Using sediment samples to assess substances in relation to the Water Framework Directive (WFD)

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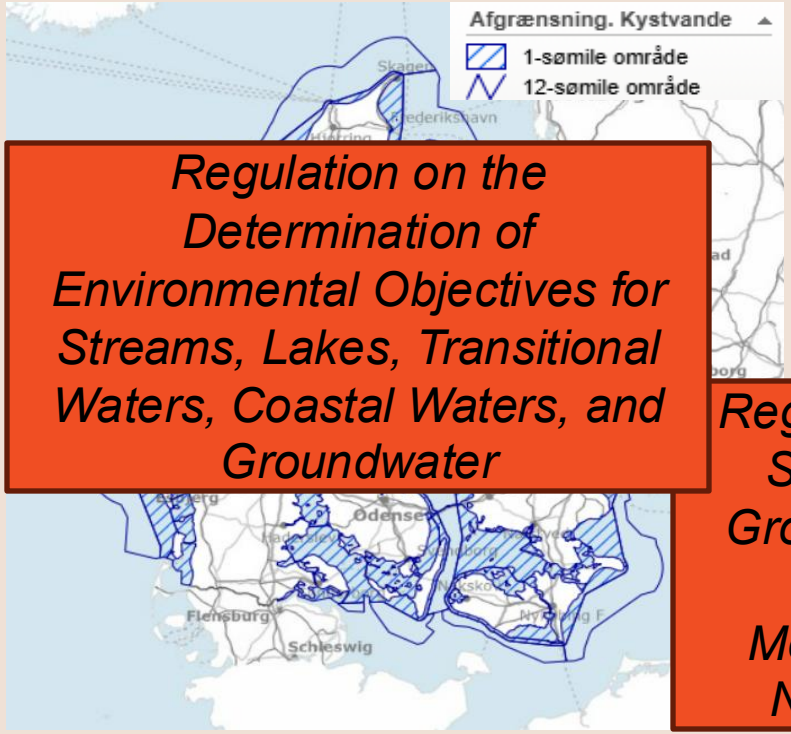
Water Framework Directive (WFD) I DK

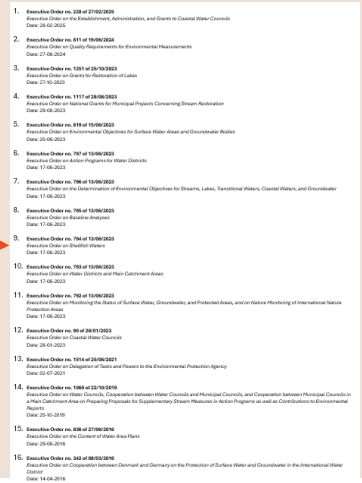


Regulation on the Determination of Environmental Objectives for Streams, Lakes, Transitional Waters, Coastal Waters, and Groundwater

Regulation on Monitoring the Status of Surface Water, Groundwater, and Protected Areas, and on Nature Monitoring of International Nature Protection Areas

Water Framework Directive (WFD)

Act on Water Planning



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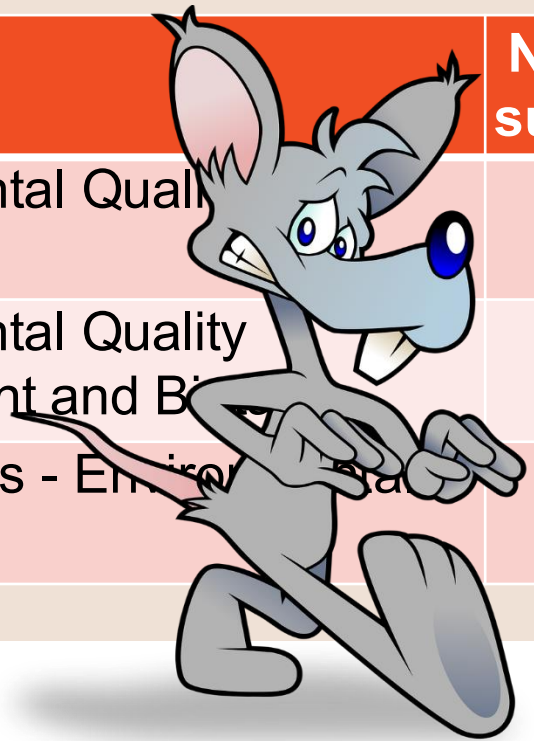
Regulation Determination of Environmental Objectives for Streams, Lakes, Transitional Waters, Coastal Waters, and ….

Tabel	Number of substances	Quality Standards
Nationally Environmental Quali… Standards for Water	222	Water
Nationally Environmental Quality Standards for Sediment and Bi…	94	Sediment and Biota
EU-Priority Substances - Envir… Quality Standards	>60	Water and Biota



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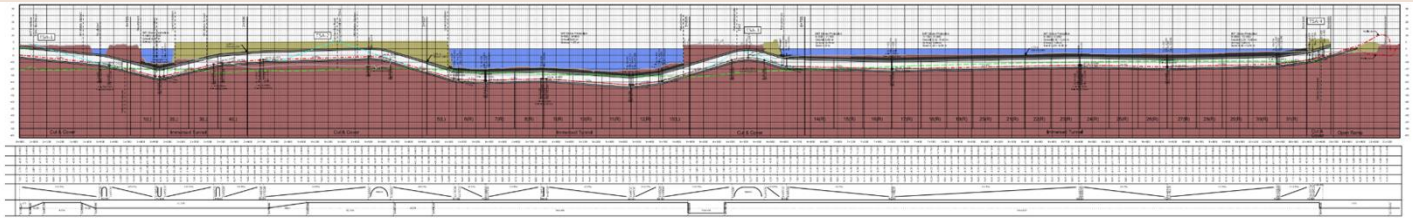
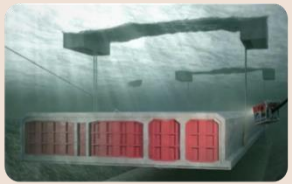
Case – Immersed Tunnel in Copenhagen

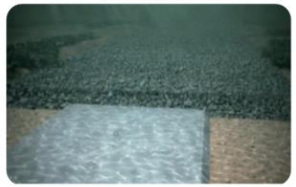


1. Dredging

4. Immersion



5. Backfilling



6. Fill up to existing seabed level

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Going from sediment samples to the assessment of water, sediment and biota quality standards

Arsenic (As)
Barium (Ba)
Lead (Pb)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Mercury (Hg)
Molybdenum (Mo)
Nickel (Ni)
Selenium (Se)
Strontium (Sr)
Zinc (Zn)
Silver (Ag)
Uranium (U)
Vanadium (V)
Tin (Sn)

Monobutyltin (MBT-Sn)
Dibutyltin-Sn (DBT-Sn)
Tributyltin (TBT-Sn)
Triphenyltin (TPhT-Sn)

Benzo(e)pyren
Naphthalen
Acenaphthylen
Acenaphthen
Fluoren
Phenanthren
Anthracen
Fluoranthen
Pyren
Benzo(a)anthracen
Chrysen / Triphenylen
Benzo(b+j+k)fluoranthen
Benzo (a) pyren
Indeno(1,2,3-cd) pyren
Dibenz(a,h)anthracen
Benzo (g,h,i) perylen
1-methylnaphthalen
2-methylnaphthalen
Dimethylnaphthalener, sum
Trimethylnaphthalener, sum
Sum af methylnaftalener

PFBA (Perfluorbutansyre)
PFBS (Perfluorbutansulfonsyre)
PFPeA (Perfluorpentansyre)
PFPeS (Perfluorpentansulfonsyre)
PFHxA (Perfluorhexansyre)
PFHxS (Perfluorhexansulfonsyre)
PFHpA (Perfluorheptansyre)
PFHpS (Perfluorheptansulfonsyre)
PFOA (Perfluoroktansyre)
PFOS (Perfluoroktansulfonsyre)
6:2 FTS (Fluortelomersulfonat)
PFNA (Perfluornonansyre)
PFDS (Perflordekanesulfonsyre)
PFOSA (Perfluoroktansulfonamid)
FDA (Perfluordekansyre)
PFUnDA (Perfluorundekansyre)
PFDoDA (Perfluordodekansyre)
PFTrDA (Perfluortridekansyre)
PFNS (Perfluornonansulfonsyre)
PFUnDS (Perfluorundecansulfonsyre)
PFDoDS (Perfluordodecansulfonsyre)

PFTrDS (Perfluortridekansulfonsyre)

Diethylhexylphthalat (DEHP)
Diethylphthalat (DEP)
Di-n-butylphthalat (DBP)
Di-n-octylphthalat (DNOP)
Benzylbutylphthalat (BBP)
Diisononylphthalat isomerbl.
Di-(2-ethylhexyl)adipat (DEHA)

Bisphenol A
Nonylphenoler
Nonylphenol Monoethoxylat
Nonylphenol Diethoxylat

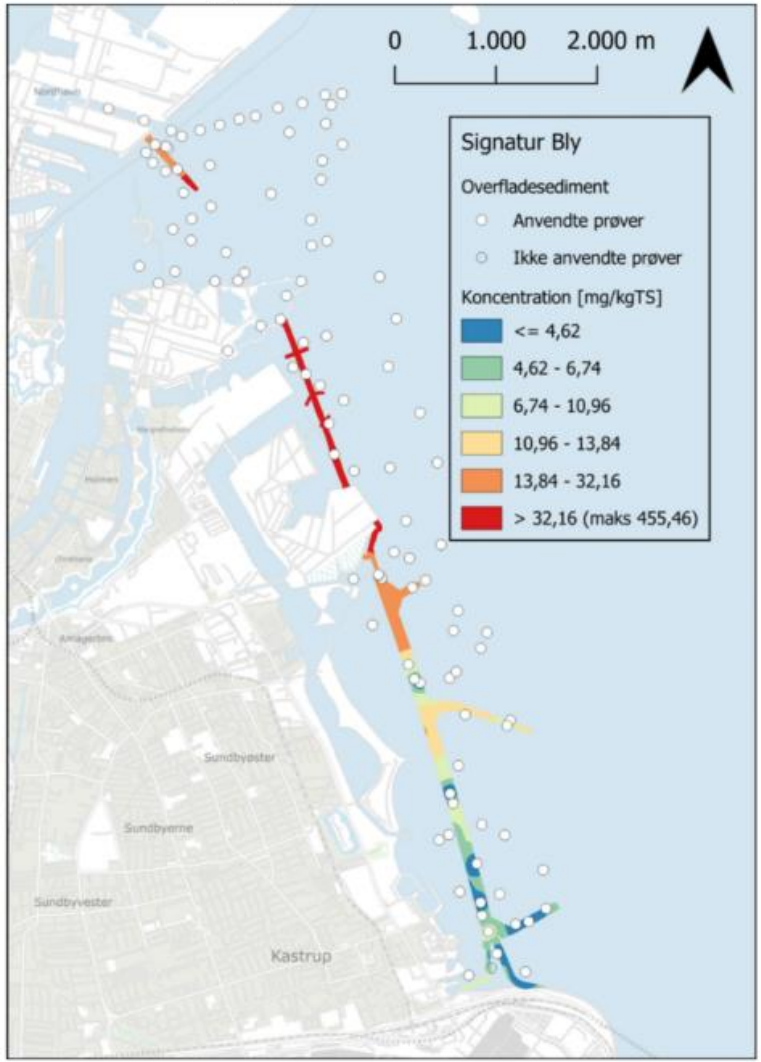
PCB 28
PCB 52
PCB 101
PCB 118
PCB 138
PCB 153
PCB 180

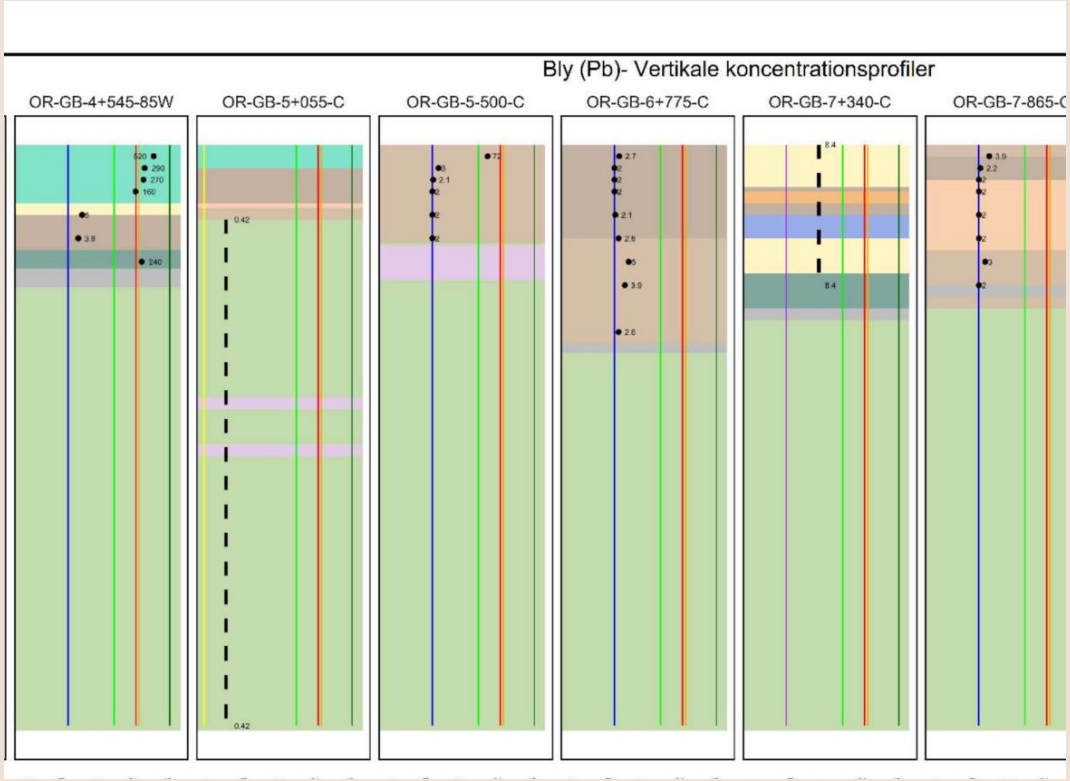
2,2',4-TriBDE
2,4,4'-TriBDE
BDE- 47
2,2',4,5'-Tetr
2 ,3‘,4,4‘-Tet
2, ,3‘,4‘,6-Te
3,3‘,4,4‘-Tetr
2,2‘,3,4,4‘-Pe

BDE-99
BDE-100
2,3‘,4,4‘,6-PentaBDE (BDE-119)
3,3',4,4',5-PentaBDE (BDE-126)
2,2',3,4,4',5'-HexaBDE (BDE-138)
BDE-153
BDE-154
2,3,3',4,4',5-HexaBDE (BDE-156)
BDE-183
2,2',3,4,4',6,6'-HeptaBDE (BDE-184)
2,3,3',4,4',5',6-HeptaBDE (BDE-191)
2,2',3,4,4',5,5',6-OctaBDE (BDE-196)
2,2',3,3',4,4',6,6'-OctaBDE (BDE-197)

2,2',3,3',4,4',5,5',6-NonaBDE (BDE-206)
2,2',3,3'4,4',5,6,6'-NonaBDE (BDE-207)

+ Farmaceutical…


0
1.000
2.000 m
Signatur Bly
Overfladesediment
Anvendte prøver
Ikke anvendte prøver
Koncentration [mg/kgTS]
<= 4,62
4,62 - 6,74
6,74 - 10,96
10,96 - 13,84
13,84 - 32,16
> 32,16 (maks 455,46)
Sundbyvester
Sundbyerne
Sundbyvester
Kastrup


Bly (Pb)- Vertikale koncentrationsprofiler
OR-GB-4+545-85W
OR-GB-5+055-C
OR-GB-5-500-C
OR-GB-6+775-C
OR-GB-7+340-C
OR-GB-7-865-C

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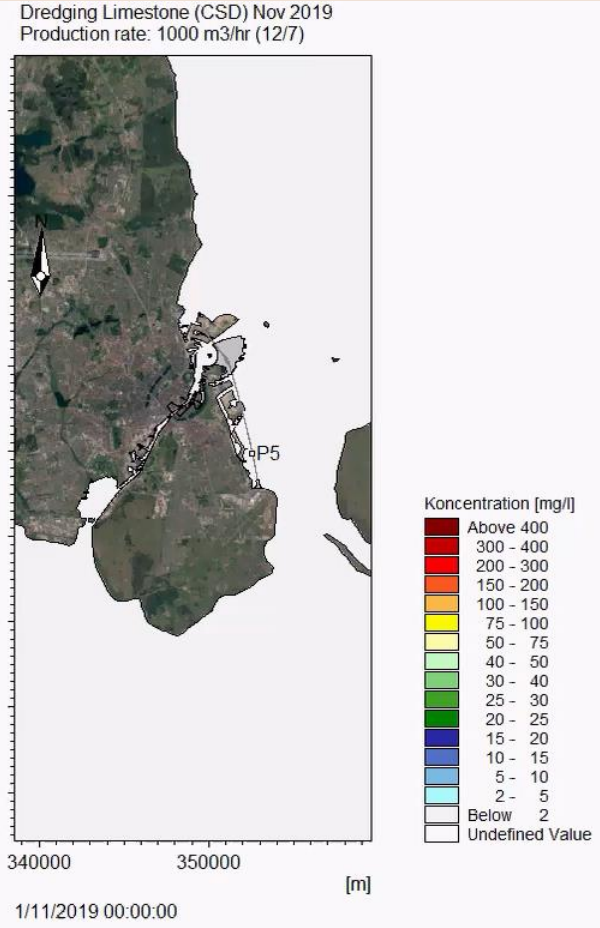


- **<u>Step wise procedure (model or "hand calculation)</u>**

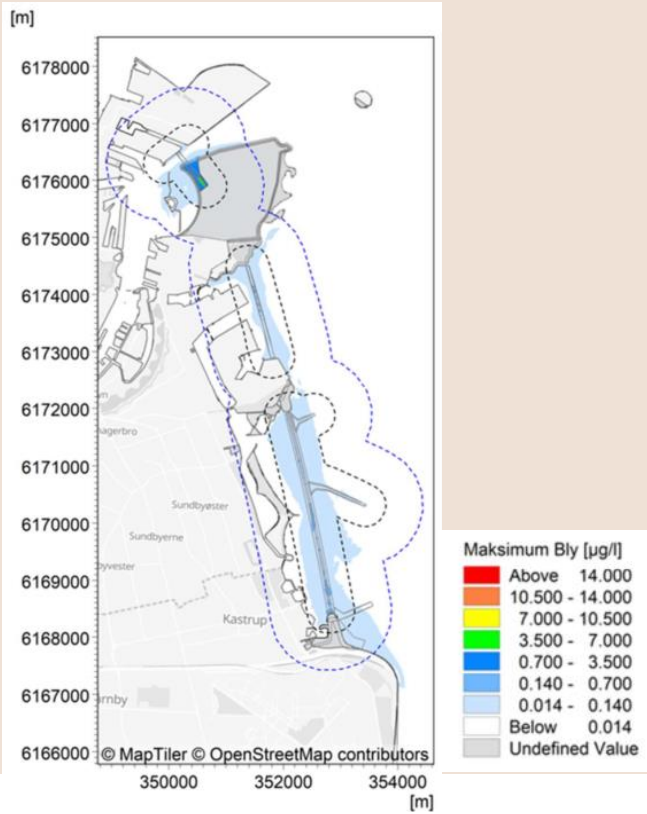
- Set dredge rate [vol/time], dry density [mass/vol], spill percentage [%]
- Measure & calculate representative concentrations of pollutants

- For substances with EQS for <u>total</u> concentrations (eg. PAH's)
- Calculate TSSmean and TSSmax from the TSS spill model.
- Multiply with pollutant sediment conc. [mg/kg DM]
- Produce pedagogic maps (and be carefull about the scale;-))
- Remember the background concentration!

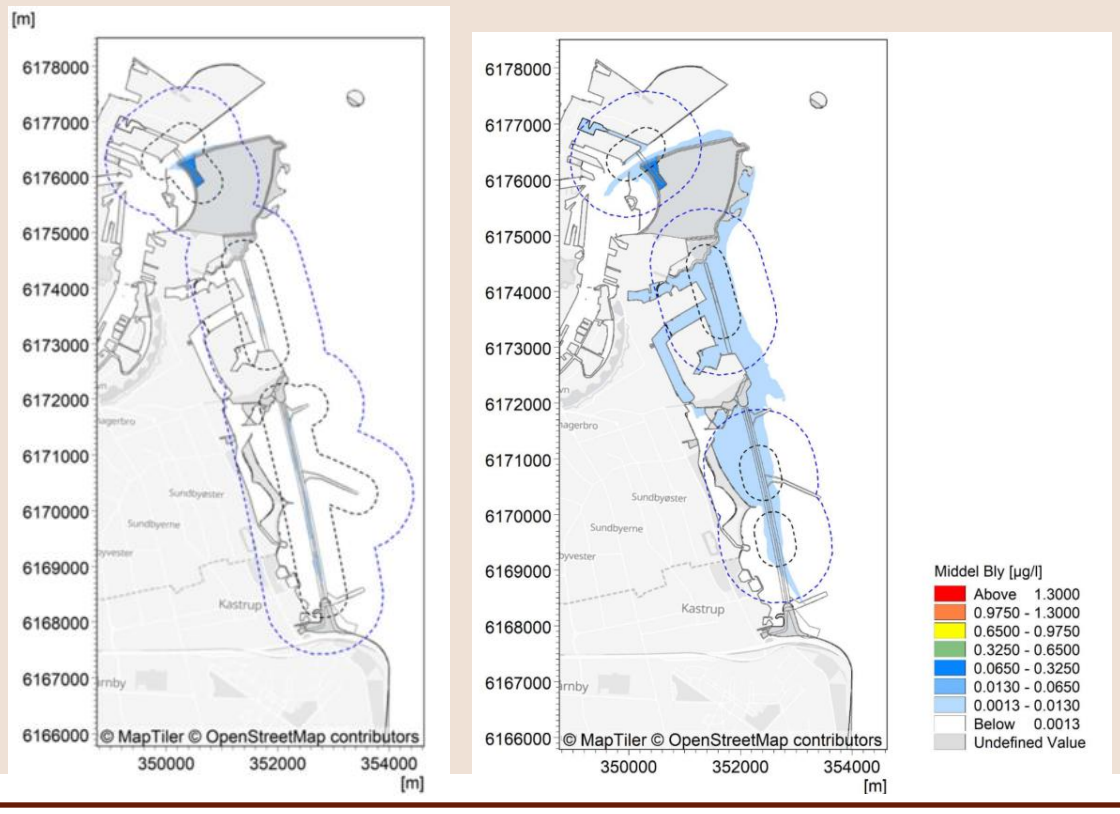
- For substances with EQS for <u>dissolved</u> concentrations (eg. PAH's)
- Either calculate TSSmean and TSSmax from the TSS spill model. Multiply with pollutant sediment conc. [mg/kg DM] and release percentace..
- Or do a direct AD model with a spill of heavy metals (more correct)
- Remember the background concentration!
- Produce pedagogic maps (and be carefull about the scale;-))

Example Lead (Pb)

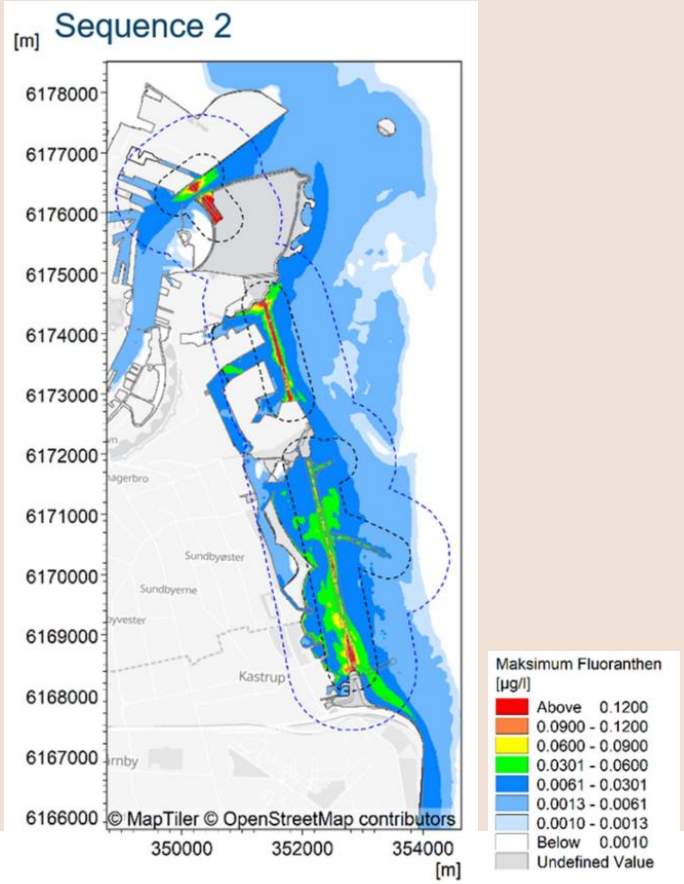
Max

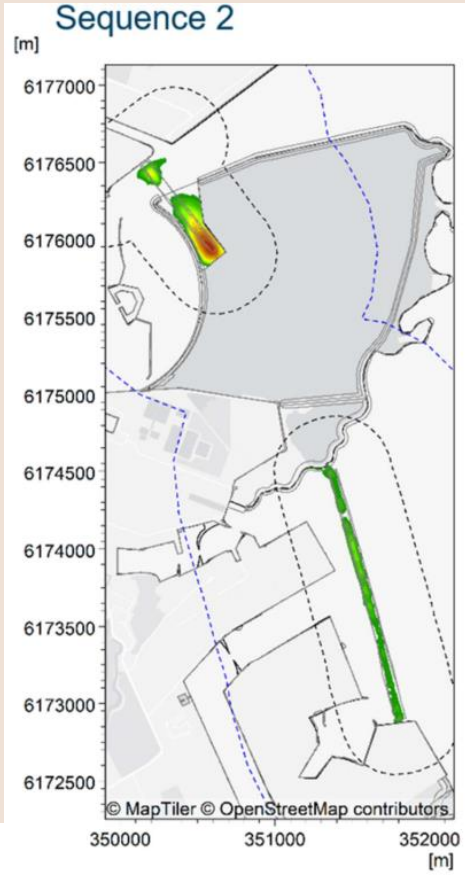


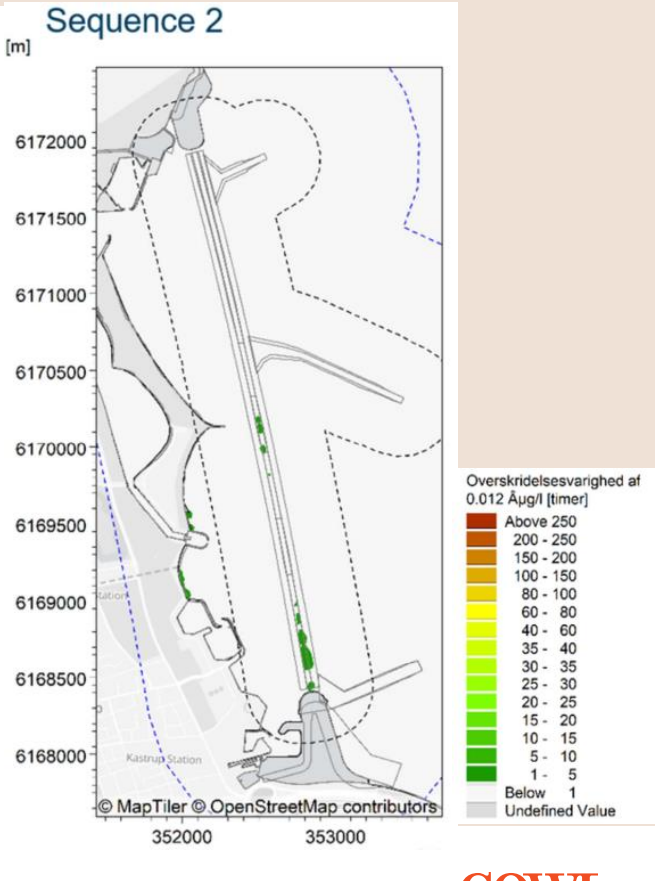
Mean – choosing the right averaging time ?



Example Flouranthene (max)







Going from sediment samples to the assessment of biota quality standards

- Since EQS for water are determined to protect biota from chronical and acute effects – the EQS for water is often used for addressing effects on biota

Going from sediment samples to the assessment of sediment quality standards

- Eg. use the deposition results from a sediment spill model
  - In DK we have some guidelines (that can't stand alone)
  - If the sediment in the waterbody do not exceed EQS – a yearly increase in concentration (of 5% of the EQS) in the top 3-5cm is normally accepted (the criteria is however original made for something else (permanent discharges…)
  - If the sediment in the waterbody does exceed EQS – a yearly increase in concentration (of 1% of the EQS) in the top 3-5cm is normally accepted (the criteria is however original made for something else (permanent discharges…)
  - The above calculation demands the background concentration in the deposition area is known to make a depth averaged concentration….

The presence of multiple substances introduces additional complexities

- A wide range of substances, including metals and PAHs, are assessed where the **environmental quality standard for sediment depends on the TOC** (total organic carbon) content. Many harbor and navigation channel sediments have a very low TOC content, which results in very low environmental quality standards — in some cases below the detection limit.
- For several metals, including arsenic, boron, and vanadium, **background concentrations exceed the environmental quality standards in most parts of Denmark**. This means it will be difficult to comply with the environmental quality standards for these substances. Moreover, this will result in the water body's status remaining in a less than good ecological status for the nationally specific substances and not in good chemical status for the EU priority substances.

Discussion:

- It is sometimes difficult to determine when there is a local and/or temporary impact and whether this falls under the WFD (Water Framework Directive).
- How are requirement values determined for a given substance in an emission when the environmental quality standards for that substance have already been exceeded in the surface water?
- Is it sufficient to look at the concentration of individual substances and the increase in the concentration of the substance in sediment, or should a calculation of the release to the water phase and the increase in the water phase also be made?
- Should the assessment be carried out across the entire water area, or is there a deterioration if there is a very local and temporary increase in concentration?
- What about the time perspective? AA-EQS is the EQS expressed as an annual average value….