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HAAKONSVERN NAVAL BASE, BERGEN-NORWAY  
POLLUTION PREVENTION OF PCB-CONTAMINATION IN SEA SEDIMENTS

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## ABSTRACT

In this paper the prevention of PCB-contamination in sea sediments at the Haakonsvern Naval Base in Bergen, Norway is discussed.

## INTRODUCTION

Norway's largest naval base, Haakonsvern, is situated near the city of Bergen in Western Norway. In 1992, about 30 years after the base was constructed, environmental investigations indicated that the soil at some locations at the base was contaminated with PCB (polychlorinated biphenyls). The following investigations also showed that the sea sediments around the base are contaminated with PCB. In addition to PCB the soil and sediments also are contaminated with PAH (polycyclic aromatic hydrocarbons) and heavy metals, but the main and most severe pollution is caused by PCB. The concentration of PCB in fish and shellfish in the area is so high that the food control authorities have imposed a ban on consumption. The registration of contaminants in the sea is well documented by surveys, between 1992 and 1998 more than 500 sediment samples from around the naval base have been analysed. Also fish and shellfish has been sampled several times from different locations.

After the detailed survey of the distribution of the PCB-contaminated soil and sediments, the Norwegian Defence Construction Service have forwarded a pollution prevention plan containing two main measures:

1. Prevention of further leakage of PCB from contaminated soil on areas at land into the sea and remediation of the most severely polluted soil.
2. Prevention of further spreading of PCB from the contaminated sediments to sea organisms such as fish and shellfish with the aim to remove the ban on consumption of sea organisms after a long time period.

## MEASURE 1: PREVENTION OF FURTHER LEAKAGE OF PCB INTO THE SEA

The first site at the base, identified as contaminated with PCB, was above the fire fighting training field where waste oil was burned. It is likely that attempts to burn PCB-oil had been made at this site. Later an additional site was found at the small boat quay. At both sites it was decided to remove the PCB-polluted soil. At the base the environmental authorities allow a maximum concentration of 1 mg PCB/kg dry soil.

The most severe PCB-pollution on land was found when drainage pipes and sewage pipes were inspected. Analyses of the mud in the pipes, registered concentrations up to 5 mg PCB/kg dry matter. The PCB found is probably only remnants of larger amounts of PCB, which already has leaked into the sea. A detailed survey of the drainage pipes and sewage pipes at the naval base showed that many of them have their outlet to the sea. The preventive action to avoid further leakage of PCB into the sea was to clean all the drainage pipes and sewage pipes with the aid of a vacuum-cleaning truck. The source of the PCB in the pipes not known, due to the large amount of workshops on the base.

Measure 1 is now almost finished and the actions, which have been taken, should assure that there is no more PCB leakage into the sea.

## MEASURE 2: PREVENTION OF SPREADING OF PCB-CONTAMINATED SEDIMENTS

Prevention of spreading of PCB-contaminated sediments at a naval base is quite a difficult task. Heavy vessels and submarine traffic causes sediment particles to go in suspension. At the Haakonsværn Naval Base there is also a diving school where underwater blasting is one of the exercises. This exercise is now mowed outside of the base due to the contamination in the sediments.

Two alternatives were studied for preventing the spreading of PCB-contaminants:

1. Covering the contaminated sediments in situ with a geotextile, and finished off with 40-60 cm clean sand.
2. Removing the contaminated sediments by dredging followed by placement in two depot basins.

It was decided to choose alternative 2 where the sediments were removed from the sea floor. Alternative 1 was not chosen because this implied imposing restrictions on anchoring, blasting etc. In addition the cost of implementing both alternatives was at the same level for shallow waters, but for deeper waters the analyses concluded with that covering the sediments was going to be very difficult and expensive.

The areas, which are going to be dredged, have water depths between 5 m and 65 m. Due to the many technological challenges it was decided to dredge in two phases. Phase 1, where about 10 % of the contaminated sea floor was dredged was performed in 1998. About 25.000 m<sup>2</sup> sea floor was dredged and about 4.000 m<sup>3</sup> contaminated sediments were removed. These were pumped into the nearby depot basins constructed for this purpose (see figure 1). There was no dewatering of dredged material, the depot basins are constructed in such a way that the clean water was channelled back to the sea through the dam filter, the contaminated sediment particles remaining in the depot basins.

The result of the dredging in phase 1 was that the average PCB-concentration in the sediments was reduced by 91 % from 0,813 mg/kg dry matter to 0,076 mg/kg dry matter. The target, to reduce the PCB-concentration with 85 %, was thereby exceeded. The cleanup limit for the contaminated sediments which have to be removed is set to 0,1 mg PCB/kg dry matter. The highest value of PCB registered in the sediments is 6,7 mg PCB/kg dry matter.

Encouraged by the success in phase 1 the even more challenging phase 2 is planned to start in August 1999. In phase 2 about 400.000 m<sup>2</sup> of the sea floor is going to be dredged in areas with water depths ranging down to 65 m. It is estimated that about 80.000 m<sup>3</sup> will be dredged. The sea depots have a total capacity of 100.000 m<sup>3</sup>. Phase 2 (dredging and placing the contaminated sediments in the depot basins) is estimated to finish in the beginning of 2001. It has been assumed that the ban on fish and shellfish consumption can be lifted in about 10 years after the operation has been completed. Ten years is the estimated lifetime of the contaminated fish in the area.

Concern has recently been raised if the aim to remove the consumption ban can be reached, as recent studies have shown that the fjord areas around the naval base are more polluted than was originally thought. If these areas are not also cleaned up, the fish population in the area will remain exposed to PCB-polluted sediments. These sediments are polluted by different civil activities. So far no plans have been introduced to clean up the sediments polluted by civil activities.

#### COST OF THE PREVENTIVE MEASURES

The cost of the preventive actions (Measure 1 and 2) is estimated to reach almost 120 million NOK (about 16 million US\$). About 90 % of the costs are related to Measure 2. The conclusion is that in a case like this, it is very important to implement preventive measures, which stop the leakage of the pollutant into the sea as early as possible.

## REFERENCES

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