Reactive mat on riverbed catches groundwater contaminants and replaces sediment

resanat
Natuurlijk saneren we de bodem

Interreg
EUROPESE UNIE
Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling

WP3 Partners

TAUW
DJN Envisan ENVIRONMENTAL SOLUTIONS
TTE consultants
SAMEN MAKEN WE MORGEN MOOIER OVAM
iFLUX
Witteveen + Bos

Presenter:
Tobias Praamstra
tobias.praamstra@tauw.com

Problem outline: point of departure

Situation

- Locations with long term discharge of contaminated groundwater into surface waters
- Sediment layer removed, discharge increases and biodegradation decreases

Examples of contaminated groundwater

- Residual contamination from industrial sites / brownfields
- Chemical landfills
- Agricultural land
- Mines

Consequences

- Decline of surface water quality → ecological and human risks (exceeding standards)
- Environmental liabilities → marketability & redevelopment issue

Conventional approach & alternative

Conventional approach to avoid influx

Excavation, pump & treat, thermal extraction, etc. are expensive and have large environmental footprint:

- Large volumes of contaminated soil and groundwater
- Limited accessibility
- Slow desorption / low concentration levels / diffusive character

Alternative approach

Reactive Mat. Low-cost solution with small environmental footprint:

- Passive system
- Long lasting

Principle of reactive mat (or Natural Catch©)

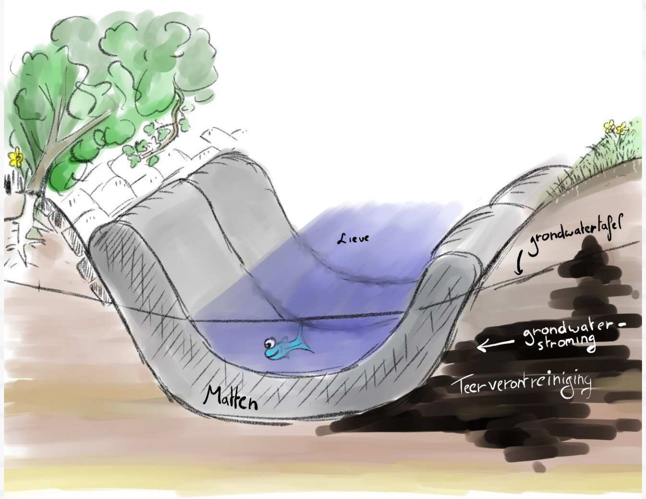
Contaminated sediment initially removed

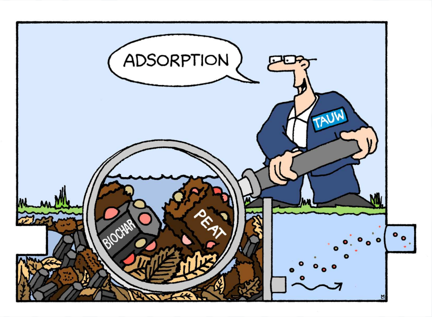
Construction: water permeable mat of geotextile packaging with adsorption material in compartments (like a down-filled winter jacket)

Implementation: hoisted into the surface water, sunk to the waterbed and anchored to the banks

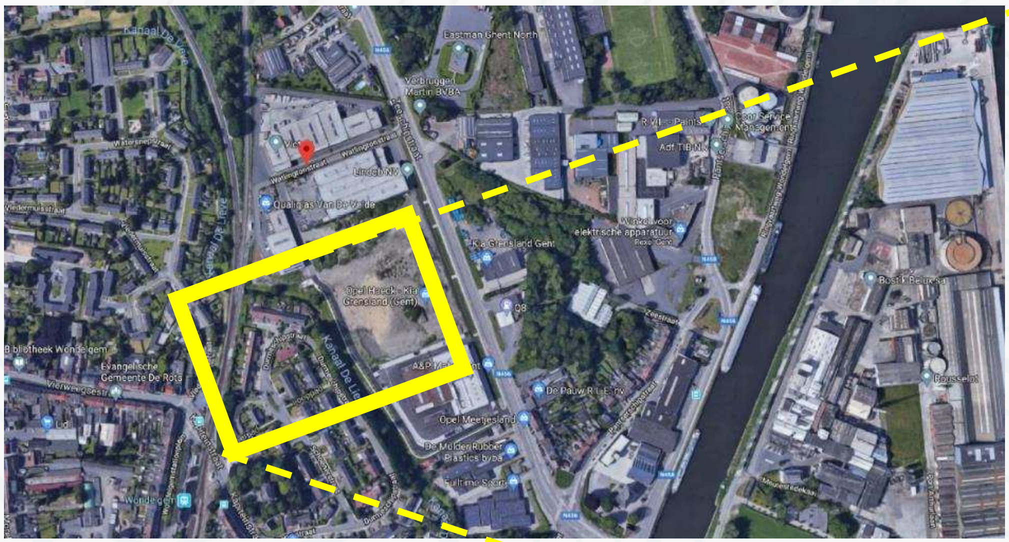
How it works (three nature based pillars):

- Natural inflow of contaminated groundwater (improved by dredging)
- Adsorption of contaminants to natural adsorbent (lowest grade!)
- Biological degradation at aerobic/anaerobic interface on mat



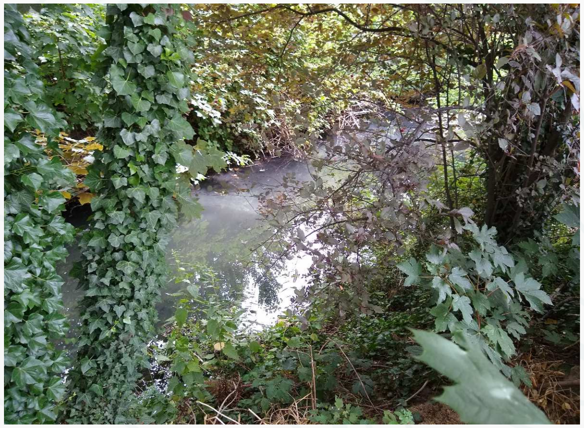


Test location: canal Lieve in Ghent (B)

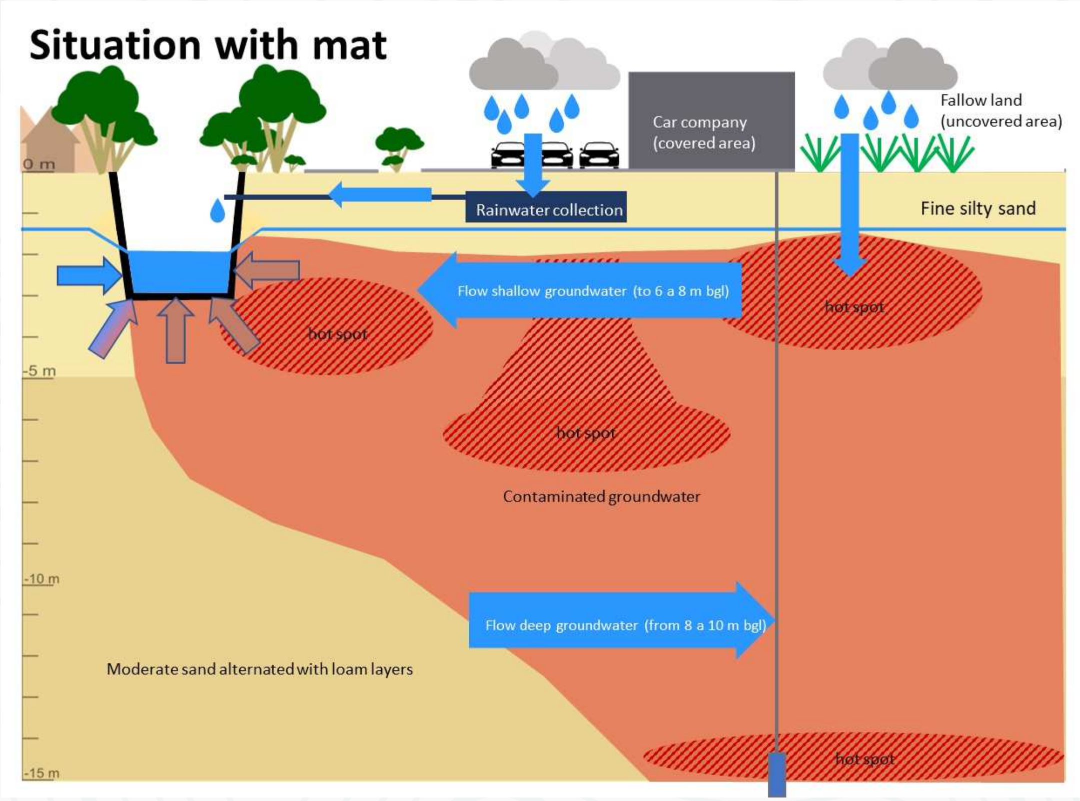


Historical site: former tar distillery and production of carbon black & asphalt
Soil contamination: PAH, PH (C6-C10), BTEXN

Situation before and after dredging (2019)



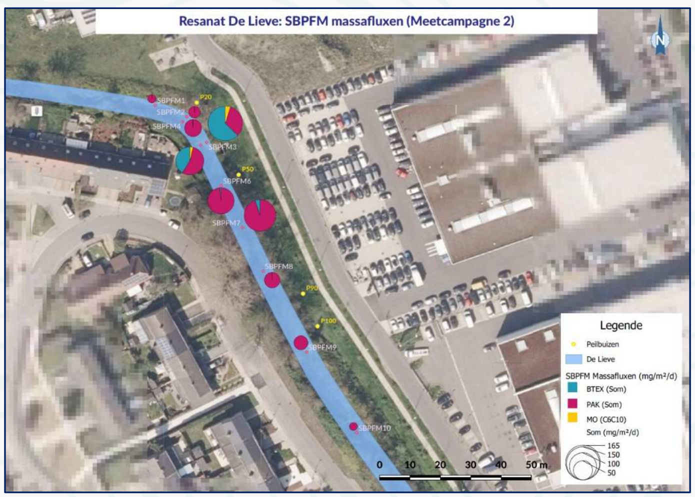
Conceptual site model – desired situation with mat



Exploratory field investigation

1. Probing in the river bank: optical sensor & MIP-GCMS (EnISSA) → hot spots incl. free product
2. Groundwater sampling in the river bank → hot spots (> 10.000 µg/l)
3. Surface water sampling → sudden increase (factor 300 > standard) and dilution downstream
4. Flux measurements through sediment bed (iFLUX)

Spatial distribution mass flux contaminants



Influx per component each segment (mg/m^2 per day)

	Segment 1	Segment 2	Segment 3
Benzene	0,00	11,8	0,00
Xylenes (sum)	0,17	20,2	0,04
Naphtalene	2,36	28,4	0,35
Fenanthrene	7,93	17,8	5,17
Pyrene	2,21	4,59	4,83
Acenaphtene	4,98	7,24	2,24
C6-C10	0,00	3,02	0,00

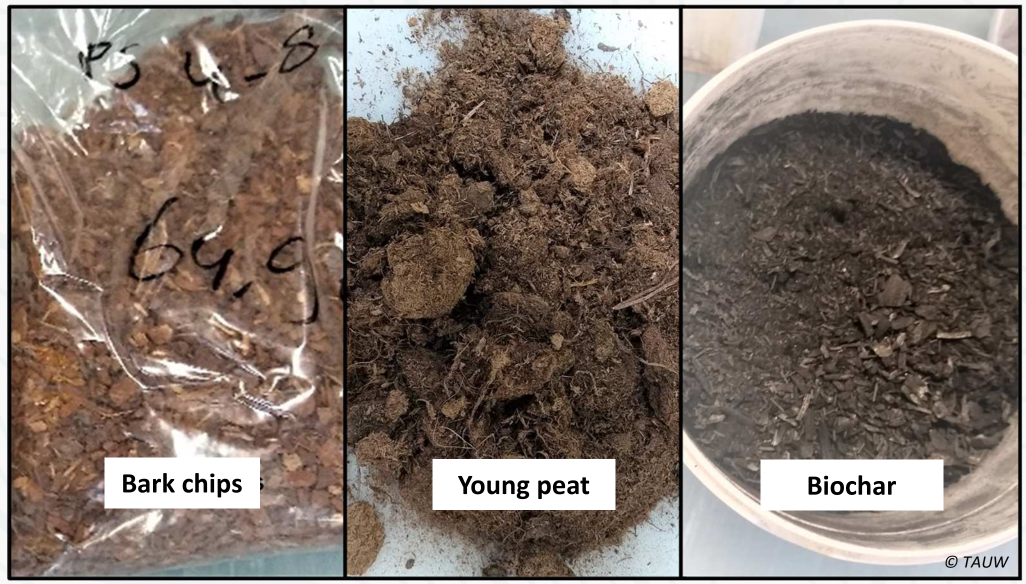
Adsorption capacity green adsorbents

Adsorption capacity batch tests by TAUW test lab (7 green adsorbents)

Precondition / constraint: thickness of mat 30 cm!

Expected reduction and lifespan:

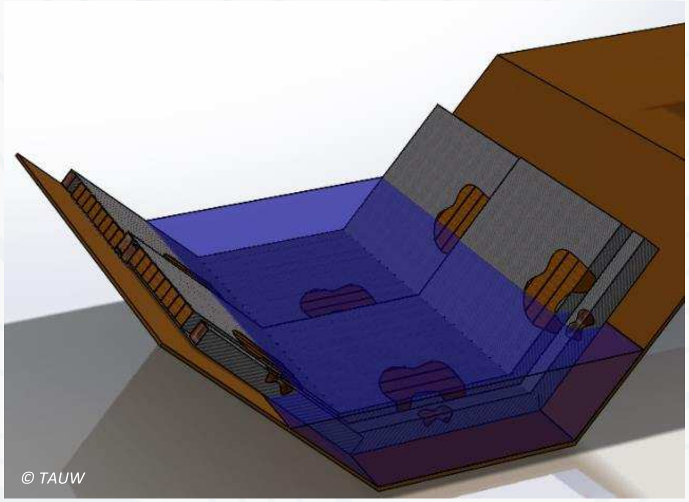
- PAH ± 90% during 12-16 years
- Benzene ± 75% during 16 years
- C6-C10 ± 97% during >50 years

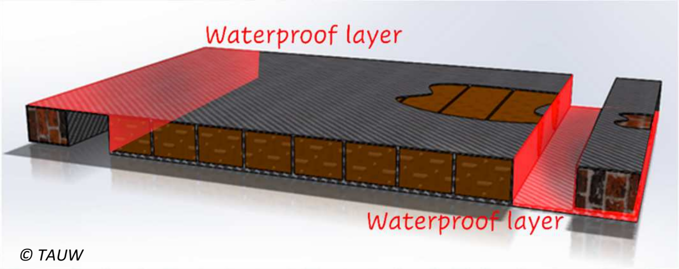


Designing

Design reactive mat by Envisan, TenCate Geosynthetics, TAUW and University of Twente

Safe	Fillable	Homogenous
Producible	Affordable	Placeable
Reliable	Strong	Weight / buoyancy
Replaceable	Anchorable	





Implementation September 2020

Execution by partner Envisan

1. Filling

2. Compartments: adsorbents and ballast

3. Hoisting mat element into canal

Implementation September 2020

Execution by partner Envisan

4. Anchoring to the bank

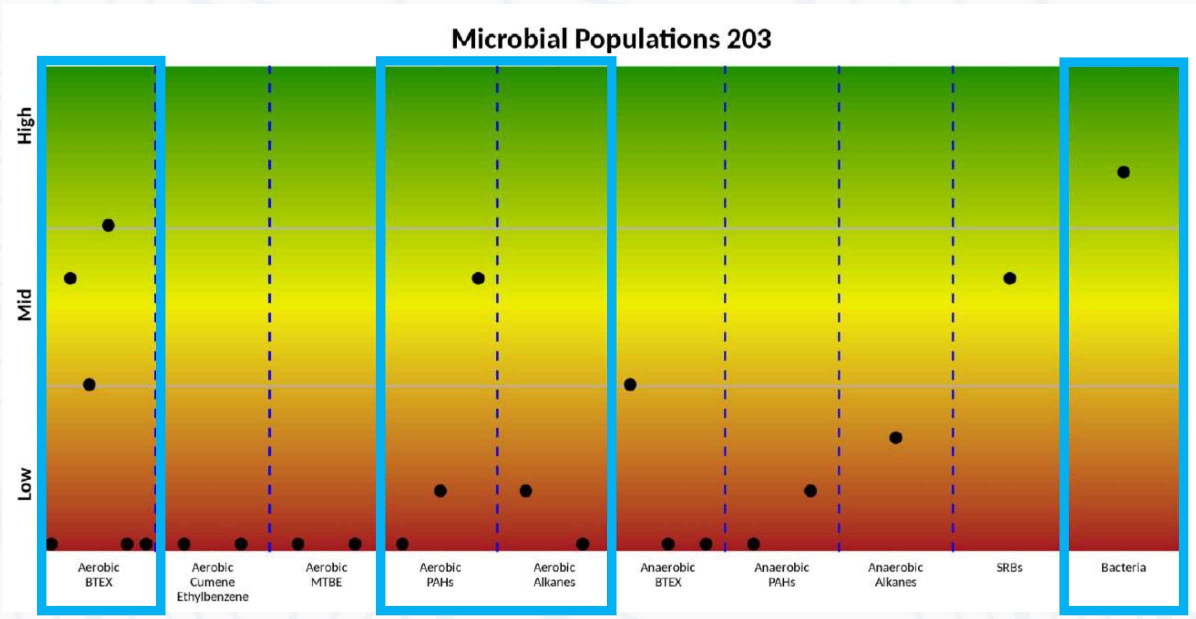
5. Full scale construction

6. Division into two adsorbent zones

Initial results micro-organisms on mat

Presence of specific micro-organisms (qPCR)

- Aerobic biodegraders for BTEX, PAH and alkanes (10 - 10.000 cells /ml)

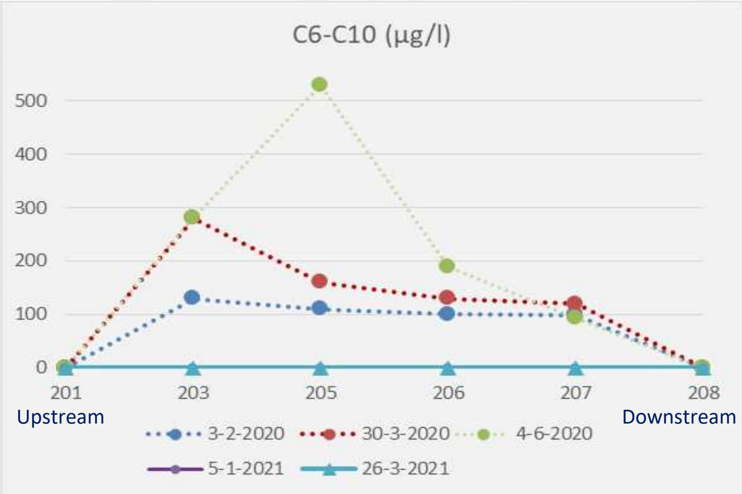


Surface water quality with and without mat

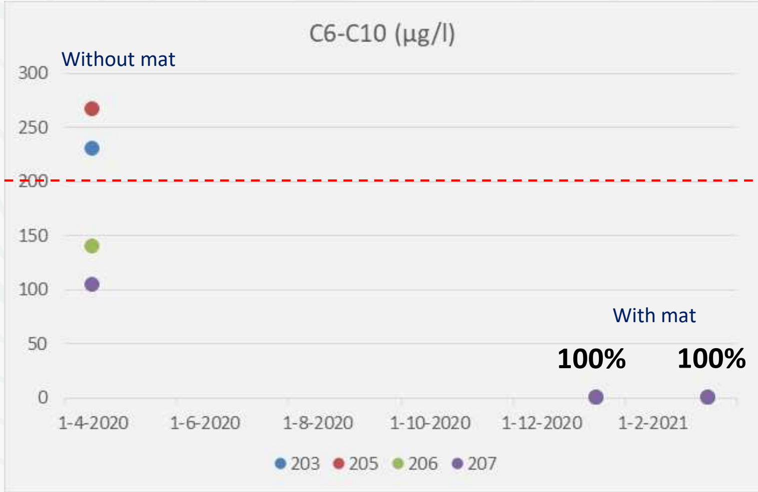
C6-C10

- C6-C10 decreased to below water quality standard
- Efficiency 100% (expected 97%)

As a function of distance



As a function of time

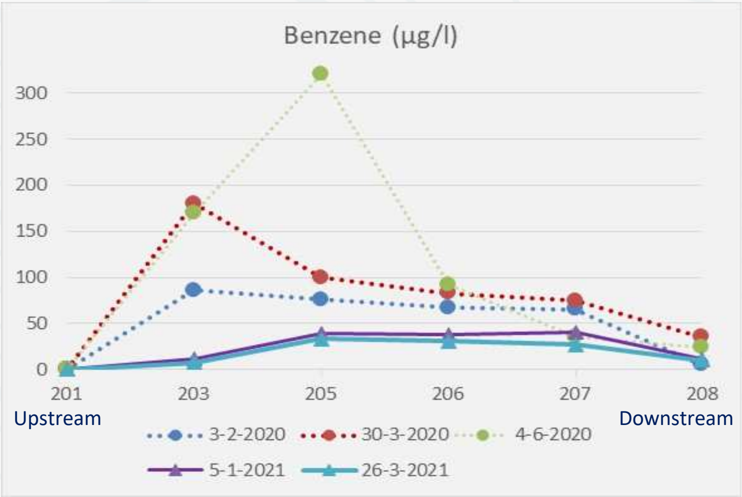


Surface water quality with and without mat

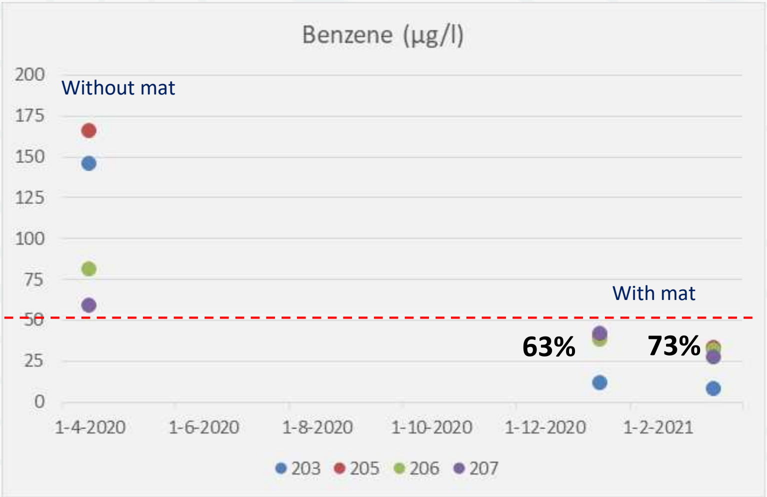
BTEX

- BTEX decreased to below water quality standard
- Efficiency benzene 63-73% (expected 75%), xylenes 80-86%

As a function of distance



As a function of time

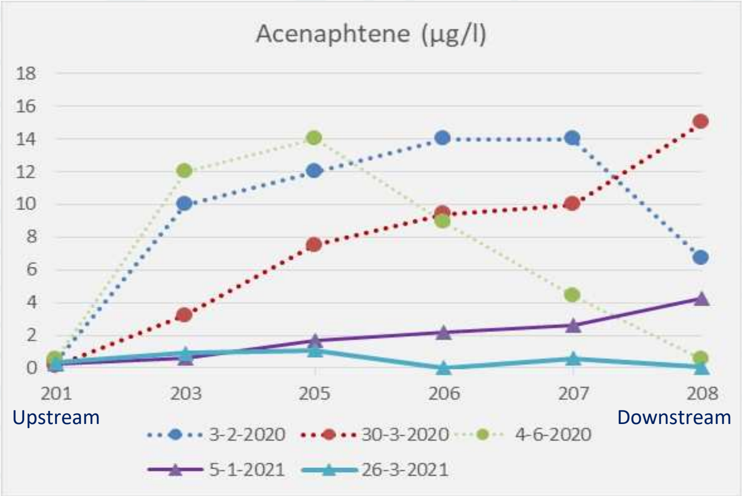


First monitoring results

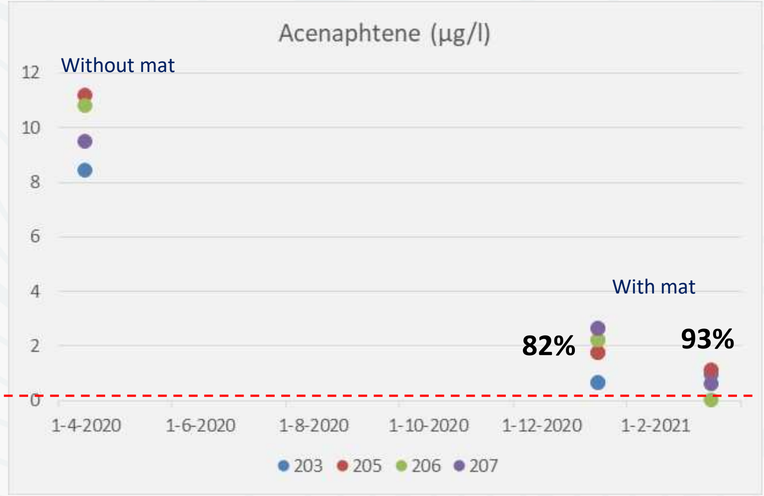
PAH

- PAH (5 of 16) still exceed water quality standard (+/- 0,1 µg/l), but
- Efficiency phenanthrene 92-99%, pyrene 94-95%, acenaphthene 82-93% (expected 85-95%)

As a function of distance



As a function of time



Conclusion and what's next?

Results

- Dense and saturated sediment layer is replaced by Nature Based Solution to improve quality of waterbody
- Interim conclusion: the reactive mat (Natural Catch) functions as it is supposed to!

Next

- Monitoring until September 2022, incl. water quality, flux, microbes and adsorption in mat (at 3 depths)
- Showing low carbon footprint (by CO2 tool TAUW) and low costs (by financial model REBEL)
- Writing Code of Good Practice (OVAM, open source)

Resanat partnership Interreg

The Resanat project is subsidized by Interreg Flanders-Netherlands (European fund for regional development) and co-financed by the Dutch Ministry of Economic Affairs.

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Ministerie van Economische Zaken en Klimaat

Contact: Tobias Praamstra, TAUW
tobias.praamstra@tauw.com