Presentation of a Memorandum to the BAPE.

Capping of contaminated sediments at Clark Island, Quebec – views, comments and suggestions.

Presentation of the author of the Memorandum.

Dr. Jens Skei is a research manager at Norwegian Institute of Water Research (NIVA), Oslo, Norway. NIVA is a semi-governmental research institute (foundation) which do basic research related to environmental water quality as well as contract work for industry, agencies, local governments etc. Dr. Jens Skei is an environmental geochemist and has worked with contaminated sediments for 30 years. He has been involved in several clean up projects in estuaries and harbors in Norway and abroad. He was one of the key persons related to the clean up project in Odda, Norway where about 90.000 m^2 of sediment was capped with a geotextile and about 0.5 m with clean sand. Jens Skei has been involved in design of monitoring programmes and experimental work to document the efficiency of capping.

Jens Skei was present at the first Public Hearing at Valleyfield, Quebec in April as an advisor for Honeywell.

General interest of remediation of contaminated sediments and the Clark Island project in particular.

Sediments are considered both as a sink and a source of contaminants. This implies that sediments may act as a secondary source of pollution. In cases where sediments are imposing a potential environmental problem, remediation may be necessary to minimize or eliminate the problem.

If contaminated sediments are present in shallow water they are exposed to wind and waves and resuspension may take place. Resuspension may cause two problems:

- Contaminated particles are redistributed and transported from contaminated sites to uncontaminated sites
- During resuspension contaminants may be mobilized and transformed from particulate form to dissolved form to become more bioavailable

To minimize the negative effect of contaminated sediments at shallow depths two remediation principles are available:

1. Removal of the contaminated sediments (dredging) and disposal (under water or on land).
2. In situ capping of the contaminated sediment to avoid resuspension and contact between benthic organisms and the contaminated sediment and to minimize release of contaminants (diffusion or advection of contaminated pore water).

The choice of remediation should be based on site specific considerations. In global terms it should be emphasized that the surface of the earth is covered by 70% water and 30% land. Disposal of waste on land should therefore be avoided if other and better alternatives exist.

Remediation of contaminated sediments are generally expensive and cost-benefit analyses should be mandatory. With the present technology available no remedial action is 100% ideal. All techniques have some shortcomings. Choice of remedy should be carefully selected and risk

assessments should be carried out to make sure that remedies are not having a negative environmental effect. If the risk of failure is high it should be considered if the damage would be permanent or if the damage is repairable, if failure occurs.

There is a general feeling world wide among environmental scientists to consider dredging to solve an environmental problem as a negative cost-benefit solution. The high costs do not match the environmental benefits and risks related to the dredging activities, both with the respect to the dredging itself and particularly to the disposal of the dredged material. However, if dredging is necessary due to navigational purposes no other alternatives are available.

Even if sediments may be considered both as a sink and a source of contaminants, it is well documented that it is mainly a sink. This is due to the facts that most contaminants are associated with particles. If not they would not be a part of the sediments. As a consequence the contaminants are normally tightly bound in the sediments. If the contaminated sediments are not physically disturbed, the contaminants generally stay in place in the sediments. Diffusion of contaminants out of the sediment is a very slow process and will normally not impose an environmental threat. This implies that contaminated sediments at water depths beyond the level where physical disturbances normally takes place should not be of much environmental concern.

Heavily contaminated sediments at shallow depth normally exist close to point sources. These hot spot sediments are in many cases characterized as solid waste rather than contaminated sediments. The potential risks related to this material depends on the origin of the waste and the speciation of the contaminants.

Capping of Eitrheim bay, Odda, Norway.

Near a zinc plant in a Norwegian fjord large amounts of residues containing high levels of trace metals (mercury, lead, zinc, cadmium, copper a.o.) where placed on shore and on the bottom of a shallow bay (< 10 m depth) since the zinc production started in 1929. Due to elevated levels of trace metals in shellfish and fish from the area as well as discoloring of the water during windy conditions (resuspension of red industrial waste) alternative remedies were considered, including dredging and on land disposal.

A one year research project was initiated to study the efficiency of capping the contaminated sediment with different types of cap material with a thickness of 50 cm at an experimental research station run by Norwegian Institute for Water Research. Fine grained material (sand and different types of industrial waste products) were tested to measure potential release of trace metals through the cap. The conclusions were convincing. Regardless of the type of cap material used, more than 90% of the release of trace metals from sediments not being capped was eliminated. This was considered sufficient to approve a situ capping project, using a geotextile to keep the contaminated sediment in place and to cover the textile with 50 cm of sand to allow development of a natural benthic community. The clean up project was finalized in 1992 and a monitoring programme has been running ever since to document the efficiency of the capping. The argument for selecting a 90.000 m^2 area for capping was that this zone represented the shallow part which was subject to resuspension. The sediments outside this zone were also heavily contaminated, but due to their presence at greater depths (> 10m) they were considered as representing a less environmental risk. Additionally, at greater depths natural accumulation of sediments take place and the sediment quality will gradually improve.

The results from the monitoring agree with the experimental results, but accidental spills of contaminated waste water from the zinc plant has slowed down the general improvement of the water quality in the area.

The Clark Island capping project.

There are a lot of similarities between the Eitrheim bay capping project and the Clark Island project. The main difference is that the waste material in the Eitrheim bay is very chemically reactive and mobile. The waste material at Clark Island has been going through a high temperature process and the trace metals in the cinders are expected to be very inert and basically immobile. This implies that the trace metals in these sediments are not expected to be very bioavailable. Consequently, the environmental problem is to a large extent an esthetical problem. There is no evidence that the pyrite cinders cause elevated levels of trace metals in fish and mussels and have an impact on human health (i.e. drinking water, exposure etc.). It is unlikely that the Clark Island case would have been considered as a high priority site with respect to clean up if it was situated in Norway.

The main argument for capping in zone A is to restore a bottom habitat which at present is an artificial substrate not suitable for bottom life. If zone A was dredged down to - 1m there would be an infill of sediments from the surroundings. These sediments are also contaminated, partly due to the activities on Clark Island and partly due to the general situation of contamination in the St Lawrence (particularly mercury). Therefore, the sediment quality in zone A would not be all that improved by dredging and it would certainly not be cost-efficient.

Overall conclusions regarding Clark Island remediation project.

Based on available reports and discussions during the first part of the public hearing my overall evaluation of the proposed capping project at Clark Island is a follows:

- A capping with geotextile and coarse gravel in the shallow zone A of Clark Island is environmental acceptable to solve the problem with discoloring of the water by pyrite cinders and to avoid benthic organism to be exposed to contaminated sediments.
- To obtain the full effect of capping I would recommend that the cap material used also contain a finer fraction than gravel to facilitate adsorbtion of dissolved metals diffusing or being advected through the geotextile onto particles. The objective of caps are also to act as a chemical buffer between the contaminated sediment and the overlaying water.

Information about the respondent

Name. Dr. Jens Skei
Affiliation: Norwegian Institute for Water Research (NIVA)
Address: P.B.173, Kjelsaas, N-0411 Oslo, Norway
Phone: 47 22 18 51 67
Fax: 47 22 18 52 00
e-mail: jens.skei@niva.no