flanders HYDRAULICS RESEARCH

departement Mobiliteit en Openbare Werken

Silt (Sludge) Test Tank: A platform for nautical bottom rheology research to optimize in-situ measurement tools and reduce dredging activities

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SedNet

6-9 April 7th International SedNet event

GEMS

anteagroup

Maritime Access

In –situ ??: (almost) not possible (depth reference; wave; current,…)

Goal 1

Testing/calibrating/ checking In-situ sensors

* Nautical bottom detection (density; rheology)

* Multi-parameter sensor from water column to mud column ??

* Other ??

Goal 2

Conditioning mud ⬇ Fluidising (non-contaminated) mud

Different dredging approach

No relocation !
No dilution with oxygen rich water!
Stirring: breaking flock structure !
Sediment barier !

Goal 3

Other research:
* flocculation study
* Navigability of mud: nautical bottom

Physical model: no scale model! 2D & 3D body towing => feeding CFD model

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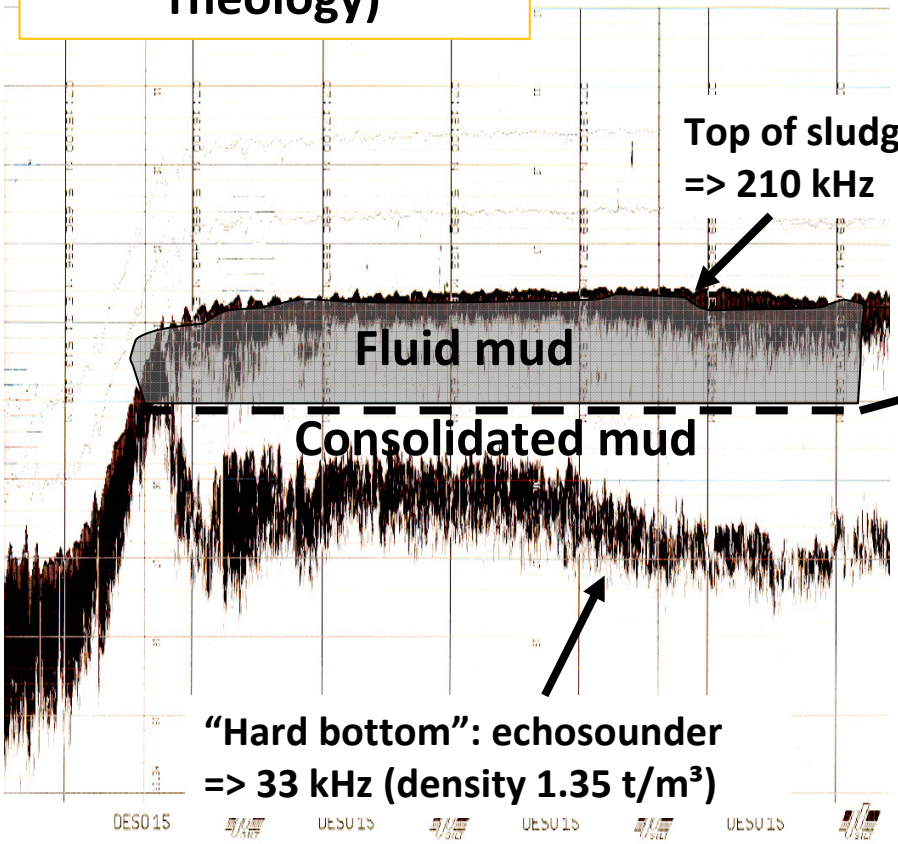
Goal 1

Testing/calibrating/ checking In-situ sensors

* Nautical bottom detection (density; rheology)



* Multi-parameter sensor from water column to mud column: feasible?

Nautical bottom level

- (1) Density: (e.g.) 1.2 t/m³ ⇔ Rheology (Thixotrophy)
- <u>Sometimes</u> a local relation

"Yoghurt" before/after stirring

* A vessel feels the resistance: "rheology" => CFD

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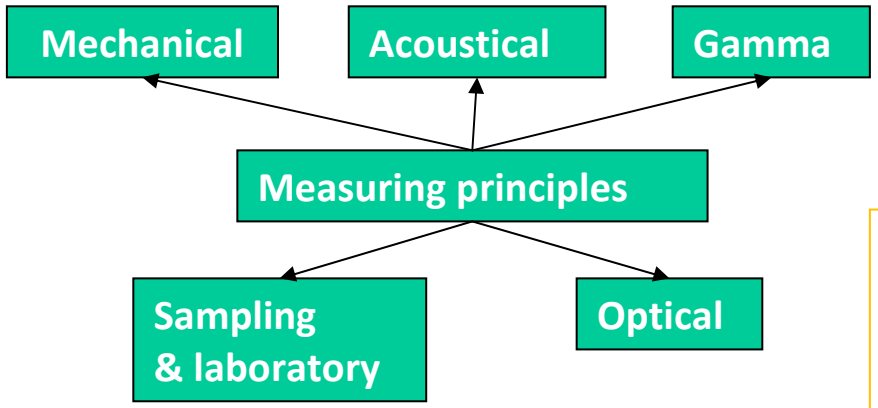
Goal 1

Testing/calibrating/ checking In-situ sensors

* Nautical bottom detection



<u>Instruments</u>:

-Densitune/Rheotune
-Mechanical In-situ Rheometer (MIR)
-Navitracker (I,"2011")
-DART
-Rheocable / Acceleroprobe
- DRDP/Admodus USP
-...

<u>Cooperation / nautical bottom research</u>:

-***<u>Ports</u>***: Deurganckdock (BE); Zeebrugge (BE); Rotterdam (NL); Delfzijl (NL); Harlinger (NL); Emden (DE); Deurganckdock (BE); Zeebrugge (BE)

-***<u>Organisations</u>***: Flemish Government (Maritime Access; MDK) (BE); Port of Rotterdam (NL); RWS (NL); Grieser & Partner (DE); A. Wurpts (DE); Wiertsema & Partners (NL) ...

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Goal 2

Conditioning mud => Fluidising ('non-contaminated') mud

Different dredging approach	Reducing dredging costs	Environmentally safe?

No relocation !	⟶	No transport cost/spill !
No dilution with oxygen rich water!	⟶	No oxygen depletion in water column / contaminant mobility?
Sediment barrier !	⟶	Reducing siltation / keeping sediment in river
Stirring: breaking flock structure !	⟶	Other dredging technique ⇒1 x month ! =f(consolidation time) ⇒ Cost reduction of 80%

CASE Study/Reality => Emden harbour => feasibility ?????

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waterbouwkundig LABORATORIUM

Goal 3

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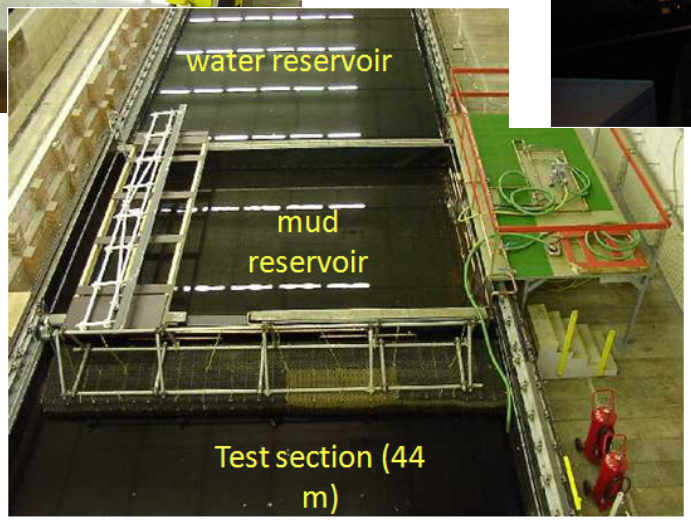
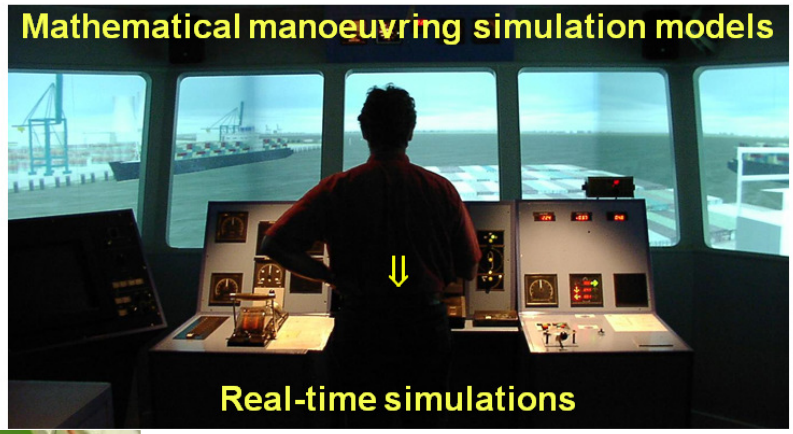
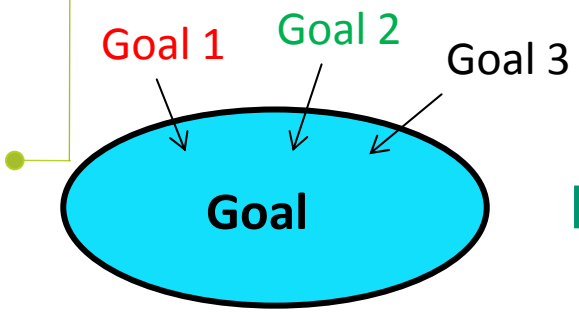
Other research:
*** flocculation study**
*** Navigability of mud: nautical bottom**





Silt (Sludge) Test Tank
STT



Flanders Hydraulic Research
Sedimentological Laboratory

departement
Mobiliteit en
Openbare Werken

KULeuven
⇒Micro-biology (EPS/slimes)
⇒Phd: Stijn Claeys

Sediment related Nautical Bottom: **website** !

Natural dredged mud! => no scale model

Properties of the Sludge Test Tank (STT)

Simulation of insitu conditions:
-Suspension
-Sedimentation
-Consolidation
-Biology
(Barnacles ☺)
Water & mud column

Re-use; recycle the sludge Creating different mud

Towing and profiling sensors/bodies

Conditioning (mixing/pumping/ vibrating/oxidising / of the sludge

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Conditioning + research

- Simulation of
  - Sedimentation
  - Coagulation
  - Flocculation
  - Consolidation

- Conditioning:
  - Biology (reduce/increase activity): anaerobe/ aerobe
  - Reducing evaporation
  - Mineralogy
    - separation of fractions
    - distribution of grain sizes
    - Adding fractions
  - Chemistry (Ph; oxygen; nutrients etc..)

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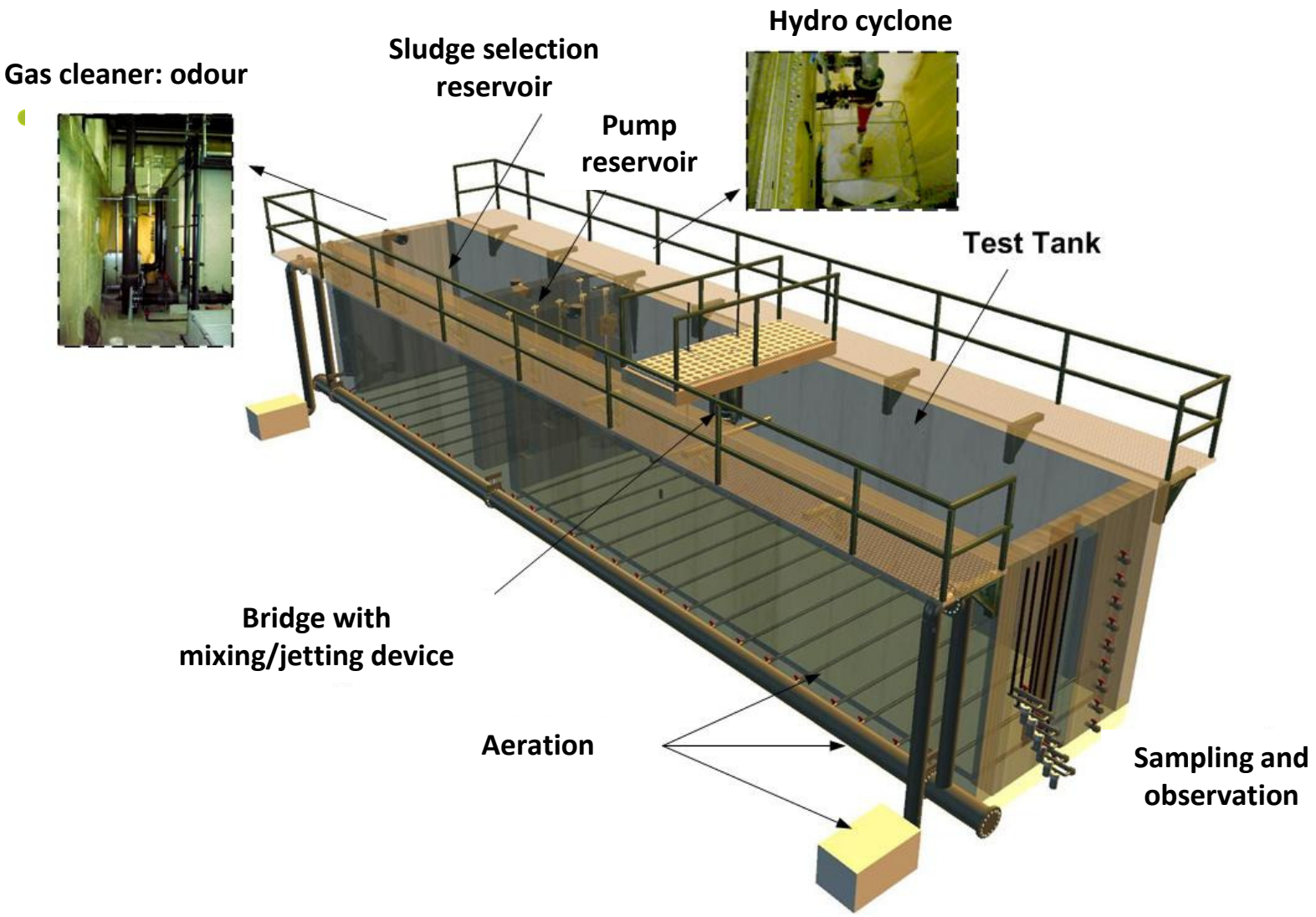

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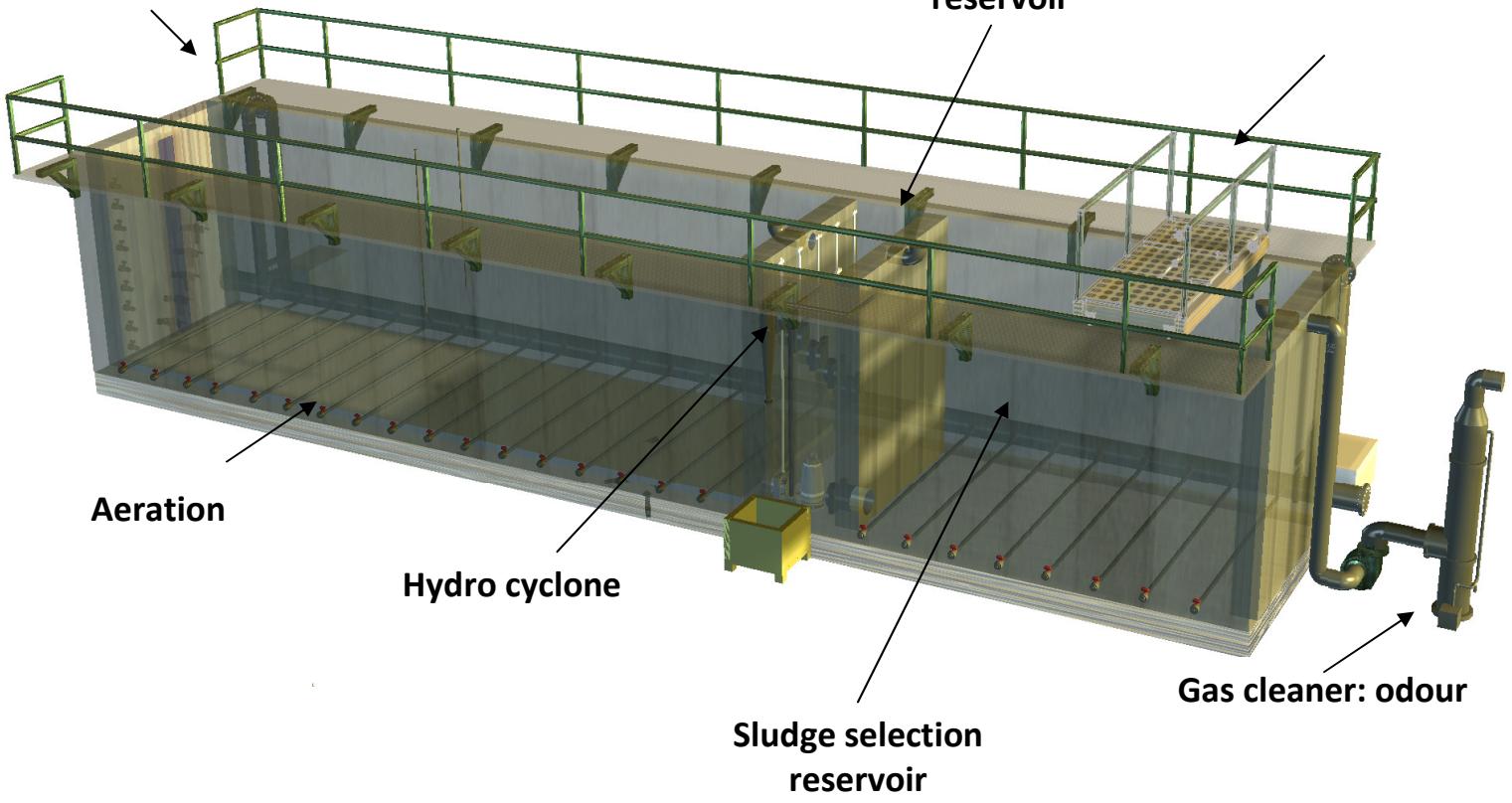
Sampling and observation
Pump reservoir
Bridge
Aeration
Hydro cyclone
Sludge selection reservoir
Gas cleaner: odour

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Sampling and measurements

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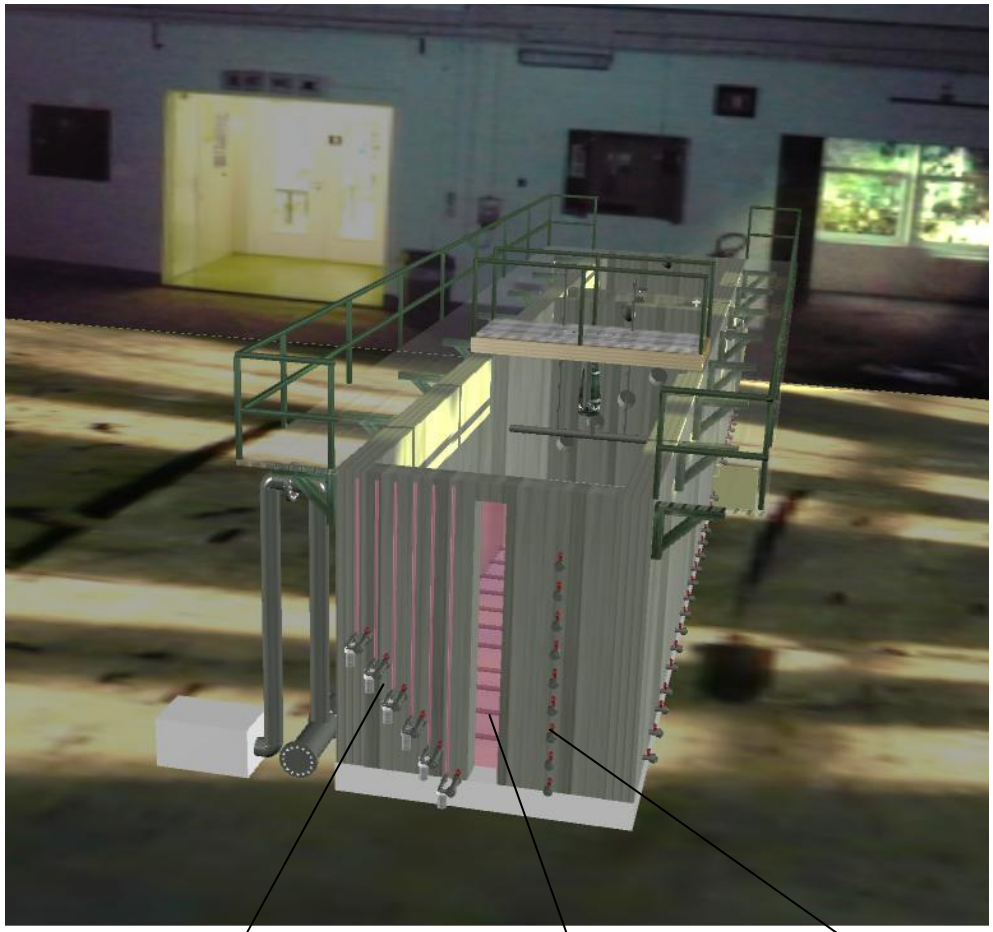
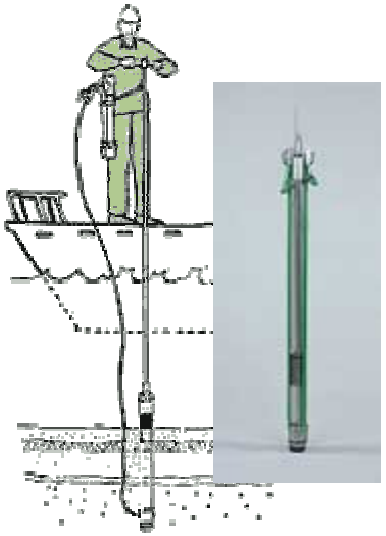
Van Veen Grab



Piëzo meters **Observation window** **Sampling taps**



Beekersampler

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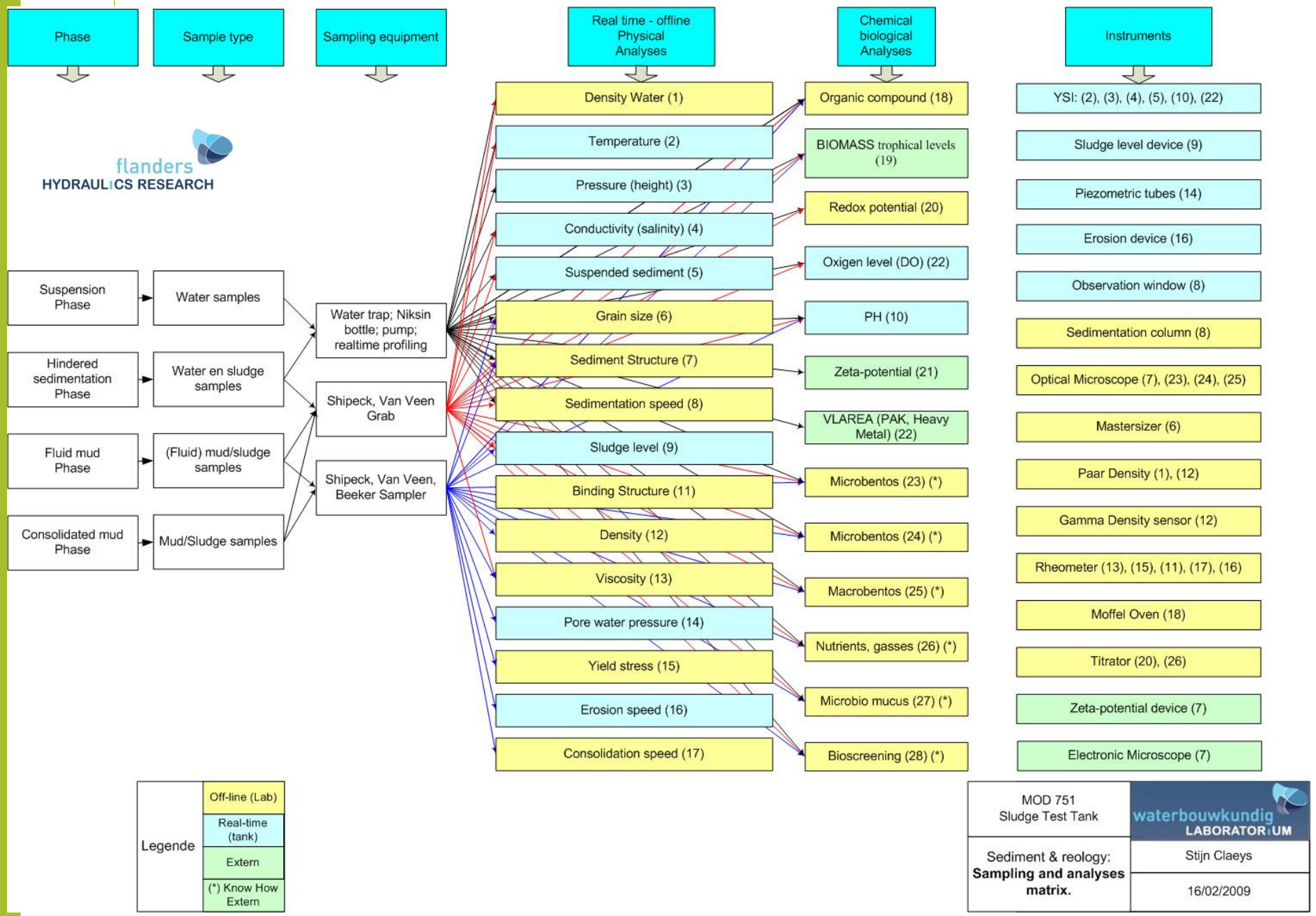
Phase
Sample type
Sampling equipment
Real time - offline Physical Analyses
Chemical biological Analyses
Instruments
flanders
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Suspension Phase
Hindered sedimentation Phase
Fluid mud Phase
Consolidated mud Phase
Water samples
Water en sludge samples
(Fluid) mud/sludge samples
Mud/Sludge samples
Water trap; Niksin bottle; pump; realtime profiling
Shipeck, Van Veen Grab
Shipeck, Van Veen, Beeker Sampler
Density Water (1)
Temperature (2)
Pressure (height) (3)
Conductivity (salinity) (4)
Suspended sediment (5)
Grain size (6)
Sediment Structure (7)
Sedimentation speed (8)
Sludge level (9)
Binding Structure (11)
Density (12)
Viscosity (13)
Pore water pressure (14)
Yield stress (15)
Erosion speed (16)
Consolidation speed (17)
Organic compound (18)
BIOMASS trophical levels (19)
Redox potential (20)
Oxigen level (DO) (22)
PH (10)
Zeta-potential (21)
VLAREA (PAK, Heavy Metal) (22)
Microbentos (23) (*)
Microbentos (24) (*)
Macrobentos (25) (*)
Nutrients, gasses (26) (*)
Microbio mucus (27) (*)
Bioscreening (28) (*)
YSI: (2), (3), (4), (5), (10), (22)
Sludge level device (9)
Piezometric tubes (14)
Erosion device (16)
Observation window (8)
Sedimentation column (8)
Optical Microscope (7), (23), (24), (25)
Mastersizer (6)
Paar Density (1), (12)
Gamma Density sensor (12)
Rheometer (13), (15), (11), (17), (16)
Moffel Oven (18)
Titrator (20), (26)
Zeta-potential device (7)
Electronic Microscope (7)
Legende
Off-line (Lab)
Real-time (tank)
Extern
(*) Know How Extern
MOD 751
Sludge Test Tank
waterbouwkundig LABORATORIUM
Sediment & reology:
Sampling and analyses matrix.
Stijn Claeys
16/02/2009