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LEKKERKERK

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SITUATION, HISTORY, STRATEGY, ORGANIZATION

In the last few years several cases of severe soil pollution have been discovered in The Netherlands. The best known one is the 'Lekkerkerk' case.

Lekkerkerk is located at about 20 kilometers east of Rotterdam on a branch of the river Rhine. A quarter of the village has been built on a former pasture, its area is about 600 x 150 m^2. There are 271 houses with nearly 1000 inhabitants.

In 1970 and 1971 before constructing the houses the ditches (depth between 2 and 3½ m) were filled with 'household and demolition' waste.

The entire area, pasture as well as filled ditches had been covered with a layer of sand of approximately 70 cm. As has been shown later the rubble had been mixed with chemical waste originating from paint industries, industries of building materials, printing offices and others.
The area is located just near the river. Its surface is below the level of the river and therefore, the area experiences upward flowing groundwater. This 'reversed' groundwater flow prevented the diffusion of the pollution.

In 1978 the first signs of severe pollution appeared:
deterioration of plastic drinking water distribution pipes; polluted groundwater; dirty clothes and limbs of children playing in the sand box; poorly growing vegetation in some gardens and later also penetration of bad odours and imflammable gasses in a number of houses.
A sensory survey on odour, a survey with a mine-detector and also analyses of samples of soil and groundwater clearly indicated a coincidence of pollution and ditch pattern.

It was concluded to carry out a preliminary excavation. Below a surface of 10 x 5 m^2 the presence of 42 filled and empty drums at a depth of 1,5 to 3 meters has been shown in a filled ditch.

At nearly the same time, April 1980, two cases of drinking water pollution occurred due to percolation of the waste through the polyethylene piping system. Drinking water had to be distributed in bottles.

It had been decided by the authorities to evacuate the population and to dig

out the contaminated content of the ditches to a depth of 2½ till 3¼ meter depending on the original situation.

This operation also covered the ditches below the houses. Because of the possible occurrence of scattered rubble the upper layer of 70 centimeters had to be removed over the entire area.

On June 1, the population of the area had moved to their temporary living quarters.

After the preparatory activities the clean-up operation which was managed by the Department of Public Works of the Province of South Holland, started the 4th of August 1980.

As decided earlier the strategy was to excavate the ditches completely and to remove the upper sand layer over the entire area. Waste, polluted soil and uncovered drums had to be transported by ship to an incineration plant.

The cleaned areas had to be filled up with non-polluted peat as well as 'flugsand'. To prevent pollution of cleaned areas the excess of groundwater had to be pumped. Before its discharge to the river the groundwater had to be purified and for this purpose a treatment plant was installed.

The operation was escorted by an extended analysis programme. This programme as well as the environmental control was assigned to the National Institute for Water Supply. A team of environmental hygienists sampled soil, water and waste, made photographical records and finally reported and listed their observations. The chemical and toxicological analyses concerned polluted ground, polluted water, waste, coagulation sludge, clean peat, flugsand, purified water and also the badges worn by the workers in the field.

The clean-up operation finished on the 16th of January 1981.

RESULTS

In total 86.700 m^3 polluted soil was transported to the incineration plant 30 km downstreams in 117 shiploads.

1652 drums were found, some were still filled with the original chemicals, some were filled with mixtures of chemicals or mixtures of chemicals, soil and water and many drums were empty.

In the entire area large quantities of xylene, toluene, ethylbenzene and other aromatic compounds as well as alkanes were found. The concentration in

the ground ranged up to 1 g/kg ground for toluene and 2 - 3 g/kg ground for total lower aromatic compounds. The highest concentrations of organic solvents in removed soil were measured in a composed sample with the following composition.

Benzene	0.3	mg/kg	Σ C_9H_{12}	300	mg/kg
Toluene	1000	mg/kg	C_{10}-Alkane	30	mg/kg
Ethylbenzene	30	mg/kg	C_{10}-Alkane	30	mg/kg
m/p-Xylene	300	mg/kg	C_{10}-Alkane	30	mg/kg
o-Xylene	100	mg/kg	C_{10}-Alkane	300	mg/kg
C_9-Alkane	100	mg/kg	Cyclohexene	30	mg/kg
Carene	30	mg/kg	C_{11}-Alkane	30	mg/kg
C_{10}-Alkane	100	mg/kg	Σ $C_{10}H_{14}$	300	mg/kg

Organic compounds other than lower aromates and alkanes were found only very rarely and on specific locations. These compounds were isophoron, tetrachloromethane, polycyclic aromatic hydrocarbons, phenols, butanol, ketones, cyclic hydrocarbons, butylacetate and carene. PCB's were observed only at one place (0.4 mg/kg ground).

High concentrations of the heavy metals lead, cadmium and antimony were measured in many composed samples of removed soil. In a number of samples other trace elements were found also. The maximum and minimum contents of trace elements in composed samples of removed soil were as follows:

Antimony	<0.2	-	230 mg/kg ground	Copper	3.6	-	490	mg/kg ground
Arsenic	<0.2	-	9 mg/kg ground	Mercury	<0.05	-	8.2	mg/kg ground
Cadmium	1.1	-	97 mg/kg ground	Lead	8	-	740	mg/kg ground
Chromium	<0.5	-	140 mg/kg ground	Zinc	37	-	1670	mg/kg ground

250 of the 1652 uncovered drums were selected for the analysis of their content.

Alkydresins on basis of orthophthalic acid and epoxy resin on basis of epichlorohydrine and bisphenol-A were found regularly. In addition aliphatic hydrocarbons, fatty acids, ketones, carbonic acids, esters, polyurethanes and polyvinylchloride were found also in some or more drums. In only one charge chloroparaffines were observed.

As for the inorganic constituents especially lead, cadmium and also barium and selenium were found frequently.

At the moment the inhabitants have returned to the homes in these parts of the quarter that have been filled up with peat or flugsand.