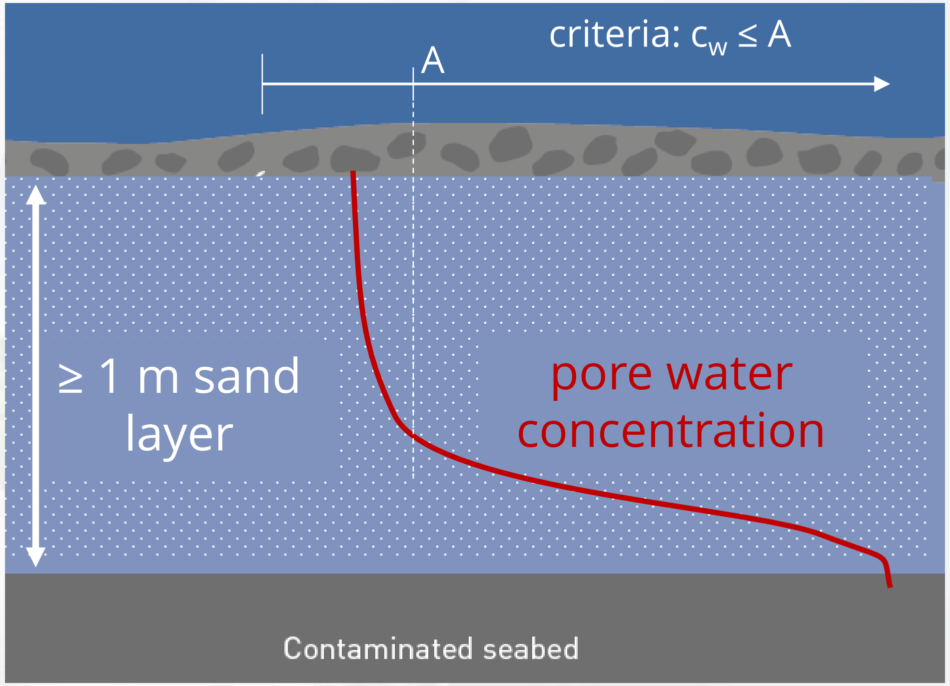
- Monitored Natural Recovery
  - Measure and Control
- Dredge & Dewatering
  - Removal of contaminated sediments
  - Ex-Situ soil dewatering before disposal
- In-Situ Capping
  - Conventional Capping
  - Amended Capping
  - **Capping with active Geocomposites**

Dredging operation

Amended Sediment Cap (Reible & Eek, 2017)

Conventional vs. Active Cap

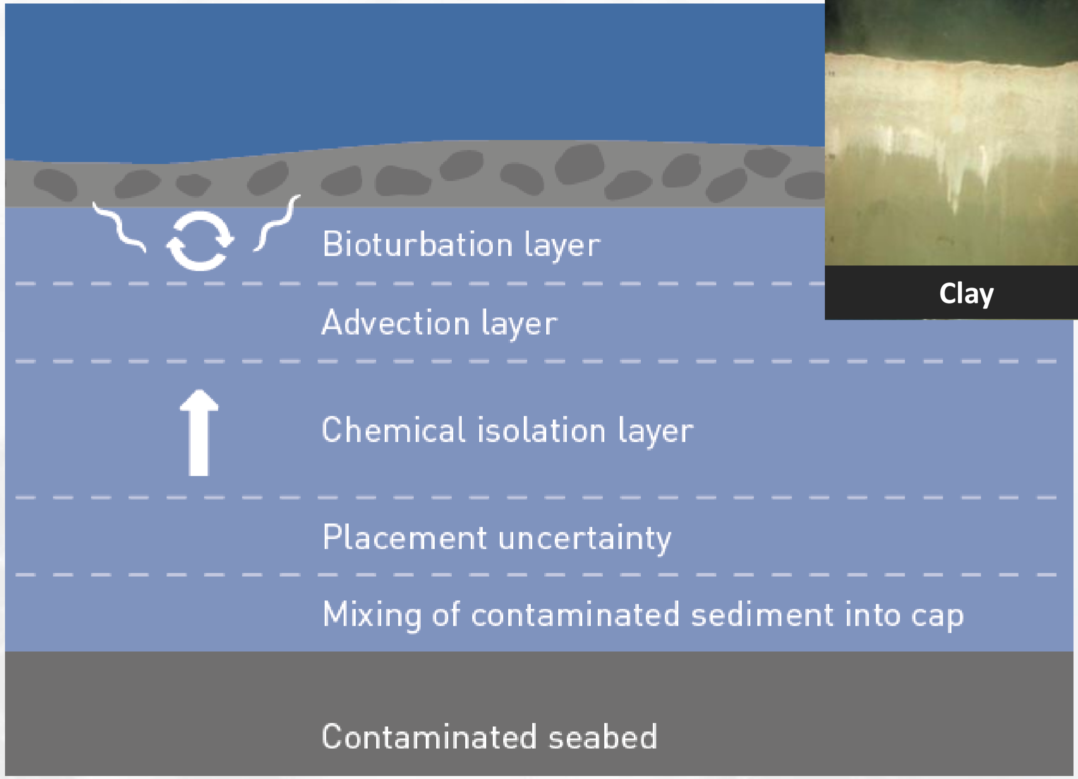
- Diminish concentration of contaminants in waterbody by chemical isolation
- Pore water concentration cw must decline below a specified level A



Source: Reible & Eek, 2017

Conventional vs. Active Cap

- Influences on isolation
  - Bioturbation
  - Erosion and advection from currents and ship maneuvering
  - Placement uncertainty
  - Groundwater discharge
  - Gas formation in the sediments
  - Diffusion and consolidation



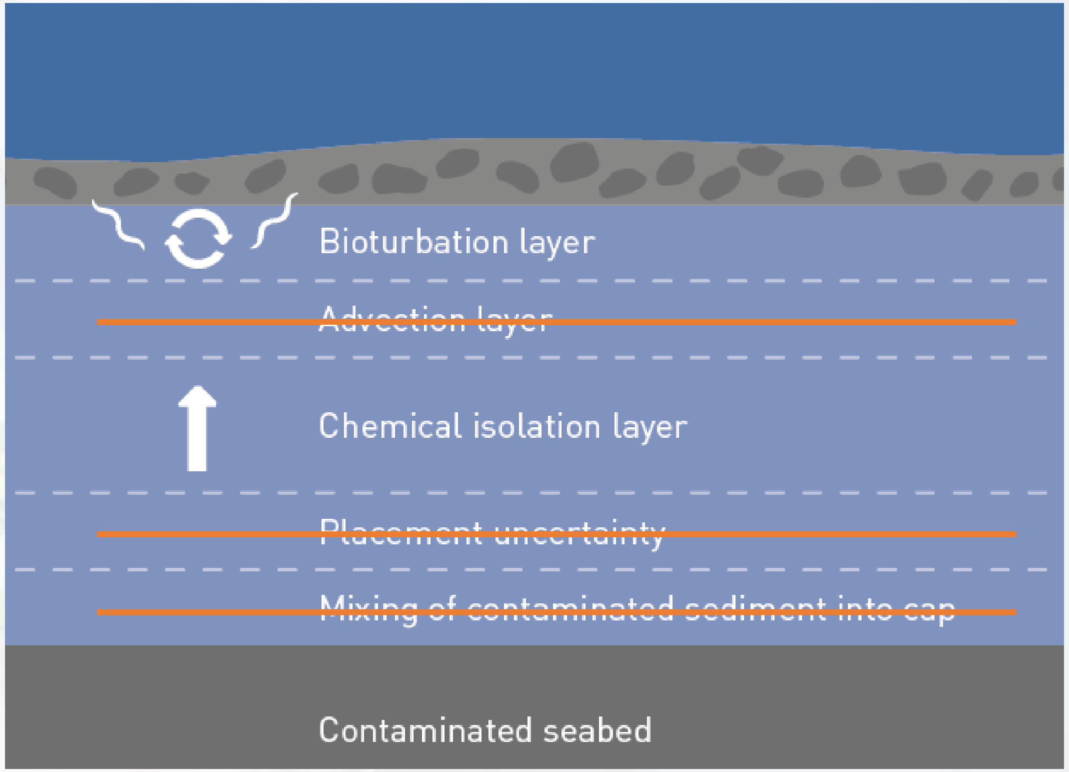
Source: Reible & Eek, 2017

Amended Sediment Cap (Reible & Eek, 2017)

$$h_{cap\_design} = h_{erosion} + h_{bioturbation} + h_{advection} + h_{isolation} + h_{uncertainty} + h_{mix}$$

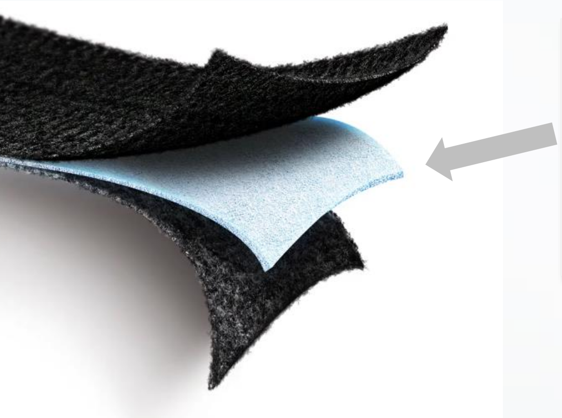
Conventional vs. Active Cap

- Geotextiles to reduce uncertainties
  - Use of geotextile functions: separation, filtration, drainage, reinforcement
    - Prevent mixing of cap and seabed
    - Minimize placement uncertainties
    - Ensure constant layer thickness of isolation layer
    - Increase slope stability and bearing capacity of organic-rich sediments

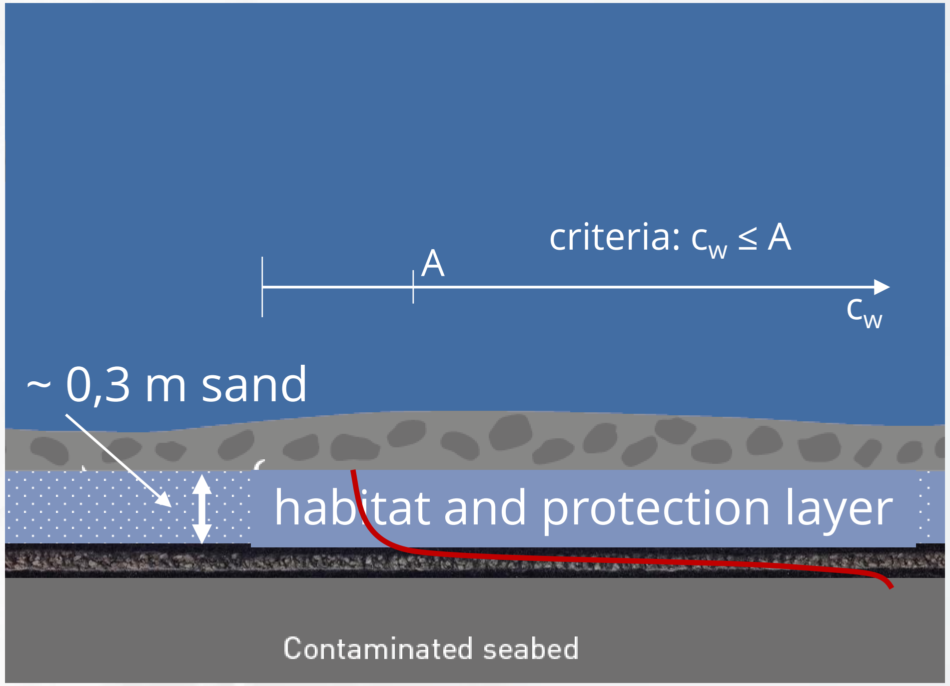


Conventional vs. Active Cap

- Increase chemical isolation

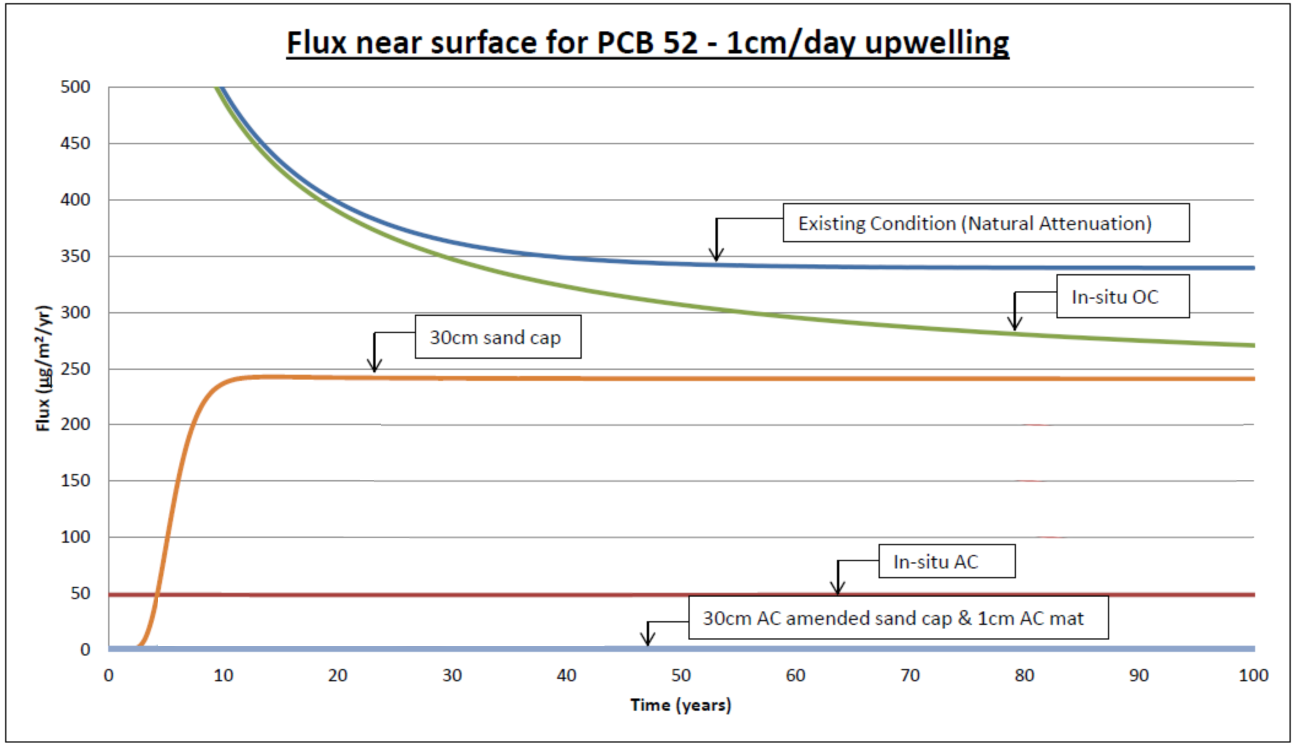


- Active materials increase chemical isolation by sorption
  - Activated carbon
  - Organophilic clay
  - ...



Capping with active Geocomposites

Flux simulation



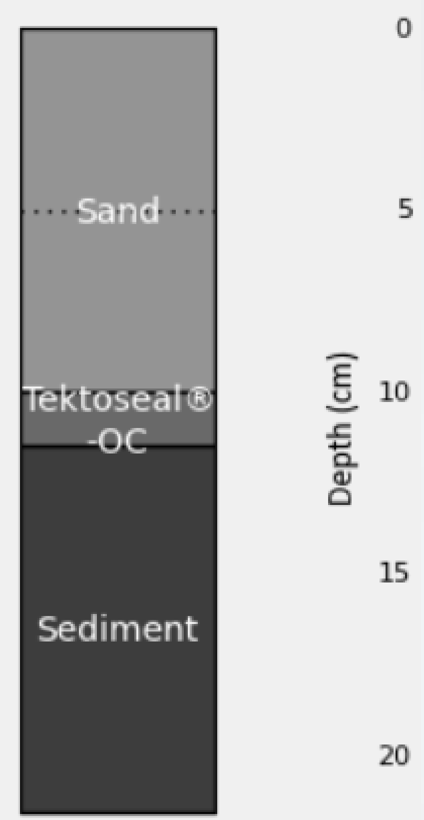
Source: following Reible & Eek, 2017

Capping with active Geocomposites

- Flux simulation

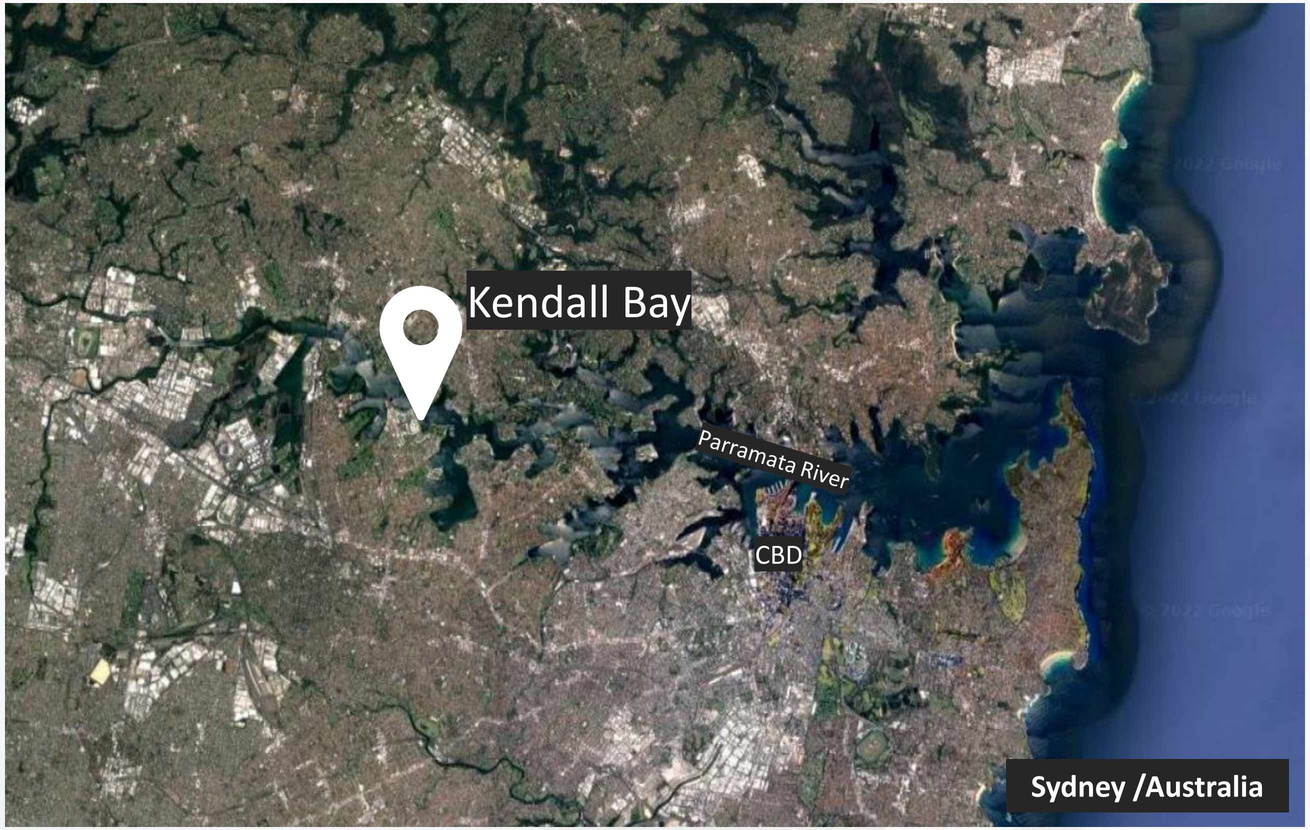
  - Modelling of contaminant transport in the Cap with “CapSIM”
  - Input parameter site:
    - Upwelling groundwater flow
    - Contaminants and concentration [µg/l]
  - Input parameter isolation layer:

Name	Properties	Porosity	Bulk density g/cm³	Particle size mm	Permeability m²	Organic carbon fraction
Tektoseal®-OC	By loading	0.5	0.9	3.464	1.818e-7	0.4444
Aquagate® RCM®-AC RCM®-OC Sedimite® Tektoseal®-AC Tektoseal®-OC Tektoseal®-Mat	Loading (g/cm²)					
	1.0	0.5	1.0	20.0	1e-6	0.0
	0.8	0.5	0.8	0.6	1e-7	1.0



Reible Group,
Texas Tech University

Kendall Bay Sediments Remediation



World's first large scale remediation with in-situ stabilization

HUESKER
Ideas. Engineers. Innovations.

Remediation

Contaminated Sites

Subaquaous Capping of highly contaminated sediments at Kendall Bay - Sydney / Australia

Remediation works on Parramatta River at Kendall Bay

Temporary ballasting of the geocomposite with the help of a frame

Situation

Kendall Bay is located 10 km west of Sydney's Central Business District. In this area, a Gasworks facility operated between 1886 and the 1980s. As result, the shore was contaminated with harmful organic compounds in the sediments. These sediments were black and oily and had a strong tar, hydrocarbon, or naphthalene odour that is characteristic of gasworks contamination. Levels of polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons (TRHs) were greatly in excess of sediment quality guidelines. This highly contaminated sediment was present to a maximum depth of more than 4 m in the area in the north-west of the bay, where the coal and coke wharves were located and to a maximum depth of almost 8 m in parts of the southern end of the bay, where a former stream had cut into the sandstone bedrock.

Solution

The New South Wales Environment Protection Authority (NSW-EPA) issued a declaration of remediation for significantly contaminated area adjacent to the former gasworks facility. It was determined that remediation was required where the sediments contain total PAH concentrations of average more than 25 mg/kg and maximum more than 60 mg/kg (normalised to 1 % total organic carbon) and TRH concentrations of average more than 4000 mg/kg and max-imum more than 5500 mg/kg.
Site Investigation showed that these thresholds were ex-ceeded at various points: Accessible foreshore areas and the western end of the mangrove area have total PAH con-centrations greater than 1 mg/kg; The rest of the of

Kendall Bay Sediments Remediation

- Gasworks facility operated between 1886 and the 1980s
  - One of the largest gas works in the southern hemisphere
- Black and oily sediments with strong tar, hydrocarbon, or naphthalene odour
- Remediation was required where sediments had high concentrations of:
  - **Total PAH**
  - **TPH**
- Selected remediation method: In-situ soil stabilization combined with **Active Sediment Capping**

Kendall Bay Sediments Remediation – Public Requests

CASE STUDY

Our new regulatory approach in action
Remediating Kendall Bay

Jemena's Kendall Bay, Sediment Remediation Project. Photo: Ventia

The EPA regulated the remediation of Kendall Bay, a bay of the Parramatta River between the Sydney suburbs of Cabarita and Breakfast Point. The bay was contaminated by the former Mortlake Gasworks at Breakfast Point. After the gasworks site was remediated, the EPA turned its attention to sediments in the bay.

The EPA required the polluter, Jemena Limited (Jemena), to assess both short-term and ongoing toxicity of the sediments through extensive baseline measurements. The EPA also influenced the setting up of site-specific remediation criteria, a process carried out by CSIRO and paid for by Jemena.

The local community called for remediation that:

- did not involve any access or treatment within Cabarita Park (which lies on the eastern side of the bay)
- ensured the preservation of mangroves and sandstone seawalls around the foreshore.

The EPA and Jemena listened. The result was 'bespoke' remediation of these areas that included excavating (by hand) coke and coal from the upper layer of sand and placing clean sand cover in mangrove areas. This satisfied the residents' requests and also improved the beach wading areas.

The EPA negotiated the performance criteria. Through bench and field trials, Jemena was able to show that stabilising contaminated sediments had reduced leachate by the required 90%. An accredited site auditor has reviewed the remediation work, as required by the EPA, and confirmed that it has been successful.

Kendall Bay's existing depth will be preserved, and in-river sheet pile walls and ongoing monitoring will protect the surrounding waters.

14 NSW EPA Annual Report 2020–21

Understanding external factors that affect regulatory activities

The EPA aims to identify changing conditions and emerging issues early and then develop effective regulatory responses as quickly as possible. We examine social and economic trends, opportunities and challenges.

Economic factors – local, national and global – affect the NSW environment by influencing the:

- demand for natural resources
- amount of waste and emissions generated.

Changes in economic activity may alter the environmental performance of households and businesses. The EPA needs to be aware of these changes so we can work more effectively with business and the community to manage emerging environmental issues.

Economic growth

The impact of the COVID-19 pandemic and the rate at which NSW reopens are likely to dominate economic performance over the next few years.

Measures taken in 2020 and 2021 to suppress the spread of the virus have had a significant impact on the NSW economy (which had already been affected by bushfires and drought in the last few years). While Australia's gross domestic product (GDP) fell by 0.3% in 2020, NSW's gross state product (GSP) fell by 0.7%[1] over the same period. This fall in activity led to an overall improvement in environmental outcomes, most notably in greenhouse gas emissions, air quality and waste production.

Economic recovery opportunities and impacts

The NSW Government will continue to invest in infrastructure to stimulate economic activity and has a record $107.2 billion of public works in the pipeline. Investment in infrastructure creates demand for raw materials (sand, rocks, timber and steel), generates industrial waste, and may require land clearing for 'greenfield' developments. Nevertheless, growth-related pressures will be limited in 2021 because GSP is expected to be -0.5%.

Economic growth will recover in 2022, when GSP is expected to be 2.75%[2].

Overall, the outlook for NSW exports (both goods and services) is positive. Growth in beef production and exports, however, will remain subdued while herds are being rebuilt in the wake of the drought. Pressure for land clearing may be low until NSW's cattle numbers are rebuilt but it will increase if exporters can establish alternative markets and beef prices are strong. Falling global demand for coal may translate into falling demand for NSW coal exports and so reduce land clearing and other environmental impacts related to coal mining.

Workforce trends

Employment in NSW rebounded when COVID-19 lockdowns ended in the second half of 2020. Despite this, the NSW unemployment rate rose to 6.5% in June 2021. It is expected to fall to 6% in 2022[2].

After the lockdowns ended, many organisations (including the EPA), adopted flexible working arrangements, which meant fewer staff in the EPA offices at any one time. If these practices continue, demand for office space may fall in the medium term, reducing private investment in construction and hence industrial waste from 'brownfield' development.

1. ABS 2020, 5220.0 Australian National Accounts: State Accounts 2019–20, Bureau of Statistics, Canberra www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-state-accounts/latest-release
2. NSW Government 2021, Economic outlook, NSW Treasury, Sydney www.treasury.nsw.gov.au/nsw-economy/about-nsw-economy/economic-outlook

NSW EPA Annual Report 2020–21 15

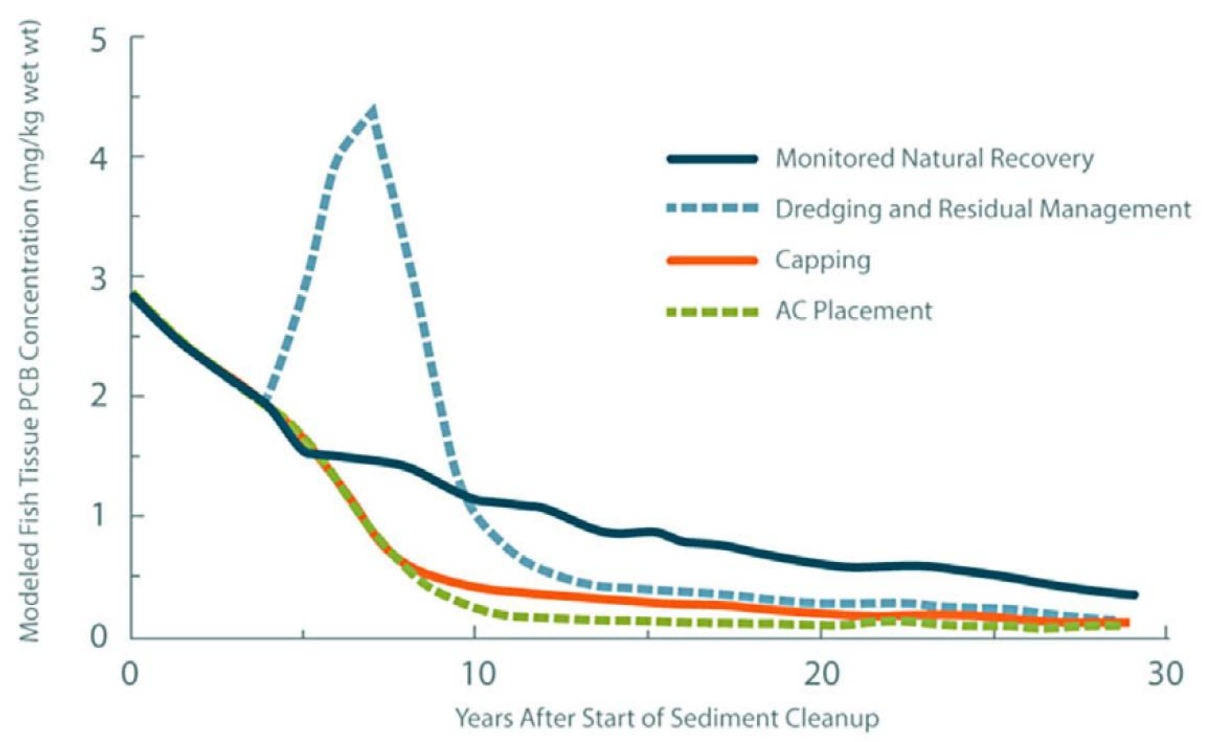
- Not involve any access or treatment within Cabarita Park (which lies on the eastern side of the bay)
- Ensured the preservation of mangroves and sandstone seawalls around the foreshore

Source: NSW EPA Annual Report 2020–21

Kendall Bay Sediments Remediation

- Protection of benthic and aquatic organisms and prevent bioaccumulation
- Lower costs and risks than with dredging, treatment and disposal of sediments

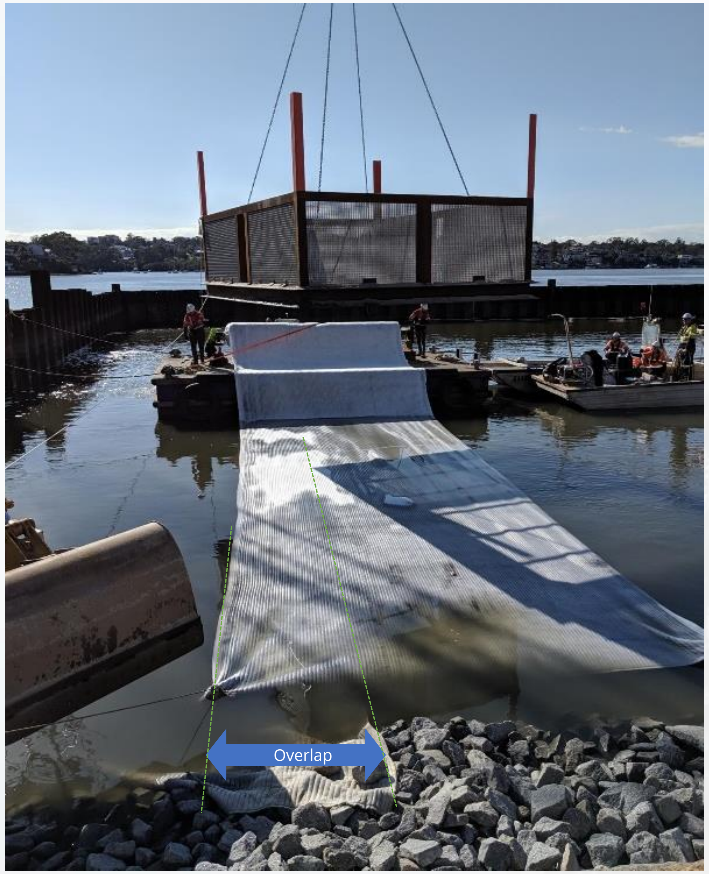
Source: Ventia Utility Services Pty Ltd



Reible Group, Texas Tech University

- Low impacts on the function of water bodies (navigable depth, flood storage, etc.)
- Short construction period

Kendall Bay Sediments Remediation



- Active Geocomposite with 3,4 kg/m² activated carbon
- Completed 2 months **ahead** of time and **under** budget

Kendall Bay Sediments Remediation - Awards

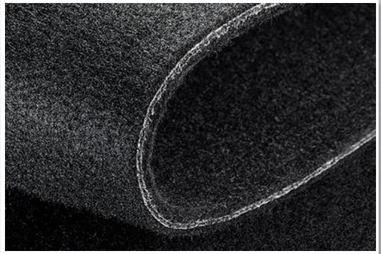
- Silver Award on ‘Sustainable Change for Good’ at the 2021 Edison Awards™
- 2021 Project Management Achievement Awards (PMAAs)
  - Project of the year
  - Best sustainable project
- Australasian Land & Groundwater Association - 2021 Award Winner Best Remedial Project (>$1M)
- 2021 Award Winner Innovation That Advanced The Practice Of Contaminated Site Remediation
- Pictured: Kendall Bay award-winning photo taken by Allan Garland, Senior Environmental Engineer – Ventia

Different Contaminants, different solutions

•Perfluorinated Compounds (PFAS)

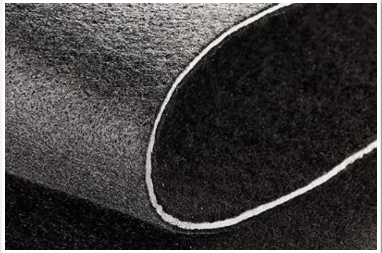
Modified Resin

Activated Carbon



•Oil and Petrochemicals

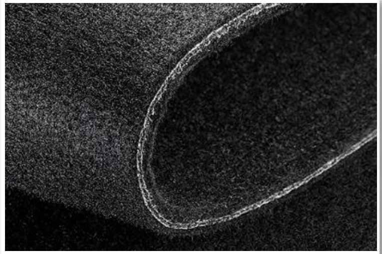
Oil Absorbent



Organophilic Clay

•Organic Compounds

Activated Carbon



Organophilic Clay

•Inorganic Compounds

Metal Adsorbent

Zeolite

Sustainable Solutions with Geocomposites

- Avoidance of energy-intensive solutions
- Conservation and reuse of Natural Resources
- Reduction of mass transports
- Energy-saving through lightweight materials
- Sealing of contaminated sites and landfills
- Filtration and remediation of harmful contaminants
- Extension of service life
- Proven **reduction in CO_2** emissions in up to 89%

Geosynthetics for Sustainable solutions

wrap Material change for a better environment

Geosystems Report, February 2010

Sustainable geosystems in civil engineering applications

Geosystems provide alternatives to some standard materials and designs used by civil engineers. This guidance document explains what geosystems are, and how they can be used to provide sustainable and cost effective solutions.

Project code: MRF116-001
Research date: 2008-2009
Date: February 2010

- Reduced volumes of excavation and consequently reduce the need for engineered backfill

- Reduced material wastage by the introduction of an engineered geo-component element permitting the reuse of lower grade materials that may be available on-site or in the locality

Thank you for your attention

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Additional Slides for Eventual Questions

Passive Remediation with Geocomposites - PFAS

High performance for short and long chain PFAS

Special high-performance textiles and the selective ion exchange resin ensure the highest pollutant absorption capacity for a wide range of applications.

Alternative solution for long chain PFAS

High-performance textiles and selected activated carbon form a pollutant barrier for selected applications.

Passive Remediation with Geocomposites - PFAS

High performance for short and long chain PFAS

Effective
Removal of all PFAS congeners with a 99.9% proven effectiveness (tested at concentration range between < 1 - 4000 µg/L).

Efficient
With a proven capacity of up to 7000 µg/g, Tektoseal Active PFAS has a much higher contaminant binding capacity than many other adsorbents.

Fast
A very fast sorption rate of fewer than 3 minutes allows use at comparatively high leachate flow rates.

Strong
Extremely high binding strength ensures that less than 0.1% of the bound PFAS have been released again (desorption). Only this level of performance can guarantee long longevity for the solution.

Durable
The durability of our materials makes it possible to protect or even reuse contaminated soils in structures over long periods of time while also passively decontaminating the soil happens with the help of natural precipitation.

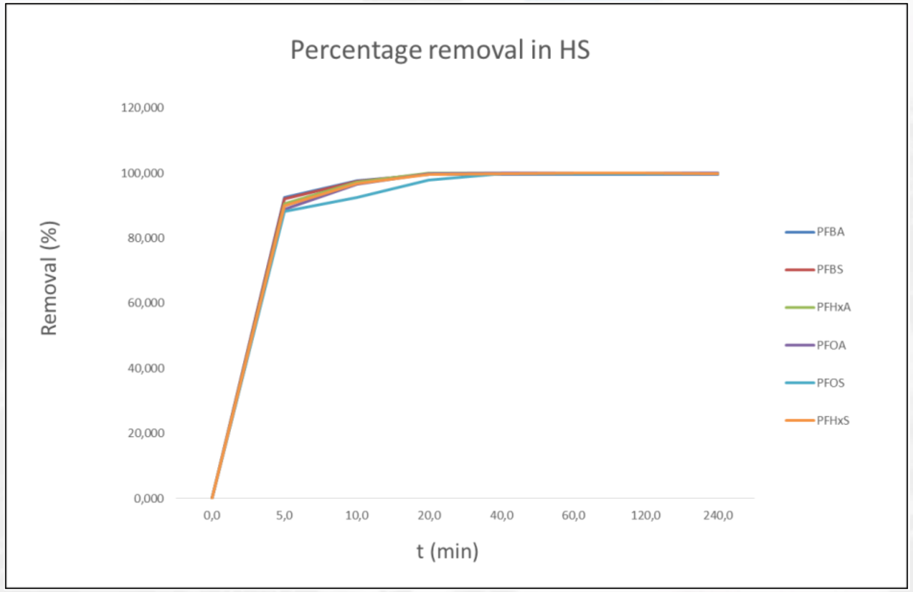
Safe
Our active geocomposite has been proven to be ideal for landfill leachate applications with mixed contaminants.

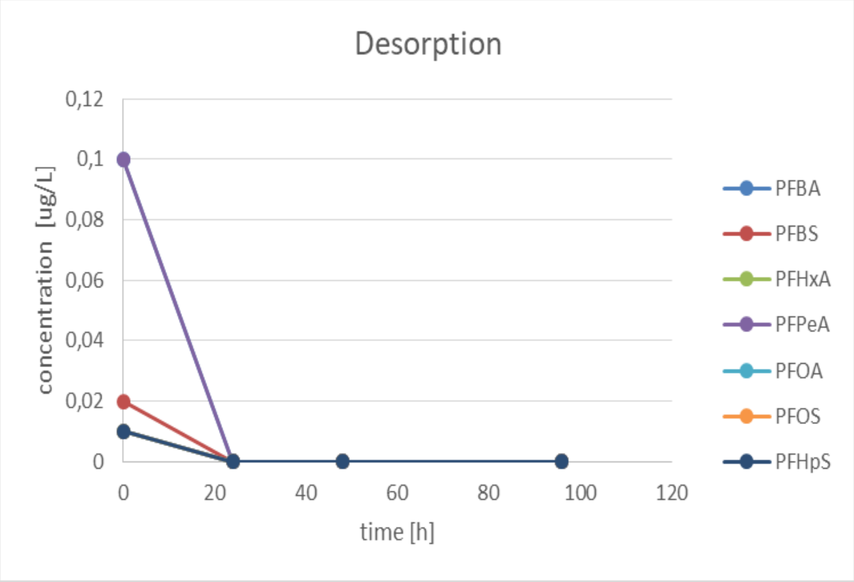
Passive Remediation with Geocomposites - PFAS

Tektoseal Active **PFAS**

Modified Resin to remove long- and short chain PFAS

- Strong selective Resin with a loading capacity up to 70 times higher than activated carbon
- Very fast sorption kinetics and strong binding that excludes desorption



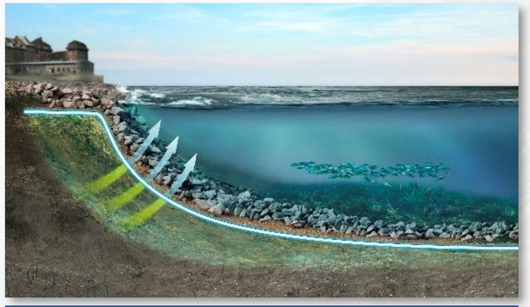


Passive Remediation with Geocomposites - Applications

In-situ securing of contaminated soils

Construction with contaminated soils

Groundwater protection (roads/airports)



Sediment capping

Landfill lining

Barrier material at mobile filling stations