

**REPUBLIC OF MAURITIUS**

**MINAMATA INITIAL  
ASSESSMENT REPORT 2018**



**MINISTRY OF ENVIRONMENT, SOLID WASTE  
MANAGEMENT AND CLIMATE CHANGE**

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## List of abbreviations and acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
BAT	Best Available Techniques
BEP	Best Environmental Practices
BRI	Biodiversity Research Institute
CEB	Central Electricity Board
CEL	Consolidated Energy Limited
CFL	Compact Fluorescent Lamp
DCCA	Dangerous Chemicals Control Act
DCCB	Dangerous Chemicals Control Board
EPA	Environment Protection Act
ESP	Electrostatic Precipitator
FAREI	Food and Agricultural Research and Extension Institute
GDP	Gross Domestic Product
GEF	Global Environment Facility
HDI	Human Development Index
HS	Harmonized System
IHWSF	Interim Hazardous Waste Storage Facility
IPP	Independent Power Producer
kg	kilogram
LED	Light-Emitting Diode
LPG	Liquefied Petroleum Gas
MCCI	Mauritius Chamber of Commerce and Industry
MCIA	Mauritius Cane Industry Authority
MEA	Multilateral Environmental Agreement
MIA	Minamata Initial Assessment
MoEHRTE&SR	Ministry of Education and Human Resources, Tertiary Education and Scientific Research
MoESD	Ministry of Environment and Sustainable Development
MoFARI&IT	Ministry of Foreign Affairs, Regional Integration and International Trade
MoHQL	Ministry of Health and Quality of Life
MoICCP	Ministry of Industry, Commerce and Consumer Protection
MoLGOI	Ministry of Local Government and Outer Islands
MoLIRE&T	Ministry of Labour, Industrial Relations, Employment and Training
MoOEMRF&S	Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping
MoEPU	Ministry of Energy and Public Utilities
MoSSNSE&SD	Ministry of Social Security, National Solidarity and Environment and Sustainable Development
MRA	Mauritius Revenue Authority
MSB	Mauritius Standards Bureau
MSIRI	Mauritius Sugarcane Industry Research Institute
MT	Million tonnes
MW	Megawatts
NAP	National Action Plan
NEL	National Environmental Laboratories
NFP	National Focal Point
NGO	Non-Governmental Organisation
PANeM	Pesticide Action Network
ppm	Parts per million
SDS	Safety Data Sheet

SIDS	Small Island Developing State
SMEDA	Small and Medium Enterprise Development Authority
Sub-C	Sub-Category
Toolkit	Toolkit for identification and quantification of mercury releases
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization
WMA	Wastewater Management Authority
y	year

## **Executive Summary**

The Minamata Convention on Mercury, which is a global treaty to protect human health and the environment from the adverse effects of mercury, was signed and ratified by the Republic of Mauritius on 10 October 2013 and 21 September 2017 respectively. Before ratification, the country carried out the Minamata Initial Assessment (MIA), with the support of United Nations Development Programme (UNDP) and the Global Environment Facility (GEF). The MIA project comprised four main outputs, namely: (i) a level 2 mercury inventory; (ii) a legal and institutional gap analysis, (iii) a communications plan, and (iv) a national implementation plan. Prior to the MIA project, a level 1 inventory of mercury releases in the country was undertaken in 2013 based primarily on 2012 input data. The total quantified emissions and releases of mercury into different phase media, as estimated in the level 1 and level 2 inventory, were 720 and 671 kg/y respectively.

The findings of the MIA project are summarized below:

### **I. Results of the level 2 mercury inventory**

The inventory was developed for the 2014 calendar year using the Toolkit Inventory Level 2 version 1.4. The required activity data have been obtained through published information sources such as from Statistics Mauritius, relevant ministries and stakeholders through questionnaires, surveys and site visits, as appropriate. Analyses of samples of soil, leachate, coal, cement, and some selected consumer products were also carried out. For all the source categories, in the absence of measured data (e.g. mercury level and activity rate), the mercury input factors from the Toolkit have been used.

Total input of mercury was estimated to be 760 kg in the year 2014 compared to 840 kg in 2012 (level 1 inventory). The individual mercury release non-waste categories contributing with the highest inputs of mercury were: (i) consumer products with intentional use of mercury (thermometers, switches and relays, light sources, batteries, polyurethanes) (266 kg/y); (ii) other intentional product/process uses (dental amalgam-mercury fillings, manometers and gauges, laboratory chemicals and equipment) (130 kg/y); and (iii) extraction and use of fuels/energy sources (106 kg/y). It is noteworthy that in the Republic of Mauritius there are no mercury mines, units or plants involved in primary metal production or making use of mercury or its compounds in industrial processes.

Six different output pathways for mercury have been identified in the country, namely (i) emissions to air; (ii) releases to water; (iii) releases to land; (iv) releases to by-products and impurities; (v) releases to general waste; and (vi) releases to sector specific waste.

The total estimated emissions and releases of mercury for the Republic of Mauritius in 2014 was 671 kg compared to 720 kg in 2012 (level 1 inventory). Table E.1 shows the contributions to the different output pathways from each source category and Figure E.1 depicts the % contribution of emissions and releases to each output pathway.

**Table E.1: Summary of mercury inventory results**

Source Category	Calculated Hg output, kg/y						Total releases by source category	% of total releases *3*4
	Air	Water	Land	By-products and impurities	General waste	Sector specific treatment /disposal		
5.1: Extraction and use of fuels/energy sources	82.3	-	24.2	-	-	-	106	16%
5.2: Primary (virgin) metal production	-	-	-	-	-	-	-	0%
5.3: Production of other minerals and materials with mercury impurities*1	0.0	-	-	-	-	-	0	0%
5.4: Intentional use of mercury in industrial processes	-	-	-	-	-	-	-	0%
5.5: Consumer products with intentional use of mercury (whole life cycle)	24.8	9.2	16.9	-	214.8	0	266	40%
5.6: Other intentional product/process uses*2	3.1	47.4	5.6	4.0	34.0	35.6	130	19%
5.7: Production of recycled metals	0.0	-	0.0	-	0.0	-	0	0%
5.8: Waste incineration and burning	54.8	-	-	-	-	-	55	8%
5.9: Waste deposition/landfilling and waste water treatment*3*4*5	25.5	164.5	19.9	-	42.7	20.2	273	14%
5.10: Crematoria and cemeteries	10.0	-	13.3	-	-	-	23	3%
<b>SUM OF QUANTIFIED RELEASES*3*4</b>	<b>201</b>	<b>59</b>	<b>60</b>	<b>4</b>	<b>292</b>	<b>56</b>	<b>671</b>	<b>100</b>

Notes:

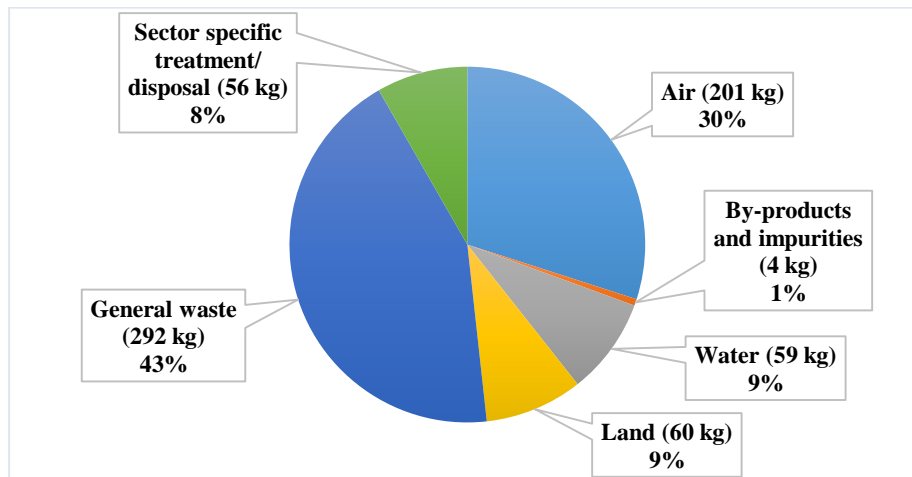
\*1 Includes production of cement, pulp and paper, lime and light weight aggregates.

\*2 Includes dental amalgam fillings, manometers and gauges, lab chemicals and equipment, Hg use in religious rituals and folklore medicine, and miscellaneous product uses.

\*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.

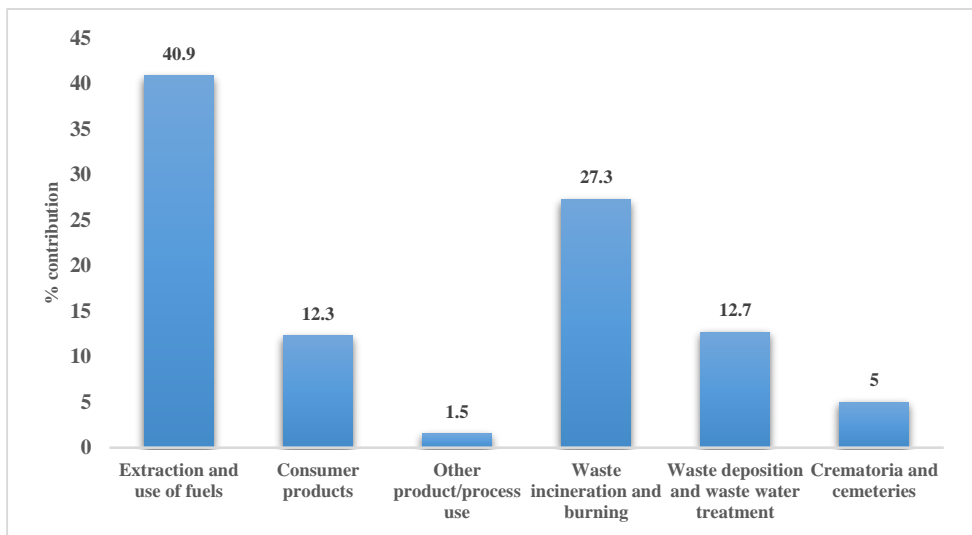
\*4 The estimated input and release to water include mercury amounts which have also been accounted for under each source category. To avoid double counting, releases to water from waste water system/treatment have been subtracted automatically in the TOTALS.

\*5 Taking into account double counting, the releases to water, land and total for source category 5.9 amount to 2.7, 0 and 91 kg respectively.



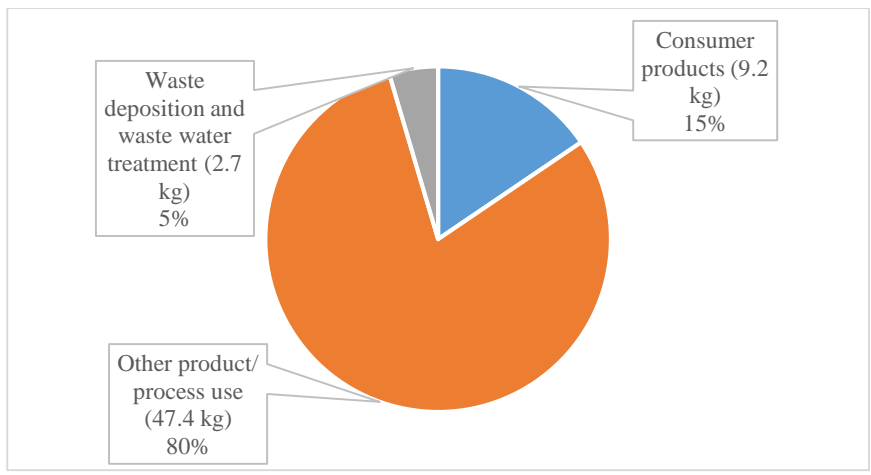
**Figure E.1: Amount and % of mercury emissions and releases to each output pathway**

The estimated mercury emission to air was 201 kg/y, with the highest mercury source emitters being (i) extraction and use of fuels/energy sources (82 kg/y; 40.9%); and (ii) waste incineration and burning (55 kg/y; 27.3%) as shown in Figure E.2.



**Figure E.2: % contribution of source category to air emissions**

59 kg of mercury was estimated to be released to water, the main source contributors being dental mercury-amalgam fillings (30 kg/y; 50.8%) and laboratory chemicals and equipment (14 kg/y; 23.7%) from the source category: other product/process use (Figure E.3).



**Figure E.3: % contribution of source category to releases to water**

The estimated mercury release to land was 60 kg/y with the main source categories being extraction and use of fuels (24 kg/y; 40%), consumer products (17 kg/y; 28%), cemeteries (13 kg/y; 22%) and other product/process use (6 kg/y; 10%).

The total mercury flow to general waste and sector specific treatment/disposal was 292 kg and 56 kg/y respectively, with the main contributions coming from consumer products (electrical switches and relays, light sources, polyurethanes and thermometers), other product/process uses (laboratory

chemicals and equipment, dental amalgam) and waste water system/treatment. Mercury release to by-products and impurities from dental amalgam fillings accounted for less than 1% (4 kg/y).

The input and output estimates of this level 2 inventory were compared with those of the level 1 inventory based on the calendar year of 2012. Significant changes were observed and the differences between the two estimates and the reasons for these are discussed in the different sections of the report.

Mauritius is not involved in the supply or trade of mercury, except when mercury wastes are exported.

Several current uses and stocks of sub-category sources which may be considered as future contributors or reservoirs of mercury releases in the country are listed below:

Thermometers:	17.4 – 156.4 kg
Sphygmomanometers:	175 – 213 kg
Other manometers/gauges:	3.1 – 38.5 kg
Switches and relays:	1.4 kg
Lighthouse light systems:	200 kg
Laboratory chemicals:	58.8 kg (including elemental mercury)

Two potentially mercury-contaminated sites identified in the inventory work are the Mare Chicose sanitary landfill and the open dumping ground at Roche Bon Dieu in Rodrigues. However, analysis of three samples of leachates at the Mare Chicose landfill were found to be less than 0.0002 mg/L and the mercury concentrations in air at Mare Chicose landfill and Roche Bon Dieu dumping site were also found to be very low, 2.95 – 15.25 and 4.38 ng/m<sup>3</sup> respectively. Further study is required to assess whether these sites are effectively contaminated.

## **II. Policy, regulatory and institutional assessment**

The legal and institutional assessment showed that there are a number of laws and institutions which already cater in a satisfactory manner for the various issues highlighted in the Minamata Convention on Mercury (Convention). However, there are some legal and institutional gaps that could be attended to in order to protect the human health and the environment and at the same time enhance our compliance with the Convention. The main policy, regulatory and institutional findings were:

- Due to the absence of metal mining and industrial processes using mercury, not all the provisions of the Convention are applicable to Mauritius, namely Article 5 (manufacturing processes in which mercury or mercury compounds are used), Article 7 (artisanal and small scale gold mining) and Article 10 (environmentally sound interim storage of mercury, other than waste mercury).
- Amendments could be made to several regulations to consolidate our international obligations towards the Convention, namely (i) Consumer Protection Regulations to broaden ban on import of mercury-added products to include items listed in Part I of Annex A of the Convention; (ii) Environment Protection (Standards for Air) Regulations 1998; and (iii) Environment Protection Act.
- New regulations to control import of cosmetics and on environmentally sound management of mercury-containing wastes, could be developed, approved and enacted.

- There are staff having the required expertise in the different ministries to oversee the national implementation plan. However, some selected activities may be outsourced in case of overload or lack of human resources.
- There is need to enhance the capacity of government and parastatal laboratories to analyse mercury content in different media and biological samples including air and hair and to be accredited for the calibration of non-liquid in glass filled thermometers.
- The level of awareness and understanding of the different stakeholders and the general public on the Convention and on the dangers of mercury and its compounds should be increased through provision of financial and human resources for training and awareness sessions/workshops, design of a webpage on the ministry website regarding all matters pertaining to mercury, and development of other modes of communication tools such as pamphlets and video spots.

### **III. The national implementation plan for mercury**

The main objective of the National Implementation Plan is to “decrease input, releases and emissions of mercury and thus reduce its impact on human health as well as the environment”.

Following the outcomes and results of the level 2 national inventory report, five mercury-related priorities have been identified, namely:

- (1) Improve the policy and regulatory framework governing the management of mercury and mercury waste;
- (2) Improve storage and waste management practices for mercury and mercury-containing wastes;
- (3) Undertake education awareness and strengthen capacity through training;
- (4) Improve monitoring and reporting capacity on mercury-containing products and mercury levels in food, soil, water, air and biological samples;
- (5) Reduce emissions of mercury and mercury compounds to the atmosphere, as well as the reduction of mercury releases to the soil and water from point sources.

Table E.2 summarises the activities to be carried out, the budget, the timeframe and the implementing entity or entities.

**Table E.2: National implementation plan for mercury**

Activity	Responsibility	Budget (USD)	Time frame	Requirement as per Convention or an enhancement
<b>1. Policy and regulatory framework</b>		<b>5,000</b>		
Amendments to existing regulation and development of new regulations	Attorney General's Office; MoSSNSE&SD; MoICCP	5,000	2019-2020	Enhancement
<b>2. Storage and waste management</b>		<b>40,000</b>		
Country-wide system for the collection of used products containing mercury	MoSSNSE&SD MoLGOI; MoEPU (CEB) MoHQL (Area Health Community Centres)	20,000	2020-2021	Enhancement
Compliance monitoring and enforcement	MoHQL; MoSSNSE&SD	20,000	2019-2023	Enhancement
<b>3. Awareness and training</b>		<b>1,060,000</b>		
Develop national protocols (technical guidelines) for handling of mercury, mercury compounds and mercury-containing wastes	MoSSNSE&SD MoLGOI	8,000	2019	Enhancement
Training on management of mercury as well as mercury-containing products and wastes for institutions and entities that have responsibilities pertaining to mercury management	MoSSNSE&SD; MoLGOI; MoLIRE&T; MoEHRTE&SR	30,000	2019-2020	Enhancement
Develop technical information on mercury management for risk groups	MoSSNSE&SD; MoLGOI; MoLIRE&T; MoHQL; Assay Office	10,000	2019-2021	Enhancement
Promote public awareness on the hazards of mercury and availability of mercury-free alternatives	MoSSNSE&SD; MoLGOI; MoHQL	20,000	2019-2020	Enhancement
Awareness raising exercise with all ministries regarding procurement of mercury containing equipment and products and availability of mercury-free alternatives	All ministries	10,000	2019-2020	Enhancement
Create and maintain a publicly accessible mercury database and repository	MoSSNSE&SD	30,000	2019-2023	Enhancement
Incorporate the Minamata Convention on Mercury and/or effects of exposure to mercury and mercury compounds on all programmes/courses dealing with environment/health/law/chemistry taught at tertiary level	MoEHRTE&SR	2,000	2019-2023	Enhancement
Train MSB staff and purchase appropriate equipment and accessories to enable MSB Metrology Division to act as an	MoICCP MSB (Metrology Division)	450,000	2019-2021	Enhancement

Activity	Responsibility	Budget (USD)	Time frame	Requirement as per Convention or an enhancement
accredited laboratory for the calibration of non-liquid in glass thermometers				
Recruit, train NEL staff and purchase appropriate equipment and accessories to analyse mercury in air	MoSSNSE&SD	500,000	2019-2021	Enhancement
<b>4. Monitoring and reporting</b>		<b>175,000</b>		
Conduct regular environmental monitoring of point sources	MoSSNSE&SD MoEPU (WMA)	100,000	2019-2024	Requirement
Conduct regular bio-monitoring of high risk groups	MoSSNSE&SD MoHQL	40,000	2019 -2024	Enhancement
Update the national inventory on mercury emissions and releases and Convention reporting	MoSSNSE&SD	30,000	2019-2024	Requirement
Enforce and monitor ban on importation of mercury-added products listed in Part 1 of Annex A	Customs Department of MRA	5,000	2019-2024	Enhancement
<b>5. Reduction of emissions and releases</b>		<b>35,000</b>		
Promote best available techniques and best environmental practices	MoSSNSE&SD	15,000	2019-2024	Enhancement
Monitor emissions from air point sources	MoSSNSE&SD	10,000	2019-2024	Requirement
Prepare a national plan	MoSSNSE&SD	10,000	2019-2020	Requirement
<b>Total Cost</b>		<b>1,315,000</b>		

#### IV. Data gaps and recommendations

Major data gaps were the following:

- (i) No site-specific data was available for mercury concentration in the exhaust gas or surrounding air following coal combustion from the Independent Power Producers and other coal users.
- (ii) No mercury content in mineral oils, fuel wood and lime was available.
- (iii) The number of mercury thermometers imported may be over or under-estimated. The Harmonized System (HS) code 90251100 (liquid-filled, direct-reading thermometers) does not differentiate between mercury filled thermometers and other liquid-filled thermometers such as alcohol. In addition, it does not indicate the type of thermometer such as clinical, laboratory or industrial, especially as they contain differing mercury levels. Due to poor responses from the potential suppliers, categorization into the different types was not done and a range of 0.5 – 4.5 g per unit was applied instead.
- (iv) HS codes for switches and relays did not enable to discriminate between those containing mercury and those which do not. Amount of electrical switches and relays containing mercury was difficult to obtain.
- (v) Number of imported manometers and gauges with mercury and laboratory equipment with mercury could not be ascertained.
- (vi) Unavailability of data on amount of dental amalgam imported.
- (vii) Amount of recycled iron and steel products by the sole foundry was estimated from past literature and a report.

- (viii) Amount of medical waste incinerated from private clinics/institutions was estimated by extrapolation.
- (ix) Data on the level of mercury in the medical wastes were missing.
- (x) No official reported data was available for the amount of wastes generated in Rodrigues Island and the amount burnt informally.
- (xi) Test of the waste water default factor used in the inventory suggested a possible overestimation of mercury releases from waste water treatment.
- (xii) Cosmetics containing mercury are sold in Mauritius but the amount imported or brought to the country could not be ascertained as they are mostly sold in informal markets.

Main priorities for further assessment:

- (i) Better estimates of mercury releases in various source categories by regular monitoring of mercury concentration in exhaust gas or surrounding air near coal combustion facilities, incinerators, workplace (e.g. dental clinics), landfills, dumping grounds and in solid and liquid samples (ash, soil, sediment, water) through purchase of an appropriate mercury analyser.
- (ii) More accurate estimates of mercury thermometers imported and its categorisation into clinical, laboratory and industrial.
- (iii) Better estimates of the amount of dental amalgam imported in the country through identification of the major suppliers and users, and the fate of dental amalgam wastes in the private dental clinics.
- (iv) More accurate data on production of iron and steel products locally.
- (v) Amount of medical waste incinerated by private clinics to be provided annually to the Ministry of Health and Quality of Life in order to obtain a better estimate of the total amount of medical waste incinerated.
- (vi) Survey among the mechanical and electrical workshops to gauge the utilisation of mercury switches and relays.
- (vii) More in-depth investigation on the waste collection and disposal in Rodrigues. It was noted that an ongoing project entitled “Study on the generation of wastes and their characteristics in Rodrigues: Implications for a sustainable Rodrigues Island” is being funded by the Mauritius Research Council.
- (viii) Determination of mercury input estimates from waste water treatment/disposal from actual analysed data instead of the default Toolkit input factors.
- (ix) Extent of availability of mercury-containing cosmetics in the country.

## **Introduction**

### **Minamata Convention on Mercury**

Mercury is considered as a dangerous pollutant and is listed by the World Health Organization (WHO) as one of the top ten chemicals or groups of chemicals of major public health concern. It can travel long distances through the oceans and the atmosphere, bio-accumulates in micro-organisms and bio-magnify along the food chain.

While mercury is a naturally occurring metal, it has broad uses in everyday objects and are released to the atmosphere, land and water from a variety of sources such as coal-fired power stations, industrial processes, waste incinerators and metal mining. Exposure to mercury, even in small amounts, through emissions in the air and from eating certain foods (mainly marine fish), may cause serious health problems especially to fetuses, young children and pregnant women. Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes.

Given the risks posed by mercury to human health and the environment and to limit global mercury emissions, the Intergovernmental Negotiating Committee on mercury adopted the Minamata Convention on the 10 October 2013. The Convention is a global treaty to protect human health and the environment from the adverse effects of mercury. It is a major international development in controlling the harmful effects of mercury pollution. The Republic of Mauritius signed and ratified the Minamata Convention on 10 October 2013 and 21 September 2017, respectively. The Convention came into force on 16 August 2017 after it had been ratified by 50 nations. As of 12 June 2018, there were 128 signatories and 92 ratifications.

The main obligations of the Minamata Convention include, amongst others, a ban on new mercury mines, the phase-out of existing ones, the phase out of mercury use in a number of products and processes, the phase down of use of dental amalgam, reduction of mercury supply and trade, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining. The Convention also addresses issues such as interim storage of mercury and its disposal once it becomes waste, sites contaminated by mercury as well as human and environmental health issues related to mercury exposure.

### **The Minamata Initial Assessment (MIA) process**

To strengthen national capacity towards implementation of future obligations under the Convention, the Global Environment Facility (GEF), as the Financial Mechanism of the Minamata Convention on Mercury, provides financing to eligible countries to undertake their Minamata Initial Assessment (MIA).

The purpose of the MIA is to facilitate the ratification and implementation of the Minamata Convention once it comes into force with the main objectives to:

- (i) Determine the national requirements for the ratification of the Minamata Convention; and
- (ii) Establish a national foundation to undertake future works towards the implementation of the Convention.

The development of a country's MIA will assist the country in taking its decision to ratify and notify the Convention, to develop its National Implementation Plan which would include a national plan to reduce emissions and releases of mercury.

### **Mauritius MIA**

As a Signatory to the Convention, the Republic of Mauritius has benefitted from financial and technical assistance from the United Nations Development Programme (UNDP) and GEF to carry out the MIA project whose main outputs were:

- Legal gap analysis report;
- National inventory of mercury releases;
- Awareness raising programmes; and
- MIA report.

The MIA project was managed by a Project Management Team comprising the Project Manager, staff of the Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD; Environment and Sustainable Development Division), the UNDP and the International Mercury Expert, under the strategic direction of a multi-stakeholder Project Steering Committee chaired by the Director of Environment.

A team consisting of four local consultants was recruited to undertake the MIA project. The legal gap analysis report was validated at a multi-stakeholder workshop held on 27-28 April 2017 and approved by the Project Steering Committee on 28 April 2017.

The level 2 mercury release inventory was carried out making use of the "*Toolkit for identification and quantification of mercury releases*" (Toolkit)<sup>1</sup> made available by the Chemicals Branch of the United Nations Environment Programme (UNEP; UN Environment Chemicals) with the reference year being the calendar year 2014.

During the implementation of the MIA project, regular exchanges were conducted among the consultants, the Project Manager, the International Mercury Expert from Biodiversity Research Institute (BRI) and the Project Steering Committee.

On a parallel track, a non-governmental organization, PANeM<sup>2</sup>, supported the process with main focus on assisting Mauritius towards phasing out mercury added products. PANeM recruited two consultants – to look at the market transition potential to Convention compliant products, and to carry out the legal gap analysis vis a vis the provisions of Article 4 of the Convention. In general, it has been concluded from that study that compliance with the product related prescriptions detailed in Article 4 of the Convention appeared generally achievable in Mauritius. However, there may be some

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<sup>1</sup> Available at: <http://web.unep.org/chemicalsandwaste/what-we-do/technology-and-metals/mercury/toolkit-identification-and-quantification-mercury-releases>.

<sup>2</sup> PANeM run a project, as part of a wider European Environmental Bureau/Zero Mercury Working Group (EEB/ZMWG) project, funded by the European Commission (EC) through the Food and Agriculture Organization (FAO) of the United Nations (UN) under the program 'Capacity Building related to Multilateral Environmental Agreements (MEAs) in Africa, Caribbean and Pacific countries' Phase 2 (ACP/MEAs Phase 2). The EEB/ZMWG project is entitled: "*Contributing to the preparation/implementation of the Minamata Convention on Mercury, with a focus on developing strategies for phasing out mercury-added products and on reducing mercury use in Artisanal and Small Scale Gold Mining through development of National Action Plans.*" July 2014-December 2017.

challenges (mainly with regard to improved information collection and monitoring of imported goods) in meeting these product-related Convention obligations. From the legal gap analysis conducted, it was concluded that existing authorities cover to a large extent the provisions of the Convention. It has been recommended that further actions could be undertaken in terms of amendments to the Consumer Protection Act and Regulations to restrict imports of all Convention listed products apart from pesticides and batteries. Moreover, it has been recommended that NGOs have the potential of being particularly helpful in contributing to the overall decision-making process by undertaking targeted public awareness raising exercises, sharing reliable information and drawing attention to issues demanding state action.

## **Chapter I: Country Profile**

### **1.1 Geography and population**

The Republic of Mauritius lies in the South West of the Indian Ocean. It comprises the main island Mauritius (20°17' S, 57°33' E), the island of Rodrigues (19°43' S, 63°25' E), Agalega Islands (10°25' S, 56°35' E), Cargados Carajos Shoals<sup>3</sup> (16°35' S, 59°37' E), Chagos Archipelagos (6°00' S, 71°30' E), Tromelin (15°53' S, 54°31' E) as well as a number of uninhabited islets within the Indian Ocean. It became independent of Britain on 12 March 1968 and acceded to the status of Republic within the Commonwealth on 12 March 1992.

The Republic of Mauritius covers a total land area of 2,040 km<sup>2</sup> and the exclusive economic zone is estimated at 1.9 million km<sup>2</sup>. It also co-manages a continental shelf of 360,000 km<sup>2</sup> with the Republic of Seychelles. As at July 2016, the population was 1,256,739 with a life expectancy of 75.6 years (males: 72.2 years; females: 79.2 years)<sup>4</sup>. With no indigenous population, Mauritius is composed of a racial mix of Asians (73%: 70% of Indian origin and about 3% of Chinese origin), Africans (about 25%) and Europeans (less than 2%) resulting from more than two centuries of European colonialism and continued international labor migration mainly from Africa and India in the 18<sup>th</sup> and 19<sup>th</sup> centuries. Many languages are commonly used in Mauritius that include creole (native), french, bhojpuri, and english, which is the official language.

### **1.2 Political, legal and economic profile**

In the Republic of Mauritius, politics take place in a parliamentary democracy framework. The separation of powers in the three branches of the Government, namely the legislative, the executive and the judiciary, is embedded in the Constitution of Mauritius. Mauritius has a Westminster system of government, and has a unicameral house of parliament, which is the National Assembly, and is supreme. The President of Mauritius, who is the Head of State is voted by a single majority of votes in the National Assembly. The Prime Minister, who is the Head of Government, comes from the political party who has the majority in the National Assembly. He has full executive power and is assisted by a council of Ministers. The Assembly is made up of 70 members of whom 62 are directly elected in 21 constituencies. The Mauritian legal system is a mixed legal system influenced by both the French and English colonial powers. Therefore, the laws in the Mauritian legal system are made up of codified laws amended as and when needed for the Mauritian context, and of Common Law principles and Equity thus creating a hybrid system.

Since its launch in 2006, Mauritius has remained at the top of the Mo Ibrahim Index for overall governance in Africa for eleven consecutive years. Mauritius is ranked 64<sup>th</sup> worldwide and 1<sup>st</sup> in Sub Sahara Africa for human development. It has a human development index (HDI) of 0.781 (2015), which is above the average of 0.746 for countries in the high human development group and above the average of 0.523 for countries in Sub-Sahara Africa<sup>5</sup>.

The country has the second highest gross domestic product (GDP) per capita in Sub-Sahara Africa (second to Seychelles) and 84<sup>th</sup> worldwide: Mauritius USD 20,500 and Seychelles USD 28,000<sup>6</sup>. In

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<sup>3</sup> Also known as St Brandon

<sup>4</sup> Source: <https://www.cia.gov/library/publications/the-world-factbook/geos/mp.html>

<sup>5</sup> [http://hdr.undp.org/sites/all/themes/hdr\\_theme/country-notes/es/MUS.pdf](http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/es/MUS.pdf)

<sup>6</sup> <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html#mp>

2016, economic growth was 3.5% of GDP, inflation rate was 1.3%, public debt was 66% of GDP and unemployment rate was 7.8%<sup>7</sup>. Since its independence, Mauritius has gradually joined a number of organisations namely the United Nations and the African Union. Mauritius is a member of the General Agreement on Tariffs and Trade (GATT) since 2 September 1970 and is a member of the World Trade Organization (WTO) since 1 January 1995. It is also member of the regional economic organizations: the Southern African Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA).

### **1.3 Profiles of economic sectors**

The economy of Mauritius is largely dependent on the service industry, which accounts for 73.9% of GDP, followed by industries (22.1%) and finally agriculture (4%)<sup>8</sup>. The main industries in Mauritius include tourism, food processing (largely sugar milling), textiles, clothing, metal products, transport equipment, and non-electrical machinery. The financial services sector, the tourism industry and the ICT sector are considered the three main pillars of the economy, and in 2016 they contributed 12.1%, 8.4% and 5.7% to the GDP. The paragraphs below describe the main economic activities that may be relevant to the Minamata Convention.

#### **1.3.1 Tourism industry**

The tourism industry is considered, after the financial services, the second pillar of the Mauritian economy and contributed to 8.4% of GDP in 2016. Compared to the past years where growth was about 4.5%, the last two years have been particularly good for the tourism industry with an increase in arrival of visitors exceeding 10% (10.9% in 2015 and 10.8% in 2016). In 2015, the total number of visitors was 1,038,968, which increased to 1,151,723 in 2015 and to 1,275,227 in 2016<sup>9</sup>. Based on recent data on tourist arrivals and information gathered from stakeholders, the forecast of tourist arrivals for the year 2017 is estimated to be around 1,340,000<sup>10</sup>. According to the World Tourism and Travel Council, the direct contribution of travel & tourism to GDP was MUR 36.0bn (USD 1.0bn) in 2016, and is forecast to rise by 2.5% in 2017, and to rise by 4.7% per annum, from 2017-2027, to MUR 58.1bn (USD 1.6bn), 9.2% of total GDP in 2027. In 2016, the total contribution of this sector to employment, including jobs indirectly supported by the industry, was 24.3% of total employment (135,000 jobs). This is expected to rise by 0.3% in 2017 to 135,500 jobs and rise by 1.7% per annum to 161,000 jobs in 2027 (27.4% of total)<sup>11</sup>.

#### **1.3.2 ICT sector**

The ICT sector, which comprises manufacturing activities, telecommunications services, wholesale and retail trade and other activities such as call centres, software development and website development and hosting, contributed 5.7% to GDP in 2016 as compared to 5.8% in 2015. The value added of ICT sector rose by 3.9% from MUR 21,137 million in 2015 to MUR 21,956 million in 2016. Around 50% of value added of the ICT sector in 2016 was generated by activities of telecommunications, 15% by wholesale and retail trade and 35% by the remaining activities such as

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<sup>7</sup> <https://www.cia.gov/library/publications/the-world-factbook/geos/mp.html>

<sup>8</sup> <https://www.cia.gov/library/publications/the-world-factbook/geos/mp.html>

<sup>9</sup> [https://en.wikipedia.org/wiki/Tourism\\_in\\_Mauritius](https://en.wikipedia.org/wiki/Tourism_in_Mauritius)

<sup>10</sup> <http://statsmauritius.govmu.org/English/Publications/Pages/Int-Travel-and-Tourism-Year-2016.aspx>

<sup>11</sup> <https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2017/mauritius2017.pdf>

manufacturing, call centres, software development and website development. Employment in this sector has increased by 2.6% from 15,006 in 2015 to 15,390 in 2016<sup>12</sup>.

### **1.3.3 Seafood industry**

In 2016, the contribution of the seafood industry to GDP was at 1.5% and its contribution to total national exports was 18.7%. The total revenue was MUR 22.28 billion and it has created (directly and indirectly) about 16,000 jobs in 2016. During the past years, this industry has known a constant growth. For example, fish production increased by 10.8% from 7,697 tonnes in the first six months of 2015 to 8,527 tonnes for the same period of 2016. Production of other catch (tuna, bank, etc.) and that of fresh coastal fish rose by 12.1% and 0.5% respectively<sup>13</sup>. Similarly regarding exportation, the volume of fish products (whole and processed) exported increased from 1,217 tonnes in 2011 to 3,006 tonnes in 2015. Export of canned tuna constitutes about 90% of the total export value of fish and fish products, and currently Mauritius is the sixth exporter of canned tuna worldwide<sup>14</sup>.

### **1.3.4 Industrial sector**

In 2016, the industrial sector, comprising amongst others, manufacturing, electricity, water supply, sewerage, and waste management, represented 16.7% of Gross Value Added (GVA). It registered a growth of 0.8% in 2016 compared to 0.4% in 2015 (Statistics Mauritius, 2017a). Manufacturing, the most important component of the industrial sector, grew by 0.3% compared to 0.1% in 2015 and accounted for 14.7% of GVA in 2016. The manufacturing sector is dominated by sugar milling, food processing and textiles. Sugar milling recorded a positive growth of 7.0% in 2016 based on a sugar production of 386,277 tonnes, compared to 366,070 tonnes in 2015. However, the latest estimate of the Mauritius Chamber of Agriculture for the production of sugar for 2017 is 350,000 tonnes, representing a decrease of 9.4% compared to 2016. A growth of 3.8% and -5.1% was noted for non-export oriented enterprises (excluding sugar) and export oriented enterprises in 2016.

In 2016, 455,339 tonnes of coal and 868,272 tonnes of petroleum products were used accounting for 29.4% and 56.0% of the primary energy requirement whereas only 14.6% of the latter was derived from renewables such as bagasse, hydro, solar, etc. (Statistics Mauritius, 2017b).

It is noteworthy that no manufacturing processes in which mercury or mercury compounds are used is found in Mauritius.

## **1.4 Environmental overview**

### **1.4.1 Policy and strategy**

The Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD) is responsible to protect and soundly manage the environment in Mauritius. Amongst its missions, the Ministry is in particular responsible to devise appropriate legal and policy framework regarding environment related issues such as climate change, solid and hazardous waste management, disaster risk reduction and beach management to effectively respond to emerging challenges. The EPA Act 2002 is the main piece of legislation that provides for the protection and

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<sup>12</sup> [http://statsmauritius.govmu.org/English/Publications/Pages/ICT\\_Stats\\_Yr2016.aspx](http://statsmauritius.govmu.org/English/Publications/Pages/ICT_Stats_Yr2016.aspx)

<sup>13</sup> [http://statsmauritius.govmu.org/English/Publications/Pages/Agri\\_and\\_Fish\\_Prod-Jan-Jun16.aspx](http://statsmauritius.govmu.org/English/Publications/Pages/Agri_and_Fish_Prod-Jan-Jun16.aspx)

<sup>14</sup> <http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/463171/>

management of the environmental assets of Mauritius. Mauritius is party to some 36 Multilateral Environmental Agreements (MEA) related to chemicals, biodiversity, marine and atmosphere and the major ones are shown in Table 1.1.

**Table 1.1: List of some major Multilateral Environmental Agreements to which Mauritius is Party to**

<b>International Agreement</b>	<b>Ratified/ Acceded</b>
Minamata Convention on Mercury	21.09.2017
Rotterdam Convention	05.08.2005
Stockholm Convention (POPs)	13.07.2004
Cartagena Protocol on Biosafety	11.04.2002
Ramsar Convention (Wetlands)	30.05.2001
Kyoto Protocol	09.05.2001
Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment in the Eastern African Region and Related Protocols	10.07.2000
Convention on the Prevention of Pollution from Ships (MARPOL)	06.04.1995
Chemical Weapons Convention	09.02.1993
Basel Convention	24.11.1992
Bamako Convention	29.10.1992
United Nations Framework Convention on Climate Change (UNFCCC)	04.09.1992
Convention on Biological Diversity	04.09.1992
Montreal Protocol	18.08.1992
Vienna Convention (ozone layer)	12.08.1992

#### **1.4.2 Waste management**

The Solid Waste Management Division of the MoSSNSE&SD is responsible for the proper management of solid and hazardous waste for the protection of the environment and public health. The current system of solid waste management comprises the Mare Chicose Sanitary Landfill and five transfer stations located across the island. Waste collection services are provided mainly by the Local Authorities. About 1,300 tonnes of solid waste are generated daily. For the year 2016, the total volume of wastes disposed at the Mare Chicose Landfill was about 444,695 tonnes<sup>15</sup>, with domestic waste accounting for 96.3% (Statistics Mauritius, 2017b).

Hazardous wastes, as defined in the Environment Protection (Standards for Hazardous Wastes) Regulations 2001, cannot be disposed of along with normal solid waste. These comprise several waste streams such as e-wastes, waste oil, waste lead acid batteries, hazardous healthcare wastes, asbestos wastes and hazardous chemical wastes, among others. While opportunities exist for the local recycling and exportation of several hazardous wastes streams, the disposal of hazardous chemical wastes was until recently a major issue of concern. The setting up of the interim storage facility for hazardous wastes at La Chaumière, Bambous in April 2017 is meant to provide for the environmentally sound management of hazardous chemical wastes. At this interim facility, the hazardous wastes are analysed, classified, segregated, repackaged, labelled, stored and prepared for subsequent exportation to licensed treatment and disposal facilities abroad<sup>16</sup>. The costs of the overall

<sup>15</sup> <http://environment.govmu.org/English/Pages/swmd/SWMD-Solid-Waste-In-Mauritius.aspx>

<sup>16</sup> <http://environment.govmu.org/English/Pages/swmd/SWMD-Hazardous-and-E-Wastes.aspx>

management and shipment of these hazardous wastes for destruction are partially borne by the generators of these wastes. According to the inventory carried out in 2012, the amount of hazardous wastes generated in 2011 was estimated at 17,000 tonnes, and for 2015 it was forecasted that about 23,000 tonnes would be generated<sup>17</sup>.

In 2016, 50.64 Mm<sup>3</sup> of wastewater were treated by the ten public treatment plants, of which 58.2, 1.6 and 40.2% underwent primary, secondary and tertiary treatment respectively.

Medical wastes are incinerated in most public hospitals and some private clinics and the resultant ash is disposed at the Mare Chicose landfill.

A list of registered recyclers and exporters is available on the website of the Solid Waste Management Division of the MoSSNSE&SD. The main types of waste recycled are carton, paper, electric and electronic wastes (e-wastes), glass, photographic and printing, plastics, textiles, waste batteries, oil and wood wastes.

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<sup>17</sup> Hazardous waste inventory report for Mauritius, 2012, Ministry of Local Government and Outer Islands, Mauritius

## Chapter II: Mercury Inventory and Identification of Emissions and Resources

This chapter presents the results of the mercury inventory for the Republic of Mauritius in 2014. If data were not available for the reference year, data from adjacent or more recent years have been used. The year for all data given is noted with the data in question in the relevant sections of this report.

The present level 2 mercury release inventory was carried out using the "*Toolkit for identification and quantification of mercury releases*" (Toolkit)<sup>18</sup> made available by the Chemicals Branch of the UN Environment (UN Environment Chemicals). It was developed using the Toolkit Inventory Level 2 version 1.4 (UNEP, 2017). The Toolkit methodology is based on the mass balance principle for each mercury release source type, which incorporates and accounts for inputs, life cycle inventory and outputs. The outputs are characterized with respect to emissions to air, and releases to land, water, general waste, by-products and impurities and sector specific treatment/disposal.

The required activity data have been obtained through published information sources such as from Statistics Mauritius, relevant ministries and stakeholders through questionnaires, surveys and site visits, as appropriate. Analyses of samples of soil, leachate, coal, cement, and some selected consumer products were also carried out. For all the source categories, in the absence of measured data (e.g. mercury level and activity rate), the mercury input factors from the Toolkit have been used. Exact data and activity rate for some sub-categories were difficult to obtain and estimates have been done through extrapolation and assumptions.

### 2.1 Summary of mercury releases, stockpiles, and supply and trade

#### 2.1.1 Mercury release source types present

Table 2.1 shows which mercury release sources were identified as present or absent in the Republic of Mauritius. If the source is present, it is labelled "Yes" (Y) and "No" (N) if absent.

**Table 2.1: Identification of mercury release sources in the Republic of Mauritius**

Sub-C	Source category	Source presence
<b>5.1</b>	<b>Extraction and use of fuels/energy sources</b>	
5.1.1	Coal combustion in power plants	Y
5.1.2.1	Coal combustion in coal fired industrial boilers	Y
5.1.2.2	Other coal use	N
5.1.3	Mineral oils – extraction, refining and use	Y
5.1.4	Natural gas – extraction, refining and use	N
5.1.5	Other fossil fuels – extraction and use	N
5.1.6	Biomass fired power and heat production	Y
5.1.7	Geothermal power production	N
<b>5.2</b>	<b>Primary (virgin) metal production</b>	
5.2.1	Mercury (primary) extraction and initial processing	N
5.2.2	Gold (and silver) extraction with mercury amalgamation processes	N
5.2.3	Zinc extraction and initial processing	N
5.2.4	Copper extraction and initial processing	N
5.2.5	Lead extraction and initial processing	N

<sup>18</sup> Available at: <http://web.unep.org/chemicalsandwaste/what-we-do/technology-and-metals/mercury/toolkit-identification-and-quantification-mercury-releases>

<b>Sub-C</b>	<b>Source category</b>	<b>Source presence</b>
5.2.6	Gold extraction and initial processing by methods other than mercury amalgamation	N
5.2.7	Aluminium extraction and initial processing	N
5.2.8	Other non-ferrous metals – extraction and processing	N
5.2.9	Primary ferrous metal production	N
<b>5.3</b>	<b>Production of other minerals and materials with mercury impurities</b>	
5.3.1	Cement production	N
5.3.2	Pulp and paper production	N
5.3.3	Production of lime and light weight aggregates	Y
<b>5.4</b>	<b>Intentional use of mercury in industrial processes</b>	
5.4.1	Chlor-alkali production with mercury-technology	N
5.4.2	VCM production with mercury catalyst	N
5.4.3	Acetaldehyde production with mercury catalyst	N
5.4.4	Other production of chemicals and polymers with mercury	N
<b>5.5</b>	<b>Consumer products with intentional use of mercury</b>	
5.5.1	Thermometers with mercury	Y
5.5.2	Electrical switches and relays with mercury	Y
5.5.3	Light sources with mercury	Y
5.5.4	Batteries with mercury	Y
5.5.5	Polyurethane with mercury catalysts	Y
5.5.6	Biocides and pesticides with mercury	N
5.5.7	Paints with mercury	N
5.5.8	Pharmaceuticals for human and veterinary uses	Y
5.5.9	Cosmetics and related products with mercury	Y
<b>5.6</b>	<b>Other intentional product/process uses</b>	
5.6.1	Dental mercury-amalgam fillings	Y
5.6.2	Manometers and gauges with mercury	Y
5.6.3	Laboratory chemicals and equipment with mercury	Y
5.6.4	Mercury metal use in religious rituals and folklore medicine	Y
5.6.5	Miscellaneous product uses, mercury metal uses, and other sources	Y
<b>5.7</b>	<b>Production of recycled metals ("secondary" metal production)</b>	
5.7.1	Production of recycled mercury ("secondary production")	N
5.7.2	Production of recycled ferrous metals (iron and steel)	Y
5.7.3	Production of other recycled metals	N
<b>5.8</b>	<b>Waste incineration</b>	
5.8.1	Incineration of municipal/general waste	N
5.8.2	Incineration of hazardous waste	Y
5.8.3	Incineration of medical waste	Y
5.8.4	Sewage sludge incineration	N
5.8.5	Informal waste burning	Y
<b>5.9</b>	<b>Waste deposition/landfilling and waste water treatment</b>	
5.9.1	Controlled landfills/deposits	Y
5.9.2	Diffuse disposal under some control	N
5.9.3	Informal local disposal of industrial production waste	N
5.9.4	Informal dumping of general waste	Y
5.9.5	Waste water system/treatment	Y
<b>5.10</b>	<b>Crematoria and cemeteries</b>	
5.10.1	Crematoria/cremation	Y
5.10.2	Cemeteries	Y

## 2.1.2 Summary of mercury inputs to society

The main input pathways for mercury in Mauritius are shown in Table 2.2. The total mercury inputs in 2014 *via* all of the pathways were about 760 kg with a range of 220 to 1359 kg.

It is observed that excluding the preparation of dental amalgam fillings, there are only limited production facilities contributing to mercury input (less than 0.2 kg/y).

A list of registered manufacturing companies was obtained from the Ministry of Industry, Commerce and Consumer Protection (MoICCP) from which 43 companies were selected. Given the range of manufactured products and items, selected manufacturing operators were interviewed by phone and they confirmed no use of mercury and mercury compounds. The survey was followed by written letters/e-mails and written confirmation for same. As of 23 June 2017, 11 companies have stated that they do not use mercury or their compounds in the manufacture of their goods. It is noteworthy that import of mercury and mercury compounds is severely restricted in Mauritius since 2004 as permit has to be sought from the Dangerous Chemicals Control Board (DCCB).

Almost all input of mercury is through use and/or disposal of fuels/energy sources, and imported mercury added products including dental amalgam, mercury thermometers, switches and relays, light sources, laboratory chemicals and equipment.

The following source sub-categories (non-waste) made the largest contributions to mercury inputs to society in 2014: (i) electrical switches and relays with mercury (169 kg/y); (ii) dental mercury-amalgam fillings (68 kg/y); (iii) coal combustion in power plants (60 kg/y); and (iv) laboratory chemicals and equipment with mercury (52 kg/y).

The estimates of mercury inputs of level 2 inventory were compared with those of level 1 inventory (Table 2.3).

Waste is not an original source of input of mercury into society as the origin of mercury in waste and waste water is mercury in products and materials. 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 (UNEP, 2017). Waste and waste water however represent substantial flows of mercury through society. The following were found to be the major flows of mercury with waste and waste water: (i) waste water system/treatment (225 kg/y); (ii) informal waste burning (31 kg/y); (iii) informal dumping of general waste (25 kg/y); and (iii) incineration of medical waste (24 kg/y).

**Table 2.2: Summary of mercury inputs to society**

Sub-C	Source category	Estimated Hg input, kg Hg/y, by life cycle phase	
		Production	Use + disposal
<b>5.1</b>	<b>Extraction and use of fuels/energy sources</b>		
5.1.1	Coal combustion in power plants	0	22.76 – 167.14 (60.46)
5.1.2.1	Coal combustion in coal fired industrial boilers	0	1.00 – 7.34 (2.66)
5.1.3	Mineral oils - extraction, refining and use	0	3.20 – 31.95 (6.39)

Sub-C	Source category	Estimated Hg input, kg Hg/y, by life cycle phase	
		Production	Use + disposal
5.1.6	Biomass fired power and heat production	0	12.27 – 61.71 (36.99)
<b>5.3</b>	<b>Production of other minerals and materials with mercury impurities</b>		
5.3.3	Production of lime and light weight aggregates	0.01	0
<b>5.5</b>	<b>Consumer products with intentional use of mercury</b>		
5.5.1	Thermometers with mercury	0	4.85 – 43.65 (24.25)
5.5.2	Electrical switches and relays with mercury	0	25.03 – 312.91 (168.97)
5.5.3	Light sources with mercury	0	12.99 – 56.72 (34.86)
5.5.4	Batteries with mercury	0	0.01 – 0.17 (0.09)
5.5.5	Polyurethane with mercury catalysts	0	12.52 – 62.58 (37.55)
5.5.9	Cosmetics and related products with mercury	0	0
<b>5.6</b>	<b>Other intentional product/process uses</b>		
5.6.1	Dental mercury-amalgam fillings	17.65 – 35.30 (26.47)	27.36 – 54.73 (41.05)
5.6.2	Manometers and gauges with mercury	0	8.71 – 9.24 (8.97)
5.6.3	Laboratory chemicals and equipment with mercury	0	37.55 – 67.07 (52.31)
5.6.4	Mercury metal use in religious rituals and folklore medicine	0	0
5.6.5	Miscellaneous product uses, mercury metal uses, and other sources	0	0.75 – 1.00 (0.88)
<b>5.7</b>	<b>Production of recycled metals ("secondary" metal production)</b>		
5.7.2	Production of recycled ferrous metals (iron and steel)	0.12	0
<b>5.8</b>	<b>Waste incineration*</b>		
5.8.2	Incineration of hazardous waste	0	0
5.8.3	Incineration of medical waste	0	8.06 – 40.32 (24.19)
5.8.5	Informal waste burning	0	5.56 – 55.60 (30.58)
<b>5.9</b>	<b>Waste deposition/landfilling and waste water treatment*</b>		
5.9.1	Controlled landfills/deposits	0	4.19 – 41.85 (23.02)
5.9.4	Informal dumping of general waste	0	4.52 – 45.20 (24.86)
5.9.5	Waste water system/treatment	0	21.40 – 428.00 (224.70)
<b>5.10</b>	<b>Crematoria and cemeteries</b>		
5.10.1	Crematoria/cremation	0	4.00 – 15.98 (9.99)
5.10.2	Cemeteries	0	5.32 – 21.28 (13.30)
	<b>OVERALL TOTAL</b>	<b>17.8 – 35.4 (26.6)</b>	<b>202.0 – 1323.6 (733.7)</b>

\*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.

**Table 2.3: Estimates of mercury inputs for level 1 (2012) and level 2 (2014) inventory**

Sub-C	Source	Estimated Hg input, kg/y		Comments
		Level 1	Level 2	
5.1.1	Coal combustion	96.2	63.1	Lower Hg content in coal used in level 2 (0.085 mg/kg) compared to level 1 (0.15 mg/kg)
5.1.3	Use of mineral oils	18.2	6.4	Lower Hg content in oils in level 2. Heavy oil (mg/tonne): 55 (level 1); 20 (level 2) Lighter oils (mg/tonne): 5.5 (level 1); 2.0 (level 2)
5.1.6	Biomass fired power and heat production	65.0	37.0	Computational error in level 1 inventory: 201,100 tonnes of charcoal instead of 20,100 tonnes
5.3.3	Production of lime and light weight aggregates	-	0.0	Not considered in level 1 inventory
5.5.1	Thermometers with mercury	6.2	24.3	Difference in the assumed % of imported liquid-filled thermometers: 20% (level 1); 75% (level 2)
5.5.2	Electrical switches and relays with mercury	181.3	169.0	Number of inhabitants inputted in level 1 (1,303,717) higher than in level 2 (1,261,721).
5.5.3	Light sources with mercury	70.4	34.9	Level 1: Of all potentially Hg containing lamps, 60% assumed to represent CFLs, 30% LFLs and 10% other Hg-containing lamps. Level 2: HS codes 85393110/85393190 indicate LFLs and HS code 85393910 - CFLs.
5.5.4	Batteries with mercury	0.0	0.1	Negligible input in level 1
5.5.5	Polyurethane with mercury catalysts	38.8	37.6	Number of inhabitants inputted in level 1 (1,303,717) higher than in level 2 (1,261,721)
5.6.1	Dental mercury-amalgam fillings	59.4	67.5	Higher dental population density in 2014
5.6.2	Manometers and gauges with mercury	6.4	9.0	Input from sphygmomanometers not considered in level 1
5.6.3.1	Laboratory chemicals	13.0	14.8	Level 1: Based on population. Level 2: Based on mean of import data and default input based on population
5.6.3.2	Laboratory equipment with mercury	51.8	37.6	Level 1: 0.04 g Hg/inhabitant; Level 2: 0.03 g Hg/inhabitant (0.04 g Hg based on EU consumption)
5.6.5	Miscellaneous product uses and other sources	-	0.9	Inclusion of input from jewelry sector in level 2
5.7.2	Production of recycled ferrous metals	0.0	0.1	Negligible input in level 1
5.8.2	Incineration of hazardous waste	17.1	-	Identified hazardous wastes incinerated in level 2 are the mineral oils which have already been accounted in the relevant category
5.8.3	Incineration of medical waste	13.2	24.2	Higher amount of medical waste estimated in level 2 based on official data and literature values
5.8.5	Informal waste burning	21.1	30.6	Inclusion of amount of waste burnt in Rodrigues in level 2 inventory
5.9.1	Controlled landfills/deposits	20.9	23.3	Inclusion of amount of waste deposited in Rodrigues in level 2 inventory
5.9.4	Informal dumping of general waste	21.1	24.9	Inclusion of amount of informal dumping of general waste in Rodrigues in level 2 inventory
5.9.5	Waste water system/treatment	205.2	224.7	Higher amount of waste water treated in 2014
5.10.1	Crematoria	11.2	10.0	Lower number of cremations in 2014
5.10.2	Cemeteries	12.1	13.3	Higher number of burials in 2014
	<b>Total</b>	<b>840</b>	<b>760.3</b>	

\*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.

### 2.1.3 Summary of mercury releases

In the Table 2.4, a summary of mercury releases from all source sub-categories present is given.

**Table 2.4: Summary of mercury releases**

Sub-C	Source category	Calculated Hg output, kg/y					
		Air	Water	Land	By-products and impurities	General waste	Sector specific treatment/disposal
<b>5.1</b>	<b>Extraction and use of fuels/energy sources</b>						
5.1.1	Coal combustion in power plants	45.34	-	15.11	-	-	-
5.1.2.1	Coal combustion in coal fired industrial boilers	2.66	-	-	-	-	-
5.1.3	Mineral oils – extraction, refining and use	6.39	-	-	-	-	-
5.1.6	Biomass fired power and heat production	27.92	-	9.06	-	-	-
<b>5.3</b>	<b>Production of other minerals and materials with mercury impurities*1</b>						
5.3.3	Production of lime and light weight aggregates	0.01	-	-	-	-	-
<b>5.5</b>	<b>Consumer products with intentional use of mercury</b>						
5.5.1	Thermometers with mercury	2.43	7.28	-	-	14.55	-
5.5.2	Electrical switches and relays with mercury	16.90	-	16.90	-	135.18	-
5.5.3	Light sources with mercury	1.74	-	-	-	33.11	-
5.5.4	Batteries with mercury	-	-	-	-	0.08	0.01
5.5.5	Polyurethane with mercury catalysts	3.75	1.88	-	-	31.92	-
5.5.9	Cosmetics and related products with mercury						
<b>5.6</b>	<b>Other intentional product/process uses*2</b>						
5.6.1	Dental mercury-amalgam fillings	1.32	30.45	5.30	3.97	13.24	13.24
5.6.2	Manometers and gauges with mercury	0.90	2.69	-	-	5.38	-
5.6.3	Laboratory chemicals and equipment with mercury	0.74	13.87	-	-	15.34	22.36
5.6.4	Mercury metal use in religious rituals and folklore medicine						
5.6.5	Miscellaneous product uses, mercury metal use, and other sources	0.18	0.35	0.35			
<b>5.7</b>	<b>Production of recycled metals (“secondary metal production”)</b>						
5.7.2	Production of recycled ferrous metals	0.04	-	0.04	-	0.04	-
<b>5.8</b>	<b>Waste incineration</b>						
5.8.2	Incineration of hazardous waste						
5.8.3	Incineration of medical waste	24.19	-	-	-	-	-
5.8.5	Informal waste burning	30.58	-	-	-	-	-
<b>5.9</b>	<b>Waste deposition/landfilling and waste water treatment*3*4</b>						
5.9.1	Controlled landfills/deposits	23.02	0.23	-	-	-	-
5.9.4	Informal dumping of general waste	2.49	2.49	19.89			
5.9.5	Waste water system/treatment	-	161.79	-	-	42.69	20.22
<b>5.10</b>	<b>Crematoria and cemeteries</b>						
5.10.1	Crematoria/cremation	9.99	-	-	-	-	-
5.10.2	Cemeteries	-	-	13.30	-	-	-
	<b>TOTAL*3*4</b>	<b>200.6</b>	<b>59.2</b>	<b>60.1</b>	<b>4.0</b>	<b>291.5</b>	<b>55.8</b>

Notes:

\*1 Includes production of cement, pulp and paper, lime and light weight aggregates.

\*2 Includes dental amalgam fillings, manometers and gauges, lab chemicals and equipment, Hg use in religious rituals and folklore medicine, and miscellaneous product uses.

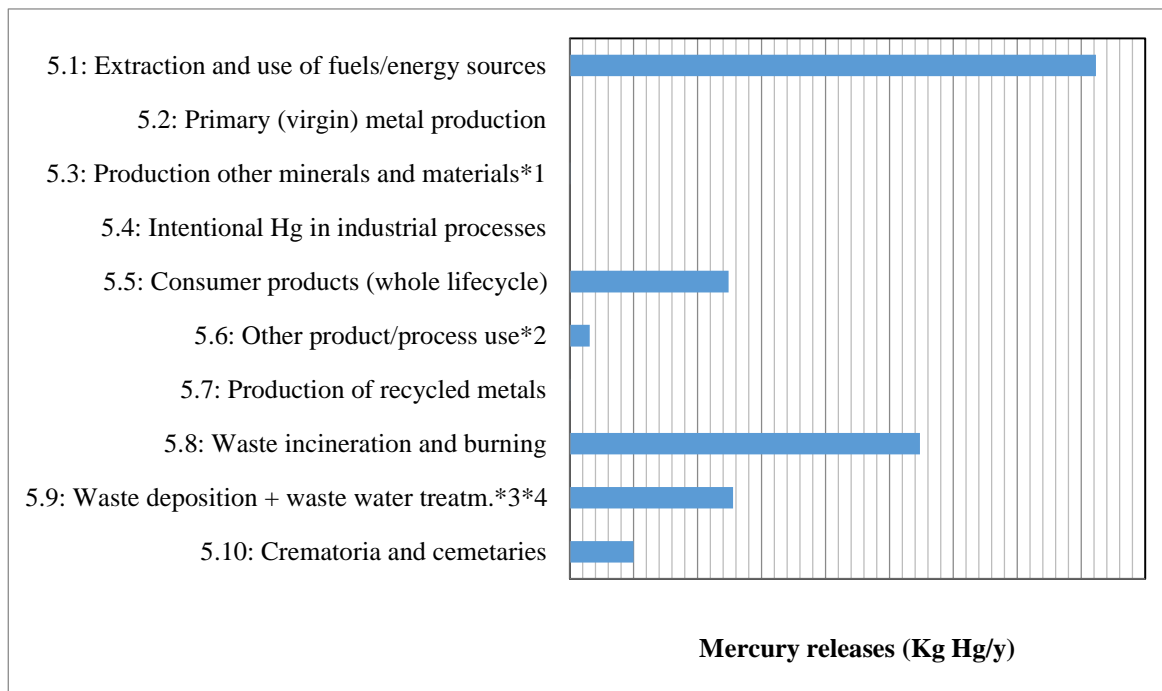
\*3 The estimated quantities include mercury in products which has also been accounted for under each product category. To avoid double counting, the release to land from informal dumping of general waste has been subtracted automatically in the TOTALS.

\*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, releases to water from waste water system/treatment have been subtracted automatically in the TOTALS.

\*5 Taking into account double counting, there is no contribution to the total releases to land from informal dumping of general waste and total releases to water from waste water system/treatment.

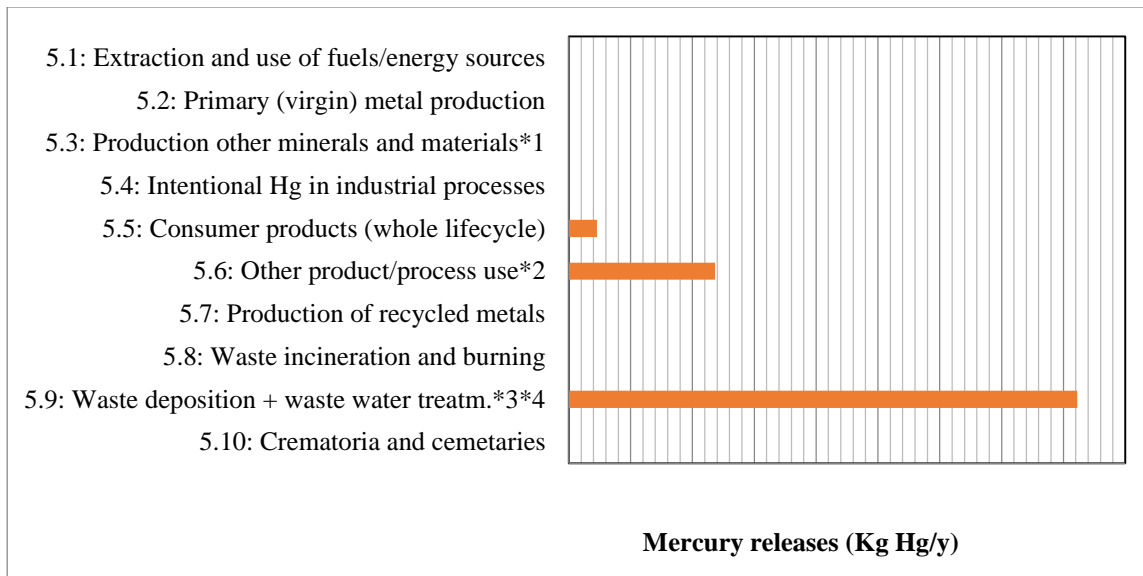
The key mercury releases are releases to air (the atmosphere), to water (marine and freshwater bodies, including via waste water systems), to land, to general waste, and to sector specific waste. An additional output pathway is "by-products and impurities" which designates mercury flows back into the market with by-products and products.

For 2014, a total of 201 (60 – 418) kg of mercury was released to air in Mauritius (Figure 2.1). The major source sub-categories were (i) coal combustion in power plants (45 kg/y); (ii) informal waste burning (31 kg/y); (iii) biomass fired power and heat production (28 kg/y); and (iv) incineration of medical waste (24 kg/y).



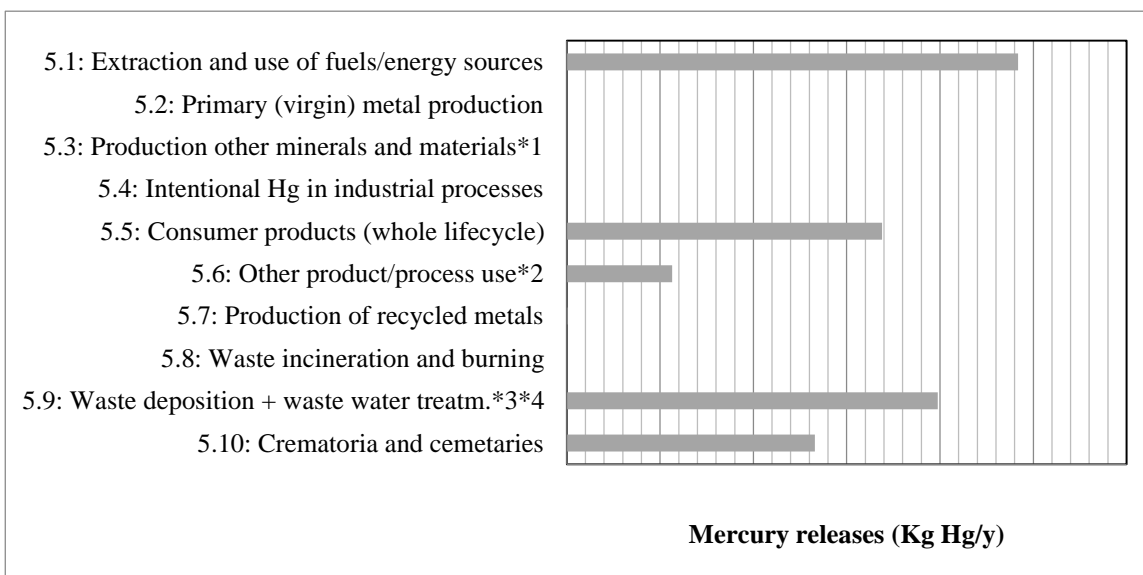
**Figure 2.1: Estimated mercury releases to air**

59 (35 – 83) kg of mercury was released to water (Figure 2.2), the main source contributors being dental mercury-amalgam fillings (30 kg/y) and laboratory chemicals and equipment (14 kg/y).



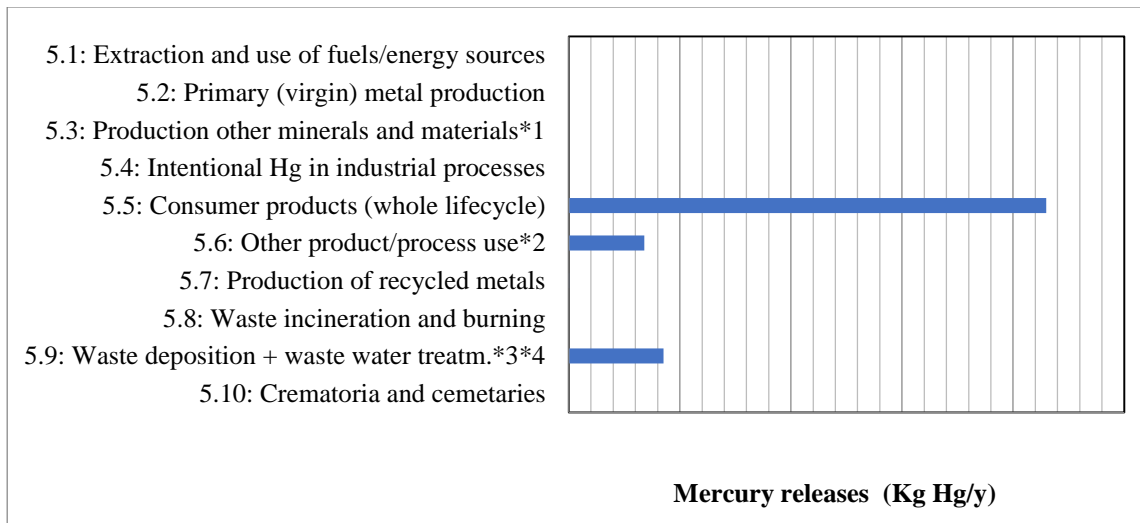
**Figure 2.2: Estimated mercury releases to water**

The main source sub-categories contributing to mercury releases to land of 60 (20 – 117) kg/y (Figure 2.3) were electrical switches and relays (17 kg/y) and coal combustion in power plants (15 kg/y).

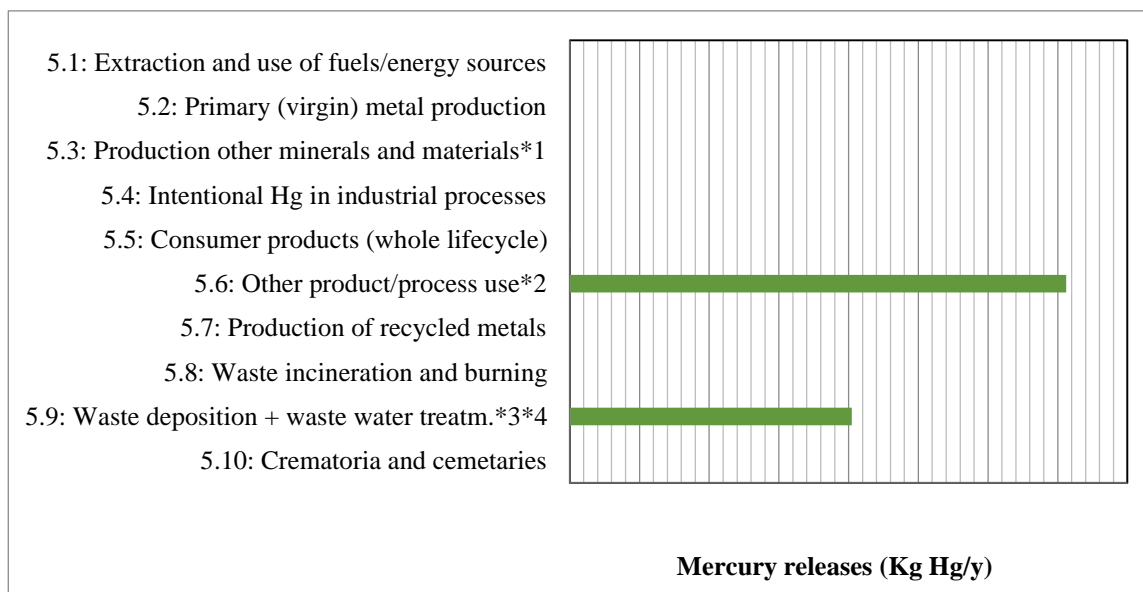


**Figure 2.3: Estimated mercury releases to land**

The total mercury flow to general waste and sector specific treatment/disposal was 292 (75 – 508) kg (Figure 2.4) and 56 (27 – 84) kg/y (Figure 2.5) respectively, with the main contributions coming from consumer products (electrical switches and relays, light sources, polyurethanes and thermometers), other product/process uses (laboratory chemicals and equipment, dental amalgam) and waste water system/treatment.



**Figure 2.4: Estimated mercury releases to general waste**



**Figure 2.5: Estimated mercury releases to sector specific waste/disposal**

Table 2.5 provides a comparison of mercury releases estimated in level 1 and level 2 inventory.

The results for each source and source sub-category in the inventory are also given certainty estimates applying the following general approach: high (if assessment was based on national or obtained specific data); medium (if limited data were available); and low (if no data were available and/or based on the Toolkit default factors).

**Table 2.5: Estimates of mercury releases for level 1 (2012) and level 2 inventory (2014)**

S-Cat	Source	Estimated Hg output, kg/y		Comments
		Level 1	Level 2	
5.1.1	Coal combustion	84.7 (air) 11.5 (sst/d)	48.0 (air) 15.1 (land)	Lower Hg releases to air in level 2 due to lower Hg coal content, inclusion of level 1 air pollution control and smaller output distribution factor. Release to land in level 2 as coal ash is spread in sugarcane fields.
5.1.3	Use of mineral oils	18.2 (air)	6.4 (air)	Lower Hg content in oils in level 2
5.1.6	Biomass fired power and heat production	65.0 (air)	27.9 (air) 9.1 (land)	Computational error in level 1 inventory for charcoal combustion and distribution of Hg releases to air and land from bagasse combustion assumed to be 75:25 in level 2 instead of 100% in level 1
5.3.3	Production of lime and light weight aggregates	-	0.0 (air)	Not considered in level 1 inventory
5.5.1	Thermometers with mercury	0.6 (air) 1.9 (water) 3.7 (waste)	2.4 (air) 7.3 (water) 14.6 (waste)	Difference in the assumed % of imported liquid-filled thermometers (HS code: 90251100): 20% (level 1); 75% (level 2)
5.5.2	Electrical switches and relays with mercury	18.1 (air) 18.1 (land) 145.1 (waste)	16.9 (air) 16.9 (land) 135.2 (waste)	Number of inhabitants inputted in level 1 (1,303,717) higher than in level 2 (1,261,721)
5.5.3	Light sources with mercury	3.5 (air) 66.9 (waste)	1.7 (air) 33.1 (waste)	Differing distribution of lamps into CFLs, LFLs and other Hg-containing lamps used
5.5.4	Batteries with mercury	0.0	0.1 (waste)	Negligible input in level 1
5.5.5	Polyurethane with mercury catalysts	3.9 (air) 1.9 (water) 33.0 (waste)	3.8 (air) 1.9 (water) 31.9 (waste)	Number of inhabitants inputted in level 1 (1,303,717) higher than in level 2 (1,261,721)
5.6.1	Dental mercury-amalgam fillings	1.2 (air) 19.7 (water) 2.1 (by-pdts) 11.4 (waste) 11.4 (sst/d)	1.3 (air) 30.5 (water) 5.3 (land) 4.0 (by-pdts) 13.2 (waste) 13.2 (sst/d)	Difference in dental population density and output distribution factors
5.6.2	Manometers and gauges with mercury	0.6 (air) 1.9 (water) 3.9 (waste)	0.9 (air) 2.7 (water) 5.4 (waste)	Input from sphygmomanometers not considered in level 1
5.6.3.1	Laboratory chemicals	4.3 (water) 4.3 (waste) 4.4 (sst/d)	0.7 (air) 1.5 (water) 3.0 (waste) 9.6 (sst/d)	Different input and output distribution factors used
5.6.3.2	Laboratory equipment with mercury	17.1 (water) 17.1 (waste) 17.6 (sst/d)	12.4 (water) 12.4 (waste) 12.8 (sst/d)	Different input factor, g Hg/inhabitant (level 1: 0.04; level 2: 0.03)
5.6.5	Miscellaneous product uses and other sources	-	0.2 (air) 0.4 (water) 0.4 (land)	Inclusion of jewellery sector in level 2
5.7.2	Production of recycled ferrous metals	0.0	0.0	Negligible input in level 1 and level 2
5.8.2	Incineration of hazardous waste	15.4 (air) 1.7 (sst/d)	-	Identified hazardous wastes incinerated not included in level 2 to avoid double counting
5.8.3	Incineration of medical waste	11.9 (air) 1.3 (sst/d)	24.2 (air)	Higher amount of medical waste estimated and 100% output to air in level 2
5.8.5	Informal waste burning	21.1 (air)	30.6 (air)	Inclusion of waste burnt in Rodrigues in level 2
5.9.1	Controlled landfills/deposits	20.7 (air) 0.2 (water)	23.0 (air) 0.2 (water)	Inclusion of amount of waste deposited in Rodrigues in level 2 inventory
5.9.4	Informal dumping of general waste	2.1 (air) 2.1 (water) 16.9 (land)	2.5 (air) 2.5 (water) 19.9 (land)	Inclusion of amount of informal dumping of general waste in Rodrigues in level 2 inventory
5.9.5	Waste water system/treatment	184.7 (water) 20.5 (waste)	161.8 (water) 42.7 (waste) 20.2 (sst/d)	Higher amount of waste water treated and different output distribution factors used in level 2
5.10.1	Crematoria	11.2 (air)	10.0 (air)	Lower number of cremations in level 2
5.10.2	Cemeteries	12.1 (land)	13.3 (land)	Higher number of burials in level 2
	<b>Total</b>	<b>720</b>	<b>671</b>	

\*sst/d: sector specific treatment/disposal

#### 2.1.4 Summary of mercury stockpiles, and supply and trade

Mauritius is not involved in the supply or trade of mercury, except when mercury wastes are exported.

Several current uses and stocks of sub-category sources noted at various sections in the report, which have not been included as they were not classified as inputs or outputs for the reference year, are listed below. They may be considered as future contributors or reservoirs of mercury releases in the country.

Thermometers:	17.4 – 156.4 kg
Sphygmomanometers:	175 – 213 kg
Other manometers/gauges:	3.1 – 38.5 kg
Lighthouse light systems:	200 kg
Switches and relays:	1.4 kg
Laboratory chemicals:	58.8 kg (including elemental mercury)

The following contaminated sites were identified as potential mercury hot-spots in the country due to deposition of mercury-containing wastes (note that mercury-containing wastes are not accepted for disposal at the Mare Chicose landfill; however these may unknowingly enter the landfill if they are being disposed together with the municipal solid wastes):

- (i) Mare Chicose sanitary landfill in Mauritius; and
- (ii) open air dumping waste ground situated at Grenade, Roche Bon Dieu in Rodrigues Island.

However, analysis of three samples of leachates at the Mare Chicose landfill were found to be less than 0.0002 mg/L and the mercury concentration in air at Mare Chicose landfill and Roche Bon Dieu dumping site was also found to be very low, 2.95 – 15.25 and 4.38 ng/m<sup>3</sup> respectively (PANeM, 2016). Further study is required to assess whether these sites are effectively contaminated such as regular analysis of concentration of mercury in air and monitoring of leachate at regular intervals to capture annual variation and also following large storm/flood events to capture episodic releases of contaminants from the landfill and dumping site.

## 2.2 Data and inventory on energy consumption and fuel production

This category is concerned with the extraction and use of fuels and other types of energy sources for electricity generation, for transportation and for application in industrial and commercial facilities and also for residential cooking and heating.

In 2014, about 86% of the total primary energy requirement of the Republic of Mauritius was met from imported fossil fuels (coal – 30.9%; fuel oil – 17.1%; diesel oil – 13.9%; gasoline – 10.2%; kerosene – 8.6%; liquefied petroleum gas (LPG) – 5.1%) whereas the share of bagasse was 12.7% (Statistics Mauritius, 2015a).

### 2.2.1 Coal combustion in power plants

The UNEP Toolkit (2015; 2017) defines large power plants as those having a capacity typically greater than 300 megawatts (MW). However, all the local coal-fired or coal-bagasse-fired facilities have a capacity ranging from 12.5 to 90 MW.

In 2014, there were five independent power producers (IPPs) operating in Mauritius using coal. However, most of them use both bagasse (during sugar cane harvest season) and coal (during off-crop season)<sup>19</sup>. The plant capacities of the different IPPs and the type of fuel used are given in Table 2.6. In 2014, the IPPs produced around 60% of the total electricity generated and the Central Electricity Board (CEB) produced the remaining 40%.

Relevant data were sought from the IPPs through a survey questionnaire and interviews of personnel at top management level of IPPs. Site visits were also made to Alteo Ltd, CEL, Terragen Ltd and Omnicane Ltd. Literature search (e.g. from Statistics Mauritius) was also carried out to fulfil data gaps.

The Digest of Energy and Water Statistics (Statistics Mauritius, 2015a) shows a total national coal consumption in 2014 of about 742,486 tonnes, out of which 711,237 tonnes were used for electricity generation by the IPPs.

**Table 2.6: Plant capacities of the IPPs and type of fuel used**

Independent Power Producer	Plant capacity Installed (MW)	Plant capacity Effective (MW)	Type of fuel used
Omnicane Thermal Energy Operations (La Baraque) Ltd (previously Compagnie Thermique de Savannah (CTSAV))	90.00	74.00	Coal and bagasse
Consolidated Energy Limited (CEL), Beau Champ	28.40	25.50	Coal only
Terragen Ltd (previously Compagnie Thermique de Belle Vue)	71.20	62.00	Coal and bagasse
F.U.E.L. Alteo Ltd	36.70	33.00	Coal and bagasse
Omnicane Thermal Energy Operations (St Aubin) Ltd (previously Compagnie Thermique du Sud (CTDS))	32.50	30.00	Coal only

The key parameter for the mercury emission factor is the mercury content of coal as the latter contains trace amounts of mercury, which are released during the combustion. The coal is imported from South Africa and is of bituminous type. Coal analyses have been performed on the bituminous coal

<sup>19</sup> The IPPs do not co-fire bagasse with coal. Bagasse and coal are combusted individually.

consignments received by the Coal Terminal Management Co. Ltd, from South Africa and data were taken for the period 2014 to mid-2016 as shown in Table 2.7 for 30 consignments.

**Table 2.7: Mercury levels (mg/kg) of the coal consignments**

Dates	Hg level, mg/kg	Dates	Hg level, mg/kg	Dates	Hg level, mg/kg
3 – 4 Jan 2014	< 0.05	29 – 30 Apr 2015	0.080	5 – 6 Jan 2016	< 0.032
9 – 10 Jun 2014	0.06	18 – 19 May 2015	0.070	27 – 28 Jan 2016	0.064
16 – 17 Jul 2014	0.075	3 – 4 Jun 2015	< 0.050	13 Feb 2016	0.064
23 – 24 Dec 2014	0.162	19 – 20 Jun 2015	< 0.050	29 Feb – 1 Mar 2016	0.095
3 – 5 Jan 2015	0.064	12 – 14 Jul 2015	< 0.032	22 – 24 Mar 2016	0.235
29 – 30 Jan 2015	0.097	20 Aug 2015	< 0.050	7 – 8 Apr 2016	0.123
11 – 12 Feb 2015	0.090	24 – 25 Sep 2015	0.098	24 – 25 Apr 2016	0.200
1 – 2 Mar 2015	< 0.050	16 – 17 Oct 2015	0.066	12 – 13 May 2016	0.104
21 – 22 Mar 2015	0.095	26 Nov 2015	< 0.032	26 – 28 May 2016	0.089
10 – 11 Apr 2015	0.098	15 – 16 Dec 2015	0.092	15 – 16 Jun 2016	0.086

Since only four mercury analyses were provided for the year 2014, it was deemed more appropriate to determine the average mercury content in the imported coal based on the 30 consignments. In order not to underestimate the mercury emissions, the detection limit values were taken for those samples which recorded a mercury content less than the detection limit. For example, samples having < 0.050 mg Hg/kg were considered as having 0.050 mg Hg/kg. Taking the above into consideration, the mean Hg content in the imported coal was found to be 0.085 mg/kg (dry weight basis) which is within the range (0.01 – 1.0 mg/kg) reported by Pirrone *et al.* (2001) for bituminous coal imported from South Africa. The average value of 0.085 mg Hg/kg together with the range 0.032 – 0.235 mg Hg/kg have been used to calculate the amount of mercury emitted during coal combustion, by multiplying it with the total annual coal consumption during the year of study, i.e. 2014. The coal imported for the year 2014 is considered to have been pre-washed as the coal analysis is based on the pre-washed coal. This may explain the rather low Hg content in the imported coal. During the inventory, a sample of coal taken in the premises of Coal Terminal Management Co. Ltd was also analysed and the mercury content was found to be below the detection limit of 0.0041 mg/kg.

### ***Emission reduction systems***

All the IPPs are equipped with either a cold-side electrostatic precipitator (ESP) coupled with cyclone or a wet scrubber coupled with cyclone as control device to retain particulate matter including mercury from the exhaust gases.

No site-specific data was available for mercury concentration in exhaust gas or in the surrounding air, and no control device efficiency data was available for the study period. Thus, the toolkit default factors have been used for the output calculations. The UNEP toolkit (2015; 2017) considered the air pollution controls used in the local IPPs as Level 1 controls. It is noteworthy that there are six levels ranging from 0 to 5 in the toolkit, level 5 being the most efficient. The recommended output distribution for bituminous coal is 75% to air and 25% to land (ash).

It is noteworthy that 40 to 50 samples of sugar, molasses and water samples are submitted annually for mercury analysis by sugar cane millers as well as the Mauritius Sugar Syndicate to the Mauritius Sugarcane Industry Research Institute (MSIRI) laboratory. Feedback received from the latter

indicated that mercury has not been detected in the samples analysed for the last eight years (sugar: < 0.005 mg/kg, molasses: < 0.05 mg/kg and water: < 0.002 mg/L).

### ***Coal ash***

Following the combustion of coal in the IPPs, two types of coal ash are generated: fly ash and bottom ash. The impacts of the residual mercury in coal ash to the environment will depend on the use and application of bottom ash and the fly ash. Currently coal ash is either stored in dedicated ash storage areas on site or applied to land as soil conditioner (80 – 100 tonnes coal ash per hectare applied in a ratio of 2:1 bottom ash to fly ash). Coal ash disposed in this way has been classified as release to land. In 2014, none of the residues was converted to marketable products. Currently coal ash re-use is under study.

The mercury content in both the bottom and fly ash (4 samples each) were determined and found to be below the detection limit of 0.0041 mg/kg. The results were consistent with results submitted by some IPPs. In addition, analyses carried out by the National Environment Laboratory in 2007 in collaboration with Wastewater Management Authority (WMA) Laboratory and the Ministry of Health and Quality of Life (MoHQL) indicated no detectable level of mercury in the leachate from coal bottom ash and coal fly ash (MoESD, 2014).

Samples of soil around the IPPs were also analysed with mercury levels in the range of 0.08 – 0.25 mg/kg compared to a control soil sample collected in Réduit<sup>20</sup> (< 0.0041 mg/kg).

### ***Input and output estimates***

Table 2.8 provides the input and output estimates for coal combustion in the IPPs for 2014 (mean given within brackets).

**Table 2.8: Input and output estimates for coal combustion in the IPPs**

Source	Activity rate, tonne/y	Mercury content, mg/kg	Annual mercury inputs, kg/y	Annual mercury outputs, kg/y	
				Air	Land
All IPPs	711,237	0.032 – 0.235 (0.085)	22.76 – 167.14 (60.46)	17.07 – 125.36 (45.34)	5.69 – 41.79 (15.11)

### ***Certainty assessment***

Activity data: HIGH (as they were obtained from the IPPs and from Statistics Mauritius).

Input estimates: MEDIUM (as they are based on a range of coal analyses carried out in 2014 – 2016; only four analyses in 2014).

Output estimates: LOW (as they are based on the default toolkit output factors).

<sup>20</sup> No IPP is located near Réduit

## 2.2.2 Coal combustion in coal fired industrial boilers and other coal use

This sub-category covers coal combustion in industrial boilers, and other coal use such as for household use and heating.

Coal is also used in the local industries like textile and food processing factories for the production of steam. The amount of coal burnt (31,249 tonnes) in 2014 was obtained from the difference of the total coal burnt (742,486 tonnes as per data obtained from Statistics Mauritius (2015a) for primary energy requirement) and the amount of coal burnt by the IPPs (711,237 tonnes). It is noteworthy that the same imported coal was used by both the IPPs and the manufacturing industries.

Emission control in these small industrial boilers is considered to be less effective than those found in the IPPs. The UNEP toolkit (2015; 2017) suggests a default distribution factor of 100% mercury discharges to air. The mercury input and output calculations for coal combustion in coal fired industrial boilers and other coal use are shown in Table 2.9 (mean given within brackets).

**Table 2.9: Input and output estimates for coal use in sectors other than IPPs**

Source	Activity rate, tonne/y	Mercury content, mg/kg	Annual mercury inputs, kg/y	Annual mercury outputs, kg/y
				Air
Sectors other than IPPs	31,249	0.032 – 0.235 (0.085)	1.00 – 7.34 (2.66)	1.00 – 7.34 (2.66)

### *Certainty assessment for coal use in sectors other than IPPs*

Activity data: HIGH (as they were obtained from a national database).

Input estimates: MEDIUM (as they are based on a range of coal analyses carried out in 2014-2016).

Output estimates: LOW (as they are based on the default toolkit output factors).

### *Overall input and output estimates for coal combustion*

Table 2.10 summarises the input and output estimates for coal combustion (mean given within brackets).

**Table 2.10: Input and output estimates for coal combustion**

<b>Coal combustion</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	742,486	-
Input factor for phase	mg Hg/kg	0.032 – 0.235 (0.085)	-
Calculated input to phase	kg Hg/y	23.76 – 174.48 (63.11)	-
<b>Output distribution factors for phase:</b>			
- Air		0.75 – 1.00	-
- Water		0.00	-
- Land		0.25	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	18.07 – 132.70 (48.01)	18.07 – 132.70 (48.01)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	5.69 – 41.79 (15.11)	5.69 – 41.79 (15.11)
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### ***Comparison with inventory level 1: 2012 estimates***

The 2012 inventory report gave an input estimate of 96.2 kg/y for coal use, although coal consumption in 2012 (641,400 tonnes) was less than in 2014 (742,486 tonnes). This is due to the higher Hg content in coal used for the 2012 inventory, namely 0.15 mg/kg, which was the default concentration in level 1 toolkit.

The mercury releases in 2012 from coal use were estimated to be 84.7 kg/y to air and 11.5 kg/y to waste compared to 48.0 kg/y and 15.1 kg/y respectively to air and land in 2014. The lower mercury releases to air in 2014 compared to 2012 is due to the inclusion of Level 1 air pollution control in the 2015 and 2017 UNEP toolkit and the difference in input factors used for the 2012 versus 2014 inventory (0.15 mg/kg and 0.085 mg/kg, respectively).

### **2.2.3 Mineral oils – extraction, refining and use**

This sub-category deals with the extraction, refining, and uses of mineral oil (also called oil/petroleum products). It includes the combustion of oil to provide power, heat, transportation, and other related uses.

Similar to other natural materials, mineral oils contain minute quantities of mercury impurities, the level of which depends on the geology of the area from which the oils are extracted.

### *Extraction*

No company in Mauritius is involved in the production and extraction of oil.

### *Use and Disposal*

Combustion of oil products releases mercury primarily to air in the form of air emissions. As no air pollution abatement systems are used locally in the oil combustion facilities, the trace amounts of mercury present in the petroleum products can be assumed to be released wholly to air during their combustion.

The most important factors determining releases from oil combustion sources are the mercury levels in the oil and the amount of fuel burnt. As no information is available on the mercury concentration in the oil used, default input factors are employed (UNEP, 2015; 2017).

Data on the amount of petrol/gasoline, diesel oil, kerosene, liquefied petroleum gas (LPG) and fuel oil consumed in 2014 (primary energy requirement) and their use were obtained from the Digest of Energy and Water Statistics (Statistics Mauritius, 2015a) and are shown in Table 2.11.

**Table 2.11: Amount of oil products consumed in 2014 and their sector use**

<b>Oil product</b>	<b>Sector use</b>	<b>Amount, tonnes</b>	<b>Input factor, mg Hg/tonne</b>	<b>Mercury input, kg/y</b>
Petrol/ gasoline	Transport (100%)	140,500	1 – 10 (2)	0.14 – 1.41 (0.28)
Diesel oil	Manufacturing (17.5%); Transport (80.8%); Agriculture (1.1%); Electricity (0.6%)	206,000	1 – 10 (2)	0.21 – 2.06 (0.41)
Kerosene	Aviation (99.3%); Household (0.1%); Electricity (0.6%)	122,800	1 – 10 (2)	0.12 – 1.23 (0.25)
LPG	Manufacturing (7.6%); Commercial & Distributive Trade (19.8%); Transport (5.3%); Household (67%)	71,000	1 – 10 (2)	0.07 – 0.71 (0.14)
Heavy (fuel) oil	Manufacturing (15.2%); Transport (1.4%); Electricity (83.4%)	265,500	10 – 100 (20)	2.66 – 26.55 (5.31)
<b>All oil products</b>				<b>3.20 – 31.96 (6.39)</b>

### *Input and output estimates*

The mercury input and output for the use and disposal of heavy (fuel) oil and petrol/gasoline, diesel oil, kerosene and LPG are shown in Table 2.12 and Table 2.13 respectively.

**Table 2.12: Input and output estimates for combustion of heavy (fuel) oil**

<b>Heavy (fuel) oil combustion</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	265,500	-
Input factor for phase	mg Hg/tonne	10 – 100 (20)	-
Calculated input to phase	kg Hg/y	2.66 – 26.55 (5.31)	-
<b>Output distribution factors for phase:</b>			
- Air		1.0	-
- Water		0.0	-
- Land		0.0	-
- Products		0.0	-
- General waste treatment		0.0	-
- Sector specific waste treatment		0.0	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	2.66 – 26.55 (5.31)	2.66 – 26.55 (5.31)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

**Table 2.13: Input and output estimates for use of petrol/gasoline, diesel oil, kerosene and LPG**

<b>Petrol/gasoline, diesel oil, kerosene and LPG</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	540,300	-
Input factor for phase	mg Hg/tonne	1 – 10 (2)	-
Calculated input to phase	kg Hg/y	0.54 – 5.40 (1.08)	-
<b>Output distribution factors for phase:</b>			
- Air		1.0	-
- Water		0.0	-
- Land		0.0	-
- Products		0.0	-
- General waste treatment		0.0	-
- Sector specific waste treatment		0.0	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.54 – 5.40 (1.08)	0.54 – 5.40 (1.08)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

The mercury input and output estimates for the sub-category: mineral oils are summarised in Table 2.14.

**Table 2.14: Input and output estimates for use of mineral oils**

Oil type	Activity rate, tonne/y	Mercury content, mg/tonne	Annual mercury inputs, kg/y	Annual mercury outputs, kg/y
				Air
Heavy (fuel) oil	265,500	10 – 100 (20)	2.66 – 26.55 (5.31)	2.66 – 26.55 (5.31)
Petrol/gasoline, diesel oil, kerosene and LPG	540,300	1 – 10 (2)	0.54 – 5.40 (1.08)	0.54 – 5.40 (1.08)
<b>All oil types</b>			<b>3.20 – 31.95 (6.39)</b>	<b>3.20 – 31.95 (6.39)</b>

### *Certainty assessment*

Activity data: HIGH (as they were obtained from a national database).

Input estimates: LOW (as they are based on the default Toolkit input factors).

Output estimates: MEDIUM (as they are based on the default Toolkit output factors and knowledge of emission controls).

### *Comparison with inventory level 1: 2012 estimates*

The level 1 inventory report (based on a previous Toolkit version) gave an output estimate of approximately 14 and 3 kg/y for the combustion of 258,400 tonnes of heavy oil and 527,700 tonnes of petrol/gasoline, diesel oil, kerosene and LPG respectively based on a default input factor of 55 mg Hg/tonne for heavy oil and 5.5 mg Hg/tonne for the lighter oils. In the present inventory, the default input factor is less (20 mg Hg/tonne for heavy oil and 2 mg Hg/tonne for the lighter oils) accounting for the lower values, namely 5.3 and 1.1 kg/y for heavy oil and lighter oils respectively.

#### **2.2.4 Natural gas – extraction, refining and use**

This sub-category is not applicable to the Republic of Mauritius as there is no extraction, refining and use of natural gas.

#### **2.2.5 Other fossil fuels – extraction and use**

This sub-category is not applicable to the Republic of Mauritius as there is no extraction and use of other fossil fuels. Some amount of peat (374 tonnes) was imported in 2014 but it was not used as a fuel.

## 2.2.6 Biomass fired power and heat production

This sub-category is concerned with the burning of wood and other biomass such as bagasse for electricity generation, as an industrial fuel and in residential heating and cooking. The mercury in wood and bagasse originates from the soil and mercury deposition from the atmosphere as a result of natural and anthropogenic emissions to air. Most of the mercury is discharged back into the air when the biomass is burned.

In an endeavour to shift from coal to more renewable forms of energy, the government introduced a plan for using cane leaves and trash at the local IPP plants. This new form of biomass shows promises, however research is still underway in this area (Extract of budget speech 2016, Section: Green economy: maximizing investment opportunities, Clause 134: Government will facilitate production of energy from bio-mass, including cane tops and trash and at the same time ensure that small planters will get their fair share of the revenue).

### 2.2.6.1 Bagasse combustion

Bagasse is a by-product of the cane industry which is widely present in Mauritius and is an important renewable source of energy. It is burnt in co-generator power plants during the cane crop season in most of the IPPs (Table 2.6) except one (Médine Sugar Milling Co Ltd) where only bagasse is used. Bagasse is burnt mostly to generate electricity (~85%) but also for manufacturing purposes within the cane industry.

Bagasse ash generated through combustion can be very low, of the order of 0.3% of the weight of sugar cane crushed at the factory. For instance, for a factory crushing 500,000 tonnes of sugar cane in a season, the total ash produced is estimated to be about 1,500 tonnes.

The same air pollution control device applies as for coal, since the bagasse burning is taking place in the same power plant as the coal.

#### *Input and output estimates*

Table 2.15 provides the input and output estimates for bagasse combustion in the IPPs for 2014 (mean indicated within brackets). The concentration of mercury in bagasse and bagasse ash in Mauritius is reported to be below 0.05 mg/kg and 0.1 mg/kg (dry weight basis) respectively (Source: Terragen Ltd).

As only one analysis of bagasse was available (< 0.05 mg/kg) and the toolkit recommends a default input factor of 0.03 mg/kg or a range of 0.007 – 0.07 mg/kg, a mean mercury content of 0.03 mg/kg and a range of 0.01 – 0.05 mg/kg are adopted for the present inventory. Since the same air pollution control is used as for coal, the distribution of mercury releases to air and land is assumed to be 75:25.

**Table 2.15: Input and output estimates for bagasse combustion**

<b>Bagasse combustion</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	1,208,536	-
Input factor for phase	mg Hg/kg	0.01 – 0.05 (0.03)	-
Calculated input to phase	kg Hg/y	12.09 – 60.43 (36.26)	-
<b>Output distribution factors for phase:</b>			
- Air		0.75	-
- Water		0.00	-
- Land		0.25	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	9.06 – 45.32 (27.19)	9.06 – 45.32 (27.19)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	3.02 – 15.11 (9.06)	3.02 – 15.11 (9.06)
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

***Certainty assessment for bagasse combustion***

Activity data: HIGH (as they were obtained from the IPPs and from Statistics Mauritius).

Input estimates: MEDIUM (as they are based on one analysis by one IPP and the default toolkit input factors).

Output estimates: LOW (as they are based on the default toolkit output factors).

**2.2.6.2 Fuel wood combustion**

From the Digest of Energy and Water Statistics 2014 (Statistics Mauritius, 2015a), 18,300 tonnes of fuel wood (including charcoal) were used to generate energy. Almost all the mercury is discharged back into the air when the fuel wood is burned. The latter is used either as an industrial fuel, or in residential heating and cooking.

There are no published data available on the mercury content in the local or imported fuel wood. Based on the Toolkit Reference report (UNEP, 2015; 2017), an input factor of 0.04 mg/kg and a range of 0.01 – 0.07 mg/kg are used in the release input calculations and also all the mercury is considered as being released to air.

The mercury input and output calculations for the burning of fuel wood are shown in Table 2.16. The figures shown within brackets are the means.

**Table 2.16: Input and output estimates for fuel wood combustion**

<b>Fuel wood combustion</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	18,300	-
Input factor for phase	mg Hg/kg	0.01 – 0.07 (0.04)	-
Calculated input to phase	kg Hg/y	0.18 – 1.28 (0.73)	-
<b>Output distribution factors for phase:</b>			
- Air		1.00	-
- Water		0.00	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.18 – 1.28 (0.73)	0.18 – 1.28 (0.73)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

***Certainty assessment for fuel wood burning***

Activity data: MEDIUM (as they were obtained from national data but wood burning for residential heating and cooking may be underestimated as no detailed data are available).

Input estimates: LOW (as they are based on literature values in the Toolkit).

Output estimates: LOW (as they are based on the default toolkit output factors).

**2.2.6.3 Overall input and output estimates for the biomass fired power and heat production**

Table 2.17 summarises the input and output estimates for the sub-category: biomass fired power and heat production.

**Table 2.17: Input and output estimates for the biomass fired power and heat production**

<b>Biomass type</b>	<b>Activity rate, tonne/y</b>	<b>Mercury content, mg/kg</b>	<b>Annual mercury inputs, kg/y</b>	<b>Annual mercury outputs, kg/y</b>	
				<b>Air</b>	<b>Land</b>
Bagasse	1,208,536	0.01 – 0.05 (0.03)	12.09 – 60.43 (36.26)	9.06 – 45.32 (27.19)	3.02 – 15.11 (9.06)
Fuel wood	18,300	0.01 – 0.07 (0.04)	0.18 – 1.28 (0.73)	0.18 – 1.28 (0.73)	-
<b>All</b>	<b>1,226,836</b>	<b>0.01 – 0.07</b>	<b>12.27 – 61.71 (36.99)</b>	<b>9.24 – 46.60 (27.92)</b>	<b>3.02 – 15.11 (9.06)</b>

### *Comparison with inventory level 1: 2012 estimates*

The 2012 inventory report gave an input estimate of 40.9 kg/y and 24.1 kg/y for bagasse and fuel wood combustion respectively. The input value for bagasse compared well with that obtained in the present inventory (36.3 kg/y) as more bagasse was burnt in 2012 (1,363,300 tonnes). It was noticed that there was a computational error in the fuel wood burning (201,000 tonnes in lieu of 20,100 tonnes) in 2012. The input should have thus been 2.41 kg/y instead of 24.1 kg/y.

The mercury releases in 2012 from bagasse and fuel wood combustion were estimated to be 40.9 and 2.41 kg/y (adjusted value) respectively to air only. In this study, instead of 100% release to air, the distribution of mercury releases to air and land from combustion of bagasse is assumed to be 75:25 as the same air pollution control used for coal is adopted by the IPPs. Thus, combustion of 1,208,536 tonnes of bagasse led to 27.2 and 9.1 kg/y to air and land respectively. Mercury release from fuel wood combustion is estimated to be 0.73 kg/y instead of 2.41 kg/y for 2012 due to the lower quantity burnt in 2014 (18,300 tonnes) and a lower input factor.

#### **2.2.7 Geothermal power production**

No such facility exists in the Republic of Mauritius.

#### **2.2.8 Overall input and output for energy consumption and fuel production**

The estimated inputs and outputs for the category ‘Energy consumption and fuel production’ are summarised in Table 2.18 (means of the reported ranges indicated within brackets). It is observed that the greatest inputs are associated with the combustion of coal, followed by combustion of biomass and use of mineral oils. The dominant release route is to air.

**Table 2.18: Summary of inputs and outputs for energy consumption and fuel production**

Sub-category	Mercury inputs, kg/y	Mercury outputs, kg/y		
		Air	Water	Land
Coal combustion in power plants	22.76 – 167.14 (60.46)	17.07 – 125.36 (45.35)	-	5.69 – 41.79 (15.12)
Coal combustion in coal fired industrial boilers	1.00 – 7.34 (2.66)	1.00 – 7.34 (2.66)	-	-
Mineral oils	3.20 – 31.95 (6.39)	3.20 – 31.95 (6.39)	-	-
Natural gas	-	-	-	-
Other fossil fuels	-	-	-	-
Biomass	12.27 – 61.71 (36.99)	9.24 – 46.60 (27.92)	-	3.02 – 15.11 (9.06)
Geothermal	-	-	-	-
<b>Total</b>	<b>39.23 – 268.14 (106.50)</b>	<b>30.51 – 211.25 (82.32)</b>	-	<b>8.71 – 56.90 (24.18)</b>

## **2.3 Data and inventory on domestic production of metals and raw materials**

There is no primary metal production industry in the Republic of Mauritius. However there is production of recycled ferrous metals.

This category also covers mercury releases from the production of minerals and materials with mercury impurities such as cement, pulp and paper, lime and other related minerals and materials.

### **2.3.1 Production of recycled ferrous metals (iron and steel)**

In 2014, there was one main foundry in Mauritius, namely Samlo Koyenko Steel Co. Ltd, involved in the manufacture of ingots, bars, rods, angles and sections of iron and steel from metal scraps. The plant processes scrap iron and steel which are either imported or purchased locally. The scrap comprises amongst others recycled metals from motor vehicles, waste metals from construction debris, metals from discarded or broken home and industrial appliances. Mercury input from this sub-category may arise from the use of mercury switches in automobiles and other appliances which form part of the metal scrap.

200 tonnes of scrap metal are reported to be handled per week by the foundry (Mohee *et al.*, 2009), amounting to an annual production of about 10,400 tonnes of iron and steel products. In a report on banning of export of scrap metal (CCM, 2016), the annual production capacity of the foundry was estimated to be 12,000 – 15,000 tonnes by some players in the local scrap and iron bar market while the foundry asserted that its absorption capacity is around 60,000 tonnes. In the absence of official production data of the foundry in 2014, an amount of 15,000 tonnes was inputted for the inventory.

The Toolkit (UNEP, 2015; 2017) recommends a preliminary default input factor of 0.2 – 2.0 g Hg/vehicle recycled. Assuming that the average weight of a car is 1.6 tonnes, the number of vehicles recycled is 9,375, corresponding to an input of 1.9 – 18.8 kg Hg, which appears on the high side.

On the other hand, an input factor of about 8.3 mg Hg/tonne was used for the level 2 mercury inventory of New Zealand (Graham & Ducker, 2013). The present inventory applied the input factor of 8.3 mg Hg/tonne, resulting in about 0.12 kg, which seems more plausible than the estimate based on the number of recycled cars. Mercury outputs are based on the Toolkit default output distribution factors of 0.33 (33%) to air, 0.34 (34%) to land and 0.33 (33%) to waste.

The mercury input and output estimates for production of recycled ferrous metals are shown in Table 2.19.

**Table 2.19: Input and output estimates for production of recycled ferrous metals**

<b>Production of recycled ferrous metals</b>	<b>Unit</b>	<b>Production</b>	<b>Use</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	15,000	-	-	-
Input factor for phase	mg Hg/tonne	8.3	-	-	-
Calculated input to phase	kg Hg/y	0.12	-	-	-
<b>Output distribution factors for phase:</b>					
- Air		0.33			-
- Water		0.00			-
- Land		0.34			-
- Products		0.00			-
- General waste treatment		0.33			-
- Sector specific waste treatment		0.00			-
<b>Calculated outputs/releases to:</b>					
- Air	kg/y	0.04	-	-	0.04
- Water	kg/y	0.00	-	-	0.00
- Land	kg/y	0.04	-	-	0.04
- Products	kg/y	0.00	-	-	0.00
- General waste treatment	kg/y	0.04	-	-	0.04
- Sector specific waste treatment	kg/y	0.00	-	-	0.00

### ***Certainty assessment***

Activity data: LOW (as they were based on literature and a report and not on actual company data).

Input estimates: LOW (as they are based on the inventory level 2 of New Zealand).

Output estimates: LOW (as they are based on the output default factors).

### ***Comparison with inventory level 1: 2012 estimates***

The 2012 inventory level 1 report noted the potential for releases from this source but gave no estimates as no data could be found. Further data collection was recommended.

### **2.3.2 Cement production**

Cement is one of the main input products in construction and is used also in the production of ready-mixed concrete, pre-cast concrete products and mortar.

Important factors for mercury releases in cement production include: the amount of raw materials processed, mercury level in the raw materials, quantity of cement produced, amount and type of fuel burnt and mercury levels in each of the fuels burned at the cement production plant (UNEP, 2015; 2017). The primary output paths of mercury fed in with raw materials are releases to the atmosphere, and trace mercury levels in the produced cement.

Cement sold in Mauritius is imported as no cement is produced locally. Cement, especially grey cement, is imported in bulk or bagged formats by companies which are mainly involved in the processing, distribution and resale.

The quantity of cement imported in 2014 amounted to 613,020 tonnes (Statistics Mauritius, 2015b). The total corresponded to all types of imported cement included in the HS codes 25232100 (white Portland cement), 25232900 (Portland cement other than white), 25233000 (aluminous cement), 25239000 (slag, super sulphate and similar hydraulic cement). Of these the Portland cement other than white comprises more than 99%. In 2014, about 90% of the cement were imported from Taiwan and Vietnam.

As there is no cement production plant in Mauritius, the releases of mercury to the atmosphere and other media for this sub-source category are considered negligible. Samples of grey Portland cement and white cement available in Mauritius were analysed for their mercury content and were found to be less than 0.0041 mg/kg<sup>21</sup>.

### **2.3.3 Pulp and paper production**

In Mauritius, there is no pulp and paper production industry, apart from paper recycling. Thus, there is no input and output of mercury from this source sub-category.

### **2.3.4 Production of lime and light weight aggregates**

Lime (quicklime and slaked) are manufactured by heating limestone at high temperature and mercury may be released to the air during this process as mercury is expected to be present in minute quantities in the limestone and in the fuels used. One company situated in the south-west coast of Mauritius reported having produced about 1,300-1,400 tonnes of lime in 2014. The lime was used principally by the sugarcane industry for application in their fields. Note however that due to the decreasing demand from the sugarcane industry, the company ceased its production of lime in 2016.

The mercury input and output estimates for the production of lime in 2014 are shown in Table 2.20 (figures shown within brackets are the means of the reported ranges), using a mean input and output factor of 9 mg/tonne and a range of 8 – 10 mg/tonne (UNEP, 2015; 2017). It is observed that the mercury contribution from this sub-category is negligible.

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<sup>21</sup> Detection limit of the analytical equipment

**Table 2.20: Input and output estimates for the production of lime**

<b>Production of lime</b>	<b>Unit</b>	<b>Production</b>	<b>Use</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	1,350	-	-	-
Input factor for phase	mg Hg/tonne	8 – 10 (9)	-	-	-
Calculated input to phase	kg Hg/y	0.011 – 0.014 (0.012)	-	-	-
<b>Output distribution factors for phase:</b>					
- Air		1.00			-
- Water		0.00			-
- Land		0.00			-
- Products		0.00			-
- General waste treatment		0.00			-
- Sector specific waste treatment		0.00			-
<b>Calculated outputs/releases to:</b>					
- Air	kg/y	0.011 – 0.014 (0.012)	-	-	0.011 – 0.014 (0.012)
- Water	kg/y	0.00	-	-	0.00
- Land	kg/y	0.00	-	-	0.00
- Products	kg/y	0.00	-	-	0.00
- General waste treatment	kg/y	0.00	-	-	0.00
- Sector specific waste treatment	kg/y	0.00	-	-	0.00

### ***Comparison with inventory level 1: 2012 estimates***

No mention of release of mercury from production of lime was reported in the inventory level 1.

## **2.4 Data and inventory on domestic production and processing with intentional mercury use**

This category is concerned with mercury releases from several industrial chemical processes using mercury technology or mercury compounds as catalysts, namely chlor-alkali production, vinyl chloride monomer production, acetaldehyde production and production of other chemicals and polymers. There are no such production industries in Mauritius and thus, the contribution of mercury from this source category is nil.

## **2.5 Data and inventory on waste handling and recycling**

### **2.5.1 Controlled landfills/deposits**

Waste management sites in Mauritius comprise the Mare Chicose sanitary landfill where wastes are disposed of and five transfer stations located strategically across the island, namely at Poudre d'Or, Roche Bois, La Chaumière, La Brasserie and La Laura. In Mauritius, about 98% of municipal solid wastes are disposed to the sole landfill (UNSD, 2011).

The Mare Chicose landfill started its operation in 1997 and as of September 2015, an approximate area of 29 hectares has been landfilled, containing about 6 million tonnes of waste. The engineered landfill works at Mare Chicose has been designed for the disposal of waste in an environmentally safe manner. The essential elements are amongst others: (i) suitable clay soil and plastic lining at the bottom of the landfill and leachate collection and carting away to prevent contamination of the ground water; (ii) abstraction of gas from the landfill for destruction of the methane, through flaring and power generation; and (iii) regular environmental monitoring (MoSSN&SD, 2017). The amount of wastes landfilled at Mare Chicose from 2010 to 2015 and the source of the wastes is shown in Table 2.21.

**Table 2.21: Amount of wastes (tonnes) landfilled at Mare Chicose and its sources**

<b>Waste type</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Domestic	402,816	389,743	365,867	408,858	401,785	431,996
Construction	2,394	5,306	5,601	6,141	2,363	1,489
Industrial (excl. textile)	1,140	1,565	680	325	190	279
Textile	432	130	233	89	18	9
Tuna/Sludge	10,949	10,402	7,370	6,963	5,191	4,693
Poultry	6,339	5,942	6,061	5,316	5,707	6,334
Rubber tyres	481	447	372	315	431	487
Asbestos	44	15	6	50	26	15
Condemned goods	1,388	848	1,573	1,588	1,586	2,841
Difficult and hazardous	42	13	7	17	1	240*
Paper waste	6	67	7	30	5	11
Others	1,771	65	149	243	175	82
<b>TOTAL</b>	<b>427,802</b>	<b>414,543</b>	<b>387,926</b>	<b>429,935</b>	<b>417,478</b>	<b>448,476</b>
Daily per capita solid waste landfilled (kg)	0.97	0.94	0.87	0.97	0.91	0.97

\*includes clinical and chemical waste

It is observed that domestic waste is by far the highest source contributor (more than 94%).

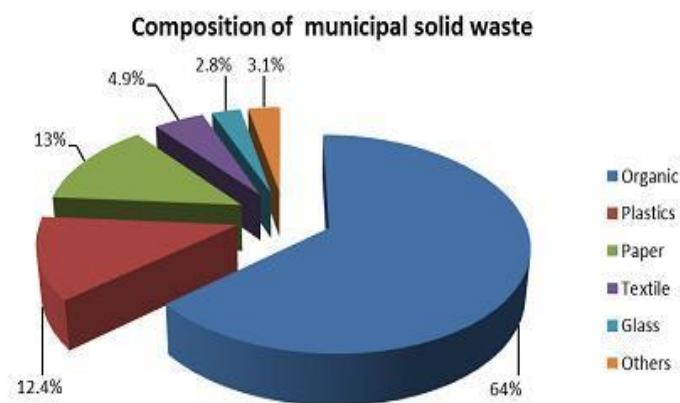
In Rodrigues, there is only one open air dumping waste ground situated at Grenade, Roche Bon Dieu. Data obtained from an on-going project funded by the Mauritius Research Council entitled “Study on the generation of wastes and their characteristics in Rodrigues: Implications for a sustainable Rodrigues Island” indicated that about 40 tonnes of waste were disposed per week, amounting to 2,080 tonnes annually. Assuming that 80% of the waste is collected and disposed at Roche Bon Dieu, the total amount of waste generated in Rodrigues is 2,600 tonnes corresponding to 0.17 kg per capita daily based on the resident population in 2014 of 41,788 (Statistics Mauritius, 2016).

From past visits to the dumping site and from information derived from the PANeM report (2016), it was noted that the site is often subject to accidental fires. Based on the inventory report of PCBs, dioxins and furans (Choong Kwet Yive, 2004), it is considered that 50% of the waste disposed at this site was burnt.

The combined amount of waste landfilled or deposited in Mauritius and Rodrigues is thus 418,518 tonnes.

The mercury content in the waste stream can be derived from four main sources: (a) intentionally used mercury in spent products and process waste; (b) natural mercury impurities in bulk materials (e.g. paper, plastics, and metals) and minerals; (c) mercury present as trace pollutant in bulk materials (UNEP, 2015; 2017); and (d) trace levels of mercury in food wastes.

The key requirements for quantifying the mercury inputs and outputs for this source sub-category are the total quantities of waste disposed to controlled landfills/deposits each year, and its average mercury content. The approximate composition of the municipal solid waste in Mauritius is depicted in Figure 2.6 and shows the preponderance of organic wastes (~64%). However there is no information available on the mercury content of the wastes. In the absence of this data, the recommended Toolkit factors have been used, namely default factors of 1 – 10 g/tonne of waste for estimating the inputs, and output distribution factors of 0.01 (1%) to air and 0.0001 (0.01%) to water. It is noteworthy that only minute amounts of mercury are released to water and air. Three samples of leachates from Mare Chicose landfill were analysed during this study and were found to be less than 0.0002 mg/L. The results are consistent to those found in another study by Dookhun & Mahadeo (2009). From a report of PANeM (2016), it was found that the mercury concentration in air at Mare Chicose landfill and Roche Bon Dieu dumping site is also very low (2.95 – 15.25 and 4.38 ng/m<sup>3</sup> respectively).



**Figure 2.6: Composition of municipal solid waste in Mauritius**

*Source:* <http://environment.govmu.org/English/Pages/swmd/SWMD-Solid-Waste-In-Mauritius.aspx>

The mercury input and output calculations for controlled landfills/deposits are shown in Table 2.22 with the figures shown in brackets being the means of the reported ranges.

**Table 2.22: Input and output estimates for controlled landfills/deposits**

<b>Controlled landfills/deposits</b>	<b>Unit</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	418,518	-
Input factor for phase	g Hg/tonne	1 – 10 (5.5)	-
Calculated input to phase	kg Hg/y	419 – 4,185 (2,302)	-
<b>Output distribution factors for phase:</b>			
- Air		0.01	-
- Water		0.0001	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	4.19 – 41.85 (23.02)	4.19 – 41.85 (23.02)
- Water	kg Hg/y	0.04 – 0.42 (0.23)	0.04 – 0.42 (0.23)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### ***Certainty assessment***

Activity data: MEDIUM (as they were based on data obtained from Mare Chicose landfill and data estimated at Roche Bon Dieu dumping site).

Input estimates: LOW (as they are based on the default Toolkit input factors).

Output estimates: LOW (as they are based on the default Toolkit output factors).

### ***Comparison with inventory level 1: 2012 estimates***

Similar methodology was used to estimate the mercury inputs (2,070 kg) and outputs (20.7 kg to air and 0.2 kg to water) for controlled landfills/deposits in the 2012 Level 1 inventory report based on 414,000 tonnes. However, waste deposition in Rodrigues was not considered.

### **2.5.2 Diffuse deposition under some control**

This sub-category relates to the use of special types of wastes, such as incineration residues or fly ash, under roads and in constructions. No such use has been at date reported in Mauritius.

### 2.5.3 Informal local disposal of industrial production waste

No informal local disposal of industrial production waste is practiced in Mauritius as the wastes are disposed to Mare Chicose landfill.

### 2.5.4 Informal dumping of general waste

There is almost certainly some uncontrolled dumping of solid wastes in Mauritius and Rodrigues. However, no formal data is available on its likely extent. It is assumed that 98% of municipal/general waste is collected (UNSD, 2011) in Mauritius and taken to the Mare Chicose landfill (417,478 tonnes), 1% is informally dumped (4,260 tonnes) and the remaining 1% (4,260 tonnes) is burnt in the open. In Rodrigues, the estimated amount of waste dumped informally is 10% of the waste generated (2,600 tonnes), corresponding to 260 tonnes. Thus the total amount of waste which can be estimated to have been dumped informally is about 4,520 tonnes.

The mercury input and releases from this sub-category are based on the default input factor of 1 – 10 g/tonne and default output distribution factors of 0.1 to air, 0.1 to water and 0.8 to land. Table 2.23 summarises the input and output estimates for the sub-category: informal dumping of general waste with the means given in brackets.

**Table 2.23: Input and output estimates for informal dumping of general waste**

<b>Informal dumping of general waste</b>	<b>Unit</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	4,520	-
Input factor for phase	g Hg/tonne	1 – 10 (5.5)	-
Calculated input to phase	kg Hg/y	4.52 – 45.20 (24.86)	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.10	-
- Land		0.80	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.45 – 4.52 (2.49)	0.45 – 4.52 (2.49)
- Water	kg Hg/y	0.45 – 4.52 (2.49)	0.45 – 4.52 (2.49)
- Land	kg Hg/y	3.61 – 36.16 (19.89)	3.61 – 36.16 (19.89)
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### *Certainty assessment*

Activity data: MEDIUM (as they were based on % collection of municipal/general waste in Mauritius and estimated % collection in Rodrigues).

Input estimates: LOW (as they are based on the default Toolkit input factors).

Output estimates: LOW (as they are based on the default Toolkit output factors).

### *Comparison with inventory level 1: 2012 estimates*

Similar methodology was used to estimate the mercury inputs (21.1 kg) and outputs (2.1 kg to air, 2.1 kg to water and 16.9 kg to land) for informal dumping of general waste in the 2012 Level 1 inventory report based on 4,224 tonnes. However the amount of informal dumping of general waste in Rodrigues was not included.

#### **2.5.5 Incineration of municipal/general waste**

To date, there is no municipal/general waste incineration facility on the island; thus the Hg contribution to this sub-category is nil.

#### **2.5.6 Incineration of hazardous waste**

An interim hazardous waste storage facility is operational since April 2017. Prior to the latter date, hazardous chemical wastes were disposed in the hazardous waste cells at Mare Chicose landfill or stored at generators' premises awaiting disposal.

As per the 2012 Mauritius Hazardous Waste Inventory (MoLGOI, 2012), fuel oil sludge generated by the CEB and by some petroleum companies is incinerated. The amount of fuel oil sludge incinerated yearly, resulting from treatment of heavy fuel oil, by the CEB is shown in Table 2.24.

**Table 2.24: Amount of sludge incinerated yearly by CEB**

<b>Location</b>	<b>Volume of sludge incinerated yearly, m<sup>3</sup></b>
Fort George power station	1,850
Fort Victoria power station	100
Saint Louis power station	100
Port Mathurin power station	15
Port Monnier power station	15
<b>Total</b>	<b>2,080</b>

Out of the four petroleum companies surveyed, two of them reported that they do not generate sludge whereas the other two generate sludge at a frequency of once-twice every ten years. One of them stated generation of about 4.5 tonnes of sludge in 2015 which is either incinerated or sent to a waste recycling company. Based on the above data, it is observed that the annual input from the petroleum companies is very small compared to that of the CEB, which generate about 2,080 tonnes (average density of heavy fuel oil is 1,000 kg/m<sup>3</sup>) of sludge.

However, the contribution from this sub-category will not be considered to avoid double counting as the Hg input and output of fuel oil and petrol/gasoline (section 2.2.3) has been estimated from the annual imports and the latter include the above quantities.

### **2.5.7 Incineration of medical waste**

While there is no local facility for municipal and general waste incineration, it is observed that incineration of medical wastes does occur in both public hospitals and private clinics in Mauritius. As per the EPA Act Government Notice No 157 of 2001, medical waste is also listed under the category of hazardous waste. It is noteworthy that since October 2006, regulations under the Environment Protection Act require all medical and clinical wastes incinerators to have an Environmental Impact Assessment prior to their operation.

The mercury content in the medical waste stream would originate primarily from intentionally used mercury in discarded products and process waste. Following observations made in three public hospitals and after discussion with the regional health directors, it was assumed that an informal sorting of mercury-containing products is taking place before medical waste is taken to the incinerator.

In 2014, there were seven gas incinerators operating in the public health institutions, namely at A.G. Jeetoo, Flacq, SSRN, Victoria, Poudre d'Or, Brown Sequard and Jawaharlal Nehru hospitals. Some private clinics, including Fortis Clinique Darné, La Clinique Mauricienne, Nouvelle Clinique du Bon Pasteur Ltee, Clinique du Nord, City Clinic and Apollo Bramwell Hospital (now called Wellkin Hospital) also possess incineration units. Following the process of incineration of medical waste, the ash is disposed at the Mare Chicose landfill (MoHQL, 2015b). Due to the high temperature used for incineration (800 – 1200 °C), the amount of mercury in the ash is considered to be negligible.

The medical waste incinerators in public hospitals and private clinics are noted to be operating without an air pollution control device (MoHQL, 2015b), and hence the emissions would be assumed to be 100% released to the air medium.

#### ***Input and output estimates***

The total medical waste incinerated by the public hospitals for the year 2010 (MoESD, 2011) and 2014 (MoHQL, 2015b) was estimated to be 1,200 and 1,700 tonnes respectively. However, the MoHQL confirmed that the amount of medical waste incinerated by the public hospitals in 2014 amounted to 808 tonnes instead of 1,700 tonnes as the latter corresponded to the total amount of medical waste generated and not to the quantity incinerated. Thus in the present inventory the figure of 808 tonnes was used to determine the mercury emissions.

Taking into consideration that there were 3,592 beds in the government hospitals in 2014 and that the average occupancy rate was 77.1% (MoHQL, 2015a), the hazardous waste generation rate amounted to 0.80 kg/bed daily, which is higher than the one stated by WHO (2015) which is 0.2 – 0.5 kg/bed/day and may be due to improper segregation of hazardous and non-hazardous wastes.

In the private sector there were, as at the end of 2014, seventeen private health institutions with a total of 656 beds. Data on the amount of medical waste incinerated were not readily available despite official requests from the parent ministry. One clinic, having about 40 beds, stated generating about 3.2 tonnes in 2014. From the inventory of hazardous wastes carried out in 2011 (MoLGOI, 2012), it was estimated that about 200 tonnes of medical wastes are generated yearly by the private clinics. Bokhoree *et al.* (2014) stated that one major clinic, having about 110 beds, incinerated about 100 kg of medical waste per day, amounting to about 30 – 36 tonnes per year. Based on the above data, the

amount of medical wastes incinerated by the private health institutions can be estimated to be about 200 tonnes yearly.

The mercury input value for medical waste incineration based on the UNEP level 2 Toolkit (2015; 2017) is 8 – 40 g Hg/tonne. The most likely value for Mauritius would be the mean, i.e. 24 g Hg/tonne given the efforts made by public hospitals and private clinics to reduce their use of mercury, namely phasing out of mercury thermometers and sphygmomanometers and the operation of a waste segregation system to separate infectious wastes from normal wastes. Mercury emissions to air was assumed to be 100% following combustion as mercury and mercury compounds are relatively volatile.

Table 2.25 shows the input and output estimates from incineration of medical waste in 2014.

**Table 2.25: Input and output estimates from incineration of medical waste**

<b>Incineration of medical waste</b>	<b>Unit</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	1,008	-
Input factor for phase	g Hg/tonne	8 – 40 (24)	-
Calculated input to phase	kg Hg/y	8.06 – 40.32 (24.19)	-
<b>Output distribution factors for phase:</b>			
- Air		1.00	-
- Water		0.00	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	8.06 – 40.32 (24.19)	8.06 – 40.32 (24.19)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### ***Certainty assessment***

Activity data: MEDIUM (as they were obtained from relevant ministry for the public hospitals and estimated for the private clinics).

Input estimates: LOW (as they are based on the default Toolkit input factors).

Output estimates: MEDIUM (as they are based on the default Toolkit output factors and the characteristics of the incinerators).

### ***Comparison with inventory level 1: 2012 estimates***

A total of 552 tonnes of medical waste was estimated in Level 1 inventory for incineration and open burning of medical waste with a mercury input of 13 kg. This figure is less than that estimated in the present inventory (1,008 tonnes and 24.2 kg respectively). In addition, an output distribution factor of 1.0 to air was considered instead of 0.9 to air and 0.1 to general waste in 2012 as there is no air control pollution device in the medical incinerators.

#### **2.5.8 Sewage sludge incineration**

No sewage sludge incineration is practised to date at any wastewater treatment station in Mauritius.

#### **2.5.9 Informal waste burning**

Uncontrolled or informal waste burning is ranked third in emitting dioxins and furans in Mauritius (Choong Kwet Yive, 2004). Households tend to burn their wastes as and when the latter accumulate to get rid of them in their own compounds and sometimes in open areas. In the process, wares, clothes, broken equipment, plastics, papers, leaves, food waste and other wrapping materials are burnt.

98% of municipal/general waste is collected (UNSD, 2011) in Mauritius and taken to the Mare Chicose landfill. Based on the level 1 mercury inventory (MoESD, 2014) and the inventory of PCBs, dioxins and furans (Choong Kwet Yive, 2004), it is assumed that 1% of uncollected municipal/general waste is informally dumped and the remaining 1% is burnt in the open.

In 2014, from data received from the Solid Waste Division of the MoSSN&SD, the total amount of municipal/general waste landfilled at Mare Chicose was 417,478 tonnes. If the latter represents 98% of waste, the amount of waste burnt informally in Mauritius would correspond to about 4,260 tonnes.

In Rodrigues, there is only one open air dumping waste ground situated at Grenade, Roche Bon Dieu, where about 2,080 tonnes of waste are disposed annually. Assuming that 80% of the waste is collected and disposed at Roche Bon Dieu, the total amount of waste generated in Rodrigues is 2,600 tonnes. From past visits to the dumping site and from information derived from the PANeM report (2016), it was noted that the site is often subject to accidental fires. Based on the inventory report of PCBs, dioxins and furans (Choong Kwet Yive, 2004), it is considered that 50% of the waste disposed at this site was burnt. In addition, if it is assumed that half of the amount of waste not collected is burnt informally, the total amount of waste burnt in Rodrigues is approximately 1,300 tonnes.

For the purpose of this inventory, the estimated total amount of waste burnt in Mauritius and Rodrigues is 5,560 tonnes. As no data are available on the mercury content of the solid waste, the recommended Toolkit default factor of 1 – 10 g/tonne is applied, giving an annual mercury input of 5.6 – 55.6 kg/y. The inputs are more likely to be at the lower end of the range as much of the waste burned is unlikely to be contaminated with mercury. For the output calculations, it has been assumed that all of the mercury will be discharged to air. Table 2.26 summarises the input and output estimates from informal waste burning.

**Table 2.26: Input and output estimates from informal waste burning**

<b>Informal waste burning</b>	<b>Unit</b>	<b>Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	tonne/y	5,560	-
Input factor for phase	g Hg/tonne	1 – 10 (5.5)	-
Calculated input to phase	kg Hg/y	5.56 – 55.60 (30.58)	-
<b>Output distribution factors for phase:</b>			
- Air		1.00	-
- Water		0.00	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	5.56 – 55.60 (30.58)	5.56 – 55.60 (30.58)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### ***Certainty assessment***

Activity data: LOW (as they were based on assumption of % waste burnt).

Input estimates: LOW (as they are based on the default Toolkit factors).

Output estimates: LOW (as the output distribution was assumed).

### ***Comparison with inventory level 1: 2012 estimates***

Same methodology was applied to estimate the total amount of waste burnt informally in the level 1 inventory. A total of 4,224 tonnes was inputted in Level 1 inventory for informal waste burning, with a mercury input of 21 kg. This figure is less than that estimated in the present inventory (5,560 tonnes and 30.6 kg respectively) as the amount of waste burnt in Rodrigues was not considered.

### **2.5.10 Waste water system/treatment**

The Wastewater Management Authority (WMA, 2015) manages a total of 10 wastewater treatment plants (Montagne Jacquot, St Martin, Grand Baie, Baie du Tombeau, Pailles, Bois Marchand, Rivière du Rempart, Flacq, Dubreuil and Vuillemin) treating about 117,400 m<sup>3</sup> of waste water daily. Depending on treatment stations, the waste waters are either (i) primarily treated and discharged outside the lagoon; or (ii) treated via sedimentation, clarification, activated sludge, UV radiation and sand filter. Whereas the treated water is used mainly for irrigation purposes or discharged into the sea, the resulting sludge is stored before being carted and disposed at Mare Chicose landfill.

A walk-through survey at St Martin wastewater treatment facility was also conducted to identify local practices with regard to sludge disposal methods. It was noted that sewage sludge is sun dried and the remaining volume of cake is disposed at Mare Chicose landfill.

Determining factors for mercury releases from waste water are the amount of mercury-containing wastes that are discharged to the system and the level of mercury in those wastes. Mercury content in waste water is mainly derived from two source groups: (i) intentionally used mercury in products and processes (such as from dental amalgams, spillage from thermometers and other devices, and industrial discharges); and (ii) atmospheric mercury washed out by precipitation and carried along in storm water. Due to the above, waste water treatment is an intermediate mercury release source where mercury inputs from original mercury contamination are treated and then re-distributed to water, land, wastes and air (through sludge incineration) (UNEP, 2015; 2017).

A total volume of 42.8 million m<sup>3</sup> of waste water was treated at the WMA treatment plants for the period January to December 2014 (WMA, 2015), resulting in about 5,000 tonnes of dried sludge.

Since May 2016, the waste water was analysed for its mercury content at the inlet and/or outlet of the wastewater treatment plants (Table 2.27).

**Table 2.27: Mercury content at the wastewater treatment plants (May – Dec 2016)**

Location	No of samples analysed	Mercury level, mg/L
Grand Baie inlet	16	< 0.005 – 0.09
Grand Baie outlet	16	n.d. – 0.013
Montagne Jacquot inlet	16	< 0.005 – 0.15
Montagne Jacquot outlet	16	< 0.005 – 0.25
St Martin inlet	16	n.d. – 0.21
St Martin outlet	16	< 0.005 – 0.12
Flacq outlet	8	< 0.005 – 0.06
Vuillemin outlet	8	< 0.005 – 0.07
Dubreuil outlet	8	< 0.005 – 0.07
Baie du Tombeau outlet	8	< 0.005 – 0.19
Riviere du Rempart outlet	8	n.d. – 0.22
Bois Marchand outlet	8	< 0.005 – 0.07
Pailles outlet	8	n.d. – 0.06
<b>All treatment plants</b>	<b>159</b>	<b>n.d. – 0.25</b>

Sludge resulting from waste water treatment at St Martin was also analysed (Table 2.28).

**Table 2.28: Mercury levels in sludge from waste water treatment at St Martin**

Year	Mercury level, mg/kg
2012	ND – 0.47
2013	ND – 270
2014	ND
2015	ND
2016	ND

ND: Not detected

It is observed that more than 50% of the values were in the range < 0.005 – 0.010 mg Hg/L wastewater, corresponding to the UNEP default input factor (UNEP, 2015; 2017). It is assumed also that the mercury concentration will not be largely different in 2014. Thus, for the purpose of this inventory, the input factor used is 0.5 – 10 mg/m<sup>3</sup> with a mean of 5.25 mg Hg/m<sup>3</sup>. The level of treatment of waste water in the different plants ranges from preliminary, advanced primary, secondary to tertiary. The % of tertiary level treated waste water is around 45%. The UNEP Toolkit default output distribution factors are 0.5 to water, 0.3 to general waste and 0.2 to sector specific treatment/disposal for tertiary treatment (mechanical and biological) and 0.9 to water and 0.1 to waste for mechanical treatment only. There is no output to air as the sludge resulting from waste water treatment is not incinerated in Mauritius but disposed at Mare Chicose landfill.

The mercury input and output calculations for waste water system/treatment are shown in Tables 2.29 – 2.31, with figures shown in brackets being the means of the reported ranges.

**Table 2.29: Input and output estimates for waste water system/treatment**

Source	Activity rate, m <sup>3</sup> /y	Hg content, mg/m <sup>3</sup>	Annual inputs, kg/y	Annual mercury outputs, kg/y		
				Water	Waste	Sector specific treatment/disposal
Waste water tertiary treatment	19.26 × 10 <sup>6</sup>	0.5 – 10 (5.25)	9.63 – 192.6 (101.10)	4.82 – 96.30 (50.55)	2.89 – 57.78 (30.33)	1.93 – 38.52 (20.22)
Waste water mechanical treatment only	23.54 × 10 <sup>6</sup>		11.77 – 235.4 (123.59)	10.59 – 211.86 (111.24)	1.18 – 23.54 (12.36)	-
<b>Waste water (all treatments)</b>	<b>42.8 x 10<sup>6</sup></b>	<b>0.5 – 10 (5.25)</b>	<b>21.4 – 428.0 (224.7)</b>	<b>15.4 – 308.2 (161.8)</b>	<b>4.1 – 81.3 (42.7)</b>	<b>1.9 – 38.5 (20.2)</b>

**Table 2.30: Input and output estimates for waste water system/treatment (tertiary)**

Waste water system/treatment (tertiary)	Unit	Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	m <sup>3</sup> /y	19.26 × 10 <sup>6</sup>	-
Input factor for phase	mg Hg/m <sup>3</sup>	0.5 – 10 (5.25)	-
Calculated input to phase	kg Hg/y	9.63 – 192.6 (101.10)	-
<b>Output distribution factors for phase:</b>			
- Air		0.00	-
- Water		0.50	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.30	-
- Sector specific waste treatment		0.20	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.00	0.00
- Water	kg Hg/y	4.82 – 96.30 (50.55)	4.82 – 96.30 (50.55)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	2.89 – 57.78 (30.33)	2.89 – 57.78 (30.33)
- Sector specific waste treatment	kg Hg/y	1.93 – 38.52 (20.22)	1.93 – 38.52 (20.22)

**Table 2.31: Input and output estimates for waste water system/treatment (mechanical only)**

Waste water system/treatment (mechanical only)	Unit	Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	m <sup>3</sup> /y	23.54 × 10 <sup>6</sup>	-
Input factor for phase	mg Hg/m <sup>3</sup>	0.5 – 10 (5.25)	-
Calculated input to phase	kg Hg/y	11.77 – 235.4 (123.59)	-
<b>Output distribution factors for phase:</b>			
- Air		0.00	-
- Water		0.90	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.10	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.00	0.00
- Water	kg Hg/y	10.59 – 211.86 (111.24)	10.59 – 211.86 (111.24)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	1.18 – 23.54 (12.36)	1.18 – 23.54 (12.36)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### *Certainty assessment*

Activity data: HIGH (as they were based on official data).

Input estimates: HIGH (as they are based on the default Toolkit input factors and on analysis of wastewater samples).

Output estimates: LOW (as they are based on the default Toolkit output factors).

### *Comparison with inventory level 1: 2012 estimates*

The mercury contribution for waste water system/treatment in the 2012 level 1 inventory report based on  $39.1 \times 10^6 \text{ m}^3$  of treated waste water were 205 kg for input, 184.7 kg for output to water and 20.5 kg for output to waste, based on output distribution factors of 0.9 to water and 0.1 to waste. Different output distribution factors have been applied in the present inventory to cater for the types of treatment, whether tertiary or mechanical whereas no such differentiation was made in the level 1 inventory.

#### **2.5.11 Test of waste and waste water default factors**

In this inventory, default input factors were used for the estimation of mercury releases from general waste treatment and waste water treatment. The default factors were based on literature data of mercury contents in waste and waste water, 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 2 spreadsheet:

In the unaltered IL2 spreadsheet tab ("Level 2-Summary"), the test was done as follows:

$$(E62 + E66 + E68 + E71) > 2*(J23 + \sum(J37 \text{ to } J55)).$$

$$E62 + E66 + E68 + E71 = 79 \text{ kg Hg/y}; \text{ and } 2*(J23 + \sum(J37 \text{ to } J55)) = 498 \text{ kg Hg/y}.$$

Thus the inequality  $(E62 + E66 + E68 + E71) > 2*(J23 + \sum(J36 \text{ to } J53))$  is found to be false, implying that the calculations made indicate that the default input factors for general waste do not necessarily over-estimate the mercury releases from these sub-categories.

The test made for waste water compares the calculated inputs to waste water treatment with the sum of outputs to water from intentional mercury uses in products plus processes as follows, using data from the Inventory Level 2 spreadsheet:

In the IL2 spreadsheet (tab "Level 2-Summary"), the test was done as follows:

$$E72 > 2*(G23 + \sum(G37 \text{ to } G56)).$$

$$E72 = 225 \text{ kg Hg/y}; \text{ and } 2*(G23 + \sum(G37 \text{ to } G56)) = 113 \text{ kg Hg/y}.$$

Thus the inequality  $E72 > 2*(G23 + \Sigma(G37 \text{ to } G56))$  is found to be true, suggesting that the calculations made indicate that the default input factors for waste water treatment may over-estimate the mercury releases from these sub-categories. This may be of priority in follow-up work, as feasible.

## **2.6 Data and inventory on general consumption of mercury in products, as metal mercury and as mercury containing substances**

This category covers mercury uses in a wide range of consumer products, namely mercury thermometers, electrical and electronic switches, contacts and relays with mercury, light sources with mercury, batteries containing mercury, polyurethane with mercury catalysts, biocides and pesticides, paints, pharmaceuticals for human and veterinary uses, and cosmetics and related products, and covers also mercury uses in other intentional product/process uses such as dental mercury-amalgam fillings, manometers and gauges, laboratory chemicals and equipment, mercury metal use in religious rituals and folklore medicine and other miscellaneous product uses and other sources (UNEP, 2015; 2017).

It is noteworthy that during the MIA project timeframe, a relevant study, “A review of the status of products in compliance with the Minamata Convention on mercury in Mauritius”<sup>22</sup>, focusing mainly on the availability of Convention compliant products in the Mauritian market and its capacity for transition, was carried out under PANEM’s project as mentioned earlier on.

### **2.6.1 Thermometers with mercury**

Mercury thermometers are used in households, laboratories, educational and health institutions, and in certain industries. For example, mercury fever or clinical thermometers are commonly encountered in many households, schools and health facilities whereas in industries they may find applications in heating and cooling equipment, dairies or bakeries. However, they are increasingly being replaced by electronic and other thermometer types.

In Mauritius, the Ministry of Health and Quality of Life (MoHQL) had decided in Oct 2007 to replace all its mercury containing apparatuses over a time frame of three years. Thus, from surveys carried out by the Occupational Health Unit of the MoHQL, the number of mercury thermometers being used in the public hospitals/dispensaries/mediclinics decreased from 702 in 2007 to 107 in 2016. The MoHQL has already removed these thermometers from use and they would currently count as "waiting for disposal". Data available for most private health institutions also indicated a shift towards use of mercury-free thermometers, the number of mercury thermometers declining from about 400 to 13. However, mercury thermometers are still being used in educational institutions, laboratories and by individuals in their homes.

No local manufacturers of mercury-filled thermometers were identified in this inventory as all thermometers are imported from overseas.

Import data for Customs Harmonized System (HS) code 90251100 (liquid-filled, direct-reading thermometers) were obtained from Statistics Mauritius for the period 2012 – 2015 (Table 2.32). It

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<sup>22</sup> [http://www.zeromercury.org/index.php?option=com\\_content&view=article&id=319%3Ainternational-eebzmwg-supported-projects&catid=36%3Ageneral&Itemid=110](http://www.zeromercury.org/index.php?option=com_content&view=article&id=319%3Ainternational-eebzmwg-supported-projects&catid=36%3Ageneral&Itemid=110)

was observed that most thermometers were imported from China (2012: 90.6%; 2013: 79.5%; 2014: 89.8%; and 2015: 87.8%).

**Table 2.32: Imports of thermometers (units) in 2012 – 2015**

HS Code	Description	2012	2013	2014	2015
90251100	Thermometers, not with other instruments, liquid-filled for direct reading	12,923	6,898	13,212	7,524
90251900	Thermometers, not combined with other instruments, excluding 90251100	38,668	32,117	38,527	55,878

From Table 2.32, it is observed that the number of imported liquid-filled thermometers (HS Code 90251100) decreased from 2012 to 2013, rose in 2014 and decreased again in 2015 and that on the other hand the number of non-liquid filled thermometers (HS code 90251900) increased by nearly 50% from 2012 to 2015. Mercury thermometers, depending on their type or use, may contain between about 0.25 and more than 100 g/unit.

It is to be noted that the HS code 90251100 does not differentiate between clinical mercury thermometers and other types of mercury thermometers such as laboratory. Neither does it discriminate between mercury filled thermometers and other liquid filled thermometers such as alcohol. However from data and informal information received from some importers the percentage of non-mercury liquid thermometers being imported is around 25%. One company stated having imported 50 and 100 alcohol thermometers in 2014 and 2015, respectively. Most of the importers stated that they have stopped importing mercury thermometers the last years.

Examples of mercury content by thermometer type are presented in Table 2.33 based on safety data sheets, literature values and the UNEP toolkit (2015; 2017).

**Table 2.33: Mercury content in thermometers by type**

Thermometer type	Mercury content (g per unit)	Default UNEP mercury content (g per unit)
Medical/clinical	0.61 – 2.25	0.5 – 1.5
Ambient air temperature	2 – 5	2 – 5
Laboratory and industrial	14 – 30	1 – 40

As the mercury thermometers are sealed, mercury emissions do not occur during their use unless there is breakage or cracking. From the literature (US EPA, 1992), it is estimated that on average 5% breakage rate occurs during use leading to mercury releases to air, land and waste water, with the highest turnover observed with medical/clinical thermometers. The proportion of mercury emission to each of the above pathways is dependent mainly upon the clean-up procedures and its disposal.

According to the UNEP toolkit (2015; 2017), medical thermometers contain 0.5 – 1.5 g of mercury per unit, whilst laboratory thermometers can contain 1 – 40 g each. From the safety data sheets available, it was observed that the upper limit for laboratory thermometers proposed by the toolkit appears on the high side. Thus for the purposes of this inventory, the input estimate is based on a range of 0.5 – 4.5 g per unit, taking also into consideration that most of the imported mercury thermometers are of medical or clinical type.

Broken and unusable thermometers are usually disposed of in municipal solid waste, or as hazardous waste. Practically no mercury recycling takes place in Mauritius, with many institutions storing them as hazardous waste pending their transfer to the interim hazardous waste storage facility or export by the authorities.

Mercury input to disposal is the amount of thermometers consumed multiplied by the mercury content in the respective thermometers. It is noteworthy that mercury disposal with thermometers reflects mercury content from earlier years due to the life-times of the thermometers and decreasing mercury levels over time. Thus, for the inventory, the imported figures of 2012 were used instead of 2014. The estimated number of mercury thermometers is 9,700 corresponding to about 75% of the imports of liquid filled thermometers in 2012.

The mercury output distribution factor assumed in the inventory taking into consideration the national waste management system is 0.1 to air, 0.3 to water and 0.6 to general waste.

### ***Current stocks***

The amount of mercury thermometers currently in use and in stock has been estimated from data supplied by the MoHQL, the Ministry of Education and Human Resources, Tertiary Education and Scientific Research (MoEHRTE&SR), and other laboratories or institutions. Note that the number of mercury thermometers in use in the industries, particularly the food sector, has not been surveyed.

The Mauritius Standards Bureau (MSB), which is the local accredited body for calibration of thermometers, calibrated 68 mercury-in-glass units, 24 liquid-in-glass units (other than mercury) and 287 digital ones in 2014. The percentage of liquid thermometers calibrated that are non-mercury ones is around 26%, substantiating the estimate of 25% for the import of non-mercury liquid thermometers. However, the amount of mercury thermometers calibrated will not be included in the total because most of them would have already been included in the laboratory total.

Although mercury thermometers have been phased out in public hospitals, doctors and veterinarians usually have in their possession still at least one mercury clinical thermometer. In 2014, from the Health Statistics Report 2014 (MoHQL, 2015a), there are 2,429 doctors registered with the Medical Council of Mauritius and about 71 veterinarians. In addition, the number of thermometers held by individuals for personal use is unknown. However, the annual imported figure can be roughly taken as an indication of the annual turnover of the current use by individuals. If thermometers are broken at a rate of once every 5 years, then the total stocks by individuals would amount to 21,250 (4,250 x 5). On the basis of the above, the estimated total current stocks of mercury thermometers are shown in Table 2.34. Note that this is underestimated as many institutions have not replied to the survey form sent.

**Table 2.34: Amount of mercury thermometers in use and stock in 2016**

<b>Institution/Laboratory/Others</b>	<b>No of units</b>
Public hospitals/dispensaries/mediclinics	107
Private clinics	13
Public secondary schools	4,926 (+ 1,064 unusable)
Private secondary schools	4,101 (+ 194 unusable)
Tertiary education institutions	220 (+ 4 unusable)
Individuals (for personal use)	21,250
Analytical laboratories	73
Mauritius Meteorological Services	310
Doctors and veterinarians	2,500
<b>Total</b>	<b>33,500 (+ 1,262 unusable)</b>

However, it should be noted that the input and output factors should only be applied to the annual imports numbers, rather than the total thermometer stocks, as the mercury is not released until the thermometers are disposed. The Toolkit makes no provision for existing stocks. The Hg amount in the current stocks, including the unusable ones, is 17.4 – 156.4 kg, with a mean of 86.9 kg.

The mercury input and output estimates for the use of thermometers are shown in Table 2.35. The figures shown in brackets are the means of the reported ranges.

**Table 2.35: Input and output estimates for mercury thermometers**

<b>Mercury thermometers</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	items/y	9,700	-
Input factor for phase	g Hg/item	0.5 – 4.5 (2.5)	-
Calculated input to phase	kg Hg/y	4.85 – 43.65 (24.25)	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.30	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.60	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.49 – 4.37 (2.43)	0.49 – 4.37 (2.43)
- Water	kg Hg/y	1.46 – 13.10 (7.28)	1.46 – 13.10 (7.28)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	2.91 – 26.19 (14.55)	2.91 – 26.19 (14.55)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### *Certainty assessment*

Activity data: LOW (as they were based on import data and assumptions).

Input estimates: MEDIUM (as they are based on the safety data sheets and Toolkit default factors).

Output estimates: LOW (as they are based on the Toolkit default factors).

### *Comparison with inventory level 1: 2012 estimates*

The methodology adopted to estimate the mercury input in 2012 was that of the imported liquid filled thermometers, only 20% were assumed to be mercury-filled, leading to an input of 6.2 kg and releases of 0.6 kg to air, 1.9 kg to water and 3.7 kg to general waste.

It is noteworthy that the mercury input and output are higher in this present inventory as it was considered that 75% of the imported liquid filled thermometers in 2012 contained mercury.

### **2.6.2 Electrical switches and relays with mercury**

Mercury has been used, and still being used, in a variety of electrical switches and relays (UNEP, 2015; 2017). Mercury switches and relays are encountered in many industrial, commercial and consumer products such as electrical appliances, telecommunication circuit boards, security systems, cooking equipment, pumps, computers, telephones, and in car boot light switches and ABS braking systems (UNEP, 2015; 2017).

As there are no identified local manufacturers of mercury switches or relays, mercury releases to air, water and land can only occur: (i) by breakage or loss of switches during use; and (ii) during disposal of the switches or the products containing the switches. It is noteworthy that since the mercury is sealed or enclosed inside the switch or relay, it is not released during normal use.

Although non-mercury substitutes/alternatives are currently and readily available, mercury switches and relays will still constitute a source of mercury input and output due to the long lifetime of the appliance/product, with some lasting even after 50 years (UNEP, 2015; 2017).

Data obtained from the Central Electricity Board (CEB) showed that the latter has about 100 units of obsolete mercury switches, each containing about 10 ml of mercury, which are currently stored in its premises.

### *Input and output estimates*

As the HS codes for switches and relays (8535xxxx – 8536xxxx) do not discriminate between mercury-containing and non-mercury-containing and also due to the fact that mercury containing switches and relays are usually incorporated as components of other equipment, the inventory applied the default method specified in the Toolkit, which assumed 0.02 – 0.25 g mercury per inhabitant for this source category, multiplied by the electrification rate of the country which was 99.2% in 2014 (World Bank, 2016).

In 2014, only a minute amount of e-wastes was collected for recycling and nearly all were dumped into the environment or stored at generators' premises. The recommended default output factor

applicable to Mauritius is 0.1 to air, 0.1 to land and 0.8 to general waste (i.e., countries with publicly controlled waste collection services, but only limited waste separation).

The mercury input and output estimates for mercury switches and relays are shown in Table 2.36, with the mean shown in brackets.

**Table 2.36: Input and output estimates for mercury switches and relays**

<b>Mercury switches and relays</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	inhabitants	1,251,627*	-
Input factor for phase	g Hg/inhabitant	0.02 – 0.25 (0.14)	-
Calculated input to phase	kg Hg/y	25.03 – 312.91 (168.97)	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.00	-
- Land		0.10	-
- Products		0.00	-
- General waste treatment		0.80	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	2.50 – 31.29 (16.90)	2.50 – 31.29 (16.90)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	2.50 – 31.29 (16.90)	2.50 – 31.29 (16.90)
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	20.02 – 250.33 (135.18)	20.02 – 250.33 (135.18)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

\*Adjusted for electrification rate

### ***Certainty assessment***

Activity data: HIGH (as they were based on national population and electrification rate).

Input estimates: LOW (as they are based on the very generic Toolkit default factors).

Output estimates: LOW (as they are based on the Toolkit default factors).

### ***Comparison with inventory level 1: 2012 estimates***

The 2012 inventory report used the same methodology to estimate the mercury input and output based on number of inhabitants and a default input factor of approximately 0.14 g Hg/inhabitant which corresponded to the mean of the range used in this present inventory. The amount estimated in 2012 (181 kg) is nearly the same as the mean obtained in this study, namely 169.0 kg. The difference is

due to the fact that the number of inhabitants inputted in 2012 (1,303,717) is higher than in 2014 (1,261,721).

### 2.6.3 Light sources with mercury

Mercury is present in small amounts in linear fluorescent tubes, compact fluorescent lamps (CFLs), and in high-pressure discharge lamps, such as metal halide, mercury vapour, sodium vapour, and ultraviolet/infra-red lamps (UNEP, 2015; 2017). The most common use for the high-pressure discharge lamps is in street lighting. Zero-mercury alternatives such as light-emitting diode (LED) lamps are now available with light performance approaching that of fluorescent lamps.

Elemental mercury is incorporated into the lamp during manufacture to act as a multi-photon source, producing ultraviolet light when an electric current is applied through it. Mercury in fluorescent lamps exists as vapour-phase elemental mercury and divalent mercury adsorbed on the phosphor powder, the metal lamp ends or other components. At the end of their lifetime, most of the mercury in the lamp is in divalent form and 99% of the mercury when disposed is embedded in the tube coating powder.

As the mercury is contained in a sealed glass tube, it is not emitted during normal use. However, when lamps break during use or when disposed of in landfill, elemental mercury will be released immediately to the air but the phosphor powder with adsorbed mercury is released only slowly.

Currently there is no systematic collection of used mercury-containing lamps for recycling. There is one company which possesses a CFL Premium Bulb Eater which is stated to crush spent fluorescent lamps of any size into 100% recyclable material, while capturing over 99.99% of the vapours released<sup>23</sup>. An activated carbon filter located inside the unit is used to capture and neutralize the mercury vapour released from the lamps during crushing. Two potential waste streams that have to be managed as Hg-containing hazardous waste are identified. One is the carbon filter where the Hg vapour is captured. The second is the crushed bulb parts where Hg can adhere to the inside walls of the bulbs (with the phosphor powder). A random analysis of a sample of crushed bulb parts indicated a mercury level of 1.72 mg/kg. The company provides this facility for its clients only and is operating the equipment to its minimal capacity.

No local company manufacturing lamps has been identified in this survey. Import data for the different lamps and tubes were obtained from Statistics Mauritius, covering the period 2012 to 2015 in addition to 2009 (Table 2.37 and Figure 2.7) using HS codes ranging from 85393110 to 85394900.

The import data indicated that lamps were imported from about 46 different countries, with the dominant suppliers being indicated below for each type.

- Discharge lamps, fluorescent, hot cathode: China (70.0%); Poland (13.1%); Indonesia (5.9%); Thailand (1.8%); Netherlands (1.7%).
- Mercury or sodium vapour lamps and metal halide lamps: China (39.0%); United Arab Emirates (31.3%); Hungary (5.7%); Germany (5.3%); France (5.1%).
- Low energy consumption lamps: China (96.9%); United Arab Emirates (1.7%).
- Light emitting diode lamps: China (90.3%); India (2.0%); South Africa (1.8%); Hong Kong (1.7%).

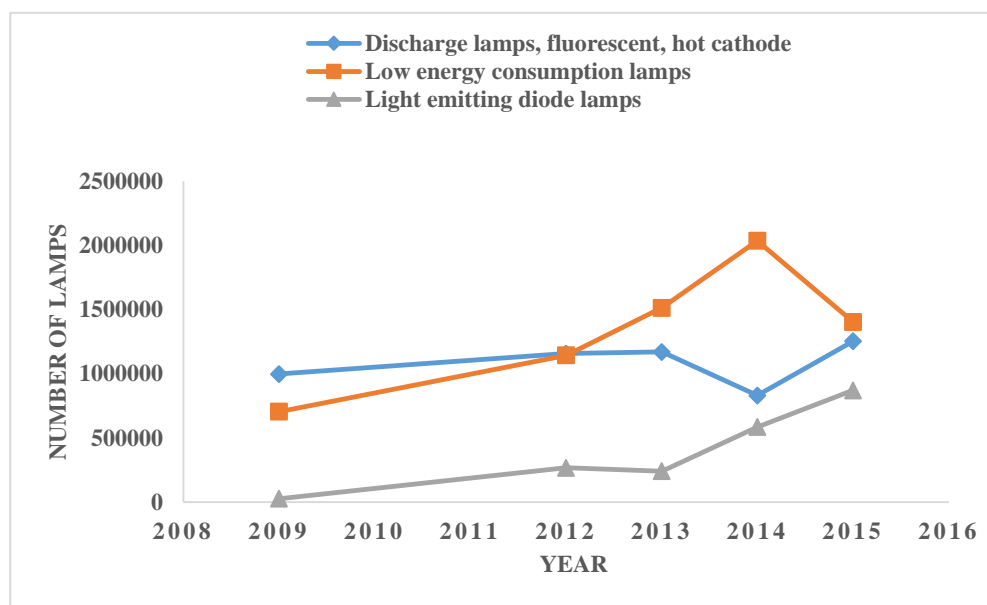
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<sup>23</sup> <http://www.aircycle.com/cfl-premium>

- Discharge lamps, other than ultra-violet, low energy and fluorescent lamps: China (91.1%); France (4.0%); Hungary (1.5%); Germany (1.1%).
- Ultra-violet or infra-red lamps excluding arc-lamps: China (84.4%); Germany (8.4%).

**Table 2.37: Amount of light sources imported in 2009 and 2012 – 2015**

HS Code	Lamp Type	2009	2012	2013	2014	2015
85393110/ 85393190	Discharge lamps, fluorescent, hot cathode	997,464	1,156,967	1,169,654	830,645	1,252,643
85393200	Mercury or sodium vapour lamps; metal halide lamps	18,368	15,789	10,414	11,120	7,427
85393910	Low energy consumption lamps (CFL)	704,361	1,143,315	1,512,963	2,035,030	1,403,178
85393920	Light emitting diode (LED) lamps	26,916	266,740	240,699	585,405	869,842
85393990	Discharge lamps, other than ultra-violet, low energy and fluorescent lamps	1,129,255	2,153,891	1,539,337	1,216,136	1,688,844
85394900	Ultra-violet or infra-red lamps excluding arc-lamps	11,655	11,411	26,074	145,279	69,401



**Figure 2.7: Import of light sources in 2009 and 2012 – 2015**

Data showed a constant rise in the import of LED lamps from 2009 to 2015 whereas the number of imported CFLs decreased sharply in 2015. It is noteworthy that the number of imported mercury, sodium vapour and metal halide lamps was also found to decrease. A drop of nearly 40% and 60%

was observed from 2009 to 2014 and 2015 respectively. On the other hand, the total number of imported ultraviolet and infrared lamps increased sharply in 2014, compared to the three previous years, most probably due to a reporting anomaly by importer(s).

The mercury content of the lamps by type is used as input factor. Examples of mercury content in lamps are shown in Table 2.38, obtained from the safety data sheets (SDS) of the main trade names. In general, the amount of mercury in fluorescent light tubes has been reduced during the last decade. The maximum mercury contents are generally 8 and 5 mg/lamp for linear fluorescent and compact fluorescent lamps respectively. The amount of mercury in discharge lamps other than fluorescent and CFLs varies from 5 to 30 mg/lamp (UNEP, 2015; 2017). On the other hand, there is no incorporation of mercury in LED lamps. Visits to supermarkets and retail shops showed that the LED lamps normally have the label ‘no mercury’ whereas CFLs have the wordings “contains mercury” but the exact or approximate mercury content in the lamps is not specified.

**Table 2.38: Mercury content in light sources**

Source type	Trade name	Country	Mercury level, % weight or item	Default Hg content, mg/item	Date of SDS
Linear fluorescent lamps	Philips	USA	~ 0.01%	10 – 40	Dec 2015
	Sylvania/Osram	USA	< 0.05%		Jun 2005
	Osram	Germany	Max 8 mg		Not indicated
Compact fluorescent lamp (CFL)	GE	USA	< 5 mg	5 – 15	Sep 2007
	Philips	USA	< 0.025%		Sep 2016
	Sylvania	USA	< 0.02%		Oct 2016
	Osram	Germany	< 5 mg		Sep 2014
Mercury vapour lamps	Philips	USA	< 0.05%	30	Sep 2016
	Sylvania	China	< 0.1%		Oct 2016
High pressure sodium lamps	Philips	USA	< 0.03%	10 – 30	Dec 2015
	Sylvania/Osram	Mexico	< 0.05%		Oct 2016
Metal halide lamps	Philips	USA	< 0.03 – 0.07%	25	Dec 2015
	Sylvania	USA	< 0.01%		Oct 2016

The Government of Mauritius carried out a pilot project in 2008 – 2009 to replace incandescent lamps by CFLs as the latter were considered a good option for minimizing energy consumption. About one million CFLs were sold at discounted prices mainly to residential customers by the CEB. However, the project was not further replicated.

From surveys carried out in secondary schools, a total of about 59 mercury spectral or vapour lamps are in use or in stock. Responses received from the Ministry of Local Government and Outer Islands (MoLGOI) showed that only CFL and LED lamps are used for street lighting.

Mercury emissions due to breakage of lamps before disposal have been estimated from the consumption of mercury lamps and the estimated percentage of the lamps that break before disposal was 5% as reported in the literature (UNEP, 2015; 2017). The remaining 95% present in the phosphor powder is assumed to be disposed of in the general waste.

According to the UNEP toolkit (2015; 2017), the mercury input to disposal is the mercury content in the light sources multiplied by the number of such items consumed a few years earlier. As the mean

lifetime of a lamp is about 5 years, the number of lamps imported in 2009 was used for calculation as well as that for 2014 to provide a good indicator for future outputs.

The estimates for the total mercury inputs for all types of lamps are summarised in Table 2.39 (mean given in brackets), based on the mercury content information given above or the Toolkit default factors in case of unavailability of information.

**Table 2.39: Mercury input estimates for light sources**

Lamp type	Hg content, mg/lamp	No of lamps imported in 2009	Total Hg input in 2009, kg	No of lamps imported in 2014	Total Hg input in 2014, kg
Linear fluorescent tubes	5 – 15 (10)	997,464	4.99 – 14.96 (9.97)	830,645	4.15 – 12.46 (8.31)
Compact fluorescent lamps (CFLs)	3 – 10 (6.5)	704,361	2.11 – 7.04 (4.58)	2,035,030	6.11 – 20.35 (13.22)
Mercury, sodium vapour lamps; metal halide lamps	10 – 30 (20)	18,368	0.18 – 0.55 (0.37)	11,120	0.11 – 0.33 (0.22)
UV/IR lamps	5 – 25 (15)	11,655	0.06 – 0.29 (0.17)	145,279	0.73 – 3.63 (2.18)
Discharge lamps, other than ultra-violet, low energy and fluorescent lamps	5 – 30 (17.5)	1,129,255	5.65 – 33.88 (19.76)	1,216,136	6.08 – 36.48 (21.28)
<b>All lamps</b>	<b>5 - 30</b>	<b>2,861,103</b>	<b>12.99 – 56.72 (34.86)</b>	<b>4,238,210</b>	<b>17.18 – 73.25 (45.21)</b>

In Mauritius where there are publicly controlled waste collection services, but only limited waste separation, it is recommended by the Toolkit to apply distribution factors of 0.05 (5%) to air, and 0.95 (95%) to waste, for the Hg outputs.

The mercury input and output estimates for mercury lamps are shown in Table 2.40 using the import figures for 2009 instead of 2014 taking into consideration the lifetime of a lamp. The figures shown in brackets are the means of the reported ranges.

**Table 2.40: Input and output estimates for light sources**

<b>Light sources with mercury</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate (linear fluorescent tubes)</b>	items/y	997,464	-
Input factor for phase	mg Hg/item	5 – 15 (10)	-
Calculated input to phase	kg Hg/y	4.99 – 14.96 (9.97)	-
<b>Activity rate (compact fluorescent lamps)</b>	items/y	704,361	-
Input factor for phase	mg Hg/item	3 – 10 (6.5)	-
Calculated input to phase	kg Hg/y	2.11 – 7.04 (4.58)	-
<b>Activity rate (mercury and sodium vapour lamps, metal halide lamps)</b>	items/y	18,368	-
Input factor for phase	mg Hg/item	10 – 30 (20)	-
Calculated input to phase	kg Hg/y	0.18 – 0.55 (0.37)	-
<b>Activity rate (UV/IR lamps)</b>	items/y	11,655	-
Input factor for phase	mg Hg/item	5 – 25 (15)	-
Calculated input to phase	kg Hg/y	0.06 – 0.29 (0.17)	-
<b>Activity rate (Discharge lamps, other than ultra-violet, low energy and fluorescent lamps)</b>	items/y	1,129,255	-
Input factor for phase	mg Hg/item	5 – 30 (17.5)	-
Calculated input to phase	kg Hg/y	5.65 – 33.88 (19.76)	-
<b>Output distribution factors for phase:</b>			-
- Air		0.05	-
- Water		0.00	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.95	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.65 – 2.84 (1.74)	0.65 – 2.84 (1.74)
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	12.34 – 53.88 (33.11)	12.34 – 53.88 (33.11)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### *Certainty assessment*

Activity data: HIGH (as they were based on national trade statistics).

Input estimates: MEDIUM (as they are based on published safety data sheets and Toolkit).

Output estimates: LOW (as they are based on the Toolkit default factors).

### *Comparison with inventory level 1: 2012 estimates*

The 2012 inventory report estimated a total mercury input from lamps of 70.4 kg/y which is much higher than the average 2009 and 2014 input of 34.9 and 45.2 kg/y. The difference can be explained by the fact that in the level 1 inventory, of the number of all potentially mercury containing lamps (4,469,962), it was assumed that 60% represent CFLs (2,681,977), 30% fluorescent tubes (1,340,988) and 10% other mercury containing lamps (446,996) whereas in the present one, it is assumed that the HS code 85393110 and 85393190 indicate LFLs and HS code 85393910 indicates CFLs.

The mercury releases in 2012 from light sources were estimated to be 3.5 kg/y to air and 66.9 kg/y to waste compared to 1.7 kg/y to air and 33.1 kg/y to waste in this study.

#### **2.6.4 Batteries with mercury**

Batteries can be categorised into two main groups: primary and secondary. Primary batteries are discarded when they are flat, as they cannot be recharged for reuse. Common types of primary batteries include alkaline, zinc-carbon, lithium, mercuric oxide, silver oxide and zinc-air. On the other hand, secondary batteries can be recharged and reused. Examples of rechargeable batteries are nickel metal hydride, nickel-cadmium and lithium ion.

Most batteries in the local market are sold either in the form of cylindrical or button-cell. Button-cell batteries are not rechargeable and are small and thin. They are commonly encountered in calculators, watches, computers, toys, cameras, hearing aids, digital thermometers and other small and portable electronic devices. Many types of button-cell batteries contain mercury, including silver oxide, zinc-air and alkaline manganese oxide. In these types of batteries, up to 25 mg of mercury is added to suppress zinc corrosion and prevent hydrogen gas development. However, mercury, serving as the positive electrode rather than an additive to control gas buildup, is still an essential component in mercuric oxide batteries, where it accounts for 30-40% of the total battery weight. They are used in medical equipment, in hearing aids and in commercial applications where a stable current and long lasting life is necessary.

Mercuric oxide batteries are prohibited in Mauritius as per the Consumer Protection (Control of Imports) Regulation of 1999 though there are still mention of imports of these types of batteries in the national trade statistics (Table 2.41). It is noteworthy that button-cell lithium ion batteries contain no intentionally-added mercury. From visits to supermarkets and some traders, it was observed that cylindrical batteries such as AAA, AA, C and D alkaline encountered in the local market were marked on the product not to contain any intentionally added mercury.

The button-cell batteries, when in use, do not pose a health risk since the probability of the mercury leaking out is small. However, the mercury can escape into the environment after they have been thrown away and are disposed in landfills when the batteries become corroded.

There is no battery manufacturing company in Mauritius and all batteries are imported. To estimate mercury inputs from batteries, import data were obtained for each battery type, using HS codes 85061000 to 85068000 (Table 2.41).

**Table 2.41: Amount of batteries (units) imported in 2012 – 2015**

HS Code	Battery type	2012	2013	2014	2015
85061000	Manganese dioxide primary cells or batteries	1,220,471	2,110,004	2,655,753	2,013,058
85063000	Mercuric oxide primary cells or batteries	78,798	81,224	79,776	84,366
85064000	Silver oxide primary cells or batteries	23,722	26,059	9,215	22,967
85065000	Lithium primary cells or batteries	18,766	29,053	18,109	36,074
85066000	Air-zinc primary cells or batteries	260	96,548	6,700	15,835
85068000	Other primary cells/batteries excluding 85061000/6000 (mainly zinc-carbon)	9,164,240	16,358,881	3,830,368	6,356,606

The UNEP toolkit (2015; 2017) mentioned that national trade statistics for mercuric oxide batteries are often severely inaccurate as these batteries are very vulnerable to mis-categorisation of other batteries in traders' reports to the statistics bureau. This may result in higher mercury inputs with even moderate reported sales of mercuric oxide batteries as its mercury content is much higher compared to the other battery types. As the import of mercuric oxide batteries is banned in Mauritius, information was requested from the customs department of the Mauritius Revenue Authority (MRA) on the identity of the companies which had imported them. Survey forms and responses received from the importing companies indicated that there had been mis-categorisation and no imported mercuric oxide batteries at all.

The amount of imported batteries may also be much higher as in addition to plain battery sales, batteries may be imported in the package of other products like electronics, toys, greeting cards with sounds, etc. However, the amounts in these products can be considered to be small compared to the volume of batteries imported shown in Table 2.41. The 2014 import data indicate that batteries were imported from about 20 different countries, with the main suppliers being:

Manganese dioxide batteries: China (78.1%), Poland (7.3%), Germany (6.0%) and Belgium (2.8%).

Silver oxide batteries: France (37.5%), Singapore (29.6%), USA (23.9%), Japan (9%).

Lithium batteries: China (60.7%), Japan (12.7%), South Africa (7.4%), Indonesia (5.0%).

Zinc-air batteries: Germany (89.6%), United Kingdom (10.4%).

Zinc-carbon batteries: China (53.7%), Singapore (45.4%).

Information on the mercury content of batteries was not obtained from the local suppliers but from the SDS of the main brand names available in Mauritius (Table 2.42). It was noted that there was no

intentional incorporation of mercury in battery types having HS codes 85061000, 85065000 and 85068000 as from 2010. The mercury content in these batteries is stated to be less than 1 mg/kg and their mercury inputs are considered to be negligible. Thus mercury input will be derived from mainly two battery types, namely silver oxide (HS code 85064000) and air-zinc (HS code 85066000), and the quantities of mercury were calculated by multiplying the number of units by their respective average weights and by the amount of mercury present in each cell.

**Table 2.42: Mercury content in batteries**

Battery type	Trade name	Country	Mercury level	Date of SDS
Primary alkaline (Zn-MnO <sub>2</sub> ) (button and cylindrical)	Varta	Germany	< 1 mg/kg (No intentionally added Hg)	Jan 2016
	Panasonic	USA	No intentionally added Hg	Jan 2013
	Energizer/Eveready	USA	No intentionally added Hg	Jan 2010
	Duracell	USA	No intentionally added Hg since 1993 (< 0.0005%)	July 2008
	GP	Hong Kong	< 1 × 10 <sup>-4</sup> %	Jan 2011
Carbon-zinc	Eveready	USA	No intentionally added Hg	Jan 2013
	Panasonic	USA	No intentionally added Hg since 1992	Jan 2014
	Varta	Germany	< 0.0001 %	Jan 2009
Zinc-air (all types)	Energizer	USA	No intentionally added Hg	Jan 2012
	Panasonic	USA	No intentionally added Hg	May 2005
	Varta	Germany	No intentionally added Hg (< 5 mg/kg); < 0.025%	Aug 2016
	Duracell	USA	No intentionally added Hg (< 0.0005%)	Jan 2015
Zinc-silver oxide button cell	Varta	Germany	0.15 – 0.5% (< 25 mg per cell)	Aug 2010; Feb 2011
	Energizer	USA	0.3 – 1.0%	Aug 2009; Jan 2010
	Maxell	Japan	< 0.5%	April 2008
	Duracell	USA	< 1%; < 0.0005%	July 2008; Dec 2015
	GP	Hong Kong	< 0.83%	Jan 2013
	Energizer (No Hg)	USA	No intentionally added Hg	Jan 2016

Since most of the batteries are imported from China, it was noted that the Chinese government has been making efforts to promote mercury-free batteries. In accordance with the *Regulation on Restriction of Hg in Batteries* issued in 1997 by China, the production of batteries containing more than 0.025 percent of mercury by weight has been banned since January 1, 2001, and the marketing of cylindrical alkaline manganese batteries containing more than 0.0001 percent of mercury by weight has been banned since January 1, 2006 (Wang Wei, 2009).

The estimated mercury inputs for the different battery types in 2014 are shown in Table 2.43 based on the average weight of different types of battery (mean of reported range indicated within brackets). For alkaline manganese dioxide batteries, it was assumed that 90% of the imported batteries were

cylindrical and the remaining button. For the batteries which were mis-categorised as mercuric oxide, the number of imported batteries was added to the battery type category: manganese dioxide primary cells or batteries. Thus the amended number of manganese dioxide primary cells or batteries amount to 2,735,529.

**Table 2.43: Estimated mercury inputs for the different battery types in 2014**

Battery type	Mercury content, g/kg	Number of batteries	Average weight per battery, g	Total weight of batteries, kg	Mercury inputs, kg
Silver oxide	1.5 – 10 (5.75)	9,215	1	9.2	0.014 – 0.092 (0.053)
Zinc air	0.005 – 12 (6.00)	6,700	1	6.7	0.000034 – 0.080 (0.040)
Manganese dioxide (button)	0 – 0.00005 (0.000025)	273,553	3	821	0 – 0.00004 (0.00002)
Manganese dioxide (cylindrical)	0 – 0.00005 (0.000025)	2,461,976	12	29,544	0 – 0.00148 (0.0007)
Carbon-zinc	0 – 0.00001 (0.000005)	3,830,368	12	45,964	0 – 0.0005 (0.0002)
Lithium	0 – 0.00005 (0.000025)	18,109	3	54.3	0 – 0.000003 (0.000001)
<b>All types</b>	<b>0 - 12</b>	<b>6,599,921</b>	<b>1 - 12</b>	<b>76,399.2</b>	0.014 – 0.174 (0.094)

From Table 2.43, it is observed that the highest mercury input is derived from the silver oxide and zinc air batteries but the overall contribution from batteries is negligible. Mercury input to disposal is the mercury content in the batteries, multiplied by the number of batteries (of the same type) that are disposed of. It is noteworthy that mercury disposal with batteries reflects battery mercury content from earlier years (life-times of a few years, depending on type and use). This is important as mercury concentrations in batteries may have changed in the last few years.

Since Oct 2010, as part of its corporate social responsibility, Mauritius Telecom has started to collect used batteries for recycling abroad. It relies on a network of 238 collection points comprising hotels, firms, municipalities, district councils, post offices, supermarkets in addition to its Orange shops. Moreover 10,000 small boxes have also been placed in offices in government and in the private sector. In February 2012, 6.4 tonnes of used batteries have been collected and for the years 2014 – 2015, the amount collected was 23.8 tonnes.

However, the major parts of the used batteries (namely those not collected) are disposed of with the general household waste in landfill. Mercury will be released only slowly if the encapsulation is degraded, by gradual evaporation to the atmosphere and leaching to waste water. The actual evaporation or bioavailability of the contained mercury may be delayed several years or even decades because the degradation of the battery encapsulation is expected to happen slowly.

For the outputs, it was assumed that 90% of the batteries were disposed to waste and 10% collected by Mauritius Telecom for recycling abroad. The input and output calculations are shown in Table 2.44. The figures shown in brackets are the means of the reported ranges.

**Table 2.44: Input and output estimates for batteries**

<b>Batteries with mercury</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate (silver oxide batteries)</b>	kg/y	9.2	-
Input factor for phase	g Hg/kg	1.5 – 10 (5.75)	-
Calculated input to phase	kg Hg/y	0.014 – 0.092 (0.053)	-
<b>Activity rate (zinc air batteries)</b>	kg/y	6.7	
Input factor for phase	g Hg/kg	0.005 – 12 (6.00)	
Calculated input to phase	kg Hg/y	0.000 – 0.080 (0.040)	
<b>Activity rate (button manganese dioxide batteries)</b>	kg/y	821	
Input factor for phase	g Hg/kg	0 – 0.00005 (0.000025)	
Calculated input to phase	kg Hg/y	0 – 0.00004 (0.00002)	
<b>Activity rate (cylindrical manganese dioxide batteries)</b>	kg/y	29,544	
Input factor for phase	g Hg/kg	0 – 0.00005 (0.000025)	
Calculated input to phase	kg Hg/y	0 – 0.00148 (0.0007)	
<b>Activity rate (carbon-zinc batteries)</b>	kg/y	45,964	
Input factor for phase	g Hg/kg	0 – 0.00001 (0.000005)	
Calculated input to phase	kg Hg/y	0 – 0.0005 (0.0002)	
<b>Activity rate (lithium batteries)</b>	kg/y	54.3	
Input factor for phase	g Hg/kg	0 – 0.00005 (0.000025)	
Calculated input to phase	kg Hg/y	0 – 0.000003 (0.000001)	
<b>Output distribution factors for phase:</b>			
- Air		0.00	-
- Water		0.00	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.90	-
- Sector specific waste treatment		0.10	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.00	0.00
- Water	kg Hg/y	0.00	0.00
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.013 – 0.157 (0.085)	0.013 – 0.157 (0.085)
- Sector specific waste treatment	kg Hg/y	0.0014 – 0.017 (0.009)	0.0014 – 0.017 (0.009)

### *Certainty assessment*

Activity data: HIGH (as they were obtained from national import statistics).

Input estimates: MEDIUM (as they are based on product SDS and the default Toolkit factors).

Output estimates: MEDIUM (as 90% of all batteries are assumed to be disposed to landfill).

### *Comparison with inventory level 1: 2012 estimates*

The 2012 inventory report did not provide any input estimate for batteries.

### **2.6.5 Polyurethane with mercury catalysts**

Organic mercury compounds have been used as catalysts in the manufacture of a variety of polyurethane elastomers such as flexible plastics, coatings, sealants and adhesives, and remain incorporated into the polymer structure and final product (UNEP, 2015; 2017). The polyurethane products have been used in a wide range of end products like rollers, flooring, and shoe soles.

The main releases of mercury are from the use of products with polyurethane parts due to wear and tear and by the disposal of discarded products, which end up in the general waste.

There is no local production of polyurethane products. Polyurethane containing mercury is imported mainly as finished products. As it is difficult to estimate the amount of mercury-containing polyurethane products in the country, the UNEP toolkit default input factor of 0.01 – 0.05, with a mean of 0.03 g Hg/inhabitant multiplied by percent population having access to electricity (99.2%) is applied (World Bank, 2016).

Based on the waste management status in Mauritius, the recommended UNEP toolkit default factor of 0.1, 0.05 and 0.85 to air, water and general waste respectively is used for mercury releases from polyurethane use and disposal.

The input and output estimates for mercury containing polyurethanes are shown in Table 2.45, with the mean shown in brackets.

**Table 2.45: Input and output estimates for mercury containing polyurethanes**

<b>Mercury containing polyurethanes</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	inhabitants	1,251,627*	-
Input factor for phase	g Hg/inhabitant	0.01 – 0.05 (0.03)	-
Calculated input to phase	kg Hg/y	12.52 – 62.58 (37.55)	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.05	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.85	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	1.25 – 6.26 (3.76)	1.25 – 6.26 (3.76)
- Water	kg Hg/y	0.63 – 3.13 (1.88)	0.63 – 3.13 (1.88)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	10.64 – 53.19 (31.92)	10.64 – 53.19 (31.92)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

\*Adjusted for electrification rate

### ***Certainty assessment***

Activity data: HIGH (as they were based on national population and electrification rate).

Input estimates: LOW (as they are based on the Toolkit default factors).

Output estimates: LOW (as they are based on the Toolkit default factors).

### ***Comparison with inventory level 1: 2012 estimates***

The 2012 inventory report used the same methodology to estimate the Hg input and output based on number of inhabitants. The amount estimated in 2012, namely 39 kg is nearly the same as in this study (37.6 kg).

### **2.6.6 Biocides and pesticides**

Biocides and pesticides are not manufactured locally. Import of pesticides and other mercury-containing compounds such as biocides are regulated by the Dangerous Chemicals Control Act (DCCA) of 2004. No permit for import of mercury-containing biocides and pesticides has been issued in 2014. Thus, input of mercury from this sub-category is estimated to be nil, as also mentioned in the level 1 inventory.

### **2.6.7 Paints**

From surveys carried out, it was observed that the local paint manufacturers no longer used mercury pigments. Analysis of two locally manufactured gloss red paints confirmed that the mercury level is below the detection limit of the analytical equipment (0.0041 mg/kg). Thus, it was concluded that there was no mercury release for this sub-category.

### **2.6.8 Pharmaceuticals for human and veterinary uses**

There are various pharmaceuticals, namely vaccines and eye drops where mercury has been/is used as preservative. Thus, thimerosal/thiomersal has been used for years in vaccines to prevent growth of various pathogens (UNEP, 2015; 2017). As the vaccines contain only about 50 µg thimerosal per dose, the mercury input from this sub-category was estimated to be minimal compared to the other categories. Note that the chemical thimerosal/thiomersal is listed in the specific exclusions list given in Annex 1 of the text for the Minamata Convention.

### **2.6.9 Cosmetics and related products**

Mercury has been reported to be used in skin lightening creams and soaps. There is no local production of skin lightening creams and soaps. The latter are mainly imported or brought to the country usually by people returning from business trips or holidays and sold on the informal market. It is practically impossible to estimate the amount of mercury-containing cosmetics in the country. However, it is felt that the contribution from this sub-category would be most likely to be small given that cosmetics containing mercury are not usually sold in supermarkets and in pharmacies, but mainly in the small shops and in the streets. Mercury can be released to water when the cosmetics are removed by washing and the small amount left in the tubes and containers is usually disposed of as general waste.

Given the health impacts of use of these mercury-containing cosmetics, action has been initiated by the Pharmacy Board to control the entry of these goods to the country. Pharmacists/ Senior Pharmacist are posted daily at the parcel post office (as from 1999), at the airport (as from 2012), and seaport (as from 2016) to verify consignments before release. Permit to import skin-lightening creams and lotions are being issued to companies only after having received certificate of analysis ruling out the presence of mercury in such products. These laboratory tests are also being repeated locally to countercheck the results. These have been confirmed by one analytical laboratory that it is getting more and more samples of creams to be analysed for mercury content.

Despite these measures, some creams available locally may still contain mercury. Thus in order to ascertain the presence of these types of creams, twelve samples were analysed and four of them, three from China and one from Pakistan, were found to exceed 1 mg/kg (two whitening creams, one speckle removing day cream and one speckle removing night cream). It is noteworthy that one whitening cream and the speckle removing night cream had a mercury level of 28.25 and about 9,000 mg/kg respectively.

Some other related products available locally, namely toilet soap (two locally manufactured and one imported), toothpaste (one locally manufactured and two imported), lens cleaning solution (one imported), and mouthwash (two imported abroad) were analysed and found to contain less than 0.0041 mg/kg mercury.

In conclusion, considering that mercury containing creams and soaps are not observed marketed in supermarkets and that many products with the same functions do not contain mercury, yet for those that do contain mercury, concentrations may be substantial. Thus, it is assumed that mercury amounts involved are likely to be moderate, but possibly not insignificant. Consequently, the authorities should consider undertaking more strict control on the sale of cosmetic products, especially whitening cream and similar product, in the informal sector (street vendors and hawkers) as these may potentially contain high levels of mercury. This subject should be prioritised in future inventories, if feasible. It is noteworthy that whitening creams with dangerous ingredients such as mercury are treated as selected prohibited goods in the Customs Act since July 2017.

#### **2.6.10 Dental mercury-amalgam fillings**

Dental amalgam fillings consist of a combination of metals, containing about 50% of mercury in elemental form and the other metals being silver, tin, copper and other trace metals. It has been used in the last 150 years for dental restoration due to its excellent mechanical properties and durability.

In Mauritius, the amalgams are still being used, although non-mercury alternatives such as composites are available. The alloy is supplied in the form of pre-dosed capsules where mercury and the metal powder need only to be mixed, before filling the cavity in the tooth. No mixing of liquid mercury and metal powder is practiced in Mauritius since the mid-2000s.

No production of amalgam capsules occur in Mauritius. Mercury is thus only released during preparation, use and disposal of the amalgam fillings. It is important to note that mercury from dental amalgams is also released when a deceased person is buried or cremated (refer to section 2.7).

Some amounts of mercury are emitted to air in the dental clinics whereas larger amounts are released in waste water or to waste. Some of the wastes are stored in bottles or containers in the premises awaiting disposal. Amalgam wastes are generated: (i) from extracted teeth containing amalgam restorations; (ii) from scrap amalgam; (iii) from used, leaking, or unusable amalgam capsules; and (iv) from amalgam captured by chair-side traps, vacuum pump filters and other devices. These wastes may enter the environment during discharge of waste water or disposal of sewage sludge. It is noteworthy that of the nine private dentists surveyed by the non-governmental organization (NGO) Pesticide Action Network (PANeM, 2016), all of them indicated that they collect the wastes in tight containers and then dispose them in the general waste. No high efficiency amalgam filters are currently used in the country.

From a report submitted by PANeM (2016), it was observed that the surgical/operational area in a dental clinic/cabinet making use of dental amalgams had the highest mercury levels in air, ranging from 735 to 14,212 ng/m<sup>3</sup>. On the other hand, the ambient air mercury levels in clinics/cabinets using only composites were much lower, in the range of 64.8 to 264 ng/m<sup>3</sup>. Mercury levels were also measured in the mouth of volunteers having: (i) no dental fillings, (ii) only amalgam fillings, (iii) only composite fillings, and (iv) just/recently been placed an amalgam filling. Though there are some exceptions, the order of mercury levels is found to be: (iv) >> (ii) > (iii) > (i). As per the standards established by the American Conference of Governmental Industrial Hygienists (ACGIH, 2009), the Threshold Limit Value (TLV) (Allowable exposure level to mercury vapor, 8 hours per day, 40 hours per week) is 0.05 mg/m<sup>3</sup> or 50 µg/m<sup>3</sup>, which is higher than the levels measured by PANeM. It should be pointed out however that the equipment used by PANeM, namely the LUMEX spectrometer gave levels over a short lapse of time (1-2 minutes).

Import data were obtained from Statistics Mauritius for the HS code 30064000: Dental cement and other dental fillings. The amount imported in 2014 was 2,607 kg (Statistics Mauritius, 2015b). However, the HS code does not differentiate between amalgam fillings and the other dental fillings and in addition the mass includes also the packaging.

The number of dental fillings effected in the government dental clinics, including Rodrigues island, from 2012 – 2015 is shown in Table 2.46 (MoHQL, 2015a). It is observed that the number of amalgam fillings decreased substantially from 2013 to 2015, whereas the number of composite fillings increased.

**Table 2.46: Number of dental fillings in 2012 – 2015 in government dental clinics**

<b>Dental filling</b>	<b>Population type</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Amalgam	School children	8,274	8,054	5,460	5,166
	Adults	38,845	39,864	33,401	31,559
	<b>Total</b>	<b>47,119</b>	<b>47,918</b>	<b>38,861</b>	<b>36,725</b>
Composite	School children	828	914	1,252	1,115
	Adults	13,872	16,977	19,580	21,106
	<b>Total</b>	<b>14,700</b>	<b>17,891</b>	<b>20,832</b>	<b>22,221</b>

Information obtained from some private dentists and from data extracted from a report (PANeM, 2016) indicate that the use of dental amalgam to non-mercury alternatives in the private sector is generally in the ratio of 1:1. However, some dentists, especially the new ones, claimed to use only non-mercury alternatives for the fillings.

From the UNEP toolkit (2015; 2017), the average mercury consumption per dental amalgam filling amounts to about 0.8 g. Using this value, the amount of Hg input from dental fillings in 2014 in the government dental clinics amounted to about 31 kg. It is noteworthy that there were 366 dentists operating in 2014 (only 58 worked in the government dental clinics), corresponding to a dental population density of about 0.29 for 1,000 inhabitants (MoHQL, 2015a).

To limit the use of dental amalgam in Mauritius, the MoHQL has been very active in initiating measures that include:

- Strengthening of oral health promotion and disease prevention in schools and communities as the strategy to reduce the use of all restorative dental materials. Preventive care reinforced by widespread use of fluoride and pits and fissure sealants among children.
- Banning of dental amalgam in pregnant women and young children.
- An increased focus on the use of ‘white fillings’, glass-ionomer cements and resin-based composite materials.
- Use of amalgam separators, together with other measures of Best Management Practices contemplated to reduce mercury discharge to the environment.

### ***Input and output estimates***

The Toolkit recommends default factors of 0.05 – 0.20 g/year per capita and an adjustment for the dental population density (0.29 for 1000 inhabitants) for estimating current mercury inputs via dental amalgams. Taking into account that the governmental dental clinics alone contribute about 31 kg, default factors of 0.10 – 0.20 g/y are suggested instead, giving input rates of between 44.1 and 88.3

kg/y, with a mean of 66.2 kg/y for preparation of dental mercury-amalgam fillings. Although there are more private dentists, this is counterbalanced by the fact that there are more patients in the governmental clinics and that some private dentists do not have recourse to dental amalgams. Thus, the estimated range and mean seemed to be reasonable.

On the other hand, mercury releases resulting from the other life cycle phases of the amalgam fillings, namely their use and disposal, should have been estimated based on mercury inputs with dental fillings at different times (5 – 20 years ago) due to the long lifetime of amalgam fillings (10 – 20 years for adult's teeth). For the present inventory, the population estimate was different at that time (1,227,075 in 2007 and 1,144.721 in 1999) and the dental population density (0.18 and 0.13) for 2007 and 1999 were lower (MoHQL, 2008; 2010). However, the amalgam to composites ratios were likely to be higher at that time since very few composites were used as dental fillings. In conclusion, it was chosen to use the 2014 estimate as activity rate for also releases during use and during disposal.

Table 2.47 summarises the input and output estimates for mercury dental amalgam, with the mean reported within brackets.

**Table 2.47: Input and output estimates for mercury dental amalgam**

Dental amalgam	Unit	Production	Use	Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	inhabitants	1,262,721	1,262,721	1,262,721	-
Input factor for phase	g Hg/ inhabitant	0.10 – 0.20 (0.15)	0.10 – 0.20 (0.15)	0.10 – 0.20 (0.15)	-
Calculated input to phase	kg Hg/y	44.13 – 88.25 (66.19)	44.13 – 88.25 (66.19)	44.13 – 88.25 (66.19)	-
<b>Output distribution factors for phase:</b>					
- Air		0.02	0.00	0.00	-
- Water		0.14	0.02	0.30	-
- Land		0.00	0.00	0.08	-
- Products		0.00	0.00	0.06	-
- General waste treatment		0.12	0.00	0.08	-
- Sector specific waste treatment		0.12	0.00	0.08	-
<b>Calculated outputs/releases to:</b>					
- Air	kg Hg/y	0.88 – 1.77 (1.32)	0.00	0.00	0.88 – 1.77 (1.32)
- Water	kg Hg/y	6.18 – 12.36 (9.27)	0.88 – 1.77 (1.32)	13.24 – 26.48 (19.86)	20.30 – 40.61 (30.45)
- Land	kg Hg/y	0.00	0.00	3.53 – 7.06 (5.30)	3.53 – 7.06 (5.30)
- Products	kg Hg/y	0.00	0.00	2.65 – 5.30 (3.97)	2.65 – 5.30 (3.97)
- General waste treatment	kg Hg/y	5.30 – 10.59 (7.94)	0.00	3.53 – 7.06 (5.30)	8.83 – 17.65 (13.24)
- Sector specific waste treatment	kg Hg/y	5.30 – 10.59 (7.94)	0.00	3.53 – 7.06 (5.30)	8.83 – 17.65 (13.24)

### *Certainty assessment*

Activity data: LOW (as they were based on national population and dental population density).

Input estimates: MEDIUM (as they are based on the Toolkit default factors and data from MoHQL).

Output estimates: LOW (as they are based on the Toolkit default factors).

### *Comparison with inventory level 1: 2012 estimates*

The level 1 inventory report determined the mercury releases due to preparation, use and disposal of amalgam fillings based on the number of inhabitants and dental population density in 2012 using an input factor of 0.20 g Hg/inhabitant while for the present inventory, the mercury releases were estimated based on the population number and dental population density in 2014 using a mean input factor of 0.15 g Hg/inhabitant. The amount of 67.5 kg in this study is higher than the 59 kg estimated in 2012 due to a higher dental population density.

### **2.6.11 Manometers and gauges**

Occurrences of mercury in this sub-category are in blood pressure apparatuses (sphygmomanometers), in manometers and pressure valves used in a range of industrial and laboratory applications (UNEP, 2015; 2017).

Manometers and gauges are all imported as there is no production of manometers and gauges in Mauritius.

Table 2.48 shows the amount of manometers and related equipment imported in 2014 (Statistics Mauritius, 2015b). However, the HS codes do not differentiate between mercury-containing equipment from those that are mercury-free.

**Table 2.48: Amount of manometers and related equipment imported in 2014**

<b>HS code</b>	<b>Item</b>	<b>Amount</b>
90258000	Hydrometers, pyrometers, hygrometers, etc, and combinations excluding 90251100	19,401
90262000	Instrument/apparatus to measure or check the pressure of liquids/gases	545,714
90321000	Thermostats	40,885
90322000	Manostats	1,066
90328900	Automatic regulating or controlling instruments and apparatus	17,828

### *Medical blood pressure gauges (mercury sphygmomanometers)*

It was noted previously that the MoHQL had initiated action in 2007 to eliminate use of mercury-containing equipment, including sphygmomanometers in its health facilities. It was observed that this measure has created a significant shift towards the use of mercury-free sphygmomanometers in public health institutions, the number of mercury sphygmomanometers declining from 708 in 2007 to only 15 in 2016. A similar trend, although less drastic, was noted in the surveyed private healthcare institutions from 76 in 2007 to 37 in 2016.

Three major importers of sphygmomanometers were surveyed. One stated having imported 20 mercury sphygmomanometers in 2014; another imported 50 mercury and 293 non-mercury ones in 2015 whereas the third one indicated having imported 50 mercury-free ones in 2013.

However, from informal contacts, it was observed that many doctors still have in their possession mercury sphygmomanometers, and still use them. In 2014, there are 2,429 doctors registered with the Medical Council of Mauritius (MoHQL, 2015a). Moreover, in the medical schools and in the Department of Medicine of the University of Mauritius, the students are still using mercury sphygmomanometers in addition to mercury free ones. For example, at the University of Mauritius, there are currently about 14 sphygmomanometers. As an estimate, if it is assumed that each doctor has his/her own mercury sphygmomanometer and taking into consideration the number in use in hospitals, clinics and medical schools, the current in-use mercury sphygmomanometers would be around 2,500, corresponding to a mercury stock of 175 – 213 kg as a mercury sphygmomanometer contains approximately 70 – 85 g of mercury.

However, since mercury sphygmomanometers are stated to have a long lifetime, mercury input and output has been estimated based on the average of the imports of 2014 and 2015, i.e. 35 (Table 2.49), and an output distribution of 0.1 to air, 0.3 to water and 0.6 to waste.

**Table 2.49: Input and output estimates for medical blood pressure gauges**

<b>Mercury blood pressure gauges</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	items/y	35	-
Input factor for phase	g Hg/item	70 – 85 (77.5)	-
Calculated input to phase	kg Hg/y	2.45 – 2.98 (2.71)	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.30	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.60	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.25 – 0.30 (0.27)	0.25 – 0.30 (0.27)
- Water	kg Hg/y	0.74 – 0.89 (0.81)	0.74 – 0.89 (0.81)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	1.47 – 1.79 (1.63)	1.47 – 1.79 (1.63)
- Sector specific waste treatment	kg Hg/y	0.00	0.00

***Certainty assessment***

Activity data: MEDIUM (as they were based on import data from suppliers).

Input estimates: LOW (as they are based on the Toolkit default factors).

Output estimates: LOW (as they are based on the Toolkit default factors).

### ***Comparison with inventory level 1: 2012 estimates***

Mercury uses in sphygmomanometers were discussed but were not quantified in the 2012 inventory report.

### ***Other manometers and gauges with mercury***

Manometers, barometers and other related equipment are used for educational purposes in secondary schools and universities, and there are also barometers in service at the Mauritius Meteorological Services. A survey carried out showed the number currently in use, in stock or unusable (Table 2.50). It should be noted that mercury-containing manometers and pressure valves may be present in many industries; due to the complexity, this was however not surveyed for this study.

**Table 2.50: Amount of manometers and related equipment in use and stock in 2016**

<b>Institution</b>	<b>Amount</b>
Public secondary schools	29 (+ 9 unusable)
Private secondary schools	18 (+ 2 unusable)
University of Mauritius	4
Mauritius Meteorological Services	15

The estimated amount of mercury in the above manometers and barometers is 3.1 – 38.5 kg based on an input factor of 40 – 500 g/item (UNEP, 2015; 2017).

Mercury releases for this sub-category may occur by breakage or loss of mercury from gauges/manometers during use and during their disposal.

For this sub-category, the UNEP Toolkit (2015; 2017) recommends, in case of non-availability of mercury content in the manometers and gauges used, a default input factor of about 0.005 g Hg per inhabitant per year and an output factor distribution similar to mercury thermometers. Based on this, the estimated annual mercury inputs and outputs for this sub-category are shown in Table 2.51.

**Table 2.51: Input and output estimates for other manometers and gauges**

<b>Other manometers and gauges</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	inhabitants	1,251,627*	-
Input factor for phase	g Hg/inhabitant	0.005	-
Calculated input to phase	kg Hg/y	6.26	-
<b>Output distribution factors for phase:</b>			
- Air		0.10	-
- Water		0.30	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.60	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.63	0.63
- Water	kg Hg/y	1.88	1.88
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	3.75	3.75
- Sector specific waste treatment	kg Hg/y	0.00	0.00

\*Adjusted for electrification rate

### ***Certainty assessment***

Activity data: LOW (as they were based on national population and electrification rate).

Input estimates: LOW (as they are based on the Toolkit default factors).

Output estimates: LOW (as they are based on the Toolkit default factors)

### ***Comparison with inventory level 1: 2012 estimates***

The Hg input and output for the 2012 inventory for the sub-category ‘other manometers and gauges’ are practically the same as in the present inventory as both have estimated the input and output based on the UNEP default factor.

### **2.6.12 Laboratory chemicals and equipment**

Mercury and its compounds are used as reagents, preservatives, and catalysts in educational, analytical and research laboratories as well as in instruments (e.g. atomic absorption spectrophotometer, potentiometer, etc.). Some of this mercury may be emitted during use to the air, primarily through vents from fume hoods. However, most of the mercury will be released in waste water or disposed of as hazardous wastes (UNEP, 2015; 2017).

Import of mercury and mercury compounds is severely restricted in Mauritius as permit has to be sought from the Dangerous Chemicals Control Board (DCCB). From data obtained from Statistics Mauritius (2015b), the amount of mercury metal (HS code: 28054000) imported from 2012 to 2015 was only 2 kg in 2012. It is noteworthy that there have been no imports of mercury metal in 2013,

2014 and 2015. On the other hand, import of mercury compounds (HS code: 28521000 and 28529000) amounted to 99, 25, 17 and 3 kg in 2012, 2013, 2014 and 2015 respectively, showing a drastic decline over the years, suggesting their phasing out or use of non-mercury alternatives.

A survey of use and stock of mercury and mercury compounds from educational institutions indicated current stocks of about 32.5 kg of elemental mercury and 25.4 kg of mercury compounds (Table 2.52). In addition, about 850 g of mercury stored in a container is kept in the Surgical Technology workshop at Jeetoo Hospital, awaiting to be disposed.

**Table 2.52: Amount of mercury and mercury compounds in use and stock in 2016**

<b>Institution</b>	<b>Mercury, kg</b>	<b>Mercury compounds, kg</b>
Public secondary schools	8.5	3.4
Private secondary schools	20	11
University of Mauritius	4	11
<b>Total</b>	<b>32.5</b>	<b>25.4</b>

### *Input and output estimates*

For the purpose of this inventory, the mercury input for laboratory chemicals will be based on a range, namely 12.52 – 17.00 kg, with the lower limit being the default input factor of 0.01 g Hg/inhabitant recommended by the UNEP toolkit and the upper limit being the annual import data for mercury and mercury compounds in 2014. On the other hand, due to limited available data on mercury-containing laboratory equipment, its mercury contribution will be estimated based on an input factor of 0.02 – 0.04 g Hg/inhabitant, the upper limit being the default input factor based on consumption in the European Union (UNEP, 2015; 2017).

The Toolkit does not define any specific output factors but observes that this is highly dependent on the waste management practices of the individual laboratories. Feedback received from some governmental laboratories and the University of Mauritius indicates that most of the chemical wastes are stored in the premises, awaiting disposal. On this basis, it has been assumed that for laboratory chemicals only 5% of the inputs are discharged to air, 10% to wastewater, 20% to general waste, with the remainder (65%) going to sector specific treatment/disposal. On the other hand, for the laboratory equipment, the default output factors recommended by the Toolkit of 0.33 to water, 0.33 to general waste and 0.34 to sector specific treatment/disposal were applied.

Table 2.53 and Table 2.54 summarise the input and output estimates for this sub-category.

**Table 2.53: Input and output estimates for laboratory chemicals**

Laboratory chemicals	Unit	Use + Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	kg/y	12.52 – 17.00 (14.76)	-
Input factor for phase	g Hg/item	-	-
Calculated input to phase	kg Hg/y	12.52 – 17.00 (14.76)	-
<b>Output distribution factors for phase:</b>			
- Air		0.05	-
- Water		0.10	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.20	-
- Sector specific waste treatment		0.34	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.63 – 0.85 (0.74)	0.63 – 0.85 (0.74)
- Water	kg Hg/y	1.25 – 1.70 (1.48)	1.25 – 1.70 (1.48)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	2.50 – 3.40 (2.95)	2.50 – 3.40 (2.95)
- Sector specific waste treatment	kg Hg/y	8.14 – 11.05 (9.59)	8.14 – 11.05 (9.59)

**Table 2.54: Input and output estimates for laboratory equipment**

Laboratory equipment	Unit	Use + Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	inhabitants	1,251,627*	-
Input factor for phase	g Hg/inhabitant	0.02 – 0.04 (0.03)	-
Calculated input to phase	kg Hg/y	25.03 – 50.07 (37.55)	-
<b>Output distribution factors for phase:</b>			
- Air		0.00	-
- Water		0.33	-
- Land		0.00	-
- Products		0.00	-
- General waste treatment		0.33	-
- Sector specific waste treatment		0.34	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.00	0.00
- Water	kg Hg/y	8.26 – 16.52 (12.39)	8.26 – 16.52 (12.39)
- Land	kg Hg/y	0.00	0.00
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	8.26 – 16.52 (12.39)	8.26 – 16.52 (12.39)
- Sector specific waste treatment	kg Hg/y	8.51 – 17.02 (12.77)	8.51 – 17.02 (12.77)

\*adjusted for electrification rate

### *Certainty assessment*

Activity data: LOW (as they were based on import data and national population).

Input estimates: MEDIUM (as they are based on the import statistics and default Toolkit input factors).

Output estimates: LOW (as they are based on the assumed and default Toolkit output factors).

### *Comparison with inventory level 1: 2012 estimates*

The mercury input for the 2012 inventory for the sub-category “laboratory chemicals and equipment” was based on the UNEP default factor based on population and electrification rate and amounted to 13 kg for laboratory chemicals and 52 kg for laboratory equipment. It is noteworthy that the total mercury input obtained (65 kg) is close to the upper limit of the range observed in this present inventory for the sub-category (37.6 – 67.1 kg).

#### **2.6.13 Mercury metal use in religious rituals and folklore medicine**

From the Toolkit (UNEP, 2015; 2017), it is noted that mercury is used in certain cultural and religious practices. In Mauritius, it was observed that murtis (statues or idols of gods in the Indian culture) may contain mercury as the latter is stated to bring wealth, luck or good health. However, the mercury use in this field is very difficult to quantify and is deemed probably minor compared to other sources; consequently it was not included in this inventory.

Some samples commonly used by Indo-Mauritians such as Holi coloured powder, sindoor and Mahavaar were analysed and were found to contain less than 0.0041 mg/kg.

#### **2.6.14 Mercury metal use in the jewellery sector**

In the jewellery sector, mercury is intentionally used to recover gold and silver dust in a process known as the mercury amalgamation process, as well as in traditional gilding techniques. Amalgamation is one of the very ancient techniques used to recover small sized or fine silver and gold dust. For example, when gold dust comes into contact with mercury, the two substances mix to form an amalgam, an alloy of gold and mercury. This allows the collection of very small sized particles of gold. At the end of the operation the mercury and gold amalgam is collected after which the two metals are separated either by the retort technique or using nitric acid, and the mercury is recycled or lost to the environment.

Historically, this method has been one of the most practiced gold and silver recycling techniques used in Mauritius to increase precious metal recovery amongst jewellers, as no major or expensive equipment was required in the process. Recycling of gold and silver metal from the jewellery industry is now practised on a larger scale by specialized recycling and refining plants such as Sterns Casting & Refining Ltd situated at Petit Raffray, in the north of Mauritius. Jewellers have now a better option than using the amalgamation method which involves mercury and can collect their gold and silver dust to send to the recycling plant on an annual or more frequent basis. The health hazard associated with mercury emission during the artisanal recycling as well as environmental risk posed by in-house recycling can thus be avoided. A site visit to Sterns Casting & Refining Ltd was undertaken and during a walk-through survey, the method of metal recycling was observed where no mercury is used.

The Assay Office is the body responsible to implement the Jewellery Act 2007. The Act regulates and controls the manufacture, sale and importation of jewellery made of gold, silver and platinum or their alloys, and the identification and grading of gemstones. The Assay Office is also a member of the International Association of Assay Offices. A list of registered jewellers is available on the website of the Assay Office (<http://industry.govmu.org/English/assay/Documents/Registered%20Jewellers%20as%20at11%20October%202016.pdf>). As at October 2016, there were 527 registered jewellers, out of which 370 – 375 would be involved in the manufacturing processes and the remaining would be only retailers.

Statistics Mauritius data and relevant reports were consulted to analyse trends in mercury imports for the last seven years. Since 2010, the amount of mercury metal (HS code: 28054000) imported was only 2 kg. It is noteworthy that there have been no imports of mercury metal in 2013, 2014 and 2015 (Statistics Mauritius, 2015b).

### ***Input and output estimates***

According to a survey carried out by the Assay Office in February/March 2015, out of a total of 254 responses, 237 jewellers (93.3%) stated that they do not use mercury at all whereas 17 (6.7%) still avail use of mercury to recover gold and silver dust. The total mercury used by these 17 jewellers amounted to 1.59 kg yearly. Most of them carry out the process of amalgamation only once in a year or every two years.

It was observed that the percentage of users of mercury has decreased considerably in the sector as in another survey carried out in 2007, 31 jewellers out of 81 respondents admitted use of mercury to purify gold and recover gold dust. However, trade statistics records indicate that there has been practically no import of elemental mercury during the last decade, implying most probably that the jewellers are still using their old stock of mercury given that most mercury used is recovered/recycled. By extrapolation to the whole jewellery sector, an estimated quantity of 3 to 4 kg of pure mercury would still be in use and stored by some jewellers.

If the amalgam is heated in open containers to evaporate the mercury, then all of the mercury in the amalgam is released to air and no mercury is recovered. If a retort is used which is mostly the prevailing situation in Mauritius, mercury emissions to air will be smaller as most of the mercury is recovered in the retort and re-used, although some mercury losses inevitably result through emission to air. According to the UNEP Toolkit (2015; 2017), 75 to 95% of mercury is recycled with the use of retorts and that ultimately about 20% of the mercury used will be emitted to air and 80% to land and water. Assuming that 75% of the mercury is recycled (worst case scenario), the annual mercury input is 0.75 – 1.0 kg through this source sub-category. The mercury input and output estimates in the jewellery sector are given in Table 2.55.

**Table 2.55: Input and output estimates for the jewellery sector**

<b>Gold and silver amalgamation in jewellery</b>	<b>Unit</b>	<b>Use + Disposal</b>	<b>Sum of releases to pathway from assessed part of life-cycle</b>
<b>Activity rate</b>	kg/y	0.75 – 1.0 (0.88)	-
Input factor for phase	g Hg/item	-	-
Calculated input to phase	kg Hg/y	0.75 – 1.0 (0.88)	-
<b>Output distribution factors for phase:</b>			
- Air		0.20	-
- Water		0.40	-
- Land		0.40	-
- Products		0.00	-
- General waste treatment		0.00	-
- Sector specific waste treatment		0.00	-
<b>Calculated outputs/releases to:</b>			
- Air	kg Hg/y	0.15 – 0.20 (0.18)	0.15 – 0.20 (0.18)
- Water	kg Hg/y	0.30 – 0.40 (0.35)	0.30 – 0.40 (0.35)
- Land	kg Hg/y	0.30 – 0.40 (0.35)	0.30 – 0.40 (0.35)
- Products	kg Hg/y	0.00	0.00
- General waste treatment	kg Hg/y	0.00	0.00
- Sector specific waste treatment	kg Hg/y	0.00	0.00

### ***Certainty assessment***

Activity data: MEDIUM (as data were based on surveys carried out and contacts with jewellers and refining company).

Input estimates: MEDIUM (as the data were obtained from the jewellers).

Output estimates: LOW (as they are based on the default Toolkit output factors).

### ***Comparison with inventory level 1: 2012 estimates***

It was estimated in 2007 that approximately 7 kg of mercury was used yearly to clean gold jewellery, recover gold from waste, purify and/or refine gold by jewellery shops compared to 3 – 4 kg in the present inventory. This can be explained by the fact that: (a) permit for import of elemental mercury is needed; (b) more and more jewellers are having recourse to the services of the local recycling/refining company; and (c) some mercury have been emitted to various media (air, water and land) through the amalgamation processes resulting in the decrease in the mercury stock.

### **2.6.15 Fish and fish products**

Consumption of fish and fish products is a potential source of mercury exposure in humans due to bioaccumulation and biomagnification of methylmercury, formed by conversion of mercury found in fresh or seawater by a variety of microorganisms. Organisms higher in the food chain are found to

have higher levels of mercury. As a result, fishes caught in the Mauritian waters and some fish products manufactured/processed locally may contain mercury.

Table 2.56 shows the results obtained for mercury analyses of fishes and fish products carried out during the inventory and those obtained from the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (MoOEMRF&S).

In addition, during the period Jan 2012 to July 2016, the Government Analyst Division of the MoHQL analyzed 79 samples of fish and fish products submitted by the public health and food safety inspectors and the Hg levels ranged from not detectable (ND) to 0.48 mg/kg.

From the results, it is observed that the mercury level in the local fish (including those from Rodrigues) and locally manufactured fish products do not exceed the limit set of 1 ppm in the Food Regulation 1999, except in 2013 for filet marlin (1.4 ppm) and swordfish (1.1 ppm), and in 2016 for frozen swordfish (2.2 ppm).

Mercury input and output releases from consumption of fish and fish products were not considered as their contribution would already be included in waste water treatment/disposal and cremation/cemeteries.

**Table 2.56: Hg levels in local fish and fish products**

Year	Fish species	Hg level, mg/kg	Year	Fish species	Hg level (mg/kg)
2012	Chilled Vieille Rouge (2 samples)	0.1 – 0.2	2014	Capitaine	0.1
2012	Vieille Rouge Crate 13	0.1	2014	Swordfish	0.1
2012	Queue Blanc	0.1	2014	Sacrechien Grande Queue (2 samples)	0.1
2012	Chilled gutted Capitaine	0.1	2014	Frozen fish	0.1
2012	Swordfish (3 samples)	0.2 – 0.8	2015	Chilled Vieille Rouge	0.1
2012	Capitaine Portion	0.1	2015	Vieille Rouge	0.1
2012	Sacrechien	0.1	2015	Swordfish (3 samples)	0.4 – 0.7
2012	Chilled Gueule Pave Dore	0.1	2015	Yellowfin Tuna	0.9
2012	Chilled Sacrechien	0.1	2015	Sacrechien Grande Queue	0.1
2013	Chilled fish	0.1	2016	Chilled fish	ND
2013	Filet marlin	1.4	2016	Frozen Tuna	0.3
2013	Gueule Pave Dore	0.1	2016	Yellowfin Tuna	0.1
2013	Chilled Yellowfin Tuna	0.5	2016	Frozen Swordfish	2.2
2013	Swordfish (3 samples)	0.6 – 1.1	2017	Canned shredded Tuna	0.12
2014	Whole Chilled Dermersal fish	0.1	2017	Salted snoek (2 samples)	0.11 – 0.16
2014	Chilled fish (3 samples)	0.1	2017	Vieille Rouge (Rodrigues)	0.01
2014	Vieille Rouge	0.1	2017	Cateau (Rodrigues)	0.02
2014	Queue Blanc	0.1	2017	Frozen Rouget (Rodrigues)	0.09
2014	Frozen Dermersal fish	0.3	2017	Frozen octopus (Rodrigues)	0.03

## 2.7 Data and inventory on crematoria and cemeteries

This category covers mercury releases from cremation and burial of human bodies (UNEP, 2015; 2017). There are only two sub-categories, namely crematoria and cemeteries.

The mercury releases from this source category come from the mercury present in the corpses, mainly due to the presence of dental amalgam fillings that contain mercury but also mercury found in minor concentrations in the body tissues due to fish consumption and other exposures.

The mercury content in each corpse depends largely on the number of dental amalgam fillings and to a lesser extent on the size of the fillings. As no data on the average mercury content of the Mauritian population has been found, the Toolkit default factors of 1 – 4 g/body have been applied.

### 2.7.1 Crematoria

In Mauritius, cremation takes place in a large number of local facilities, either in open air or with limited confinement of the cremation process or in crematoria equipped with furnaces having limited emission controls. During cremation, the mercury present in corpses is predominantly released to air.

Data on the number of cremations in Mauritius and Rodrigues were obtained from the Civil Status Department for the years 2013-2015 and are shown in Table 2.57. It is observed that in 2014 (inventory year), about 43% of the corpses were cremated.

**Table 2.57: Number of cremations in Mauritius and Rodrigues (2013 – 2015)**

<b>Year</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
<b>Cremations (Mauritius)</b>	3,779	3,995	4,133
<b>Cremations (Rodrigues)</b>	0	0	0
<b>Cremations (Total)</b>	3,779	3,995	4,133

The results of crematoria are shown in Table 2.58 with a release of 4.00 – 15.98 kg Hg/y to air, using UNEP default input and output factor.

**Table 2.58: Input and output estimates for crematoria**

Crematoria	Unit	Production	Use	Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	corpses/y		3,995		-
Input factor for phase	g Hg/corpse		1 – 4 (2.5)		-
Calculated input to phase	kg Hg/y		4.00 – 15.98 (9.99)		-
<b>Output distribution factors for phase:</b>					
- Air			1.0		-
- Water			0.0		-
- Land			0.0		-
- Products			0.0		-
- General waste treatment			0.0		-
- Sector specific waste treatment			0.0		-
<b>Calculated outputs/releases to:</b>					
- Air	kg/y		4.00 – 15.98 (9.99)		4.00 – 15.98 (9.99)
- Water	kg/y		0.0		0.0
- Land	kg/y		0.0		0.0
- Products	kg/y		0.0		0.0
- General waste treatment	kg/y		0.0		0.0
- Sector specific waste treatment	kg/y		0.0		0.0

### 2.7.2 Cemeteries

There is a large number of cemeteries in Mauritius and Rodrigues and in cemeteries the mercury present in corpses is released to land.

Data on the number of burials in Mauritius and Rodrigues were obtained from the Civil Status Department for the years 2013-2015 and are shown in Table 2.59.

**Table 2.59: Number of burials in Mauritius and Rodrigues (2013 – 2015)**

Year	2013	2014	2015
<b>Burials (Mauritius)</b>	5,172	5,077	5,220
<b>Burials (Rodrigues)</b>	171	244	233
<b>Burials (Total)</b>	5,343	5,321	5,453

Applying the UNEP default input and output factor, the release to land amounts to 5.32 – 21.28 kg Hg/y as shown in Table 2.60.

**Table 2.60: Input and output estimates for cemeteries**

Cemeteries	Unit	Production	Use	Disposal	Sum of releases to pathway from assessed part of life-cycle
<b>Activity rate</b>	corpses/y		5,321		-
Input factor for phase	g Hg/corpse		1 – 4 (2.5)		-
Calculated input to phase	kg Hg/y		5.32 – 21.28 (13.30)		-
<b>Output distribution factors for phase:</b>					
- Air			0.0		-
- Water			0.0		-
- Land			1.0		-
- Products			0.0		-
- General waste treatment			0.0		-
- Sector specific waste treatment			0.0		-
<b>Calculated outputs/releases to:</b>					
- Air	kg/y		0.0		0.0
- Water	kg/y		0.0		0.0
- Land	kg/y		5.32 – 21.28 (13.30)		5.32 – 21.28 (13.30)
- Products	kg/y		0.0		0.0
- General waste treatment	kg/y		0.0		0.0
- Sector specific waste treatment	kg/y		0.0		0.0

### 2.7.3 Overall input and output for crematoria and cemeteries

The estimated inputs and outputs for crematoria and cemeteries are summarised in Table 2.61, with the figures shown in brackets being the means of the reported ranges.

**Table 2.61: Summary of inputs and outputs for crematoria and cemeteries**

Category	Mercury inputs, kg/y	Mercury outputs, kg/y	
		Air	Land
Crematoria	4.00 – 15.98 (9.99)	4.00 – 15.98 (9.99)	-
Cemeteries	5.32 – 21.28 (13.30)	-	5.32 – 21.28 (13.30)
<b>Total</b>	<b>9.3 – 37.3 (23.3)</b>	<b>4.0 – 16.0 (10.0)</b>	<b>5.3 – 21.3 (13.3)</b>

#### *Certainty assessment*

Activity data: HIGH (as they were based on national data).

Input estimates: LOW (as they are based on the Toolkit default factors).

Output estimates: MEDIUM (as the assumed air/land distribution is certain except for the minute amounts of mercury that may be present in crematoria ash).

### ***Comparison with inventory level 1: 2012 estimates***

The level 1 inventory report estimated cremation inputs/outputs of 11.2 kg/y (4,480 cremations) and cemetery inputs/outputs of 12.1 kg/y (4,854 burials). Though the number of burials and cremations differ from the data obtained for 2014, the overall input and output, i.e. 23.3 kg/y, are similar as the total number of burials and cremations is practically the same (9,334 and 9,316 respectively in 2012 and 2014). It is noteworthy that there is a slight discrepancy in the number of burials and cremations reported in the first inventory (should have been 3,879 cremations and 5,452 burials instead of 4,480 and 4,854 respectively).

## **2.8 Stocks of mercury and/or mercury compounds, and storage conditions**

Mauritius does not have stocks of mercury or mercury compounds over 50 metric tonnes, as well as sources of mercury supply generating stocks exceeding 10 metric tonnes per year, that are located within its territory.

Mercury-containing chemical wastes as well as mercury thermometers will be stored at the newly constructed interim hazardous waste storage facility found at La Chaumière, pending export to specialized facilities abroad. However, CFLs and other mercury containing lamps and e-wastes will be managed separately under the national e-waste management system being put in place.

## **2.9 Contaminated sites**

The following contaminated sites were identified as potential mercury hot-spots in the country due to inadvertent deposition of mercury-containing wastes mixed with municipal solid wastes:

- (i) Mare Chicose sanitary landfill, Mauritius; and
- (ii) open air dumping waste ground situated at Grenade, Roche Bon Dieu, Rodrigues.

However, analysis of three samples of leachates at the Mare Chicose landfill were found to be less than 0.0002 mg/L and the mercury concentration in air at Mare Chicose landfill and Roche Bon Dieu dumping site was also found to be very low, 2.95 – 15.25 and 4.38 ng/m<sup>3</sup> respectively (PANeM, 2016). Further study is required to assess whether these sites are effectively contaminated such as regular analysis of concentration of mercury in air and monitoring of leachate at regular intervals to capture annual variation and also following large storm/flood events to capture episodic releases of contaminants from the landfill and dumping site.

## **2.10 Impacts of mercury in human health and the environment**

Mercury is a bioaccumulative, persistent toxic pollutant that can circulate through the atmosphere and the oceans, and poses a significant threat to human health and the environment. It exists in various forms, each differing in their degree of toxicity: elemental (or metallic); inorganic (e.g. mercury(II) chloride and mercury(II) sulfate); and organic (e.g. methylmercury).

Mercury is a naturally occurring element that is found in air, water and soil. However, mercury releases in the environment result mainly from anthropogenic activities, such as coal-fired power

stations, waste incinerators, mining activities and industrial processes, and from use of mercury-containing materials such as thermometers, switches, manometers, dental amalgam and fluorescent lamps. Once released in the aquatic environment, mercury can be transformed by bacteria into methylmercury that bioaccumulates in fish and shellfish (WHO, 2017).

Human exposure can occur through direct skin contact with mercury or mercury-containing compounds/equipment, inhalation of mercury vapors during industrial processes and through consumption of fish and shellfish contaminated with methylmercury.

Human exposure to mercury, even small amounts, may cause serious health problems such as:

- Impaired fetal development during pregnancy and childhood development
- Nervous system disorders (tremors, insomnia, memory loss, headache, cognitive and motor dysfunction)
- Kidney, lung, liver, skin and eye damage
- Digestive complications

The severity of the health effect depends on the type of mercury concerned (inorganic, organic or elemental), the dose, the duration of exposure, the exposure route (inhalation, ingestion or dermal contact), and the age or developmental stage of the person exposed. Studies have shown that fetuses and young children are more sensitive to mercury effects impairing in particular their neurological development (WHO, 2017).

## Chapter III: Policy, Regulatory and Institutional Framework Assessment

### 3.1 Policy and regulatory assessment

Prior to the ratification of the Minamata Convention by Mauritius on 21 September 2017, a legal and institutional gap analysis on the existing and required policy and regulatory framework as well as institutional capacity to implement the Convention was carried out. The legal and institutional gap analysis is a necessary and fundamental step to evaluate the national legal and institutional framework and identify the measures that need to be taken in order to be in compliance with the Convention that will be binding on Mauritius as from the date of ratification.

In Mauritius, there are currently several laws which regulate the issues linked to the presence of mercury, namely:

- **The Consumer Protection (Control of Imports) Regulations 2017** prohibit the import of some products which could contain substances dangerous for human health.
- **The Consumer Protection (Control of Imports) (Amendment No. 3) Regulations 2006** banned the import of batteries containing mercury. A certificate is required from importers attesting that the batteries imported are mercury-free.
- **Dangerous Chemicals Control Act (DCCA) 2004** whose aim as it proclaims is to “*provide for the prevention of damage to health and to the environment caused by dangerous chemicals and for better protection of the workers, members of the public and the environment against dangerous chemicals*”. Mercury and compounds are classified as “Dangerous chemical” in the First Schedule and as “Extremely dangerous chemical” in the Second Schedule pertaining to industrial chemicals. In addition, mercury compounds are prohibited under Part II in the Eighteenth Schedule of the DCCA pertaining to agricultural chemicals.
- **Environment Protection Act (EPA) 2002**. Section 7 allows the minister to whom responsibility for the subject of the environment is assigned to propose and develop policies on all aspects of environmental protection and management, and to establish such standards for the protection of the air, land and water as may be necessary to safeguard the human health and the environment. It designates in its Fourth Schedule several enforcing agencies linked to environmental media or pollutants. An enforcing agency shall in respect of its sphere of responsibility: (a) supervise enforcement of national environmental standards and notices, orders and directives issued under an environmental law; (b) verify compliance with environment laws; (c) conduct such regular monitoring, sampling, test and analyses as to ensure compliance with environmental laws; etc. Effluent limitations are also defined as well as activities requiring an environmental impact assessment.
- **Wastewater Management Authority Act (WMAA) 2000** which has as one of its main objectives to control and monitor pollution, private sewers and the use of equipment in relation to wastewater systems. Some main duties of the Wastewater Management Authority are to: (a) undertake wastewater treatment to such, predetermined quality as may be prescribed for safe disposal of the effluent and sludge to the environment or re-use; (b) control and monitor the pollution discharged to wastewater systems by any person; (c) establish and maintain laboratories for the purpose of testing wastewater and sanitary equipment; and (d) carry out, against payment

of such fees as may be prescribed for and on behalf of any Authority or Organisation responsible for the enforcement of wastewater laws, any wastewater analysis which may be necessary for such enforcement.

- **The Environment Protection (Standards for Effluent Discharge) Regulations 2003** provide for standards pertaining to effluent discharge where the maximum permissible limit for mercury is 0.005 mg/l for both land/underground and surface water courses.
- **The Environment Protection (Standards of Effluent for Use in Irrigation) Regulations 2003** require that “[a] person treating effluent for use in irrigation shall ensure that the quality of the treated effluent complies with the standards set out in the Schedule” where the maximum limit of mercury allowed is 0.02 mg/l.
- **The Environment Protection (Standards for Effluent Discharge into the Ocean) Regulations 2003** set the maximum limit for the presence of mercury for effluent discharge into the ocean (10 mg/l).
- **The Environment Protection (Drinking Water Standards) Regulations 1996** set the maximum limit for the presence of mercury in drinking water (0.001 mg/l).
- **The Environment Protection (Standards for Hazardous Wastes) Regulations 2001** wherein mercury wastes are considered as hazardous wastes. Regulation 3 provides that no person has the right to dispose of a hazardous waste at any place other than a disposal site after such pre-treatment as may be imposed by the enforcing agency prior to disposal.
- **The Waste Water (Standards for Discharge of Industrial Effluent into a Waste Water System) Regulations 2004.** According to the Third Schedule, licensed industries falling under category of 11 (mechanical workshops), 12 (paint manufacturer) and 16 (tannery) shall monitor their discharge of mercury into the wastewater system and that such discharge must be within the limit prescribed under the Fourth Schedule of the Regulations which is 0.1 mg/l applicable to the daily discharge of mercury into a wastewater system.
- **The Fisheries and Marine Resources (Export of Fish and Fish Products) Regulations 2009, as amended in 2012.** According to Chapter I of the Second Schedule, fish business operators shall ensure that primary products are protected against contamination.
- **The Local Government Act (LGA) 2011** regulates what it terms as “*classified trade*” meaning a business specified in the Twelfth Schedule and may cover activities that may be relevant in respect to mercury.
- **The Explosives Act 1959** defines “explosives” as, amongst other things, “fulminate of mercury”. It provides for the manufacture of explosives to be prohibited under article 3 unless a permit is granted by the Police Commissioner. Article 6 prohibits the import of explosives unless a permit is granted.
- **The Food Regulations 1999** restrict metal contaminant mercury in at least 59 items. According to the Seventh Schedule, the maximum permitted proportion of mercury in agar, beer, caramel, chemicals (excluding synthetic colouring), cider, cocoa products, coffee and chicory, curry powder, dried herbs, edible fat and oil, flour, fortified wine, fruit vegetable juice, honey, ice

cream, meat, milk, sugar, tea, vegetable and fruit products, etc. is 0.03 parts per million (ppm). The maximum permitted proportion of mercury in fish and fish products is 1 ppm. No mercury is allowed in apples and alcoholic beverages.

- **The Toys (Safety) Regulations 1994.** Toys shall be so designed and constructed that they do not present health hazards or risks of physical injury by ingestion, inhalation or contact with the skin, mucous tissues or eyes and for the protection of children's health. Bioavailability resulting from the use of toys shall not exceed 0.5 µg mercury per day.
- **The Occupational Safety and Health Act (OSHA) 2005.** No employer has the right to employ a young person in any activity involving work with heavy metals, including lead and mercury. Moreover, according to the Ninth Schedule of the Act, mercury is considered as a substance hazardous to health.
- **The Fisheries and Marine Resources (Import of Fish and Fish Products) Regulations 2012.** No imported fish shall contain heavy metals (mercury is a heavy metal) more than the maximum limits specified in the Codex Alimentarius or determined by the Permanent Secretary.

The legal and institutional gap analysis conducted shows the extent to which the laws, policies and institutions in Mauritius are compliant with the Convention. It has been found that there are a number of laws and institutions which already cater in a satisfactory manner for the various issues as highlighted in the Minamata Convention on Mercury. In some circumstances, such legal regulation goes beyond the scope of the Convention thus showing the extent to which the Mauritian Government is keen to ensure the protection of human health and environment.

Furthermore it needs to be mentioned that a legal gap analysis referring to the Product related provisions of the treaty Art. 4 and Art 6, was carried out by the same consultant but under the hospices of the PANeM project, to assure complementarity.

Table 3.1 summarizes the legal gap analysis of the policy and regulatory framework pertaining to mercury and its management in Mauritius and identifies the legal and administrative actions that are needed in order to comply with the Minamata Convention. It is noteworthy that due to the absence of metal mining and industrial processes using mercury, not all the provisions of the Minamata Convention are applicable to Mauritius.

**Table 3.1: Policy and regulatory measures in place and remaining gaps**

<b>Article 3 – Mercury supply sources and trade</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit new primary mercury mining;</li> <li>▪ Identify individual mercury stocks and sources of stocks exceeding 50 million tonnes (MT), and mercury supply generating stocks exceeding 10 MT/y;</li> <li>▪ Not allow the export of mercury unless the importing country provides written consent, the mercury is for an allowed use or environmentally sound storage, and all other conditions of Article 3.6 are met;</li> <li>▪ Not allow the import of mercury without government consent, ensuring both the mercury source and proposed use are allowed under the Convention (and applicable domestic law).</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Dangerous Chemicals Control Act (DCCA) 2004	<ul style="list-style-type: none"> <li>▪ Article 3(3) and 3(4) are not applicable since there are no primary mercury mining in Mauritius and mercury stocks exceeding 10 or 50 MT;</li> <li>▪ The legal framework in Mauritius on the export and import of mercury is in conformity with the Convention.</li> </ul>
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions:</b>	
<ul style="list-style-type: none"> <li>▪ Administrative measures to be taken at the level of the Dangerous Chemicals Control Board (DCCB) regarding Article 3(6) and Article 3(8) of the Convention.</li> </ul>	

<b>Article 4 – Mercury-added products</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit the manufacture, import or export of mercury-added products listed in Part I of Annex A after the phase-out date specified;</li> <li>▪ Phase down the use of the mercury-added products listed in Part II of Annex A (dental amalgam);</li> <li>▪ Take measures to prevent the incorporation of prohibited mercury-added products (switches, relays, batteries, etc.) into assembled products.</li> <li>▪ Discourage manufacture, import and export of new mercury-added products.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Consumer Protection (Control of Imports) Regulations 2006, 2017	The Regulations contain a list of prohibited products amongst which products containing mercury, e.g. batteries. By virtue of this listing, mercury batteries are considered “prohibited goods”, and thereby subject to an import ban.
Pharmacy Act 1983	The manufacture of poisons including mercury is regulated. Although topical antiseptics fall under this Act, cosmetics do not. No Convention relevant provisions are currently regulated.
Dangerous Chemicals Control Act (DCCA) 2004	There is no law specifically banning manufacture of mercury-added products. However, as the import of mercury is strictly regulated, there is no known manufacturing of mercury-added products in Mauritius. Import of mercury-containing pesticides is not permitted.
Ministry of Health and Quality of Life	Replace mercury-containing equipment by non-mercury ones in public health hospitals and institutions. No dental amalgam fillings in the case of children and pregnant women.

<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions:</b>	
<ul style="list-style-type: none"> <li>▪ Amendments to be made to Consumer Protection Regulations to broaden ban on import of mercury-added products to include items listed in Part I of Annex A of the Convention.</li> <li>▪ Pharmacy Act 1983 to regulate cosmetics with mercury – on-going work on new Pharmacy Bill.</li> </ul>	

<b>Article 5 – Manufacturing processes in which mercury or mercury compounds are used</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit the use of mercury or mercury compounds in the manufacturing processes listed in Part I of Annex B;</li> <li>▪ Restrict the use of mercury in the processes listed in Part II of Annex B;</li> <li>▪ Discourage the development of facilities with manufacturing processes in which mercury or mercury compounds are intentionally used.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
None	Not applicable to Mauritius as it does not have or intend to have any manufacturing processes that use mercury or mercury compounds.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions:</b>	
None	

<b>Article 6 – Exemptions available to a Party upon request</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	Any State or regional economic integration organization may register for one or more exemptions from the phase-out dates listed in Annex A and Annex B.
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
None	Mauritius, at the time of ratification, has not registered for any exemptions.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions:</b>	
None	

<b>Article 7 – Artisanal and small-scale gold mining</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take steps to reduce, and where feasible, eliminate the use of mercury and mercury compound in the artisanal and small-scale gold mining and processing.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
None	Not applicable to Mauritius (no artisanal and small-scale gold mining and processing).
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions:</b>	
None	

<b>Article 8 – Emissions</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Regulate the control and the reduction of emissions of mercury and mercury compounds to the air from point sources falling within the sources categories defined by the Convention;</li> <li>▪ Take measures to control emissions from relevant sources;</li> <li>▪ Use BAT and BEP standards to control and reduce emissions from new sources;</li> <li>▪ Include in any national plan, and to implement, regarding the existing sources, one or more of the five measures prescribed in the Convention;</li> <li>▪ Establish and maintain an inventory of emissions from relevant sources;</li> <li>▪ Report in respect to the implementation of adopted measures.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Environment Protection (Standards for Air) Regulations 1998	<p>The Regulations are in the process of amendment in order to set the maximum level of mercury in the air:</p> <p>National Environmental Standards for Ambient Air Quality and Measurement Methods – 0.3 µg/m<sup>3</sup> on an averaging time of 24 hours.</p> <p>National Environmental Standards for Incinerator Stack Emission: new plant – 0.05 mg/m<sup>3</sup> and existing plant (up to 2017) – 0.10 mg/m<sup>3</sup>, average over a period of 30 minutes to 8 hours.</p> <p>National Environmental Standards for Stack Emissions – 0.05 mg/Nm<sup>3</sup> for coal fired thermal power plants.</p>
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions:</b>	
<ul style="list-style-type: none"> <li>▪ Amendments to be made to the Environment Protection (Standards for Air) Regulations 1998.</li> <li>▪ Devise a National Plan to control mercury emissions.</li> <li>▪ Implement the use of BAT/BEP practices in IPPs and medical waste incinerators.</li> <li>▪ Apply one or more measures prescribed in the Convention to the existing sources.</li> <li>▪ Maintain a national inventory of emissions from relevant sources.</li> </ul>	

<b>Article 9 – Releases</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Control and reduce releases of mercury and mercury compounds to land and water from relevant point sources;</li> <li>▪ Identify the relevant point source categories;</li> <li>▪ Take measures to control releases according to a national plan;</li> <li>▪ Establish and maintain an inventory of releases from relevant sources;</li> <li>▪ Communicate the information in respect to the implementation of adopted measures.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure mentioned above</b>
Environment Protection (Standards for Effluent Discharge into the Ocean) Regulations 2003	Regulations provide for 10 mg/l mercury as the permissible limit for discharge into the ocean.

Environment Protection (Standards for Effluent Discharge) Regulations 2003	The Regulations provide for standards pertaining to effluent discharge where the maximum permissible limit for mercury is 0.005 mg/l for both land/underground and surface water courses.
Environment Protection (Standards of Effluent for Use in Irrigation) Regulations 2003	The Regulations require that “[a] person treating effluent for use in irrigation shall ensure that the quality of the treated effluent complies with the standards set out in the Schedule” where the maximum limit of mercury allowed is 0.02 mg/l.
Waste Water (Standards for Discharge of Industrial Effluent into a Waste Water System) Regulations 2004	According to the Third Schedule, licensed industries falling under category of 11 (mechanical workshops), 12 (paint manufacturer) and 16 (tannery) shall monitor their discharge of mercury into the wastewater system and that such discharge must be within the limit prescribed under the Fourth Schedule of the Regulations which is 0.1 mg/l applicable to the daily discharge of mercury into a wastewater system.
Environment Protection (Effluent Discharge Permit) Regulations 2003	The Regulations set the frequency of analysis to be conducted in respect of the effluent parameters including mercury. However, the frequency of analysis is subject to review by the enforcing agency.
Environment Protection (Drinking Water Standards) Regulations 1996	The Schedule to the Regulations sets the maximum limit for the presence of mercury in drinking water (0.001 mg/l).
Environment Protection (Standards for Hazardous Wastes) Regulations 2001	Regulation 3 provides that no person has the right to dispose of a hazardous waste at any place other than a disposal site after such pre-treatment as may be imposed by the enforcing agency prior to disposal. Mercury and mercury compounds are defined as hazardous wastes according to the Regulation 2 and the Second and Third Schedules.
Fisheries and Marine Resources (Export of Fish and Fish Products) Regulations 2009, as amended in 2012	According to Chapter I of the Second Schedule, fish business operators shall ensure that primary products are protected against contamination. Based on inventory results and data gathered from the Competent Authority, it has been noted that contamination of fish and fish products is not an issue in Mauritius since the mercury levels found are within permissible levels.
Fisheries and Marine Resources (Marine Protected Areas) Regulations 2001	Under regulation 5 (2) (a), no person shall, in any Marine Protected Area discharge or deposit any waste, oily liquid, acid or other chemical or toxic or polluting substance. This definition clearly encompasses mercury.
Coastal Water Quality Requirements	Monitoring of heavy metals in estuarine waters is conducted by the Laboratories Division of the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (MoOEMRF&S) which presently monitors eight estuaries twice per year for heavy metals, including mercury. As at November 2016, the level of mercury in estuarine waters is said to be within the limits of the <i>Coastal Water Quality Requirements</i> , where the acceptable limit is below 0.0005 mg/l.
National Mercury Inventory	Already identified the sources of mercury releases to land and water.
Mercury National Action Plan (NAP) 2015-2020/ MIA Report	A National Implementation Plan for mercury is incorporated in the MIA report.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions:</b>	

<ul style="list-style-type: none"> <li>▪ Amend Section 18(2) of the EPA in respect to environmental impact assessment to include “any action or measure that the proponent proposes to promote the use of alternatives, best available techniques and environmental practices to minimize use, release and emission of hazardous substances, including mercury”.</li> <li>▪ Maintain an inventory of releases from relevant sources.</li> </ul>
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<b>Article 10 – Environmentally sound interim storage of mercury, other than waste mercury</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take appropriate measures to ensure that the interim storage of mercury and its compounds is undertaken in an environmentally sound and friendly manner;</li> <li>▪ Cooperate with each other and with relevant intergovernmental organizations and other entities.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Dangerous Chemicals Control Act (DCCA) 2004	Sixteenth Schedule regulates storage site and handling etc. (mercury and mercury compounds are included); Article is deemed not to be applicable to Mauritius in light of the local context where primary mining does not take place and it does not have mercury stocks exceeding 10 or 50 MT.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions:</b>	
None	

<b>Article 11 – Mercury wastes</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take appropriate measures so that mercury waste is managed in an environmentally sound manner, only recovered, recycled, reclaimed or directly re-used for a use allowed to a Party under the Convention or for environmentally sound disposal, not transported across international boundaries except for the purpose of environmentally sound disposal in accordance with the Basel Convention;</li> <li>▪ Cooperate with each other and with relevant intergovernmental organizations and other entities, as appropriate, to develop and maintain global, regional and national capacity for the management of mercury wastes in an environmentally sound manner.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Dangerous Chemicals Control Act (DCCA) 2004	As per section 26 of the DCCA, “[e]very person manufacturing or using any dangerous chemical shall comply with the requirements relating to waste storage and handling of dangerous chemicals, as specified in the Seventeenth Schedule”.
Environment Protection (Standards for Hazardous Wastes) Regulations 2001	According to Regulation 2 and the Second and Third Schedules, mercury and mercury compounds are defined as hazardous wastes. Under regulation 3, no person shall dispose of a hazardous waste-(a) at any place except at a disposal site; and (b) after such pre-treatment as may be imposed by the enforcing agency prior to disposal.

Basel Convention/ Bamako Convention	Mauritius is Party to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal <sup>24</sup> , where wastes containing mercury and mercury compounds are included. An interim hazardous waste storage facility (IHWSF) has been set up at La Chaumière whereby hazardous chemical wastes (including mercury containing wastes) generated in Mauritius will be analysed, collected, sorted, regrouped, packaged, labelled, stored and exported to authorised hazardous wastes recovery/disposal facilities in compliance with the Basel Convention. Mauritius is also Party to the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions:</b>	
Draft, approve and adopt regulations for environmentally sound management of mercury containing wastes including amalgam wastes from dental clinics by applying the Polluter Pay Principle.	

<b>Article 12 – Contaminated sites</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Develop appropriate strategies for identifying and assessing sites contaminated by mercury or mercury compounds;</li> <li>▪ Conduct any risk reduction activities at contaminated sites in an environmentally sound manner, incorporating risk assessment to human health and the environment, where appropriate.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure:</b>
Environment Protection Act 2002	In respect to contamination involving mercury wastes, there already exists the legislative framework, and the recent coming in operation of the IHWSF is relevant to the extent that the contract for the operation, management and maintenance of the facility has been said to require the Contractor of the facility to provide technical expertise and resources in any clean-up operation during and after emergency situations involving hazardous wastes and their subsequent disposal. This will apply also in the case of emergency situations involving mercury wastes. No cases of sites contaminated with mercury have been reported to the Solid Waste Management Division (SWMD).
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
None	

<b>Article 13 – Financial resources and mechanism</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Provide within its capabilities domestic resources as well as seek participation from the private sector as may be needed to implement Convention obligations;</li> <li>▪ Access financial resources available under the Convention and other resources available from multilateral, regional, and bilateral funding sources.</li> </ul>

<sup>24</sup> The Basel Convention has been adopted on 22 March 1989 and entered into force on 5 May 1992. Mauritius acceded to it on 24 November 1992 and it entered into force for Mauritius on 22 February 1993.

<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure</b>
None	
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
<ul style="list-style-type: none"> <li>▪ To include funding within its capabilities for the national implementation plan for mercury in the national budget.</li> <li>▪ To seek funding from the financial mechanism to be operated under the guidance of CoP and from other external sources for the national implementation plan for mercury.</li> </ul>	

<b>Article 14 – Capacity building, technical assistance and technology transfer</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Provide timely and appropriate capacity-building and technical assistance to developing country parties, especially least developed countries and SIDS through cooperation among Parties;</li> <li>▪ Deliver capacity-building and technical assistance through arrangements which can be bilateral or multilateral, or which can be through regional, sub-regional or national levels;</li> <li>▪ Provide information and access to up-to-date environmentally sound alternative technologies to developing country Parties, in particular least developed countries and SIDS.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure</b>
None	
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
<ul style="list-style-type: none"> <li>▪ Mauritius can engage in collaboration with other SIDS and also regionally within the African Union.</li> <li>▪ Cooperation with developed countries in the area of mercury management, scientific research and knowhow.</li> </ul>	

<b>Article 16 – Health aspects</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Promote the development and implementation of the following: <ul style="list-style-type: none"> <li>➢ Identification and protection of populations at risk;</li> <li>➢ Science-based educational and preventive programmes on occupational exposure to mercury and its compounds;</li> <li>➢ Appropriate health-care services for prevention, treatment and care for affected populations.</li> </ul> </li> <li>▪ Establish and strengthen institutional and health professional capacities for the prevention, diagnosis, treatment and monitoring of health risks related to the exposure of mercury and its compounds.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
<b>Relevant Policy and Regulatory Measure</b>	<b>Explanation on what aspects of the above provisions are being addressed by policy/regulatory measure</b>
Policy of Ministry of Health and Quality of Life	Mercury-containing medical devices (e.g. thermometers and sphygmomanometers) are no longer being acquired. Banning of dental amalgam in pregnant women and young children.

Pamphlet for jewellery	Pamphlet for the jewellery sector on dangers of mercury and existence of alternatives distributed to all local jewellers.
Fisheries and Marine Resources (Export of Fish and Fish Products) Regulations 2009, as amended in 2012/ Food Regulation 1999	Provides maximum safe limits for mercury. The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, the Government Analyst Division of the Ministry of Health and Quality of Life as well as exporters of fish (mainly tuna) conduct regularly analyses of mercury in fish (both local and imported).
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
<ul style="list-style-type: none"> <li>▪ Organisation of raising awareness sessions/workshops on the dangers of mercury and its compounds.</li> <li>▪ Development of fish consumption information guidelines.</li> <li>▪ Results of fish mercury analyses to be made available to public.</li> </ul>	

<b>Article 17 – Information exchange</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Share information on a number of issues related to mercury, namely: <ul style="list-style-type: none"> <li>➢ Scientific, technical, economic and legal information;</li> <li>➢ Information on reduction or elimination of the production, use, trade, emissions and release of mercury and its compounds;</li> <li>➢ Information on technically and economically viable alternatives;</li> <li>➢ Epidemiological information concerning health impacts, with collaboration with WHO and other relevant organisations.</li> </ul> </li> <li>▪ Collect and disseminate information on annual quantities of mercury and mercury compounds emitted, released, or disposed; and other information specified in Article 18.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
None	
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
Establish the Ministry of Social Security, National Solidarity and Environment and Sustainable Development as the National Focal Point (NFP) for the sake of information exchange amongst Parties and various other international bodies.	

<b>Article 18 – Public information, awareness and education</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Promote and facilitate provision of information to the public, within their capabilities, on topics related to mercury and mercury compounds, including education, training and public awareness related to the effects of exposure to mercury and mercury compounds on human health and the environment, and alternatives to mercury and mercury compounds;</li> <li>▪ Collaborate with relevant intergovernmental and non-governmental organisations and vulnerable populations.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
Awareness workshops/ seminars/ sessions	Several workshops/seminars/sessions have been held with different stakeholders such as jewellers, importers, etc.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention's provisions</b>	
<ul style="list-style-type: none"> <li>▪ Design a webpage on the ministry website regarding all matters pertaining to mercury.</li> </ul>	

<b>Article 19 – Research Development and Monitoring</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Cooperate with Parties, taking into account their respective circumstances and capabilities, to develop and improve: <ul style="list-style-type: none"> <li>➢ Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds;</li> <li>➢ modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;</li> <li>➢ assessments of the impact of mercury and its compounds on human health and the environment in addition to social, economic, and cultural impacts, particularly in respect of vulnerable populations;</li> <li>➢ harmonised methodologies for the above undertaken activities;</li> <li>➢ information on the environmental cycle, transport, transformation and fate of mercury and mercury compounds in a range of ecosystems;</li> <li>➢ information on commerce and trade in mercury and mercury compounds and mercury-added products; and</li> <li>➢ information and research on the technical and economic availability of mercury-free products and processes and on best available techniques (BAT) and best environmental practices (BEP) to reduce and monitor emissions and releases of mercury and mercury compounds.</li> </ul> </li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
Assessment on human health	Some hair samples taken from relevant stakeholders have been analysed during the MIA project.
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions</b>	
<ul style="list-style-type: none"> <li>▪ Build capacity to undertake research, development and monitoring of mercury.</li> <li>▪ Participate in international studies involving mercury analysis in hair to assess human health impact.</li> </ul>	

<b>Article 21 – Reporting</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Report to the CoP, through the Secretariat, on measures taken to implement the provisions of the Convention and on their effectiveness;</li> <li>▪ Include in its reporting information on articles 3, 5, 7, 8 and 9 of the Convention.</li> </ul>
<b>Policy and regulatory measures in place to comply with the above listed provisions:</b>	
None	
<b>Outstanding regulatory or policy aspects that would need to be addressed/developed to ensure compliance with the Convention’s provisions</b>	
<ul style="list-style-type: none"> <li>▪ Task to be entrusted to the National Focal Point (NFP) which will prepare the report in collaboration with the Mercury Focus Group.</li> </ul>	

### 3.2 Institutional assessment

Institutions constitute a major component in a given legal system. They ensure that the laws are respected and therefore are responsible for the implementation of laws and measures as may be devised. Various ministries, institutions and stakeholders have been identified which are or will be

involved in the implementation of the Minamata Convention. Relevant institutions related to obligations under the Convention pertain to the protection of the environment and health and they additionally include the local government bodies, the customs department as well as institutions related to consumer protection.

The respective roles and responsibilities of the identified key institutions and stakeholders for each article of the Convention as well as an assessment of the institutional capacity gaps for implementation of the corresponding articles are presented in Table 3.2.

**Table 3.2: Existing national institutional capacity and remaining gaps**

<b>Article 3 – Mercury supply sources and trade</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit new primary mercury mining;</li> <li>▪ Identify individual mercury stocks and sources of stocks exceeding 50 MT, and mercury supply generating stocks exceeding 10 MT/y;</li> <li>▪ Not allow the export of mercury unless the importing country provides written consent, the mercury is for an allowed use or environmentally sound storage, and all other conditions of Article 3.6 are met;</li> <li>▪ Not allow the import of mercury without government consent, ensuring both the mercury source and proposed use are allowed under the Convention (and applicable domestic law).</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Health and Quality of Life (DCCB)	<b>Role with respect to the above listed provisions:</b> Regulate the export and import of mercury
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Existing capacity in place. Requirement of a permit from the DCCB for import of mercury and mercury compounds. The Dangerous Chemicals Control Act (DCCA) vests powers to the Minister under various sections on matters relating to dangerous chemicals.
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<b>Role with respect to the above listed provisions:</b> As the designated National Focal Point (NFP), it will be responsible for the general notification to the Secretariat by the importing Party or non-Party as per section 3 (7).
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has necessary staff in place.
Ministry of Foreign Affairs, Regional Integration and International Trade (MoFARI&IT)	<b>Role with respect to the above listed provisions:</b> The International Trade Division is responsible for the formulation and negotiation of trade policies as well as the negotiation of trade agreements. Compliance will be relevant where trade obligations undertaken by Mauritius through agreements may be related to importation of mercury and mercury compounds.
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
Mauritius Revenue Authority (MRA)	<b>Role with respect to the above listed provisions:</b> Enforce provisions relating to the import and export of mercury and mercury compounds.

	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff at Customs Department.</p>
<p><b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b></p> <ul style="list-style-type: none"> <li>▪ Need for close collaboration amongst enforcement agencies.</li> <li>▪ Training of staff of Customs Department of MRA on relevant sections of Minamata Convention.</li> </ul>	

<b>Article 4 – Mercury-added products</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit the manufacture, import or export of mercury-added products listed in Part I of Annex A;</li> <li>▪ Phase down the use of the mercury-added products listed in Part II of Annex A (dental amalgam);</li> <li>▪ Take measures to prevent the incorporation of prohibited mercury-added products (switches, relays, batteries, etc.) into assembled products.</li> <li>▪ Discourage manufacture, import and export of new mercury-added products.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Foreign Affairs, Regional Integration and International Trade (MoFARI&IT)	<p><b>Role with respect to the above listed provisions:</b> Trade negotiations in respect to agreements where import/export of mercury-added products are involved.</p>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.</p>
Ministry of Industry, Commerce and Consumer Protection (MoICCP -Commerce Division)	<p><b>Role with respect to the above listed provisions:</b> Amendments to be made to Consumer Protection Regulations to broaden ban on import of mercury-added products to include items listed in Part I of Annex A.</p>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required expertise to incorporate the amendments with the help of Attorney General’s Office.</p>
Mauritius Revenue Authority	<p><b>Role with respect to the above listed provisions:</b> Enforce provisions relating to import and export of mercury added products. Ensure exact reporting as to the importation of products by their specific Harmonized System (HS) Codes. Apply sanctions if there is import of any prohibited goods.</p>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.</p>
Ministry of Health and Quality of Life (Dangerous Chemicals Control Board)	<p><b>Role with respect to the above listed provisions:</b> Regulate the import and export of pesticides by issuing licences. Refuse permits for prohibited goods.</p>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.</p>
Ministry of Health and Quality of Life (Pharmacy Division and Pharmacy Board)	<p>Regulate import of cosmetics containing mercury and/or mercury compounds. Control the entry of cosmetics to the country by having pharmacists/ senior pharmacist posted daily at the parcel post office, at the airport, and seaport to verify consignments before release. Analyse cosmetics for their mercury content with the help of laboratories.</p>

	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
Statistics Mauritius	<b>Role with respect to the above listed provisions:</b> Compile statistical data on export and import of mercury, mercury compounds and mercury-added products in collaboration with Customs Department of the MRA. <b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
Ministry of Health and Quality of Life	<b>Role with respect to the above listed provisions:</b> Implement further measures to limit the use of dental amalgam. <b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Amendments to be made to Consumer Protection Regulations to broaden ban on import of mercury-added products to include items listed in Part I of Annex A.</li> <li>▪ Training of staff of Customs Department of MRA on relevant sections of Minamata Convention.</li> <li>▪ Legislative provision required with regards to cosmetics with mercury (New Pharmacy Bill).</li> <li>▪ Enhance capacity of government laboratories to analyse mercury content in cosmetics and other products.</li> <li>▪ Implement further measures, subject to its capabilities, to limit or discourage the use of dental amalgam.</li> </ul>	

<b>Article 5 – Manufacturing processes in which mercury or mercury compounds are used</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Prohibit the use of mercury or mercury compounds in the manufacturing processes listed in Part I of Annex B;</li> <li>▪ Restrict the use of mercury in the processes listed in Part II of Annex B;</li> <li>▪ Discourage the development of facilities with manufacturing processes in which mercury or mercury compounds are intentionally used.</li> </ul>
<b>Relevant national stakeholder:</b>	
Mauritius Chamber of Commerce and Industry (MCCI)	<b>Role with respect to the above listed provisions:</b> Inform and advise businesses with regards to Article 5 requirements. <b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place. The MCCI is represented in the Mercury Focus Group and is also a member of the Project Steering Committee of the MIA project.
Ministry of Health and Quality of Life (Dangerous Chemicals Control Board)	<b>Role with respect to the above listed provisions:</b> Regulate the export and import of mercury and mercury compounds. <b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
None	

<b>Article 6 – Exemptions available to a Party upon request</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	Any State or regional economic integration organization may register for one or more exemptions from the phase-out dates listed in Annex A and Annex B.
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b> MoSSNSESD as the NFP through the Ministry of Foreign Affairs, Regional Integration and International Trade. No exemption was forwarded upon becoming a party to the Convention.</p> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.</p>
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
None	

<b>Article 7 – Artisanal and small-scale gold mining</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take steps to reduce, and where feasible, eliminate the use of mercury and mercury compound in the artisanal and small-scale gold mining and processing</li> </ul>
<b>Relevant national stakeholder:</b>	
None. No action is required as no such activities exist in Mauritius.	

<b>Article 8 – Emissions</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Regulate the control and the reduction of emissions of mercury and mercury compounds to the air from point sources falling within the sources categories defined by the Convention;</li> <li>▪ Take measures to control emissions from relevant sources which may include a national plan;</li> <li>▪ Use BAT and BEP standards to control and reduce emissions from new sources;</li> <li>▪ Include in any national plan, and to implement, regarding the existing sources, one or more of the five measures prescribed in the Convention;</li> <li>▪ Establish and maintain an inventory of emissions from relevant sources;</li> <li>▪ Report in respect to the implementation of adopted measures.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Propose and develop policies on all aspects of environmental protection and management, and to establish such standards for the protection of the air, as may be necessary to safeguard the human health and the environment.</li> <li>▪ Ensure, through its Pollution Prevention and Control (PPCD) Division, compliance to environmental legislation and standards under the EPA and the Environment Protection (Industrial Waste Audit) Regulations 2008.</li> <li>▪ Monitor mercury emissions to air of incinerators, coal-fired facilities, etc.</li> <li>▪ Devise a national plan to control mercury emissions, including use of BAT and BEP standards to control and reduce emissions from new sources.</li> <li>▪ Maintain a national inventory of emissions from relevant sources.</li> <li>▪ Report in respect to the implementation of adopted measures as the National Focal Point.</li> </ul>

	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b>          Has knowledgeable staff in place. However, may outsource in case of overload or lack of human resources.</p>
<p><b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b></p> <ul style="list-style-type: none"> <li>▪ Implement amendments to Environment Protection (Standards for Air) Regulations 1998.</li> <li>▪ Funding to acquire necessary equipment for analysis of mercury in air.</li> <li>▪ Training of staff for monitoring and analysis of air samples.</li> </ul>	

<p><b>Article 9 – Releases</b></p>	
<p><b>Description of Article:</b></p>	
<p><b>Succinct summary of relevant provisions</b></p>	<ul style="list-style-type: none"> <li>▪ Control and reduce releases of mercury and mercury compounds to land and water from relevant point sources;</li> <li>▪ Identify the relevant point source categories;</li> <li>▪ Take measures to control releases according to a national plan;</li> <li>▪ Establish and maintain an inventory of releases from relevant sources;</li> <li>▪ Communicate the information in respect to the implementation of adopted measures.</li> </ul>
<p><b>Relevant national stakeholder:</b></p>	
<p>Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSESD)</p>	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Propose and develop policies on all aspects of environmental protection and management, and to establish such standards for the protection of land and water as may be necessary to safeguard the human health and the environment.</li> <li>▪ Devise a national plan to control mercury releases.</li> <li>▪ Maintain a national inventory of releases from relevant sources.</li> <li>▪ Report in respect to the implementation of adopted measures as the National Focal Point.</li> </ul> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b>          Has knowledgeable staff in place. However, may outsource in case of overload or lack of human resources.</p>
<p>Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (MoOEMRF&amp;S)</p>	<p><b>Role with respect to the above listed provisions:</b>          Monitor heavy metals in estuarine waters. Presently eight estuaries are monitored twice per year for heavy metals, including mercury.</p> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b>          Has required staff and facilities in place.</p>
<p>Ministry of Energy and Public Utilities (MoEPU)</p>	<p><b>Role with respect to the above listed provisions:</b>          The Wastewater Management Authority (WMA) is the main undertaker for the collection, treatment and disposal of wastewater throughout Mauritius. One of its main activities is to control and monitor pollution in relation to wastewater systems. Mercury analysis of wastewater and sludge is carried out periodically.</p> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b>          Has required staff and facilities in place.</p>
<p><b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b></p> <ul style="list-style-type: none"> <li>▪ Identify, assign or recruit appropriate staff to devise national plan and maintain inventory of releases.</li> </ul>	

<b>Article 10 – Environmentally sound interim storage of mercury, other than waste mercury</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take appropriate measures to ensure that the interim storage of mercury and its compounds is undertaken in an environmentally sound and friendly manner;</li> <li>▪ Cooperate with each other and with relevant intergovernmental organizations and other entities.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Health and Quality of Life (MoHQL -DCCB)	<b>Role with respect to the above listed provisions:</b> Regulate storage of dangerous chemicals and storage site.
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
None as there is no mercury mining and no manufacturing processes using mercury and/or mercury compounds.	

<b>Article 11 – Mercury wastes</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Take appropriate measures so that mercury waste is managed in an environmentally sound manner, only recovered, recycled, reclaimed or directly re-used for a use allowed to a Party under the Convention or for environmentally sound disposal, not transported across international boundaries except for the purpose of environmentally sound disposal in accordance with the Basel Convention;</li> <li>▪ Cooperate with each other and with relevant intergovernmental organizations and other entities, as appropriate, to develop and maintain global, regional and national capacity for the management of mercury wastes in an environmentally sound manner.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD - Solid Waste Management Division)	<b>Role with respect to the above listed provisions:</b> <ul style="list-style-type: none"> <li>▪ Propose measures to manage mercury wastes in an environmentally sound manner.</li> <li>▪ Export mercury wastes in accordance with the Basel Convention, and international rules, standards, and guidelines.</li> <li>▪ Monitor the functioning of the interim hazardous waste storage facility.</li> </ul>
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> An interim hazardous waste storage facility (IHWSF) is operational since April 2017. Institutional capacity exists at the Ministry for trans-boundary movement of hazardous waste in accordance with the Basel Convention (Has previously exported hazardous wastes to overseas specialised recovery and disposal facilities).
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Legislation for environmentally sound management of mercury containing wastes including amalgam wastes from dental clinics by applying the Polluter Pay Principle.</li> </ul>	

- Devise a country-wide system for the collection for used products containing mercury such as compact fluorescent lamps (CFLs) and other mercury-containing lamps, mercury thermometers and manometers, switches and relays and other mercury-containing electrical and electronic wastes.

<b>Article 12 – Contaminated sites</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Develop appropriate strategies for identifying and assessing sites contaminated by mercury and/or mercury compounds;</li> <li>▪ Conduct any risk reduction activities at contaminated sites in an environmentally sound manner, incorporating risk assessment to human health and the environment, where appropriate.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<b>Role with respect to the above listed provisions:</b> Develop strategies for identifying and assessing sites contaminated by mercury and/or mercury compounds. Monitor mercury levels in air and leachate at landfills.
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place to identify or assess potential sites contaminated by mercury and/or mercury compounds.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
So far, no cases of sites contaminated with mercury have been reported to the Solid Waste Management Division. This is to be expected in the absence of mining and industrial activity using mercury and/or mercury compounds. Potential contaminated sites are the landfills at Mare Chicose and Roche Bon Dieu in Rodrigues where mercury-containing products are disposed. Mercury level in leachate from landfill at Mare Chicose is being monitored but not in the air. Training of staff for monitoring and analysis of air samples.	

<b>Article 13 – Financial resources and mechanism</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Provide within its capabilities domestic resources as well as seek participation from the private sector as may be needed to implement Convention obligations;</li> <li>▪ Access financial resources available under the Convention and other resources available from multilateral, regional, and bilateral funding sources.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<b>Role with respect to the above listed provisions:</b> <ul style="list-style-type: none"> <li>▪ Seek funding from the financial mechanism to be operated under the guidance of CoP and from other external sources for the national implementation plan for mercury.</li> <li>▪ To budget funding for the national implementation plan for mercury.</li> </ul>
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place to fulfil the above roles.
Ministry of Finance and Economic Development	<b>Role with respect to the above listed provisions:</b> To provide funding for the national implementation plan for mercury in the national budget.
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff in place.

<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>
▪ Funding, either local or overseas, for the national implementation plan for mercury

<b>Article 14 – Capacity building, technical assistance and technology transfer</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Provide timely and appropriate capacity-building and technical assistance to developing country parties, especially least developed countries and SIDS through cooperation among parties;</li> <li>▪ Deliver capacity-building and technical assistance through arrangements which can be bilateral or multilateral, or which can be through regional, sub-regional or national levels;</li> <li>▪ Provide information and access to up-to-date environmentally sound alternative technologies to developing country Parties, in particular least developed countries and SIDS.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b> Cooperation for capacity building and technical assistance, in particular between developed countries, least developed countries, and SIDS..</p> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> The Ministry has the required knowhow in engaging in collaboration with developed countries, developing countries and other SIDS on issues relating to mercury management and scientific research.</p>
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Foster collaboration, nationally, regionally and internationally, in the area of mercury management, scientific research and knowhow.</li> <li>▪ Train relevant MSB staff and purchase appropriate equipment and accessories to enable MSB Metrology Division to act as an accredited laboratory for the calibration of non-liquid in glass thermometers.</li> </ul>	

<b>Article 16 – Health aspects</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Promote the development and implementation of the following: <ul style="list-style-type: none"> <li>➢ Identification and protection of populations at risk, especially vulnerable groups;</li> <li>➢ Science-based educational and preventive programmes on occupational exposure to mercury and its compounds;</li> <li>➢ Appropriate health-care services for prevention, treatment and care for affected populations.</li> </ul> </li> <li>▪ Establish and strengthen institutional and health professional capacities for the prevention, diagnosis, treatment and monitoring of health risks related to the exposure of mercury and its compounds.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Health and Quality of Life (MoHQL)	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Promote prevention, treatment, and health care services for affected populations.</li> <li>▪ Strengthen institutional and health professional capacities for the prevention, diagnosis, treatment and monitoring of health risks related to the exposure of mercury and its compounds.</li> </ul>

	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> MoHQL has the required staff for treatment and care of affected populations.</p>
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Promote the development and implementation of strategies to identify and protect populations at risk, especially vulnerable groups.</li> <li>▪ Promote preventive programmes on occupational exposure to mercury and its compounds.</li> </ul>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has required staff to put the programmes in place in collaboration with the Ministry of Labour, Industrial Relations, Employment and Training (MoLIRE&amp;T) and MoHQL.</p>
<p><b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b></p> <ul style="list-style-type: none"> <li>▪ Updating and upgrading the knowledge of health care professionals for the prevention, diagnosis, treatment and monitoring of health risks related to the exposure of mercury and its compounds.</li> <li>▪ Organising awareness sessions/workshops on the dangers of mercury and its compounds.</li> <li>▪ Assessing health impact of Mauritians by conducting regular bio-monitoring of high risk groups (e.g. determining mercury levels in hair of individuals occupationally exposed to mercury and mercury compounds and high consumers of fish and fish products.</li> </ul>	

<p><b>Article 17 – Information exchange</b></p>	
<p><b>Description of Article:</b></p>	
<p><b>Succinct summary of relevant provisions</b></p>	<ul style="list-style-type: none"> <li>▪ Share information on a number of issues related to mercury, namely: <ul style="list-style-type: none"> <li>➢ Scientific, technical, economic and legal information;</li> <li>➢ Information on reduction or elimination of the production, use, trade, emissions and release of mercury and its compounds;</li> <li>➢ Information on technically and economically viable alternatives;</li> <li>➢ Epidemiological information concerning health impacts, with collaboration with WHO and other relevant organisations.</li> </ul> </li> <li>▪ Collect and disseminate information on annual quantities of mercury and mercury compounds emitted, released, or disposed; and other information specified in Article 18.</li> </ul>
<p><b>Relevant national stakeholder:</b></p>	
Ministry of Social Security, National Solidarity and Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b> All the above acting as the proposed National Focal Point (NFP)</p>
	<p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Has the required expertise to carry out the roles. However, may outsource in case of overload or lack of human resources.</p>
<p><b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b></p> <ul style="list-style-type: none"> <li>▪ Dedicated staff to be assigned to the roles.</li> <li>▪ Provision of financial resources for annual data collection and dissemination.</li> <li>▪ Option of outsourcing for updating the mercury national profile.</li> </ul>	

<b>Article 18 – Public Information, Awareness and Education</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Promote and facilitate provision of information to the public, within their capabilities, on topics related to mercury and mercury compounds, including education, training and public awareness related to the effects of exposure to mercury and mercury compounds on human health and the environment, and alternatives to mercury and mercury compounds;</li> <li>▪ Collaborate with relevant intergovernmental and non-governmental organisations and vulnerable populations.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<b>Role with respect to the above listed provisions:</b> All of the above
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> The Ministry can assign staff for the above. However, it may also outsource in case of overload or lack of human resources.
Ministry of Education and Human Resources, Tertiary Education and Scientific Research (MoEHRTE&SR)	<b>Role with respect to the above listed provisions:</b> Education and training related to the effects of exposure to mercury and mercury compounds
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> The Ministry can issue guidelines to tertiary institutions to incorporate the Minamata Convention and/or effects of exposure to mercury and mercury compounds on all programmes/courses dealing with environment/health/law/chemistry.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Assign staff or provide resources to design a webpage on the MoSSNSE&amp;SD website regarding all matters pertaining to mercury, including mercury-free alternatives, fish mercury analyses carried out and fish consumption information guidelines.</li> <li>▪ Provision of financial and human resources for conducting awareness sessions and training on the management of mercury as well as mercury-containing products and wastes to targeted stakeholders in collaboration with relevant governmental and non-governmental organisations.</li> <li>▪ Design and distribution of pamphlets to targeted stakeholders.</li> <li>▪ Use of other modes of communication to sensitise the public about the dangers of mercury and mercury compounds.</li> </ul>	

<b>Article 19 – Research Development and Monitoring</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Cooperate with Parties, taking into account their respective circumstances and capabilities, to develop and improve: <ul style="list-style-type: none"> <li>➤ Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds;</li> <li>➤ modelling and geographically representative monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media, including biotic media such as fish, marine mammals, sea turtles and birds, as well as collaboration in the collection and exchange of relevant and appropriate samples;</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>➤ assessments of the impact of mercury and its compounds on human health and the environment in addition to social, economic, and cultural impacts, particularly in respect of vulnerable populations;</li> <li>➤ harmonised methodologies for the above undertaken activities;</li> <li>➤ information on the environmental cycle, transport, transformation and fate of mercury and mercury compounds in a range of ecosystems;</li> <li>➤ information on commerce and trade in mercury and mercury compounds and mercury-added products; and</li> <li>➤ information and research on the technical and economic availability of mercury-free products and processes and on best available techniques (BAT) and best environmental practices (BEP) to reduce and monitor emissions and releases of mercury and mercury compounds.</li> </ul>
<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development (MoSSNSE&SD)	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Inventories of use, consumption, and anthropogenic emissions to air and releases to water and land of mercury and mercury compounds</li> <li>▪ Information on mercury free products and processes and BAT/BEP</li> <li>▪ Assessment of the impact of mercury and its compounds on human health by analysis of hair samples</li> </ul> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> The Ministry can assign staff for the above. However, it may also outsource in case of overload or lack of human resources.</p>
Mauritius Research Council, Tertiary Education Commission and tertiary education institutions	<p><b>Role with respect to the above listed provisions:</b></p> <ul style="list-style-type: none"> <li>▪ Modelling and monitoring of levels of mercury and mercury compounds in vulnerable populations and in environmental media.</li> <li>▪ Assessments of the impact of mercury and mercury compounds on human health and the environment in addition to social, economic, and cultural impacts, particularly in respect of vulnerable populations.</li> <li>▪ Research on the technical and economic availability of mercury-free products and processes and on best available techniques (BAT) and best environmental practices (BEP) to reduce and monitor emissions and releases of mercury and mercury compounds.</li> </ul> <p><b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Academic staff in tertiary education institutions can apply to carry out the above research projects through funding research schemes available at the Tertiary Education Commission and Mauritius Research Council.</p>
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Ministry to outsource selected activities in case of overload or lack of human resources.</li> <li>▪ Build capacity to undertake research, development and monitoring of mercury.</li> <li>▪ Participate in international studies involving mercury analysis in hair to assess human health impact.</li> </ul>	

<b>Article 21 – Reporting</b>	
<b>Description of Article:</b>	
<b>Succinct summary of relevant provisions</b>	<ul style="list-style-type: none"> <li>▪ Report to the CoP, through the Secretariat, on measures taken to implement the provisions of the Convention and on their effectiveness;</li> <li>▪ Include in its reporting information on articles 3, 5, 7, 8 and 9 of the Convention.</li> </ul>

<b>Relevant national stakeholder:</b>	
Ministry of Social Security, National Solidarity, Environment and Sustainable Development (MoSSNSE&SD)	<b>Role with respect to the above listed provisions:</b> All the above as being the National Focal Point.
	<b>Relevant institutional capacity in place to comply with the above listed provisions:</b> Possess the required expertise to fulfil the above roles in collaboration with the Mercury Focus Group.
<b>Remaining Capacity Gaps at National Level that need to be addressed before provisions can be met:</b>	
<ul style="list-style-type: none"> <li>▪ Appoint dedicated staff for the above activities.</li> </ul>	

## Chapter IV: Identification of Populations at Risks and Gender Dimensions

### 4.1 Preliminary review of potential populations at risk and potential health risks

This chapter provides an overview of the assessment of mercury exposures for some specific scenarios including occupational exposure and other ‘hot spots’ exposures. The human health risk assessment for chemicals is generally an exercise to estimate the likelihood of adverse health effects occurring in an individual, subpopulation or population due to exposure to the chemical (in this case – mercury). It normally comprises of four steps: 1) hazard identification; 2) hazard characterization, including dose-response assessment; 3) exposure assessment; and, 4) risk characterization.

The routes of exposure of mercury and mercury compounds for individuals or populations are *via* ingestion, inhalation, dermal or trans-placental for the fetus. Exposures can be estimated by measuring the pollutant levels in various body tissues (such as hair, blood, urine, or nails) referred to as biomarkers.

In all the predominant forms of mercury the most important form that tends to bio-accumulate due to its lipophilic behavior is the organic form of mercury (namely methylmercury) present in fish. Higher mercury levels are found in larger fishes such as marlin, swordfish and tuna (c.f. Table 2.56). Exposure to other forms of mercury will occur during the use of products such as: use of liquid mercury during jewellery processing, or use and disposal of mercury-containing products such as thermometers, manometers, fluorescent lamps, batteries, electrical switches and dental amalgam fillings. Mercury is also released to the environment from various industrial sources that mobilize mercury impurities in input materials (such as fuels or feedstock) or from burning of medical waste contaminated with mercury.

Occupational exposures have been reported from poor waste handling practices. Long term exposures to smaller quantities of elemental mercury or inorganic mercury forms can also occur due to use of some skin-lightening creams and soaps, the presence of mercury in some traditional medicines, use of mercury in cultural practices, and due to various accidental mercury spills in homes, schools or other locations.

#### Susceptible populations

There are two groups of people susceptible to mercury, namely those who are more sensitive to the effects of mercury and those who are exposed to higher levels of mercury. The “*WHO/UNEP Guidance for Identifying Populations at Risk from Mercury Exposure*<sup>25</sup>” reports that the foetus, newborns and children are especially susceptible to mercury exposure because of the sensitivity of the developing nervous system.

In addition to in utero exposure, neonates can be further exposed through mercury contaminated breast milk, although only a small percentage of maternal mercury is excreted in breast milk. Individuals suffering from diseases of the liver, kidney, nervous system, and lung are at higher risk of encountering the toxic effects of mercury. The other group are those individuals exposed to higher levels of mercury, either through occupational, use of mercury-added products or environmental exposure. This group also includes persons who regularly consume fish and other seafood, particularly larger predatory fish. Pregnant women, and women who might become pregnant are

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<sup>25</sup> <http://www.who.int/foodsafety/publications/risk-mercury-exposure/en/>

generally the populations considered to be potential high risk groups because of potential exposure to the foetus.

### Health effects

All humans are exposed to some forms of low levels of mercury; however, the health effects developed depend on various factors such as duration, frequency, dose received, age, the developmental stage of the person exposed and the route of exposure. There are many studies on the impacts of methylmercury toxicity on the neurological, cardiovascular, and immune systems within humans. For example, the neurological impacts are often measured through lowered IQ levels (Spadaro and Rabl, 2008) and through various neuropsychological tests (Grandjean *et al.*, 1998). Cardiovascular and immunological impacts are often found to be related to chronic exposure to mercury (Sweet and Zelikoff, 2010; Downer *et al.*, 2017). However, the relative impacts from the toxic effects of methylmercury were found to vary across human populations, as some may be more affected than others with similar exposure.

### Reference levels

Based on risk assessment studies and other considerations, health standards have been developed. Some reference standards for mercury and mercury compounds is presented in Table 4.1.

**Table 4.1: Health reference standards for mercury and mercury compounds**

Mercury/ mercury compound	Reference level ( $\mu\text{g}/\text{kg}$ body weight per week)	Health standard	Remarks
Methylmercury	0.7 to 2	WHO	
Total mercury	5*	Joint FAO/WHO Expert Committee on Food Additives (JECFA)	Provisional tolerable weekly intakes (PTWIs) for food supply
Methylmercury	1.6*	JECFA	PTWIs for food supply

\*These values represent permissible human weekly exposure without appreciable health effects over a lifetime and were derived taking into consideration the most susceptible part of the population (developing foetuses).

To regulate sale of fish, Codex Alimentarius set guideline levels to 0.5 mg methylmercury/kg in non-predatory fish and 1 mg methylmercury/kg in predatory fish.

The US EPA has developed Reference Doses (RfDs) for mercuric chloride of 0.3  $\mu\text{g}/\text{kg}$  body weight/day and methylmercury of 0.1  $\mu\text{g}/\text{kg}$  body weight/day and a Reference Concentration (RfC) for elemental mercury of 0.3  $\mu\text{g}/\text{m}^3$ .

The European Community allows 0.5 mg mercury/kg in fishery products (with some exceptions), and Japan allows up to 0.4 mg total mercury/kg (or 0.3 mg methylmercury/kg) in fish.

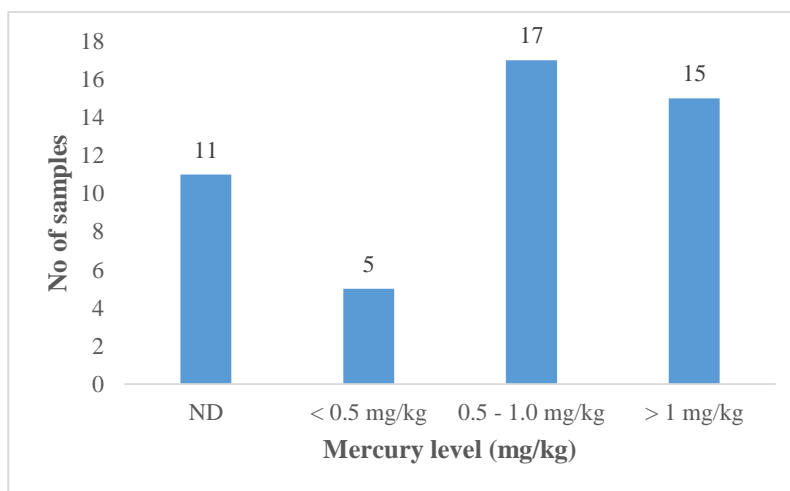
The standards and limits for fish and fish products, and drinking water in Mauritius are 1 mg/kg (Food Regulations, 1999) and 0.001 mg/l (Environment Protection Regulations – Drinking Water Standards, 1996) respectively.

## Estimating exposure through biomonitoring

A detailed study using appropriate biomarkers can yield important findings and serve as useful tools for human exposure assessment, and as surveillance tools for monitoring mercury exposure in individuals and populations. There is a well-established relationship between several biomarkers of mercury exposure and adverse health effects. However, a complete biomonitoring was considered beyond the scope of the MIA project and requires important financial implication. As per the recommendation of the Project Steering Committee, some hair samples were collected from volunteers in the identified 'hot spots' and tested for mercury content, in order to provide a snapshot of the local situation with respect to mercury level in hair.

Hair is a preferred choice to blood monitoring, since once incorporated in hair, the mercury does not return to the blood and most mercury in hair is in the form of methylmercury. A daily average methylmercury intake of 0.1 microgram per kg body weight by a pregnant woman is estimated to result in hair mercury concentrations of roughly about 1 µg/g. This relationship is generally linear, or directly proportional.

48 samples of hair (27 males and 21 females) from different stakeholders and the normal population were analysed. The mercury levels ranged from non-detectable (< 0.0041 mg/kg) to 11.31 mg/kg with a mean of 1.17 mg/kg. Figure 4.1 depicts the frequency of the hair samples having the different ranges. It is noteworthy that 31% of the samples exceeded the U.S. Environmental Protection Agency guideline of 1 mg/kg. Females were found to have a higher mean (1.54 mg/kg) compared to males (0.78 mg/kg). The sample having the highest level, namely 11.31 mg/kg, was taken from a female working in the jewellery sector. A higher mercury prevalence was observed in population sample with fish consumption diet both for Mauritius and Rodrigues. Two vegetarians had non-detectable mercury hair contents.



**Figure 4.1: Mercury hair levels in the sampled population**

## A review of impact studies and case studies on mercury in Mauritius

Below is a literature review of some available research on mercury assessment in various environmental media:

- Bhoyroo *et al.* (2015) conducted a study to assess the level of trace elements (Zn, Cu, Ni, Cr) and heavy metals (Pb, Hg, Cd, As) in the muscle tissues of four commercially important fish species, *Thunnus albacares*, *Gymnosarda unicolor*, *Makaira mazara* and *Coryphaena hippuru*. The levels of mercury detected in the four fish species (wet weight) were found to lie in the range of 0.02 to 0.71 ppm. It was concluded that periodical monitoring of heavy metals in commercial fishes are needed for safety evaluations and the environmental water quality should be assessed.
- Dookhun and Mahadeo (2008) conducted an assessment of mercury input to Mare Chicose landfill through products containing mercury and estimated the work-surface exposures.
- The Zero Mercury Working Group (2013), in a study on assessment of hair mercury levels of women of childbearing age in 9 countries (Armenia, Bangladesh, Côte d'Ivoire, Japan, India, Mauritius, Nepal, South Africa and Spain), revealed that 36% of the women sampled near a fishing village in Mauritius exceeded the U.S. Environmental Protection Agency guideline of 1 µg/g.

In addition, several studies on mercury level in hair, fish, and cosmetic products have been conducted by final year students at the University of Mauritius as part requirement for the award of their degrees.

#### **A review on studies on policies and strategies for mercury pollution in Mauritius**

- A level 1 inventory of mercury releases in 2012 was carried out by the Ministry of Environment and Sustainable Development, and the Ministry of Health and Quality of Life (MoESD & MoHQL, 2014).
- The report published by the Ministry of Environment and National Development Unit (MoE&NDU, 2009) compiled a summary of policies, strategies, mechanisms & programmes for chemicals risk assessment, including evaluation and reduction of risks posed by lead, mercury, cadmium and other harmful heavy metals. A brief of the UNEP programme in which Mauritius was participating with the objective to monitor releases of mercury and its compounds into the environment has also been provided.
- A report from the Ministry of Human Rights, Child Development, Family Welfare and Child Protection (MoHRCDFW&CP, 2006) highlights the provision of the Occupational Safety and Health Act which prohibits young people (< 18 years) to be recruited for work that involves exposure to heavy metals including lead and mercury.

#### **4.2 Assessment of potential gender dimensions related to the management of mercury**

This section presents the differing roles of gender with regards to management of mercury in Mauritius. The aim is to ensure that gender considerations are effectively mainstreamed into the national action plan for mercury. It is to be noted that an extensive assessment of gender issues for mercury has not been conducted principally due to the absence of mercury and gold mining and industrial processes using mercury and its compounds. The inventoried sources being more related on imported consumer products and goods, the effects of mercury exposure on gender would be mostly related to how men and women would be using the products containing mercury and on the impact of their job related exposures. A short descriptive summary is provided below that shows clear differences in gender within various areas where mercury contamination is likely to occur.

### **4.2.1 Occupational exposure**

A screening assessment was carried out to identify the likely sources of mercury exposure at the workplace in Mauritius in consultation with the various stakeholders. The screening assessment investigations concluded potential job related exposures for the following workers: waste collectors, landfill operators, dental practitioners and assistants, medical professionals, laboratory personnel, environment officers / enforcement officers, gas station attendants, jewellers, workers at coal-bagasse fired power plants, workers at medical waste incinerators and open cremation facilities, and firemen during emergency responses. Air monitoring of workplace to assess mercury levels was not carried out due to unavailability of appropriate equipment.

#### **Waste collectors, landfill operators, workers at medical waste incinerators and open cremation facilities**

Waste collectors are provided with the necessary personal protective equipment (PPE) and no municipal waste incineration is practiced locally. Disposal of broken fluorescent tubes, broken equipment containing mercury (e.g. thermometers), electrical switches and relays containing mercury, batteries in the waste commingled with the municipal waste can increase risk of exposure of mercury to these workers. Workers at medical waste incinerators and open cremation facilities may face exposures due to burning of products containing mercury and incineration of body parts or teeth with dental amalgam.

All the above works are mostly performed by male workers.

#### **Dental practitioners and dental assistants**

Dental amalgams are still being used by both public and private dentists, although non-mercury alternatives such as composites are available. Exposures are more prominent mostly during filling operations. The dental practitioners are aware that use of chairside traps, proper containment of waste materials and proper spill management will reduce risk of exposures. Dentistry has been mostly a male dominant sector; however, the trend is shifting to equal proportion of male and female dentists. On the other hand, most dental assistants are found to be female and they can be occupationally exposed to mercury also.

#### **Medical professionals including nurses**

With the replacement of mercury thermometers and sphygmomanometers by non-mercury alternatives, the risk of exposure has decreased significantly in the local hospitals and private clinics. It is however reported that some broken equipment may at times find its way commingled with medical waste due to absence of proper disposal area for obsolete products with mercury. Both men and women work in this sector.

#### **Laboratory personnel / educators**

Risk of exposure will occur only during the breakage of mercury thermometers and manometers, and when using mercury and mercury compounds. Laboratory personnel are trained to managing and containing mercury spills. Special containers have been placed at the University of Mauritius laboratories for example to contain the spills. This sector has equal distribution of male and female workers.

### **Environment officers / enforcement officers**

Environment and enforcement officers may be exposed during monitoring interventions. With the appropriate wearing of PPE, exposure is significantly reduced. No major mercury spill has been reported for Mauritius. Both men and women are employed in the sector.

### **Gas station attendants**

Petroleum products may contain low levels of mercury and as a matter of consequence, gas station environment may have low levels of mercury. Both men and women work as gas station attendants with the majority being male workers.

### **Firemen and fire respondents to chemical accidents**

No major mercury spill has been reported. Exposure levels may be significant during fires due to combustion of products containing polyurethane. With appropriate PPE, mercury exposure is significantly reduced. Male workers predominate in the fire and rescue services in Mauritius.

### **Jewellers**

Use of mercury in the jewellery sector is banned in Mauritius. The few jewellers still practicing gold recovering from mercury amalgams have alternatives for better practices, for instance, they may send their gold dust to more specialised recycling facilities available locally. Although predominantly jewellers are male workers, mercury toxicity may be extended to workers' families touching both women and children.

### **Workers at power plants**

Exposures may arise mainly from inhalation of air containing significant levels of mercury due to emissions from coal burning and from coal ash handling. Control rooms are well designed to prevent air contamination. Exposures can occur during worker long term interventions on the platform near the furnaces. Reducing time spent near combustion furnaces and wearing appropriate PPE during interventions significantly reduce exposure risks. Workers are predominantly male.

### **Conclusion**

Normally men are at a greater risk of occupational exposure. In the absence of a national mercury-oriented industry, the main workgroups identified for occupational exposure were:

- Waste collectors
- Medical waste incinerator workers and landfill workers
- Dental professionals and assistants

Workers in the waste management stream comprising mostly men are at greater risk of exposure due to waste mercury containing devices. Although dental professionals comprised more male dentists than females, it is noted that dentist assistants were mainly female. In such case, male dentists would be more prone to contact with dental amalgam but assisting females may also be affected.

Gas station attendants are almost exclusively men whereas environmental / enforcement officers (called upon to investigate environmental pollution cases) are generally gender balanced. Firemen and first responders to chemical accidents are primarily males.

It can be concluded that in terms of occupational exposure, men are at a greater risk than women.

#### **4.2.2 Mercury in fish**

As regards fish consumption, both males and females generally eat the same amounts of fish. However, the adverse health impacts due to exposure of mercury are more strongly felt in children, pregnant women and women in child-bearing years as the developing organ systems (such as the foetal nervous system) are the most sensitive to toxic effects of mercury. Recent studies by Downer *et al.* (2017) showed that there may be increased risk for cardiovascular disease in adults, which are either sensitive to methylmercury or those having elevated mercury levels. It is noteworthy that men are more prone to cardiovascular disease than women.

Methylmercury intake for individuals or population can be estimated from the following basic equation:

Methylmercury intake per kg body weight per week =

$$\frac{\text{Amount of fish ingested per week (kg)} \times \text{Hg level in the fish ingested } (\mu\text{g/kg})}{\text{kilogram body weight (kg bw)}}$$

From data of the Food and Agricultural Organization (FAO, 2000), the amount of fish ingested by a woman in Mauritius was estimated to be about 20 g/day. Data from analysed samples of fish revealed a mercury concentration of less than 1 mg/kg for more than 90% of the samples (refer to Table 2.56), with most of the fishes having a level of 0.1 mg/kg.

Assuming consumption of 20 g/day/capita by women of child bearing age with mean body weight of 53 kg in Mauritius and a mercury concentration of 0.5 mg/kg, mercury exposure will stand as at 1.3 µg/kg body weight per week.

Risk to mercury is therefore considered low since it is lower than the WHO and JECFA reference value, which is 5 µg/kg body weight per week.

It is noted that fresh and marine fish supply for Mauritius stands as at 4.06 kg/capita per day (FAO, 2017).

#### **4.2.3 Mercury in household**

Within the households, women and children are more likely to be exposed to mercury from broken thermometers, since women primarily use them, especially mothers. Broken fluorescent tubes still pose a problem as they are usually disposed in the general waste. With the sensitization and awareness campaigns, it is expected that the population will be more aware on the necessity of separating mercury waste from other waste. A proper disposal scheme for broken CFL tubes and other mercury-containing products will divert such waste from the main waste streams.

#### **4.2.4 Mercury in cosmetics**

Women are more susceptible to exposure by mercury-added cosmetics and personal products such as soaps, creams and shampoos. The use of skin lightening creams in Mauritius and some African countries is quite prevalent due to prevailing beauty perception, with particular preferences for lighter coloured, unblemished skin. Skin lightening creams of different brands are available in the Mauritian market and most local women who use these products generally have limited knowledge of the harmful effects of mercury to their health.

Several samples of soaps, skin whitening creams and products available locally have been tested. Most of them were found to have mercury level less than the detection limit of 0.0041 mg/kg. However, some whitening and speckle-removing products imported from China and Pakistan were detected with levels of mercury exceeding 1 mg/kg (Refer to Section 2.6.9). Given the health impacts of use of these mercury-containing cosmetics, action has been initiated by the Pharmacy Board to control the entry of these goods to the country. Pharmacists/ Senior Pharmacist are posted daily at the parcel post office, at the airport, and seaport to verify consignments before release. Permit to import skin-lightening creams and lotions are being issued to companies only after having received certificate of analysis ruling out the presence of mercury in such products. It is noteworthy that whitening creams with dangerous ingredients such as mercury are treated as selected prohibited goods in the Customs Act since July 2017.

Mercury was also undetected in samples of colour powders and ritual products used by the people of Indian origin in Mauritius. Monitoring of local markets should be a continuous exercise and the personnel of customs departments should be trained for identification of mercury containing products.

#### **4.2.5 Conclusion**

From the above, it is clear that males should be principally targeted for occupational exposure, especially in the field of waste management, coal burning and first responders, such as firemen. However, in the medical profession, both males and females are equally susceptible to mercury exposure. On the other hand, females are a more important target group concerning mercury in cosmetics.

However, despite having more men than women exposed to mercury, women may have different susceptibility to the impacts of toxic chemical exposure, e.g. due to differences in physiology and in connection with their reproductive cycles. With generally a higher proportion of body fat, women are also more likely to store more environmental pollutants in their tissues. At particular stages of their lives, such as pregnancy, lactation, and menopause, women's bodies undergo rapid physiological changes that also may change their vulnerability to health damage from toxic chemicals (UNDP, 2011). It is noteworthy that in the small study done during the project on mercury levels in hair, females were found to have a higher mean (1.54 mg/kg) compared to males (0.78 mg/kg) and the sample having the highest level (11.31 mg/kg) was taken from a female working in the jewellery sector.

Thus, allowance should be made when considering training, education and awareness programmes on safe handling of mercury to target the gender dimension in order to achieve maximum benefit.

## Chapter V: Awareness/Understanding of Workers and the Public; and Existing Training and Education Opportunities of Target Groups and Professionals

The MIA project includes a Communications Plan whose main objectives are:

- To ensure a good visibility of the project amongst the major stakeholders and also the general public;
- To inform the major stakeholders about the Minamata Convention;
- To raise the awareness of the main stakeholders in sectors dealing with Hg products (e.g. jewellery, dentistry, medical sector, educational institutions, etc.) or releasing Hg (e.g. power plants running on coal) regarding the need to phase down the use of Hg containing products or to put in place adequate abatement devices to reduce the Hg releases to the environment;
- To raise the awareness of the general public and more specifically the occupationally exposed workers (e.g. jewelers, IPP, dentistry, medical sector, etc.) about the impact of mercury on human health and the environment.

During the MIA project, the following training and awareness activities were carried out under the guidance of the Project Steering Committee:

<b>Dates</b>	<b>Training and awareness activity</b>	<b>Stakeholders</b>
7-9 June 2016	Training on Mercury Level 2 Inventory	Assay Office, CEB, Commission of Environment, Rodrigues, Food and Agricultural Research and Extension Institute (FAREI), IPP, Mauritius Cane Industry Authority (MCIA), MIA consultants, MoEHRTE&SR, MoHQL, MoICCP, MoLIRE&T, MoOEMRF&S (Fisheries Division), MoSSNSE&SD, MRA, PANeM, Statistics Mauritius, University of Technology Mauritius (UTM), Water Resources Unit, WMA
28 July 2016	Awareness session on Minamata Convention, its implications and the MIA project	Importers of chemicals, lamps, paints, batteries, thermometers, MoSSNSE&SD, MRA, PANeM
9 March 2017	Talk on ‘Use of Mercury in the Jewellery Sector and Associated Health Hazards’ during the Sensitisation workshop on ‘Jewellery Sector for Tomorrow’	Jewellers and MoICCP
9 March 2017	Distribution of the pamphlet for the jewellery sector to all the participants of the sensitization workshop	Jewellers
27 April 2017	Validation workshop for legal gap analysis report	Assay Office, Attorney General’s Office, Central Water Authority, CEB, FAREI, IPPs, MCCI, MCIA, Ministry of Agro Industry and Food Security, Ministry of Civil Service and Administrative Reforms, Ministry of Defence and Rodrigues, Ministry of Financial Services and Good Governance, Ministry of Gender Equality, Child Development and Family Welfare, MoEHRTE&SR, MoOEMRF&S (Fisheries Division), MoFARI&IT, MoHQL, MoICCP, MoLGOI, MoLIRE&T, MoPU, MoSSNSE&SD,

<b>Dates</b>	<b>Training and awareness activity</b>	<b>Stakeholders</b>
		MRA, MSB, PANeM, SMEDA, Statistics Mauritius, UNDP, UTM, Water Resources Unit, WMA
7 June 2018	Awareness Raising Workshop on Mercury and its Alternatives	NGOs
8 June 2018	Validation workshop for Minimata Initial Assessment Report	Assay Office, Attorney General's Office, Central Water Authority, CEB, FAREI, IPPs, MCCI, MCIA, Ministry of Agro Industry and Food Security, Ministry of Civil Service and Administrative Reforms, Ministry of Defence and Rodrigues, Ministry of Financial Services and Good Governance, Ministry of Gender Equality, Child Development and Family Welfare, MoEHRTE&SR, MoOEMRF&S (Fisheries Division), MoFARI&IT, MoHQL, MoICCP, MoLGOI, MoLIRE&T, MoPU, MoSSNSE&SD, MRA, MSB, PANeM, SMEDA, Statistics Mauritius, UNDP, UTM, Water Resources Unit, WMA

In addition, the NGO, PANeM, has conducted several awareness raising activities on mercury and its effects in many communities, institutions and civil society organisations in Mauritius and Rodrigues (PANeM, 2016). To complement this present MIA work, PANeM has also focused on work towards assisting Mauritius to phase out mercury added products<sup>26</sup>.

It was observed that generally there was a rather high awareness of mercury issues within the dental and medical profession and also in the different ministries related to environment, health, trade and energy. A dentistry poster has been designed and will be sent to all the dentists. However, it was felt that further awareness and training sessions targeting priority groups and the public at large are needed (Refer to the National Implementation Plan).

For the general public, short spots lasting 30 to 90 seconds have been designed and were broadcasted on selected bus routes during the months of December 2017-Feb 2018. Discussions are under way to broadcast the spots in other venues such as the local authorities and ministries. In addition, roll-up banners will be designed and put up for display during activities organized by ministries. They will contain information such as toxicity of mercury and its impact on human health and environment, sources of mercury and alternatives to mercury.

A one-day validation workshop on the MIA report where major stakeholders were present was held on 8 June 2018.

The main objectives of the workshop were:

- To inform the stakeholders about the findings of the inventory and to validate the latter;
- To set priorities regarding mercury management / phasing out for the different sectors;
- To identify sectors where training would be required for the sound management of mercury containing products and related wastes.

<sup>26</sup> [http://www.zeromercury.org/index.php?option=com\\_content&view=article&id=319%3Ainternational-eebzmwg-supported-projects&catid=36%3Ageneral&Itemid=110](http://www.zeromercury.org/index.php?option=com_content&view=article&id=319%3Ainternational-eebzmwg-supported-projects&catid=36%3Ageneral&Itemid=110)

## Chapter VI: Implementation Plan & Priorities for Action

The main objective of the National Implementation Plan is to “decrease input, releases and emissions of mercury and thus reduce its impact on human health as well as the environment” in accordance with the priorities 6 and 7 of the Minamata Convention on Mercury.

Prior to the Minamata Convention on Mercury, the Republic of Mauritius has already initiated various measures to reduce mercury input, releases and emissions, as detailed in the previous sections (c.f. legal and institutional gap analysis). Under the Dangerous Chemicals Control Act 2004, mercury and its derivatives are classified as extremely dangerous chemicals and their import and use are restricted to laboratory purposes only. Import of mercury-containing batteries and mercury-containing agricultural chemicals is prohibited. Since 2007, the MoHQL has been phasing out mercury-containing apparatuses from the public health care facilities. As of date, from a survey carried out in 2016-2017, public and private health care facilities are no longer purchasing mercury containing thermometers and sphygmomanometers.

Standards for the maximum acceptable level for mercury in different media such as drinking water, surface water, effluent, estuarine water and wastewater are in place. Limits are being proposed for mercury levels in air, in stack and incinerator emissions. Limits have been imposed for mercury level in fish (1 mg/kg) and various foodstuffs under the Food Regulations 1999. Use of dental amalgam fillings in small children and pregnant women is banned in the public dental clinics. In addition, the government is promoting the use of renewable sources of energy such as solar and wind energy to decrease use of fossil fuels.

It is noteworthy that a Mercury Focus Group comprising representatives of relevant stakeholders and mercury experts has been set up in September 2013 to act as a national consultation platform to monitor the activities required to implement and ratify the Minamata Convention on Mercury.

Following the outcomes and results of the Level 1 National Inventory Report, a Mercury National Action Plan (NAP) 2015-2020 was prepared with the active contribution of the Mercury Focus Group. Seven mercury-related priorities were identified and are indicated below:

- Priority 1: Assess national capacity to implement Convention through policy analysis, level 2 mercury inventory, and institutional capacity strengthening
- Priority 2: Improve the policy and regulatory framework governing the management of mercury
- Priority 3: Undertake awareness raising among priority groups and build capacity through training on mercury management
- Priority 4: Phase-down/Phase-out the use of mercury containing products and high mercury content products
- Priority 5: Improve storage and waste management practices for mercury and mercury containing wastes
- Priority 6: Improve monitoring and reporting capacity on mercury levels in food, soil, water and air

- Priority 7: Reduce emissions of mercury and mercury compounds to the atmosphere, soil and water from point sources

Several actions have already been carried out or initiated, namely the level 2 mercury inventory, legal and institutional gap analysis, awareness sessions on the Minamata Convention on Mercury and the harmful effects of mercury on health and the environment, a pamphlet for jewellers and spots for general public, and proposed limits for mercury levels in air, stack and incinerator emissions.

Following the outcomes and results of the Level 2 National Inventory Report and taking into consideration the Mercury National Action Plan (NAP) 2015-2020, five mercury-related priorities together with their proposed actions for 2019-2024 are identified and are indicated below:

- (1) Improve the policy and regulatory framework governing the management of mercury and mercury waste
- (2) Improve storage and waste management practices for mercury and mercury containing wastes
- (3) Undertake education awareness and strengthen capacity through training
- (4) Improve monitoring and reporting capacity on mercury-containing products and mercury levels in food, soil, water, air and biological samples
- (5) Reduce emissions of mercury and mercury compounds to the atmosphere, as well as the reduction of mercury releases to the soil and water from point sources

**Priority 1: Improve the policy and regulatory framework governing the management of mercury and mercury waste**

The legal gap analysis shows that there are a number of laws and institutions which already cater in a satisfactory manner for the various issues as highlighted in the Minamata Convention on Mercury. In some circumstances, such legal regulation goes beyond the scope of the Convention showing the extent to which the Mauritian Government is keen to ensure the protection of human health and the environment.

Amongst the laws regulating mercury and mercury-added products in Mauritius, the Consumer Protection (Control of Imports) Regulations 2017 is an invaluable tool which is in line with the Convention to the extent that it deals with the prohibition of the import of some products which could contain dangerous substances for human health including mercury. The regulation of dangerous chemicals is another issue which already benefits from strong control under the Dangerous Chemicals Control Act (DCCA) 2004 where mercury is imported for laboratory purposes only. However, there are some instances where the legislation needs to be amended to ensure a higher level of compliance with the Convention. Subject areas requiring attention pertain to manufacture of mercury-added products and importation of certain mercury-added products as covered by Article 4 of the Convention and its Annex A. It has been recommended that the description of prohibited goods in the Second Schedule of the Consumer Protection (Control of Imports) Regulations 2017 be broadened to include the mercury-added products in Annex A which are not already prohibited in the Mauritian legal system.

With the coming in operation of the interim hazardous waste storage facility at La Chaumière, it is recommended to draft and adopt regulations for environmentally sound management of mercury containing wastes including amalgam wastes from dental clinics by applying the Polluter Pay Principle. It is noteworthy that the Environment Protection (Standards for hazardous wastes) Regulations 2001 are being currently amended and will contain provisions for the management of hazardous wastes, including mercury containing wastes and payment for disposal of hazardous wastes by waste generators. Introduction of take-back obligations on electrical works installation companies can also be envisaged. For example, companies which are involved in electrical works installation would be required to take back the mercury containing materials (e.g. bulbs, switches, relays, etc.) and send them to approved management sites.

<b>Proposed Actions</b>		<b>Lead Agency</b>	<b>Proposed budget (USD)</b>	<b>Time Frame</b>
1.1	Include the mercury added products listed in Part I, Annex A of the Minamata Convention on Mercury which are not already prohibited in the Mauritian legal system in the Second Schedule of the Consumer Protection (Control of Imports) Regulations 2017	Attorney General's Office MoICCP (Commerce Division)	1,000	2019-2020
1.2	Draft, approve and adopt regulations prescribing the collection and disposal of mercury-containing waste	Attorney General's Office MoSSNSE&SD	3,000	2019-2020
1.3	Adopt and enact regulations to reduce emissions from relevant point sources by incorporating limit levels of mercury for ambient air, incinerator stack emission and coal fired power plants in the Environment Protection (Standards for Air) Regulations 1998	Attorney General's Office MoSSNSE&SD	1,000	2019
<b>Sub total Priority 1</b>			<b>5,000</b>	<b>2018-2019</b>

**Priority 2: Improve storage and waste management practices for mercury and mercury containing wastes**

In light of the specificities of the Republic of Mauritius, especially as a SIDS, it has been observed that it is economically not viable to set up recovery/disposal facilities for several hazardous waste streams, as the quantity generated is too low. Hence, exportation of hazardous wastes for recovery/disposal at overseas licensed hazardous waste facilities has been seen to be the best option. Consequently, an interim hazardous waste storage facility (IHWSF) has been set up at La Chaumière whereby hazardous chemical wastes generated in Mauritius are analysed, collected, sorted, regrouped, packaged, labelled, stored and exported to authorised hazardous wastes recovery/disposal facilities in compliance with the Basel Convention. This interim facility is in operation since April 2017.

It is noteworthy that prior to the setting up of the IHWSF, about 21 kg of mercury and mercury compounds and more than 400 mercury thermometers were exported as wastes in 2014 under the “Sustainable Management of POPs” project funded by UNDP.

Mercury waste results mainly from use of mercury and mercury compounds in laboratories, use of dental amalgam in dental clinics, and disposal of broken and unused mercury-containing products such as thermometers, sphygmomanometers, barometers, lamps, batteries, switches, relays, etc. To ensure the financial sustainability of the IHWSF, it is recommended to monitor and enforce that generators of mercury waste dispose their chemical waste at the IHWSF. A cost recovery mechanism for hazardous waste in line with the “Polluter Pay Principle” whereby generators of hazardous waste (industries, laboratories, dental clinics) would bear the cost of managing their hazardous waste, is already in place.

Currently, there is no guideline for the proper disposal of broken or used mercury-containing household products such as fluorescent lamps and mercury thermometers. The latter waste should in principle be treated as hazardous and should not be disposed in the landfill. Thus, a country-wide system for the collection of broken, used and unused common household mercury-containing products such as fluorescent lamps, thermometers, etc. is proposed. Discussions could be initiated with the Ministry of Energy and Public Utilities (MoEPU) and the Central Electricity Board with a view to organising a collection system for the lamps at the CEB offices throughout the island. These offices are easily accessible to the general public and would provide an effective proximity service for collection of used products containing mercury. The services of dismantlers and exporters of lighting equipment could also be roped in the initiative in that they can provide a service to their customers by acting as a collection point. Similarly the area health community centres of the MoHQL can act as collection points for the mercury thermometers. A programme for exchange of mercury thermometers by digital ones can also be considered.

<b>Proposed Actions</b>		<b>Lead Agency</b>	<b>Proposed budget (USD)</b>	<b>Time Frame</b>
2.1	Devise a country-wide system for the collection of used products containing mercury (e.g. CFLs and other lamps, thermometers, etc.)	MoSSNSE&SD MoLGOI MoEPU MoHQL	20,000	2020-2023
2.2	Decrease environmental contamination from inappropriate disposal of mercury from generators of mercury waste through focused compliance monitoring and enforcement of mercury restrictions and requirements	MoHQL MoSSNSE&SD	20,000	2019-2023
<b>Sub total Priority 2</b>			<b>40,000</b>	<b>2019-2023</b>

### **Priority 3: Undertake education awareness and strengthen capacity through training**

A key aspect of any National Action Plan is the need for education, awareness and capacity building. Several workshops/meetings with relevant stakeholders (importers, jewellers, ministries) have already been held during the MIA project. A pamphlet highlighting the adverse effects of mercury, proper disposal of mercury and alternatives to mercury use has been devised and distributed to all jewellers. Spots targeted towards the general public are currently in preparation. In addition, the non-governmental organisation, PANeM, has conducted several awareness sessions for the public and some institutions. Further awareness sessions on mercury management, familiarization with the Minamata Convention on Mercury, occupational exposure of mercury and mercury compounds and availability of non-mercury alternatives targeting priority groups and ministries (procurement section/department) and the public at large are proposed.

It was observed that there is limited protocol and training for the handling of mercury and mercury compounds during use, spillage, storage and disposal among users and importers of mercury and mercury compounds. Thus, a standard protocol and training for the above are recommended. It is noteworthy that the Mauritius Standards Bureau (MSB) Metrology Division, which is an ISO 17025 accredited laboratory for the calibration of mercury thermometers has implemented a mercury spillage management protocol based on international and local (Dangerous Control Board) guidelines.

The MSB Metrology Division is accredited by the Mauritius Accreditation Service (MAURITAS) for the calibration of liquid in glass thermometers only. As mercury thermometers will be phased out in 2020, the need for MSB Metrology Division to be accredited to undertake calibration of non-liquid in glass thermometers such as digital is strongly felt. Thus, capacity building through training of appropriate staff and purchase of required equipment and accessories is proposed.

According to the inventory, the burning of coal and bagasse to produce electricity by IPPs and medical waste incineration are major release pathways to air (45, 28 and 24 kg/y respectively). However, to date the mercury level in the flue gases and incinerator outlets have not been measured, hence it is not known if these levels exceed the limits that are being proposed in the National Environmental Standards for Ambient Air Quality and Measurement Methods ( $0.3 \mu\text{g}/\text{m}^3$  over 24 hours), the National Environmental Standards for Stack Emission from coal-fired thermal power plants ( $0.05 \text{ mg}/\text{m}^3$ ) and in the National Environmental Standards for Incinerator Stack Emission (New plant:  $0.05 \text{ mg}/\text{m}^3$  for a period of 30 minutes to 8 hours; existing plants (up to 2017):  $0.10 \text{ mg}/\text{m}^3$  for a period of 30 minutes to 8 hours). There is thus a need to strengthen the capacity of the National Environmental Laboratory (NEL) to sample flue gases at the stack of IPPs and at medical waste incinerators and to analyze for Hg by recruiting appropriate staff for stack emission testing, purchase of sampling devices/equipment and training of personnel. It is also proposed that the test results indicating the mercury level in the flue gases due to the burning of coal and bagasse should be submitted to the Central Electricity Board for monitoring of the mercury level.

From the inventory, the highest estimated mercury inputs (kg Hg/y) from non-waste categories apart from coal combustion in power plants (60 kg Hg/y) originate from mercury contained in products, namely electrical switches and relays with mercury (169 kg Hg/y), dental mercury amalgam fillings (68 kg Hg/y) and laboratory chemicals and equipment with mercury (52 kg/y). Adoption and use of mercury-free or less mercury-containing products is the most effective means to decrease releases of mercury to different media. For practically all mercury containing products, cost-effective mercury-free or low content mercury alternatives do exist.

It is also recommended to incorporate the Minamata Convention on Mercury and/or effects of exposure to mercury and mercury compounds on all programmes/courses dealing with environment/health/law/chemistry taught at tertiary level. Sensitisation of secondary and tertiary level students through talks and posters is also proposed.

Proposed Actions		Lead Agency	Proposed budget (USD)	Time Frame
3.1	Develop national protocols (technical guidelines) for the handling of mercury, mercury compounds and mercury-containing wastes	MoSSNSE&SD; MoLGOI	8,000	2019
3.2	Conduct training on the management (handling, clean-up, storage, disposal, treatment, transport) of mercury as well as mercury-containing products and wastes for institutions and entities that have responsibilities pertaining to mercury management	MoSSNSE&SD; MoLIRE&T; MoLGOI; MoEHRTE&SR	30,000	2019-2020
3.3	Develop targeted technical information in a simple, accessible, and relevant format on mercury management for risk groups (e.g. waste handlers, dentists, schools, power generation sector, jewellery sector, laboratory personnel involved in mercury use and analysis, etc.)	MoSSNSE&SD; MoLIRE&T; MoHQL; MoLGOI; MoICCP Assay Office	10,000	2019-2021
3.4	Promote public awareness on the hazards of mercury to human health and on the availability of mercury-free alternatives through information dissemination, education and training	MoSSNSE&SD; MoLGOI MoHQL	20,000	2019-2020
3.5	Awareness raising exercise with all ministries regarding procurement of mercury containing equipment and products and availability of mercury-free alternatives	All ministries	10,000	2019-2020
3.6	Create and maintain a publicly accessible mercury database and repository which include amongst others results and outcomes of studies pertaining to mercury, a list of locally available mercury-free or low mercury content cost-effective alternatives, best practices information for the prevention and reduction of anthropogenic releases of mercury and for the sound management of mercury	MoSSNSE&SD	30,000	2019-2023
3.7	Incorporate the Minamata Convention on Mercury and/or effects of exposure to mercury and mercury compounds on all programmes/courses dealing with environment/health/law/chemistry taught at tertiary level	MoEHRTE&SR	2,000	2019-2023
3.8	Train relevant MSB staff and purchase appropriate equipment and accessories to enable MSB Metrology Division to act as an accredited laboratory for the calibration of non-liquid in glass thermometers	MoICCP (MSB Metrology Division)	450,000	2019-2021
3.9	Recruit, train relevant NEL staff and purchase appropriate equipment and accessories to enable NEL to sample flue gases at the stack of IPPs and at medical waste incinerators and to analyze for Hg	MoSSNSE&SD	500,000	2019-2021
<b>Sub total Priority 3</b>			<b>1,060,000</b>	<b>2019-2023</b>

**Priority 4: Improve monitoring and reporting capacity on import of mercury-containing products and mercury levels in food, soil, water, air and biological samples**

There is need to have strict enforcement and monitoring in respect to the ban on importation of the mercury added products listed in Part I, Annex A of the Convention as from 2020. Since the Harmonized System (HS) Codes do not distinguish between mercury-containing and non-mercury containing products, for example in thermometers, switches, relays, it is recommended that importers provide a certificate from their suppliers indicating that there is no intentional incorporation of mercury in their products or the mercury content in the products, if applicable. A working session with the Customs Officers to familiarize themselves with the requirements of the Convention is proposed. In respect to the reliance on documentary evidence in respect to certain products, it is recommended that testing be carried out to ensure verification of products, wherever possible.

The Minamata Convention on Mercury requires the country to establish and maintain an inventory of emissions and releases from relevant sources no later than five years after the date of ratification. From the Level 2 inventory, the major release sources have already been identified and there is thus only a need to monitor these emissions on a yearly basis and to keep track of new sources. Mercury analyses in several media and products (effluent, wastewater, sludge, estuarine water, fish, etc.) are already being carried out by different governmental laboratories. However, mercury levels in air and in biological samples such as hair are not being monitored. To obtain more accurate and reliable data for the emissions and releases, it is thus recommended to measure and monitor the mercury level in selected media (e.g. air near IPPs and from flue gas exhaust) and biological samples such as hair for selected groups in the communities.

Proposed Actions		Lead Agency	Proposed budget (USD)	Time Frame
4.1	Conduct regular environmental monitoring of point sources (e.g. landfill leachate, waste water treatment effluent, water bodies, flue gases of coal fired power stations / medical waste incinerators/ crematoria, etc.)	MoSSNSE&SD	100,000	2018-2023
4.2	Conduct regular bio-monitoring of high-risk groups (e.g. hair analysis of waste handlers, dentists, dental assistants, workers in IPPs, jewellers, laboratory personnel involved in mercury analysis, etc.)	MoSSNSE&SD MoHQL	40,000	2018-2023
4.3	Update the national inventory on mercury releases and Convention reporting	MoSSNSE&SD	30,000	2018-2023
4.4	Ensure enforcement and monitoring in respect to the ban on importation of mercury-added products listed in Part I of Annex A	Customs Department, MRA	5,000	2018-2023
<b>Sub total Priority 4</b>			<b>175,000</b>	<b>2018-2023</b>

**Priority 5: Reduce emissions of mercury and mercury compounds to the atmosphere, as well as the reduction of mercury releases to the soil and water from point sources**

The Minamata Convention on Mercury requires a Party to control and reduce emissions of mercury to air (Article 8), as well as the releases of mercury to land and water (Article 9). From the Level 2 inventory, the main source contributors to air were (i) coal combustion in power plants (45 kg/y); (ii) informal waste burning (31 kg/y); (iii) biomass fired power and heat production (28 kg/y); and (iv)

incineration of medical waste (24 kg/y). The main source contributors to water were dental mercury-amalgam fillings (30 kg/y) and laboratory chemicals and equipment (14 kg/y) whereas for land were electrical switches and relays (17 kg/y) and coal combustion in power plants (15 kg/y).

The already proposed measures such as limit values in ambient air, stack emission from coal-fired thermal power plants and in the incinerator stack emission and the bans of the mercury added products listed in Part I, Annex A of the Minamata Convention on Mercury will no doubt decrease significantly the mercury emissions to air, and the mercury releases to water and land in the years to come. Another recommended measure is adoption of best practices for the prevention.

<b>Proposed Actions</b>		<b>Lead Agency</b>	<b>Proposed budget (USD)</b>	<b>Time Frame</b>
5.1	Promote best available techniques (BAT) and best environmental practices (BEP), wherever feasible, for the prevention and reduction of anthropogenic releases of mercury and for the sound management of mercury, through awareness raising and training on newly developed regulations and guidelines	MoSSNSE&SD	15,000	2018-2023
5.2	Monitor emissions from air point sources such as medical waste incinerators and coal-fired plants by gathering high quality emissions data to address the uncertainties about the mercury emissions and to support regulatory actions	MoSSNSE&SD	10,000	2018-2023
5.3	Prepare a national plan setting out the measures to be taken to control releases from point sources and the plan's expected targets, goals and outcomes (releases to air, land and water)	MoSSNSE&SD	10,000	2018-2019
<b>Sub total Priority 5</b>			<b>35,000</b>	<b>2018-2023</b>

## **Chapter VII: Mainstreaming of Mercury Priorities**

MIA projects supported by the UNDP contain an additional Outcome and Output that are not contained in MIA projects supported by other GEF or UN agencies, namely:

**Outcome 1.4:** Importance of Hg priority interventions at the national level raised through mainstreaming in relevant policies/plans

**Output 1.4.1:** National Hg priority interventions mainstreaming in national policies/plans.

The national implementation plan on mercury that has been developed within this MIA will be mainstreamed in relevant national policies and funded through the national budget and overseas sources.

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## **ANNEX I: Stakeholder Engagement Process**

A list of all institutions and organizations engaged with during the preparation of the MIA report, the Level 2 Mercury Inventory, the legal and institutional gap analysis and other aspects of the MIA project are given below:

Aadicon Biotechnologies Ltd  
Agreenergy Ltd  
Allied Motors Ltd  
Alteo Energy Ltd  
Assay Office  
Attorney General Office  
Central Electricity Board  
Central Water Authority  
Chantier Naval de l’Océan Indien Ltd  
Coal Importers Limited  
Commission of Environment – Rodrigues  
Consolidated Energy Ltd  
Dangerous Chemicals Control Board  
Dionics Ltd  
Ducray Lenoir Ltd  
Food and Agricultural Research and Extension Institute  
IBL BrandActive  
Mauritius Cane Industry Authority  
Mauritius Chamber of Commerce and Industry  
Mauritius Revenue Authority (Customs)  
Mauritius Standards Bureau  
Mauvilac Industries Ltd  
Ming Chu Co. Ltd  
Ministry of Agro Industry and Food Security  
Ministry of Civil Service and Administrative Reforms  
Ministry of Defence and Rodrigues  
Ministry of Education and Human Resources, Tertiary Education and Scientific Research  
Ministry of Energy and Public Utilities  
Ministry of Financial Services, Good Governance and Institutional Reforms  
Ministry of Finance and Economic Development  
Ministry of Foreign Affairs, Regional Integration and International Trade  
Ministry of Gender Equality, Child Development and Family Welfare  
Ministry of Health and Quality of Life  
Ministry of Health and Quality of Life (Dentistry Division)  
Ministry of Health and Quality of Life (Pharmaceutical Services) / Pharmacy Board  
Ministry of Industry, Commerce and Consumer Protection (Commerce Division)  
Ministry of Industry, Commerce and Consumer Protection (Industry Division)  
Ministry of Labour, Industrial Relations, Employment and Training  
Ministry of Local Government and Outer Islands

Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (Fisheries Division)  
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development - EA  
Division  
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development - EIA/ PER  
Monitoring Division  
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development - Pollution  
Prevention and Control Division  
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development - Solid  
Waste Management Division  
Ministry of Social Security, National Solidarity, and Environment and Sustainable Development - Statistics  
Division  
Mopirove Ltd  
National Environmental Laboratory  
Omnican Thermal Energy Operations (La Baraque) Ltd  
Omnican Thermal Energy Operations (St Aubin) Ltd  
Pesticide Action Network  
Pharmacie Nouvelle Ltd  
Police de L'Environnement  
Polytol Ltd  
Private Secondary Schools Authority  
Scott and Co. Ltd  
Small & Medium Enterprise Development Authority  
SOFAP Ltd  
Statistics Mauritius  
Terragen Ltd  
The Mauritius Pharmacy  
United Nations Development Programme  
United Nations Institute for Training and Research (UNITAR)  
University of Mauritius  
University of Technology Mauritius  
Waste Water Management Authority  
Water Resources Unit

**Annex II: UNEP Toolkit Calculation Spreadsheet**

A separate Excel file has been submitted.