MERCURY RELEASE INVENTORY, WASTE STORAGE AND DISPOSAL IN JAMAICA

DECEMBER 2016

This inventory was performed in accordance with UNEP's "Toolkit for identification and quantification of mercury releases", Inventory Level 1 (version 1.02, April 2013, or newer.)

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Report issuing date	December 15, 2016

Contents

List of Abbreviations

ADO – Automotive Diesel Oil
Alpart - Alumina Partners of Jamaica
AMAP- Arctic Monitoring and Assessment Programme
ASGM- Artisanal and Small Scale Gold Mining
BCRC-Caribbean- Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean
CCL- Caribbean Cement Company Limited
FDA- U.S. Food and Drug Association
GDP – Gross Domestic Product
HFO – Heavy Fuel Oil
Hg - mercury
ICENS - The International Centre for Environmental and Nuclear Sciences
IPPs- Independent Power Producers
ISWA- International Solid Waste Association
JBI- Jamaica Bauxite Institute
JEP – Jamaica Energy Partners
JISCO - Jiuguan Iron and Steel
JPPC - Jamaica Private Power Company
JPSCO- Jamaica Public Service Company
LPG- Liquid Petroleum Gas
MEGJC- Ministry of Economic Growth and Job Creation
MOH- Ministry of Health
NEPA- National Environment and Planning Agency
Norway ODA- Norway Official Development Assistance
NSWMA- National Solid Waste Management Authority
NWC- National Water Commission
PCA- Pesticides Control Authority
Ppb – parts per billion
PU/ PUR- polyurethane
SEL- Specially engineered landfills
SRD- Standards and Regulation Division
UNEP – United Nations Environment Programme
UNEP DTIE-United Nations Environment Programme Division of Technology, Industry and Economics
UNITAR- United Nations Institute for Training and Research
USD- United States Dollar
VCM- vinyl chloride monomer
WHO- World Health Organisation
Windalco - West Indies Alumina Company

List of Figures

List of Tables

Executive Summary

Mercury is considered by the World Health Organization (WHO), as one of the top ten chemicals or groups of chemicals of major public health concern. This is primarily because all forms of mercury have been established as toxic to both humans and animals; with no biological benefits and causing deleterious health impacts. It also results in serious contamination to the natural environment. The chemical is used in a range of areas including the industrial, commercial, health, domestic and waste sectors.

The Minamata Convention on Mercury was formally adopted on October 10th, 2013 as a global response to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. The Convention embodies both voluntary and compulsory measures that aim to reduce the impact of mercury on health and the environment, through various provisions related to extraction, usage, releases, trade, storage and waste management.

Jamaica is the third largest country in the Greater Antilles, with an area of 10,991 square kilometres divided into 14 parishes. Jamaica has a population of 2,723,246. The main economic industries are Agriculture, Forestry & Fisheries, Mining & Quarrying, Construction, Services, and Manufacturing. The Services industry is the largest employer accounting for almost 80% of Gross Domestic Product (GDP) with Agriculture, Forestry & Fisheries being the second largest employer. Jamaica is a signatory to the Minamata Convention on Mercury and has developed a roadmap for its ratification.

The Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean (BCRC-Caribbean), in collaboration with the UNEP "Chemicals and Waste Branch" of the United Nations Environment Programme Division of Technology, Industry and Economics (UNEP DTIE), received funding from the Norway Official Development Assistance (ODA) for execution of the "Mercury Storage and Disposal Project in the Caribbean: Jamaica, Trinidad and Tobago, Suriname." The Project aims to increase the capacities for environmentally sound storage and disposal of mercury in the participating countries and thereby assist participating countries with acceding, ratifying and implementing the Minamata Convention.

One way to advance this process is to provide evidence of the potential sources of mercury and mercury pollution through the development of a national inventory of Mercury Releases in Jamaica. As such, relevant stakeholders participated in the development of the inventory which was developed in 2016 based on availability of data from 2014 and 2015. This inventory was designed using the United Nations Environment Programme's (UNEP) Toolkit for Identification and Quantification of Mercury Releases (Inventory Level 1). The Toolkit is based on mass balances for each mercury release source type group. The Inventory Level 1 works with pre-

determined factors used in the calculation of mercury inputs to society and releases, the so-called default input factors and default output distribution factors.

The inventory found that the major sources of mercury, in terms of estimated total releases, in Jamaica are:

- Alumina production from bauxite: 1851 kg Hg/y[1]*
- Use and disposal of other products: 453 kg Hg/y
- Other materials production (cement production): 105 kg Hg/y

It should be noted that according to the Technical Background Report for the Global Mercury Assessment 2013, the production of aluminium rather than alumina was assessed so no figures for alumina production from bauxite in Jamaica were available from this report. However, the sectors, cement production and waste from products, were noted to be in the top three sectors for mercury emissions (although much lower at 48.7 kg Hg/y and 44.15 kg Hg/y respectively) which was also reflected in this inventory.

It is also important to note that the Toolkit Inventory Level 1 was a desktop study that was completed using information gathered from questionnaires dispersed to relevant stakeholders, as well as from statistical websites and reports. The questionnaires used are attached at Appendix I. The data entered into the Toolkit was based on assumptions and activity rates which generated the data values for each sector. For a more detailed estimation of mercury releases, it is recommended that a Level 2 inventory be completed.

The project also examined two additional components:

- Legislative and Policy Review and
- Storage and Disposal Options

[1] * **NOTE: Estimation for total Hg releases for alumina production from bauxite based on assumptions in UNEP Toolkit for Identification and Quantification of Mercury Releases (Inventory Level 1). Upon consultations with representatives in the Mines and Geology Division of the Ministry of Transport and Mining, Jamaica, and the Jamaica Bauxite Institute, it was noted that the mercury releases caused by alumina production from bauxite in Jamaica may actually be lower than determined in this inventory and further assessments may be necessary. See SECTION 4.1 of this report for clarifications.**

In Jamaica, the legislative and policy review indicated that several pieces of legislation need to be amended in order to cover mercury. These are:

- The Natural Resources Conservation Act (NRCA), 1991
- National Solid Waste Management Act, 2001
- Trade Act, 1955
- Public Health Act, 1985
- The Standards Act, 1969
- The Mining Act, 1947
- The Quarries Control Act, 1983
- The Clean Air Act, 1961

As it relates to storage and disposal, three (3) main options were detailed:

1) To develop a facility (or facilities) for interim storage of mercury waste, the location of which will need to be determined in further discussions with relevant stakeholders. A consolidation of mercury waste produced by individual companies would be done by the companies themselves who would have to develop infrastructure "in-house" to arrange for the environmentally sound collection and transport of the waste to the interim storage facility. The interim storage sites would be developed in collaboration with the main waste management companies as a sanitary engineered landfill under an integrated waste management approach, meaning that mercury waste as well as other hazardous waste will be handled at the facility.

2) To have stabilisation/ solidification processes done at the interim storage facilities for the mercury waste. The recommended process would be solidification via cementation where the mercury waste would be encased in a solid block.

3) To export the waste at a national level for environmentally sound disposal to a processing facility where environmentally sound mechanisms exist for the proper extraction and disposal of mercury, for example in countries like the United States of America, Canada, Spain and the Netherlands. The exportation of solidified waste may be expensive due to the potentially large mass of the solid blocks so considerations would need to be made as to how these costs could be off-set.

Based on the low response rate to questionnaires disseminated for data collection in this inventory, a follow-up survey with stakeholders is recommended. It is also recommended that further assessments be done with respect to potential mercury releases for the sectors, use and disposal of products, cement production, dental amalgam and, most notably, the alumina production from bauxite sector.

It is recommended that the Government of Jamaica ratify the Minamata Convention on Mercury in order to better facilitate the implementation of environmentally sound management of mercury waste in the country. However, it should be noted that the time dedicated to obtaining the data for this project was approximately three (3) months resulting in an inventory that was incomplete. As a direct result, Jamaica cannot commit to any policy directives at this time. Additionally, this high level of decision making must be approved under the auspices of Cabinet.

Fortuitously, Jamaica is part of the more detailed Minamata Initial Assessment Project which will utilise the Inventory Level 2 and be conducted over a two (2) year period. It is anticipated that an informed decision can then be made once a thorough inventory is complete.

1.0 Introduction

1.1 Country Background

Jamaica is the third largest country in the Greater Antilles (Figure 1), with an area of 10,991 square kilometres which is divided into 14 parishes (Figures 2). Jamaica has a population of 2,723,246. The main economic industries are Agriculture, Forestry & Fisheries, Mining & Quarrying, Construction, Services, and Manufacturing. The Services industry is the largest employer, and accounts for almost 80% of Gross Domestic Product (GDP) (UNITAR, 2006). Agriculture, Forestry & Fisheries constitutes the second largest employer. According to 2014 data, the mining and quarrying sector which comprises mainly of bauxite and alumina production, contributed to 2.3% of Jamaica's GDP.

Figure 1: Map Showing the Location of Jamaica in the Caribbean Region (Mona Geoinformatics Institute, 2014)

Figure 2: Map of Jamaica (Mona Geoinformatics Institute, 2014)

1.2 Mercury

Mercury, commonly called quicksilver, is an odourless, liquid metal and is slightly volatile at standard temperature and pressure. Elemental mercury (Hg) and its compounds are highly toxic to human beings. These harmful effects manifest in the nervous, digestive and immune systems, lungs and kidneys. It can be fatal. The damage also extends to the environment where there has been evidence of bioaccumulation in fishes as well as severe neurological disorders in birds. The various sources of mercury and the transport and mobilization processes are complex and they come together to create a biogeochemical cycle appropriately titled the Global Mercury Cycle (UNEP, 2013). This is shown below in Figure 3.

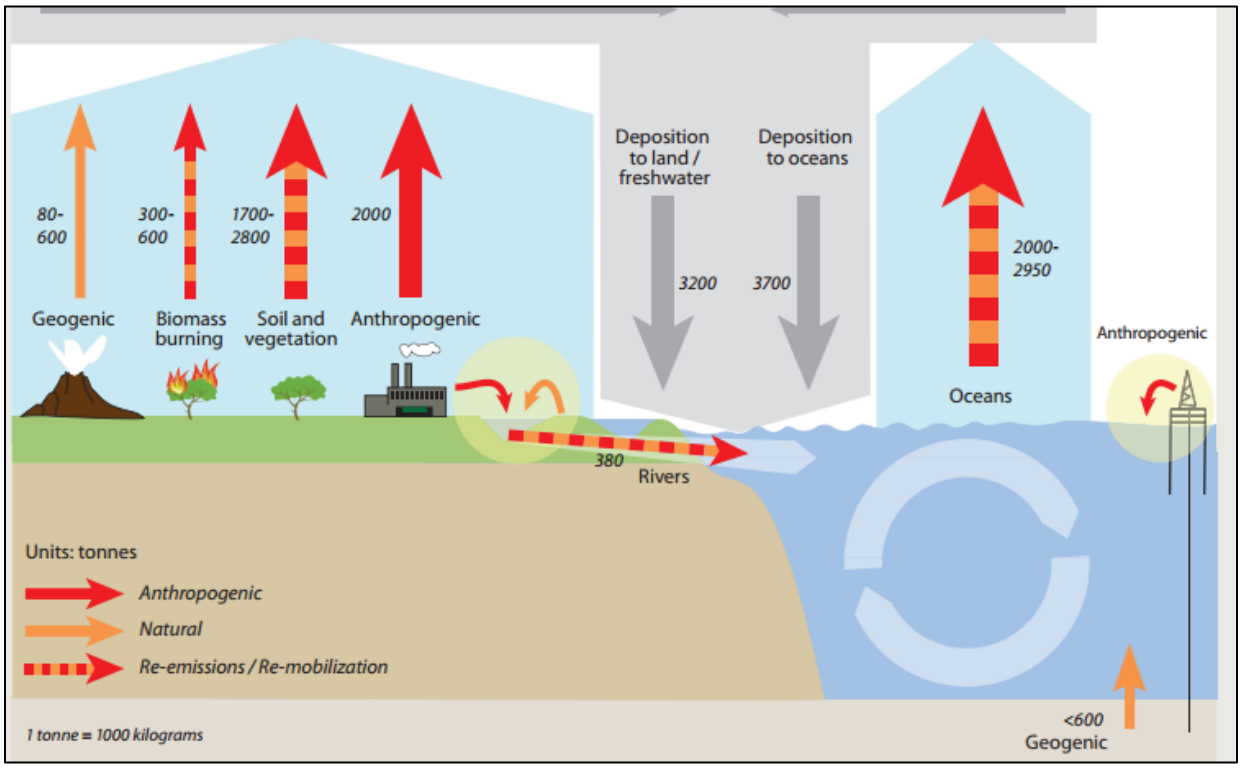

Figure 3: The Global Mercury Cycle (UNEP, 2013)

Jamaica along with 127 other countries signed the Minamata Convention on Mercury on October 10, 2013. To date, 35 countries have ratified. The aim of the treaty is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. One way to achieve this is to phase out by 2020, the production, export and import of mercury containing products such as batteries, certain types of compact fluorescent lamps, thermometers and blood pressure machines.

The main sources of mercury can be categorized as:

1. **Natural sources**- Mercury is very widely distributed in nature, although usually at low concentrations. It occurs in all rock types, usually at concentrations < 200 ppb in igneous and sedimentary rocks. In Jamaica, the range of mercury concentrations in surface soils is 40-830 ppb compared with 100-500 ppb for world soils (Lalor, 1995). Figure 4 shows the natural distribution of mercury across the island.

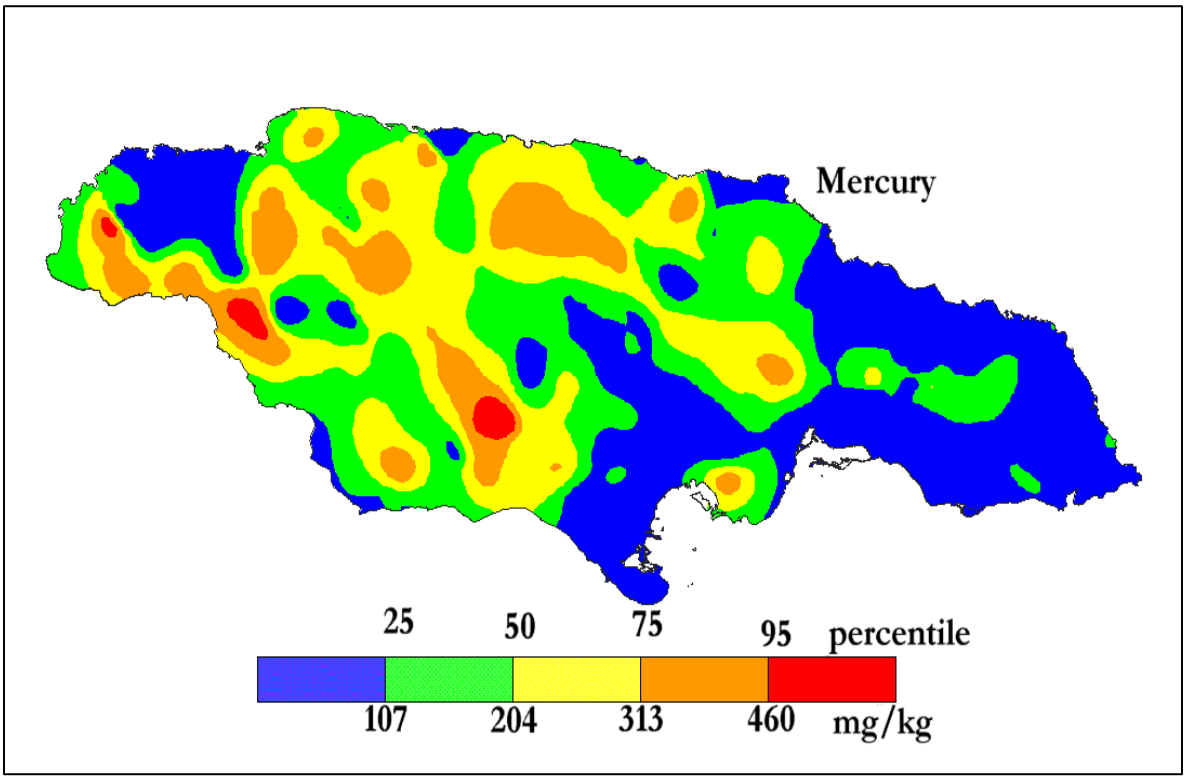

Figure 4: Mercury Distribution across Jamaica Source: ICENS

2. **Anthropogenic sources**- Mercury can be released into the environment due to human activities whether intentionally (used in the manufacture of products) or unintentionally. In the manufacture of alumina, for example, mercury is present as an impurity in bauxite. In fact, small amounts of liquid Hg have occasionally been observed during bauxite processing (Lalor, 1995). However, the exact concentration of mercury in bauxite deposits varies significantly depending on location and so, is difficult to assess.

   According to AMAP (Arctic Monitoring and Assessment Programme), the major sectors in Jamaica responsible for mercury emissions are cement production (unintentional) (48.72 kg Hg/y), waste from products (intentional) (44.15 kg Hg/y) and oil and gas burning

(unintentional) (31.44 kg Hg/y) based on 2010 inventory results (Figure 5). It should be noted that data on sectors was based on assumptions made for the country and that alumina production was not assessed for this 2010 inventory as data could not be obtained.

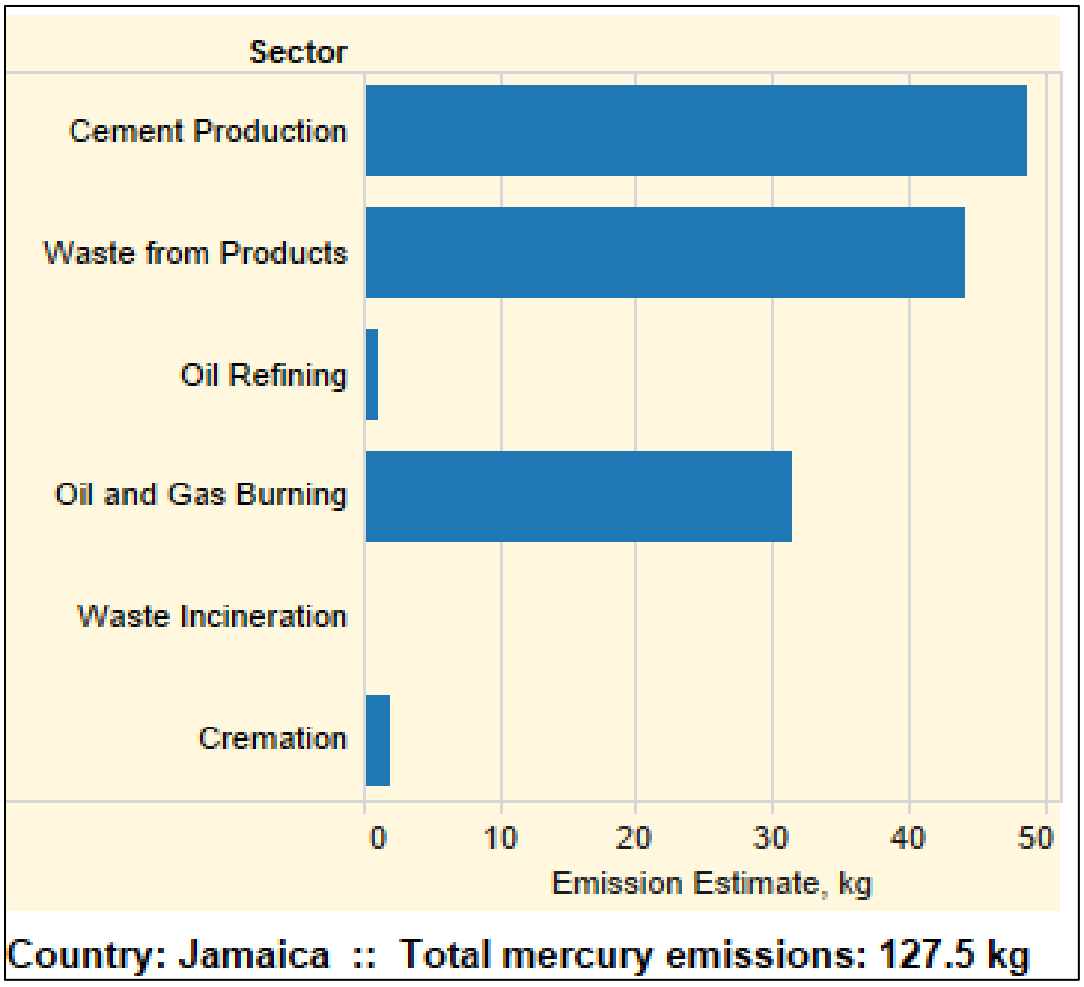

Figure 5: Results of 2010 Mercury Emissions Inventory in Jamaica (AMAP, 2013)

1.3 Project Background

The BCRC-Caribbean and the United Nations Environment Programme (UNEP) with funding from Norway ODA implemented a series of activities under the Project 'Mercury Storage and Disposal Project in the Caribbean: Jamaica, Trinidad and Tobago and Suriname'. This project is designed to enhance capacities and promote the environmentally sound storage and disposal of surplus mercury in Jamaica, Trinidad and Tobago and Suriname as well as to enhance these countries' understanding of the mercury waste and commodity issues as these relate to surplus mercury at country level.

The selected countries are in need of targeted assistance to enable them to manage their surplus mercury in an environmentally sound manner. In this, they face distinct challenges: Artisanal and small scale gold mining (ASGM) is practiced in Suriname and presumably constitutes the largest source of mercury emissions and releases. In the case of Suriname, the threat to human health and the environment from poor mercury emissions and waste management is particularly prevalent in the capital of Paramaribo, where the gold is smelted and purified.

By contrast, there is no ASGM in Jamaica and Trinidad and Tobago. However, in these small island developing states, there are potentially significant sources of mercury releases due to the operations of well-established mineral extractive industries and heavy industrial activities on each island. In the case of Jamaica, the major extractive industry is bauxite mining and processing while in Trinidad and Tobago, it is oil and gas extraction and refining. It is also suspected that spent mercury-added products are a major source of mercury emissions.

All three countries face similar challenges, in that there is no understanding of the existing mercury waste streams. Accurate data on the sources and quantities of mercury waste as well as the amounts of mercury released to the environment are not available. The problem is aggravated by a lack of dedicated facilities for the environmentally sound temporary storage of mercury and mercury wastes. This is in part due to a lack of efficient decision-making processes bringing together stakeholders from all relevant sectors and insufficient coordination between the different government agencies. Consequently, dedicated regulatory frameworks and strategies to ensure the environmentally sound storage and waste management are not in place.

As a result, the current status of mercury in Jamaica will be assessed and mercury release sources identified and quantified. The information gathered will inform national policy and possible ratification of the treaty.

1.4 Methodology

A national project inception workshop was held to introduce key stakeholders from Jamaica to the Minamata Convention and to the project activities. Following this, a National Working Group was formed comprising of representatives from the core group of stakeholders such as the ministerial bodies and associated agencies including:

- Environment & Risk Management Division of the Ministry of Economic Growth and Job Creation (MEGJC)
- Ministry of Transport and Mining
- Ministry of Health
- National Environment & Planning Agency

- Jamaica Bureau of Standards
- Jamaica Bauxite Institute (JBI)
- National Solid Waste Management Authority (NSWMA)

The Chemistry Department of the University of the West Indies, Mona, Jamaica, was also consulted.

Data collection was very important for the inventory in order to derive the necessary calculations for mercury releases. The National Working Group further identified stakeholders who may be major contributors to mercury emissions and coordinated their efforts to obtain data from these stakeholders. The group collaborated with the BCRC-Caribbean in the development of questionnaires for each of the following sectors:

- Oil and Gas
- Bauxite/ Cement
- Power Generation
- Mercury and Mercury Containing Devices
- Dental
- Waste
- Funeral Homes

The questionnaires were then distributed to the appropriate personnel within these sectors to gather relevant data for the inventory. All questionnaires developed are attached as Annex 1 to this report.

This inventory was conducted in 2016 using the UNEP's Toolkit for Identification and Quantification of Mercury Releases (Inventory Level 1). The Toolkit is based on mass balances for each mercury release source type. Inventory Level 1 works with pre-determined factors based largely on assumptions on 2015 population data. These assumptions are used to calculate mercury inputs to society and releases, the so-called default input factors and default output distribution factors. These factors were derived from data on mercury inputs and releases from the relevant mercury source types from available literature and other relevant sources such as the International Energy Agency's website.

The Toolkit consisted of a Microsoft Excel spreadsheet with predetermined formulae in certain cells to automatically calculate mercury inputs and releases. Data was separated based on the following sectors or steps:

- Energy Consumption and Fuel Production
- Domestic Production of Metals and Raw Materials
- Domestic Production and Processing with Intentional Mercury Use
- Waste Treatment and Recycling
- General Consumption of Mercury in Products, as Metal Mercury and as Mercury Containing Substances
- Crematoria and Cemeteries
- Miscellaneous Mercury Sources

The completed inventory Toolkit is available as Annex 2.

NOTE: When available, data for the year 2015 has been used for this inventory. For some data sets however, data from that year may not have been available and as such, the corresponding year for all data retrieved has been indicated for that data group.

The National Working Group developed an Action Plan for achieving the objectives of the project which is available in Annex 3. Table 1 below provides the project timeline for the activities of the project.

Table 1: General Project Timeline 2016

April May	June	July Aug Sept Oct	Nov	Dec
Preparation for Workshops	National Inception Workshop	Data Collection, Questionnaires, Draft Report	Results Workshops	Closure of Project

1.5 Data Gaps

The biggest challenge in completing the inventory was acquiring the adequate data to complete the various sections that were applicable to the country, in a very short timeframe. In order to collect the information required, questionnaires based on various sectors that emit mercury were used (attached as Annex I) and distributed to the relevant personnel. However, due to the limited voluntary responses received, alternate data sources had to be utilised, as is detailed below.

Information relating to the quantity of each type of fuel used in energy consumption was retrieved from the International Energy Agency database for 2014.

Data for wastewater system/ treatment was based on the maximum capacity of Soapberry Sewage Treatment Plant which is limiting as this plant only serves three (3) parishes.

Data for the section on mercury products and substances was obtained from the questionnaires. For the first section (Use and disposal of products) questionnaires were distributed to dentists. The response rate was low, but from the data obtained, assumptions could be made. The low response rate however, did not hinder the completion of the inventory as information was also gathered from external sources who confirmed that a number of dentists still use amalgam fillings. Information on the importation and production of bleaching creams that contain mercury is not captured in this report as the Jamaica Customs Agency was unable to provide this data. Data for some other products such as medical blood pressure gauges, could not be verified within the timeframe for the report and so, exact figures were excluded. With respect to thermometers, data used did not distinguish between medical and other glass mercury thermometers.

The main priorities for a future assessment would be to obtain the exact values for those steps in the inventory that are data scarce. There were cases where this data was simply not recorded in the country which is a situation that needs to be rectified. In addition, a more efficient method of distributing the questionnaires is required and it is recommended that direct or face-to-face distribution may be more rewarding as this may encourage persons to fill them out.

1.6 Information[2] on Key Legal Instruments Relating to Chemicals (e.g. Mercury)

The management of chemicals and, in particular mercury, falls primarily under four (4) Ministries of the Jamaican Government.

1. The Ministry of Health (MOH) is the main Government organization whose mandate is "To ensure the provision of quality health services and to promote healthy lifestyles and environmental practices". The Ministry, together with its Regional Health Authorities (RHAs), Agencies and related organizations make up the public health system and are responsible for health care delivery across the island.

The MOH has responsibility for all chemicals (except petroleum) throughout their life cycle. The Standards and Regulation Division (SRD), the Environmental Health Unit (EHU) within the Ministry and the Pesticides Control Authority (PCA), an executive agency of the ministry, are directly involved in carrying out this function.

[2] Adapted from Chapter 3 of the National Profile for the Management of Chemicals in Jamaica, second edition, 2016.

The Health sector is directly responsible for the purchase of mercury containing products as well as dental amalgam.

2. The Ministry of Economic Growth and Job Creation (MEGJC) was created in March 2016. The Ministry is charged with drafting the blueprint to drive economic growth and sustainable development in Jamaica. The Ministry has responsibility for seven (7) critical portfolio areas. They are: Land, Environment, Climate Change, Investment, Water and Wastewater, Housing and Works. Under its portfolio areas, the Ministry has oversight for some forty-eight (48) Agencies, Departments and Divisions, which are responsible for approximately sixty-eight (68) subject areas.

The National Environment and Planning Agency (NEPA), which includes the Natural Resources Conservation Authority falls under this Ministry and its mission is to promote sustainable development by ensuring protection and management of the environment in Jamaica. It is the environmental management (monitoring, pollution control and planning) agency and it is also responsible for the transboundary movement of hazardous waste.

3. The Ministry of Local Government and Community Development (MLGCD) has a mission to provide a sound policy, legal, technical and administrative framework that supports excellent service delivery and operational management by the Local Authorities and portfolio agencies, in a manner that advances the ideals of effective local governance and the goals of sustainable, community development, through a purpose-driven and competent work force. The MLGCD has the mandate to manage solid waste in Jamaica, The National Solid Waste Management Authority (NSWMA) is the lead agency. The NSWMA will have a direct role in the storage and disposal of mercury in Jamaica.

4. The Ministry of Science, Energy and Technology is responsible for the petroleum industry in Jamaica. The Petroleum Corporation of Jamaica established under the Petroleum Act, 1979 is charged with managing Jamaica's fuel needs. The Mines and Geology Department however, now falls under the Ministry of Transport and Mining. This Ministry will be responsible for the bauxite production in Jamaica.

The legal instruments related to the management of **ALL** chemicals and hazardous wastes in Jamaica are detailed in Table 2 below.

Table 2: Overview of All Existing Legal Instruments Which Address the Management of Chemicals in Jamaica

Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Category of Chemicals, Type of by-product, or Type of Related Waste Covered	Chemical Life Cycle Stage Covered	Objective of Legal Instrument	Relevant Articles/ Provisions
The Banana Board Act, 1953	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To regulate the growing, purchase and sale of bananas in the country and the export of bananas from the country	Sections 11 -12 of Act
The Calcium Carbide (Sale and Storage) Act, 1901 and the Calcium Carbide (Storage) Rules, 1901	Ministry of Health	Calcium carbide	Import Distribution Storage	To make provision for the import, distribution and storage of calcium carbide	The entire Act and Rules
The Civil Aviation Act, 1966 and The Civil Aviation Regulations, 2012	Ministry Transport and Mining	Dangerous goods	Handling Transportation	To make provisions in respect of civil aviation	Sections 2-3, 10, 77-78 of the Regulations
The Clean Air Act, 1961	Ministry of Economic Growth and Job Creation	Noxious or offensive gas	Escape Discharge	To make provision for abating the pollution of the air	Sections 2, 5-6 and the Schedule of the Act
The Cocoa Industry Board Act, 1957	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To regulate the growing, processing, purchase and sale of cocoa in the country and the export of cocoa from the country	Section 5 of the Act
The Coconut Industry Control Act, 1945	Ministry of Industry, Commerce,	Pesticides Fertilizers	Purchase Use	To regulate the growing, processing, purchase and sale of	Sections 14, 20 of the Act

	Agriculture and Fisheries			coconut in the country and the export of coconut from the country	
The Coffee Industry Regulation Act, 1948	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To regulate the growing, processing, purchase and sale of coffee in the country and the export of coffee from the country	Section 6 of the Act
The Customs Act, 1941	Ministry of Finance and the Public Service	Dangerous goods	Import Export Storage Disposal	To make provision for custom duties, prohibited goods and connected matters	Sections 39-43 of the Act
The Dangerous Drugs Act, 1948	Ministry of National Security	Dangerous drugs	Cultivation Import Manufacture Sale Use Export Disposal	To regulate the importation, export, manufacture, sale and use of dangerous drugs	Sections 3-18 of the Act
The Disaster Risk Management Act, 2015	The Ministry of Local Government and Community Development	Dangerous chemicals	Clean up Disposal	To make new provision for the management and mitigation of disaster and t he reduction of risks associated with disaster	Section 2 of the Act
The Explosives (Control of Manufacture) Act, 1897	Ministry of National Security	Explosives	Manufacture	To prevent the unlicensed manufacture of explosives	Sections 3 - 6 of the Act
The Explosives (Sale of Deposited Stores) Act, 1889	Ministry of National Security	Dangerous explosives Gunpowder	Sale Export	To provide for the use, export or sale of dangerous explosives or gunpowder in storage	Sections 3 – 4 of the Act
The Factories Act, 1943	Ministry of Labour &	Dangerous chemicals	Import	To provide for the registration and	Sections 4, 6-12 of the

	Social Security		Export Manufacture Sale Use Packaging Labelling Transportation Disposal	supervision of factories, for the health safety and welfare of employees	Act
The Fertilizers and Feeding Stuffs Act, 1942	Ministry of Industry, Commerce, Agriculture and Fisheries	Fertilizers Feed for cattle or poultry	Sale	To make provision in relation to fertilizers and feeding stuffs	Sections 3, 4, 12, 15 of the Act
The Fire Brigade Act, 1988	Ministry of Local Government and Community Development	Dangerous fumes or fluids Oil spills Dangerous pollutants of the sea or air	Emergency response	The establishment and regulation of Fire Brigades	Sections 2, 5, 9-12 of the Act
The Food and Drugs Act, 1975 **The Food and Drugs Regulations, 1975**	Ministry of Health	Food Drugs Cosmetics Food additives Food preservatives Therapeutic devices	Import Manufacture Packaging Labelling Sale	To make provisions relating to foods, drugs, cosmetics and therapeutic devices	Sections 4, 5, 6, 9, 11, 12, 15, 16, 17, 19 of the Act
The Gunpowder and Explosives Act, 1925	Ministry of National Security	Gunpowder Explosives	Import Sale Storage	To make provisions for the importation, sale, storage and packing for transportation of gunpowder and the import and possession of dangerous explosives	Sections 3, 4, 6, 10, 12, 13, 14, 17, 18, 20 of the Act

The Harbours Act, 1874	Ministry Transport and Mining	Oil Mixture containing oil Oil residues	Disposal	To make provisions for harbours	Section 19 of the Act
The Jamaica Agricultural Society Incorporation Act, 1941	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To incorporate the Jamaica Agricultural Society and matters incidental	Section 6 of the Act
The Maritime Areas Act, 1996	Ministry Transport and Mining	Polluting substances Nuclear substances or other dangerous or noxious substances	Disposal	To declare Jamaica an archipelagic state and to make provision with respect to certain Maritime Areas of Jamaica	Sections 9(3)(a) 14(2)(b), 17, 18(1)(g), 22(1)(d) of the Act
The Mining Act, 1947 **The Mining (Safety and Health) Regulations, 1977**	Ministry Transport and Mining	Explosives Explosive materials Airborne contaminants Caustic soda, acid or other corrosive substances	Storage Transportation Handling	To control and regulate mines and mining and refinery operations	Regulations Part III, Part V, Part XIII
The National Health Services Act, 1997 **The National Health Services (Southern Regional Health Authority) Management Scheme, 1997**	Ministry of Health	Dangerous chemicals used in health facilities Medical waste	Import Use Storage Disposal	To provide for the establishment of regional health authorities to administer the country's health services and facilities	Sections 5, 13 of the Act and section 5 of the Management Scheme
The National Solid Waste Management Act, 2001 **The National Solid Waste Management**	Ministry of Local Government & Community Development	Solid Waste	Collection Sorting Transportation Recycle Reuse	To provide for the regulation and management of solid waste, to establish the National Solid Waste Management Authority	Section 4, 20-32, 42-60, 68 of Act and the Regulations

(Public Cleanliness) Regulations, 2003			Storage Disposal		
The Natural Resources Conservation Authority Act, 1991 **The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996** **The Natural Resources Conservation (Permits and Licences) Regulations, 1996 (Amended 2015)** **The Natural Resources (Hazardous Waste) (Control of Transboundary Movement) Regulations, 2002 and other Orders and Regulations**	Ministry of Economic Growth and Job Creation	Industrial chemicals Sewage effluent Trade effluent Hazardous waste Emissions	Manufacture Packaging Sale Use Handling Storage Transportation Disposal Export	To provide for the management, conservation and protection of the natural resources of Jamaica, to establish the Natural Resources Conservation Authority through environmental permitting and licencing of emissions.	Sections 4, 5, 8-13, 15-20, 36-38 of the Act and the Orders and Regulations
The Pesticides Act, 1987 **The Pesticides Regulations, 1996**	Ministry of Health	Pesticides	Import Manufacture Packaging Sale	To make provision for regulating the importation, manufacture, sale and use of pesticides, for the licensing of pest control operators	Sections 3, 4, 7-20, Second and Third Schedules of the Act and the Regulations.

			Use Storage Transportation Disposal		
The Petroleum Act, 1979 **The Petroleum (Prescribed Articles) Regulations, 1981**	Ministry of Energy, Science and Technology	Petroleum Petroleum products Chemicals for drilling and blasting	Exploration Development Management Construction Maintenance Operating Processing Refining Storage Purchase Sale Distribution Transportation Import Export	To provide for the establishment and functions of the Petroleum Corporation of Jamaica	Section 6 of the Act and the Regu-lations
The Petroleum and Oil Fuel (Landing and Storage) Act, 1925 **The Petroleum (Landing and Storage) Rules, 1941** **The Oil Fuel (Landing and Storage) Regulations, 1941**	Ministry of Energy, Science and Technology	Petroleum Oil fuel	Import Storage Sale Transportation	To make provision as regards petroleum and oil fuel	The entire Act, the Rules and the Regulations

The Petroleum (Quality Control) Act, 1990 **The Petroleum (Quality Control) Regulations, 1990**	Ministry of Energy, Science and Technology	Petroleum products	Production Import Blending Distribution Sale Transportation	To make provision for monitoring the quality of petroleum distributed or sold	Sections 2-10, 14-20 of the Act and the Regulations
The Port Authority Act, 1972	Ministry of Transport and Mining	Dangerous chemicals	Handling Storage	To constitute a Port Authority, for providing, operating and regulating all port facilities	Section 6 of the Act
The Precursor Chemicals Act, 1999	Ministry of Health	Precursor chemicals Solvents Reagents Catalysts	Import Production Manufacture Preparation Distribution Export	To provide for the monitoring and control of precursor chemicals and other chemical substances used or capable of being used in any type of illicit transaction involving narcotic drugs, psychotropic substances or other substances having a similar effect	The entire Act
The Processed Food Act, 1987 **The Processed Food (General) Regulations, 1959** **The Processed Food (Establishments) Regulations, 1959** **The Processed Food (Grades and Standards) Regulations, 1964** **The Processed Food (Prepared Syrups)**	Ministry of Health	Preservatives Additives Other chemicals used in facilities	Purchase Use	The establishment of standards for processed food intended for export or for sale in Jamaica and to the control of the exportation or sale of such food	Sections 2 – 8 of the General Regulations Section 10(i) of the Establishments Regulations The Grades and Standards Regulations Sections 2 - 4 of the Prepared Syrups Regulations

Regulations, 1974					
The Public Health Act, 1985 **The Public Health (Nuisance) Regulations, 1995**	Ministry of Health	Industrial chemicals Consumer chemicals Fertilizers Noxious emissions Waste Offensive smells	Import Manufacture Collection Disposal	To make provision for promoting the public health and for preventing the spread of communicable and epidemic diseases	Sections 6-8, 12, 14, 20-28 of the Act and the Regulations
The Quarantine Act, 1951	Ministry of Health	Dangerous chemicals	Import Export	To establish the Quarantine Authority, make provision relating to quarantine matters	First and Second Schedules of the Act
The Quarries Control Act, 1983 and the Quarries (General) Regulations, 1958	Ministry of Transport and Mining	Explosives Dust	Handling Use Storage	To control and regulate quarries and quarry operations	Sections 6(j), 11(4), Part III and Part VI of the Regulations
The Rural Agricultural Development Authority Act, 1990	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To establish the Rural Agricultural Development Authority with responsibility for development of agriculture in rural areas	Section 4 of the Act
The Shipping Act, 1998	Ministry of Transport and Mining	Dangerous Goods	Handling Transportation	To make better provision in respect of the regulation of merchant shipping generally	Sections 288 – 292 of the Act
The Standards Act, 1969	Ministry of Industry, Commerce, Agriculture and Fisheries	Chemicals	Standardization	To establish the Bureau of Standards, to promote standardisation in relation to commodities, processes and practices	Section 6 of the Act

The Sugar Industry Control Act, 1937	Ministry of Industry, Commerce, Agriculture and Fisheries	Pesticides Fertilizers	Purchase Use	To regulate the sugar industry in the country and the import and export of sugar	Section 5 of the Act
The Trade Act,1955 **The Trade (Prohibition of Importation) (Equipment containing Chlorofluorocarbons) Order, 1998** **The Trade (Restriction on Importation) (Chlorofluorocarbons) Order, 1999** **The Trade (Prohibition of Exportation) (Halon) Order, 2002** **The Trade (Prohibition of Importation) (Halon) Order, 2002** **The Trade (Restriction on Importation) (Carbon Tetrachloride) Order, 2007** **The Trade (Restriction on Importation) Methyl Chloroform) Order, 2007**	Ministry of Industry, Commerce, Agriculture and Fisheries	Chlorofluorocarbons (CFCs) Halon Carbon Tetrachloride Methyl Chloroform	Import Export	To make provision for imports, exports and prices	Sections 8(1)(b), 11 of Act and the Orders
The Wharfage Act, 1895	Ministry of Transport and Mining	Goods (other than explosives)	Handling Storage	To make provision for wharfingers	Section 12 of the Act

The key pieces of legislation that are of importance to Mercury in Jamaica are the:

1. The Natural Resources Conservation Act, 1991
2. National Solid Waste Management Act, 2001
3. Trade Act, 1955
4. Public Health Act, 1985
5. The Standards Act, 1969
6. The Mining Act, 1947
7. The Quarries Control Act, 1983
8. The Clean Air Act, 1961

A more specific elaboration of each of these pieces of legislation is detailed below:

1. The Natural Resources Conservation Authority Act, 1991

This Act seeks to provide for "the effective management of the physical environment of Jamaica so as to ensure the conservation, protection and proper use of its natural resources ...". More specifically, the Act empowers the National Environment and Planning Agency (NEPA) (which incorporates the former Natural Resources Conservation Authority) to:

"(a) formulate standards and codes of practice to be observed for the improvement and maintenance of the quality of the environment generally, including the release of substances into the environment in connection with any works, activity or undertaking;

(b) investigate the effect on the environment of any activity that causes or might cause pollution or that involves or might involve waste management or disposal, and take such action as it thinks appropriate;

(c) undertake studies in relation to the environment and encourage and promote research into the use of techniques for the management of pollution and the conservation of natural resources."

Under the Permits and Licences Regulations (1996), a permit is required to carry out "any enterprise, construction or development of a prescribed description or category" anywhere in Jamaica and its Territorial Sea. Under the Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996, prescribed categories of "enterprise, construction or development" include water treatment facilities, mining and mineral processing, solid waste treatment and disposal facilities, cemeteries and crematoria, hazardous waste storage, treatment and disposal facilities, processing of agricultural waste, industrial

projects – including chemical plants, petroleum production, refinery, storage and stockpiling, food processing plants, detergent and soap manufacturing, cement and lime production plants, paint manufacture, manufacture of pesticides or other hazardous or toxic substances, and citrus, coffee, cocoa, coconut, sugar cane processing plants. The Permits and Licences Regulations were amended in 2015, principally to remove the grandfathering clause of the 1996 Regulations.

A licence is required to:

"(a) discharge on or cause or permit the entry into waters, on the ground or into the ground, of any sewage or trade effluent or any poisonous, noxious or polluting matter; or

(b) construct, reconstruct or alter any works for the discharge of any sewage or trade effluent or any poisonous, noxious or polluting matter."

Detailed information concerning permits and licences is contained in the Natural Resources (Permits and Licences) Regulations, amended 2015.

The transboundary movement of hazardous waste is dealt with by the Natural Resources (Hazardous Waste) (Control of Transboundary Movement) Regulations, 2002. These regulations, under which a system of permits is established, give effect to the provisions of the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention). Limits for approximately forty chemical parameters, including mercury, are set out in the Third Schedule of the Wastewater and Sludge Regulations, 2013. The regulations state the permissible mercury concentrations for Trade Effluent Limit (0.02 mg/L), National Treated Sewage Sludge Standard for Fully Treated Sewage Sludge that can be applied to Agricultural Land (maximum concentration of 0.045 mg/kg), and Standard for Solid Waste/Industrial Sludge Suitable for Landfill (based on Leachate quality test results) (0.1 mg/L).

2. The National Solid Waste Management Act, 2001

This Act establishes the National Solid Waste Management Authority (NSWMA) which is mandated to inter alia "take all such steps as are necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that the waste is collected, stored, transported, recycled, reused or disposed of, in an environ-mentally sound manner and promote safety standards in relation to such waste..." Solid waste is defined to include "medical and hazardous waste and –

(a) refuse or sludge from a waste treatment facility, water supply plant, air pollution control facility and garbage;

(b) commercial, mining or agricultural operations or domestic activities; and

(c) any contained substance or object which is or is intended to be, or required by law to be, disposed of, but does not include ... (iii) industrial discharges from pipelines conveying such waste."

The Act requires every person who operates or wishes to operate a solid waste disposal facility, or who provides or wishes to provide solid waste collection or transfer services, or who otherwise manages solid waste, to apply for a licence from the NSWMA. The Minister of Local Government and Community Development is empowered to exempt categories of persons from this requirement. Licences are granted or refused on the basis of inspections by the NWSMA and recommendations from the relevant agencies, for example, NEPA.

The NSWMA, after consultation with NEPA, is authorised to require the owner or operator of a sewage treatment plant, industrial waste treatment facility or other solid waste disposal facility that generates sludge to provide it with information about the operation of the facility. Failure to provide the information is a criminal offence. The NSWMA is also authorised to issue cessation orders in prescribed circum-stances as well as enforcement notices. Appeals against enforcement notices can be made to an Appeal Tribunal established under the Act. Appeals against the decision of the NSWMA not to grant a licence, or to suspend or revoke a licence or the inclusion of certain terms and conditions in a licence can be made to the Minister. An authorised officer under the Act has power to enter any solid waste disposal facility, inspect any book or record and seize and detain any equipment or other article reasonably believed to be used in contravention of the Act.

The Act provides for a number of criminal offences and penalties. The NSWMA is authorised to institute legal proceedings against any person for an offence under the Act.

3. The Public Health Act, 1985

Chemicals other than pesticides and petroleum are regulated by the Standards and Regulation Division (SRD) of the Ministry of Health. There is no specific legislative authority for the exercise of this function. However, the management of chemicals is seen as part of the wider public health function under the Public Health Act. The SRD receives applications and issues permits to importers and manufacturers of chemicals – industrial chemicals, consumer chemicals and fertilizers.

The Public Health Act establishes a Local Board of Health in each parish of Jamaica. In addition, the Act also establishes a Central Health Committee based in the Ministry of Health. The function of the Central Health Committee is to advise the Minister and the Local Boards on matters of public health. With the coming into force of the National Health Services Act in

1997, Jamaica was divided into four health regions with each region being managed by a Regional Health Authority.

In exercising its regulatory function, the SRD relies heavily on the Public Health (Nuisance) Regulations, 1995 which define "nuisance" to include:

- "Dust, smoke, fumes, gases or effluvia emitting from any manufacturing process or caused by the carrying on of any trade or business or otherwise by the action of any person.
- The discharge of any sewage, industrial waste or any other noxious matter into the sea or any watercourse or onto any land.
- Offensive smells, including the emission of noxious fumes, gases or powerful smells, as a result of agricultural, domestic or industrial processes or otherwise."

These Regulations prohibit an owner, occupier or other person from causing, permitting or aiding and abetting another person to cause or permit a nuisance on any premises. A Medical Officer of Health, a Public Health Inspector or other authorised person or the Local Board can serve a notice on the owner, occupier or other person to stop the nuisance or prevent its recurrence. Failure to comply with the notice is a criminal offence. Where the Local Board takes action to stop the nuisance and/or prevent its recurrence, any expenses incurred by the Local Board are recoverable in a Court from the owner of the premises as a civil debt.

Other regulations relating to chemical management under the Public Health Act include:

1. The Public Health (Garbage Collection and Disposal) Regulations, 1998.

Under these Regulations "garbage" is defined to include "re-fuse of any description, whether generated by domestic, commercial or industrial activity, and all forms of solid and liquid waste matter". These Regulations operate at the parish level and the Local Board is charged with the responsibility of collecting and disposing of garbage.

2. The Public Health (Tourist Establishments) Regulations, 2000

Anyone who intends to or operates a tourist establishment must apply to the Medical Officer of Health for the parish for a health certificate for the establishment. Under these Regulations, "hazard" is defined to mean "any physical, chemical or microbiological or other agent which is likely to cause a health risk"; "hazardous material" is defined to include "gasoline, kerosene, fuel oil, explosives, pesticides, rodenticides, insecticides, herbicides, disinfectants and cleansers"; and "solid waste" is de-fined to mean "material or by-product, solid or semi-solid, generated by a tourist establishment". These Regulations are comprehensive covering, inter alia, the areas of food safety, safety and conduct of employees, water supply, medical and first-aid facilities, and

solid waste management. Contravention of these Regulations constitutes a criminal offence punishable by a fine and/or imprisonment.

3. The Public Health (Hairdressers, Beauty Therapists, Cosmetologists and Beauty Salons) Regulations, 2004.

These Regulations prohibit a person from operating a beauty salon, or holding himself/herself out as or performing the functions of a beauty therapist, cosmetologist or hairdresser without a valid licence issued by the Local Board. Public Health Inspectors or other authorised persons are empowered to enter beauty salons and inspect the premises, tools, equipment or appliances, products and the licence. Contravention of these Regulations constitutes a criminal offence punishable by a fine.

4. The Trade Act, 1955

This Act, in section 8(1), empowers the Minister of Industry, Investment and Commerce, by order, to:

(a) prohibit "the importation or exportation of goods or any class or description of goods from or to any country;"

(b) prohibit "the importation or exportation of goods or any class or description of goods from or to any country except under the authority of a licence granted by the Minister;"

(c) regulate "the distribution, purchase or sale of goods or any class or description of goods;"

5. The Standards Act, 1969

This Act establishes the Bureau of Standards Jamaica which is mandated under section 6 to "promote and encourage the maintenance of standardization in relation to commodities, processes and practices". The Bureau has the power inter alia:

"(a) to make recommendations to the Minister in respect of the formulation of specifications and the promulgation and application of standard specifications, and compulsory standard specifications;

(b) to promote research in relation to specifications and to pro-vide for the examination and testing of commodities, processes and practices;".

Examples of existing standards are:

JS 1, 1992. The labelling of commodities. Part 15: The labelling of household chemicals.

JS 1, 1996. Part 17: The precautionary labelling of hazardous industrial chemicals.

6. The Mining Act, 1947

Mining is prohibited except under a mining lease. The Mining (Safety and Health) Regulations, 1977 set out comprehensive regulations dealing with, inter alia, explosives, materials storage and handling, air quality and personal protection.

7. The Quarries Control Act, 1983

The Act prohibits the opening, establishment or operation of a quarry for the purpose of extracting quarry material or quarry mineral except under a licence issued by the Minister of Science, Technology, Energy and Mining. The Commissioner of Mines, a Medical Officer or other authorised person is empowered "at all reasonable times to enter, inspect and examine any premises or land on which a quarry is being operated or where quarried material or quarried mineral is stored..." If such person finds "any quarry to be operated in a dangerous or defective manner..., he must give a notice in writing to the person operating the quarry requiring that remedial action be taken. Failure to comply constitutes a criminal offence. The Quarries Control Regulations, 1958 set out comprehensive regulations dealing with inter alia safety, health and welfare of workers and with explosives.

8. The Clean Air Act, 1961

This Act empowers an inspector to "enter any affected premises at any time while work is being carried on there, or while there is any discharge of smoke or fumes or gases or dust into the air from any part of such premises..." inspect and examine the premises, make enquiries and make tests and take samples of any substance, smoke, fumes, gas or dust as necessary.

The owner, including a lessee or occupier, of affected premises is required to "use the best practicable means for:

(a) preventing the escape of any noxious or offensive gas;

(b) preventing the discharge of any such gas into the air; and

(c) rendering such gas, where discharged, harmless or inoffensive..."

"Affected premises" is defined in the Act to mean "any premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust into the air." Breach of this Act constitutes a criminal offence punishable by a fine and if in de-fault of payment, by imprisonment.

The Schedule lists the noxious or offensive gases to which the Act applies as:

1. Fumes or dust emanating from any works for the production of alumina;
2. Fumes or dust from any cement works;
3. Fumes or dust from any lime works;
4. Gas containing any sulphur compound emanating from any petroleum works;
5. Fumes, vapour, or gas from any electrical generating station;
6. Fumes or dust from any gypsum works;
7. Ash, dust or soot from any sugar factory.

This Act is administered by the Central Committee of Health established under the Public Health Act.

These laws are dated and will require amendments to include considerations specifically for mercury. Table 3 details a possible action plan towards the amendment of national legislation as well as starting the conversation on non-regulatory instruments for the management of mercury and by extension other hazardous and chemical wastes.

Table 3: Priorities and Possible Actions: Legal Instruments and Non-Regulatory Mechanisms for the Sound Management of Mercury (and by extension other chemicals)

Priority Issues (Ranked from highest to lowest)	Level of existing capacity (Low, medium, high)	Summary of Capacity - Strengths, Gaps, and Needs	Possible Action	Concerned Actors
Develop comprehensive regulatory framework for the management of chemicals	High	There is awareness of the issues and some are addressed in different regulations. There is need for an analysis of the costs (financial, human, efficiency) of the status quo	Establish a committee to design and cost the new regulatory framework and analyse the costs of the status quo	Ministries with responsibility for Legislation, Health, Environment and relevant agencies
Review all existing laws to determine which should be kept, updated, or repealed in the context of the new framework **Determine whether new laws need to be promulgated in the context of the new framework.**	High	Aspects of this review have already been done	Engage/assign someone to carry out this review	Attorney-at-Law with knowledge of this area, Ministries with responsibility for Legislation, Health, Environment and relevant agencies

Review all the chemicals conventions to which Jamaica is a party and determine if enabling legislation is needed	High	Aspects of this review have already been done	Engage/assign someone to carry out this review	Attorney-at-Law with knowledge of this area, Ministries with responsibility for Legislation, Health, Environment and relevant agencies
Research and evaluate non-regulatory mechanisms which have been successfully implemented in other countries	Medium		Engage/assign someone to carry out this activity	Ministry with responsibility for Health National Environment and Planning Agency Solid Waste Management Authority
Engage with entities concerned with the management of chemicals to develop non-regulatory mechanisms	Low		Engage/assign someone to carry out this activity	Ministry with responsibility for Health, NEPA, NSWMA

2.0 Results and Discussion

An aggregated presentation of the results obtained from the inventory for the main groups of mercury release sources is presented in Figures 6 to 12 below.

As shown in Table 4, the source groups that contribute to the input of mercury are:

- Primary Metal Production (Alumina Production from Bauxite)

- Use and Disposal of Other Products

- Other Materials Production (Cement Production)

- Other Fossil Fuel and Biomass Combustion

- Crematoria and Cemeteries

- Application, Use and Disposal of Dental Amalgam Fillings

- Wastewater System/ Treatment

NOTE: With respect to the waste deposition, only 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of the Toolkit. The origin of mercury in waste and waste water produced in the country is mercury in products and materials. Waste fractions and waste water therefore do not represent original mercury inputs to society (except imported waste). Waste and waste water may however, represent substantial flows of mercury through society.

Table 4: Summary of mercury inventory results

Source category	Estimated Hg input, Kg Hg/y	Estimated Hg releases, standard estimates, Kg Hg/y							Percent of total releases *3*4
		Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal	Total releases *3*4*5	
Coal combustion and other coal use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Other fossil fuel and biomass combustion	77.0	77.0	0.0	0.0	0.0	0.0	0.0	77	3%
Oil and gas production	4.1	1.0	0.0	0.0	0.0	0.0	0.6	2	0%
Primary metal production (excl. gold production by amalgamation)	1,851.0	277.6	185.1	0.0	0.0	1,203.1	185.1	1,851	**71%**
Gold extraction with mercury amalgamation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Other materials production	104.6	78.4	0.0	0.0	26.1	0.0	0.0	105	**4%**
Chlor-alkali production with mercury-cells	-	-	-	-	-	-	-	0	0%
Other production of chemicals and polymers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Production of products with mercury content*1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Application, use and disposal of dental amalgam fillings	52.5	1.1	17.4	2.5	1.9	8.8	8.8	41	2%
Use and disposal of other products	452.5	15.4	82.8	0.0	0.0	311.7	42.6	453	**17%**
Production of recycled metals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Waste incineration and open waste burning*2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0%
Waste deposition*2	3,449.0 (actual input = 345)	34.5	0.3	0.0	-	-	-	35	1%
Informal dumping of general waste *2*3	0.0	0.0	0.0	0.0	-	-	-	0	0%
Waste water system/treatment *4	157.5	0.0	141.8	0.0	0.0	15.8	0.0	16	1%
Crematoria and cemeteries	42.4	10.6	0.0	31.8	0.0	0.0	0.0	42	2%
TOTALS (rounded) *1*2*3*4*5	**2,930**	**500**	**290**	**30**	**30**	**1,540**	**240**	**2,620**	**100%**

Notes to table above:

*1 To avoid double counting of mercury in products produced domestically and sold on the domestic market (including oil and gas), only the part of mercury inputs released from production are included in the input TOTAL.

*2: To avoid double counting of mercury inputs from waste and products in the input TOTAL, only 10% of the mercury input to waste incineration, waste deposition and informal dumping is included in the total for mercury inputs. These 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of the Toolkit.

*3: The estimated quantities include mercury in products which has also been accounted for under each product category. To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS.

*4: The estimated input and release to water include mercury amounts which have also been accounted for under each source category. To avoid double counting, input to, and release to water from, waste water system/treatment have been subtracted automatically in the TOTALS.

*5: Total inputs do not necessarily equal total outputs due to corrections for double counting (see notes*1-*3) and because some mercury follows products/metal mercury which are not sold in the same country or in the same year.

2.1 Presentation of Results

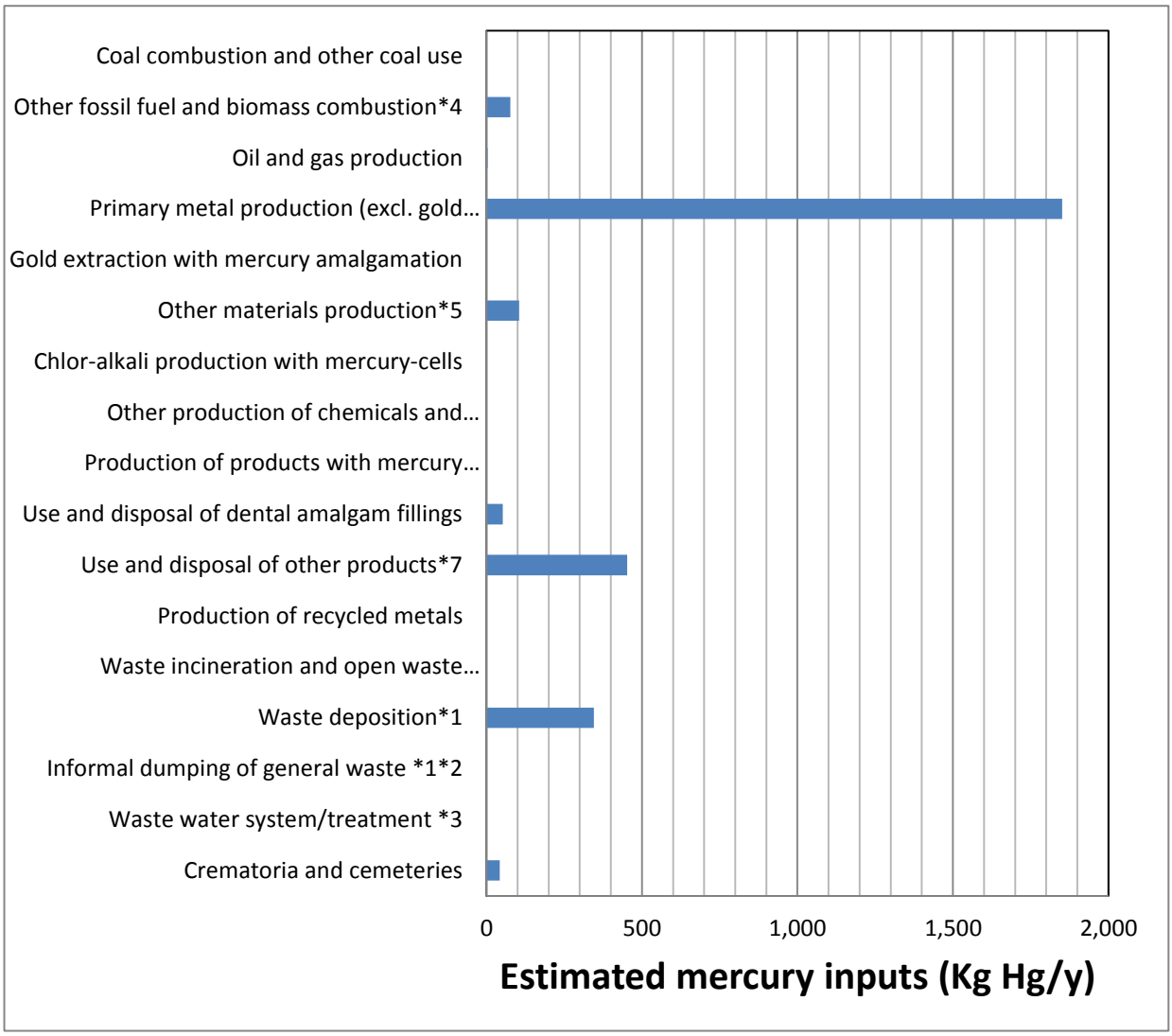

Figure 6: Major Mercury Inputs (Estimated)

Figure 6 clearly indicates that the largest amount of mercury inputs came from primary metal production referring to alumina production from bauxite. This is due to the naturally high concentration of mercury in Jamaica's geology, especially the bauxite deposits, most likely due to the geology's volcanic origins.

The use and disposal of products containing mercury (excluding dental amalgam) contributed the second largest inputs at 453 kg Hg/y. These products include medical blood pressure clinical

gauges, clinical thermometers, lightbulbs and skin whitening creams. Waste deposition was the third largest sector responsible for mercury inputs however, this value was determined from estimating the total amount of waste going to waste disposal sites and therefore included waste that would be represented by other sectors such as Use and Disposal of Products. In order to account for this double counting, only 10% of the mercury input for Waste Deposition is included in the total for mercury inputs based on assumptions made in the Toolkit.

Other material production refers to cement production which accounted for estimated inputs of 104.6 kg Hg/y. This value is based on assumptions in the Toolkit on the raw materials, type of fuel and cleaning methods used for the process.

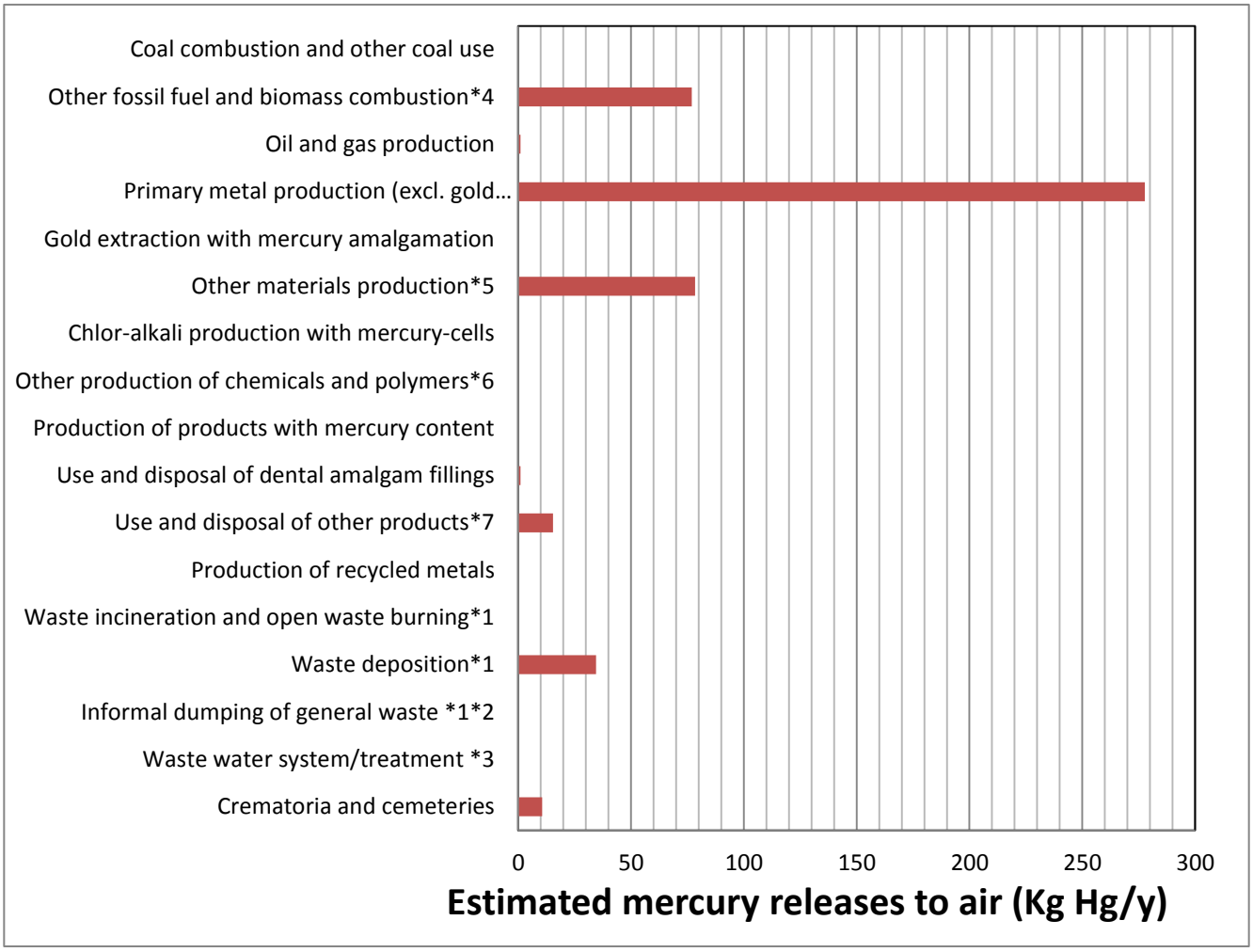

Figure 7: Major Mercury Releases to Air (Estimated)

Figure 7 illustrates that the largest releases of mercury to air came mainly from alumina production from bauxite (primary metal production) followed by the two sectors; other materials production (cement production) and, other fossil fuel and biomass combustion, with estimated releases of 78.4 kg Hg/y and 77 kg Hg/y respectively. This is due to the release of mercury-containing fumes to air during combustion processes. With respect to cement production, mercury is released to air mainly due to the combustion of mercury containing fuel in the cement kilns.

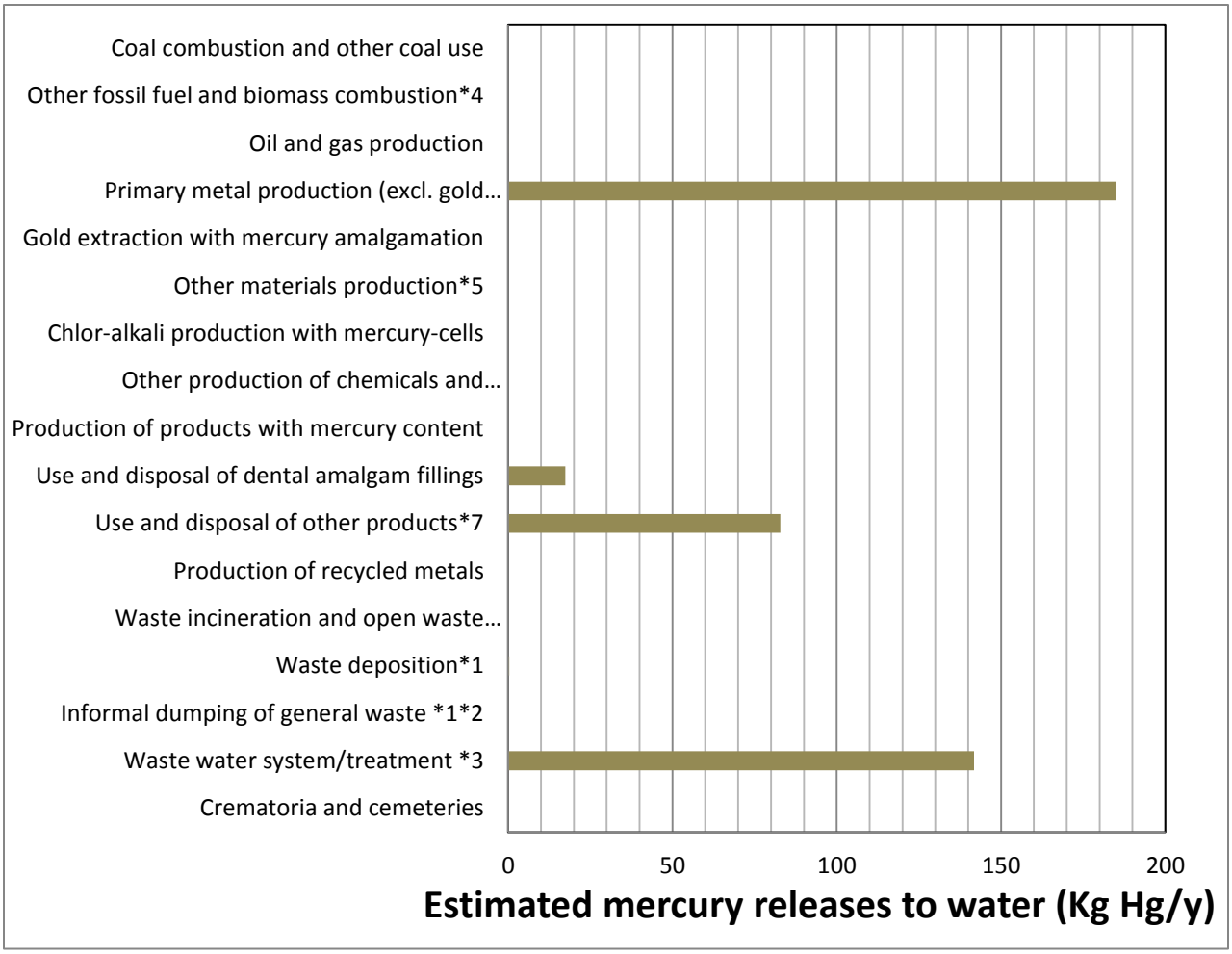

Figure 8: Major Mercury Releases to Water (Estimated)

As Figure 8 shows, the releases of mercury to water from alumina production from bauxite was estimated to be 185.1 kg Hg annually which was approximately 10% of the total estimated input of Hg from that sector.

Wastewater system/treatment is responsible for the second highest estimated releases to water. This estimation includes releases from components of other relevant sectors such as to the

presence of mercury-containing laboratory chemicals or the disposal of dental amalgam down drains. The estimated releases to water due to the use and disposal of products containing mercury (excluding dental amalgam) is also high (82.8 kg Hg/y), especially in comparison to the release of mercury to air or land from that sector.

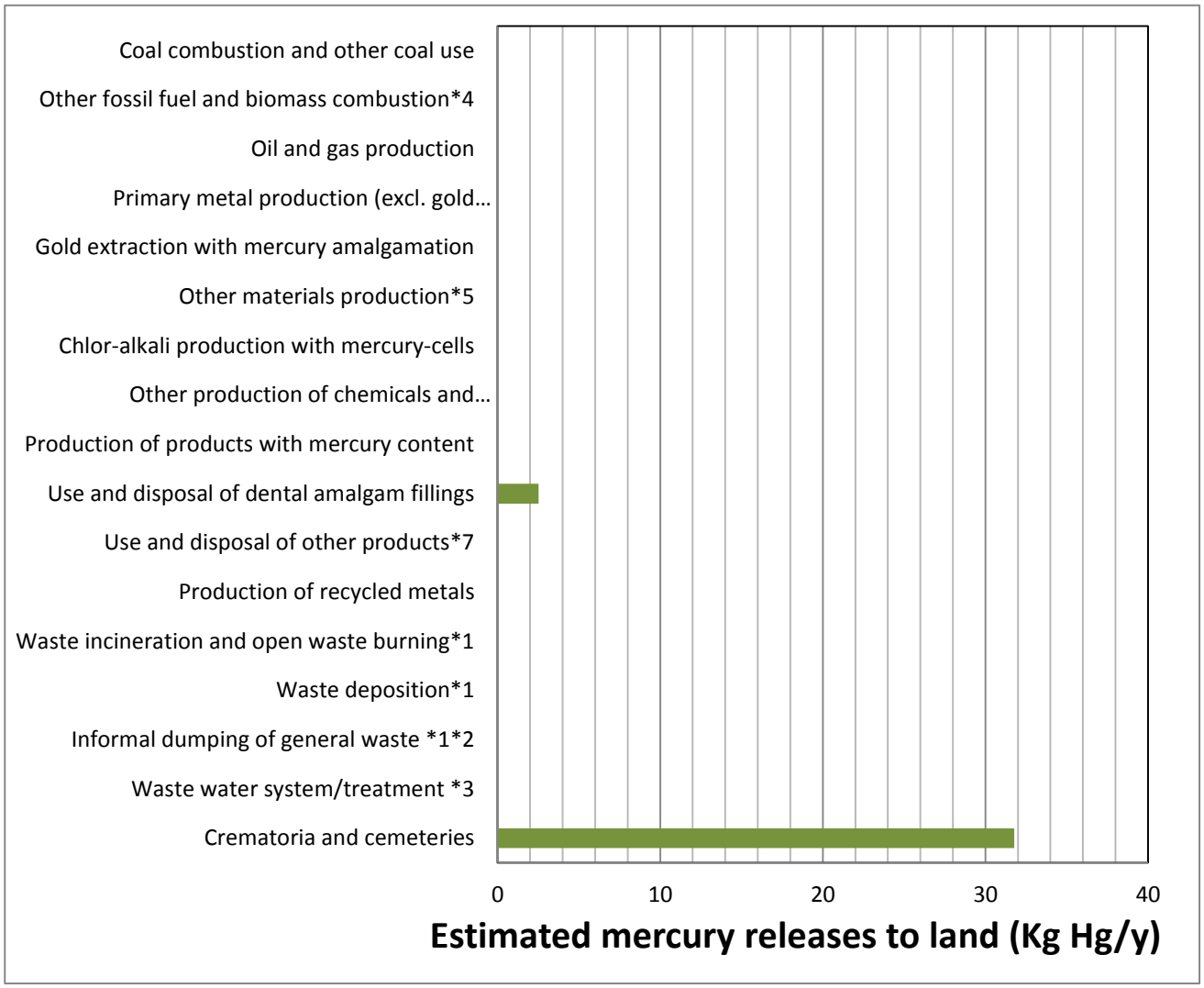

Figure 9: Mercury Releases to Land (Estimated)

Figure 9 illustrates that the most prominent releases of mercury to land come both directly and indirectly from the dental amalgam sector. The use and disposal of dental amalgam can cause it to accumulate on land over time. The presence of dental amalgam fillings in the deceased leads to an eventual release to land as the body decays in cemeteries or is cremated. Cremation tends to cause a larger and more rapid release of mercury than burial as mercury would escape in fumes.

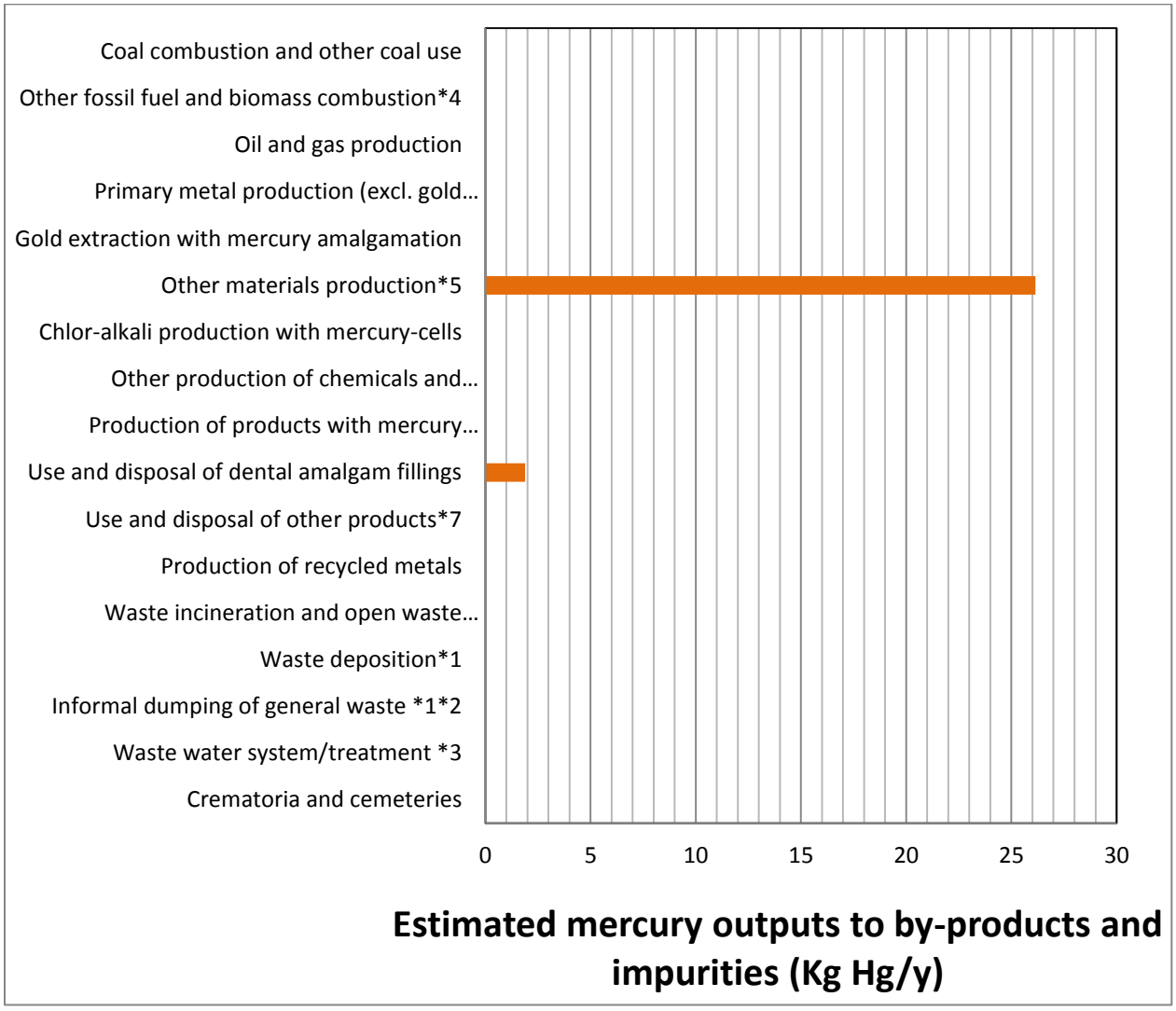

Figure 10: Mercury Outputs to by-products and impurities (Estimated)

Other materials production significantly accounts for the largest estimated mercury outputs to by-products and impurities as shown in Figure 10. This refers mainly to cement production which typically causes these releases from mercury contained both in the raw material (limestone) used to make cement as well as the fuel used to heat the materials. In some instances, alternative fuels including wastes that may contain mercury are used for the cement kilns. The use and disposal of dental amalgam fillings also contributed to this presence of mercury.

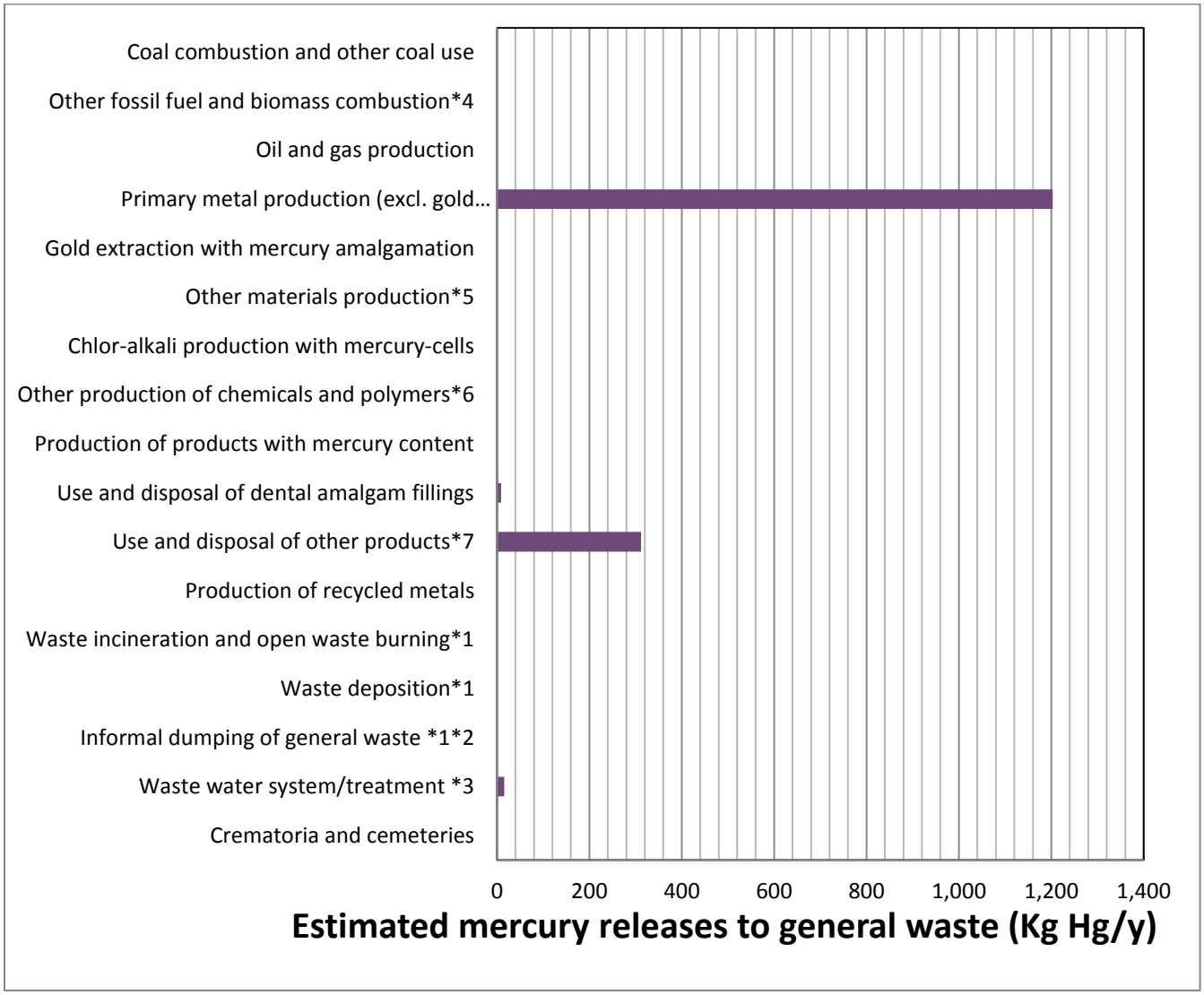

Figure 11: Mercury Releases to General Waste (Estimated)

The estimated mercury release to general waste (Figure 11) was significantly high for alumina production from bauxite (primary metal production) with an estimated 1,203 kg Hg being released annually. The use and disposal of other products (containing mercury excluding dental amalgam) followed with an estimated 311 kg Hg/y being released to general waste. This is most likely because the general public are not typically aware of the hazards posed by these products and tend to dispose of them indiscriminately with other household wastes in landfills.

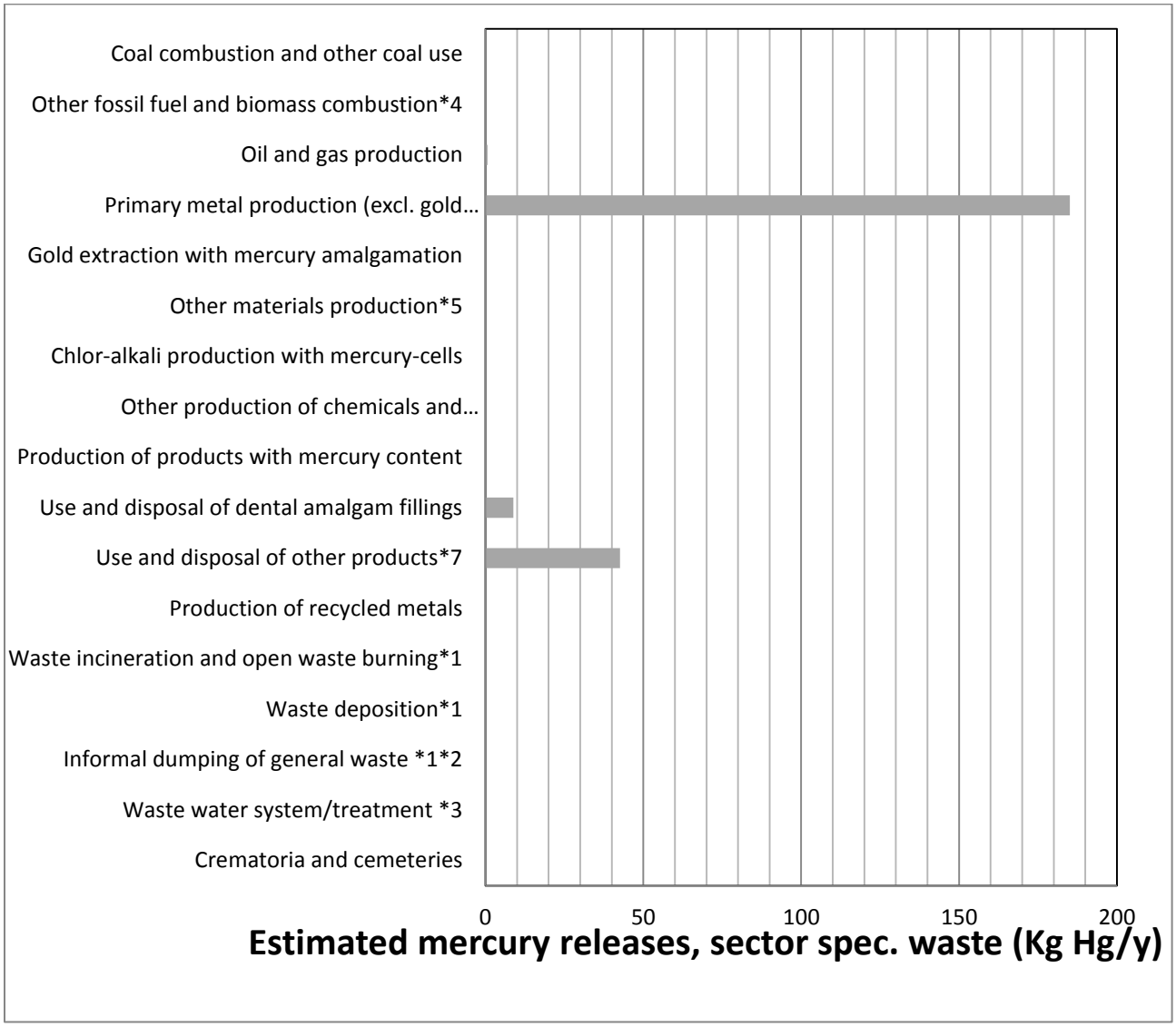

Figure 12: Estimated mercury release by sector.

As compared to the other sectors, alumina production from bauxite is responsible for the most significant releases of mercury at 185.1 kg Hg/y, most likely due to the high concentration of mercury naturally present in the bauxite deposits in Jamaica, however this will be discussed further in Section 4.1. Use and disposal of mercury containing products (excluding dental amalgam) is the second largest at 42.6 kg Hg/y as mercury containing products are widespread in many different applications throughout Jamaica. 8.8 kg Hg/y released due to the use and disposal of dental amalgam fillings accounted for the second largest contribution to mercury releases.

Notes to graphs:

*1: Waste is not an original source to mercury input to society. To avoid double counting of mercury inputs from waste and products in the graphs, only 10% of the mercury input to waste incineration, waste deposition and informal dumping is included in the chart for mercury inputs. These 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of this Toolkit. See Appendix 1 to the Inventory Level1 Guideline for more explanation.

*2: Waste is not an original source to mercury input to society. The estimated quantities include mercury in products which has also been accounted for under each product category. To signal the importance of this release pathway, the release to land from informal dumping of general waste has NOT been subtracted in the charts.

*3: Wastewater is not an original source to mercury input to society. The estimated input and release to water include mercury amounts which have also been accounted for under each source category. To avoid double counting, input to waste water system/treatment have been subtracted automatically in the charts. To signal the importance of this release path-way, releases to water via waste water system/treatment has NOT been adjusted in the charts in spite of double counting.

*4: Includes petroleum coke, heavy fuel oil, diesel, gasoil, petroleum, kerosene, natural gas, char-coal and other biofuels.

*5: Includes production of cement and pulp and paper.

*6: Includes production of VCM and acetaldehyde

*7: Includes thermometers, electrical switches and relays, light sources, batteries, polyurethane with Hg catalyst, paints and skin creams with Hg, blood pressure gauges and other manometers, lab chemicals, and other lab and medical uses.

Detailed presentation of mercury inputs and releases for all mercury release source types present in Jamaica are shown in the following report sections.

The Toolkit spreadsheets used in the development of this inventory are posted along with this report, or can be submitted upon request.

2.2 Mercury release source types present

Table 5 shows which mercury release sources were identified as present or absent in Jamaica. Only source types positively identified as present are included in the quantitative assessment.

Table 5 - Identification of mercury release sources in Jamaica; sources present (Y), absent (N), and possible but not positively identified (?)

INVENTORY LEVEL 1 - MERCURY SOURCES IDENTIFIED	
Source category	Source present?
	Y/N/?
Energy consumption	
Coal combustion in large power plants	N
Other coal uses	N
Combustion/use of petroleum coke and heavy oil	Y
Combustion/use of diesel, gasoil, petroleum, kerosene, LPG and other light to medium distillates	Y
Use of raw or pre-cleaned natural gas	N
Use of pipeline gas (consumer quality)	Y
Biomass fired power and heat production	N
Charcoal combustion	N
Fuel production	
Oil extraction	N
Oil refining	Y
Extraction and processing of natural gas	N
Primary metal production	
Mercury (primary) extraction and initial processing	N
Production of zinc from concentrates	N
Production of copper from concentrates	N
Production of lead from concentrates	N
Gold extraction by methods other than mercury amalgamation	N
Alumina production from bauxite (aluminium production)	Y
Primary ferrous metal production (pig iron production)	N
Gold extraction with mercury amalgamation - without use of retort	N
Gold extraction with mercury amalgamation - with use of retorts	N
Other materials production	
Cement production	Y
Pulp and paper production	N
Production of chemicals	
Chlor-alkali production with mercury-cells	N

VCM production with mercury catalyst	N
Acetaldehyde production with mercury catalyst	N
Production of products with mercury content	
Hg thermometers (medical, air, lab, industrial etc.)	N
Electrical switches and relays with mercury	N
Light sources with mercury (fluorescent, compact, others: see guideline)	N
Batteries with mercury	N
Manometers and gauges with mercury	N
Biocides and pesticides with mercury	N
Paints with mercury	N
Skin lightening creams and soaps with mercury chemicals	Y
Use and disposal of products with mercury content	
Dental amalgam fillings ("silver" fillings)	Y
Thermometers	Y
Electrical switches and relays with mercury	?
Light sources with mercury	Y
Batteries with mercury	Y
Polyurethane (PU, PUR) produced with mercury catalyst	?
Paints with mercury preservatives	?
Skin lightening creams and soaps with mercury chemicals	Y
Medical blood pressure gauges (mercury sphygmomanometers)	Y
Other manometers and gauges with mercury	Y
Laboratory chemicals	Y
Other laboratory and medical equipment with mercury	Y
Production of recycled of metals	
Production of recycled mercury ("secondary production")	N
Production of recycled ferrous metals (iron and steel)	N
Waste incineration	
Incineration of municipal/general waste	Y
Incineration of hazardous waste	?
Incineration and open burning of medical waste	Y
Sewage sludge incineration	?
Open fire waste burning (on landfills and informally)	N
Waste deposition/landfilling and waste water treatment	
Controlled landfills/deposits	Y
Informal dumping of general waste *1	Y
Waste water system/treatment	Y
Crematoria and cemeteries	
Crematoria	Y
Cemeteries	Y

It should be noted however, that the presumably minor mercury release source types shown in Table 6 were not included in the detailed source identification and quantification work.

Table 6: Miscellaneous potential mercury sources not included in the quantitative inventory; with preliminary indication of possible presence in Jamaica.

Source category	Source present?
	Y/N/?
Combustion of oil shale	N
Combustion of peat	N
Geothermal power production	N
Production of other recycled metals	N
Production of lime	Y
Production of light weight aggregates (burnt clay nuts for building purposes)	N
Production of other chemicals (than chlorine and sodium hydroxide) in Chlor-alkali facilities with mercury-cell technology	N
Polyurethane production with mercury catalysts	?
Seed dressing with mercury chemicals	?
Infra red detection semiconductors	?
Bougie tubes and Cantor tubes (medical)	?
Educational uses	Y
Gyroscopes with mercury	?
Vacuum pumps with mercury	?
Mercury used in religious rituals (amulets and other uses)	N
Mercury used in traditional medicines (ayurvedic and others) and homeopathic medicine	N
Use of mercury as a refrigerant in certain cooling systems	?
Light houses (levelling bearings in marine navigation lights)	?
Mercury in large bearings of rotating mechanic parts in for example older waste water treatment plants	?
Tanning	?
Pigments	?
Products for browning and etching steel	?
Certain colour photograph paper types	?
Recoil softeners in rifles	?
Explosives (mercury-fulminate a.o.)	?
Fireworks	?
Executive toys	?

2.3 Summary of mercury inputs to society

Mercury inputs to society should be understood here as the mercury amounts made available for potential releases through economic activity in Jamaica, as shown in Table 7. This includes mercury intentionally used in products such as thermometers, blood pressure gauges, fluorescent light bulbs, etc. It also includes mercury mobilised via extraction and use of raw materials which contain mercury in trace concentrations.

Table 7: Summary of mercury inputs to society

Source category	Source present?			Estimated Hg input, Kg Hg/y
	Y/N/?	Activity rate	Unit	Standard estimate
ENERGY CONSUMPTION				
Combustion/use of petroleum coke and heavy oil	Y	1,310,000	Oil product combusted, t/y	72
Combustion/use of diesel, gasoil, petroleum, kerosene, LPG and other light to medium distillates	Y	895,000	Oil product combusted, t/y	5
Use of pipeline gas (consumer quality)	Y	1,868,800	Gas used, Nm^3/y	0
FUEL PRODUCTION				
Oil refining	Y	1,214,188	Crude oil refined, t/y	4
PRIMARY METAL PRODUCTION				
Alumina production from bauxite (aluminium production)	Y	3,701,920	Bauxit processed, t/y	1,851
OTHER MATERIALS PRODUCTION				
Cement production	Y	804,294	Cement produced, t/y	105
PRODUCTION OF PRODUCTS WITH MERCURY CONTENT				
Skin lightening creams and soaps with mercury chemicals	Y	0	Mercury used for production, kg/y	0
USE AND DISPOSAL OF PRODUCTS WITH MERCURY CONTENT				
Dental amalgam fillings ("silver" fillings)	Y	2,723,246	Number of inhabitants	53
Thermometers	Y	125,750	Items sold/y	126
Electrical switches and relays with mercury	?	2,723,246	Number of inhabitants	?
Light sources with mercury	Y	1,270,336	Items sold/y	32
Batteries with mercury	Y	1	t batteries sold/y	157
Polyurethane (PU, PUR) produced with mercury catalyst	?	2,723,246	Number of inhabitants	?
Paints with mercury preservatives	?	0	Paint sold, t/y	?
Skin lightening creams and soaps with mercury chemicals	Y	0	Cream or soap sold, t/y	0

Medical blood pressure gauges (mercury sphygmomanometers)	Y	0	Items sold/y	0
Other manometers and gauges with mercury	Y	2,723,246	Number of inhabitants	13
Laboratory chemicals	Y	2,723,246	Number of inhabitants	25
Other laboratory and medical equipment with mercury	Y	2,723,246	Number of inhabitants	100
WASTE INCINERATION				
Incineration of municipal/general waste	Y	0	Waste incinerated, t/y	0
Incineration of hazardous waste	?	0	Waste incinerated, t/y	?
Incineration and open burning of medical waste	Y	0	Waste incinerated, t/y	0
Sewage sludge incineration	?	0	Waste incinerated, t/y	?
WASTE DEPOSITION/LANDFILLING AND WASTE WATER TREATMENT				
Controlled landfills/deposits	Y	689,808	Waste landfilled, t/y	3,449 (actual input = 345)
Informal dumping of general waste *1	Y	0	Waste dumped, t/y	0
Waste water system/treatment	Y	30,000,000	Waste water, m3/y	158
CREMATORIA AND CEMETERIES				
Crematoria	Y	4,238	Corpses cremated/y	11
Cemeteries	Y	12,712	Corpses buried/y	32
TOTAL of quantified inputs*1*2*3				**2,930**

Notes:

*1: To avoid double counting of mercury inputs from waste and products in the input TOTAL, only 10% of the mercury input to waste incineration sources, waste deposition and informal dumping is included in the total for mercury inputs. These 10% represent approximately the mercury input to waste from materials which were not quantified individually in Inventory Level 1 of this Toolkit.

See Appendix 1 to the Inventory Level1 Guideline for more explanation.

*2: The estimated quantities include mercury in products which has also been accounted for under each product category.

To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS.

*3: The estimated input and release to water include mercury amounts which have also been accounted for under each source category. To avoid double counting, input to, and release to water from, waste water system/treatment have been subtracted automatically in the TOTALS.

Note that the following source sub-categories made the largest contributions to mercury inputs to society:

- Alumina production from bauxite
- Controlled landfills/deposits
- Waste water system/treatment

2.4 Summary of mercury releases

In Table 8 below, a summary of mercury releases from all source categories present is given. The key mercury releases here are releases to air (the atmosphere), to water (marine and freshwater bodies, including via waste water systems), to land, to general waste, and to sectors specific waste treatment. An additional output pathway is "by-products and impurities" which designate mercury flows back into the market with by-products and products where mercury does not play an intentional role. See Table 6 below for a more detailed description and definition of the output pathways.

Table 8: Summary of mercury releases

Source category	Estimated Hg releases, standard estimates, Kg Hg/y					
	Air	Water	Land	By-products and impurities	General waste	Sector specific waste treatment /disposal
ENERGY CONSUMPTION						
Combustion/use of petroleum coke and heavy oil	72.1	0.0	0.0	0.0	0.0	0.0
Combustion/use of diesel, gasoil, petroleum, kerosene, LPG and other light to medium distillates	4.9	0.0	0.0	0.0	0.0	0.0
Use of pipeline gas (consumer quality)	0.0	0.0	0.0	0.0	0.0	0.0
FUEL PRODUCTION						
Oil refining	1.0	0.0	0.0	0.0	0.0	0.6
PRIMARY METAL PRODUCTION						
Alumina production from bauxite (aluminium production)	277.6	185.1	0.0	0.0	1,203.1	185.1
OTHER MATERIALS PRODUCTION						
Cement production	78.4	0.0	0.0	26.1	0.0	0.0
PRODUCTION OF PRODUCTS WITH MERCURY CONTENT						
Skin lightening creams and soaps with mercury chemicals	0.0	0.0	0.0	0.0	0.0	0.0
USE AND DISPOSAL OF PRODUCTS WITH MERCURY CONTENT						

Dental amalgam fillings ("silver" fillings)	1.1	17.4	2.5	1.9	8.8	8.8
Thermometers	12.6	37.7	0.0	0.0	75.5	0.0
Electrical switches and relays with mercury	?	?	?	?	?	?
Light sources with mercury	1.6	0.0	0.0	0.0	30.1	0.0
Batteries with mercury	0.0	0.0	0.0	0.0	157.3	0.0
Polyurethane (PU, PUR) produced with mercury catalyst	?	?	?	?	?	?
Paints with mercury preservatives	?	?	?	?	?	?
Skin lightening creams and soaps with mercury chemicals	0.0	0.0	0.0	0.0	0.0	0.0
Medical blood pressure gauges (mercury sphygmomanometers)	0.0	0.0	0.0	0.0	0.0	0.0
Other manometers and gauges with mercury	1.3	3.8	0.0	0.0	7.5	0.0
Laboratory chemicals	0.0	8.3	0.0	0.0	8.3	8.5
Other laboratory and medical equipment with mercury	0.0	33.1	0.0	0.0	33.1	34.1
WASTE INCINERATION						
Incineration of municipal/general waste	0.0	0.0	0.0	0.0	0.0	0.0
Incineration of hazardous waste	?	?	?	?	?	?
Incineration and open burning of medical waste	0.0	0.0	0.0	0.0	0.0	0.0
Sewage sludge incineration	?	?	?	?	?	?
WASTE DEPOSITION/LANDFILLING AND WASTE WATER TREATMENT						
Controlled landfills/deposits	34.5	0.3	0.0	-	-	-
Informal dumping of general waste *1	0.0	0.0	0.0	-	-	-
Waste water system/treatment *2	0.0	141.8	0.0	0.0	15.8	0.0
CREMATORIA AND CEMETERIES						
Crematoria	10.6	0.0	0.0	-	0.0	0.0
Cemeteries	0.0	0.0	31.8	-	0.0	0.0
TOTAL of quantified releases*1*2	**500.0**	**290.0**	**30.0**	**30.0**	**1,540.0**	**240.0**

Notes to table above:

*1: The estimated quantities include mercury in products which has also been ac-counted for under each product category. To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS. *2: The estimated release to water includes mercury amounts which have also been accounted for under each source category. To avoid double counting, input to, and release to water from, waste water system/treatment have been subtracted automatically in the TOTALS.

Note that the following source sub-categories made the largest contributions to mercury releases to the atmosphere:

- Alumina Production from Bauxite
- Cement Production
- Combustion/Use of Petroleum Coke and Heavy Oil (mainly Fuel Oil)

Table 9 provides general descriptions and definitions of the output pathways.

Table 9: Description of the types of results

Calculation result type	Description
Estimated Hg input, Kg Hg/y	The standard estimate of the amount of mercury entering this source category with input materials, for example calculated mercury amount in fuel used annually in Jamaica for combustion in power plants.
Air	Mercury emissions to the atmosphere from point sources and diffuse sources from which mercury may be spread locally or over long distances with air masses; for example from: • Point sources such as fossil fuel power plants and waste incineration; • Diffuse sources such as informal burning of waste with fluorescent lamps, batteries, thermometers.
Water	Mercury releases to aquatic environments and to waste water systems; point sources and diffuse sources from which mercury will be spread to marine environments (ocean), and freshwaters (rivers, streams, etc.). for example releases from: • Industry, households, etc. to aquatic environments; • Surface run-off and leachate from mercury contaminated soil and waste dumps
Land	Mercury releases to the terrestrial environment: General soil and ground water. For example releases from: • Uncollected waste products dumped or buried informally • Local un-confined releases from industry such as on site hazardous waste storage/burial • Spreading of sewage sludge with mercury content on agricultural land (sludge used as fertilizer)
By-products and impurities	By-products that contain mercury, which are sent back into the market and cannot be directly allocated to environmental releases, for example: • Raw materials used in cement production • Use and disposal of dental amalgams.

General waste	General waste: Also called municipal waste in some countries. Typically, household and institution waste where the waste undergoes a general treatment, such as incineration, landfilling or informal dumping. The mercury sources to waste are consumer products with intentional mercury content (batteries, thermometers, fluorescent tubes, etc.) as well as high volume waste like printed paper, plastic, etc., with small trace concentrations of mercury.
Sector specific waste treatment /disposal	Waste from industry and consumers which is collected and treated in separate systems, and in some cases recycled; for example: • Hazardous consumer waste with mercury content, mainly separately collected and safely treated batteries, thermometers, mercury switches, lost teeth with amalgam fillings, etc. • Confined deposition of tailings and high volume rock/waste from extraction of non-ferrous metals

3.0 Data and inventory on energy consumption and fuel production

Certain source categories in Table 7 such as coal combustion and use of natural gas do not apply to Jamaica currently and shall not be included in section.

3.1 Combustion/use of petroleum coke, heavy oil, diesel, gasoil, petroleum, kerosene

Jamaica Public Service Company (JPSCO) Limited is the sole distributor of electricity in Jamaica. For the year 2015, according to their annual report, 367.3 million USD was spent on fuel for electricity (JPSCO Ltd, 2015). 95% of electricity generated is by oil. The two types of fuel purchased were HFO (heavy fuel oil) and ADO (automotive diesel oil) with a mixing ratio of 66:34 (HFO: ADO).

For this sector, data was obtained from the International Energy Agency's website using domestic supply figures from 2014 for fuel oil, gas/diesel, naphtha, liquefied petroleum gases, motor gasoline, and other kerosene supplies.

Approximately 24% of JPSCO's energy generation capacity comes from Independent Power Producers (IPPs) such as Jamaica Energy Partners (JEP), Jamaica Private Power Company (JPPC), Wigton Wind Farm and Jamalco.

Mineral oil tends to contain small amounts of mercury impurities naturally which are primarily released to air during combustion. Many oil combustion facilities do not use air pollution abatement systems or "end of pipe" controls. "End of pipe" refers to control methods at the point of emission so that the pollutant is hindered. They can be applied to a stream of air, wastewater, water, and their implementation occurs just before disposal or delivery. An end-of-pipe-technique like exhaust gas filtration is deemed appropriate for raw materials that contain trace amounts of mercury.

3.2 Oil refining

Petrojam Ltd is Jamaica's only petroleum refinery. According to their 2013 annual report, the amount of crude oil processed was 8.9 million barrels (approximately 1.2 million metric tons) (Petrojam Ltd, 2013). The production mix consisted of Liquid Petroleum Gas (LPG), gasoline, diesel, jet fuel, heavy fuel oil, and asphalt.

The conversion used in the calculation was 7.33 barrels = 1 metric ton. (*This is the standard conversion in the USA*)

4.0 Data and inventory on domestic production of metals and raw materials

4.1 Alumina production from bauxite (aluminium production)

In 1957, Jamaica was the number one producer of bauxite worldwide, however after years on the market, the production fell (JBI, date unknown). In 2014, the mining and quarrying sector (bauxite and alumina mainly) contributed 2.3 % to Jamaica's GDP. According to the World Mineral Production 2010-2014 report (British Geological Survey, 2016) the production of alumina in Jamaica in 2014 was 1,850,960 tonnes. According to USGS (2015), as a general rule, it is assumed that 4 tons of dried bauxite is required to produce 2 tons of alumina (2:1 ratio).

Bauxite reserves are located in the central parishes (Figure 13). There are three bauxite refining companies in Jamaica, namely, Alpart (recently acquired by Jiuquan Iron and Steel (JISCO), Windalco (presently owned by UC Rusal, formerly Alcan) and Jamalco.

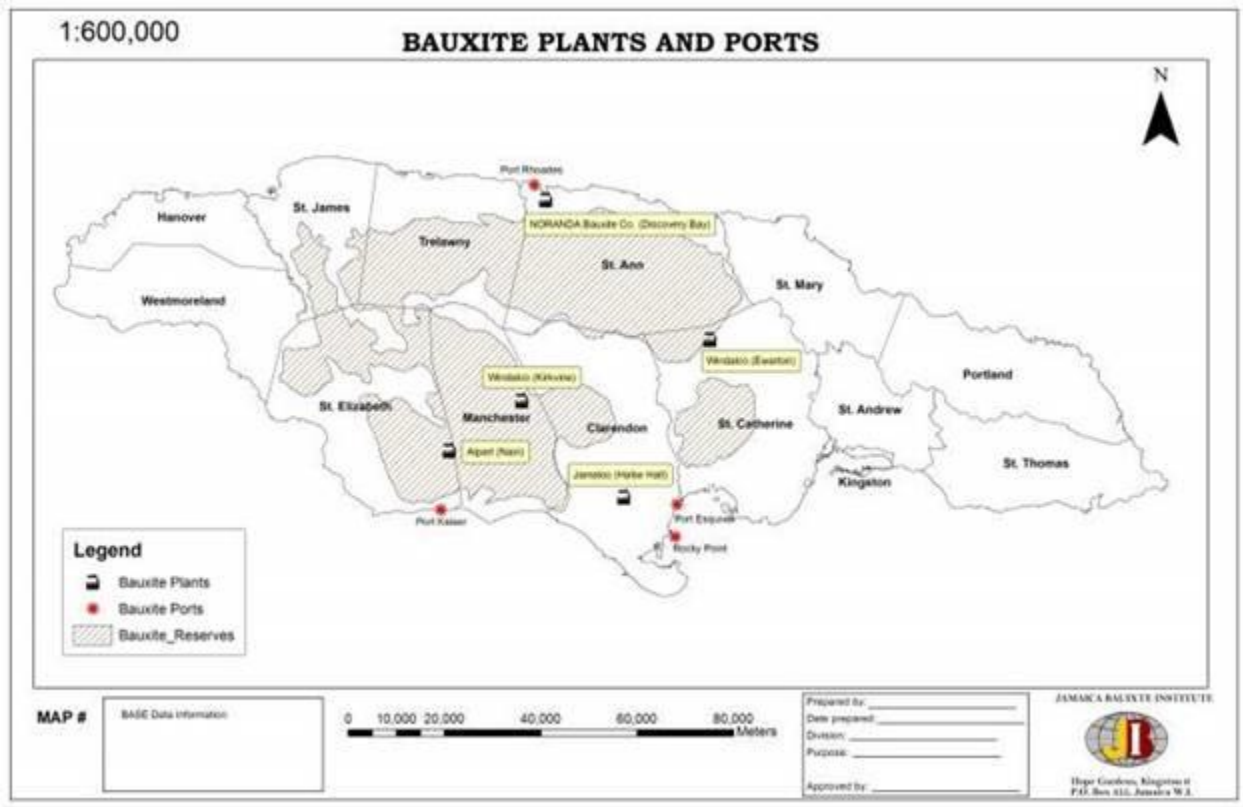

Figure 13: Bauxite-bearing Areas in Jamaica (JBI, Date unknown)

In the manufacture of alumina, mercury has been found to be present as an impurity in bauxite. Small amounts of liquid Hg have occasionally been observed during bauxite processing (Lalor, 1995). The correlation between the location of bauxite areas and the higher levels of natural mercury found in Jamaica as shown in Figure 14 below may be due to the volcanic origins of bauxite deposits and naturally occurring mercury.

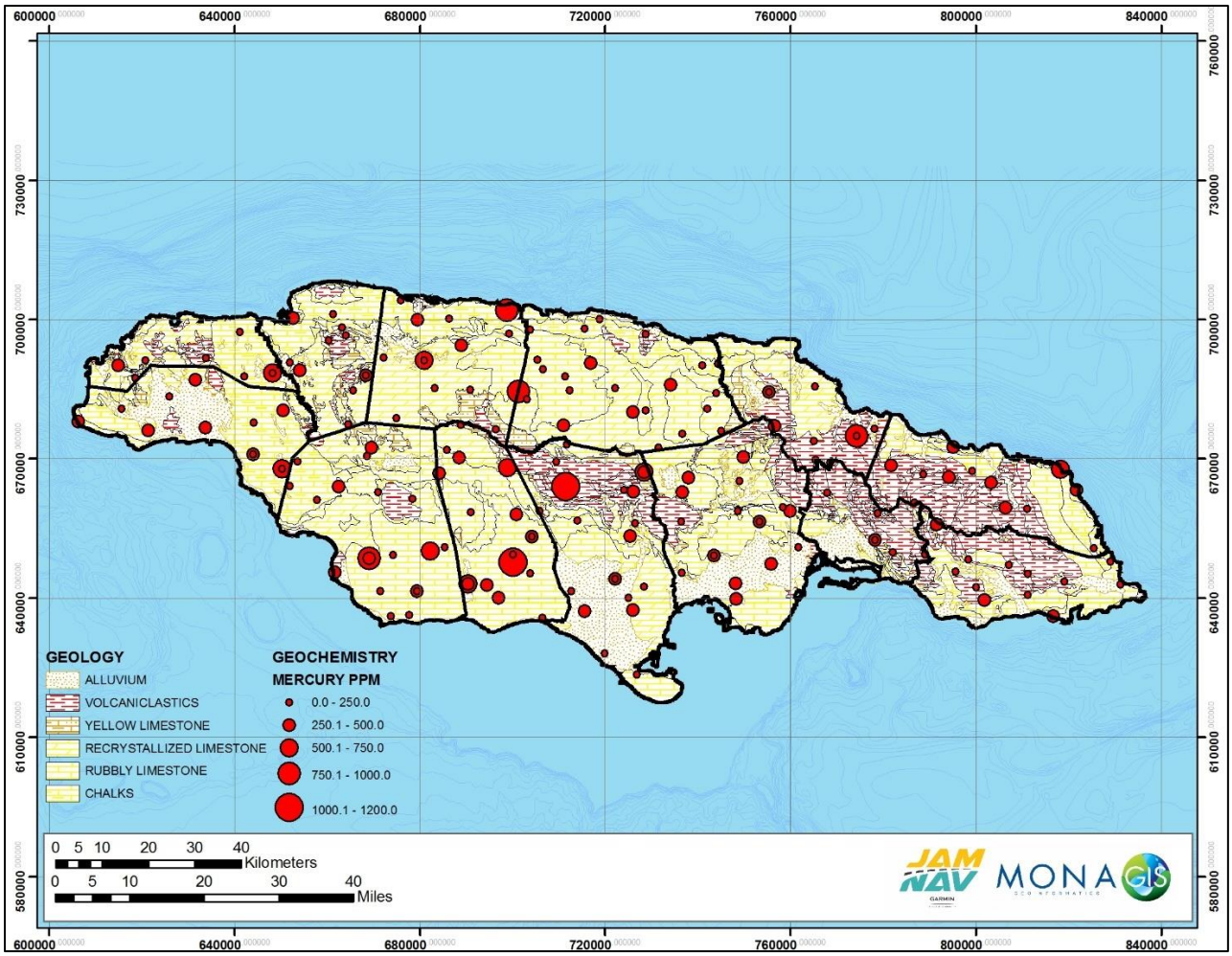

Figure 14: Map showing The Geology of Jamaica overlaid with Mercury Values (Mona Geoinformatics, date unknown)

Originally, bauxite residue (red mud) was commonly disposed of in depressions left after the bauxite mining process; presently, disposal occurs in lined engineered sites, and dry stacking technology is promoted rather than wet mud impoundments.

NOTE: Upon consultations with representatives in the Mines and Geology Division of the Ministry of Transport and Mining, Jamaica, it was noted that while the Toolkit uses a default factor of 0.5 grams Hg/tonne bauxite, it was found that concentrations in Jamaica may be less than 0.39 grams Hg/tonne which would significantly reduce the calculated value determined in

the Toolkit. Additionally, according to information received from the Jamaica Bauxite Institute, approximately 2.6 Million metric tonnes of bauxite is mined annually from the Jamalco operation (the major bauxite operations in Jamaica) which is estimated to contain roughly 50 kg of Hg based on their conversion factors. Even when taking into consideration the additional bauxite processing activities that occur in Jamaica, the estimated Hg releases would be significantly lower than those determined by the Toolkit. It can therefore be assumed that actual mercury releases from this sector may be lower and further assessment is required. A Level 2 Inventory may better capture the estimates for this sector.

4.2 Cement Production

Carib Cement Company Limited has been in operation in Jamaica since 1952. It is located in Rockfort, Kingston (Figure 15). The company is a major contributor to the construction sector and has a staff complement of more than 300 (CCL, 2015). According to Carib Cement's annual report for the year 2015, total clinker production was 804,294 tonnes.

Figure 15: Carib Cement Company Limited Facility (Source: CEAC Solutions)

The production of cement done in Jamaica involves a number of steps. Limestone is excavated and crushed until it is fine enough for water, iron oxide and sand to be added to it to form "slurry". The slurry is then transported to the manufacturing plant where it is put into an oven. The heat transforms the slurry to "clinker" (large, glassy, red-hot cinders). The clinker is sent to a grinding ball mill for final grinding (TCL Learning Academy, 2015).

Mercury is present in the cement process due to its presence in the raw materials used (mainly limestone and gypsum in Jamaica) and mainly in the fuel used for the thermal process in cement production. Mercury concentrations may vary greatly based on the type of raw materials, fuel and mercury contained within deposits or quarries. The major pathway for mercury releases from the cement industry is via emissions to the air. Figure 16 further illustrates how mercury is cycled in a modern cement plant which shows that the main release of mercury is through the emissions stacks.

Mercury abatement methods do exist and include the use of a scrubber in the emissions stacks to reduce the amount of mercury released into the environment.

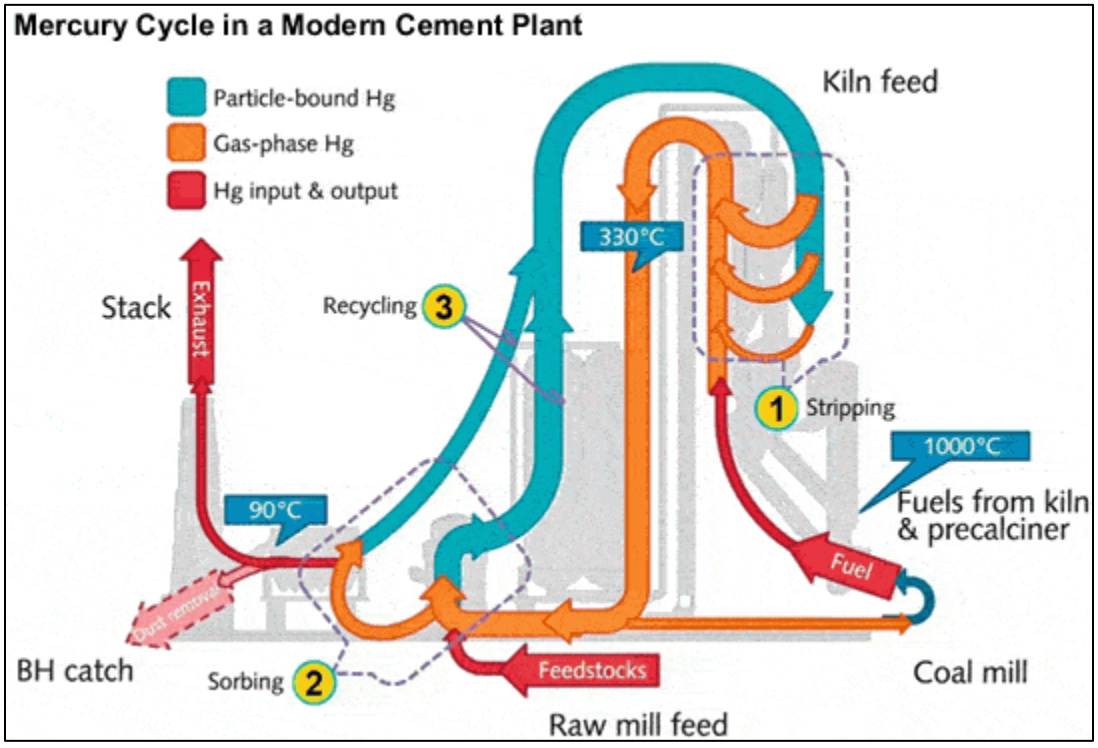

Figure 16: Mercury Cycle in a Modern Cement Plant (Source: ZKG)

Note: The estimated mercury releases due to cement production in this inventory (105 kg Hg/y) was more than two times greater than previously estimated in the Technical Guidance Report for the Global Mercury Assessment 2013 (AMAP/UNEP, 2013). Further assessments should be done to account for this variation.

5.0 Data and inventory on domestic production and processing with intentional mercury use

5.1 Skin lightening creams and soaps with mercury chemicals

Globally persons, particularly women, use cosmetic products such as creams and soaps that promise to lighten the complexion of their skin. Although illegal in many countries, mercury is quite a common pharmacological compound used in skin lightening creams and soaps as it is effective in blocking the production of melanin. Mercury can accumulate in the body over time, making diseases and disorders potentially linked to one's exposure, difficult to diagnose.

Mercury use in skin creams as well as in other consumer products nurtures the trade in mercury across the globe right from production, to the processes and supply of mercury which then ends up in the consumer products.

The practice of skin lightening is popular in Jamaica. The market hosts a wide variety of bleaching creams and soaps which contain chemicals such as mercury and hydroquinone. The import, sale and use is largely unregulated where the option of legal, illegal, labelled and unlabelled creams and soaps exists. Even the labelled products sometimes do not display all ingredients, according to a recent study in *Clinical and Experimental Dermatology* (Maneli et al, 2016). Locally manufactured (by E. W. Abrahams) bleaching cream (Figure 17) marketed under the trade name Silken (formerly Nadinola) contains 3% ammoniated mercury according to the ingredients listing on its label.

Figure 17: Image of Silken Packaging (image subject to copyright)

According to a 2011 WHO report, creams typically contain approximately 1 -10% mercury ammonium and some cream products tested contained up to 33,000 mg/kg of mercury. While most international regulations on mercury in cosmetics ban the use of its compounds in

production completely, some regulations like those by the United States Food and Drug Administration and Health Canada allow less than 1 mg/kg or less than 3 mg/kg of mercury respectively in cosmetics (other than eye area products) as an unavoidable impurity in the manufacturing process. In the Philippines, skin lightening products with mercury levels exceeding 1 mg/kg are banned.

6.0 Data and inventory on waste handling and recycling

6.1 Waste Incineration

There are incinerators located at Carib Cement Company Limited, Ministry of Health, Ministry of National Security and Sweet River Abattoir & Supplies Company Limited. General waste is incinerated at the Airport Authority. The Ministry of Health incinerates waste such as pharmaceutical items, papers and consumable products. However, medical waste such as broken mercury thermometers, mercury sphygmomanometers and dental amalgams are presently being stored at health centres. Data on the amount of waste incinerated at these facilities could not be found within the timeframe for this project.

6.2 Waste deposition/landfilling

There are eight (8) authorized public solid waste disposal sites distributed across the island which are managed by NSWMA (National Solid Waste Management Authority) The NSWM has demarcated the country for its management purposes into four (4) regions otherwise termed "waste-sheds": Riverton, Retirement, Southern and Northeastern "waste-sheds". Each region is made up of two or more parishes with accompanying disposal sites for the proper disposal of solid waste to ensure environmental protection, solid waste disease and pest or nuisance control (NSWMA, 2015). According to the Waste Characterisation Study of the NSWMA (2015) there are eight (8) disposal sites in the country as detailed in Table 10.

Table 10: Description of Disposal Sites in Jamaica (NSWMA, 2015)

Disposal site	Acreage	Type of Solid Waste	Volume (Tonnes) 2014	Status
Riverton	106	Municipal & Hazardous	390,585	Active
Church Corner	3	Municipal	17,760	Active
Doctorswood	7.4	Municipal	17,522	Active
Hadden	9	Municipal	25,053	Active
Tobolski	12.2	Municipal	8,342	Active
Myersville	9	Municipal	15,348	Active
Martin's Hill	19	Municipal	61, 976	Active
Retirement	27	Municipal	153,222	Active

None of these disposal sites are properly designed landfills and only Riverton deals with hazardous wastes. Specific categories of hazardous waste are usually separated from general waste at the disposal site, Riverton (in Kingston), which is the largest disposal site in the country with an acreage of 106 (Figure 18) and facilitates both municipal and industrial waste. In 2014, the combined total solid waste disposed of at the 8 public facilities was calculated to be 689,808 tonnes.

Figure 18: Riverton Waste Disposal Site

6.3 Waste water system/ treatment

Wastewater is a combination of liquid or water carried waste removed from residences, institutions, as well as commercial and industrial entities. The NWC (National Water Commission) collects, treats and disposes of wastewater from these sources (NWC, 2016). NWC is the main service provider for wastewater treatment in Jamaica. The number of persons who use the service is in excess of 700,000 island-wide. The NWC operates nearly 100 wastewater treatment plants in Jamaica. The types of wastewater treatment facilities used in the island include oxidation ditch, activated sludge, waste stabilization pond and primary treatment (NWC, 2016). Soapberry Sewage Treatment Plant (Figure 19) is the largest. It is located in St. Catherine and serves Kingston, St Andrew and St Catherine, and has a maximum capacity of 30 million cubic meters per year.

Figure 19: Soapberry Sewage Treatment Plant

The presence of mercury in wastewater may be generally due to mercury-containing laboratory chemicals, or products such as dental amalgam which are flushed down the drain and ends up in sewage sludge or the surface water system.

Test of waste and wastewater default factors

In this inventory, default input factors were used for the estimation of mercury releases from general waste treatment and wastewater treatment. The default factors were based on literature data of mercury contents in waste and wastewater, and these data were only available from developed countries. The following test of the results was performed to qualify the results for these sources.

The test made for general waste compares the calculated inputs to all four-general waste sub-categories with the sum of general waste outputs from intentional mercury uses in products plus processes as follows, using data from the Inventory Level 1 spreadsheet:

In the IL1 spreadsheet, the test was done as follows: Tab "Level 1-total summary":

$$(E60+E64+E66+E67)\ 3449 > 2*(J25+J26+\sum(J31 \text{ to } J55)) \equiv 11{,}895{,}601 > 27{,}134.5$$

The test made for wastewater compares the calculated inputs to wastewater treatment with the sum of outputs to water from intentional mercury uses in products plus processes as follows, using data from the Inventory level 1 spreadsheet:

In the IL1 spreadsheet the test was done as follows: Tab "Level 1-ExecSummary":

B19 > 2*(D8+D10+D11+D12+D13+D14+D15).

[The calculations made indicate that the default input factors for general waste and wastewater treatment may over-estimate the mercury releases from these sub-categories. This may be of priority in follow-up work, as feasible.]

However, (157.5) B19 < (27,014.6) 2*(D8+D10+D11+D12+D13+D14+D15)

[The calculations made indicate that the default input factors for general waste and wastewater treatment does not necessarily over-estimate the mercury releases from these sub-categories].

7.0 Data and inventory on general consumption of mercury in products, as metal mercury and as mercury containing substances

7.1 General background data

Background calculations were done for the following product groups:

- Dental amalgam fillings ("silver" fillings)
- Electrical switches and relays with mercury[3]
- Polyurethane (PU, PUR) produced with mercury catalyst[2]
- Other manometers and gauges with mercury[2]
- Laboratory chemicals
- Other laboratory equipment with mercury

These were based on the data on population, electrification rate (percent of population with access to electricity) and dental personnel density shown in Table 10.

Table 11: Background data for default calculations for dental amalgam and certain other product types

BACKGROUND DATA FOR DEFAULT CALCULATIONS AND RANGE TEST			
Country	Population in 2010 (or as recent as available data allow; UNSD, 2012)	Dental personnel per 1000 inhabitants	Electrification rate, % of population with access to electricity
Jamaica	2,702,314	0.080	92

The data in Table 11 are provided as part of the Toolkit. For most countries they are based on authoritative international data sources (population data: UNSD; Dental data: WHO; Electrification data: IEA).

[3] No information was available for these product groups.

7.2 Dental amalgam fillings ("silver" fillings)

Treatments for tooth decay include extraction, root canal and filling. The option selected, generally depends on the severity of the decay. The two main types of fillings used in Jamaica are amalgam and composite. The amalgam filling is of particular importance because it consists of nearly 50% elemental mercury (liquid) and a powdered alloy of silver, tin and copper (FDA, 2015). The mixture is sold to dentists in a capsule (Figure 20).

Figure 20: Dental amalgam capsules - Image may be subject to copyright

Both private and public sector dental clinics use amalgam fillings. There are more than 12 suppliers to both sectors. According to one of the major suppliers, Optimum Trading Limited, amalgam fillings are more prominent in public sector dental clinics because it is cheaper than the alternative (composite). They supply amalgam fillings mostly to public sector dental clinics and a small percentage to private sector dental clinics and dental schools. Other local suppliers such as Cornwall Medical and Dental Supplies and Dental and Medical Supplies Ltd are not currently supplying amalgam fillings. A survey of 20 private sector dental clinics across the island (Figure 21) suggested that 7 offered composite only and 13 offered both composite and amalgam (they offer amalgam filling but mostly do composite filling). Additionally, removal of amalgams in the private sector is generally not treated in a specialized manner (that is, it is washed down the sink).

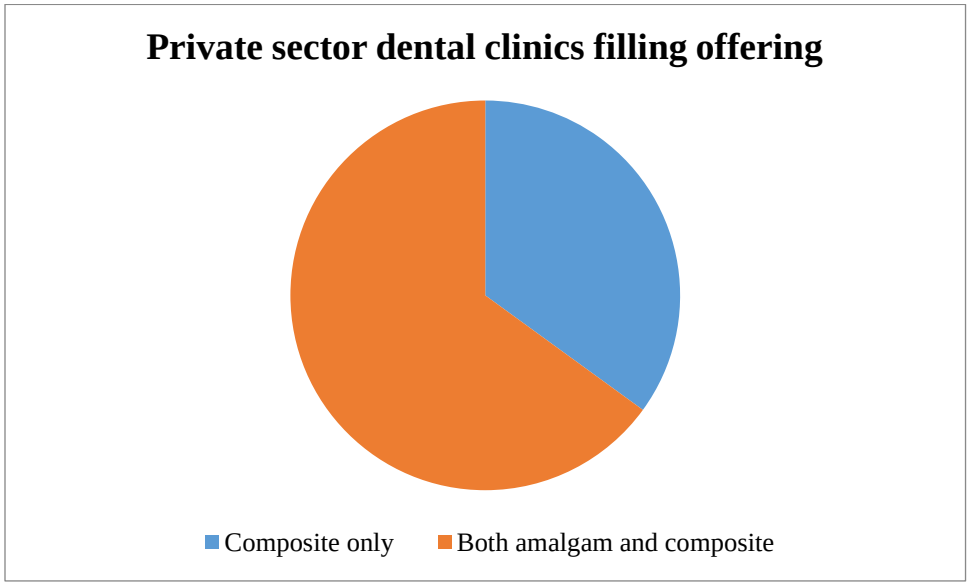

Figure 21: Private sector dental clinics that provide fillings.

According to a 2013 AMAP/UNEP study, dental amalgam is responsible for approximately 10% of global mercury consumption overall and over 20% of global mercury consumption in products.

The UNEP (2016) report indicated that in regards to the dental sector, mercury pollution may occur during:

- Production of amalgam capsules;
- Preparation, placement and removal of dental restorations;
- Discharge of dental amalgam residues into wastewater (e.g. at the dental clinic or via normal human waste at home);
- Disposal of amalgam into solid, medical or hazardous wastes or otherwise;
- Disposal or land application of municipal sewage sludge that is contaminated with mercury from amalgam;
- Release from amalgam fillings in the deceased who are buried, or more so, when the remains are cremated.

Mercury wastes and releases generated by dentistry are difficult to monitor and control due to the various pathways by which they may be released. Approximately two-thirds of dental mercury is

eventually released to the environment. Figure 22 further illustrates the pathways by which mercury is released to the environment.

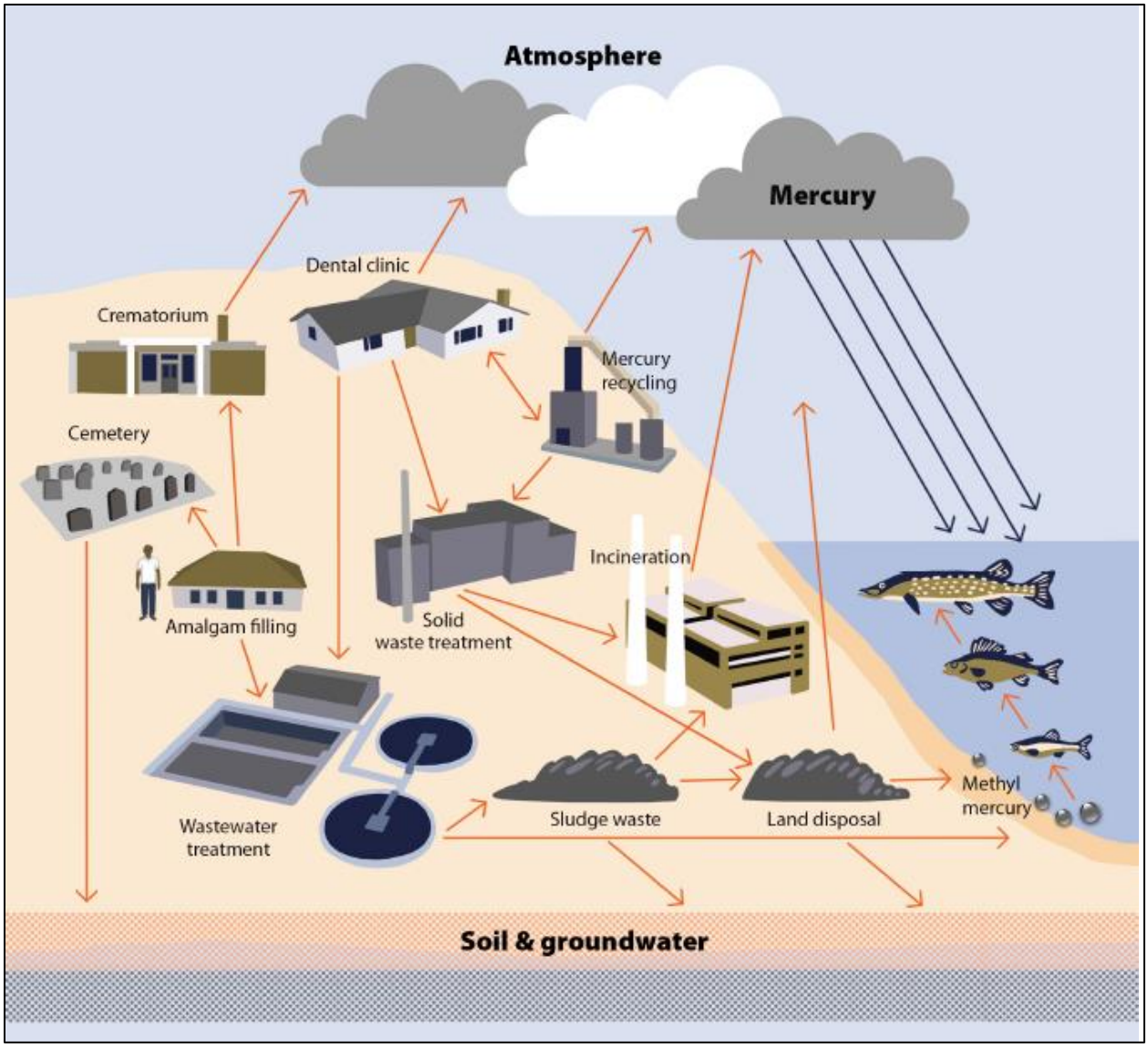

Figure 22: Mercury releases to the environment from dental care SOURCE: Concorde 2007 (UNEP 2016)

7.3 Thermometers & Laboratory Chemicals

Mercury thermometers are widely distributed across the island in secondary and tertiary institutions, laboratories, hospitals, etc. Locally, there has been a trend for replacement of these thermometers with alcohol thermometers. Elemental mercury and its compounds are present mainly in educational institutions. Storage/disposal of these wastes consisting of mercury is generally inadequate.

7.4 Light Sources with Mercury

In 2006 and later in 2013, there was a drive to replace incandescent bulbs with energy saving compact fluorescent lamps (CFLs) under the Jamaica/Cuba Bulb project. Four million of these bulbs were (to be) distributed (Planning Institute of Jamaica, 2007). However, a single CFL bulb contains approximately 5 mg- 30 mg of mercury (Stemp-Morlock, 2008). In addition, the Bureau of Standards, Jamaica reported importation of sub-standard CFLs with a shorter life-span (Planning Institute of Jamaica, 2007). This will result in an increase in the frequency of replacements and the potential amount of mercury present, therefore leading to an increase in this type of waste. The double-ended type of fluorescent lamps, which contain up to 10 mg of mercury, are also widely in use in organizations such as schools, churches and hospitals. Most of the fluorescent bulbs are disposed of in the local trash and are therefore deposited on the landfills.

8.0 Data and inventory on crematoria and cemeteries

When burning humans or other animals, there are toxic emissions associated with the process. These are:

- any mercury amalgam dental fillings which haven't been removed
- organohalogens (dioxins, furans, etc.) and other toxics accumulated through diet and other exposures
- any plutonium pacemakers which haven't been removed
- silicone breast implants, which can contain PVC, Methylene Chloride and other toxic chemicals
- other metal or plastic implants in humans
- radioactive or toxic tracers or testing chemicals from animal experimentation (for animal carcass incinerators)
- metal or plastic implants of tracking chips in pets (for pet crematoria)

There are about 50 funeral homes in Jamaica. It is estimated (based on a survey of funeral home operators) that 25% of corpses are cremated in the four crematoriums in Jamaica. Though there has been an increase in the number of cremations due to the cheaper cost and other factors, the majority of Jamaican corpses are buried. According to the Registrar's General Department 2013 data, there were 16,950 registered deaths in 2013; based on collected data, approximately 25% were cremated.

Cemeteries are low-risk sites, considering the methodology used locally where bodies are placed in vaults or tombs that are oftentimes water-tight. As a direct result, there is less potential for Hg in the bodies (as amalgam etc.) to be chemically mobilized. There is greater risk however, of Hg being released in the atmosphere at the crematoria if corpses have dental amalgam filling still intact.

9.0 Storage and Disposal Options

According to UNEP/ISWA (2015), some options for storage and disposal are outlined in Figure 23.

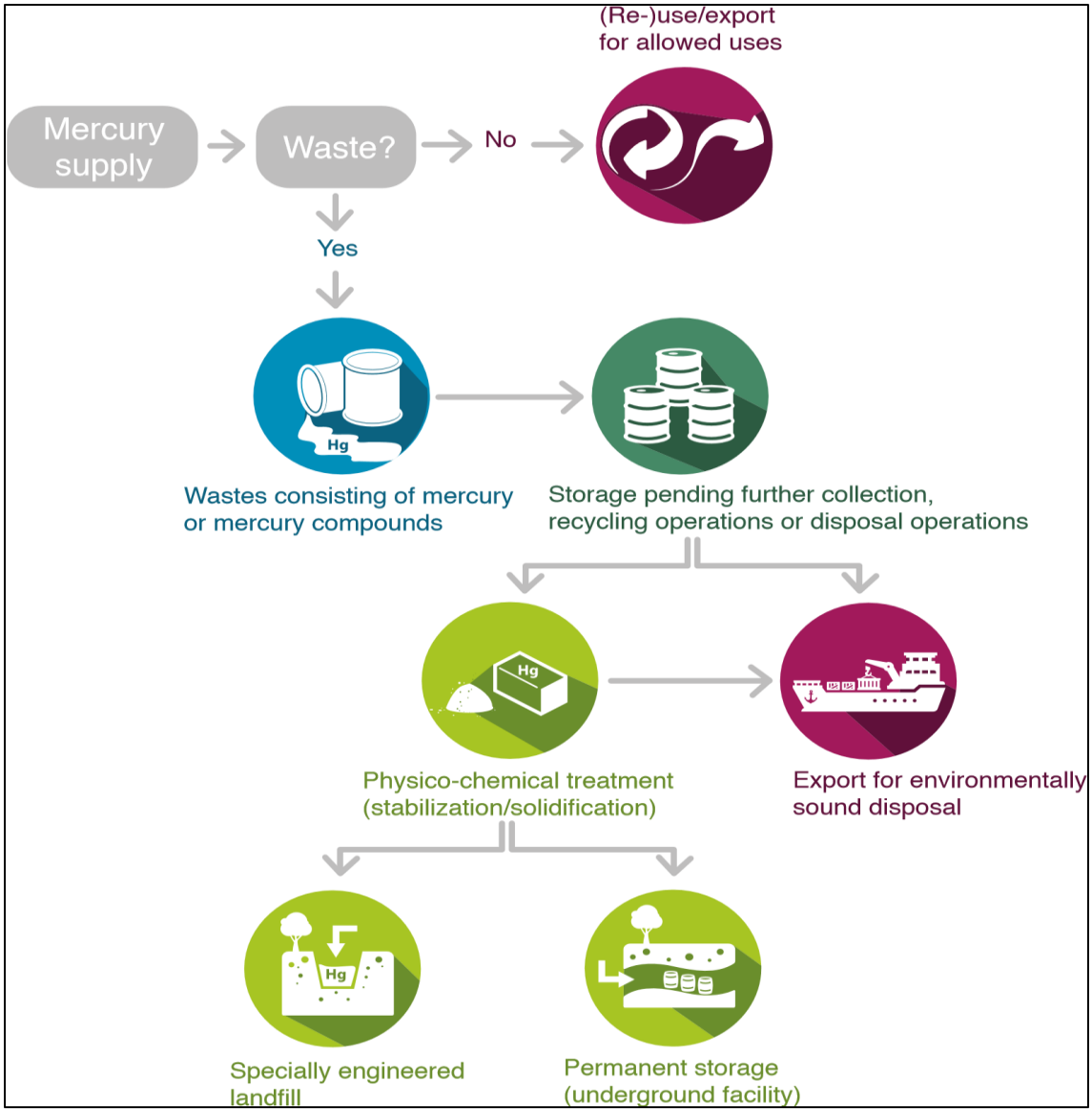

Figure 23 - Options for the ESM of Wastes Consisting of Mercury or Mercury Compounds (UNEP/ISWA, 2015).

For Jamaica, the best options may be:

1. To develop a facility (or facilities) for interim storage of mercury waste, the location of which will need to be determined in further discussions with relevant stakeholders. A consolidation of mercury waste produced by individual companies would be done by the companies themselves who would have to develop infrastructure "in-house" to arrange for the environmentally sound collection and transport of the waste to the interim storage facility. The interim storage sites would be developed in collaboration with the main waste management companies as a sanitary engineered landfill under an integrated waste management approach, meaning that mercury waste as well as other hazardous waste will be handled at the facility. A recommendation from stakeholders engaged at the project's results workshop was that the location of the storage facility may be best located within one of the current landfills and the Riverton landfill was proposed as it handles hazardous waste and also receives the most amount of waste for Jamaica.

   This recommendation would require the following:

   - Determining the location
   - Agreement/ Ownership
   - Finance
   - Maintenance of Facility

2. To have stabilisation/ solidification processes done at the interim storage facilities for the mercury waste. The recommended process would be solidification via cementation where the mercury waste would be encased in a solid block.

3. To export the waste at a national level for environmentally sound disposal to a processing facility where environmentally sound mechanisms exist for the proper extraction and disposal of mercury, for example in countries like the United States of America, Canada, Spain and the Netherlands. The exportation of solidified waste may be expensive due to the potentially large mass of the solid blocks so considerations would need to be made as to how these costs could be off-set.

10.0 Conclusion

According to this Level 1 Inventory, it is suggested that primary metal production (alumina production from bauxite); use and disposal of products (excluding dental amalgam); and other materials production (cement production) are the main contributors to mercury releases for the country as seen in Figure 24. However, it should be emphasised that these values were based on estimations made in the Toolkit and upon consultations with relevant stakeholders, it was noted that actual mercury releases from these sectors, particularly alumina production from bauxite, may be significantly lower. Further assessments are therefore required in order to make more accurate estimations for mercury releases in Jamaica.

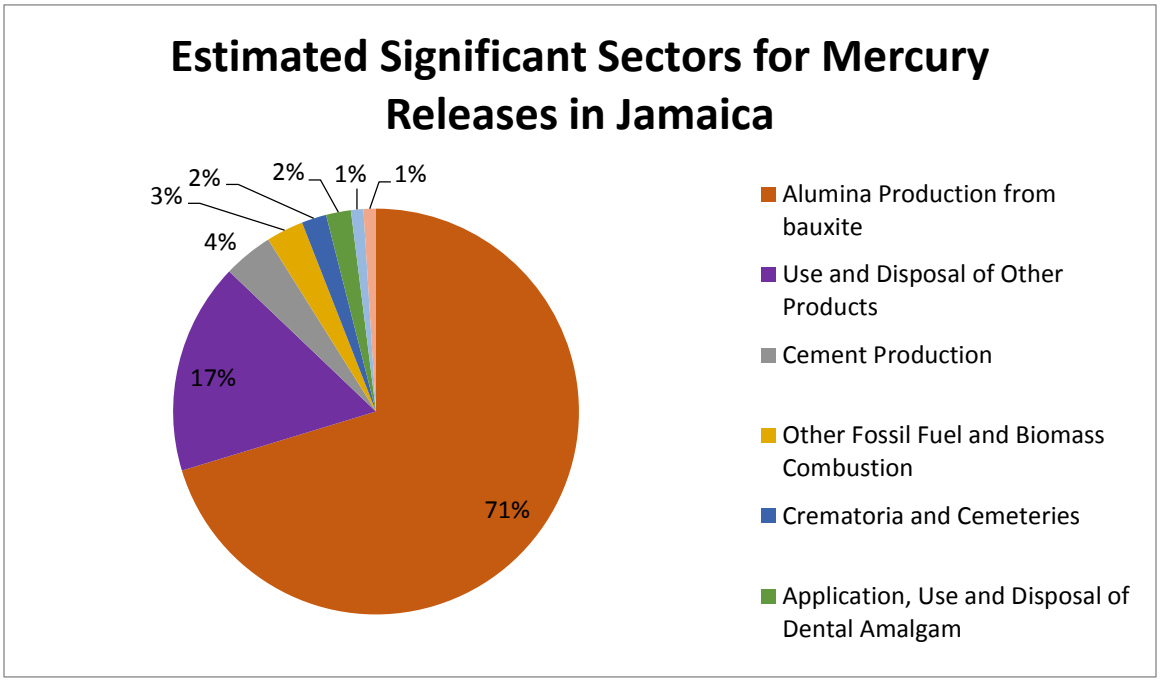

Figure 24: Estimated Significant Sectors for Mercury Releases in Jamaica

In order to successfully ratify the Minamata Convention on Mercury, several pieces of legislation need to be amended in order to cover the environmentally sound management mercury. These are:

- The Natural Resources Conservation Act (NRCA), 1991
- National Solid Waste Management Act, 2001
- Trade Act, 1955

- Public Health Act, 1985
- The Standards Act, 1969
- The Mining Act, 1947
- The Quarries Control Act, 1983
- The Clean Air Act, 1961

Only after such amendments have taken place and are implemented, can Jamaica successfully comply with the provisions of the Minamata Convention.

The time dedicated to obtaining the data for this project was approximately three (3) months resulting in an inventory that was incomplete. As a direct result, Jamaica cannot commit to any policy directives at this time. Additionally, this high level of decision making must be approved under the auspices of Cabinet.

Fortuitously, Jamaica is part of the more detailed Minamata Initial Assessment Project which will utilise the Inventory Level 2 and be conducted over a two (2) year period. It is anticipated that an informed decision can then be made once a thorough inventory is complete.

11.0 Recommendations

This report has highlighted alumina production from bauxite as the main contributor to mercury releases in Jamaica. However it was noted that the estimation for total mercury releases for this sector was based on assumptions in UNEP Toolkit for Identification and Quantification of Mercury Releases (Inventory Level 1) and may actually be lower. A follow up survey with relevant stakeholders is recommended to better assess the releases of mercury from these activities. It is recommended that an Inventory Level 2 (UNEP Toolkit for Identification and Quantification of Mercury Releases: Level 2) be conducted in which the factors by which mercury releases are calculated can be adjusted to better reflect the assumed mercury content in Jamaica's bauxite deposits. The same should be done for other sectors particularly, use and disposal of other products; cement production and; application, use and disposal of dental amalgam fillings, which were estimated to have higher mercury releases than expected in comparison to previous studies. Follow up surveys are also recommended for stakeholders who were unable to respond to questionnaires distributed within the timeframe for the project.

Collaboration amongst the main environmental agencies/divisions, waste management organisations and education institutions to set up public awareness campaigns and collection centres or collection/exchange drives for personal mercury containing products such as thermometers and fluorescent bulbs can be effective measures to removing these products from homes and ensuring that they are managed in an environmentally sound manner as authorities can then accumulate mercury with the intent to conduct either recycling, reclamation or recovery. For example, the possibility of using centralized box crushers for fluorescent bulb disposal as a means of reducing mercury releases to landfill and concentrating any Hg liquids should be explored.

In addition, in some cases substitute products could be used as opposed to those that contain mercury. These would include mercury-free digital thermometers, LED (light emitting diode) lights and dental amalgam substitutes like ceramic, porcelain, gallium, cold silver and glass isomers. However, it is important to note that many of these mercury products are used due to their low cost in comparison to their mercury-free counterparts. Considerations should be given to reducing the tariffs placed on these mercury-free alternatives to make them more economically feasible options. The Ministry of Health can also be collaborated with to ensure that the public are made aware of the direct health implications caused by mercury containing products such as skin lightening creams.

For the oil and gas sector as well as cement production, mercury was mainly released due to combustion of mercury containing fuel. Measures should be taken to reduce these mercury emissions such as, "end of pipe" techniques to contain the emissions of mercury. "End of pipe" refers to control methods at the point of emission so that the pollutant is hindered. They can be applied to a stream of air, wastewater, water, and their implementation occurs just before

disposal or delivery. An end-of-pipe-technique like exhaust gas filtration is deemed appropriate for raw materials that contain trace amounts of mercury. Companies within the oil and gas sector should be strongly urged to regularly test their catalysts that may contain mercury so that accurate data can be obtained.

Existing legislation must be reviewed to determine if they should be updated or repealed in the context of a new framework. Legislation needs to be amended to incorporate a comprehensive regulatory framework for the management of chemicals. The chemical conventions to which Jamaica is a party, should be reviewed to determine if enabling legislation is needed in order to implement their provisions. For example, the Wastewater and Sludge Regulations, 2013 were developed to incorporate the provisions of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal in which standards and limit concentrations for mercury in trade effluent, fully treated sewage sludge (that can be applied to agricultural lands) and solid waste/industrial sludge suitable for landfills were set. Regulations to the Trade Act, 1955 should be developed to prohibit or limit the importation/exportation of mercury and mercury containing compounds or equipment. The Bureau of Standards, Jamaica should be engaged to ensure that standards are in place and up-to-date for commodities that may contain mercury, including cosmetics such as skin lightening creams.

In Jamaica, the best options for storage and disposal are:

1) To develop a facility (or facilities) for interim storage of mercury waste, the location of which will need to be determined in further discussions with relevant stakeholders. A consolidation of mercury waste produced by individual companies would be done by the companies themselves who would have to develop infrastructure "in-house" to arrange for the environmentally sound collection and transport of the waste to the interim storage facility. The interim storage sites would be developed in collaboration with the main waste management companies, including NSWMA, as a sanitary engineered landfill under an integrated waste management approach, meaning that the facility would be equipped to handle mercury wastes as well as other hazardous wastes. It was suggested that the Riverton landfill site be selected for this facility.

2) To have stabilisation/ solidification processes done at the interim storage facilities for the mercury waste. The recommended process would be solidification via cementation where the mercury waste would be encased in a solid block.

3) To export the waste at a national level for environmentally sound disposal to a processing facility. The exportation of solidified waste may be expensive due to the potentially large mass of the solid blocks so considerations would need to be made as to how these costs could be off-set.

A possible interim solution for reducing mercury releases to landfills can include retrofitting the landfills with some form of groundwater capture and treatment.

It is strongly recommended that the implementation of the national work plan for the Mercury Storage and Disposal Project in the Caribbean (developed by the stakeholders and provided in Annex 3) be continued in order to better facilitate the ratification of the Minamata Convention on Mercury by the Government of Jamaica. However, it should be noted that the time dedicated to obtaining the data for this project was approximately three (3) months resulting in an inventory that was incomplete. As a direct result, Jamaica cannot commit to any policy directives at this time. Additionally, this high level of decision making must be approved under the auspices of Cabinet.

An opportunity for accessing funds to offset the financial requirements of the storage and disposal options suggested for Jamaica would be the upcoming seventh replenishment of the Global Environment Facility Trust Fund (GEF-7) for the period 2018-2022.

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Annex 1

Questionnaire Templates

QUESTIONNAIRE FOR OIL AND GAS SECTOR

MERCURY STORAGE AND DISPOSAL PROJECT

COMPANY NAME			
MAILING ADDRESS (NUMBER, STREET, VILLAGE/CITY)/P.O. Box No.			
CEO/VICE PRESIDENT/DIRECTOR			
COMPANY CONTACT	Name (first,last):		
	Official Position:		
	Mailing Address (number, street, village/city)/ P.O. Box No.:		
	Telephone No.: Fax No.: Mobile No.: Email:		
SIGNATURE			
DATE (DD/MM/YYYY)			

1. Facility Category

☐ Petroleum

☐ Natural Gas Production, Compression, Blending or Liquifaction Facility

☐ Other (*please specify*)

2. Provide a brief description of the facility's operations and activities that generate or are expected to generate Mercury, Mercury containing or Mercury Contaminated Waste.

Process	**Raw Materials**	**Products & By-products**	**Wastes and Emissions**	**Frequency of Production**

3. For the past five (5) years, kindly indicate the following information where applicable:

FUEL PRODUCTION			
	Oil Extraction	**Oil Refining**	**Extraction and Processing of Natural Gas**
Years	**Crude Oil produced (t/y)**	**Oil refined (t/y)**	**Produced gas (Nm^3/y)**
2011			
2012			

2013			
2014			
2015			

4. Please provide any information on mercury, mercury containing or mercury contaminated waste/effluent/wastewater/liquids/materials generated through your process/es and company facilities.

	Industry Segment	**Category**	**Amount Discharged (including what is stored and what is disposed of)** **(Please state appropriate units)**
Water	Natural Gas Production, Compression,blending or liquifaction facility	Produced Water	
	Oil Refining	Refinery WasteWater	
	Oil Transport	Tanker Ballast Wastewater	
Solid Waste	Oil and Gas Exploration	Drilling Waste	
	Oil Refining	Refinery Waste	
Air	Natural Gas Production, Compression, blending or liquifaction facility	Spent catalyst, carbon beds, Absorbent material, other	
	Oil and Gas Production, Compression, Compression, blending or liquifaction facility	Flared Gas/Stack Emissions	
	Oil Production	Fugitive Emissions	

	Natural Gas Production, Compression,blending or liquifaction facility and Transmission	Fugitive Emissions	
	Oil Production	Fuel Combustion	
	Natural Gas Production, Compression, ,blending or liquifaction facility	Fuel Combustion	
OTHER Examples: Mercury Containing or Contaminated Material, Condensate, bulbs and light fixtures, etc.			
CATALYST (if used in your process please identify the type of catalyst material)			

5. Mercury Management Programme

Is there any mercury management program or are there any measured in place currently to reduce, manage or prevent the use of Mercury and/or to prevent Mercury from entering into the atmospheres, land, water or disposal of Mercury, Mercury containing and Mercury contaminated waste?

6. **Confidentiality Claim**

If any information provided is considered to be a trade secret, confidential business information and/or if disclosed, would be contrary to the public interest; please indicate below:

Yes ☐

No ☐

Please explain:

<u>Please submit this data within three (3) weeks of receipt of this correspondence.</u>

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR AMMONIA AND METHANOL SECTOR

MERCURY STORAGE AND DISPOSAL PROJECT

COMPANY NAME			
MAILING ADDRESS (NUMBER, STREET, VILLAGE/CITY)/P.O. Box No.			
CEO/VICE PRESIDENT/DIRECTOR			
COMPANY CONTACT	Name (first,last):		
	Official Position:		
	Mailing Address (number, street, village/city)/ P.O. Box No.:		
	Telephone No.: Fax No.: Mobile No.: Email:		
SIGNATURE			
DATE (DD/MM/YYYY)			

1. For the past five (5) years, kindly indicate the following information where applicable:

	Processing of Natural Gas
Years	**(Nm^3/y)**
2011	
2012	
2013	
2014	
2015	

2. Does the facility consume treated (to remove trace mercury) natural gas or does it treat incoming natural gas to remove trace mercury at the plant?

3. If there isan operating mercury treatment process at the plant, describe this treatment system to address mercury in feed natural gas?

4. Does the facility currently use a non-regenerative sorbent system to remove mercury? If yes describe how the system operates.

5. Does this non- generative sorbent system generate liquid or solid wastes? If yes describe the types of wastes, annual amounts generated and how they are disposed.

6. Does the facility use regenerative adsorbents to remove mercury? If yes describe that process.

7. If regenerative adsorbents are used, do they generate liquid or solid wastes? If yes describe the waste types, the annual amounts of wastes and howeach waste is disposed of.

8. **Mercury Management Programme**

Describe the company's mercury management program to reduce mercury waste generation, manage the disposal of mercury wastes and actions to prevent Mercury from entering into the atmospheres, land, and water.

9. **Confidentiality Claim**

If any information provided is considered to be a trade secret, confidential business information and/or if disclosed, would be contrary to the public interest; please indicate below:

Yes ☐

No ☐

Please explain:

Please submit this data within three (3) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR POWER GENERATION SECTOR

MERCURY STORAGE AND DISPOSAL PROJECT

COMPANY NAME			
MAILING ADDRESS (NUMBER, STREET, VILLAGE/CITY)/P.O. Box No.			
CEO/VICE PRESIDENT/DIRECTOR			
COMPANY CONTACT	Name (first,last):		
	Official Position:		
	Mailing Address (number, street, village/city)/ P.O. Box No.:		
	Telephone No.: Fax No.: Mobile No.: Email:		
SIGNATURE			
DATE (DD/MM/YYYY)			

1. For the past five (5) years, kindly indicate the following information where applicable:

	Processing of Natural Gas
Years	**(Nm^3/y)**
2011	
2012	
2013	
2014	
2015	

2. What is the MW rating for the plant?
3. How much electricity (MW) do you produce annually? At Peak?
4. Is the purchased natural gas treated to remove mercury? If yes what is the purchase specification for mercury content in purchased natural gas?
5. Is there any mercury air emission monitoring systems operating at your plant? If so describe their operation and results.
6. Mercury Management Programme:

Describe the company's mercury management program to reduce mercury waste generation, manage the disposal of mercury wastes and actions to prevent Mercury from entering into the atmospheres, land, and water.

Please submit this data within three (3) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR MERCURY AND MERCURY CONTAINING DEVICES

MERCURY STORAGE AND DISPOSAL PROJECT

NAME			
COMPANY NAME (IF APPLICABLE)			
ADDRESS			
CONTACT INFORMATION	PHONE	MOBILE	EMAIL

	Do You Import These Items?	**Yes/No**	**Quantity /Year**	**Purchasing Institution (i.e. who purchases this from you)**	**Comments (Is it still imported, replacement devices on market?)**
1	Mercury Lab Thermometer				
2	Mercury Fever Thermometer				
3	Mercury Cooking Thermometer				
4	Mercury Sphygmomanometer				
5	Mercury Barometer				
6	Mercury Hygrometer				

7	Mercury Hydrometer				
8	Mercury Vacuum Gauge				
9	Mercury Spectral Tube				
10	Mercury Sling Psychrometer				
11	Mercury Gas Law Apparatus				
12	Mercury Anemometer				
13	Other metallic mercury containing instruments (Please list as needed)				

Please submit this data within two (2) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR BAUXITE AND CEMENT SECTOR

MERCURY STORAGE AND DISPOSAL PROJECT

NAME			
COMPANY NAME			
ADDRESS			
CONTACT INFORMATION	PHONE	MOBILE	EMAIL

1. For the past five (5) years, kindly indicate the following information where applicable:

	Primary Metal Production	**Other Materials production**
Years	**Alumina Production from bauxite [aluminium production]** **(Bauxite processed, t/y)**	**Cement Production** **(tonnes of cement produced, t/y)**
2011		
2012		
2013		
2014		
2015		

2. What type of fuel do you use at your facility for processing cement?

3. Do your scrubbers contain mercury?

4. If 'YES' to #3 above, please describe the disposal process.

Please submit this data within two (2) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR DENTAL SECTOR

MERCURY STORAGE AND DISPOSAL PROJECT

NAME			
COMPANY NAME (IF APPLICABLE)			
ADDRESS			
CONTACT INFORMATION	PHONE	MOBILE	EMAIL

1. Which do you use in your dental practice?

- ☐ Elemental mercury (from a dispenser)
- ☐ Pre-capsulated mercury
- ☐ None

2. Can you indicate the dental amalgam supplier to your dental practice?

_____

3. For the past year (1), kindly indicate the following information where applicable:

Years	**Old Amalgams Removed**	**New Amalgams Placed**
2015		

4. What type of chair side trap filter do you use?

Reusable

Disposable

5. How do you manage your waste from chair side traps? (please tick all that are applicable)

- ☐ Recycle
- ☐ General garbage
- ☐ Biohazard Waste
- ☐ Wash down sink
- ☐ Don't know
- ☐ Other (please explain)

_____

_____

Please submit this data within two (2) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey

QUESTIONNAIRE FOR WASTE

MERCURY STORAGE AND DISPOSAL PROJECT

NAME			
COMPANY NAME			
ADDRESS			
CONTACT INFORMATION	PHONE	MOBILE	EMAIL

1. Kindly fill in the following information where applicable:

WASTE INCINERATION					
Years	**Incineration of Municipal/ General Waste** **Waste incinerated (t/y)**	**Incineration of hazardous waste** **Waste incinerated (t/y)**	**Incineration of medical waste** **Waste incinerated (t/y)**	**Sewage Sludge Incineration** **Waste incinerated (t/y)**	**Open fire waste burning (on landfills and informally)** **Waste burned (t/y)**
2011					
2012					
2013					
2014					
2015					

Please submit this data within two (2) weeks of receipt of this correspondence.

Thank you for taking the time to complete this survey.

QUESTIONNAIRE FOR FUNERAL HOMES

MERCURY STORAGE AND DISPOSAL PROJECT

NAME			
COMPANY NAME			
ADDRESS			
CONTACT INFORMATION	PHONE	MOBILE	EMAIL

1. For the past five (5) years, kindly indicate the following information:

Years	**Number of Burials/Year**	**Number of Cremations/Year**
2011		
2012		
2013		
2014		
2015		

Please submit this data within one (1) week of receipt of this correspondence.

Thank you for taking the time to complete this survey

Annex 2

Completed National Mercury Inventory Level 1 UNEP Toolkit for Identification and Quantification of Mercury Releases

Jamaica Mercury Releases Inventory Level 1 UNEP Toolkit for Identification and Quantification of Mercury Releases

(Microsoft Excel Spreadsheet)

Available at:
https://www.dropbox.com/s/1zqoca7g5wgzvks/FINAL%20JAMAICA%20Hg%20Inventory_Level_1_electronic_spreadsheet.xlsx?dl=0

Annex 3

National Work Plan

WORKPLAN FOR THE IMPLEMENTATION OF THE MERCURY STORAGE AND DISPOSAL PROJECT IN THE CARIBBEAN-JAMAICA

GENERAL OBJECTIVE : TO ENHANCE CAPACITIES AND PROMOTE THE ENVIRONMENTALLY SOUND MANAGEMENT (ESM) AND DISPOSAL OF SURPLUS MERCURY IN JAMAICA

Specific Objective 1: To establish decision making processes to support the implementation of the Project					
Output/Activities	**Tasks**	**Responsible**	**Partners**	**Timeframe**	**Resources**
Establishment of a National Inter-agency/ Inter-ministerial Committee (NIC)	1. Invite Ministries, Departments and Agencies to become members of the NIC 2. Establish the NIC 3. Facilitate the coordination and monitoring of the Project through the NIC.	Ministry of Economic Growth & Job Creation (MEGJC)	• Ministry of Transport and Mining (MTM) • Ministry of Health (MOH) • National Environment & Planning Agency (NEPA) • Jamaica Bureau of Standards (JBS) • Jamaica Bauxite Institute (JBI) • National Solid	1.5 months	Staff time

			Waste Management Authority (NSWMA)		
National Inter-agency Meetings and Workshops	1. Identify key stakeholders 2. Organise meetings/workshops/consultations 3. Facilitate and or conduct meetings/workshops/consultations 4. Make decisions associated with the recommendations arising from the findings of the project	MEGJC BCRC	NIC Users of mercury products Generators of mercury wastes	2 months	At least one face-to-face meeting Teleconferences Emails
Specific Objective 2: To assess the national situation on mercury					
National Inventory of mercury	1. Obtain detailed information from stakeholders on mercury sources and types of mercury wastes for the inventory 2. Updating of existing inventories	NEPA BCRC	MEGJC MOH NIC Working group Private enterprises	4 months	Existing Inventories UNEP Toolkit Staffing Project funds

Specific Objective 3: To review existing regulations addressing Mercury and Mercury Waste and update or develop new regulations as needed and implement the National Action Plan					
Review of Regulatory framework related to Mercury and Mercury Wastes	1. Review of relevant laws and policies on chemicals including hazardous wastes 2. Identification of gaps in the regulatory framework 3. Conduct needs analyses in regulatory framework on chemicals	BCRC MEGJC		2 months	Staffing Project Funds
Specific Objective 4: To develop national storage and waste management action plans for the ESM of mercury and mercury wastes					
Identify potential locations for temporary storage of mercury and mercury wastes	1. generate list of approved treatment, storage and disposal facilities 2. investigate the suitability of the identified facilities 3. assess public owned wastes facilities 4. conduct analyses/explore how the recommended storage facilities may be utilized	BCRC	NEPA NSWMA PRIVATE ENTERPRISES	4 months	

Assessment of Management Options and Development of Action Plans	1. identify basic management options based in the results of the inventory, assessment of the regulatory framework and assessment of the existing infrastructure 2. assessment of technologies/ storage sites available in country 3. develop action plan with recommendations, strategies and timelines	BCRC MEGJC NIC	Working Group Private enterprises	5 months	Data on storage and disposal facilities Inventory