

# Unexpected results from risk assessment of mercury-contaminated sediments at Tollare, Sweden

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**Introduction:** This paper describes the unexpected results from a risk assessment which was performed for mercury-contaminated sediments at Tollare, Sweden.

The decommissioned Tollare paper mill site is a brown-field intended for redevelopment with residential housing. Marine sediments in the area contain cellulose fibers, a discharge residue from the mill. From 1941 until it closed in 1964, the mill used phenyl mercury to control bacterial and fungal growth in its various processes, thereby contaminating the fibrous sediments.

When the redevelopment project was restarted shortly after 2000, it was noted that a comprehensive risk assessment had never been made. Instead, all concerned parties had simply assumed that the contamination posed a significant risk. A set of geochemical and ecotoxicological investigations was therefore performed in 2001-2002 [1]. These served as input to an evaluation of the spread of mercury [1], a wide-ranging assessment of environmental and health risks [2], and an appraisal of potential remedial actions [2, 3].

**Methods:** Investigations included sampling and chemical analysis at numerous stations throughout the affected area and nearby waters. Matrices studied included surface and deeper sediments, bay water from various depths, pore water, benthic fauna, fish and gases generated by sediment decomposition.

The human health risk assessment included residential, commercial and marine activities on land; residential construction above the water; docks and quays for small boats, and swimming in central locations. The environmental risk assessment encompassed marine organisms as well as terrestrial and semi-aquatic animals. It also included a brief review of potential remedial measures to address the problems identified during the investigative phase of the project.

**Results:** Sampling showed that surface sediments in the vicinity of the old mill were composed of organic material with some observable content of cellulose fibers, often underlain by pure fibrous sediment. The

fibrous sediments can at times produce large quantities of gas, mostly methane. Only small amounts of mercury are released in the gas phase. Mercury concentrations in surface sediments near the mill were significantly elevated. Most of the surface sediments exhibited some degree of ecotoxicity, while deeper sediments were not considered toxic.

The distribution of mercury concentrations in marine water and pore water indicated about ten times greater sorption to fibrous sediment than to sediment without fibers.

No living benthic fauna were observed at water depths exceeding 12 meters, within or outside the contaminated area. Elevated mercury levels were measured in both northern pike and perch.

Risk assessment showed that there was no risk for potential negative effects for humans. Although calculated exposures slightly exceeded the low-risk level for mink and most of the other terrestrial and semi-aquatic species studied, conservatively estimated uptakes were still significantly below LD<sub>50</sub> values.

**Discussion:** The most important, and unexpected, result of the study was that neither humans nor terrestrial and semi-aquatic species were significantly at risk due to the presence of mercury contaminated sediments in the bay. Instead, low levels of oxygen in combination with the presence of hydrogen sulphide in deeper waters were shown to negatively affect marine organisms, as demonstrated by the complete lack of benthic fauna in such areas. The mechanisms and data underlying these conclusions will be further developed and discussed in the paper.

Finally, it was concluded that although remediation was neither necessary nor feasible, and would be prohibitively expensive, the development project could not be implemented without some protective measures due to the potential for propwash erosion of the sediments. The project owner, NCC Construction, therefore decided to construct an erosion protection barrier along the shoreline near the old factory location [4]. This work is discussed in another paper [5].