

Use of tracer particles - a new technique to monitor and quantify transport of contaminated sediments

Jens Laugesen and Thomas Mørskeland, Det Norske Veritas
8 October 2009

Introduction

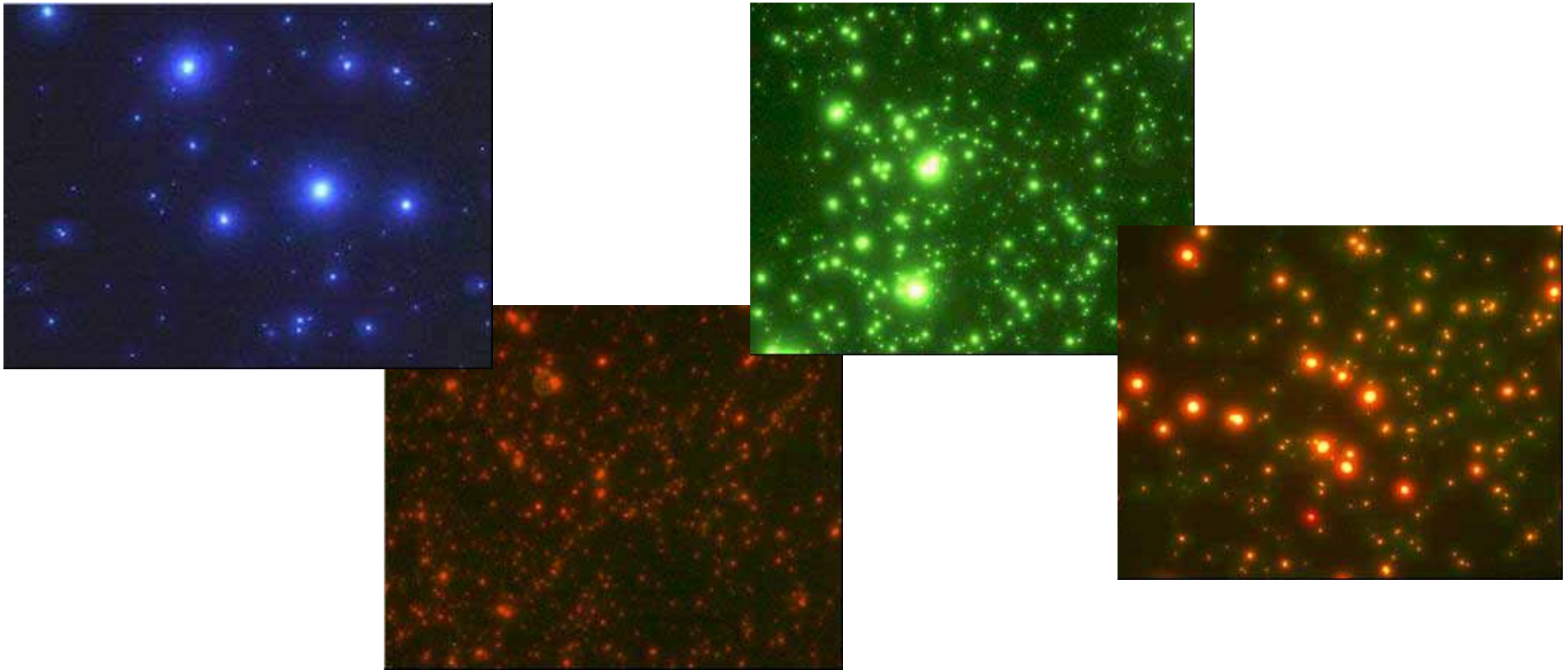
- How do we measure/quantify and describe how sediments are spreading in estuaries and coastal areas?
 - In many cases, the sediments are contaminated and the spreading pattern of the sediment particles will give information about how and where the contamination is spread.



Sediment in the Raglan estuary, south of Auckland in New Zealand, following a January storm. (Photo: Sandy Elliott, NIWA)

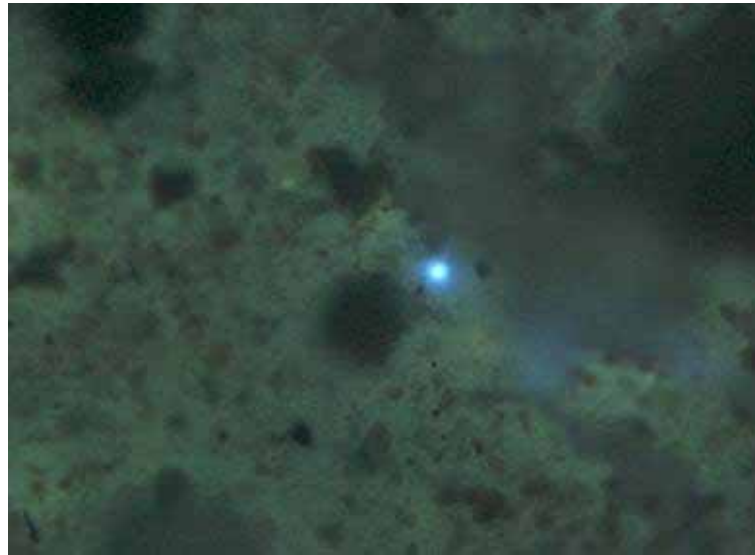
Tracing the sediments

- It is difficult to tag sediment particles in a way that they can be traced directly.
- An indirect method is to use fluorescent tracer particles with the same properties as the local sediment.



Characteristic properties of fluorescent tracer particles

- Tracer particles are manufactured to mimic the size, density and surface charge of the target species for a wide variety of applications.
- Tracer particles are non-toxic and environmental friendly



A 5 μm fluorescent tracer particle at $\times 20$ magnification in sediment.

Size of tracer particles

- The particle size is adjusted to the size of sediment particles you want to study
- This is mostly fine sediment particles with a diameter equivalent to fine silt and clay particles



Example illustrating the size of tracer particles: if a sand particle would have the size of a football, a tracer particle (fine silt/clay) would have the size of a marble.

How are the tracer particles placed on the seafloor?

- The tracer particles can be placed on the seafloor either in soluble bags, in frozen state or pumped as slurry to avoid any spreading (cross-contamination).



Tracer particles in soluble bags



Frozen tracer particles

Example 1: Study of confined disposal facility for contaminated sediments in Trondheim, Norway

- Tracer particles were added in a CDF with 80 000 m³ capacity in 2005 and 2007 in the Trondheim harbour.
- In 2005 blue tracer particles were added.
- In 2007, violet, orange and yellow tracer particles were added to make it possible to study from which part of the CDF particles were spread to the sea and the sediments.



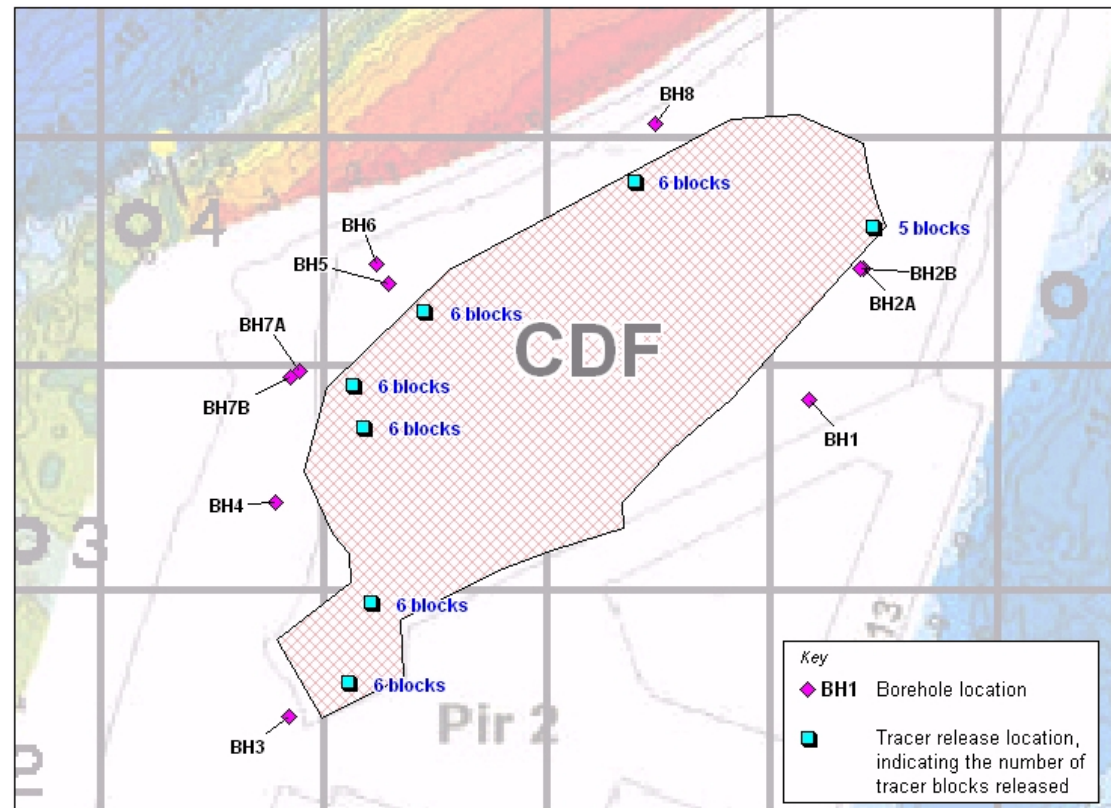
Use of tracer particles - a new technique to monitor and quantify transport of contaminated sediments
8 October 2009

© Det Norske Veritas AS. All rights reserved.

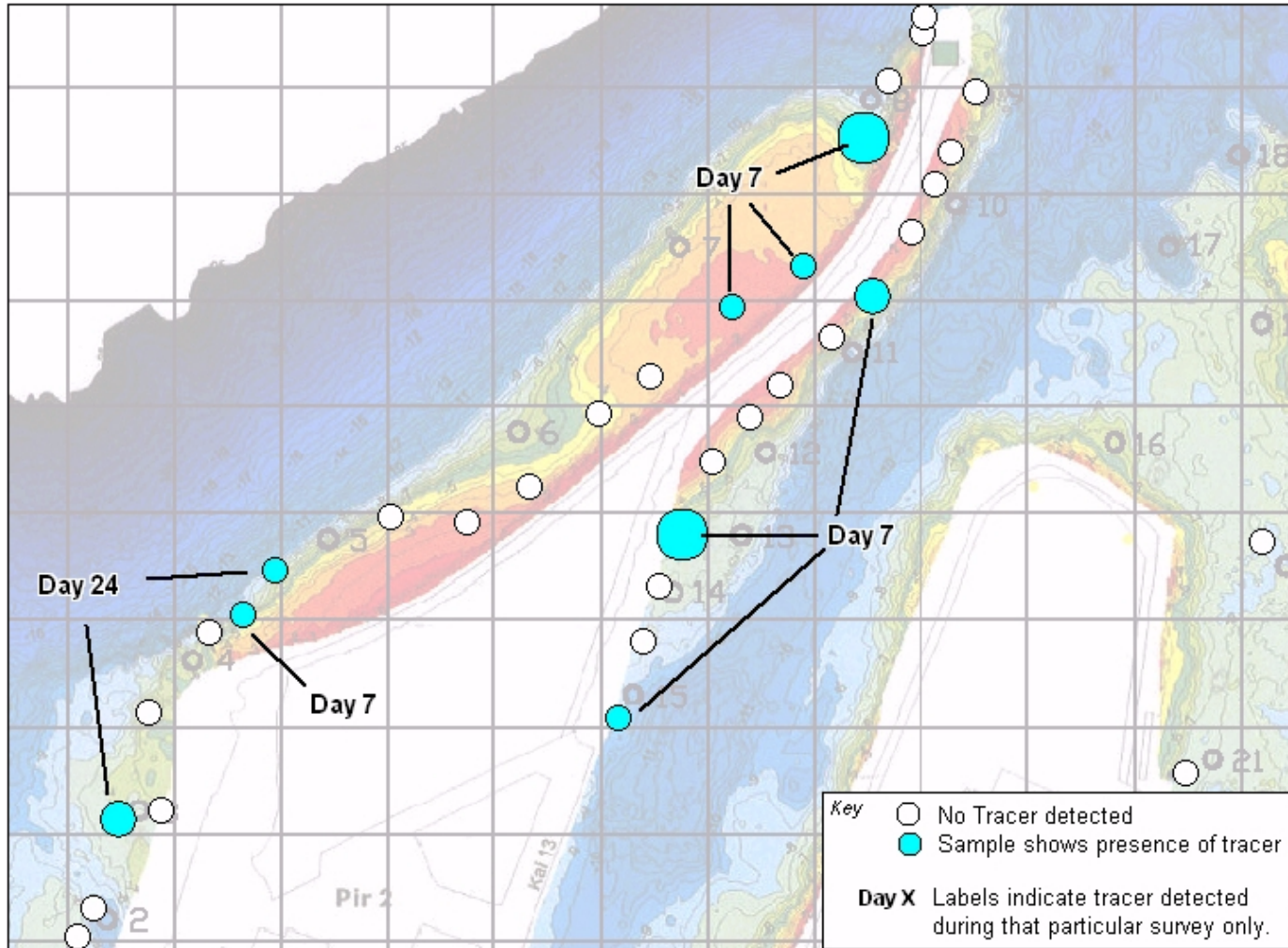
Trondheim: Adding blue tracer in 2005



The blocks of tracers were placed in dug holes in the CDF



Trondheim: Results from blue tracer added in 2005

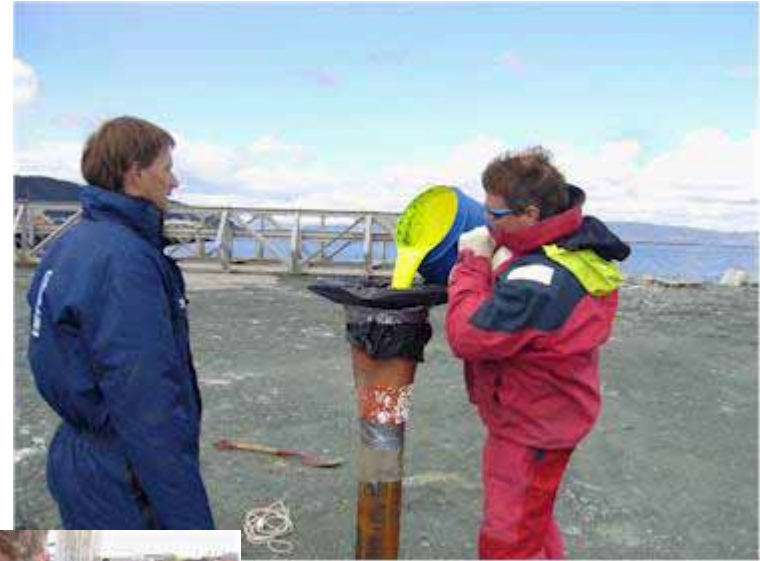


Tracer particle sampling after day 1, 7, 24 and 58 after the tracer was placed.

No tracer found in sediment samples on day 1 and 58.

There were 36 sampling stations.

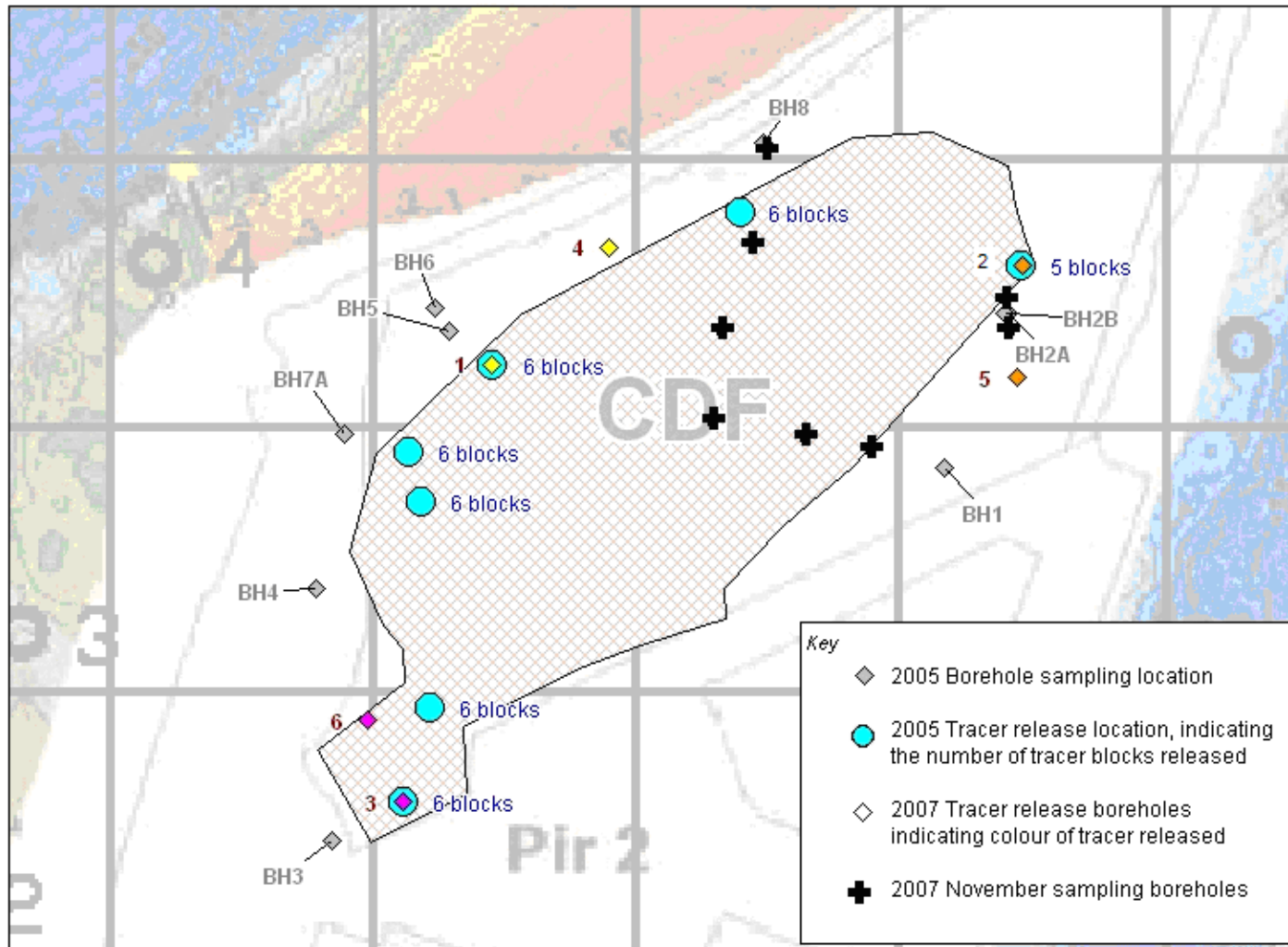
Trondheim: Adding violet, orange and yellow tracer in 2007



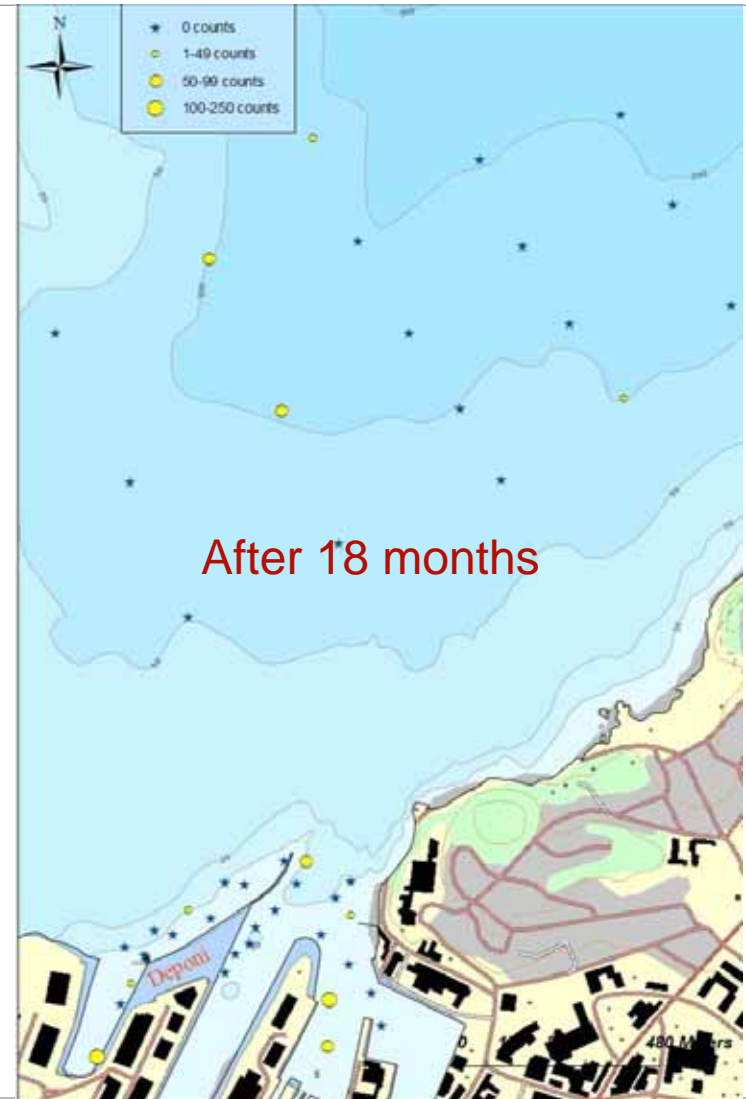
Use of tracer particles - a new technique to monitor and quantify transport of contaminated sediments
8 October 2009

© Det Norske Veritas AS. All rights reserved.

Trondheim: Locations where tracer was added in 2007



Trondheim: Results from yellow tracer added in 2007

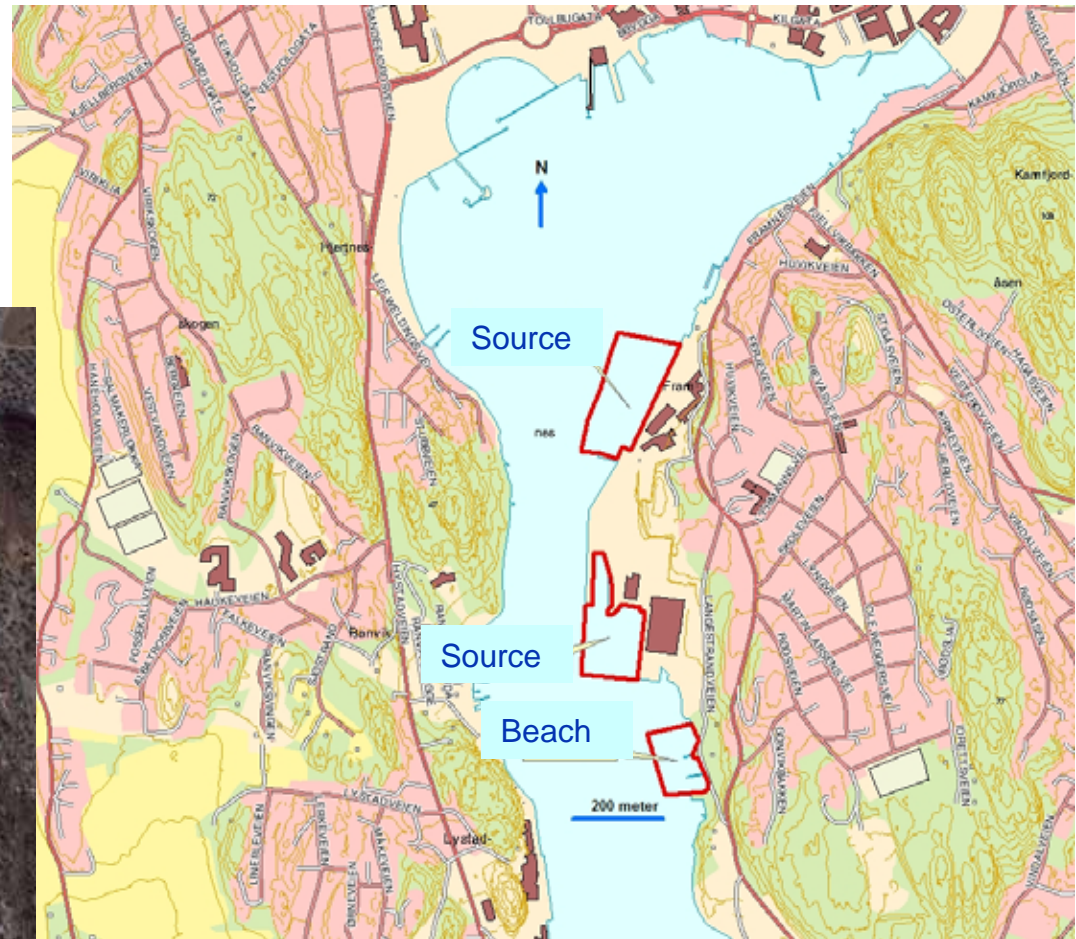


Use of tracer particles - a new technique to monitor and quantify transport of contaminated sediments
8 October 2009

© Det Norske Veritas AS. All rights reserved.

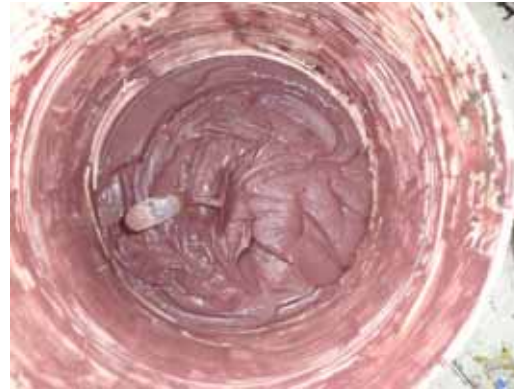
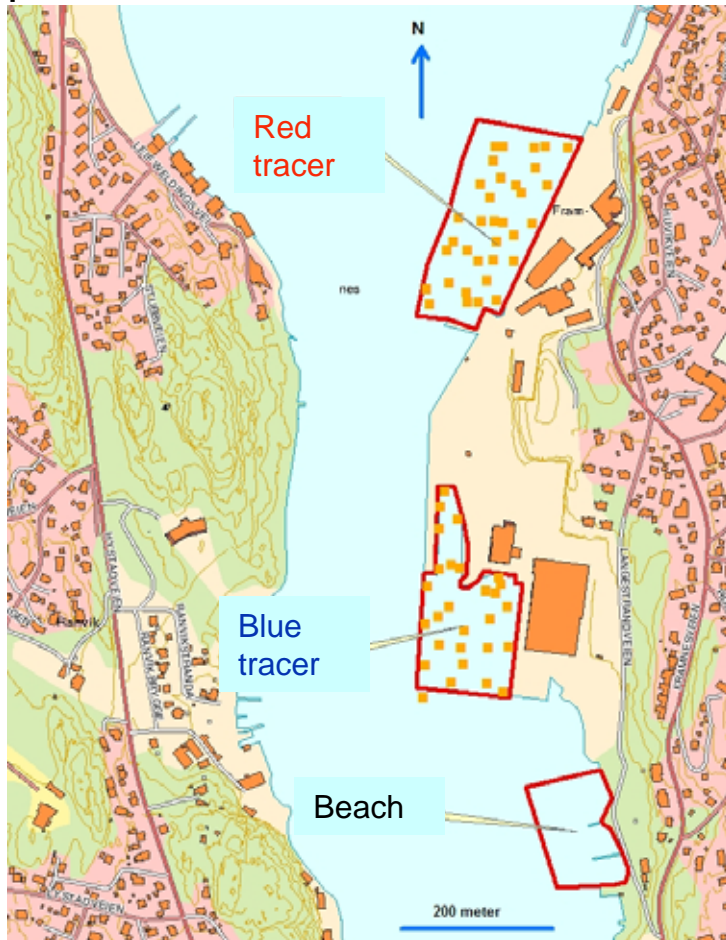
Example 2: Study of spreading of contaminated sediments from two locations in the inner Sandefjord fjord, Norway

- In the inner Sandefjord fjord there are two locations (sources) with contaminated sediments which have potential for spreading to a nearby beach and the fjord in general.



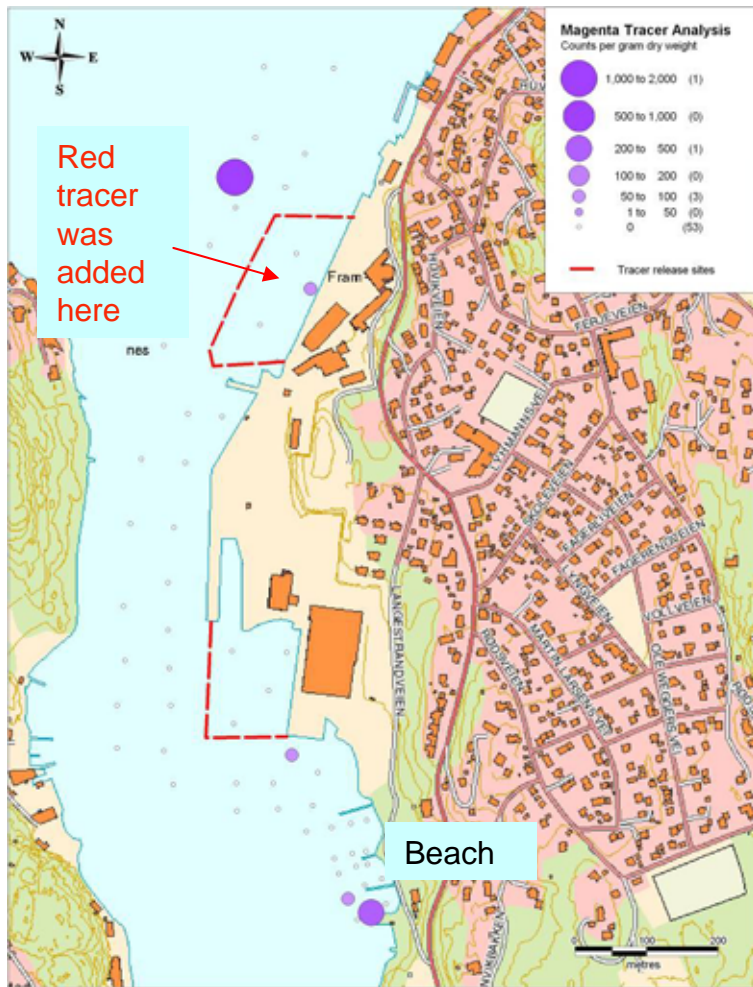
Sandefjord: Placement of the tracer particles

- A blue tracer was placed in the sediments in the first location and a red tracer was placed in the second location.

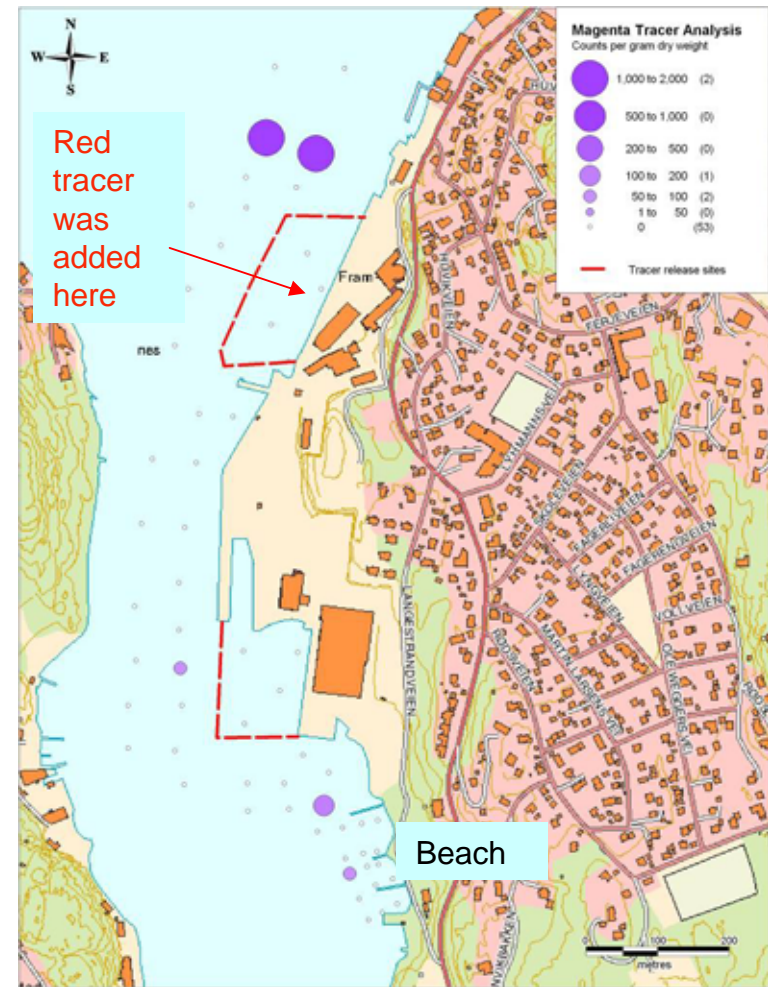


The tracer was placed in soluble bags

Sandefjord: Findings of red tracer particles



45 days after red tracer was added

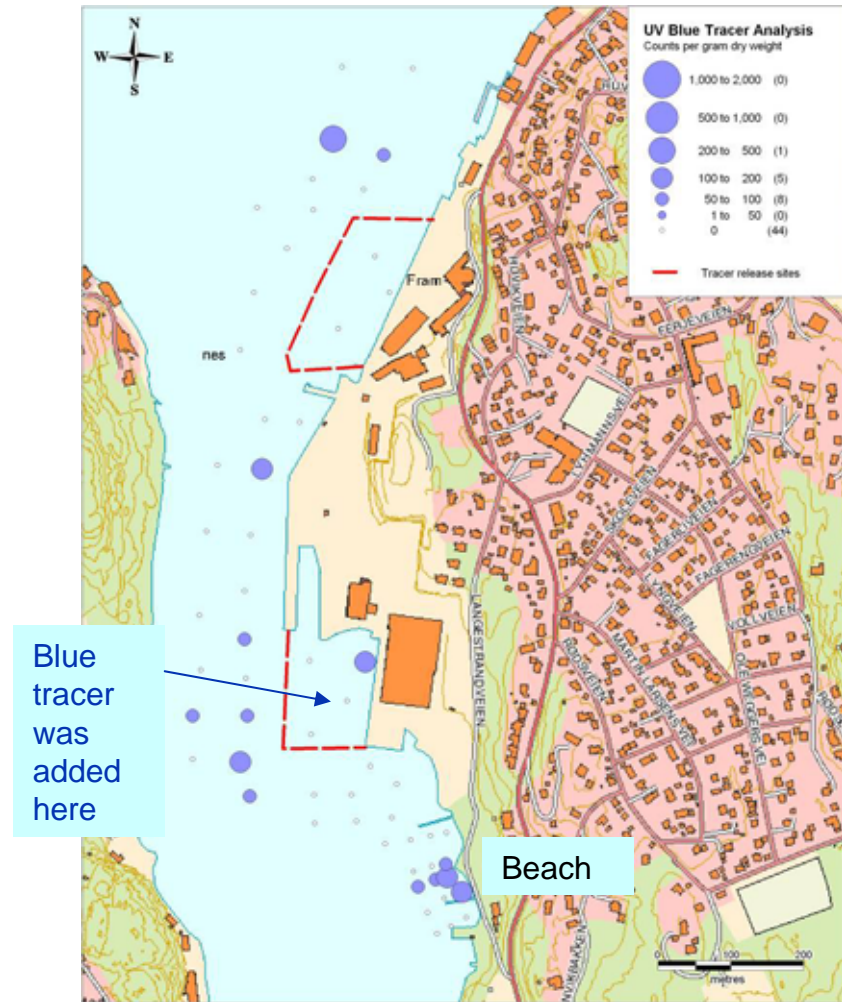


73 days after red tracer was added

Sandefjord: Findings of blue tracer particles



45 days after blue tracer was added



73 days after blue tracer was added

Conclusions

- Both in Trondheim and Sandefjord it was possible to count and register tracer particles in the sediments.
- In Trondheim, the amount of tracer particles found was low, indicating that the amount of contaminants leaking from the CDF was low.
- In Sandefjord, low amounts of tracer particles were registered in the sediments at the beach area. This indicated that small amounts of contaminants were spread from the two locations to the beach area.

Conclusions

- Tracer particle study is a promising technology to monitor and quantify the spreading of contaminants and a useful tool to verify sediment transport modelling.
- The method needs however a large amount of sediment samples which have to be analysed for tracer particles to be able to give good results.
- Methods to quantify the spreading of contaminants with tracer particles need to be further refined.

Thank you for your attention!



Safeguarding life, property and the environment

www.dnv.com



MANAGING RISK