



**Works in Abidjan, Ivory Coast
Summary Report**

McGuireWoods London LLP

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1 Introduction

1.1 INTRODUCTION

WSP Environment & Energy (**WSPE&E**) was commissioned by McGuireWoods London LLP (the **Client**)¹ to undertake a series of environmental investigations at various sites in and around Abidjan, Ivory Coast.

WSPE&E is a wholly owned subsidiary of WSP Group plc, an engineering consultancy listed on the London Stock Exchange since 1987. WSP Group has over 10,000 staff working from offices in 35 countries located in Europe, Africa, the Middle East, Asia and the Americas. WSPE&E has over 1,000 staff located worldwide, including an African practice headquartered in South Africa. WSPE&E's Soil & Groundwater Contamination practice has over 300 staff in the UK alone, including staff in an in-house analytical laboratory and a remediation business with extensive experience of quantifying, remediating and/or assuming the liability for significantly contaminated sites.

The investigations were commissioned to assess the presence of contamination and ongoing health risks at various sites in and around Abidjan, Ivory Coast, associated with the alleged depositing of ship's slops from the Probo Koala in 2006 (the **Slops**) and more generally. The works undertaken were completed in three phases, and subsequently reported in three individual reports; however, the works effectively comprised two areas of investigation designed to meet the two following objectives:

- Exploratory Investigation focused on the assessment of soils, sediment, surface water and ambient air at a representative selection of the alleged Slops disposal sites (based on the disposal locations identified by the UN Disasters Assessment and Coordination (UNDAC) team and detailed in version 1.4 of the UNOSAT map dated 18 September 2006) (as defined more particularly in section 1.2 below, the Subject Sites) in order to evaluate the presence of contaminants associated with the Slops and provide an assessment of the associated human health risks; and,
- A Contextual Assessment aimed to assess the general environmental conditions in Abidjan and relate these to human health issues experienced in the region. The Contextual Assessment was designed to place the findings of the Exploratory Investigation work at the Subject Sites in the context of their wider environmental setting.

1.2 SCOPES OF WORK & REPORTING

WSPE&E's findings are presented in three reports:

- Works in Abidjan, Ivory Coast, Volume 1 – Exploratory Investigation Report, referenced 12024964-001 and dated April 2009;
- Works in Abidjan, Ivory Coast, Volume 2 – A Contextual Assessment, referenced 12024964-002 and dated April 2009; and,
- Works in Abidjan, Ivory Coast, Volume 3 – Follow-up Investigation, referenced 12024964-003 and dated July 2009.

The scope of works for each phase undertaken was set out in separate proposals to the Client dated 15 December 2008, 18 February 2009 and 19 May 2009 respectively (a copy of each proposal is appended within the corresponding report). Certain aspects of the investigation methodologies to be employed were then revised and/or the scope expanded following WSPE&E's review of existing information, in response to field conditions and due to the need to respond to issues that arose subsequent to the issuing of the various proposals.

Exploratory Investigation

Within the Exploratory Investigation, the majority of the sites where Slops were alleged to be deposited (the **Sites**) were visited in December 2008 and a background data review undertaken. Only four of the eighteen Sites could not be visited due to either security concerns or access restrictions: (i) Abobo Boulangerie (Plaque 1) (UNDAC 11.1); (ii) Abobo Coco Services (truck stops) (UNDAC 2.3 and 2.5); and (iii) Koumassi (UNDAC 10.1).

Subsequently in January 2009, a representative selection of the Sites comprising Akouédo Bridge and Runoff (UNDAC 1.1 and 1.3 respectively), Forêt de Banco (UNDAC 3.1), Maca Route de Anyama 1 and 2 (UNDAC 6.1 and 6.2 respectively) and Vridi (Canal) (UNDAC 8.1) (together the **Subject Sites**) as well as three additional control sites

¹ As of 1 May 2009, Grundberg Mocatta Rakison LLP became known as McGuireWoods London LLP



(comprising a working area of the Akouédo landfill, a location within the Ébrié lagoon and the Hotel Tiama in the Plateau area) were subject to investigation.

The investigation of the Subject Sites and control sites was designed to assess the potential presence of residual contamination within air, soils, sediment and/or surface water associated with the disposal of the Slops. The samples collected at the Subject Sites and control sites were analysed and the data obtained used to consider human health risks associated with identified contaminants that could be expected to be present in the Slops from the available data concerning their composition (the **Contaminants of Concern**).

Contextual Assessment

The Contextual Assessment included a review of a range of information on the general environmental, geological and hydrological conditions in Abidjan (and related human health issues), an initial visit to Abidjan undertaken in early March 2009 and further independent monitoring and sampling investigations undertaken in mid-March 2009.

The March 2009 investigations included additional soil and sediment sampling and the assessment of surface and drinking water and ambient air in order to evaluate general environmental conditions in Abidjan and associated human health issues. This further sampling exercise took place at a total of 15 locations in and around Abidjan. Drinking water supplies were sampled in Abobo, Akouédo village, two locations in Plateau and in Vridi. Sediment samples from the banks of the Ébrié lagoon were taken beside the Baie de Cocody (where a lagoon water sample was also taken) and in Vridi (the Petit-Bassam area). Air monitoring was undertaken within the Forêt Du Banco National Park, in Akouédo Village, beside principal roads in Adjamé and Cocody, besides the Ébrié lagoon in Baie de Cocody and Biétri as well as the alleged Slops deposition sites of Forêt de Banco (UNDAC 3.1) and Vridi (Canal) (UNDAC 8.1).

Follow-up Investigation

Subsequently, in March 2009, a World Bank funded waste collection campaign was announced in Abidjan with the intention of clearing 500,000 tonnes of municipal waste from Abidjan (**Operation Clean City**). To ensure that WSPE&E's earlier evaluation of environmental and health issues remained up-to-date, a final assessment, the Follow-up Investigation, was commissioned to evaluate the progress and effectiveness of Operation Clean City and consider what impact, if any, it has had on the conclusions of the first two reports.

The Follow-up Investigation included a review of information concerning the clean up exercise obtained from publicly accessible sources, together with site observations made in Abidjan in June 2009. In addition, the report also details further works undertaken in the area of Alépé 1 & 2 (Djibi) (UNDAC 4.1, 4.2 & 5.1). These areas were visited but were not part of the sample of sites subject to subsequent investigation during WSPE&E's earlier works. In the light of recent reports of ongoing potentially harmful emissions at these sites, it was considered prudent to revisit the sites and assess the current situation. Field observations were made at each of the sites. In addition, exploratory air sampling was undertaken at the area of Alépé 1 also referred to as the Remediation Store (UNDAC 4.2), where reclaimed material allegedly impacted by the Slops, is stored in big bags.

1.3 LIMITATIONS

WSPE&E has prepared this report solely for the use of the Client and those parties with whom either a warranty agreement has been executed, or an assignment or disclosure arrangement has been agreed in writing. Should any third party wish to use or rely upon the contents of the report such a written agreement must be entered into with WSPE&E. WSPE&E accepts no responsibility or liability for:

- a. the consequences of this document being used for any purpose or project other than for which it was commissioned; and
- b. this document to any third party with whom an appropriate agreement has not been executed with WSPE&E.

The work undertaken to provide the basis of this report comprised a study of documents and other information from a variety of sources (including those detailed in this report as well as WSPE&E's work in Abidjan in December 2008 and January and March 2009), discussions with the Client and other parties, observations from the March and June 2009 visits to Abidjan and the exploratory sediment, surface water, drinking water and ambient air investigations undertaken in January, March and/or June 2009. Should additional information become available which may affect the opinions expressed in this report, WSPE&E reserves the right to review such information and, if warranted, to modify the opinions accordingly.



2 Summarised Findings & Conclusions

2.1 FINDINGS FROM INVESTIGATIVE SAMPLING WORKS

2.1.1 Approach

Exploratory investigations including sampling were undertaken to assess the potential presence of residual contamination within air, soils, sediment and surface water associated with the disposal of Slops from the Probo Koala in and around Abidjan in the Ivory Coast in 2006.

Samples were also collected from control sites (sites not considered to have been impacted by Slops) including air, soil, sediments and water samples. Sampling locations included roadside locations in various districts, the Ébrié Lagoon and the public drinking water supply during the works to provide a provisional assessment of the general environmental conditions. Collected samples were analysed and the data obtained used to consider human health risks associated with identified Contaminants of Concern.

2.1.2 Results from Suspected Dumping Sites (the 'Subject Sites')

- No elevated concentrations of any Contaminants of Concern (those considered to be specifically indicative of the Slops) were recorded within ambient air at the Subject Sites and no risk to human health has been identified associated with the Contaminants of Concern at the Subject Sites and/or the control sites.
- In addition, during the Follow-up Investigation in June 2009, no hydrogen sulfide gas was detected in any of the Dräger Tubes exposed adjacent to or above material storage bags within the Alépé 1 Remediation Store. No distressed vegetation or other visual or olfactory evidence of the continued impact from contamination was noted either within the bag store area, immediately surrounding it, or at the other Alépé sites (and nearby fish farm).
- The results of the exploratory investigation further indicate that there is no risk to human health in the soils, sediment and surface water at the Subject Sites from the Contaminants of Concern. No compounds specifically characteristic of the Slops have been detected at any of the Subject Sites. Furthermore, there is no evidence of the broader range of contaminants that could additionally relate to the Slops at any of the Subject Sites, with the possible exception of the Vridi Canal and Akouédo sites (as explained below).
- Analysis of sediment and water samples for the Vridi Canal and water samples for the Akouédo dump sites identified small traces of light hydrocarbons and sulphides which could possibly relate to the Slops. However, these compounds are also present in a wide range of wastes from a broad variety of processes undertaken in the region or are naturally occurring. In any event, WSP concludes that there is no risk to human health from these identified trace contaminants at these two sites based on their current use.; and,
- A range of contaminants not related to the Slops were identified at some of the Subject Sites (for example Isodrin at Forêt de Banco), suggesting historical contamination associated with other processes/activities.

Notwithstanding the above, no risks to human health were been identified associated with the Contaminants of Concern (those considered to be indicative of the Slops) at the Subject Sites.

2.1.3 Control Sampling Locations

The key findings from the sampling exercise of 'control' locations can be summarised as:

- Elevated concentrations of particulate matter in excess of WHO guidelines were recorded and may be indicative of a chronic risk to human health from long term exposure. Significant concentrations of benzene well in excess of the applied WHO guidelines were recorded within the ambient air at two busy road junctions; such concentrations may represent a risk to human health from long term exposure;
- A control sample of soil collected from an area of Akouédo landfill in an area considered not to be impacted by Slops, contained light and heavy hydrocarbon fractions, phthalates and other contaminants consistent with the field observations. These findings indicate historical contamination in and around this control site not related to the Slops. It is considered that the concentrations of contaminants (notably hydrocarbons) found to be present at the Akouédo control site may represent a risk to human health based on the activities observed on-site.

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- Water samples from the lagoon, in an area considered not to be impacted by Slops, provided evidence of hydrocarbon impacts considered consistent with the presence of petroleum industries in Abidjan and the effluents / sewage observed during the fieldworks. A large variety of pesticides were also identified in the Lagoon;
 - Evidence for the industrial contamination of lagoon sediments was found including a number of metals, phenols, cresols and limonene. Dimethyl sulphide was also identified but its source not determined; and,
 - Water samples from the public water supply identified contamination of the drinking water supply with pesticides, chlorinated solvents and other industrial chemicals including concentrations which could represent a chronic risk to human health. Elevated nitrates in the drinking water supply were found demonstrating an increase over time when compared against historical values. Abstraction boreholes have been closed due to contamination with nitrates considered to be related to the sewage disposal practices.

2.2 ENVIRONMENTAL CONDITIONS IN ABIDJAN

The Contextual Assessment included a desk based review of background information on Abidjan. The review identified that the city can be considered, in a Sub-Saharan African context, as relatively modern and industrialised. Abidjan's significant port has made the city an industrial and trading hub in the region, with both its economic success and later economic downturn and social unrest acting to swell its population. However, the population increase over the past few decades has not been matched by improvements to the provision of basic public services in the city.

A large proportion of the population live in the informal housing sector with dwellings typically comprising temporary or semi-permanent accommodation. These areas routinely have no formal sanitation system which is instead generally limited to the more formal housing areas within the centre of Abidjan. The poor provision of sanitation in many areas is further exacerbated by a failing waste collection system, which together promote the spread of disease.

A significant proportion (50% in 2001) of municipal solid waste has not routinely been collected by the city authorities and instead was observed in all WSPE&E visits to be left in 'heaps' in the streets or in unofficial dumps where it is, on occasions, ignited and usually accompanied by significant unpleasant odours. The majority of the waste that is collected is disposed of to the Akouédo landfill. No sorting or pre-treatment is undertaken and no temporary or permanent 'cap' is present leaving the waste exposed.

In March 2009, a World Bank funded clean up campaign (called Operation Clean City) was announced in Abidjan with the intention of removing 500 thousand tonnes of municipal waste from the city. By 4 June 2009, 394,578 metric tonnes had reportedly been cleared from Abidjan's streets. During WSPE&E's June 2009 visit, significant quantities of wastes were noted to have been collected and some principal roads and public spaces were free of litter. However, evidence of wastes that had not been cleared remained, away from the main roads, in the back streets/alleys or where access to the wastes is more difficult including steeper banks, drainage ditches and water courses and the shores of the lagoon. Thus, whilst the environment was observed to have been dramatically improved in certain areas by Operation Clean City, in others, notably the poorer residential areas, wastes remained in situ and thus continue to represent a potential health issue. Furthermore, it is understood that the funding will last only until December 2009 after which, unless the funding is renewed or substituted, it would be expected that wastes would begin to accumulate again as the underlying waste collection facilities are insufficient and poorly serviced.

The legacy of liquid and solid waste and sewage disposal to the Ébrié Lagoon has resulted in pollution of the water body and has made the water odorous and unsuitable for any recreational use. Industrial contamination (including pesticides) has been identified within the fauna of the lagoon. Epidemiological evidence linking conditions within the lagoon to disease outbreaks has also been identified.

The city is well served by its public water supply system, however, the system has not been upgraded at the same rate that the population has grown and is considered to be significantly under strain. The public drinking water supply is fed from a number of boreholes installed within the underlying Abidjan Aquifer. The quality of the abstracted water has become an issue with evidence of pollutant impact to the aquifer, particularly with nitrates, occurring which are primarily considered to be related to the poor condition of the sewerage system. A number of boreholes are reported to have been closed for these reasons. Private water supply from wells and boreholes do exist across the city but are generally from the same source (Abidjan Aquifer) and are anticipated to be similarly impacted.

Air pollution in the city represents a potentially significant health issue with significant inputs from industry, domestic sources and road traffic. Road traffic inputs are accentuated by the use of older vehicles in poor condition of repair



which result in release of significant particulate, un-burnt fuel and other pollution. Domestic inputs from the use of wood and charcoal for heat generation and cooking are also significant. The estimated concentrations of particulates in the city were noted at levels which would represent a potential chronic risk to human health and may be considered to result in an increased risk of cardiopulmonary and lung cancer mortality based on exceedence of World Health Organisation guidelines (WHO 2005).

Underlying the above issues, Malaria is endemic, accounting for approximately 10% of all deaths in the country. As with much of Sub-Saharan Africa, HIV is also a significant issue with 7% of the population thought to be infected and 19% of deaths attributed to HIV/AIDS, the largest single cause of death in the country. Life expectancy at birth in the Ivory Coast is consequently 47.7 years (ranked 166th out of 179 countries), significantly below the world average of 68.1 years and the UK life expectancy of 79.0 years.

2.3 CONCLUSIONS

The results of the Exploratory Investigation indicate that no risk to human health has been identified at the investigated Subject Sites from the contaminants potentially relating to the Slops (i.e. the Contaminants of Concern). No compounds specifically characteristic of the Slops have been detected at any of the Subject Sites. Furthermore, there is no evidence of the broader range of contaminants that could additionally relate to the Slops at any of the Subject Sites, with the possible exception of the Vridi Canal and Akouédo sites. Analysis of sediment and water samples for the Vridi Canal and water samples for the Akouédo dump sites identified small traces of light hydrocarbons and sulphides which could possibly relate to the Slops. However, these compounds are also present in a wide range of wastes from a broad variety of processes undertaken in the region or are naturally occurring. In any event, WSP concludes that there is no risk to human health from these identified trace contaminants at these two sites based on their current use.

The investigations of various 'control' sites including roadside locations and samples obtained from the public water supply did identify background contamination in soils, air, the Ébrié Lagoon (water and sediment) and within the public water supply indicative of general industrial pollution. The concentrations identified in some of the media exceeded applied screening values indicating potential risks to human health from general industrial pollution.

The investigations of the various 'control' sites reflects the findings of the desk based study demonstrating the presence of degraded environmental conditions within Abidjan which have arisen primarily related to human activity, over a number of years and which are likely to have an impact upon the health of the average individual living in the city through disease and exposure to chemical and other contaminants.

The findings and conclusions presented herein represent a distilled summary of the reports produced; a more detailed assessment of the findings of each phase of works and recommendations for further works is presented in the respective reports.