Monitoring plan for WP I1 investment Pilot application of sediment:

Reallocation within the system to 'reset' a natural system for bank nourishment in Port of Rotterdam

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WP Nr	Type	Title	Start month	End month	Budget
WP. T2	implementation	**Demonstrate and evaluate innovative sediment reuse solutions for flood and erosion protection**	Sep-2017	Dec-2020	1 437 105.38

Contents

Short description of the WP I1 Pilot goals

The investment consists in the management and monitoring of the dredging and reallocation of 200.000 tons (500.000 m^3) of sediment within the river in Port of Rotterdam.

The reallocation of the sediment should not impact the sedimentation rate in the harbor, while at the same time should have a positive impact on the river bank nourishment. The reallocated sediment must be traceable within the inter tidal area and coastal zone to establish this nourishing impact on the river bank.

Figuur 1 Dredging sites and target area for reallocation

Main outputs

Please describe the project main outputs that will be delivered based on the activities carried out in this work package. For each project main output a programme output indicator should be chosen. Please note that they need to have the same measurement unit.				
Project main output	Describe the project main output and its contribution to project sub-objectives	Quantify the contribution	Delivery month	Programme output indicator to which the project main output will contribute. Please check the Programme Manual for the obligatory output indicators.
Implementation of new solution in Port of Rotterdam (sediment realocation within the system)	reallocation of 200.000 tons of dredged sediments in Port of R'dam	200 000.00	Sep-2020	5.05. Amount of increased material recovery, re-use and recycling
		200 000.00	Sep-2020	5.04. Amount of decreased raw material use

Activities and deliverables

I1.2	On site pilot implementation of Port of Rotterdam pilot		Sep-2017	Sep-2020
Port of Rotterdam and Deltares will work to manage together the implementation of the pilot site, to coordinate operators onsite, and get operational feedback linked to implementation works to link with replication condition analyses in WPT2/WPLTE				
	Deliverable nr	Title	Target value	End month
	Deliverable I1.2.1	1 pilot application of 200.000 t sediments within Port of Rotterdam	1.00	Sep-2019
	Management of dredgings and reallocations of sediment in Port of R'dam to influence the bank and beach nourishment completed. Dreging cost not claimed.			
	Deliverable I1.2.2	Report on experience learnt from sediment realocation in the port pilot site	1.00	Sep-2020
	One report on the experiences learnt to produce inputs for replication and roll-out analyses and dissemination.			

Timeframe

The reallocation will start at the end of the storm season (15-04-2019), to not compromise the safety of the Maeslantkering.

In total 500.000 m3 of sediment will be reallocated, the capacity of the hopper is 5.500 m3 per trip:

- 91 trips
- 2 trips per day (tide dependent) = 11.000 m3 per day
- 45.5 working days
- 9 weeks

Start: 16-04-2019 (week 16)

End: 21-04-2019 (week 25)

Impact pilot output requirements on the monitoring plan

The monitoring of the pilot has three mayor goals;

1) To establish the reallocated sediment volume (deliverable 1.2.1.)
2) To establish the sediment balance in the harbor because of the pilot (boundary condition -> no impact on the sedimentation rate in the harbor)
3) To establish the nourishing impact on the river bank

Goal 1) Reallocated sediment volume

The amount of sediment reallocated will be monitored by the dredged volumes in the target area's:

Tabel 1 Sediment volumes in the target area's

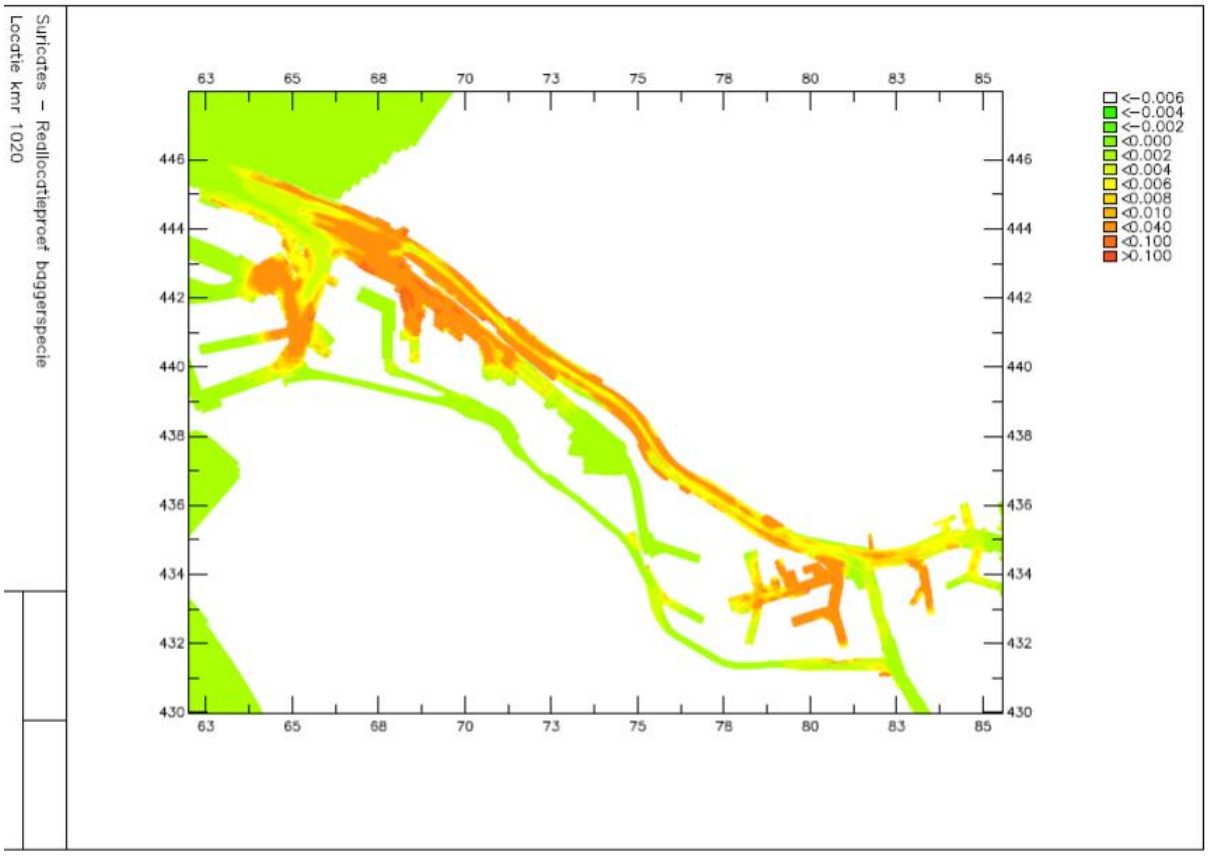
Monstervak	Haven	Beheerder	Hoeveelheid in m3	TDS
22	Waalhaven monding	Port of Rotterdam	25.000	9.500
23A deels		Port of Rotterdam	135.000	51.000
25 deels		Port of Rotterdam	50.0000	19.000
29	Madroelhaven	Port of Rotterdam	10.000	3.800
31	Eemhaven slibput	Port of Rotterdam	300.000	114.000
34	Eemhaven Centrale Geul	Port of Rotterdam	100.000	38.000
35	Frisohaven	Port of Rotterdam	30.000	11.000
39	Pr. Margriethaven	Port of Rotterdam	5.000	2.000
			655.000	250.000

The reallocated volumes will be checked by:

- The hoppers dredged volume registration
- The number of hopper trips
- The sounding of the target area's before and after dredging (change in depth)

Goal 2) Sediment balance in the harbor

The impact of the reallocation on the sedimentation patter in the harbor is estimated with a model prediction on the settling area's (Figuur 2).



Figuur 2 Impacted area, first model predictions on setting of reallocated sediment

The sediment balance validation is split in different parts:

Composition of the sediment by grab sampling

Target for sediment grab:

- Establish the rheology and resuspension/settling properties of the sediment in the target area (potential upstream and downstream settling locations) (Port of R'dam/ Deltares)
- Establish the impact of the reallocation pilot on the port sediment balance, where does the sediment settle? (Deltares)
- Characterization of mineral fraction (BRGM)

There are three sampling campaigns for grab sampling of sediments:

- T0, before the start of the reallocation

- T1, one time between 75% and 100% reallocated volume
- T2, one time in the period 1-2 months after end of reallocation

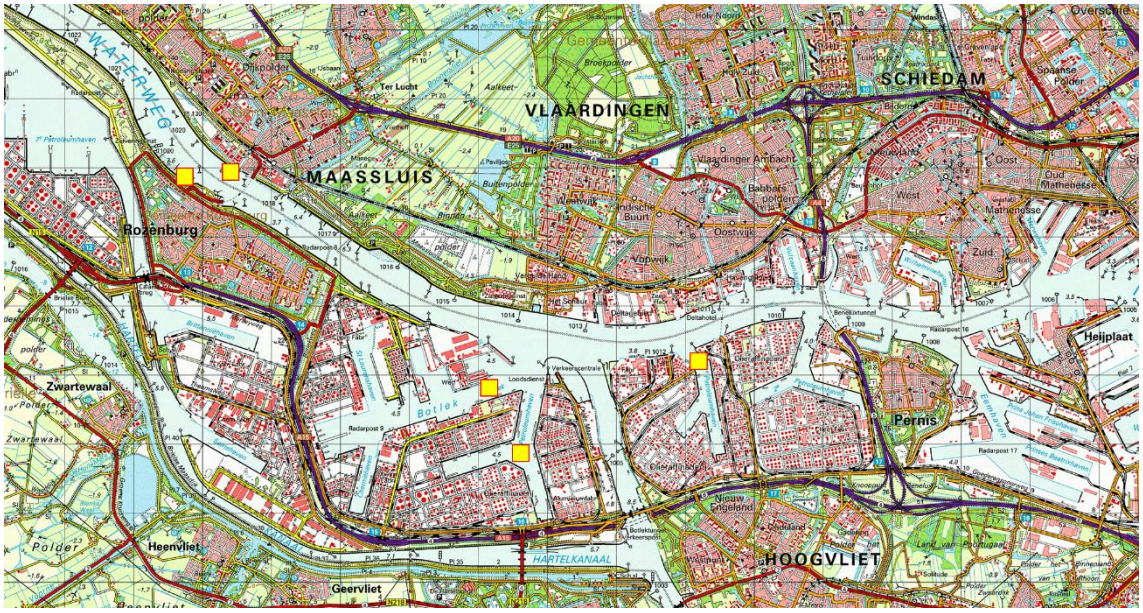
Boundary sample conditions:

- Sample sites should have fines, since:
  - Settling and erosion of the coarse sand fraction is well known, and can be calculated with a relative high certainty (stokes law and flow velocity/channel profile)
  - The fines are needed for the rare earth elements finger printing
- Grab sample locations:
  (1) Upstream sedimentation location 5
  (2) Downstream sedimentation location 5
  (3) Reallocation location 4
  (4) Green Port as sedimentation location 3
  (5) Source location 8
- Total number of sites: 25

Tabel 2 Grab sample Locations

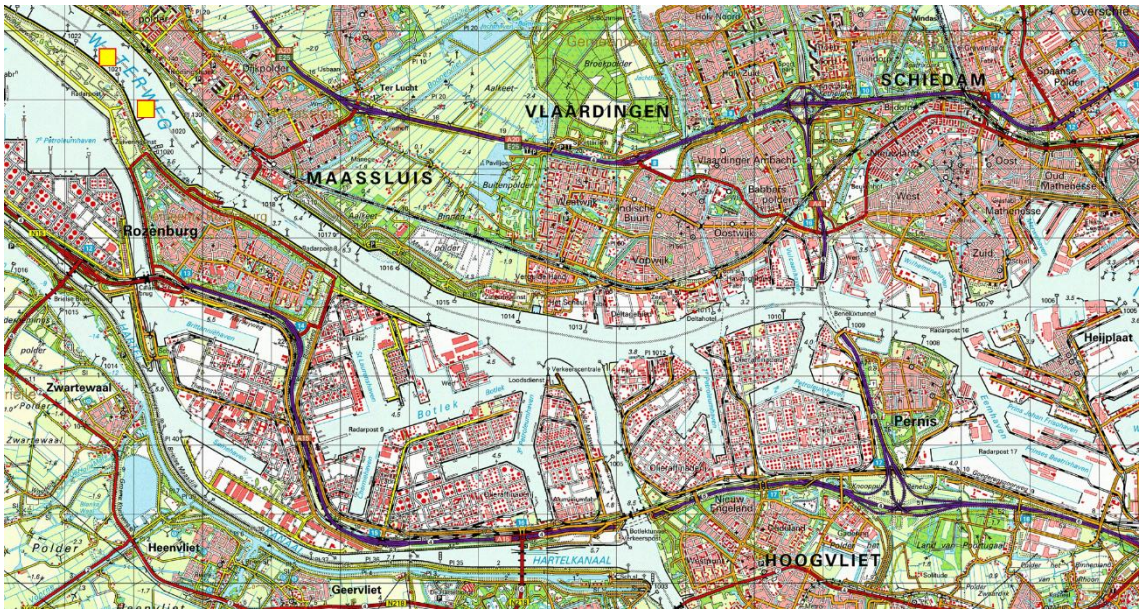
Project:	Suricates		
Purpose:	T0 survey sediment composition		
Date:	07/02/2019		
naam	N	E	beschrijving
UP_01	51.891361	4.345915	1e Petroleumhaven
UP_02	51.879551	4.307058	3e Petroleumhaven
UP_03	51.887775	4.297639	Botlek
UP_04	51.915851	4.246268	Hellinggat
UP_05	51.914033	4.237111	RWS opslag boeien
HER_01	51.917437	4.231685	Voetbalvereniging Rozenburg
HER_02	51.926152	4.221768	Nabij EIC mainport Rotterdam
HER_03	51.932246	4.210733	Stortvak
HER_04	51.932246	4.210733	EMCR Rozenburg
DOWN_01	51.962592	4.142131	Europort Landtong
DOWN_02	51.976424	4.102659	NWW kant splitsingsdam
DOWN_03	51.967383	4.125644	De Punt
DOWN_04	51.969143	4.105128	nabij Breeddiep
DOWN_05	51.964744	4.091627	6e Petroleumhaven
vak 22			
vak 23A, 1			
vak 23A, 2			
vak 25			
vak 31, 1			
vak 31, 2			
vak 34, 1			
vak 34, 2			
Green Port			
Vak 1	51.919857	4.227039	Upstream
Vak 2	51.921943	4.225411	Upstream
Vak 3	51.936283	4.198126	Downstream

(1) Upstream sedimentation location



(2) Downstream sedimentation location

(3) Reallocation location



Bathymetry and turbidity profile due to the sediment reallocation

The local bathymetry will be checked at the T0, T1 and T2 surveys of the impacted area (km 1013 – 1033) by Multi beam echo sounder (230 kHz)

The turbidity directly after a reallocation (5.500 m^3) will be checked by in total six survey's:

- Floating with the reallocation flume towards sea,
    - Three times during the reallocation period (period of 9 weeks) 23-04 / 08-05 / 22-05
- Staying at a stationary location close to the reallocation site
    - Three times during the reallocation period (period of 9 weeks) 25-04 / 14-05 / 28-05

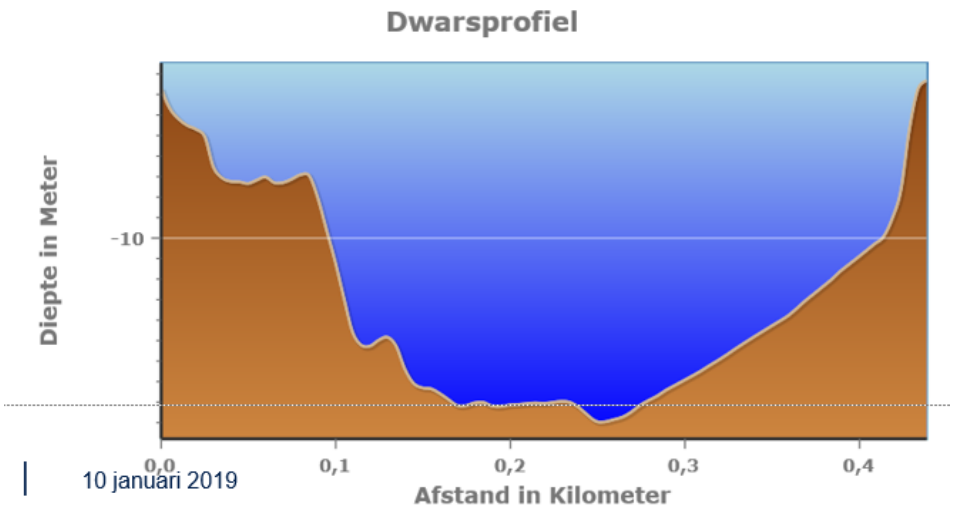
The survey will make use of an ADCP (for flow velocity's and turbidity), and a profiler with OBS (turbidity), temperature and EC (conductivity) to check the tidal inflow of water in relation to the turbidity in the water column.

Goal 3) the nourishing impact on the river bank

The reallocation will be carried out with the hopper, the Ecodelta. The Ecodelta has a capacity of 5.500 m^3 per trip and a draft depth of 7.35 meter. This results in a reallocation within the main channel, while the river bank target Green Port area is on average only 5- 6 meters in depth. The nourishment of the river bank has to come from the trapping of suspended sediments.

Figuur 3 Channel profile at the reallocation site

Figuur 4 Target nourishment site

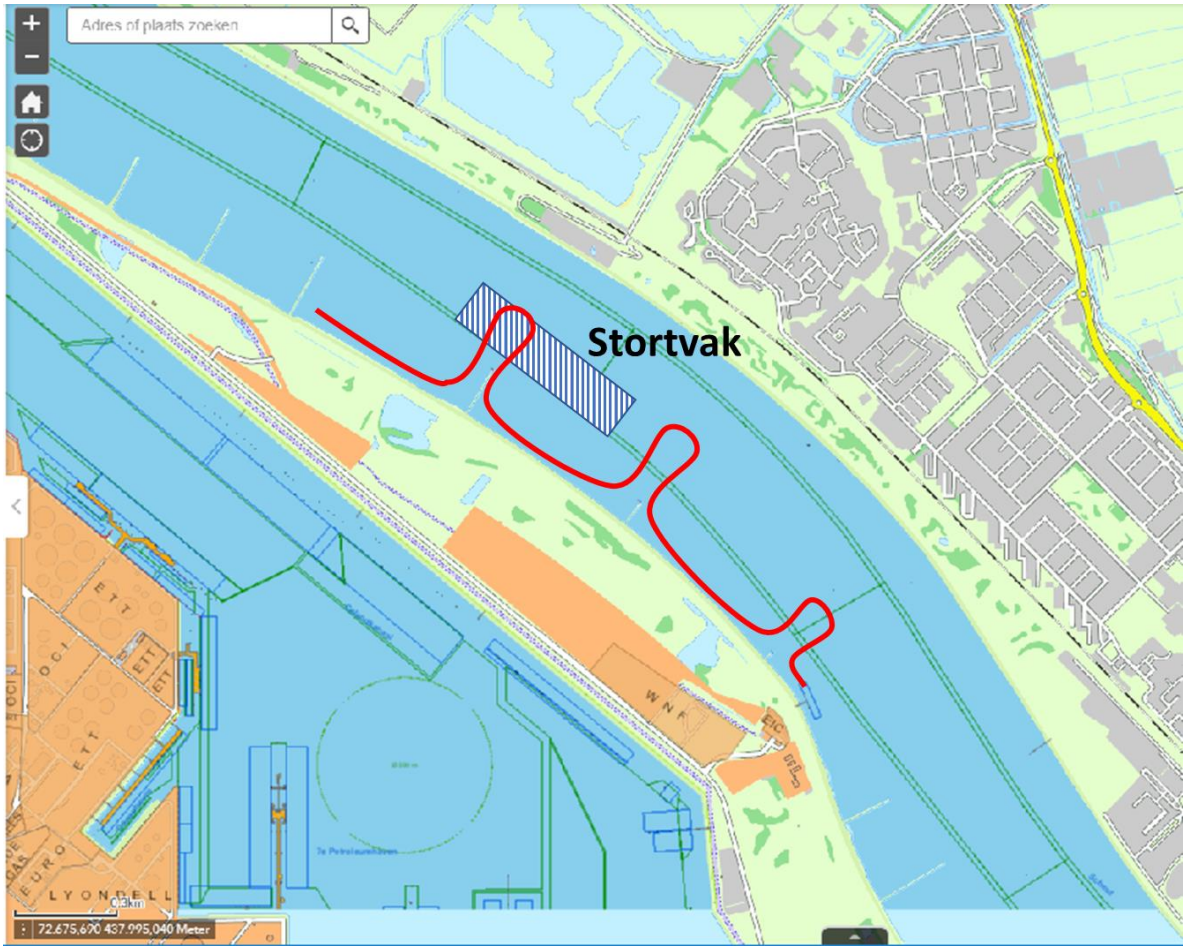


Figuur 5 Channel profile at target site, reallocation can only take place in the main channel

To validate the impact of the sediment reallocation on the Green Port river banks Deltares will install optical fibers (see explanation (in Dutch)):

Optical fiber 1: 1 km long passive cable

The cable will be installed between km 1021 (Ponton) and km 1022.



Figuur 6 Optical cable

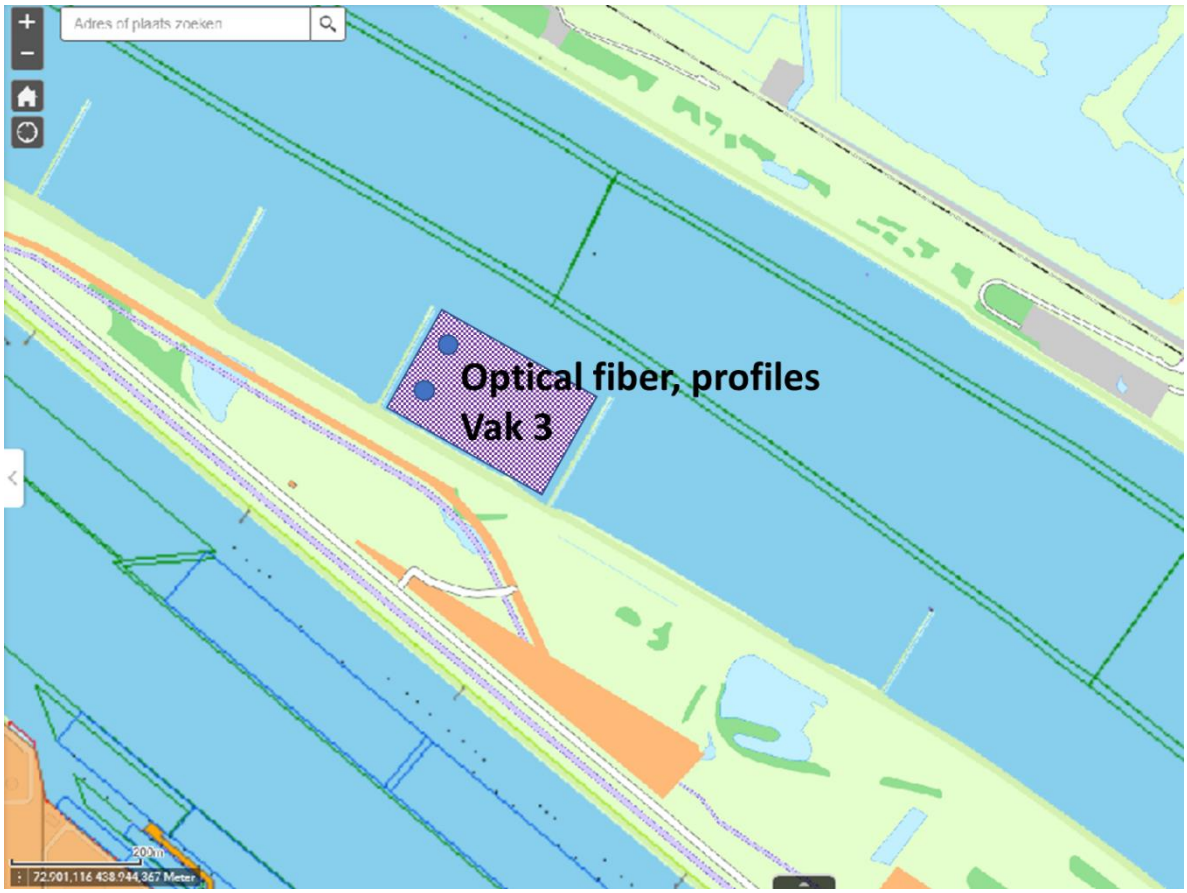
The installation will be done following the -6 m line along the river bank and cribs, with 3 extra loops into the central part of the channel (-16 m).

The installation and removal of the cable will be coordinated with the harbor authorities.

The cable will be implemented before 16-04-2019 (start reallocation) and be in place for a period of at least 4 weeks.

Optical fiber 2: vertical pole with active heating

Two vertical poles will be installed in the Green Port area (vak 3)

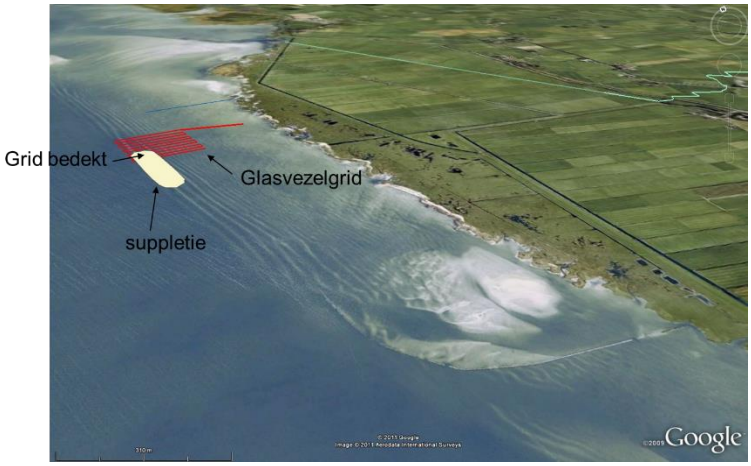


Figuur 7 Vertical cable in vak 3

Toelichting werking optische kabel (in Dutch)

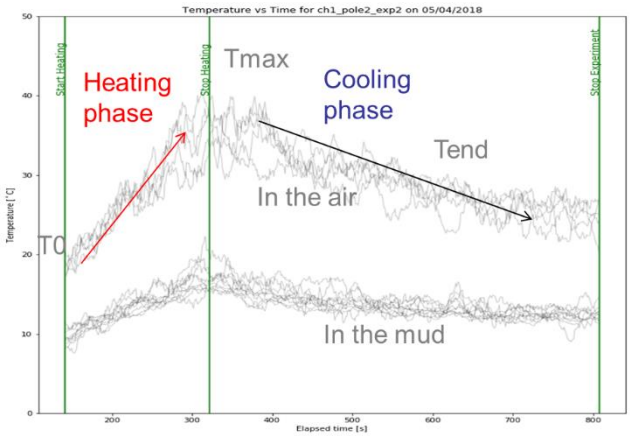
Passief

De mogelijkheid bestaat om de erosie/depositie van de suppletie te volgen, door de actieve glasvezelkabel onder de suppletie aan te leggen. Met deze glasvezelkabel wordt over de gehele lengte van de kabel nauwkeurig en continue de temperatuur geregistreerd. In de waterkolom is er sprake van een dag-nacht ritme in de verticale temperatuur verdeling, de mate waarop deze geregistreerd wordt is afhankelijke van de bedekking van de kabel met gesuppleerd materiaal. Daar waar de kabel diep begraven is dit ritme niet herkenbaar daar waar de bedekking dun is wordt het ritme waargenomen. De hypothese waarbij hier wordt uitgegaan is het bestaan van en relatie dus de mate van registratie van het dag-nacht temperatuur ritme en de dikte van de afdekkende sediment laag. Deze hypothese is reeds getoetst in een gebied met een zandige waterbodem. De temperatuur data kunnen kan daarom dienen als een proxy voor erosie en depositie. De metingen worden continue uitgevoerd en de data wordt automatisch verwerkt, het is niet meer nodig om 'meetrondes' te doen of om de data handmatig uit te werken.

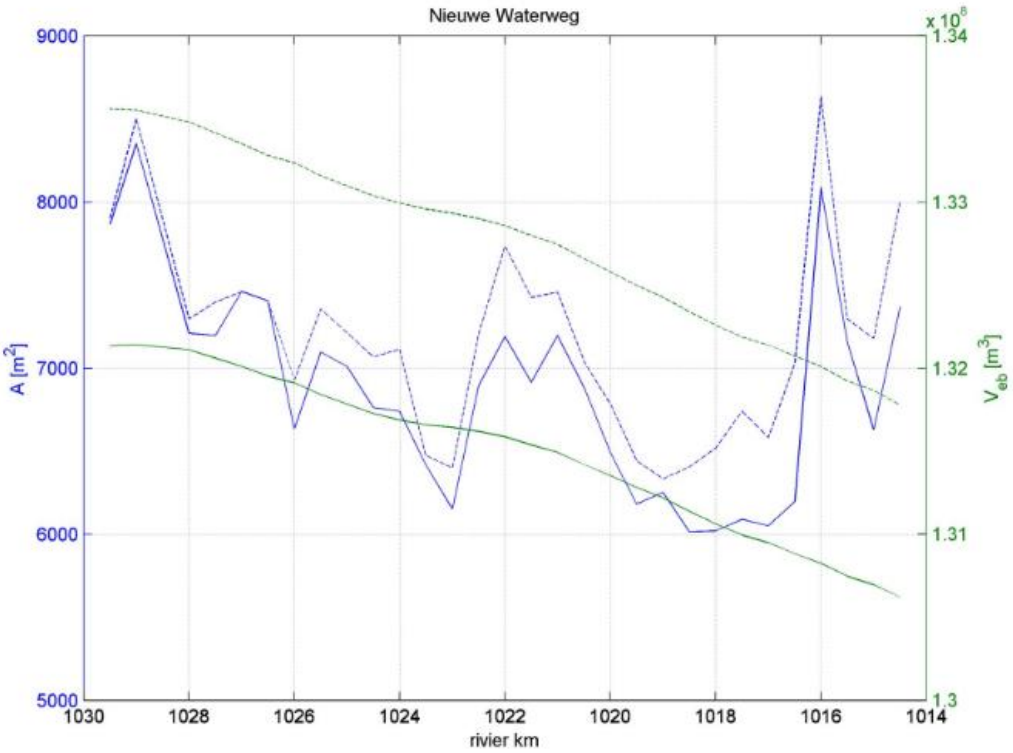


Actief

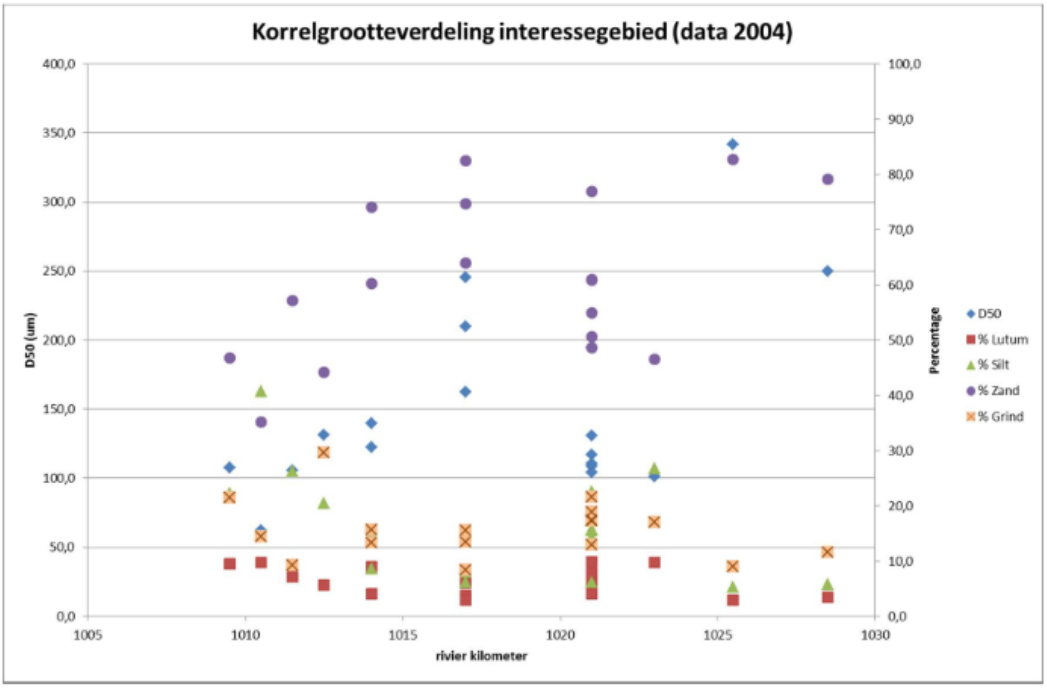
Met een ADTS meting (Active Distibruted Temperature Sensing) wordt er naast het natuurlijk ritme de kabel actief ritmisch verwarmd. De mate van afkoeling van de kabel is afhankelijk van de samenstelling en de porositeit van het afdekkende sediment en mogelijk de dikte van het sediment.



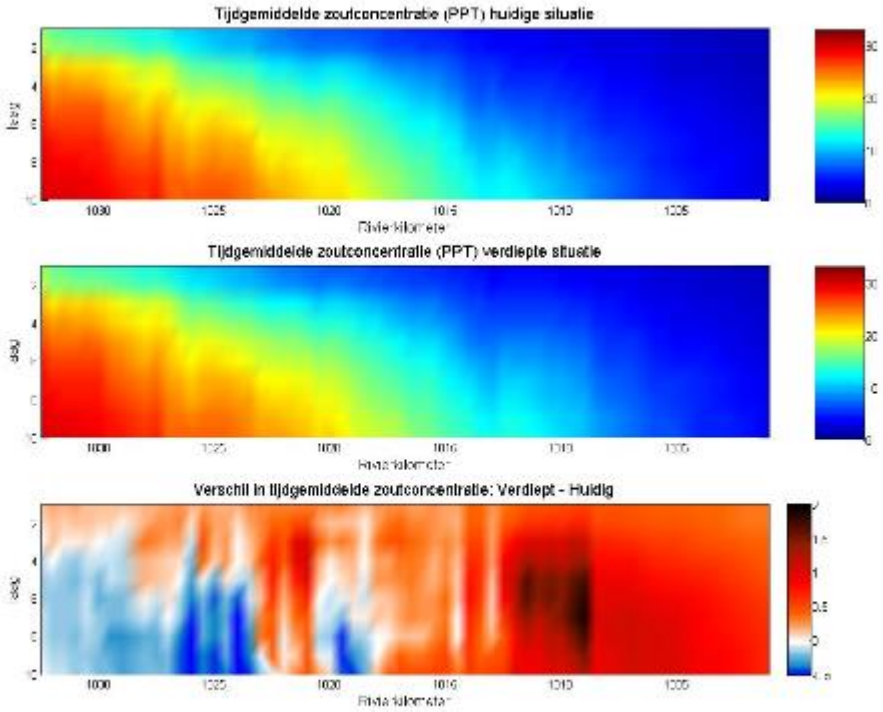
Appendix, supportive data



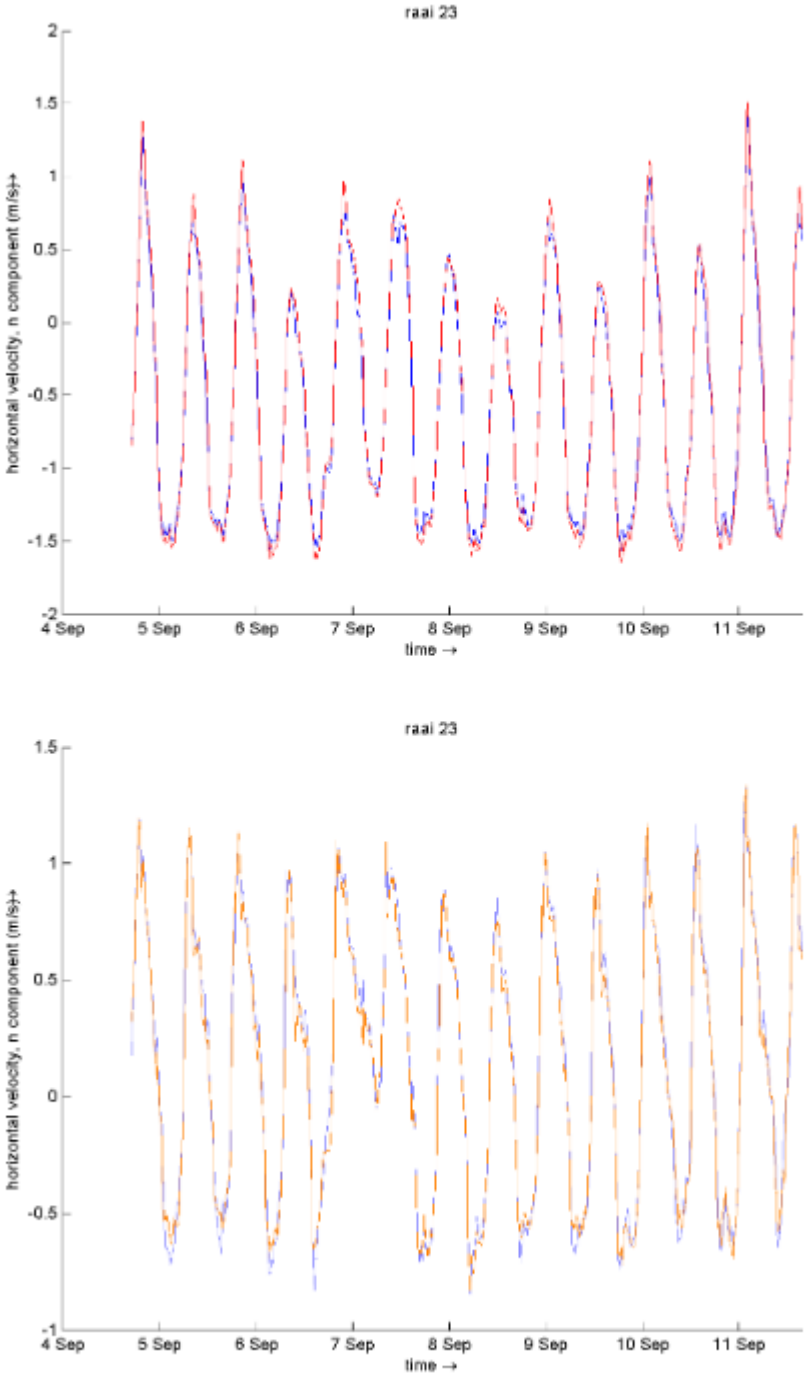
Figuur 4.9 Doorstroomoppervlakte en ebvolume van Nieuwe Waterweg met (gestippelde lijn) en zonder (getrokken lijn) verdieping.



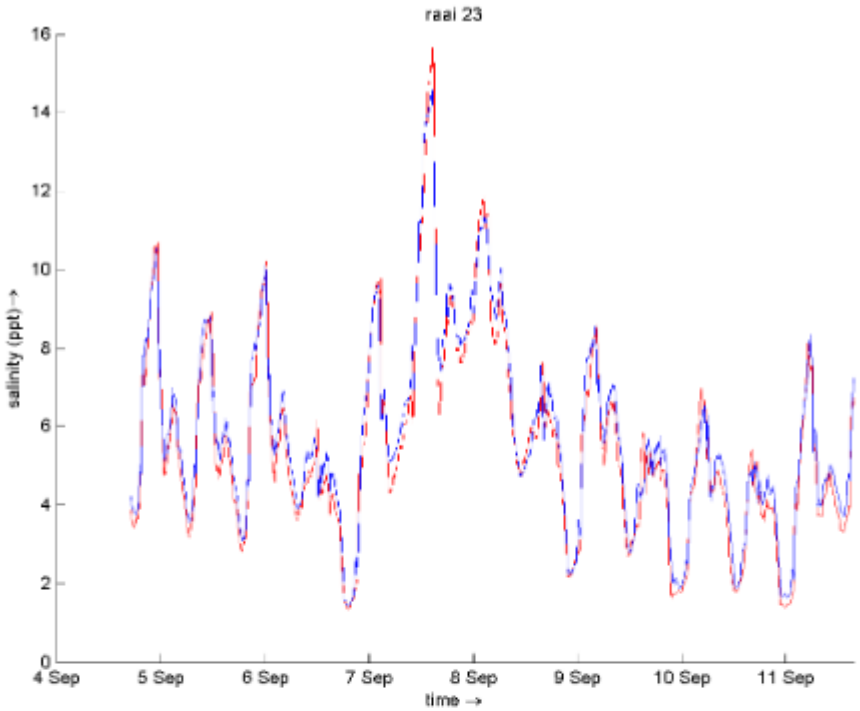
Figuur 5.3 Sedimentsamenstelling Nieuwe Waterweg en stukje van de Oude Maas op basis van data uit het rapport "Kwaliteit Onderhoudsbaggerspecie" (Wensveen 2004). De D50 is weergegeven in blauw, met de linker-as als bijbehorende as. Op de rechter-as staan de percentages voor de sedimentfracties grind(gele symbolen, >2 mm), zand (paars, tussen 64 µm en 2 mm), silt (groen, tussen 2 en 64 µm) en lutum (rood, < 2 µm).

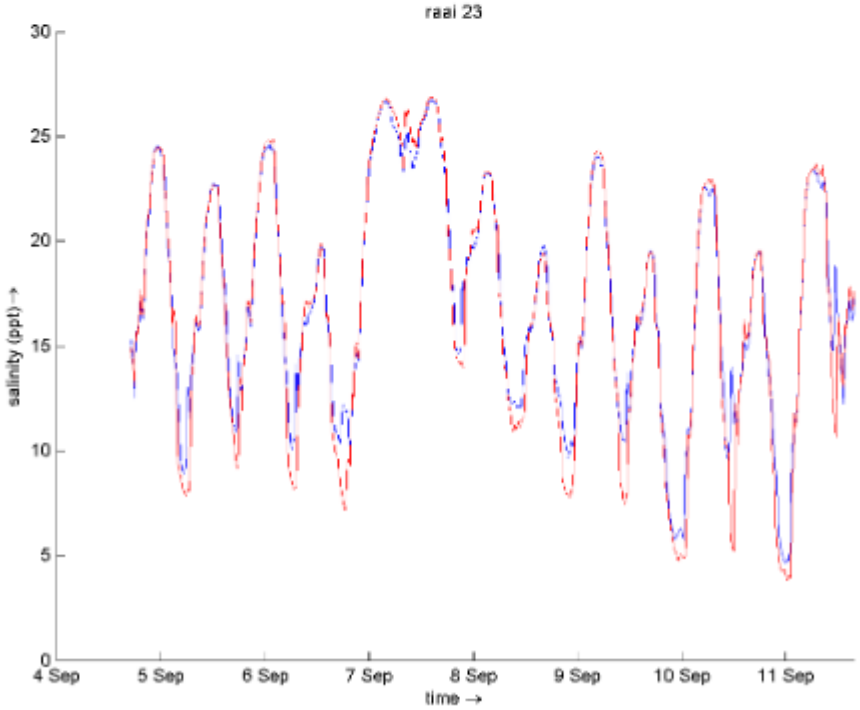


Figuur 6.2: Tijdgemiddelde saliniteit in de Nieuwe Waterweg met en zonder verdieping.

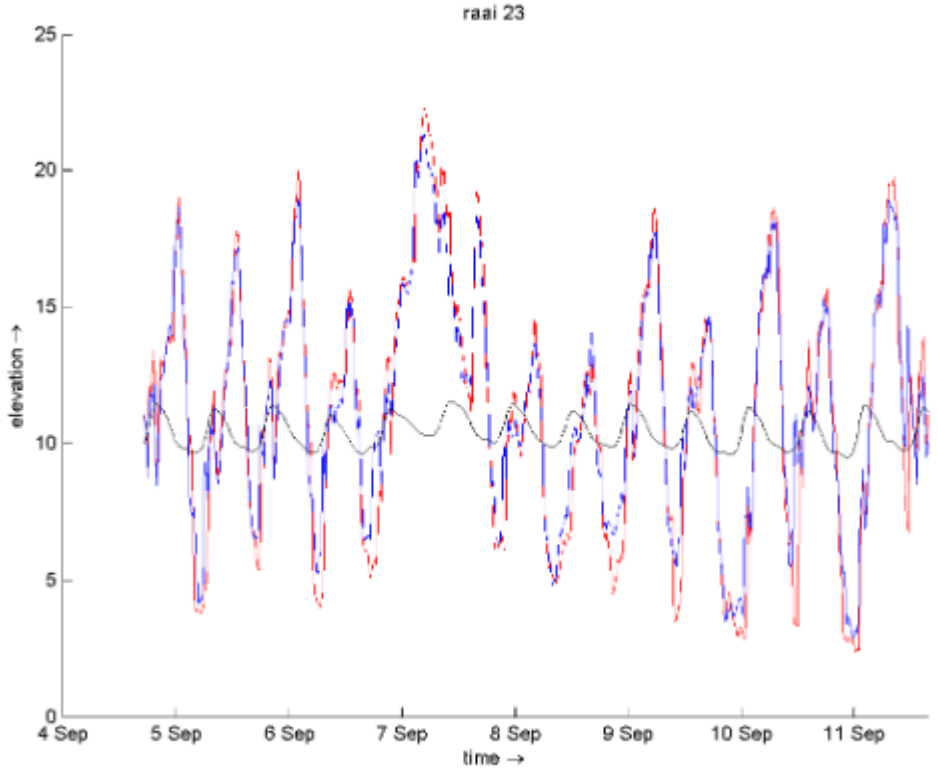


Figuur 6.5. Snelheid boven- en onderin de vaargeul met (blauw) en zonder (rood) verdieping ter hoogte van de Botlekhaven. Bovenzijde = bij oppervlak; onderzijde = bij bodem.





Figuur 6.6. Saliniteit boven- en onderin de vaargeul met (blauw) en zonder (rood) verdieping ter hoogte van de Botlekhaven. Bovenzijde = bij oppervlak; onderzijde = bij bodem.



Figuur 6.7. Saliniteitsverschil bodem – oppervlak in de vaargeul ter hoogte van de Botlekhaven. Rood = huidige bodem, blauw = met verdieping.