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PARLIAMENT OF KENYA




NATIONAL ASSEMBLY

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**ELEVENTH PARLIAMENT – FOURTH SESSION - 2016**

**DEPARTMENTAL COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES**

# REPORT ON THE INQUIRY INTO THE ALLEGED LEAD POISONING AT THE OWINO - UHURU VILLAGE IN MIKINDANI MOMBASA BY METAL REFINERY EPZ LIMITED AND MAX INDUSTRIES

**DIRECTORATE OF COMMITTEE SERVICES**
**CLERK'S CHAMBERS**
**PARLIAMENT BUILDINGS,**
**NAIROBI**

**MARCH, 2016**

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APPENDICES

## 1 PREFACE

The Departmental Committee on Environment and Natural Resources is established under Standing Order No. 216(1).

### 1.1MANDATE OF THE COMMITTEE

The functions and mandate of the Committee are:-

a) Investigate, inquire into, and report on all matters relating to the mandate, management, activities, administration, operations and estimates of the assigned Ministries and departments;

b) Study the programme and policy objectives of the Ministries and departments and the effectiveness of the implementation;

c) Study and review all legislation referred to it;

d) Study, access and analyze the relative success of the Ministries and Departments as measured by the results obtained as compared with its stated objectives;

e) Investigate and inquire into all matters relating to the assigned Ministries and departments as they may deem necessary, and as may be referred to them by the House;

f) Vet and report on all appointments where the constitution or any law requires the National Assembly to approve, except those under Standing Order 204; and

g) Make reports and recommendations to the House as often as possible, including recommendation of proposed legislation.

The subject matter of the Departmental Committee on Environment and Natural Resources as provided for in the Second Schedule of the National Assembly Standing Order include: climate change, environment management and conservation, forestry, water resource management, wildlife, mining and natural resources, pollution and waste management.

## 1.2MEMBERSHIP OF THE COMMITTEE

The Committee comprises of the following members:-

1. Hon. Amina Abdalla, CBS, M.P - **Chairperson**
2. Hon. A. K. Kosgey, M.P. - **Vice Chairperson**
3. Hon. Alice Ng'ang'a, M.P.
4. Hon. Samuel Ndiritu, M.P.
5. Hon. Aisha Jumwa Karisa, M.P.
6. Hon. Ejidius Njogu Barua, M.P.
7. Hon. Jude Njomo, M.P.
8. Hon. Moitalel Ole Kenta, M.P.
9. Hon. Kathuri Murungi, M.P.
10. Hon. Sunjeev Birdi, M.P.
11. Hon. Jackson K. Rop, M.P.
12. Hon. Abdi Noor Ali, M.P.
13. Hon. Joyce Emanikor, M.P.
14. Hon. Abdulaziz Farah, M.P.
15. Hon. Ronald Tonui, M.P.
16. Hon. (Dr.) Reginalda Wanyonyi, M.P.
17. Hon. Gideon Mwiti, M.P.
18. Hon. Hassan Dukicha, M.P.
19. Hon. Chachu Ganya, M.P.
20. Hon. Opiyo Wandayi, M.P
21. Hon. Charles G. Mongare, M.P.
22. Hon. (Dr.) Wilber K. Ottichilo, M.P.
23. Hon. Khatib Mwashetani, M.P.
24. Hon. George Ogalo, M.P.
25. Hon. (Major) Muluvi Mutua, M.P.
26. Hon. Mohamed, Diriye M.P.
27. Hon, Peter Kinyua, MP.
28. Hon. Shukra Hussein Gure, M.P

## 1.3 VISIT TO OWINO – UHURU VILLAGE

Following concerns raised by the public on alleged lead poisoning at Owino-Uhuru village the Committee on its own volition resolved to inquire into the issue. The inquiry sought to investigate the effects of lead on the health of the residents of Owino-Uhuru Village in Mikindani Ward, Jomvu Constituency.

In order to achieve this objective, the Committee held meetings with NEMA and the Ministry of Health and also undertook a fact finding visit to Owino-Uhuru Village on 20th June, 2015. The following Members undertook the Visit:-

1. Hon. Khatib Mwashetani, M.P. – **Leader of the Delegation**
2. Hon. Sunjeev Sonia Birdi, M.P.
3. Hon. Charles Mong'are Geni, M.P.
4. Hon. Ronald Tonui, M.P.
5. Hon. (Dr.) Reginalda Wanyonyi, M.P.
6. Hon. Dukicha Hassan, M.P.
7. Hon. Jude Njomo, M.P.
8. Hon. Joyce Emanikor, M.P.
9. Hon. Moitalel Ole Kenta, M.P.

## 1.4 COMMITTEE OBSERVATIONS

Following the meetings with various stakeholders and a visit to Owino-Uhuru village, the Committee made the following observations:

i). The relevant state agencies (NEMA and the Ministry of Health) had taken inordinately long to react to the health crisis in the village;

ii). There was lack of coordination between NEMA and the Ministry of Health that allowed Metal Refinery EPZ Ltd to flout rules;

iii). The patients at Owino-Uhuru were still being exposed to lead poisoning after treatment since the dust particles contained lead particles. There is need for a long term solution to the problem.

## 1.5 COMMITTEE RECOMMENDATIONS

The Committee recommends that:-

i). Metal Refinery EPZ Ltd and Max Industries should be held responsible for the lead poisoning and should be made to treat and compensate all the people affected by lead poisoning arising from their activities;

ii). NEMA should institute criminal proceedings against Metal Refinery EPZ Ltd and Max Industries;

iii). NEMA and the County Government of Mombasa should compel Metal Refinery EPZ Ltd and Max Industries to clean and restore the environment in the area to its original state devoid of lead poisoning;

iv). NEMA should consult other relevant agencies before issuing licenses, the licenses should only be pegged on 'no objection' from all relevant state agencies;

v). The National Government should fast-track the gazzettement of the 1999 regulations requiring proponents of projects to deposit security bonds with NEMA. The regulations should be forwarded to the National Assembly as per the provisions of the Statutory Instruments Act, within three weeks of the tabling of this report.

vi). Noting that this is a health issue and considering that health is a devolved function, the Committee recommends that the following actions should be taken by the Mombasa County Assembly:-

vii). Ensure all people in Owino-Uhuru are tested to check whether they have been exposed to lead poisoning;

viii). Ensure that the patients exposed to lead poisoning are given continuous medical treatment; and

ix). Institute public consultations with the residents of Owino-Uhuru Village to consider the viability of relocating the residents in order to prevent continuous exposure.

## 1.6 ADOPTION OF THE REPORT

We the Members of the Departmental Committee on Environment and Natural Resources have pursuant to Standing Order 199 adopted this report and affix our signatures to affirm our approval and confirm its accuracy, validity and authenticity.

1. Hon. Amina Abdalla, M.P. .....
2. Hon. Alexander K. Kosgey, M.P. .....
3. Hon. Alice Ng'ang'a, M.P. .....
4. Hon. Samuel Ndiritu, M.P. .....
5. Hon. Aisha Jumwa Karisa, M.P. .....
6. Hon. Ejidius Njogu Barua, M.P. .....
7. Hon. Jude Njomo, M.P. .....
8. Hon. Moitalel Ole Kenta, M.P. .....
9. Hon. Kathuri Murungi, M.P. .....
10. Hon. SunjeevBirdi, M.P. .....
11. Hon. Jackson K. Rop, M.P. .....
12. Hon. Abdi Noor Ali, M.P. .....
13. Hon. Joyce Emanikor, M.P. .....
14. Hon. Abdulaziz Farah, M.P. .....
15. Hon. Ronald Tonui, M.P. .....
16. Hon. (Dr.) Reginalda Wanyonyi, M.P. .....
17. Hon. Gideon Mwiti, M.P. .....

18. Hon. Hassan Dukicha, M.P. .....

19. Hon. Chachu Ganya, M.P. .....

20. Hon. Opiyo Wandayi, M.P .....

21. Hon. Charles G. Mongare, M.P. .....

22. Hon. (Dr.) Wilber K. Ottichilo, M.P. .....

23. Hon. Khatib Mwashetani, M.P. .....

24. Hon. George Ogalo, M.P. .....

25. Hon. (Major) MuluviMutua, M.P. .....

26. Hon. Mohamed, Diriye M.P. .....

27. Hon, Peter Kinyua, MP. .....

28. Hon. Shukra Hussein Gure, M.P .....

## 1.7 ACKNOWLEDGEMENT

The Committee wishes to register its appreciation to the offices of the Speaker and the Clerk of the National Assembly for the support accorded to the Committee in the execution of its mandate.

I also take this opportunity to thank all Members of the Committee for their dedication to Committee business. On behalf of the Departmental Committee on Environment and Natural Resources and pursuant to Standing Order 199 of the National Assembly I now have the honor to present the Committee's Report on the Inquiry into the lead poisoning at Owino-Uhuru Village in Mikindani, Mombasa by Metal Refinery EPZ Limited and Max Industries.

Thank You,

**SIGNED** .....

**CHAIRPERSON**

**DATE** 18/2/2016

## 2.0 BACKGROUND

Owino-Uhuru Village is a low income human settlement hosting a community of approximately 8,000 residents on the outskirts of the Island of Mombasa City. It is in Mikindani Ward, Jomvu Constituency in Mombasa County.

The Metal Refinery EPZ Limited Kenya is located at Mikindani along Mombasa-Nairobi highway next to corrugated sheets limited and was established in 2005. The project was intended to manufacture lead and lead alloys using scrap batteries (lead-acid batteries) from the region as raw materials.

### 2.1 EFFECTS OF METAL REFINERIES LIMITED FACTORY

The residents of Owino-Uhuru complained that the Metal Refineries Limited factory was having an adverse impact on their health and the buildup environment in the village. They alleged that the factory was a manufacturer of lead-acid batteries and that it had failed to properly manage its waste, both solid and liquid and gaseous emissions. This failure had led to the pollution of air, and water sources in and out the village and causing severe health problems in the village. They also alleged that the emissions from the factory had corroded the corrugated iron sheet roofs of their homes.

## 3.0 COMMITTEE FINDINGS

### 3.1 MEETING WITH NATIONAL ENVIRONEMNT MANAGEMENT AUTHORITY (NEMA)

The Committee met with the Director General National Environmental Management Authority Prof. Geoffrey Wahungu on 4th June, 2015. He informed the Committee that:-

i). On 13th March, 2007 NEMA received an Environmental Impact Assessment (EIA) Report from Metal Refinery EPZ Ltd for the construction of a Lead Smelting and Refinery Facility. The EIA was processed in line with the set procedures and the need for institution recognition;

ii). On 16th May, 2007, NEMA issued conditions for licensing to Metal Refinery EPZ Ltd. The proponent confirmed in writing to abide by the conditions set therein;

iii). A key condition for licensing was that the proponent was required to put in place adequate environmental protection measures to ensure the workers and the surrounding

inhabitants were not exposed to any fugitive lead emissions. These environmental protection measures included a properly functioning expansion chamber, the cooling tower, the cyclone, the filter bag house, scrubbers and provision of adequate protection equipment;

iv). Noting the high risk nature of the facility, the Authority on June 2007 undertook a trial run to ensure that the facility would operate within the prescribed standards and that the environmental protection measures were operational;

v). On 5th February, 2008, NEMA issued a conditional EIA licence to Metal Refinery EPZ Ltd. The licence was to undertake an installation of lead smelting and refinery facility;

vi). While the facility was operating, environmental audits were done to confirm the adequacy and efficacy of the environmental protection measures;

vii). The proponent was directed by NEMA to address air and water pollution vide Improvement Order dated 15th September, 2009;

viii). Nearly same time in September 2009 a letter was issued by Dr. Kepha M. Ombacho, the then Chief Public Health Officer, Ministry of Public Health and Sanitation recommending that the facility resumes operations on grounds that inspection were carried out indicated that the proponent achieved most of the conditions and omissions that were identified in earlier inspections;

ix). On 26th October, 2009, NEMA on advice from the Public Health department having been satisfied with the implementation of the environmental audit recommendations issued acknowledgement of compliance to the facility;

x). An inter-agency monitoring team was constituted by NEMA upon the issuance of the EIA to oversee that the conditions set in the licence and the improvement notices arising from the control audit were adhered to. The team comprised officers from NEMA, Public Health, Occupational Safety and Health, and the then Mombasa Municipal Council;

xi). Despite the measures set herein above, the authority received a complaint concerning the operation of the facility. As a result, control audit and inspection were carried out which revealed malfunctioning of environmental protection facilities;

xii). On 3rd October, 2011 the facility was issued with a closure order and advised to address the inadequacies noted during the control audit and that a further inspection was to be carried afterwards to confirm compliance with the order;

xiii). After NEMA sought interventions of Public Health, they received an inspection report by Mr. John K. Ndungu, the then Public Health Officer in Mombasa, who confirmed that the factory had complied with all major conditions issued to them and recommended that the cessation order to the lifted and allow the facility to operate but under close monitoring and supervision;

xiv). Furthermore air quality data undertaken by Polucon Services Limited confirmed that the air quality of the Metal RefineryEPZ Ltd was not posing a health risk to the environment. However the company recommended that another air quality survey should be done after one year;

xv). In March 2013, NEMA received a notification of the transfer of EIA licence from Metal Refinery EPZ Limited to Max Industries Ltd and subsequent a certificate of transfer of the EIA Licence was issued on 26th April, 2013;

xvi). Following the transfer, an Inter-agency Inspection Team undertook another control audit to confirm compliance with the conditions of the licence given to Max Industries Ltd. The team confirmed malpractices and illegal operations on recycling of lead batteries without a recycling licence subsequently a closure order was issued on 29th November, 2013,Compliance with the order was confirmed by the inter-agency team in the subsequent visits;

xvii). NEMA has already started a decommissioning strategy on the facility. The enforcement team has initiated an investigation on the criminal element of this issue with the intention of preferring charges against the proponent.

## 3.2 MEETING WITH RESIDENTS AND SITE VISIT

On 20th June 2015 the Committee held a meeting at Owino-Uhuru Village in Mikindani ward, Jomvu Constituency Mombasa County where it received submissions from the area's Leaders and Residents;-

**Hon.Badi Twalibu (Area M.P.)**

Hon. Badi Twalib, M.P informed the Committee as follows, that:

i). The Metal Refinery EPZ Ltd company was closed and the residents had agreed that they will not allow the company to be reopened again;

ii). There was need for the Government to ensure that justice is done for the people of Owino-Uhuru Village who were affected by lead poisoning as a result of the activities of Metal Refinery EPZ Ltd;

iii). The people have a right to clean environment and the government's role is to ensure clean environment for all as per the constitution;and,

iv). There is need for the government to do environmental restoration so that the residents of Owino-Uhuru can continue to live normally as they used to.

**Mr. Jackson Osewa** representing the residents of Owino-Uhuru Village

He informed the Committee that:-

i). The Owino-Uhuru village has 3,000 residents and out of these only fifty of the residents were screened;

ii). The residents were tested and were found to have high levels of lead in their blood. After testing with lead, the victims were given zinc and calcium but no treatment thereafter and have not healed; and,

iii). The Government should assist the residents to get continuous treatment and the restoration of the soil so that the residents can continue living normally as they used to.

**Mr. David Miago** - Resident of Owino-Uhuru Village

He informed the Committee that:-

i). He has lived in Owino-Uhuru Village for the last fifteen years and he is one of the residents, whowere affected and is now paralyzed and unable to walk properly; and,

ii). The factory started in 2007/08. When they questioned the presence of lead smelting factory in the village, they were told by the ministry of public health that the factory was bringing a lot of money to the Government.

**Mama Scholastica,** a resident and a grand-mother to an affected child (Kevin Musyoka)

She informed the Committee that:-

i). She has stayed in Owino-Uhuru Village since 2006;

ii). Her grand-son (Kevin Musyoka) was born healthy but in 2008 his health started to deteriorate. He started suffering from diarrhoea, weakness, loss of weight and skin started to change the color;

iii). She visited several government hospitals (Makadara and State House hospitals) but the boy's health did not improve;

iv). After visiting government hospitals without any change, she decided to visit Bangladesh Mission Hospital. The boy's blood sample was taken for testing and at this time it was discovered that the boy had been affected by lead poisoning; and

v). Master Kevin and other patients were given drugs however after the dosage was finished they were not given more drugs, they were informed that the county government was waiting to get the drugs from South Africa.

### 3.3 MEETING WITH THE MINISTRY OF HEALTH

The committee held a meeting on 2nd July, 2015 with Dr. Kepha Ombacho, **Director** Public Health at the Ministry of Health. He informed the Committee that:-

i). The Public Health Office was not involved in the Licensing of Metal Refinery EPZ Ltd;

ii). The Company was licensed by NEMA on 5th February, 2009 without public participation and consultation of other stakeholders;

i). The Metal Refinery EPZ Ltd started its operations in 2007 and yet it obtained its license in 2008;

ii). Before starting operation the company did not comply with EMCA,1999 regulations, Public Health and EIA Requirements;

iii). The Ministry of Health stopped the company's operations on two occasions citing flouting of conditions;

iv). The closure order on both occasions was lifted conditionally and the Factory was finally closed in October, 2014;

v). Detailed Correspondence between the company and the Ministry of Health indicated that the company was clearly involved in underhand deals as it tried to involve the then Municipal Council in Mombasa who were not privy to the history of the company instead of dealing with NEMA and the Public Health Office;

vi). The Ministry had to wait for results of blood samples from workers of the factory and residents to determine on the drug administration to the affected people;

vii). The treatment course to people affected by lead poisoning takes 19 days, the patient would require continuous testing thereafter but the patient would also have to be removed from the area to avoid continuous exposure;

viii). In 2014 the Public Health constituted a multidisciplinary team to investigate the issue of Lead poisoning, some of the recommendations include; the closure of the factory, clinical management of the residents affected, expand the screening of all the residents and relocation of the residents to avoid continued exposure to lead poisoning;

ix). Soil samples and dust particles in the area indicate high level of contamination and there is need to dig up the soil and have the area refilled with clean soil;

x). The Ministry has also developed guidelines for safe handling and disposal of hazardous substances including heavy metals in line with Basel, Rotterdam conventions to which Kenya is a signatory; and

xi). In conclusion, the Ministry stated that there was need to ensure that a public health report was provided before licensing premises to curtail licensing of harmful companies.

## 4.0 COMMITTEE OBSERVATIONS

Following the meetings with various stakeholders and a visit to Owino- Uhuru village, the Committee made the following observations:-

i). The relevant state agencies (NEMA and the Ministry of Health) had taken inordinately long to react to the health crisis in the village;

ii). There was lack of coordination between NEMA and the Ministry of Health that allowed Metal Refinery EPZ Ltd to flout rules;

iii). The patients at Owino-Uhuru were still being exposed to lead poisoning after treatment since the dust particles contained lead particles. There is need for a long term solution to the problem.

## 5.0 COMMITTEE RECOMMENDATIONS

The Committee recommends that:-

i). Metal Refinery EPZ Ltd and Max Industries should be held responsible for the lead poisoning and should be made to treat and compensate all the people affected by lead poisoning arising from their activities;

ii). NEMA should institute criminal proceedings against Metal Refinery EPZ Ltd and Max Industries;

iii). NEMA and the County Government of Mombasa should compel Metal Refinery EPZ Ltd and Max Industries to clean and restore the environment in the area to its original state devoid of lead poisoning;

iv). NEMA should consult other relevant agencies before issuing licenses, the licenses should only be pegged on 'no objection' from all relevant state agencies;

v). The National Government should fast-track the gazzettement of the 1999 regulations requiring proponents of projects to deposit security bonds with NEMA. The regulations should be forwarded to the National Assembly as per the provisions of the Statutory Instruments Act, within three weeks of the tabling of this report.

vi). Noting that this is a health issue and considering that health is a devolved function, the Committee recommends that the following actions should be taken by the Mombasa County Assembly:-

a)Ensure all people in Owino-Uhuru are tested to check whether they have been exposed to lead poisoning;

b)Ensure that the patients exposed to lead poisoning are given continuous medical treatment; and

c)Institute public consultations with the residents of Owino-Uhuru Village to consider the viability of relocating the residents in order to prevent continuous exposure.

# APPENDEX ONE

# MINUTES

**MINUTES OF THE 7TH SITTING OF THE DEPARTMENTAL COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES HELD ON THURSDAY FEBRUARY 18TH, 2016 AT 10.30 AM CPA ROOM, MAIN PARLIAMENT BUILDING.**

**PRESENT**

1. Hon. Abdalla Amina, M.P. – **Chairperson.**
2. Hon. Alexander Kosgey, M.P. – **Vice Chairperson.**
3. Hon. Wandayi James Opiyo, M.P.
4. Hon. Dr. Wanyonyi Reginalda N. M.P.
5. Hon. Sunjeev Kaur Birdi, M.P.
6. Hon. Kathuri Murungi, M.P.
7. Hon. Ottichillo K. Wilber, M.P.
8. Hon. Abdinoor Mohammed Ali, M.P.
9. Hon. Ole Kenta Richard Moitalel, M.P.
10. Hon. Muluvi Marcus Mutua, M.P.
11. Hon. Emanikor Joyce, M.P.
12. Hon. Farah, Abdulaziz Ali, M.P.
13. Hon. Irea Gideon Mwiti, M.P.
14. Hon. Ganya Francis Chachu, M.P.
15. Hon. Ogalo George Oner, M.P.
16. Hon. Gure Shukra Hussein, M.P.

**APOLOGIES**

1. Hon. Dukicha Hassan Abdi, M.P.
2. Hon. Geni Charles Mong'are, M.P.
3. Hon. Rop Jackson Kipkorir, M.P.
4. Hon. Ng'ang'a Alice Wambui, M.P.
5. Hon. Mwashetani Khatib, M.P.
6. Hon. Katana Aisha Jumwa, M.P.
7. Hon. Peter Kinyua, M.P.
8. Hon. Mohamed Diriye Abdullahi, M.P.
9. Hon. Jude Njomo, M.P.
10. Hon. Tonui Ronald Kiprotich, M.P.
11. Hon. Barua Ejidius Njogu, M.P.
12. Hon. Ndiritu Samuel Mathenge, M.P.

**THE NATIONAL ASSEMBLY**

1. Ms. Chebet Koskei - Clerk Assistant II
2. Mr. Hassan A. Araie -Clerk Assistant III
3. Mrs. Amran Yunis -Fiscal Analyst
4. Mr. James Muguna – Research Officer
5. Mr. Stephen Nyakuti –Hansard

**MIN.NO. DC/ENR/026/2016- PRELIMINARIES**

The meeting was called to order at 10.30 am after which prayers were said. The chair then welcomed the members.

**MIN.NO.DC/ENR/027/2016: ADOPTION OF REPORT ON THE INQUIRY INTO THE ALLEGED LEAD POISONING AT THE OWINO- UHURU VILLAGE IN MAKINDI MOMBASA BY METAL REFINERY EPZ LIMITED AND MAX INDUSTRIES.**

The committee went through the report and unanimously adopted after it was proposed by Hon. Dr. Wilber K. Ottichilo, M.P and seconded by Hon.Gideon Mwiti, M.P

And the committee also considered and adopted unanimously the **REPORT ON THE PROPOSED SAND HARVESTING IN DIANI AT THE SOUTH COAST BY THE CHINA ROAD AND BRIDGE CORPORATION** after it was proposed by Hon. Abdinoor Mohamed Ali, M.P and seconded by Hon. Moitalel Ole Kenta, M.P.

**MIN.NO. DC/ENR/028/2016 ADJOURNMENT**

There being no other business the meeting was adjourned at 11.10 AM.

**SIGNED**.....

**(Chairperson)**

**DATE**.....

# MINUTES OF THE 47TH SITTING OF THE DEPARTMENTAL COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES HELD ON THURSDAY 2ND JULY, 2015 AT 10.00AM C.P.A ROOM, MAIN PARLIAMENT BUILDINGS

## PRESENT

1. Hon. Abdalla Amina, M.P. – **Chairperson**
2. Hon. Ottichilo Wilber Khasilwa, M.P.- **Chairing**
3. Hon. Geni Charles Mong'are, M.P.
4. Hon. Ole Kenta Richard Moitalel, M.P.
5. Hon. Wandayi James Opiyo, M.P.
6. Hon. Kathuri Murungi, M.P.
7. Hon. Sunjeev Kaur Birdi, M.P.
8. Hon. Abdinoor Mohammed Ali, M.P.
9. Hon. BaruaEjidiusNjogu, M.P.
10. Hon. Gure Shukra Hussein, M.P.
11. Hon. Ogalo George Oner, M.P.
12. Hon. Peter Kinyua, M.P.
13. Hon. Mwashetani Khatib, M.P.
14. Hon. Ndiritu Samuel Mathenge, M.P.
15. Hon. Irea Gideon Mwiti, M.P.

## APOLOGIES

1. Hon. Alexander Kosgey, M.P. – **Vice Chairperson**
2. Hon. Muluvi Marcus Mutua, M.P.
3. Hon. Rop Jackson Kipkorir, M.P.
4. Hon. Dr. Wanyonyi Reginalda N. M.P.
5. Hon. Emanikor Joyce, M.P.
6. Hon. Farah Abdulaziz Ali, M.P.
7. Hon. Ganya Francis Chachu, M.P.
8. Hon. Tonui Ronald Kiprotich, M.P.
9. Hon. Ng'ang'a Alice Wambui, M.P.
10. Hon. Mohamed Diriye Abdullahi, M.P.
11. Hon. Katana Aisha Jumwa, M.P.
12. Hon. Dukicha Hassan Abdi, M.P.
13. Hon. Jude Njomo, M.P.

## IN-ATTENDANCE

THE NATIONAL ASSEMBLY

1. Ms. Chebet Koskei - Clerk Assistant II
2. Mr. Joshua Ondari - Clerk Assistant III
3. Ms. Lynette Otieno - Legal Counsel II

THE MINISTRY OF HEALTH

1. Dr. Kepha M. Ombacho – Ag. Director, Public Health
2. Dr. Kioko J.K – Head, Department of Public Health Services
3. Mr. Ibrahim M. Abdi – Ministry of Health
4. Mr. Robert M. Kilonzo – Ministry of Health

**MIN.NO. DC/ENR/211/2015 - PRELIMINARIES**

The Chairperson called the meeting to order at 10.20 am after which prayers were said. In the absence of the Chairperson, Hon. Wilber Ottichillo, M.P was elected by members present to chair the meeting.

**MIN. NO. DC/ENR/212/2015 – SUBMISSION BY THE MINISTRY OF HEALTH REGARDING LEAD POISONING AT UHURU- OWINO VILLAGE**

The Committee was informed that:-

(i) The Public Health Office was not involved in the Licensing of Metal Refinery EPZ Ltd. The Company was licensed by NEMA on 5thFebruary, 2009 without public participation and consultation of other stakeholders as required by law.

(ii) The Metal Refinery EPZ Ltd started its operations in 2007 and yet it obtained its license in 2008. Before starting operations the company did not comply with EMCA,1999 regulations, Public Health and EIA Requirements.

(iii) The Ministry of Health stopped the company's operations on two occasions citing flouting of conditions. The closure order on both occasions was lifted conditionally; the Factory was finally closed in October, 2014.

(iv) Detailed Correspondence between the company and the Ministry of Health indicated that the company was clearly involved in underhand deals as it tried to involve the then Municipal Council in Mombasa who were not privy to the history of the company instead of dealing with NEMA and the Public Health Office.

(v) The Ministry had to wait for results of blood samples from workers of the factory and residents to determine the drug administration to the affected people. The treatment course to people affected by lead poisoning takes 19

days. The patients would require continuous testing thereafter and would also have to be removed from the area to avoid continuous exposure.

(vi) On actions taken, the Ministry informed the Committee that in 2014 the Public Health constituted a multidisciplinary team to investigate the issue of Lead poisoning. Some of the recommendations include; the closure of the factory, clinical management of the residents affected, expand the screening of all the residents and relocation of the residents to avoid continued exposure to lead poisoning.

(vii) Soil samples and dust particles in the area indicate high level of contamination and there is need to dig up the soil and have the area refilled with clean soil.

(viii) The Ministry of Health has also developed guidelines for safe handling and disposal of hazardous substances including heavy metals in line with Basel, Rotterdam conventions to which Kenya is a signatory.

(ix) In conclusion, the Ministry stated that there was need to ensure that a public health report is provided before licensing the premises.

**MIN. NO. DC/ENR/213/2015 – SUBMISSION BY THE MINISTRY OF HEALTH ON NAKURU LEAD FACTORY,**

The Committee was informed that:-

(i) The factory was licensed by NEMA. The Ministry of Health both at National and County Level were not involved in the licensing process.

(ii) Following complaints, the County Public Health officer had ordered for closure of the factory.

(iii) Soil samples and blood samples from employees had been taken for testing.

**MIN. NO. DC/ENR/214/2015 - COMMITTEE OBSERVATIONS AND RESOLUTIONS**

The Committee made the following observations:-

(i) The Ministry of Health took very long to respond to act given the serious health effects of lead exposure.

(ii) There was and there still exists a lack of coordination between NEMA and Public Health which has created a loop hole for rogue companies to operate.

(iii) There is need to have a joint-sitting with NEMA and Public Health to establish who is culpable in both cases.

(iv) The members undertook to re-look at existing regulations and recommend on how much bond a company should pay before starting operations, this fund would be used to compensate for any harm committed by the company to human or the environment.

## MIN.NO. DC/ENR/213/2015 ANY OTHER BUSINESS

The Substantive Chair informed the Members that amendments to the Water Bill, 2014 would be in the Order Paper in the afternoon and requested the Members to be in the House to support the amendments.

## MIN.NO. DC/ENR/214/2015 ADJOURNMENT

There being no other business the meeting was adjourned at quarter to One O'clock.

SIGNED.....

(Chairperson)

DATE.....20/8/2015.....

MINUTES OF THE 29TH SITTING OF THE DEPARTMENTAL COMMITTEE ON ENVIRONMENT AND NATURAL RESOURCES HELD ON TUESDAY 6TH MAY, 2015 AT 10.00AM IN THE C. P. A. ROOM, MAIN PARLIAMENT BUILDINGS

PRESENT

1. Hon. Abdalla Amina, M.P. – Chairperson
2. Hon. Wandayi James Opiyo, M.P.
3. Hon. Dr. Wanyonyi Reginalda N. M.P.
4. Hon. Tonui Ronald Kiprotich, M.P.
5. Hon. Rop Jackson Kipkorir, M.P.
6. Hon. Geni Charles Mong'are, M.P.
7. Hon. Muluvi Marcus Mutua, M.P.
8. Hon. Ndiritu Samuel Mathenge, M.P.
9. Hon. Abdinoor Mohammed Ali, M.P.
10. Hon. Barua Ejidius Njogu, M.P.
11. Hon. Emanikor Joyce, M.P.
12. Hon. Kathuri Murungi, M.P.
13. Hon. Sunjeev Kour Birdi, M.P.

APOLOGIES

1. Hon. Ganya Francis Chachu, M.P.
2. Hon. Jude Njomo, M.P.
3. Hon. Peter Kinyua, M.P.
4. Hon. Ole Kenta Richard Moitalel, M.P.
5. Hon. Mohamed Diriye Abdullahi, M.P.
6. Hon. Ottichilo Wilber Khasilwa, M.P.
7. Hon. Farah Abdulaziz Ali, M.P.
8. Hon. Mwashetani Khatib, M.P.
9. Hon. Ogalo George Oner, M.P.

ABSENT

1. Hon. Alexander Kosgey, M.P. – Vice Chairperson
2. Hon. Irea Gideon Mwiti, M.P.
3. Hon. Katana Aisha Jumwa, M.P.
4. Hon. Gure Shukra Hussein, M.P.
5. Hon. Ng'ang'a Alice Wambui, M.P.
6. Hon. Dukicha Hassan Abdi, M.P.

IN-ATTENDANCE – THE NATIONAL ASSEMBLY

1. Ms. Tracy Chebet Koskei - Clerk Assistant II
2. Mr. Joshua Ondari - Clerk Assistant III
3. Ms. Lynette Otieno - Legal Counsel I

IN-ATTENDANCE – NEMA

1. Prof. Geoffrey Wakhungu – Director General NEMA
2. Irene Kamunge – Director Legal NEMA
3. Salome Machua – Deputy Director Enforcement, MEMA

MIN. NO. DC/ENR/130/2015 – PRELIMINARIES

The Chair called the meeting to order at 10.20 am and the proceedings started with a word of prayer followed by round of introductions.

MIN. NO. DC/ENR/131/2015 MEETING WITH NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

(i) LEAD POISONING IN OWINO-UHURU BY MAX INDUSTRIES

The Director General Prof. Geoffrey Wakhungu informed the Committee as follows: THAT

a) On 13th March, 2007, NEMA received from Metal Refinery EPZ Ltd an Environmental Impact Assessment report for the construction of a Lead Smelting and Refinery Facility. The EIA was processed in line with the set procedures and the need for institutional recognition;
b) On 16th May, 2007, NEMA issued conditions for licensing to Metal Refinery EPZ Ltd. The proponent confirmed in writing to abide by the conditions set;
c) The key condition for the license was that the proponent was required to put in place adequate environmental protection facilities to ensure workers and the surrounding inhabitants were not exposed to any fugitive Lead Emissions;
d) In June 2007, the authority undertook a trial run to ensure that the facility would operate within the prescribed standards and that the environmental protection measures were operational;
e) On 5th February, 2008, NEMA issued a conditional EIA license to Metal Refinery EPZ Ltd. The license was to undertake an installation of a Lead Smelting and Refinery Facility;
f) While the facility was operating, environmental Audits were done to confirm the adequacy and efficacy of the environmental protection;
g) On 15th September, 2009, the proponent was directed by NEMA to address on air and water pollution vide improvement order;
h) Nearly on the same time in September, 2009 a letter was issued by Kepha M. Ombacho, the then Chief Public Health Officer, Ministry of Public Health and Sanitation recommending that the facility resumes operations on grounds that inspection carried out indicated that the proponent achieved most of the conditions and emissions that were identified in earlier inspections;

i) On 26th October 2009 NEMA on advice from the Public Health department and having been satisfied with the implementation of the Environmental Audit recommendations issued acknowledgement of compliance to the facility;
j) An Inter-agency Monitoring team was constituted by NEMA upon the issuance of the EIA to oversee that the conditions set in the license and improvement notices a rising from the control audit were adhered to;
k) Despite the measures set herein above, the authority received a complaint concerning the operation of the facility. As a result, a control audit and inspections were carried out which revealed malfunctioning of environmental protection facilities;
l) On 3rd October, 2011 the facility was issued with a closure order and advised to address the inadequacies noted during the control audit and that a further inspection was to be carried afterward to confirm compliance with the order;
m) After NEMA sought intervention of Public Health, they received an inspection report by Mr. John K. Ndungu, the Public Health Officer in Mombasa, who confirmed that the factory had complied with all major conditions issued to them and recommended that the cessation order to be lifted and allow the facility to operate but under close monitoring and supervision;
n) In March 2013, NEMA received a notification of the transfer of the EIA licence from Metal Refinery EPZ Limited on Max Industries Ltd and subsequently a certificate of Transfer of the EIA licence was issued on 26th April, 2013;
o) Following the transfer, an inter-agency inspection team undertook another control audit to confirm compliance with the condition of the licence given to Max Industries Ltd. The team confirmed malpractices and illegal operations on recycling of lead batteries without a recycling licence and subsequently a close order was issued on 29th November, 2013, and
p) Following this NEMA has already started a decommissioning strategy on the facility. The enforcement team has initiated an investigation on the criminal element of this issue with the intention of preferring charges against the proponent.

(ii) EIA ON OIL EXPLORATION IN TURKANA AREA

The Director General Prof. Geoffrey Wakhungu informed the Committee as follows: THAT

a) So far the EIA licenses issued to Tullow Oil by NEMA in Turkana Block 10BB are for exploration. The EIA exploration covers appraisal phase because this is just a testing process to confirm commercialisation potential of the oil fields;
b) Currently, Tullow Oil is in the process of preparing EIA for the production phase since the appraisal phase has strong indication that the there is potential for commercial oil production. In this phase environmental impact assessment studies will be undertaken to cover Central Processing Facility, Connection Pipeline within the block, Road networks among other associated infrastructure,
c) The Authority is undertaking targeted inspections in the oil fields to ensure adherence with the EIA licence conditions, and
d) They are following up on the sewerage system and the quality of water from the wells dug by Tullow.

MIN.NO. DC/ENR/132/2015 COMMITTEE RESOLUTION

a) The Committee felt that there is need in future for NEMA to assess all big projects because it affects the communities, and
b) Tullow should involve the local community in any technology they want to adopt.

MIN.NO. DC/ENR/133/2015 ANY OTHER BUSINESS

The Chair informed the Committee that amendments to the EMCA Bill was before the Mediation Committee and would look at four clauses only.

MIN.NO. DC/ENR/134/2015 ADJOURNMENT

There being no other business the meeting was adjourned at quarter past twelve O'clock.

SIGNED.....

(Chairperson)

DATE.....28/5/2015.....

# APPENDEX TWO

# SUBMISSION.

# MINISTRY OF HEALTH.

REPUBLIC OF KENYA

MINISTRY OF HEALTH

# Assessment of blood lead levels among children in Owino Ouru Settlement in Mombasa County, Kenya, 2015

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By
Lead Poisoning Investigation Team

May 2015

## Table of Contents

## Investigators and Collaborators

| | Name | Institution |
|---|---|---|
| 1. | Dr. Etiang' Nancy | MOH, Resident FELTP (Principal Investigator) |
| 2. | Dr. Samwel Amwayi | MOH, FELTP |
| 3. | Tura Galgalo | AFENET |
| 4. | Dr. Charles Mbakaya | KEMRI |
| 5. | Gamaliel Omondi | MOH, Environmental Health |
| 6. | Mary Jean, Brown | CDC, Atlanta |
| 7. | Dr. Wences Arvelo | CDC |
| 8. | Dr. Shem Patta | Mombasa County Health Director |
| 9. | J. Kimwele | Mombasa County PHO |
| 10. | John Ndungu | Jomvu Sub-County PHO |
| 11. | Dr. Zeinab Gura, | MOH,FELTP |
| 12. | Dr. Jane Githuku, | MOH,FELTP |
| 13. | Waqo Boru, | MOH,FELTP |
| 14. | Dr. Mark Obonyo | MOH,FELTP |
| 15. | Emily Okworo | MOH, Government Chemist Department |
| 16. | Ibrahim Longolomoi | MOH, Environmental Health |
| 17. | Hezron Onyangore | MOH, Government Chemist Department |
| 18. | Wandera Bideru | MOH, Government Chemist Department |
| 19. | Pauline Ngari | MOH, Environmental Health |
| 20. | Erastus Muniu | KEMRI |
| 21. | Shem Ochieng | JKUAT |
| 22. | Albert Bunyasi | MOH, Biosafety and Biosecurity |

## Executive Summary

**Background:** Concerns of possible lead exposure from fly ash emissions of a battery recycling factory in an informal settlement in Mombasa was brought up by the community members following high lead levels found in blood samples from three children. This study aimed at determining blood lead concentrations, lead levels in the environment and factors associated with elevated blood lead level among children aged 12 to 59 months from the settlement.

**Methods:** This is a cross sectional study of children aged 12-59 randomly selected from households in two informal neighbouring settlements (Owino Ouru and Bangladesh). Structured questionnaires on social, demographic, child's behaviour and household characteristics were administered to caregivers. Venous blood (1-3ml) drawn from each child was tested for lead using LeadCare®II portable analyzer. Household dust, drinking water and soil from compound in half of the sampled households was collected and tested for lead using graphite furnace atomic spectrometry at the Government chemist.

**Results:** We obtained blood samples from 161 children in 161 households, 83 soil samples, 76 dust and 73 water samples. Of these, 31 blood samples were not included in the analysis because they were obtained during pretesting and upon parents' request. We randomly selected 130 children, 65 from each settlement, of these 59 (45%) were males and median age was 39 months (Interquartile Range (IQR): 30 - 52). Blood lead levels ranged from 1µg/dL to 31µg/dL with 20 (31%) children from Owino Ouru and 5 (8%) children from Bangladesh having blood lead levels of ≥ 10µg/dL. Forty five (69%) children from Owino Ouru and 18 (28%) children from Bangladesh had blood lead levels of ≥ 5µg/dL. None of the children had blood lead levels above 45µg/dL. The mean blood lead level (9µg/dL; Standard deviation (SD): 6) of children from Owino Ouru was significantly higher than the mean blood lead level (4.4µg/dL; SD: 3) of children from Bangladesh, t= 5.47; 95% CI: 2.9 - 6.2; (p = < 0.0001). The mean lead concentration of soil (387 mg/Kg; SD: 625) from Owino Ouru was also significantly higher than the mean lead concentration of soil (74mg/Kg; SD: 127) from Bangladesh, t= 2.77; 95% CI: 87 – 539; (p = 0.007). The presence of soil lead > 400 mg/Kg was associated with higher blood lead levels (p=0.01).

**Conclusions:** There were significantly high blood lead levels in children from Owino Ouru indicating that the children are being exposed to lead in their living environment. This requires medical care, blood lead screening, community sensitization, health education, nutritional counselling, surveillance and environmental lead reduction interventions.

**Key words:** Childhood, Blood, Lead, Environmental Exposure, Kenya

## Introduction

It is estimated that high blood lead levels contribute to approximately 600,000 cases of intellectual disability in children annually (WHO, 2010) and was responsible for 143,000 deaths in 2004. There is no known safe threshold of blood exposure since adverse effects have been shown to occur at levels of below 5µg/dL (1). Low lead levels in young children results in mental retardation, impaired intellectual and cognitive function, learning disabilities, poor attention, hearing disorders and decreased growth (2). Acute lead poisoning causes gastrointestinal disturbances (anorexia, nausea, vomiting, abdominal pain), hepatic and renal damage and neurological effects (malaise, drowsiness, encephalopathy) that may lead to convulsions, coma and death (3). Lead exposure is often asymptomatic at low levels hence remains undiagnosed and untreated.

Children <5 years old are at increased risk of lead poisoning because of their innate curiosity and hand to mouth behaviour (4). Children have higher lead intake per unit body weight and body systems not fully developed leading to increased gastrointestinal absorption and distribution to the brain through the blood brain barrier (5). Their developing central nervous system is also more vulnerable to lead. Absorption of lead into the body is affected by many factors, including age, nutritional status and lead particulate size. Lead is poorly excreted, and most lead is sequestered in bone. As a result, elevated BLLs take months to years to decrease, even in cases where external exposures have been well controlled and chelation therapy has been instituted, because bone stores are mobilized into blood (6).

During the last decade measures have been taken to reduce lead exposure globally. Following the removal of lead from gasoline, dramatic reductions in blood lead concentrations have been observed (7) (8) however, leaded paint in houses built before 1950 remains the major source of lead exposure for American children (9). Children are exposed to lead through ingestion of weathering paint and inhaling dust or soil contaminated with such paint. In low income countries children are at increased risk of exposure to lead from other multiple sources (10). Studies have documented elevated blood lead levels in children living in communities involved in mining (11) smelting (12) and used acid lead battery recycling (13) where the children get exposed to lead by eating the contaminated soil or inhaling polluted air from the industrial emissions. Additionally, outbreaks of lead intoxication have been associated with drinking water from pipes, solders and fittings containing lead, use of ceramic utensils glazed with lead, eating food stored in lead soldered cans, playing with toys

containing lead, use of traditional remedies such as *kohl* and cosmetics containing lead (10). Adults working in jobs or hobbies such as smelting, auto repair, firing ranges, painting, ceramics, pottery, electrical, wire and cable works, battery manufacturing and recycling and stained glass making, carry the generated lead dust on clothes and contribute to the lead dust in the child's home. Children living in these homes are exposed to lead by licking dust laden fingers or inhaling lead particles in the air.

In 2007 a battery recycling and smelting factory was established in an informal settlement in Mombasa County along coastal Kenya. In 2010 an investigation was conducted in the Owino Ouru and three children were tested for blood lead levels. They had blood lead levels as high as 23µg/dl, 17µg/dl and 12µg/dl (Okeyo, 2012). Following these findings community members complained and the factory was closed in July 2012 by the local health authorities. Despite this action, concerns remained regarding appropriate closure of the factory and possible ongoing lead exposures in the community.

On 21st July 2014, the Ministry of Health (MOH) began an investigation to determine blood lead levels among children aged 12 to 59 months in the informal settlement, lead levels in the environment and identify risk factors for elevated blood lead level in this population. Findings from the investigation will enable public health authorities to make evidence based actions to safeguard public health in the affected community.

## Methods

### Site

We conducted the investigation in two informal settlements located in Mombasa County along coastal Kenya (Figure 1). Owino Ouru borders the northern side of the battery recycling factory, and consists of 450 households with a population of 1,700 persons. Bangladesh, a community located on the south western side and more than 2km upwind from the factory was included as the comparison site. Bangladesh consists of 1,500 households with a population of 5,000 persons. Bangladesh has similar demographics (such as traffic patterns, housing conditions) but does not share water sources with Owino Ouru and has no known battery recycling factories.

### Investigation

We enrolled children aged 12 to 59 months who resided in either of the settlements since January 2014. We investigated children because at this age they are vulnerable to relatively low lead levels and develop irreversible health effects. We excluded children from the survey whose parents or guardians did not provide consent and households that were vacant at time of household listing. Village elders from the two settlements filled in a household list with details of household membership and ensured that all eligible households with children 12-59 months of age were included in the sampling frame.

When we assumed blood lead level variance in this population to be 25 and 10% non-response rate, a sample size of 65 children from each settlement provided us 99% power to detect a difference in mean blood lead levels of 4µg/dL at 95% confidence. We randomly selected 65 households from each sampling frame using table of random numbers. Upon reaching a house we administered four screening questions to whoever was found in the house. These questions included whether the household has a child aged 12 – 59 months, duration of stay in the settlement ≥12 months, presence of parent or guardian and whether they will provide a written consent. If the answers to all the four questions were 'yes' we proceeded with the interview. One child was randomly selected to participate in the study. If a house was unoccupied or the sampled child was not present at time of visit, the house was visited later that day or at different time on another day. If a house was permanently vacant, if the caregiver declined to participate or was not available for interview after multiple attempts

then the next household in the sampling frame was visited. We recorded this information on a household visitation log sheet.

A standard explanation describing the purpose of the study, the procedures to be followed, the risks and benefits of participation was read to all caregivers and a signed written consent obtained. Data was collected using a pretested structured questionnaire translated to Kiswahili. We collected demographic information including sex and age, clinical and treatment history, factors known to increase risk for elevated blood lead levels such as children's behaviour habits (frequency of outdoor playing, washing hands before eating, eating soil or sand), housing type, sources of drinking or cooking water, the presence of a household member with known exposure to lead, proximity to a battery recycling factory, and whether waste from factory stand around the house. Global positioning system (GPS) coordinates of place of residence was taken at the entrance of the house and used to map and calculate distances from the smelter factory.

**Laboratory**

A venous blood specimen was collected from every child. The venepuncture site was thoroughly cleaned with alcohol wipes, dried with dry gauze before the specimen was obtained. Approximately 1 -3ml of blood sample was collected in a vacutainer containing an anticoagulant, ethylenediamine tetra acetic acid (EDTA). In 10% of the children a second sample was obtained for quality control. Lead free blood collection supplies were provided by the Inorganic Chemistry Laboratory at US CDC. All blood samples were stored at 4°C and venous samples were shipped on frozen packs to be analyzed at the National Public Health Laboratory in Nairobi accompanied by laboratory request form.

The blood samples were tested for lead using LeadCare ® II, a portable blood lead analyzer. The LeadCare ® II instrument quantifies BLLs from 3.3- 65 µg/dL. These levels are measured with a level of detection (LOD) accuracy level of ± 3 µg/dL. We used the actual value of levels below the LOD for statistical analyses. However, parents and clinical health care providers were only notified that the child's BLL is below the LOD.

**Environmental Sampling**

We collected dust, water and soil samples from fifty percent of randomly visited households as per the US Housing and Urban Development (HUD) protocol sampling procedures

recognized by EPA (HUD, 1996). We collected five composite soil samples from bare soil outside the households where the child normally plays. A subsample was obtained from the center and one subsample from each of four different directions one meter from the center. The subsamples were collected by scooping the top surface soil using a four oz plastic scoop and poured into a labelled zip-lock bag. We collected water used by the household for drinking into a 125ml sample bottle. Dust was collected from the floor of the house by multidirectional wipe sampling method using wet wipes over an area laid using reusable template measuring 6 by 6 inches. The folded wipe was placed in a zip lock bag. All the used materials were discarded in trash bags. To prevent contamination or exporting of lead dust, hands were cleaned with baby wipes after each sample collection and clean gloves worn before collecting samples in the next area. All environmental samples were placed separately in properly labeled clean, plastic bags. Sample forms were filled with details that included unique sample number, gprs location, sampling method used, date of collection, and the name of the person who collected each sample. The samples together with laboratory form were sent to Government chemist laboratory for analyses. The environmental samples were analyzed for lead levels using graphite furnace atomic absorption spectrometry at the Government chemist laboratory.

**Data management and analysis**

All data was entered and validated in database using Epi Info™ 7.1.4 (CDC, Atlanta, GA, USA). We performed descriptive analysis and used the two-sample t-test in the continuous variables. An elevated blood lead level was defined as blood lead concentration ≥10µg/dL based on WHO guidelines. Contaminated environment was defined as lead concentration in either soil >400mg/Kg, in house dust >40µg/f$^2$ or in drinking water >50µg/L (0.05mg/L). The results were presented in tables and figures.

**Ethical Considerations**

Written informed consent to administer the questionnaire and draw blood was obtained from the caregivers. All the questionnaires, laboratory specimens and other records were identified by unique identity number to maintain participant confidentiality. We obtained additional blood samples from other children in the sampled household when the parent requested but their data was not included in this analysis. All the children who had elevated blood lead levels (≥ 10µg/dL) were linked to follow up care as per the CDC guidelines of managing elevated BLL in children (ACCLPP, 2012). Questionnaires were stored under lock and key.

Electronic data was stored in a password protected database. The scientific approval for the study was obtained from the Ministry of Health, lead poisoning Technical Working Group (TWG). Expedited ethical approval was sought from the Kenya Medical Research Institute (KEMRI) since this investigation was considered a public health response. Prior to commencement of the investigation, permission was sought from the Mombasa County Department of Health Services.

## Results

We visited 161 households and obtained blood samples from 161 children in both settlements. Responses from 31 participants were excluded from data analysis because data and blood samples were obtained during pretesting or from the children whose parents requested but were not in the sampling list. A total of 130 children aged 12 – 59 months: 65 from each settlement were included in the analysis. Median age was 39 months (IQR: 30 - 52), and 59 (45%) males. The median number of people living in households of sampled children was five (range 2 -13) and the median number of children 12 – 59 months in each sampled household was one child (range: 1 – 4). Of the 65 children from Owino Ouru, 31 (48%) lived within 200m radii from factory and 16 (25%) lived in a household with at least one adult working in any job involving lead for last five years. Nine (14%) of the children from Bangladesh were also living in a household with at least one adult working in any job involving lead for last 5 years (Table 1).

Blood lead levels among sampled children ranged from 1µg/dL to 31µg/dL. In overall, 63(48%) children had blood lead levels of ≥5µg/dL and 20 (19%) children had blood lead levels of ≥ 10µg/dL. There were 45 (69%) children from Owino Ouru and 18 (28%) children from Bangladesh with blood lead levels of ≥ 5µg/dL. Twenty (31%) children from Owino Ouru and five (8%) children from Bangladesh had blood lead levels of ≥ 10µg/dL. None of the children had blood lead levels above 45µg/dL. The mean blood lead level (9µg/dL; Standard deviation (SD): 6) of children from Owino Ouru was significantly higher than the mean blood lead level (4.4µg/dL; SD: 3) of children from Bangladesh, t= 5.47; 95% CI: 2.9 - 6.2; (p = < 0.0001).

We collected 83 soil samples, 76 dust and 73 water samples. Among these, 62 of each sample type: 30 from Owino and 32 from Bangladesh were included in the analysis. The remainder were obtained from households that recorded high blood lead in children and from the factory and its environs. The mean lead concentration of soil from Owino Ouru (387 mg/Kg; SD: 625) was significantly higher than the mean lead concentration of soil from Bangladesh (74mg/Kg; SD: 127); t= 2.77; 95% CI: 87 – 539; (p = 0.007). Soil samples obtained in the factory compound had the highest lead concentration (26,837 mg/Kg) followed by the one collected at the factory gate (2,381 mg/Kg). The mean lead loading of house dust from Owino Ouru (15.6µg/f$^2$; SD: 29) was higher than the mean lead loading of house dust samples from Bangladesh (4.7µg/f$^2$; SD: 14) but this difference was not statistically

significant t= 1.93; 95% CI: 0.4 – 22; (p = 0.058) and both levels were below the action levels. The lead concentration of water samples from Owino Ouru was below the action level (50µg/L).

In the analysis of children from Owino Ouru only, more males 24 (60%) as compared to females had blood lead levels ≥ 10µg/dL (OR: 5 (95% CI:2-15). Of the 20 children with blood lead level ≥ 10µg/dL, 19(90%) reside <200m radii from factory. There was no significant difference in blood lead among children living in households that had adults who worked for the last 5 years in jobs that involved lead. The main source of drinking or cooking water in 100% the households was from tanks supplied by the municipality. Children from houses that used other sources of water such as wells 8(40%), rain water 2(10%) and boreholes in 6(30%) did not show significant differences in the blood lead levels. Mud floor 5(25%), mud wall 15(60%), growing own or obtaining vegetables grown by neighbour for consumption 1(5%), eating soil/sand 13(65%), not washing hands all times before eating 9(45%), ever breastfed 65(100%), playing outside >6hrs 13(65%) and spending most time in school 3(15%), in compound 2(10%) or in the house 2(10%) also did not reveal any differences in blood lead (Table 2).

## Discussion

Findings from our study demonstrate significant elevations in blood lead levels among children aged 12 – 59 months in Owino Ouru in comparison to similar children from Bangladesh. There were also significant elevations in soil lead concentration in Owino Ouru. Lead content in soil, close proximity of the household to the smelter and sex of child were identified as risk factors that expose children living in Owino Ouru to higher blood lead levels. Our findings support the hypothesis that blood lead levels among children in Owino Ouru are different from the blood lead levels of children from Bangladesh and the difference is associated with increased lead concentrations in the Owino Ouru children's environment. Urgent interventions are required to reduce lead exposure in the affected community.

Although none of the children had blood lead level 45µg/dL or above, the level at which CDC recommends chelating therapy, the resulting study showed that 70% of the tested children in Owino Ouru had levels above the reference value of 5µg/dL and 30% had blood lead levels at or above the WHO maximum acceptable level ≥10µg/dL, a rate 4 times higher than that found in children in a demographically similar community of Bangladesh that does not have a battery factory. This prevalence is higher than the prevalence of 1.4% reported in bio-monitoring studies of U.S. children 1-5 years old in NHANES 1999-2004 (7). Blood lead elevations have similarly been documented in other studies of children exposed to industrial emissions from used acid battery recycling informal establishments. Fifty nine percent of children in Jamaica (12), 80% of Nicaragua children (14) and 91% of children from Haina, Dominican (12) had blood lead level ≥10µg/dL. Three of the children in Owino Ouru had levels of between 20 and 45µg/dL. At those levels, there could be clinical evidence of lead poisoning (interference with vitamin D metabolism), but the health consequences of the prevailing elevations of blood lead are usually demonstrable only on a population basis as cognitive and developmental deficits. Further studies on neuropsychological and developmental evaluations are necessary. The public health response to such findings should be termination of toxic emissions and abatement of existing contamination; removal of children from the identified sources is usually not an option.

The finding that 8% of the children from Bangladesh had blood lead level >10µg/dL indicates that sources of lead exposure other than battery activities in these communities exist. This finding is however lower than the prevalence of 14% reported among 1-3 year old well Lebanese children presenting to paediatric clinics (15) and 30% of the controls in the

Nicaraguan children (14). Higher lead concentration observed in water samples could be a possible reason for this elevation. There is need to screen for blood lead, monitor water quality and establish the other common causes of lead exposure among the children not necessarily living near battery factory.

Our study had two limitations. First, the study sample size focused on determining difference in blood lead levels in the two settlements. We did not have enough statistical power to study the potential risk factors between the children with different blood lead levels. We also had few adults working in jobs known to involve lead and therefore we could not determine effect of take home lead. Secondly because this cross sectional investigation carried out two years after closure of factory, the magnitude of poisoning may have been different among the children who were in this age category two years ago. The difference in blood lead levels obtained in this study cannot be generalised to that of children living in the settlement when the factory was operational. Despite these limitations it appears that significant childhood lead exposure from the environment still persists, however follow-up assessments are needed to identify all potential sources.

Conclusions

There was significantly high blood lead levels in children from Owino Ouru associated with high soil lead concentrations. The most immediate priority is to reduce exposure to lead and other contaminants. This is best accomplished by developing and implementing a comprehensive and integrated intervention plan. Specifically, the process should ensure that the factory remains closed so as to reduce air lead emissions; Implement interventions that have been demonstrated scientifically to reduce lead exposure from historical soil contamination and develop a scientifically robust plan to monitor the impact of lead reduction efforts. To strengthen the overall process and plan, and to improve credibility and ensure that monitoring and other needs of affected parties are met, stakeholders should participate in reduction planning, implementation, and monitoring of lead and other contaminants.

Laboratory results should be made available to study participants immediately for appropriate action. In 2012 CDC adopted an upper reference range value for blood lead of 5µg/dL based on the 97.5% of the distribution of BLLs in children. We recommend that children with blood lead levels $\geq$ 5µg/dL have venous blood lead tests performed three months after this investigation and follow up of the children over time until the environmental investigations

and subsequent responses are complete. Children with blood lead levels < 5 μg/dL require retesting in not less than one year until the lead sources have been controlled or eliminated or they turn 6 years old. In this community irreversible adverse effects of lead poisoning will be prevented if children undergo monitoring of blood lead levels.

Certain vitamins and minerals, especially Calcium, Iron, Zinc and vitamin C, play a specific role in minimizing lead absorption. A well-balanced diet is essential to meeting the child's recommended daily allowance of essential vitamins and minerals and to provide adequate calories for growth. Regular assessment of the child's nutritional status during follow up care can identify children with inadequate intake of these and other nutrients, and allow the clinician to proactively recommend supplementation. Children exposed to lead should be evaluated for anaemia and any iron deficiency corrected using iron supplements (AAP guidelines).

Training of clinicians on high index of suspicion, lead screening questions, blood testing of lead, and treatment is essential in management of lead exposure. Clinicians should emphasize on healthy nutrition and/or dietary supplements. They should also be involved in outreach and community health education, overseeing ongoing monitoring of children with elevated blood lead levels, defined as levels above the reference value, coordinating efforts with parents and county authorities to minimize risks to individual children and to assist communities in their primary prevention efforts.

Primary prevention is a strategy that emphasizes the prevention of lead exposure, rather than a response to exposure after it has taken place. Primary prevention is necessary because the effects of lead appear to be irreversible. In the U.S., this strategy largely requires that children not live in older housing with lead-based paint hazards. Screening children for elevated BLLs and dealing with their housing only when their BLL is already elevated is no longer advisable (Centers for Disease Control and Prevention (CDC) Advisory Committee on Childhood Lead Poisoning Prevention (ACCLP, 2012). The goal of primary prevention is to ensure that all homes become lead-safe and do not contribute to childhood lead exposure. Prevention requires that we reduce environmental exposures before children are exposed to these hazards. It is important to carry out regular environmental testing of dust, soil and water testing and evaluation of homes for lead sources. Termination of toxic emissions and abatement of existing contamination is necessary to reduce exposures. This may require the

removal of children from the identified sources until the environment is confirmed to be safe for the children.

There is need for coordination of care with the local authorities and organizations to plan a response strategy. Efforts to increase awareness of lead hazards and ameliorative nutritional interventions are also key components of a successful prevention policy. Finally the establishment of a screening program and effective screening policies and practices by the Kenya Ministry of Health will ensure that the children of high-risk families are screened, and that lead-exposed children or children with elevated blood lead levels receive key environmental interventions and case management services.

## Acknowledgements

This investigation was financially supported by the Ministry of Health, Kenya Field Epidemiology and laboratory training program and testing materials from CDC Atlanta. The authors thank the community members and village elders for their cooperation during the investigation; the assistant Deputy Commissioner, Gitonga and Chiefs Ima and Bakari for social mobilization; Mombasa County Department for Health services: B.Omar, K.Shikely, R.Mwanyamawi, H.Mohammed, T.Suleiman for permitting us to carry out the investigation; Jomvu Sub-County Health Officers: S.Swaleh, N.Tindell, H.Wasike, F.Kenyatta, Wycliff for actively participating in the investigation; Human Rights activist: P.Omide for mobilizing the community; FELTP staff: A.Sitati, M.Mwangi, Gabriel for administrative support; FELTP Cohort 11 residents for data and sample collection (T.Kigen, Mark, Angeline, V.Oramisi, C.Kiama, Boniface, Maza, Miheso, J.Rotich, Muiruri, Morris, Abdulkadir, Paul, Ngere, B. Ochieng, Caren, Tabitha, Omesa, Githuka); MOH staff: K.Kassachoon, J.Kioko, K.Ombacho for permitting us to carry the investigation; KEMRI Ethics and Review Committee for ethical approval; Government Chemist staff: Munyoki, Musyoki, Mombasa staff for laboratory testing; CDC staff Timothy Dignam, Nielsen Jay for developing the study maps and study design; Alfred Musekiwa for providing statistical support and Dorothy L Southern for providing guidance in scientific writing and critically reviewing this report.

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## Tables and figures

**Table 1: Demographic, clinical and environmental characteristics of children in Lead study in two informal Settlements, Mombasa County, Kenya, January 2015**

| Characteristics | Owino Ouru (N = 65) n (%) | Bangladesh (N = 65) n (%) | Total (N = 130) n (%) |
|---|---|---|---|
| Male | 13 (52) | 58 (55) | 71 (55) |
| Median age in months (IQR) | 42 (31 – 50) | 36 (27 – 52) | 39 (30 – 52) |
| Age Groups (Months) | | | |
| 12 – 23 | 10 (15) | 14 (22) | 24 (19) |
| 24 – 35 | 15 (23) | 18 (28) | 33 (25) |
| 36 – 47 | 18 (28) | 6 (9) | 24 (19) |
| 48 – 59 | 22 (34) | 27 (42) | 49 (38) |
| Living < 200m from Battery recycling Factory | 31 (48) | 0 0) | 31 (24) |
| Living in HH* with adults working in job involving lead for last 5 yrs | 16 (25) | 9 (14) | 25 (19) |
| Blood lead Levels (µg/dL) | | | |
| < 5.0 | 20 (31) | 47 (72) | 67 (52) |
| 5 – 9.9 | 25 (39) | 13 (20) | 38 (29) |
| 10 – 19.9 | 16 (25) | 5 (8) | 21 (16) |
| 20 – 45.0 | 4 (6) | 0 (0) | 4 (3) |
| Clinical Symptoms | | | |
| Recurrent abdominal Pain | 20 (31) | 18 (28) | 38 (29) |
| Speech/language delay | 11 (17) | 2 (3) | 13 (10) |
| Recurrent constipation | 6 (9) | 4 (6) | 10 (8) |
| Joint pains | 4 (6) | 2 (3) | 6 (5) |
| Poor concentration | 2 (3) | 2 (3) | 4 (3) |
| Muscle aches | 2 (3) | 1 (2) | 3 (2) |
| Seizures | 0 (0) | 1 (2) | 1 (1) |
| Lead content of environmental samples | | | |
| (n) | 30 | 32 | 62 |
| Soil (>400mg/Kg) | 6(20) | 1(3) | 7(11) |
| House dust (>40µg/f$^2$) | 4(13) | 3(9) | 7(11) |
| Drinking water (>10µg/L or 0.01mg/L) | 1(3) | 14(44) | 15(24) |

*Households

**Table 2: Analysis of child's behaviour, household characteristics and environment by blood lead level among children aged 12 – 59 months in an informal Settlement, Mombasa County, Kenya, January 2015**

| | Blood Lead Level (µg/dL) | | | |
|---|---|---|---|---|
| | >10 (N=20) n (%) | < 10 (N=45) n (%) | OR (95% CI) | p- Value |
| Male | 24 (60) | 12 (53) | 5 (2 -15) | 0.002 |
| Age Groups (Months) | | | | |
| 12 – 23 | 3 (15) | 7 (16) | 1 (0.2 - 4) | 0.950 |
| 24 – 35 | 7 (35) | 8 (18) | 3 (1 - 8) | 0.131 |
| 36 – 47 | 4 (20) | 14 (31) | 1 (0.2 - 2) | 0.359 |
| 48 – 59 | 6 (30) | 16 (36) | 1 (0.2 - 2) | 0.665 |
| Living < 200m from Battery Recycling factory | 18 (90) | 13 (29) | 22 (5 - 109) | < 0.0001 |
| Adult worked in job that involved lead | 6 (30) | 10 (22.2) | _2 (1 - 5) | 0.5 |
| Households with adults working in following jobs for last 5 yrs. | | | | |
| Smelting | 2 (10) | 2 (4) | 2 (0.3 - 18) | 0.393 |
| Auto Repair | 1 (5) | 5 (11) | 1 (0.1 - 4) | 0.436 |
| Firing Ranges | 0 (0) | 2 (4) | | |
| Painting | 2 (10) | 6 (13) | 1 (0.1 - 4) | 0.708 |
| Ceramics | 2 (10) | 2 (4) | 2 (0.3 -18) | 1.393 |
| Electrical | 1 (5) | 2 (4) | 1 (0.1 -14) | 0.922 |
| Battery Manufacturing | 2 (10) | 0 (0) | | |
| Recycling Batteries | 5 (25) | 0 (0) | | |
| Wire and Cable | 1 (5) | 0 (0) | | |
| Pottery | 2 (10) | 1 (2) | 5 (0.4 - 57) | 0.171 |
| Stained glass making | 2 (10) | 2 (4) | 2 (0.3 - 18) | 1.393 |
| Primary Drinking & Cooking Water Source | | | | |
| Public Water | 65 (100) | 65 (100) | | |
| Well | 8 (40) | 11 (24) | 2 (1 - 6) | 0.207 |
| Rain Water | 2 (10) | 7 (16) | 1 (0.1 - 3) | |
| Bore hole | 6 (30) | 10 (22) | 2 (1 - 5) | 0.505 |
| Water Vendors | 0 (0) | 2 (4) | | |
| Floor Type | | | | |
| Mud | 5 (25) | 17 (38) | 1 (0.2 - 2) | 0.318 |
| Concrete | 13 (65) | 26 (58) | 1 (1 - 4) | 0.586 |
| Wall type | | | | |
| Mud | 15 (60) | 76 (72) | 1 (0.2 – 1) | 0.227 |
| Bricks/Stone | 15 (24) | 18 (27) | 1 (0.4 – 2) | 0.690 |
| Sources of Vegetables/Fruits consumed in household | | | | |
| Grow Own | 1 (5) | 12 (27) | 0.1 (0.02 - 1) | 0.04 |
| Neighbour grows | 0 (0) | 4 (9) | | |
| Vendors | 15 (75) | 35 (78) | 1 (0.3 - 3) | 0.808 |
| Types of Vegetables consumed that are grown by household or from neighbour who grows | | | | |
| Tomatoes | 0 (0) | 8 (18) | | |
| Kales | 0 (0) | 11 (24) | | |

| | | | | |
|---|---|---|---|---|
| Onions | 0 (0) | 9 (20) | | |
| Traditional Vegetables | 1 (5) | 17 (38) | 0.1 (0.01-1) | 0.007 |
| Carrots | 0 (0) | 6 (13) | | |
| Spends most of day | | | | |
| In School | 3 (15) | 9 (20) | 3 (1 -13) | 0.245 |
| Inside compound | 2 (10) | 4 (9) | 2 (0.2 - 7) | 0.887 |
| In the house | 2 (10) | 4 (9) | 2 (0.2 - 7) | 0.887 |
| Eat Soil or Sand | 13 (65) | 23 (51) | 2 (1 – 5) | 0.302 |
| Doesn't wash hands all times | 9 (45) | 15 (33) | 2 (1 – 5) | 0.372 |

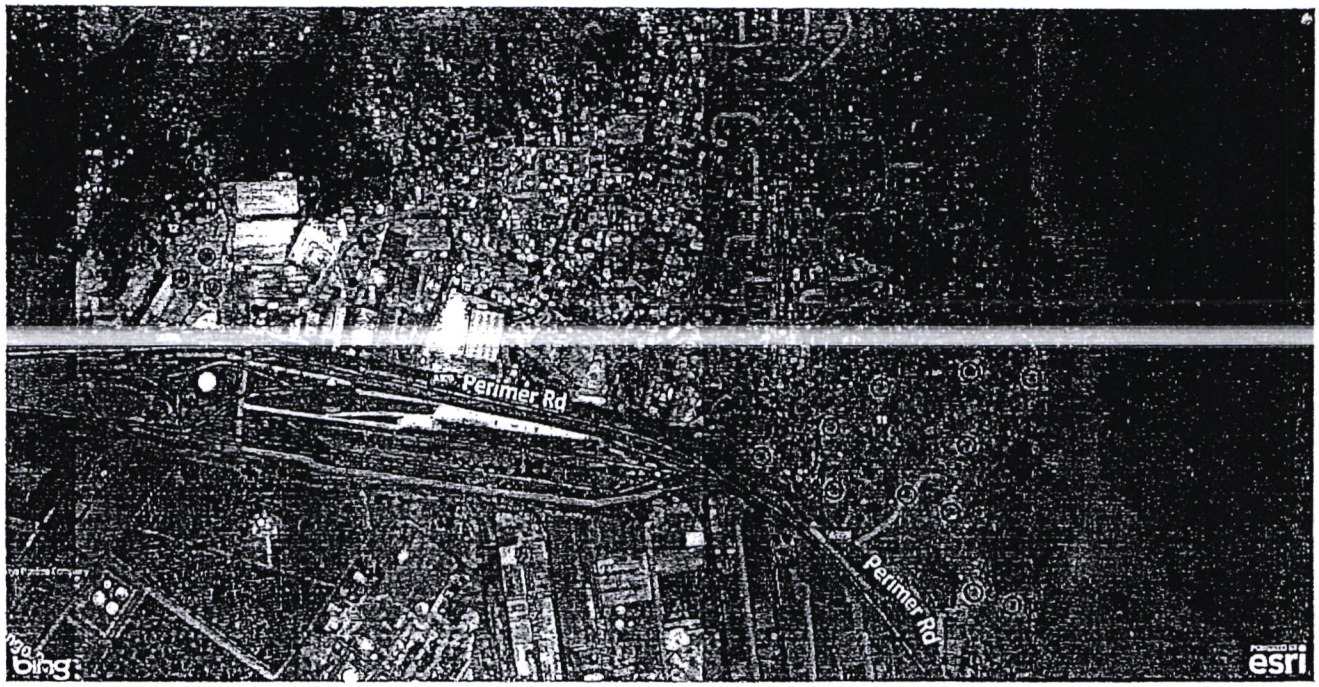


**Figure 1: Map showing distribution of children aged 12 – 59 months in two informal settlements**

MINISTRY OF HEALTH

# REPORT ON LEAD EXPOSURE IN OWINO-UHURU SETTLEMENT, MOMBASA COUNTY, KENYA

## THE REPORT OF GOVERNMENT CHEMIST

*[Sect. 2 of The Food, Drugs and Chemical Substances Act, Cap. 254; Sect. 119 of Environmental Management and Co-ordination Act (1999)]*

**APRIL 2015**

Government Chemist Department
P.O. BOX 20753 - 00202,
NAIROBI

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## EXECUTIVE SUMMARY

A battery recycling factory, Metal Refinery EPZ Ltd, was opened within the settlement in 2007. Leaded Factory fumes, dust, trade effluent and solid waste were discharged into Owino-Uhuru settlement and its environs without due consideration of likely short and long-term effects on humans and livestock in the area. The factory was closed in 2013 following public outcry by residents of the said settlement.

Blood lead levels (BLL) of 11 adults (22%) out of 50 tested residents were higher than 70µg/dl (range: 72.6 – 420.04 µg/dl). Blood lead levels of 12 adults out of 50 tested residents (24%) were higher than 10µg/dl but below 70µg/dl (range: 11.12 – 64.8 µg/dl). Blood lead levels of 3 adults and I child out of 50 tested residents (8 %) were higher than 5µg/dl but below 10µg/dl (range: 7.76 – 8.66 µg/dl). Blood lead levels of 21 adults and 2 children out of 50 tested residents (46 %) were below 5µg/dl. Soil lead levelsrange from 405.1µg/Kg (ppb) to 26.84 g/Kg. Dust lead levels range from 0.0196 – 140.51µg/ft$^2$. The levels of Lead in drinking water are very low and do not present a toxicity threat to the residents of Owino-Uhuru settlement. However, the levels of Lead in majority of residents tested and in Soil and Dust means that there is Lead exposure in Owino-Uhuru settlement.

The results (report) of Lead exposure in Owino-Uhuru should be immediately disseminated to Mombasa County government, Owino-Uhuru community, the Senate Parliamentary committee on Health, Mombasa County commissioner, NEMA, DOSH and any other agency as shall be agreed upon between the Ministry of Health (National government) and Mombasa County government as stipulated in Sect. 4 (c), (e) and (h) of The Intergovernmental Relations Act, 2012.

A functional diagnostic and treatment centre to be set up in Mombasa for screening and treatment for lead exposure. Affected residents to be relocated to safer area(s) by Mombasa County government, Lands Commission, Ministry of Land, Housing and Urban development, and area contaminated soils replaced procedurally.

*Wandera Chrispus Bideru*
For: **GOVERNMENT CHEMIST**



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## I.0 INTRODUCTION

A battery recycling factory known as Kenya Metal Refinery was established in 2007 within Owino - Uhuru settlement. Owino-Uhuru is an informal low income urban settlement (aka village) with a population of approx. 3000 people located in Kwa-Shee Sub-Location, Mikindani Location, Jomvu Division, Changamwe Sub-County within Mombasa County Kenya.

By 2010, residents of Owino-Uhuru settlement started raising issues regarding their public health and safety. These concerns arose following the death of one resident and many others who were taken ill under circumstances suspected to be associated with the battery recycling factory located in their midst. Further, a number of children residing in Owino-Uhuru settlement were found to suffer from mental retardation, a medical condition referred to as encephalopathy, which was found to be symptomatic of Lead poisoning ('lead encephalopathy').

Following a public complaint by the residents of Owino-Uhuru settlement, the battery recycling factory was technically closed down in 2014 due to suspected Lead (Pb) poisoning in the area as provided for under The Public Health Act (Cap. 242 Laws of Kenya) as read with Article 70 (1) of Kenya Constitution 2010: enforcement of environmental right to a clean and healthy environment. The Senate parliamentary committee on health visited the affected area in 2014, and in exercising its powers under Article 125 (2) as read with Article 70 (2) of Kenya Constitution 2010directed that an investigation be carried out by the Mombasa County Government in collaboration with other key State agencies into the matter of Lead poisoning as publicly raised by residents of Owino-Uhuru settlement. Accordingly, the Mombasa County Government through its County Health Director sought technical assistance from the Ministry of Health (read National Government) in undertaking the said investigations.

The Government Chemist Department, an institution appointed and gazetted under The Foods, Drugs, Chemical Substances Act, Cap 254 and Environmental Management and Coordination Act, EMCA, (1999) Laws of Kenya undertook analysis of blood samples submitted from the Mombasa County Health Director and environmental samples submitted by a technical team at the Ministry of Health. The objective of the analysis was to establish the levels of Lead (Pb) in the various samples and make a comprehensive report based on empirical data for dissemination to the Mombasa County Government and affected residents of Owino-Uhuru settlement at the earliest time possible.



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## 2.0 METHODOLOGY

### 2.1 Blood Samples

The office of the Mombasa County Health Director submitted 50 blood samples drawn from 50 residents (female = 24, male = 26) of Owino-Uhuru settlement to the Government Chemist Laboratory on 3rd September 2014. The blood samples were in Lead-free plastic vials with names of persons from whom drawn clearly marked. Particulars of blood samples are as follows: (i) Former factory employees = 10; (ii) Relatives (wives) of former employees = 2; (iii) Complainants = 5; (iv) Neighbors to the Factory (within a radius of 70 Meters) = 32; (v) Children (5 – 15 years) = 6; and, (vi) Food supplier to Company (or the Factory) = 1.

### 2.2 Environmental Samples

The Lead Poisoning Investigation Team from the Ministry of Health submitted 232 environmental samples (soil = 83, dust = 76, water = 73) from Owino-Uhuru and Bangladesh settlements to the Government Chemist Laboratory on 20th March 2015 and 23rd March 2015. The main purpose of submitting the said samples was to help establish the source of Lead poisoning in Owino-Uhuru settlement. Glaringly missing were primary case samples, namely: (i) factory (occupational exposure) samples which were to help in establishing whether or not the factory was the source of Lead poisoning, (ii) factory trade effluent/drains outside the precincts of the factory, (iii) pond/stream water within Owino-Uhuru settlement and its immediate environs (environmental exposure ) samples which were to provide additional empirical data on whether or not the factory is culpable in environmental lead poisoning which is adversely affecting residents and livestock in Owino-Uhuru settlement.

## 3.0 ANALYSIS (METHODOLOGICAL APPROACH)

### 3.1 Analysis of Blood Lead Levels

Method Contr. AA 700≠ 161 k 0773: Whole blood samples were systematically analyzed for Lead (Pb) levels using Graphite Furnace Atomic Absorbance (GFAA) spectrometer with a detection limit of 0.047µg/ml. The rationale of this analytical platform and methodical approach is its assured analytical performance and past studies which found that about 95 % of blood Lead (Pb) is found in erythrocytes.

### 3.2 Analysis of Soil Lead Levels

Method 3050 B (Acid Digestion of Sediments, Sludges, and Soils): Portions of various soils weighing 1.0014 – 2.1030 grams were systematically analyzed for Lead levels using Graphite Furnace Atomic Absorbance (GFAA) spectrometer. This platform has assured analytical performance having also been found useful in the Montana soil case study (soil had highly elevated trace element levels).



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### 3.3 Analysis of Dust Lead Levels

Method 3050 B (Acid Digestion of Sediments, Sludges and Soils): Portions of various dust samples per 0.25 square foot ($ft^2$) were systematically analyzed for Lead levels using Graphite Furnace Atomic Absorbance (GFAA) spectrometer. The choice of this method was informed by the sameness of soil and dust matrices.

### 3.4 Analysis of Water Lead Levels

Method 200.9 (Determination of trace elements by stabilized temperature Graphite Furnace Atomic Absorption): Aliquots of various water samples each measuring 50 ml was analyzed for Lead levels using Graphite Furnace Atomic Absorbance (GFAA) spectrometer. This is the method adopted by the U.S. Environmental Protection Agency for environmental monitoring systems laboratories.

## 4.0 RESULTS OF ANALYSES

### 4.1 Blood Lead Levels

A summary of blood Lead (Pb) results for the 50 residents of Owino-Uhuru settlement is provided in Table 1 and annexed to this report. A second summary of blood Lead (Pb) results for residents who have elevated exposures warranting one form of intervention or another is provided in Table 2 below:

*Table 1: A Summary of Blood Lead (Pb) Level Results for the 50 Residents from Owino – Uhuru Settlement (Annex)*

*Table 2: A Summary of Elevated Blood Lead (Pb) Level Results for 16 out of 50 Residents from Owino – Uhuru Settlement*

| No | Name | Age (years) | Duration of Stay (years) | Blood Lead (Pb) Levels | | Remarks |
|---|---|---|---|---|---|---|
| 1 | Ms. Irene Akinyi Odhiambo | 21 | 10 | 4.2004 µg/ml | 420.0 µg/dl | Wife c employee |
| 2 | Ms. Linet Nabwire Wanyama | 23 | 5 | 2.3820 µg/ml | 238.2 µg/dl | Wife c employee |
| 3 | Ms. Millicent Achieng Awaka | 60 | 30 | 2.3442 µg/ml | 234.4 µg/dl | Next to Factory |
| 4 | Mr. Jackson Oseya Wabedha | 52 | 52 | 1.2430 µg/ml | 124.3 µg/dl | Next to Factory |
| 5 | Mr. Wilson Wasonga Omoka | 29 | 7 | 1.0606 µg/ml | 106.1 µg/dl | Former employee |
| 6 | Ms. Irene Saru Alfred | 63 | 4 | 0.9956 µg/ml | 99.6 µg/dl | Next to Factory |
| 7 | Ms. Ellizabeth Francisca Mwailu | 67 | 40 | 0.9932 µg/ml | 99.3 µg/dl | Complainant |



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| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Mr. Alfred Ogolla Mulo | 57 | 30 | 0.9324 µg/ml | 93.2 µg/dl | Complainant |
| 9 | Mr. Oluoch Martin Owuor | 21 | 10 | 0.8902 µg/ml | 89.2 µg/dl | Former employee |
| 10 | Ms. Margret Akinyi Owaki | 46 | 20 | 0.7680 µg/ml | 76.8 µg/dl | Next to Factory |
| 11 | Ms. Rose Munni Kamolo | 40 | 25 | 0.7256 µg/ml | 72.6 µg/dl | Next to Factory |
| 12 | Mr. Benjamin Kyalo Musingila | 42 | 20 | 0.6482 µg/ml | 64.8 µg/dl | Next to Factory |
| 13 | Mr. Elius Ochieng Oseya | 22 | 22 | 0.6340 µg/ml | 63.4 µg/dl | Former employee |
| 14 | Mr. Daniel Ochieng Ogola | 23 | 23 | 0.5780 µg/ml | 57.8 µg/dl | Former employee |
| 15 | Ms. Janet Adhiambo Ongira | 43 | 25 | 0.5278 µg/ml | 52.8 µg/dl | Next to Factory |
| 16 | Ms. Namu Muthami Muli | 65 | 40 | 0.4732 µg/ml | 47.3 µg/dl | Next to Factory |

*Footnote: Concentration units for blood Lead are presented in two measurement units for ease of comparison.*

Blood lead levels (BLL) of 11 adults (22%) out of 50 tested residents were higher than 70µg/dl (range: 72.6 – 420.04 µg/dl). This category comprised 4 females capable of bearing children (2 were wives of former Factory employees and other 2 lived nest to the Factory), 3 females not capable of bearing children (2 live next to the Factory and 1 is a complainant); and 4 males (2 are former Factory employees and 2 live next to the Factory). Blood lead levels of 12 adults out of 50 tested residents (24%) were higher than 10µg/dl but below 70µg/dl (range: 11.12 – 64.8 µg/dl). This category comprised 10 adults (3 are former Factory employees, 8 live next o the Factory and 1 is a complainant); and 2 children, aged 6 and 9 years. Blood lead levels of 3 adults and I child out of 50 tested residents (8 %) were higher than 5µg/dl but below 10µg/dl (range: 7.76 – 8.66 µg/dl). In this category are 1 former Factory employer (male adult), 1 male, 1 female adult, and 1 female child live next to the Factory. Blood lead levels of 21 adults and 2 children out of 50 tested residents (46 %) were below 5µg/dl.



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| | | | | | | |
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## 4.2 Soil Lead Levels

A summary of soil lead levels in Owino-Uhuru settlement is provided in Table 3.

*Table 3: A summary of soil Lead (Pb) levels in Owino-Uhuru settlement*

| No. | Sampling Points | µg/g | µg/Kg | No. | Sampling Points | µg/g | µg/Kg |
|---|---|---|---|---|---|---|---|
| 1 | Owino-Ohuru (1428)$^0$ | 0.4051 | 405.1 | 20 | Owino-Ohuru (1358)* | 64.17 | 64170 |
| 2 | Owino-Ohuru (1443)* | 354.85 | 354,850 | 21 | Owino-Ohuru (1296)* | 229.08 | 229080 |
| 3 | Owino-Ohuru (1238)* | 63.05 | 63050 | 22 | Owino-Ohuru (1165)* | 109.86 | 109860 |
| 4 | Owino-Ohuru (1462)* | 21.33 | 21330 | 23 | Owino-Ohuru (1134)* | 101.78 | 101780 |
| 5 | Owino-Ohuru (1389)* | 160.65 | 160650 | 24 | Owino-Ohuru (1144)* | 114.51 | 114510 |
| 6 | Owino-Ohuru (1263)* | 42.98 | 42980 | 25 | Owino-Ohuru (1081)* | 113.88 | 113880 |
| 7 | Owino-Ohuru (1241)* | 294.06 | 294060 | 26 | Owino-Ohuru (1140)* | 127.99 | 127990 |
| 8 | Owino-Ohuru (1456)* | 287.18 | 287180 | 27 | Owino-Ohuru (1335)** | 2654.55 | 2654550 |
| 9 | Owino-Ohuru (1200)* | 680.26 | 680260 | 28 | Owino-Ohuru (0010)* | 106.32 | 106320 |
| 10 | Owino-Ohuru (1232)* | 661.71 | 661710 | 29 | Owino-Ohuru (003)* | 70.55 | 70550 |
| 11 | Owino-Ohuru (1052)* | 677.63 | 677630 | 30 | Owino-Ohuru (0050)** | 2380.79 | 2380790 |
| 12 | Owino-Ohuru (1066)* | 308.66 | 30660 | 31 | Owino-Ohuru (004)*** | 26836.74 | 26836740 |
| 13 | Owino-Ohuru (1047)* | 640.30 | 640300 | 32 | Owino-Ohuru (1293)* | 6.12 | 6120 |
| 14 | Owino-Ohuru (1344)* | 297.49 | 297490 | 33 | Owino-Ohuru (0020)* | 504.02 | 504020 |
| 15 | Owino-Ohuru (1312)* | 320.06 | 32060 | 34 | Owino-Ohuru (0060)* | 84.88 | 84880 |
| 16 | Owino-Ohuru (1294)* | 632.55 | 632550 | 35 | Owino-Ohuru (1055)* | 247.90 | 247900 |
| 17 | Owino-Ohuru (1214)* | 221.80 | 221800 | 36 | Owino-Ohuru (1328)* | 262.13 | 262130 |
| 18 | Owino-Ohuru (1020)* | 336.65 | 336650 | 37 | Owino-Ohuru (1261)* | 291.42 | 291420 |
| 19 | Owino-Ohuru (1136)* | 521.17 | 521170 | | | | |



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Footnote:

*** Extremely elevated Lead exposure – Bare soil inside the Factory

** Very highly elevated Lead exposure – Gate entry to the Factory

* High elevated Lead exposure – Within a radius of 500 Metres from Factory)

0 Moderate Lead exposure level (outside a radius of 500 Metres from Factory)

*Remark (2):*

(i) Soil (residential) Lead (Pb) level of 400 ppm (mg/Kg) in bare soil in children's play areas is a hazard. (*source: Environmental Protection Agency, EPA*)

(ii) Soil (residential) Lead (Pb) level of 1200 ppm (mg/Kg) is acceptable for non-play areas. *(source: Environmental Protection Agency, EPA)*

### 4.3 Dust Lead Levels

A summary of dust Lead levels in Owino-Uhuru settlement is provided in Table 4.

*Table 4: A Summary of Results for Dust Lead (Pb) Levels In Owino-Uhuru Settlement*

| No. | Sampling points | µg per ft$^2$ | No. | Sampling points | µg per ft$^2$ |
|---|---|---|---|---|---|
| 1 | **Owino-Uhuru** (1134) | 0.4496 | 20 | **Owino-Uhuru** (1232) | 0.2152 |
| 2 | **Owino-Uhuru** (1344) | 0.3144 | 21 | **Owino-Uhuru** (1428) | 0.3152 |
| 3 | **Owino-Uhuru** (1140) | 32.186 | 22 | **Owino-Uhuru** (1081) | 33.306 |
| 4 | **Owino-Uhuru** (1200) | 0.3601 | 23 | **Owino-Uhuru** (1020) | 14.682 |
| 5 | **Owino-Uhuru** (1317) | 0.3892 | 24 | **Owino-Uhuru** (1296) | 2.7216 |
| 6 | **Owino-Uhuru** (1214) | 140.51 | 25 | **Owino-Uhuru** (1052) | 10.846 |
| 7 | **Owino-Uhuru** (1456) | 47.310 | 26 | **Owino-Uhuru** (1144) | 6.374 |
| 8 | **Owino-Uhuru** (1330) | 14.814 | 27 | **Owino-Uhuru** (1047) | 45.550 |
| 8 | **Owino-Uhuru** (1263) | 1.1416 | 28 | **Owino-Uhuru** (1312) | 0.034 |
| 9 | **Owino-Uhuru** (1462) | 1.0376 | 29 | **Owino-Uhuru** (1435) | 0.379 |
| 10 | **Owino-Uhuru** (1402) | 46.43 | 30 | **Owino-Uhuru** (1443) | 1.3896 |
| 11 | **Owino-Uhuru** (1450) | 0.3456 | 31 | **Owino-Uhuru** (1270) | 1.4068 |
| 12 | **Owino-Uhuru** (1294) | 0.2672 | 32 | **Owino-Uhuru** (1442) | 0.1599 |
| 13 | **Owino-Uhuru** (1066) | 0.0638 | 33 | **Owino-Uhuru** (1293) | 0.0638 |
| 14 | **Owino-Uhuru** (1241) | 0.0638 | 34 | **Owino-Uhuru** (1139) | 6.934 |
| 15 | **Owino-Uhuru** (1165) | 32.074 | 35 | **Owino-Uhuru** (1090) | 0.1622 |
| 16 | **Owino-Uhuru** (1386) | 0.0638 | 36 | **Owino-Uhuru** (1145) | 0.1289 |
| 17 | **Owino-Uhuru** (1389) | 0.0642 | 37 | **Owino-Uhuru** (1136) | 0.1600 |
| 18 | **Owino-Uhuru** (1335) | 34.018 | 38 | **Owino-Uhuru** (1293) | 0.0196 |
| 19 | **Owino-Uhuru** (1319) | 0.0689 | | | |



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*Footnote:*

(i). Lead at levels ≥ 40µg/ft$^2$ on floors is a hazard *(source: U.S. EPA).*

(ii). Lead at levels ≥ 250µg/ft$^2$ on interior window sills is a hazard *(source: EPA Residential Lead Dust Hazard Standards for lead in Paint, Dust and Soil)*

(iii). There are pockets of dust with high lead levels which is hazardous especially for children in play areas including persons who spend time in enclosed places.

### 4.4 Water Lead Levels

A summary of results for water Lead (Pb) levels in Owino-Uhuru settlement is provided in Table 4 below.

*Table 4: A Summary of Results for Water (Piped) Lead Levels in Owino-Uhuru Settlement*

| No. | Sampling points | µg/L | mg/L | No. | Sampling points | µg/L | mg/L |
|---|---|---|---|---|---|---|---|
| 1 | **Owino-Uhuru** (1165) | 42.465 | 0.0425 | 20 | **Owino-Uhuru** (1443) | 3.748 | 0.0038 |
| 2 | **Owino-Uhuru** (1389) | 2.643 | 0.0026 | 21 | **Owino-Uhuru** (1047) | 0.165 | 0.0002 |
| 3 | **Owino-Uhuru** (1450) | 1.813 | 0.0018 | 23 | **Owino-Uhuru** (1238) | 0.386 | 0.0004 |
| 4 | **Owino-Uhuru** (1241) | 3.75 | 0.0033 | 23 | **Owino-Uhuru** (1052) | 0.091 | 0.0001 |
| 5 | **Owino-Uhuru** (1330) | 0.507 | 0.0005 | 24 | **Owino-Uhuru** (1232) | 1.362 | 0.0014 |
| 6 | **Owino-Uhuru** (1462) | 5.454 | 0.0055 | 25 | **Owino-Uhuru** (1144) | 0-.372 | 0.0004 |
| 7 | **Owino-Uhuru** (1214) | 3.005 | 0.0030 | 26 | **Owino-Uhuru** (1081) | 1.417 | 0.0014 |
| 8 | **Owino-Uhuru** (1402) | 1.684 | 0.0017 | 27 | **Owino-Uhuru** (1200) | 1.522 | 0.0015 |
| 9 | **Owino-Uhuru** (1445) | 1.513 | 0.0015 | 28 | **Owino-Uhuru** (1319) | 1.128 | 0.0011 |
| 10 | **Owino-Uhuru** (1263) | 0.832 | 0.0008 | 29 | **Owino-Uhuru** (1335) | 43.445 | 0.0435 |
| 11 | **Owino-Uhuru** (1020) | 0.427 | 0.0004 | 30 | **Owino-Uhuru** (1134) | 1.971 | 0.0020 |
| 12 | **Owino-Uhuru** (1344) | 2.152 | 0.0022 | 31 | **Owino-Uhuru** (1312) | 1.047 | 0.0011 |
| 13 | **Owino-Uhuru** (1296) | 12.575 | 0.0126 | 32 | **Owino-Uhuru** (1140) | 0.725 | 0.0007 |
| 14 | **Owino-Uhuru** (1428) | 7.594 | 0.0076 | 33 | **Owino-Uhuru** (1066) | 0.328 | 0.0003 |
| 15 | **Owino-Uhuru** (1294) | 2.542 | 0.0025 | 34 | **Owino-Uhuru** (1442) | 6.686 | 0.0067 |
| 16 | **Owino-Uhuru** (1386) | 3.394 | 0.0034 | 35 | **Owino-Uhuru** (1098) | 0.14 | 0.0001 |
| 17 | **Owino-Uhuru** (1271) | 1.226 | 0.0012 | 36 | **Owino-Uhuru** (1145) | 0.586 | 0.0006 |
| 18 | **Owino-Uhuru** (1456) | 0.638 | 0.0006 | 37 | **Owino-Uhuru** (1039) | 4.757 | 0.0048 |
| 19 | **Owino-Uhuru** (1317) | 0.155 | 0.0002 | 38 | **Owino-Uhuru** (0010) | 0.603 | 0.0006 |

***Remark (3):*** Water samples drawn from Mombasa water supply line points serving households in Owino-Uhuru settlement conform to WHO/UNEP, British and Kenya Standard Guidelines for Drinking water – Maximum allowable level of Lead ($Pb^{2+}$) in drinking water is 0.05 mg/L.



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## 5.0 DISCUSSION

### 5.1 Lead Exposure and Public Health

The median diameter of airborne Lead (Pb) particulates is approx. 0.25μm. This size is small enough for particulates of Lead in the air to be fairly absorbed from the respiratory tract of a subject who becomes exposed *(Principles of Drug Action by Goldstein, Aronow and Kalman).* Thus, the most probable entry point of lead, a highly toxic chemical, into the bodies of affected residents of Owino-huru was through the respiratory tract (inhalation of leaded factory fumes and leaded dust).

Blood samples from 16 adult residents of Owino-Uhuru had Lead (Pb) levels of 47.32μg/dl and above. Blood Lead has half-life ranging from 2 – a few months; and exposure levels lower than 0.4μg/ml in subjects do not overtly show signs of poisoning. Clinical toxicity is frequently observed at blood Lead levels of 84μg/dl and above. Encephalopathy is associated with blood Lead levels in excess of 100μg/dl – 200μg/dl (*Principles of Drug Action: The Basis of Pharmacology by Arram, Lewis and Summer).* It is advised that affected persons whose blood lead levels were found to be high should be re-tested if their exposure levels have since changed before appropriate interventions.

Blood Lead levels ranging from 0.06μg/ml (6μg/dl) – 0.35μg/ml (35μg/dl) with a medium value of 0.13μg/ml (13μg/dl) is normal; and subjects exposed to blood Lead (Pb) levels of 36 μg/dl – 80μg/dl are sometimes free from symptoms of intoxication. Children with Lead levels in excess of 30μg/dl should be investigated further. Adults exposed to Lead at levels of 80μg/dl – 120μg/dl often exhibit mild symptoms. This level (80μg/dl – 120μg/dl) of exposure in children may cause 'lead encephalopathy'. Subjects exposed to Lead at concentrations above 120μg/dl often exhibit severe clinical symptoms *(Clarke's Isolation and Identification of Drugs, Second Edition).*

Blood Lead maximum concentration level of 10μg/dl (100μg/L) in both adults and children is recommended upon consideration of the possibility of intellectual impairment in children with blood Lead concentrations below 100μg/L (≈ 0.5μmol/L) and that lead levels higher than 10μg/dl may be acceptable in adults who are occupationally exposed to Lead but with careful monitoring of exposure *(Clarke's Analysis of Drugs and Poisons in pharmaceuticals, body fluids and postmortem material).*

Blood Lead (Pb) level of 30μg/dl: exposure at threshold limit level (TLV) – advisory *(source: American Conference of Governmental Industrial Hygienists, ACGTH).* Blood Lead (Pb) level of 10 μg/dl is a level of individual management – advisory *(source: Center for Diseases Control, CDC).* Blood Lead (Pb) level of 40μg/dl: cause for written notification and medical examination – regulation *(source: Occupational Safety and Health Act, OSHA).* Blood Lead (Pb) level of 60μg/dl: cause for medical removal from exposure – regulation *(source: Occupational Safety and Health Act, OSHA).*



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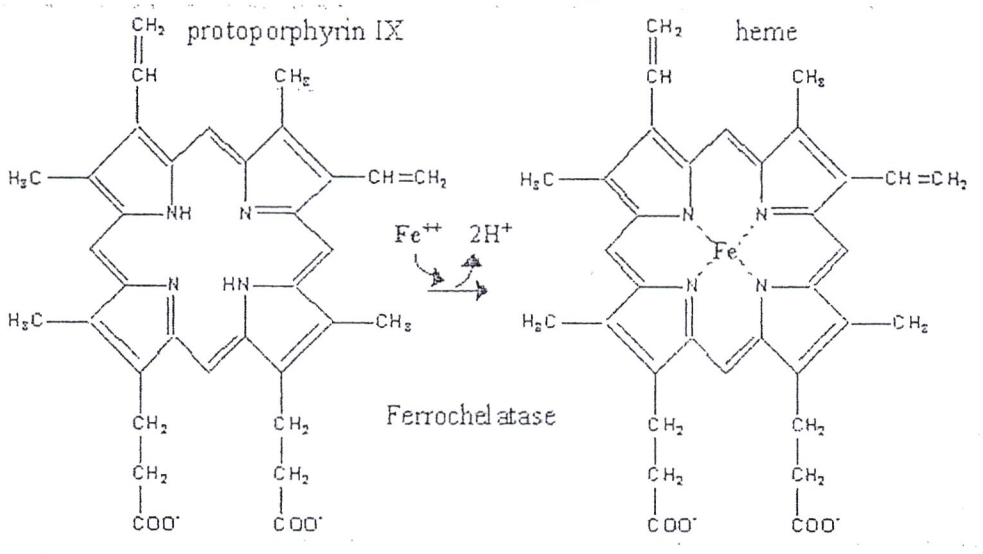
A comprehensive assessment of Lead exposure in affected persons should be based on circumstantial, clinical and analytical evidence. Intervention- decisions, whether policy or professional or ethical should be founded on relevant empirical data.

### 5.2 Mechanism of Lead Toxicity

Lead inhibits enzyme ferrochelatase. This enzyme is involved in iron transport in the bone marrow and catalyzes the introduction of ferrous iron ($Fe^{"}$) into the porphyrin (protoporphyrin IX) ring to form haem. The formation of haem is the last stage of haemoglobin synthesis. Therefore the net effect of Lead exposure is reduction in blood haemoglobin level leading to anaemia (*Clarke's Analytical Forensic Toxicology*by Jickells &Negrusz, 2008; and *Molecular Biochemistry II, Synthesis of Heme* by Diwan,J.J, 2008). This inhibition effect of Lead on enzyme ferrochelatase is diagrammatically illustrated in Diagram 1 below.

*Diagram 1: Formation of haem*




### 5.3 Summary of Blood Lead Levels

Whereas blood lead levels of 6 – 35µg/dl is generally considered as normal in man, a maximum concentration of 10µg/dl is recommended in both adults and children. However, a BLL lower than10µg/dl may cause intellectual impairment in children. Subjects with blood lead level of 36 – 70 µg/dl are sometimes free from symptoms of intoxication. Adults exposed to blood lead level of 80 – 120µg/dl often exhibit mild symptoms, but in children this level may cause 'lead encephalopathy'. Subjects exposed to blood lead level above 120µg/dl often exhibit severe clinical symptoms (sources: Clarke's Isolation and Identification of Drugs, 2nd Ed; Clarke's Analysis of Drugs and Poisons in pharmaceuticals, body fluids and postmortem material, 3rd Ed.).



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### 5.4 Occupational Lead Exposure in Owino-Uhuru Settlement

Soil lead levels in Owino-Uhuru settlement range from 405.1µg/Kg (ppb) to 26.84 g/Kg. The soil-dust sampled beyond the gate entry to the Factory (within Factory outer compound) had the highest lead exposure. This was followed by the soil-dust sampled at the gate entry to the Factory with lead levels of 2.655 and 2.381 g/Kg. The rest of the soils had lead levels ranging from 0.680 g/Kg (within 500 meters radius from the Factory) to 405.1µg/Kg or ppb (outside radius from the Factory). Dust lead levels in Owino-Uhuru settlement range from 0.0196 – 140.51µg/ft$^2$. Soil in Owino-Uhuru settlement has high levels of Lead, and that these levels incrementally tail towards the battery recycling factory suggesting that the said factory was the source of lead contamination. Urgent interventions by concerned environmental actors are needed to safeguard the environment of Owino-Uhuru.

Failure to take case-directing primary samples from factory, factory trade effluent, and open body of waters (pond/stream) by concerned parties is inexcusable. The said act technically torpedoed direct linkage between Factory and Lead exposure in Owino-Uhuru settlement, and if not corrected immediately will sanitize the factory and shield it from possible criminal charges in future. This means that affected residents will not only fail to seek compensation from the factory if they so wish. On the other hand the said factory which was forcefully closed down may possibly sue Government for compensation. It is recommended that primary case samples be immediately collected and submitted to a designated laboratory for analysis.

Residents of Owino-Uhuru settlement are exposed to high Lead (Pb) levels and require immediate intervention by all concerned actors – both government and non-government agencies. The available data for now is not sufficient to be used as material evidence to directly link the factory to lead poisoning in Owino-Uhuru settlement despite overwhelming circumstantial and clinical evidence suggesting so. To remedy the situation, measures should be initiated to gather the missing material evidence as per the Analytical Process – chain of custody, analysis, etc.

### 5.5 Summary of Soil and Dust Lead Levels

Soil (residential) lead level of 400 mg/Kg in bare soil in children's play areas is a hazard. Soil (residential) lead level of 1200 mg/Kg (ppm) is acceptable for non-play areas. Dust lead levels ≥ 40 µg/ft$^2$ on floors and dust lead levels ≥ 250 µg/ft$^2$ on interior window sills is hazard (source: U.S. Environmental Protection Agency).

## 6.0 CONCLUSSION

Owino-Uhuru Settlement is exposed to Lead, a highly toxic chemical substance. This elevated Lead exposure presents a serious threat her residents and livestock.



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## 7.0 RECOMMENDATIONS

The following practical and cost-effective intervention measures are recommended to mitigate against Lead exposure in Owino-Uhuru settlement:

1. The battery recycling factory known as Metal Refinery EPZ Ltd to remain closed to stop further contaminating the environment with Lead.
2. Disseminate results of lead analysis and attendant report to concerned parties. Rationale: communicate and communicate to spur interventions. The report is to be disseminated to Mombasa County government, Owino-Uhuru community, the Senate Parliamentary committee on Health, NEMA, DOSH, Mombasa County commissioner, and any other agency or office as shall be agreed upon between Ministry of Health (National government) and the Mombasa County government as provided in principles of intergovernmental relations in Sect. 4 (c), (e) and (h) of The Intergovernmental Relations Act, 2012.
3. A functional diagnostic and treatment centre to be set up at a convenient place in Mombasa for screening and treatment of persons affected by lead exposure in Owino-Uhuru settlement and its immediate environs. all residents whose blood lead levels are life-threatening including those who are yet to be tested for lead but who are already showing clinical symptoms of lead poisoning to be put on treatment immediately to save already threatened lives.
4. Medically and toxicologically examine all persons for signs which are associated with Lead poisoning who live within radius of 500 metres from the factory with a view to identifying those requiring treatment to mitigate against lead poisoning for persons whose health is under serious threat.
5. Advise persons living beyond 500 metres from the battery recycling factory in Owino-Uhuru settlement through the chief's public barazas to present themselves for lead testing and clinical examination at designated place(s); and create public awareness on the toxic effects of lead metal and preventive measures.
6. Relocate the affected residents of Owino-Uhuru settlement to alternative safe area(s). Main actors: Mombasa County government, Lands Commission, Ministry of Land, Housing and Urban development, Ministry of Health, and Mombasa County commissioner/Coast Regional commissioner.
7. Excavate Soil and Dust areas with elevated lead levels after mapping, and safely tuck away in either a landfill or in any other environmentally safe place. Main actors: Ministry of Health, Mombasa County government, Ministry of Land, Housing and Urban development, Lands Commission, and NEMA.

Dated: 28th April 2015

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