SITE 12: AKOUÉDO 2

ENVIRONMENTAL AUDIT OF THE SITES IMPACTED BY THE "PROBO KOALA" TOXIC WASTE DUMPING IN ABIDJAN, CÔTE D'IVOIRE

This series of fact sheets was prepared as part of UN Environment's environmental audit of the sites impacted by the "Probo Koala" toxic waste dumping in Abidjan, Côte d'Ivoire. The fact sheets provide complete analysis results, observations and the recommendations for each of the sampling sites. They should be read in conjunction with the full assessment report, available at: www.unep.org/CotedIvoire

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Site Description

Site name: Akouédo 2
UN Environment site reference no: 12

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Spill History

This spill site is the second located within the Abidjan's municipal waste disposal site at Akouédo. It is comprised of a slanted concrete pad upon which suction-tankers routinely park to discharge sewage sludge. Probo Koala wastes are reported to have been brought onto the site in a suction-tanker that parked on the concrete pad. The liquid waste leaked from the vehicle onto the concrete and flowed into the surrounding drainage ditch. Clean-up by Trédi in 2006-2007 entailed breaking up and removing part of the concrete pad, as well as excavating the contaminated soil within the ditch for off-site treatment. At the time of sampling, numerous crops were observed to be growing in close proximity to the site, including maize, papaya and cassava.

Approach

One composite surface (0-20 cm) soil sample was taken at the bottom of the concrete pad. A layer of refuse had to be removed to gain access to the underlying soil.

In addition, one air sample, one surface water sample, and one sample of comestible vegetation (sweet potato) were collected at the site.

Assessment Criteria

Based on the different analyses of the chemical composition of the samples taken onboard the Probo Koala in 2006, as well as those undertaken on samples collected on the dumping sites, UN Environment considered the following groups as the key contaminants of interest for the audit:

- Petroleum hydrocarbons;
- Sulfur compounds; and
- Heavy metals.

The speciation of contaminants to be analyzed within the above three groups was primarily determined by what was present in the Probo Koala waste as well as the environmental standards set by the Government of Côte d'Ivoire for clean-up. In addition, the impact of high levels of sodium hydroxide was measured through the pH value of the soil.

The results obtained from the analyses of **soil** samples were screened according to the following process:

1. Findings were first compared with relevant national standards. In this case, results for soil from all the sites where Probo Koala wastes were dumped and which had undergone remediation were compared with the environmental standards set by the Government of Côte d'Ivoire for clean-up operations conducted by Biogénie at Alépé. If the values obtained were lower than the standards set by the Government, UN Environment considered that no additional clean-up intervention was necessary on the site.

2. If laboratory results for a given parameter showed values exceeding the clean-up standards set by the Government or contractor, results were then compared with the internationally recognized Dutch soil remediation standards (intervention values) to see if further immediate action was needed from an environmental point of view. Dutch standards have been in existence for over 30 years and are used as a basis for contaminated site assessment and clean-up in many parts of the world, when local standards are not available. For most parameters of analysis, however, the Government's clean-up standard was more stringent than the Dutch values.

3. Results were also compared with the control sites to see if the observed pollution was also present in the background.

For **air** quality analysis, for which no national standards exist in Côte d'Ivoire, the approach taken was to compare air quality results from the affected sites with Control Site 21.

It was not possible to compare **surface water** results, however, as Côte d'Ivoire does not have a national standard for surface water quality, and surface water was not sampled at any of the control sites.

Fruit and vegetable samples were tested using similar protocols as those used for analysis of soil and water samples. In the absence of national food quality standards, the European Commission's maximum levels of certain contaminants in food stuffs (EC regulation 1881/2006) are used for comparison. It should be noted that as it was found that there were interferences from naturally occurring substances with the hydrocarbon analyses, the analytical results relating to hydrocarbons were discarded.

Laboratory Analysis Findings

Soil Parameters (mg/kg)	Site 12 Akouédo 2 0-20 cm	Government standard (mg/kg)
Total Hy C5-C44	1,020	1,000
Benzene	< 0.009	1
Ethylbenzene	< 0.003	25
Toluene	0.0149	5
Xylene	< 0.01096	5
Total sulfur (%)	0.0275	10
Pb	23	400
Cd	0.2	20
As	7.1	37
Cr	64	130
Ni	30	140
Co	4	240
Hg	0.092	7
Cu	12	190
Zn	50	9,000
pH	7.67	

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Air Parameters/units		Site 12 Akouédo 2	Control Site 21 Agboville
Dimethyl sulfide	ppm v/v	< 0.1	< 0.1
Ethyl mercaptan	ppm v/v	< 0.1	< 0.1
Methyl ethyl sulfide	ppm v/v	< 0.1	< 0.1
Carbonyl sulfide	ppm v/v	< 0.1	< 0.1
Tertiary butyl mercaptan	ppm v/v	< 0.1	< 0.1
Hydrogen sulfide	ppm v/v	< 0.1	< 0.1
Methyl tert-butyl ether	µg/m3	ND	ND
Benzene	µg/m3	ND	ND
Toluene	µg/m3	12	ND
Ethylbenzene	µg/m3	ND	ND
Xylene	µg/m3	ND	ND
Naphthalene	µg/m3	ND	ND
TPH (C4-C6)	µg/m3	ND	10
TPH (C6-C8)	µg/m3	37	20
TPH (C8-C10)	µg/m3	59	35
TPH (C10-C12)	µg/m3	51	53
TPH (C4-C12)	µg/m3	29	120
Aliphatic (C4-C6)	µg/m3	180	ND
Aliphatic (C6-C8)	µg/m3	37	17
Aliphatic (C8-C10)	µg/m3	46	31
Aliphatic (C10-C12)	µg/m3	26	53
Aromatic (EC5-EC7)	µg/m3	28	ND
Aromatic (EC7-EC8)	µg/m3	ND	ND
Aromatic (EC8-EC10)	µg/m3	12	ND
Aromatic (EC10-EC12)	µg/m3	25	ND

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Surface water Parameters (µg/l)	Site 12 Akouédo 2 Drainage ditch
Total Hy C5-35	187
Benzene	< 7
Ethylbenzene	< 5
Toluene	< 4
Xylene	< 11
Free sulfur	< 50
Pb	4
Cd	0.39
As	4.6
Cr	7.8
Ni	13
Co	6.6
Hg	6.6
Cu	7.3
Zn	20

Fruit and vegetable Parameters (mg/kg)	Site 12 Akouédo 2 Sweet potato	Control site 21 Agboville Pomegranate	EC regulation (mg/kg)
Total sulfur (%)	0.0341	0.0547	
PAH	< 0.118	< 0.118	
Pb	< 0.7	< 0.7	0.1
Cd	0.106	< 0.02	0.1
As	< 0.6	< 0.6	
Cr	< 0.9	1.62	
Ni	< 0.2	0.82	
Co	< 0.1	0.149	
Hg	< 0.14	< 0.14	
Cu	10.3	3.85	
Zn	17.4	22.9	

Conclusions and Recommendations

Analysis results for soil samples collected at this site show slightly elevated levels of hydrocarbons as compared to the clean-up standards set by the Government. However, all other parameters are below the established limit values.

Considering that the site has remained operational as an active waste disposal site throughout the ten years since it was cleaned up following the dumping of wastes from the Probo Koala, and that this is a location where heavy vehicles are routinely parked, results showing elevated levels of hydrocarbons are not unexpected. Against this background, it is not possible to attribute this contamination to any specific incident of pollution.

Furthermore, concentrations in this case are far below Dutch intervention values (5,000 µg/kg). No immediate action is therefore recommended. However, when the waste disposal site is closed, a comprehensive environmental assessment should be undertaken as part of environmental due diligence and the site should be decommissioned following good industry practices.

The results of the air quality analysis can be summarized as follows:

- Mercaptans, hydrogen sulfide and related components cannot be detected in this site, nor the control site. This is significant considering that the key odorants in the Probo Koala wastes were most likely hydrogen sulfide and mercaptans.

- Concentrations of the various analytes at the affected site are comparable to the concentrations found at the control site.

Surface water quality analysis shows some heavy metal pollution in samples taken at the site, which is to be expected in a municipal waste disposal site. To address this, a leachate monitoring plan should be made for the Akouédo municipal waste disposal site, covering its operational lifecycle, including decommissioning.

Based on the fruit and vegetable results, the following observations can be made:

- All samples, including the pomegranate sample from Control Site 21 at Agboville, show the presence of various analytes and heavy metals. Fruits and vegetables naturally accumulate heavy metals from the soil. As most of the heavy metals are essential to human health in small quantities, their uptake through fruits and vegetables is not considered to be a risk.

- Moreover, the concentration of cadmium is slightly above EC regulations for the sweet potato sample collected from this site. Presence of slightly elevated levels of heavy metals in vegetables grown on waste disposal sites is well documented. While results for one sample are not sufficient to issue a safety advisory, it would be appropriate – from a due diligence point of view – to conduct additional sampling at this site. In addition, as previously mentioned, an appropriate decommissioning plan needs to be developed for the waste disposal site as a whole, covering leachate monitoring, landfill gas collection arrangements and land use restrictions.

- The EC standard for lead is below the detection limit of the laboratory analyses. However, considering that all samples, including control samples, show comparable heavy metal values, these results are not considered to warrant further follow up.

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Site Photos

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