Storing and Disposing Excess Mercury in Central America

Advancing National Initiatives in Mexico and Panama

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UNEP CHEMICALS

Cover photos: *Potential storage facility in Panama (bunker). Source: Project for storage and disposal of mercury in Panama. Final report. August 2013*

Retort for mercury distillation in Mexico. Source: Química Wimer, S.A. de C.V.

This paper has been prepared by Gustavo Solórzano, consultant, under contract with UNEP Chemicals, with all reasonable care and diligence. While the author has greatly benefited from valuable contributions and comments from a number of colleagues, he accepts complete responsibility for the accuracy of the final product. Nevertheless, third parties who rely on information contained in this document, or their own interpretation thereof, do so at their own risk.

Executive summary

Governments successfully completed their negotiations to prepare a global legally binding instrument on mercury, at the fifth session of the Intergovernmental Negotiating Committee (INC) that took place in Geneva from 13 to 18 January 2013.. The text of the Minamata Convention on Mercury agreed at the end of the 5th INC session, was presented at the Conference of Plenipotentiaries for adoption and opened for signature in Kumamoto and in Minamata, Japan, from 9 to 11 October 2013. The Convention shall enter into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification, acceptance, approval or accession. Mexico and Panama have both signed the Convention on October 10, 2013.

The Chemicals Branch of the United Nations Environment Programme's (UNEP) Division of Technology, Industry and Economics (DTIE) has developed and implemented a number of projects on mercury related issues under the umbrella of the Global Mercury Partnership (GMP). The Governing Council (GC) at its 27th session has affirmed the role of the GMP as a vehicle for immediate action on mercury. Within the Partnership area on supply and storage, regional assessments of excess mercury supply were undertaken in Latin America and the Caribbean (LAC), in Eastern Europe and Central Asia (EECA), and in the Asia-Pacific region. These studies revealed that many countries will likely soon face a situation where mercury supply exceeds demand. A part of this surplus, excess mercury will classify as waste and will have to be stored and eventually disposed of in an environmentally sound manner. However, as the Partnership's feasibility studies and analyses of regional storage options indicate, favorable conditions for the effective and economically viable long-term storage of mercury are lacking in many developing countries and countries with economies in transition. This situation has also been mentioned at various events, such as the meeting of the Executive Committee of the LAC Mercury Storage Project (21-22 October 2010, Santiago, Chile), and the second session of the Intergovernmental Negotiating Committee on Mercury (INC 2; 24-28 January 2011, Chiba, Japan). Delegates attending the Santiago meeting also expressed the need to establish facilities for the temporary storage of elemental mercury and the management of mercury-containing waste.

In order to provide a better understanding of mercury storage and disposal issues at country level and to promote the environmentally sound management of excess mercury, Argentina and Uruguay were selected for the "Mercury Storage and Disposal Two Countries Project in South America"[1], a follow-up to the LAC Mercury Storage Project. The Project was initiated in 2011 and successfully completed in 2012. Given its encouraging results and in order to benefit from the experiences gained, a decision was taken in 2012 to replicate the project in Mexico and Panama.

[1] Individual country reports and a general project report can be found at http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/SupplyandStorage/Activities/StorageandDisposalCentralAmerica/tabid/106665/Default.aspx

As in the previous project implemented in Argentina and Uruguay, the methodology followed in the "Mercury Storage and Disposal Project in Two Selected Countries in Central America" is based on the "Suggested framework for decision making for the safe management of surplus mercury", an important output of a workshop organized by the Integrating Knowledge to Inform Mercury Policy (IKIMP) Initiative and held in October 2009 at the University of Oxford in the United Kingdom. Following this methodology, the following steps were taken in each of the two countries: 1) Survey and analysis of possible temporary storage locations within the country; 2) Review of the regulatory framework; 3) Establishment of a decision-making process; 4) Technology status/Assessing basic management options; and 5) Developing a national storage and waste management action plan.

RESULTS

Mexico

Review of regulatory framework.

Mexico reported a total of 24 national instruments (acts, rules, norms and decrees) currently in place related to hazardous waste (HW) management. At the regional level, an important instrument is the North American Agreement on Environmental Cooperation (NAAEC), adopted by Canada, Mexico and the United States of America. As regards the international sphere, Mexico has adopted national laws implementing both the Basel and the Rotterdam Convention. In Mexico HW control falls under the responsibility of the federal government, so States and Municipalities do not legislate on this subject. Currently, a specific legal framework addressing mercury waste management is not available in Mexico.

Mercury waste data in Mexico.

Mexico reported data on mercury waste in the country from different sources, including the National Mercury Releases Inventory (NMRI), the Pollutants Release and Transfer Register (PRTR), and recent publications from the (North American) Commission for Environmental Cooperation (CEC). The Final Report – Mexico 2004 – National Mercury Releases Inventory, published in 2008, reported that nearly 448 tons of mercury were released to the environment, the most significant source being gold extraction and processing followed by batteries and landfills. More than 40% of mercury was released to the soil (185.6 ton), a little less than 40% was released as waste (185.3 ton), and 10% was emitted to the atmosphere (50.46 ton). Data from two other sources (PRTR, CEC) give an estimation of 332.2 tons of mercury waste generated in Mexico, an amount higher than the 185.3 tons reported by the NMRI. The difference may be explained by the particular methodologies followed by each source and by the different base years that were used. Moreover, the PRTR data are provided by the various sources in the register that are responsible for the releases.

Primary mercury mining in Mexico has not been officially reported since 1995, although it has taken place informally in recent years. The situation is similar with regard to artisanal and small-scale gold mining (ASGM), an activity that is not officially reported in Mexico but has been recently observed.

Survey and analysis of possible temporary storage locations in the country.
While Mexico focused its survey on current waste treatment facilities, other possibilities were also assessed. A total of 35 private companies specialized in mercury waste handling were reported for the following services: 3 for treatment, 4 for landfilling, 28 for transportation, and 4 for temporary storage. An analysis of these sites concluded that two security landfills constitute the best options for the environmentally sound storage of mercury and mercury waste in Mexico. The possibility of disposing of mercury waste in salt domes was also explored, but the results obtained were not encouraging as several obstacles were identified, such as existing connections between geological formations and a lack of information on this subject.

Establishing a decision-making process.
Mexico organized a National Working Group (NWG) in which a number of stakeholders took part, including representatives from the public sector, academia, the chlor-alkali industry, the health sector, the waste management sector, the mining industry and civil society. The Group was scheduled to meet several times during the project development. However, the Group only met once before the Results Workshop, namely in the transition stage which involved the Instituto Nacional de Ecología y Cambio Climático (INECC, the Mexican counterpart for the project)[2].

Developing a national storage and waste management action plan.
Given that the NWG only met once, it was merely able to draft the guidelines of a National Action Plan (NAP). Six factors were identified as main elements of the NAP: a) Mercury releases inventory, b) Informal primary mercury mining, c) Artisanal and small scale gold mining, d) Processes, and e) End-of-life mercury containing products. General guidelines have not been formulated for any of the six listed elements. Performance indicators, deadlines, resources and responsible entities for the above mentioned activities were not established at this point, but will be considered as important activities for the NWG in the near future.

Panama

Review of regulatory framework.
Panama reported a total of 43 regulatory instruments related to solid and HW management, including a National Policy for Comprehensive Management of Hazardous and Non-hazardous Wastes in 2007. Nevertheless, a specific regulatory framework for the comprehensive management of mercury waste is currently not available. Acts, decrees,

[2] During the project development, the National Institute of Ecology was transformed into the National Institute of Ecology and Climate Change

and resolutions have been reported in Panama, some of them dealing directly with mercury issues. Also, considering that HW related activities taking place in natural areas are controlled by the central government, a large number of additional legal instruments related to national parks were reported. While the regulatory framework in Panama is in place, law enforcement for HW matters is still premature, especially in regions other than the capital and its immediate surroundings.

Panama prohibits the import of HW and has adopted national laws implementing both the Basel and the Rotterdam Convention.

Mercury waste data in Panama.

Inventory results reported the highest release value in the subcategory 'Batteries with mercury', with 15.58 tons of mercury released as waste in 2011. 'Informal waste dumping sites' was listed as the second largest source, with an annual release of 1.78 tons of Hg, in this case released to the 'earth' factor. 'Cement production' was reported as the third largest source, with a release as waste of 0.146 tons of Hg per year. Two subcategories were identified as the fourth largest sources of releases: 'Mercury dental amalgams' accounted for 0.123 tons released as waste and other 0.123 tons released to *treatment or specific sector* factor, while 0.261 tons of Hg released as waste originated from 'Manometers and gauges with mercury'.

Survey and analysis of possible temporary storage locations in the country.

As regards potential sites for temporary storage, Panama decided to identify options for two separate sites: one for elemental mercury, and a different one for mercury containing waste. The results of the site selection process are as follows:

1. The best potential sites for temporary storage of elemental mercury waste are the 'bunkers', a group of concrete structures that were used as military constructions when the Panama Canal was administrated by the United States of America.

2. The best potential locations for temporary storage of mercury-containing waste are the EMAS company´s landfill (an approved future sanitary landfill), the Cerro Patacon sanitary landfill and the Tocumen extension of the Technological University of Panama (currently a research and workshop facility), in that order of priority.

Establishing a decision-making process.

Panama invited stakeholders from the public and private sector as well as civil society to participate in the NWG. A total of 19 institutions from these sectors were invited to participate, with representatives from subsectors attending the NWG meetings, namely representatives from the national government (environment, health, commerce and industry, agriculture, national police, energy, industry, and customs), associations of municipalities, academia, professional associations (the dental society), mining associations, and Civil Society Organizations (CSO).

The NWG met on five occasions throughout 2012 and 2013. Eight subgroups were established and each was assigned different tasks and responsibilities across the following categories: 'Releases inventory update', 'Regulatory framework update', 'Analysis of potential sites for mercury waste storage', 'Assess basic management options', 'Definition of the decision making process', 'National Action Plan development', 'Progress report development', and 'Final report development and delivery'.

Technology status/Assessing basic management options.

The relatively small size of the country and the fact that the most relevant sector in Panama´s economy is represented by services, rather than industry, were factors taken in account when discussing management options in Panama. In order to assess Panama's basic management options, the NWG evaluated the following items:

- The current situation in terms of mercury waste management at the national level.
- The geographical location of those sites generating the largest share of mercury waste in the country.
- The results of the regulatory framework analysis relevant for mercury waste.

Panama has developed a limited infrastructure for HW management, consisting mainly of two incinerators for outdated pharmaceutical drugs and international waste. Additionally, a private contractor operates a facility which collects fluorescent lamps from private businesses. Moreover, the Cerro Patacon sanitary landfill receives certain HW for disposal. However, Panama lacks an adequate infrastructure to properly treat and dispose of HW other than medical and international waste, including mercury waste.

Developing a national storage and waste management action plan.

The subgroup in charge of defining the NAP prepared a draft version that was presented to the NWG members during their fourth meeting. At this meeting, the draft NAP was discussed and improved and a final version was obtained as a result of this task. The proposed 'National Action Plan for the Management of Mercury' was presented at the 'Regional Workshop on Project Results' held in Mexico City on July 3 and 4, 2013. Panama's NAP features three general components:

1) Legal framework,
2) Promotion and awareness of mercury management, and
3) Intersectoral partnerships.

For each one of these elements, the NAP defines the following concepts: objectives, activities, assumptions and responsible entities.

ANALYSIS AND RECOMMENDATIONS

Mexico

Review of regulatory framework.

More than thirty years ago, Mexico started developing a comprehensive regulatory framework on HW management. To a certain degree, it has allowed for the

environmentally sound management of HW generated in the country. It is still necessary, however, to develop legal instruments specifically addressing mercury waste management issues.

Having signed the Minamata Convention, Mexico might need to review its regulatory framework in light of the most significant provisions, especially those on control measures. Specifically, it is recommended to modify the regulation prescribing a six-month limit for temporary storage of HW. It is also advisable for Mexico to draft legal instruments on maximum limits and characteristics for waste receiving pre-treatment before final disposal. Finally, it would be useful to review the legal instruments on mercury trade and the import/export of mercury containing products, in order to address the problem represented by the difficulty of getting accurate and solid information on these subjects.

Mercury waste data in Mexico.

As different sources of information were consulted in order to get reliable data on the current situation of mercury waste in Mexico, there were some variations in the results. As data obtained from the mercury releases inventory is almost ten years old and given that several important mercury release sources are missing, it is recommended for Mexico to update its inventory using the most recent version of UNEP's Toolkit for Identification and Quantification of Mercury Releases (UNEP's Toolkit). Updating this information, with the support of relevant stakeholders, will provide Mexico with recent and more reliable data and will allow it to make informed decisions in relation to compliance with the Minamata Convention. Finally, it is strongly recommended for Mexico to assess the situation in terms of ASGM and primary mercury mining - two activities apparently taking place in Mexico, but not formally assessed or reported by official sources.

Survey and analysis of possible temporary storage locations in the country.

From a technical point of view, both of the two pre-selected sites are potential temporary storage facilities for mercury waste since they have similar advantages. The most important advantage is their ongoing activity in the field of HW treatment and disposal, as both sites have been authorized to carry out these activities for several years. Both sites are located in northern Mexico, relatively far from important HW generators which can be found in the center and south-southeast regions of the country.

It is important to have further discussions with the owners/operators of the two pre-selected landfills in order to gain an understanding of the kind of treatment or pre-treatment which they offer for mercury waste. Both firms have already provided some technical information on their treatment methodologies, but it is still necessary to obtain further information in order to select the most suitable site. It would also be useful to define their interest, taking into consideration this project's objective. Finally, Mexico should continue the assessment of geologic formations as potential sites for the permanent storage of mercury waste.

Establishing a decision-making process.
It is strongly recommended to keep the NWG involved in the elaboration of the definitive National Action Plan and to strengthen the relations between the different institutions involved in this process. For this purpose, it will be necessary to establish the required mechanisms or instruments to keep the Group working, especially at a time when Mexico has signed the Minamata Convention.

It is necessary to work on the definition of performance indicators, timeframes and resources needed for each of the twenty-three activities included in the Plan. For this purpose, it is necessary to define the next activities and to increase the involvement of all relevant stakeholders in this process.

Technology status/Assessing basic management options.
With regard to the technology status and management options, Mexico has a well-developed infrastructure in place and the corresponding regulatory framework to offer HW treatment/disposal options to national generators. However, there are very limited possibilities for the stabilization/solidification (S/S) of elemental mercury. At the same time, Mexico offers mercury waste treatment by means of a retort. HW regulations created a certain demand for this alternative that did not exist in Mexico before 2013. In this regard, it is recommended to assess the future demand for this kind of service from mercury waste generators. As regards mercury waste (sludge) from the chlor-alkali sector, the only option currently envisaged is dewatering and final disposal in a security landfill.

Developing a national storage and waste management action plan.
The NWG in Mexico was formed at a late stage of the project development. Thus, there was but one opportunity for the Group to meet before the Results Workshop in July 2013. It was not until this Workshop that the Group discussed and proposed several guidelines to be considered in Mexico's NAP. Under these constraints, Mexico presented a list of elements to be considered in preparing its NAP, consisting of six components or areas of interest which should be considered in the NAP and several activities corresponding to each of these sectors.

It is therefore recommended for Mexico to keep the NWG as an active entity until the pending tasks are achieved and to proceed in the development of the formal NAP defining detailed activities for each of the six components. Important items, such as communication, awareness raising, training and education, and research, are missing. The NWG should incorporate them in the final version of the NAP in the near future (a six-month term is recommended).

Panama

Review of regulatory framework.
Panama has reported a total of 43 legal instruments related to solid and HW management. Although several of these instruments have already been passed, they have

either not been implemented or enforcement is not satisfactory. It is recommended for Panama to proceed with the implementation of all relevant regulatory instruments. As Panama itself has recognized, it is also necessary to develop a legal instrument establishing institutional coordination in order to address the issue of mercury and mercury wastes more effectively. Additional recommendations consist of passing the necessary legal provisions applicable to developing a Pollutant Release and Transfer Register, developing the necessary instruments to generate reliable information on mercury and mercury products for import-export activities, and preparing a legal instrument for HW storage facilities, including all types of mercury waste, rather than only mercury-containing medical waste.

Mercury waste data in Panama.
Panama reported difficulties in getting the data necessary to produce its mercury releases inventory. As new and more reliable information becomes available from the different sources, it is recommended that a periodic update and validation of the inventory results be carried out using the new data that will be obtained in the future.

In order to control and avoid the dispersion of informal elemental mercury storage in health facilities belonging to the government (currently being placed in glass jars and stored in working areas either in pre-made shelves, improvised deposits or under desks), an effort should be made to minimize the associated hazards to human health and the environment. The same goes for amalgams, which are currently being disposed of in landfills without pretreatment, as well as for other mercury-containing devices and products. Furthermore, in order to solve the problems encountered during data collection for the inventory and to maintain an updated inventory in the future, the legal instruments necessary for having more efficient import controls of elemental mercury and mercury-containing products should be developed. This requires that importers provide a minimum of relevant information.

Survey and analysis of possible temporary storage locations in the country.
As regards the storage of elemental mercury, it will be necessary to adapt the selected bunker(s) for this purpose. Also, given that the shelters were built many years ago, a thorough structural evaluation is strongly recommended. In terms of mercury waste storage, it is necessary to move forward with the final selection from the four different options, thereby taking into account the advantages and disadvantages of each potential site. The owners/operators of all potential facilities should be contacted in order to determine whether there is an interest and a possibility of using these sites, thus determining whether these are likely to become part of the project.

Establishing a decision-making process.
Panama started organizing the NWG at an early stage of the project. This allowed Panama to establish a Group and to organize five meetings. However, it is still necessary to involve the group in the elaboration of the final NAP and to strengthen the coordination between the different institutions involved in this process. It is also advisable for the NWG to

continue with the process of selecting the most suitable storage option for mercury waste, both for elemental mercury and for mercury contaminated waste.

Technology status/Assessing basic management options.
Panama has a limited infrastructure for mercury waste treatment. A lamp crusher is available; however, the resulting powder is not treated, but stored at the crushing facility. In its basic management options assessment, Panama does not consider recovery of elemental mercury from end-of-life products (such as lamps, thermostats and others). As of today, there is no infrastructure in Panama to separate elemental mercury contained in products (current available technology allows only to separate 'white' powder in lamps and to store it at the treatment facility).It is therefore recommended to explore the possibility of incorporating distillation (retorting) technology in order to make more efficient use of the future elemental mercury storage facility.

Developing a national storage and waste management action plan.
Panama has outlined three elements to be featured in its NAP: 1) Regulatory framework, 2) Promotion and awareness of mercury management, and 3) Intersectoral partnerships. Panama has chosen the best approach for its situation. Sectors and waste streams are included in Panama´s NAP under its three main elements. However, public sector institutions (government ministries) are the sole entities responsible for activities listed in the NAP. In this regard, the involvement of other stakeholders as co-responsible entities along with the central government branches is recommended.

A further recommendation for Panama is to continue the work within the NWG and to keep the group involved in the elaboration of the final National Action Plan.

CONCLUSIONS

Given that the same methodology was applied in both studies, some conclusions may be similar to those outlined for Argentina and Uruguay: First, in line with a key objective of this project, a pre-selection of potential sites for the temporary storage of mercury waste has been conducted. Two potential sites have been identified in Mexico, whereas five sites with the potential of becoming temporary mercury waste storage facilities have been identified in Panama.

Also, each country has established the basis from which they can develop a comprehensive National Action Plan in accordance with the project's objective. Different approaches have been followed by each country, reflecting significant differences between the two countries.

Both countries acquired a deeper knowledge of the regulatory instruments that are still missing and that are necessary to ensure the environmentally sound management of mercury and mercury waste.

Panama has been able to update its 2004 Mercury Releases Inventory, applying the most recent version of UNEP's Toolkit for Identification and Quantification of Mercury Releases. In Mexico, it was important to collect available data on mercury waste generation and compare results obtained from different sources. This revealed the need to update available data. Furthermore, it was important for Mexico to include representatives from the private HW management infrastructure in discussions on solutions to mercury waste management for the first time. It was also important for Mexico to include activities in its NAP that will be crucial in implementing the Minamata Convention. The assessment of primary mercury mining and ASGM is another important activity.

Finally, it is important to stress the need for both countries to continue the development of the NAPs and to proceed with their implementation, thereby engaging the stakeholders involved in each of the activities that were designed for the action plans.

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ACRONYMS

(NA)CEC	(North American) Commission for Environmental Cooperation
CSO	Civil Society Organizations
DEFRA	(United Kingdom's) Department for Environment, Food and Rural Affairs
DTIE	Division of Technology, Industry and Economics
EU	European Union
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
HW	Hazardous waste
IKIMP	Integrating Knowledge to Inform Mercury Policy
INC	Intergovernmental Negotiating Committee
INECC	National Institute of Ecology and Climate Change
LAC	Latin America and Caribbean
LBI	Legally Binding Instrument
MNRI	Mexican National Mercury Releases Inventory
MSW	Municipal solid waste
NAAEC	North American Agreement for Environmental Cooperation
NAP	National Action Plan
NGO	Non-Governmental Organization
NWG	National Working Group
PRTR	Pollutant Release and Transfer Register
SEMARNAT	Ministry of Environment and Natural Resources (Mexico)
TUP	Technological University of Panama
UNEP	United Nations Environment Programme
USEPA	United States Environmental Protection Agency

1. INTRODUCTION.

At the fifth session of the Intergovernmental Negotiating Committee to prepare a global legally binding instrument on mercury, held in Geneva from 13 to 18 January 2013, participating Governments successfully completed their negotiations. The text of the Minamata Convention on Mercury was agreed at the end of the session. It was presented at the Conference of Plenipotentiaries for adoption and opened for signature in Kumamoto and in Minamata, Japan, from 9 to 11 October 2013. The Convention shall enter into force on the ninetieth day after the date of deposit of the fiftieth instrument of ratification, acceptance, approval or accession. Mexico and Panama have both signed the Convention on October 10, 2013.

The Minamata Convention on Mercury has 35 Articles. The following articles are considered as possibly most relevant to Mexico and Panama as they are related to control measures in the Convention. Its compliance will probably demand important efforts and the application of the necessary resources in each country:

- Article 3. Mercury supply sources and trade.
- Article 4. Mercury-added products.
- Article 5. Manufacturing processes in which mercury or mercury compounds are used.
- Article 8. Emissions.
- Article 9. Releases.
- Article 10. Environmentally sound interim storage of mercury, other than waste mercury.
- Article 11. Mercury wastes.
- Article 12. Contaminated sites.

The Chemicals Branch of the United Nations Environment Programme's (UNEP) Division of Technology, Industry and Economics (DTIE) has developed and implemented a number of projects on mercury related issues under the umbrella of the Global Mercury Partnership (GMP). The Governing Council (GC) at its 27th session has affirmed the role of the GMP as a vehicle for immediate action on mercury. Within the Partnership area on supply and storage, regional assessments of excess mercury supply were undertaken in Latin America and the Caribbean (LAC), in Eastern Europe and Central Asia (EECA), and in the Asia-Pacific region. These studies revealed that many countries will likely soon face a situation where mercury supply exceeds demand. A part of this surplus or excess mercury will classify as waste and will have to be stored and eventually disposed of in an environmentally sound manner. However, as the Partnership's feasibility studies and analyses of regional storage options indicate, favorable conditions for the effective and economically viable long-term storage of mercury are lacking in many developing countries and countries with economies in transition. This situation has also been mentioned at various events, such as the meeting of the Executive Committee of the LAC Mercury Storage Project (21-22 October 2010, Santiago, Chile), and the second session of the Intergovernmental Negotiating Committee on Mercury (INC 2; 24-28 January 2011, Chiba, Japan). Delegates attending the Santiago meeting also expressed the need to establish facilities for the temporary storage of elemental mercury and the management of mercury-containing waste.

For the Latin America and Caribbean region, the assessment report "Excess mercury supply in Latin America and the Caribbean, 2010-2050", was prepared by consultant Peter Maxson and presented at the inaugural workshop that took place in Montevideo, Uruguay, on 23-24 April 2009. The report revealed that supply is likely to exceed demand in the region in the near future, possibly even before 2015. It therefore highlighted the urgent need for adequate regional mercury storage capacities. Taking these findings into consideration, the participants of the workshop agreed to proceed with an options analysis and feasibility study which would form the basis for deciding on the preferred storage options[3]. Consequently, the study "Options Analysis and Feasibility Study for the Long Term Storage of Mercury in Latin America and Caribbean" was prepared by the Laboratorio Tecnológico del Uruguay (LATU) in 2010. The study provided information on various options that countries may wish to consider for the environmentally sound storage of excess mercury in the region[4]. Among others, the study concluded that underground storage is currently not feasible. Instead, it recommended that mercury be

[3]Options Analysis and Feasibility Study for the Long Term Storage of Mercury in Latin America and the Caribbean. Laboratorio Tecnológico del Uruguay (LATU). Montevideo, 2010

[4]http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/SupplyandStorage/Activities/LACMercuryStorageProject/tabid/3554/Default.aspx

stored in aboveground specially engineered warehouses. This is the most viable option from both a technical and financial point of view. Moreover, the exports option in combination with temporary aboveground storage was recommended as a short-term solution for countries with very small excess mercury. In either case, accompanying national and regional legislation is crucial.

Again funded by Norway, the 'Mercury Storage and Disposal Two Countries Project in Latin America' is a follow up to these projects. It provides capacity-building for storage in order to protect human health and the environment from the release of mercury and its compounds. Responding to the priorities identified by governments, it is part of the continuing effort to provide technical assistance to countries in search for environmentally-sound long-term storage solutions for elemental mercury. Thus, the project builds on decision 25/5 of the Governing Council: In paragraph 34, the Council "...requests the Executive Director, coordinating as appropriate with Governments, intergovernmental organizations, stakeholders and the Global Mercury Partnership, subject to the availability of resources and concurrently with the work of the intergovernmental negotiating committee, to continue and enhance, as part of the international action on mercury, the existing work, in the following areas: (a) Enhancing capacity for mercury storage; (b) Reducing the supply of mercury ...".

At the second meeting of the executive committee of the LAC Mercury Storage Project (21-22 October 2010, Santiago, Chile), representatives expressed the need to develop temporary facilities to store elemental mercury – mostly coming from chlor-alkali plants and occurring as a by-product of nonferrous smelting – and to manage mercury-containing waste, such as end-of-life mercury added products. A few months later, the importance of finding solutions for mercury storage was re-affirmed by many representatives at the second session of the Intergovernmental Negotiating Committee (INC 2) on mercury (24-28 January 2011, Chiba, Japan). Moreover, the LAC region expressed concern over insufficient information on the capacity of many developing countries for the effective and economically viable long term storage of mercury. The UNEP Mercury Storage Project in the LAC region estimated that excess or surplus elemental mercury might amount to a total of approximately 8,300 tons between 2015 and 2050.

In order to provide a better understanding of mercury storage and disposal issues at country level and to promote the environmentally sound management of excess mercury, Argentina and Uruguay were selected for the "Mercury Storage and Disposal Two Countries Project in South America"[5], a follow-up to the LAC Mercury Storage Project. The Project was initiated in 2011 and successfully completed in 2012. Given its encouraging results and in order to benefit from the experiences gained, a decision was taken in 2012 to replicate the project in Mexico and Panama.

These two countries had previously carried out different mercury-related projects, such as the national mercury releases inventories. In recent years, Mexico worked on several mercury-related projects within the framework of the North American Agreement on Environmental Cooperation (NAACEC), signed by Canada, Mexico and the United States of America.

The project was developed in collaboration with the UNEP Regional Office for Latin America and the Caribbean (ROLAC). For Mexico, the project was coordinated by CENICA, the National Center for Environmental Research and Training with the National Institute of Ecology and Climate Change, which has been appointed as the Stockholm Convention Regional Center in Mexico. For Panama, the coordination was led by the Ministry of Health/Stockholm Convention Regional Center in Panama, in alliance with the Young Men's Christian Association (YMCA) in Panama.

This report is based on the contents of the country reports from Mexico and Panama as well as the Inception and Results Workshop in which the author participated.

Project methodology

A workshop to explore scientific and engineering issues associated with the Safe Storage and Disposal of Redundant Mercury was held at St Anne's College, University of Oxford on October 13th and 14th of 2009. The workshop was organized by the Integrating Knowledge to Inform Mercury Policy (IKIMP) Initiative[6] and sponsored by the United Kingdom's Department for Environment, Food and Rural Affairs (DEFRA). It featured over 40 experts from 7 different countries, representing public bodies, non-governmental organizations, consulting firms, industry, academia and independent research institutions.

[5] Individual country reports and a general project report can be found at http://www.unep.org/hazardoussubstances/Mercury/PrioritiesforAction/SupplyandStorage/Activities/StorageandDisposalCentralAmerica/tabid/106665/Default.aspx

[6] www.mercurynetwork.org.uk/

The Workshop built on previous meetings related to this topic, including the UNEP regional storage group meetings in Bangkok and Montevideo, held in 2008 and 2009 respectively. Primarily focusing on scientific and technical issues, the event was followed by a sub-group discussion on the safe management of surplus mercury worldwide. An important output of this Initiative was the "Suggested framework for decision making for the safe management of surplus mercury". This document has been used as a reference for the methodology established in the 'Two Countries Project'. The suggested framework consists of four steps: 'Initial actions', 'Assessment of basic management options', 'Selecting between technical concepts' and 'Enabling implementation'. Each step features a number of possible elements to be featured in a national or regional decision making process addressing the management of surplus mercury.

The methodology suggested by the IKIMP was applied during the Argentina/Uruguay project. Given the positive results, the same methodology has been used in Mexico and Panama within the framework of this project.

Consideration of IKIMP's framework for decision-making constituted the first step in this project. Thus, a framework for conducting an inventory of storage facilities and related legislation/regulation was prepared as a practical tool to help the two participating countries achieve the project objectives. This framework consists of two separate tools, each designed as a matrix. Application of the first one gives a weighted list of possible temporary storage locations in the country, as well as an inventory of existing mercury and/or HW treatment facilities. These can potentially serve as interim storage facilities for elemental mercury/mercury waste (see Annex A).

The second tool was designed to gain an overview of existing local, national, regional and international legislation/regulatory measures that may be relevant vis-à-vis the storage and disposal of mercury in each country and to detect any potential need for additional regulatory instruments. This tool was used and applied in Argentina and Uruguay. With slight modifications, it was also used for Mexico and Panama.

Taking into account the findings resulting from the application of these tools as well as the results of the sectorial mercury releases inventories and the regulatory framework review, recommendations for the drafting of a National Action Plan (NAP) were elaborated for each country. This was done in cooperation with stakeholders in a national working group (see Annex B).

Basic management options in GRULAC countries were thoroughly analyzed in the "Options Analysis and Feasibility Study for the Long Term Storage of Mercury in Latin America and the Caribbean"[7] study. The study concluded that "*Underground facilities are an unlikely solution in the short term for most countries in the LAC region, and that an above-ground engineered warehouse can be also a short-term solution for mercury storage in the LAC region".* Therefore, although options like stabilization and landfills are briefly referred to in this document, this project focuses mainly on above-ground temporary storage in an existing facility selected from a number of potential sites for each of the two countries.

[7] Options Analysis and Feasibility Study for the Long Term Storage of Mercury in Latin America and the Caribbean. Laboratorio Tecnológico del Uruguay (LATU). Montevideo, 2010. http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/supplystorage/Final_Draft_LAC%20Hg%20Options_Chile.pdf

2. COUNTRY RESULTS.

The following sections include a synthesis of the results obtained for Mexico and Panama, corresponding to each of the activities conducted in these countries and having as a reference the IKIMP's suggested framework.

2.1 Mexico.

2.1.1 Review of regulatory framework.

Mexico's regulatory framework on waste includes several kinds of legal instruments, most of them addressing HW control. A few of them directly address mercury waste management control, and some others are related to environmental quality criteria. In total, 24 instruments were reported by Mexico, including acts, regulations, decrees, standards and norms. These legal instruments can be found at the national, state and municipal level. Regional and international instruments have also been reported, such as the North American Agreement on Environmental Cooperation (NAAEC), signed by Canada, Mexico and the United States of America, as well as the Basel and Rotterdam Conventions.

A legal framework specifically addressing mercury waste management is currently not available in Mexico. Most environmental legal instruments stem from the General Act for Ecological Equilibrium and Environmental Protection passed in 1988. A specific instrument for municipal solid waste (MSW) and HW, the General Act for the Comprehensive Waste Management and Prevention was passed in 2004. Later, in 2006 and as an instrument of this Act, the Regulations (*Reglamento*) pertaining to the General Act was passed. This particular instrument includes stipulations that must be observed for HW storage facilities, including mercury waste.

Regarding mercury waste, the 'General Act for the Comprehensive Waste Management and Prevention' states that a Waste Management Plan, a formal, well defined policy instrument, should be elaborated for batteries, lamps and other mercury containing devices, among other waste streams.

Under these regulatory instruments, Mexico has several standards dealing with HW (e.g. waste classification, leachate test, rules for siting design and operation of security landfills). Most standards particularly addressed to mercury deal with maximum limits for releases to air or water, or water/air/soil quality criteria, but not directly with mercury waste. This is the case for mercury emissions to the atmosphere from cement kilns or

waste incinerators, and the mercury contents in bio solids, drinking water or labor environments, for which specific legal instruments exist in Mexico.

According to environmental authorities, the current Mexican regulatory framework is in line with the project objectives and requirements. However, a regulation is in place which prohibits the storage of HW for a period exceeding six months. It is valid for HW generators as well as providers of services such as collection, treatment, storage, etc. The stakeholders raised this issue during the Results Workshop in Mexico City as a legal impediment to operate storage facilities for mercury/mercury waste unless the corresponding legal instrument is modified. Mexico also reported a lack of legal instruments on maximum limits and characteristics for waste subject to pre-treatment before final disposal.

Unlike most GRULAC countries, Mexican regulations permit the import of HW into its territory, except for final disposal. Thus, HW is allowed to be imported into Mexico for reclaiming or recycling purposes, but not for final disposal at security landfills.

An important advantage is that Mexico has been working for several years on its own Pollutants Release and Transfer Register (PRTR). It is now available to the public and it has been a valuable tool in preparing source inventories for different pollutants, including mercury and persistent organic pollutants (POPs).

Mexico reported the difficulty of getting accurate and solid information on mercury trade as well as the import/export of mercury containing products. Moreover, the information obtained frequently differs depending on the sources of information.

Finally, it is worth noting that Mexico has passed a legal instrument dealing with HW disposal in salt domes, although this kind of permanent storage has not occurred in Mexico yet. All regulatory instruments directly or indirectly related to mercury waste in Mexico were included in a schematic form in the tool (matrix) that was presented at the Project's Inception Workshop in Panama City in October 2012. The matrix is shown in Annex 1.

Table 2.1 sketches the hierarchy and gives an overview of the regulatory framework in Mexico related to this project.

Multilateral agreements	Basel Convention Rotterdam Convention
General Acts	General Act for Ecological Equilibrium and Environmental Protection (LGEEPA) General Act for Comprehensive Waste Management and Prevention (LGPGIR)
Rules	LGEEPA Rules: • PRTR • Environmental Impact Environmental Audits LGPGIR Rule
Plans Programs Norms	**Hazardous waste:** • NOM-052-SEMARNAT-2005 • NOM-055-SEMARNAT-2003 • NOM-056-ECOL-1993 • NOM-057-ECOL-1993 • NOM-058-ECOL-1993 • NOM-145-SEMARNAT-2003 • NOM-147-SEMARNAT/SSA1-2004 **Waste Management Plans :** • NOM-161-SEMARNAT-2011 • PROY-NOM-160-SEMARNAT-2011 **National Program for Comprehensive Waste Management and Prevention (PNPGIR)**

Table 2.1: Simplified hierarchy of the waste regulatory framework in Mexico.
Source: *Almacenamiento y disposición de mercurio en México*. August 2013

2.1.2 Mercury waste data in Mexico.

HW in Mexico is managed in accordance with the existing legal framework. Waste generators are responsible for the sound management of their waste. In order to assure an environmentally sound management of these wastes, there are fifteen different activities listed in the catalog prepared by the Mexican environmental authority. Among others, the following activities are listed: recycling, reclamation, treatment, incineration, security landfills, co-processing, and storage. Most of these are services offered by private companies. Therefore, HW generators are able to select from a catalog of different options to treat their waste in order to comply with the existing regulations in Mexico.

Inventory.

Mexico produced its National Mercury Releases Inventory (MNRI) in 2008, featuring data from 2004, and used UNEP's Toolkit for Identification and Quantification of Mercury Releases. Unlike Panama, Mexico did not update its Inventory within the framework of this project. According to this Inventory, a total of nearly 448 tons of mercury were

released to the environment in Mexico in 2004. Gold extraction and processing was the main source, followed by batteries and landfills. More than 40% of mercury was released into the soil (185.6 ton), a little less than 40% was released as waste (185.3 ton), and 10% was emitted into the atmosphere (50.46 ton). It is important to mention that data from this Inventory is characterized by a certain degree of uncertainty. However, they give an impression of the general conditions for that year regarding mercury releases to the environment in Mexico. Also, only those sectors for which UNEP Toolkit provided input factors were included in this Inventory. A total of 895 facilities were considered as sources of releases.

In addition to the NMRI, Mexico has been able to draw on other sources of information related to mercury and mercury waste as well. These sources are the previously mentioned PRTR and a study developed with the support of the (North American) Commission for Environmental Cooperation (CEC) - a result of the North American Agreement on Environmental Cooperation (NAAEC) signed by Mexico with Canada and the United States of America.

Application of data from these alternate sources results in an estimated 332.2 tons of mercury waste generated in Mexico, a number superior to the 185.3 tons reported by the NMRI. According to these sources, 82% of mercury waste is stored in tailings dams, 10.6% is stored in security landfills, and 7.4% is disposed of at sanitary landfills/open dumps. No data was available for waste from dental amalgam.

Waste Fluxes.

In order to better understand the situation regarding mercury waste generation, treatment and disposal in Mexico, Figure 2.1 illustrates the sources and fate for this kind of waste.

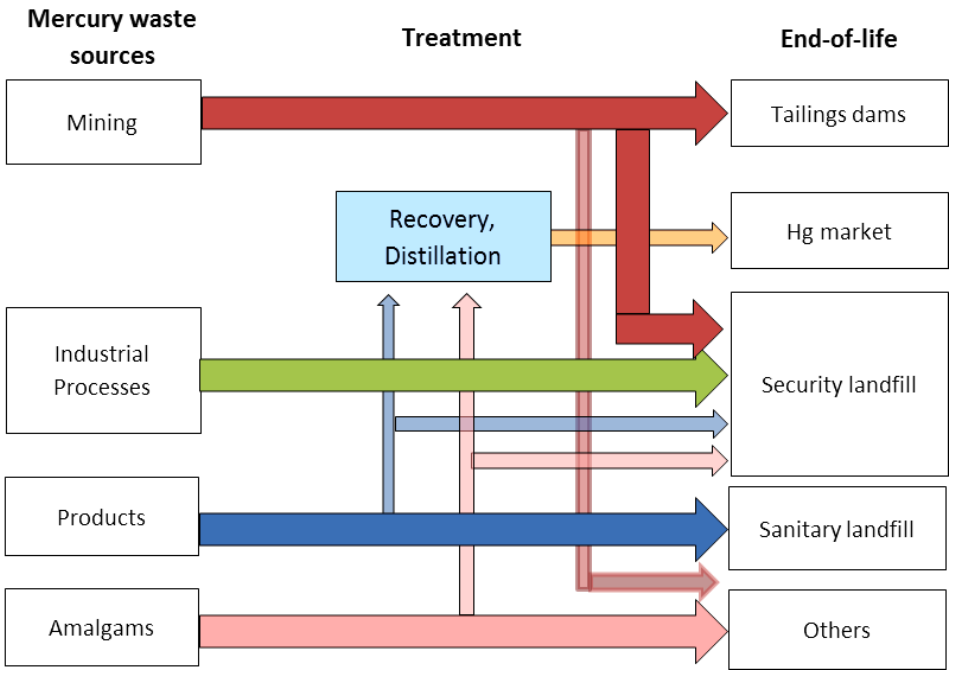


Figure 2.1. Mercury waste flows in Mexico.

Source: *Almacenamiento y disposición de mercurio en México*. August 2013

Finally, it is important to mention that primary mercury production in Mexico has not been officially reported since 1995 (although secondary production from mine tailings has been ongoing). With metal prices increasing and other economic factors as additional drivers, mercury mining is now again being practiced in several Mexican states, with a production of 121.5 tons of mercury reported in 2011, an estimated number obtained from import-export figures[8]. It is likely that a certain amount of mercury waste is generated during the mining/processing activities, but no reliable data is available on this issue. A similar situation can be observed regarding artisanal and small-scale gold mining (ASGM), an activity which is not officially reported in Mexico but is supposed to exist according to non-official reports.

2.1.3 Survey and analysis of possible temporary storage locations in the country.

Out of the 15 different HW management services provided by the private sector, four were reported as having authorization for mercury waste handling. These are: final disposal at security landfills, treatment, transport, and temporary storage. For these services, Mexico reported a total of 35 private companies: 3 for treatment, 4 for landfilling, 28 for transportation, and 4 for storage.

[8] ALMACENAMIENTO Y DISPOSICIÓN DE MERCURIO EN MÉXICO. Proyecto en la Región de América Latina y el Caribe. México – Panamá. INE.2013

As Argentina previously did, Mexico focused its survey and analysis of possible temporary storage locations on existing waste treatment facilities, although other possibilities were also assessed. The approach followed by Mexico consisted of several steps, with the tool matrix as a methodological reference. First, a list of companies authorized for HW treatment/disposal was prepared. Later, these facilities were investigated to select those with authorization to receive mercury containing waste. Finally, this review produced a short list of four potential sites, consisting of security landfills for final disposal of HW. Based on further analysis of these sites, two security landfills were judged to be the most suitable options to be considered for the storage of mercury and mercury waste in Mexico. Figure 2.2 shows the location of these sites and the HW treatment plants authorized to receive mercury waste.

Figure 2.2. HW infrastructure in Mexico considered in this project.
Source: adapted from *Almacenamiento y disposición de mercurio en México.* August 2013.

During the process of assessing potential sites for the temporary storage of mercury and mercury waste in Mexico, special attention was paid to several sites potentially suited for underground storage, such as salt domes located in three different regions in central and southeast Mexico. An investigation was conducted in order to find one or more potential sites to store mercury/mercury waste. However, currently the results are not encouraging

as several obstacles were encountered during this process. These regions are shown in Figure 2.3.

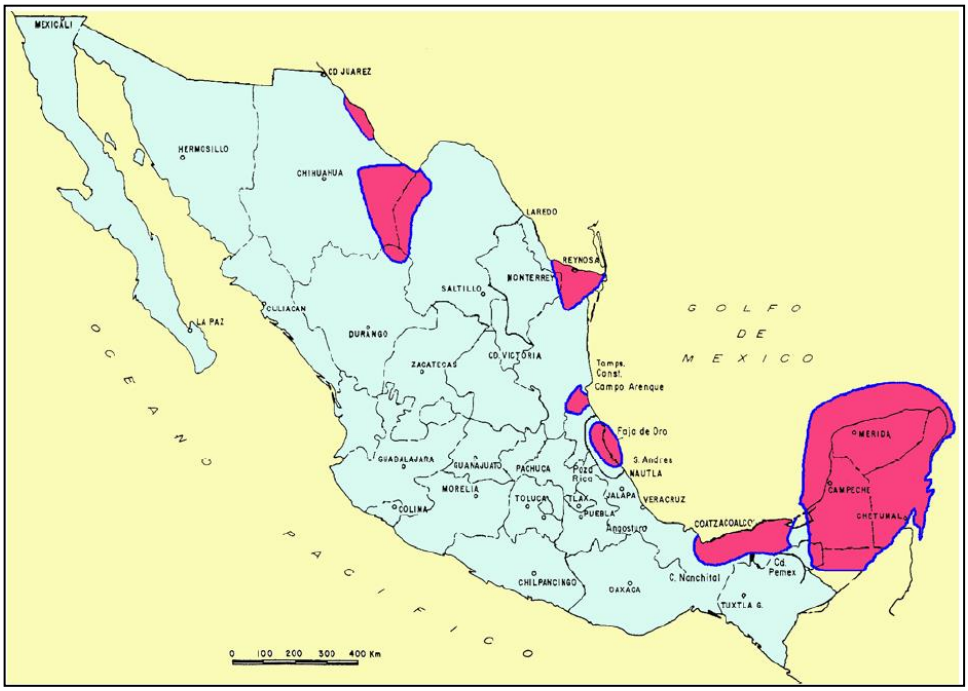


Figure 2.3. Regions with salt structures in Mexico.

Source: *Almacenamiento y disposición de mercurio en México*. August 2013

In this regard, it is important to note that the company owning the two chlor-alkali plants currently operating Mexico is also the owner of a salt mine. This company is part of the National Working Group (NWG) in Mexico, which is described in 2.1.4 below.

The possibility of selecting these as potential sites for the purposes of this project has been discussed with the respective owners/operators. Representatives of the companies operating the two security landfills are also part of the NWG.

2.1.4 Establishing a decision-making process.

As suggested in the IKIMP framework decision-making process, Mexico organized a National Working Group (NWG) in which a number of stakeholders took part. The NWG included representatives from the public sector, academia, the chlor-alkali industry, the health sector, the waste management sector, the mining industry and NGOs (Annex 2 includes the lists of stakeholders).

The Group was scheduled to meet several times during project development, but the transition stage in which the INECC is involved allowed the Group to meet only once

before the Results Workshop. At this meeting, the Group discussed issues related to the project, such as the results of the global negotiations for a legally binding instrument on mercury, the status of the project in Mexico, mercury waste management issues, and the situation regarding the chlor-alkali sector in Mexico. At this early stage of the NWG, the National Action Plan was not included in the meeting agenda. Conclusions and a set of agreements were obtained at the end of the meeting by INECC representatives.

In closing the Project Results Workshop held in Mexico City on July 3 & 4, 2013, the Mexican NWG members committed to a follow-up meeting in order to advance the agreements and NAP development.

2.1.5 Technology status/Assessing basic management options.

Mexico has developed significant infrastructure in the field of HW treatment and disposal, most of which is designed to receive certain waste streams, such as spent oils and solvents, acid solutions, etc. Nevertheless, as mentioned above, there are just a few facilities offering services for mercury waste treatment/disposal.

The current infrastructure in Mexico for HW treatment/disposal includes two facilities authorized to receive mercury waste for final disposal purposes. These two facilities are also authorized to provide mercury waste treatment prior to final disposal (security landfills). Both firms delivered information on their treatment methodologies. Unfortunately, this information lacks the necessary technical details in order to assess the methodologies.

As regards other treatment options, Mexico has recently authorized at least one facility to operate a small retort as a means of recovering mercury from mercury containing waste, such as lamps, amalgams, thermometers, sphygmomanometers, thermostats, etc. This is an adequate method to separate mercury from other materials prior to final disposal in security landfills. The operator of this plant is planning to enhance the installed capacity and sell the recovered mercury on the local market.

Mexico has reported the need to review the regulatory instrument prohibiting the storage of HW for a period exceeding six months, as this may be an obstacle in reaching a consistent solution for the temporary storage of mercury waste in the country.

2.1.6 Developing a national storage and waste management action plan.

The Mexico National Working Group managed to meet only once before the Results Workshop due to administrative changes which took place in the federal government during project implementation. This prevented further development of the NAP

guidelines. The NWG was able to discuss these guidelines during the Results Workshop in Mexico City, but only managed to identify the components to be featured in the Plan, and several activities for each one of the selected components. The Guidelines include six components or areas of interest and a set of activities for each of these. They are described in Table 2.2 below.

Component	Activity
a) Mercury releases inventory	• Update mercury releases inventory in Mexico • Obtain national emission factors for most significant sources and those included in the Minamata Convention • Engage all stakeholders in order to reduce data uncertainties
b) Informal primary mercury mining	• Develop a diagnosis on informal activities of mercury mining in Mexico. • Evaluate waste type produced during cinnabar processing, and its current disposal. • Define control measures for the environmentally sound management of waste generated. • Characterize environmental impact as a result of current waste management practices
c) Artisanal and small scale gold mining (ASSGM)	• Assess ASGM activities in Mexico • Assess mercury use in ASGM activities. • Evaluate the type of waste generated during ASGM activities and its current disposal • Define control measures for the environmentally sound management of waste generated. • Characterize environmental impact as a result of current waste management practices.
d) Processes	• Assess the current mercury waste stabilization/ solidification techniques applied at security landfills • Define actions for the disposal and storage of mercury and mercury-containing waste generated during the dismantling of the mercury-cell chlor- alkali plants. • Define a remediation plan after dismantling mercury-cell chlor- alkali plants.
	• Assess the current infrastructure capacity installed in Mexico (retorting) for the treatment of mercury in end-of-life products. <u>Industrial waste</u> a. Implement management plans for large generators

e) End-of-life mercury containing products	<u>Household waste</u> b. Develop a separation plan and selective waste collection c. Implement a national management plan pilot program d. Reach public awareness <u>Health sector</u> e. Replace mercury thermometer and sphygmomanometer at the national level f. Define the necessary regulations for the import and use restrictions.
f) Health sector – dental amalgams	• Prepare an action plan to replace dental amalgam. • Define a plan for the environmentally sound management of waste from dental amalgams.

Table 2.2. Mexico´s National Action Plan Guidelines.

Source: *Almacenamiento y disposición de mercurio en México*. August 2013

No performance indicators, deadlines, resources or responsible entities for the activities included were established by the NWG members - hence the need for the group to have a follow up meeting.

2.2 Panama

The most significant project results obtained for Panama are reported as follows for each of the six concepts under analysis.

2.2.1 Regulatory framework.

Panama reported 19 regulatory instruments (a total of 43 including national parks resolutions) related to solid and HW management, including a National Policy for Comprehensive Management of Hazardous and Non-hazardous Wastes in 2007. Acts, decrees and resolutions have been reported, with some of them dealing directly with mercury issues. Nevertheless, there is currently no regulatory framework in place for the comprehensive management of mercury waste in Panama.

In spite of a regulatory framework being available, law enforcement for HW matters is still a pending issue. This is especially true for regions in the country other than the capital and its surroundings. Panama reported that the above mentioned National Policy is not being developed and has not been implemented yet. At the institutional level, there is no coordination among responsible entities to deal with the different mercury and mercury waste issues in the country. Also, the lack of a 3R's-oriented culture (reduce, recycle, reuse) is an obstacle to achieving an environmentally sound management for solid and HW. Although there are regulatory instruments that may apply to the registration of mercury release (and other) sources, there is no legal provision applicable to developing a PRTR in Panama.

Meanwhile, Panama has adopted national laws implementing both the Basel and the Rotterdam Convention. Unlike Mexico, Panama prohibits the import of HW into its territory, a rule prevailing in most countries within the GRULAC region.

The regulatory instruments directly or indirectly related to mercury waste in Panama were included in a schematic form in the tool (matrix) that was presented at the Project's Inception Workshop in Panama City in October 2012. It is included in Annex 3.

2.2.2 Mercury waste data in Panama.

As in Mexico, the HW generator is responsible for managing its waste in an environmentally sound manner in line with the corresponding regulations. The central government maintains the powers of governance and regulation of HW through ANAM (the environment authority) and MINSA (the health authority), whereas the competence of the municipalities is restricted to the management of municipal solid waste. For this purpose, some specialized infrastructure - mainly for HW collection, treatment and disposal - is currently available in Panama. Most of the HW is generated in the capital and its surroundings. The relevant infrastructure is located in the same area.

With this infrastructure, there are several facilities including a public municipal solid waste (MSW) landfill which receives certain kinds of HW. There are also two HW incinerators, mainly for pharmaceutical products and international waste. One company is authorized to collect and receive mercury containing waste, such as thermometers and lamps, for treatment. The main sources of international waste are the large number of ships arriving in Panama at both ends of the Canal and the international airport in Tocumen.

It is estimated that the share of HW recycled in Panama lies between 2% and 5%. Although the relevant regulatory framework is in place, a large portion of HW is currently not being processed in an environmentally sound manner. Special attention is paid to hazardous medical waste, which is properly managed, mainly at private incineration

plants, within the capital and the surroundings. However, in the rest of the country, medical waste continues to be disposed of in landfills or open dumps, with open burning practices being frequently used. Fluorescent lamps are collected and crushed under controlled conditions by a private contractor. The broken glass and filtered powder are stored at the crushing facility/on-site in drums of 55 gallons, awaiting treatment or shipment abroad for treatment purposes. The Panama Canal Authority collects mercury-containing luminaires, crushes them and transports them properly contained in special bags to the Cerro Patacon landfill, where they are disposed of in a special area equipped for this purpose.

There is no selective collection for other end-of-life mercury-containing devices such as electrical and electronic switches, contactors, relays, light sources, gauges, blood pressure gauges, barometers, pressure valves and thermostats. These are handled in similar fashion as other waste, i.e., mostly disposed of in existing dumps and landfills.

To some extent, batteries are collected, stored and subjected to a treatment methodology involving an encapsulation process in cement. As regards electronic waste, computers are collected by an NGO which reassembles one computer per several end-of-life computers. This computer is sold but a lot of scrap, which is indefinitely stored on-site, is generated in the process. Another private contractor receives used computers, scraps them and ships part of the waste to the United States of America. Plastic waste and cathode ray tubes are sent to the landfill at Cerro Patacon.

Inventory.

Panama produced its Mercury Emissions Inventory in 2008, using UNEP's Toolkit for Identification and Quantification of Mercury Releases to determine the amount of mercury releases from specific sectors and sources. Within the framework of this project, Panama updated its Inventory using the new 2011 version of the Toolkit in order to generate more recent data which could be helpful in identifying the most appropriate option for mercury waste storage.

Compared to the 2008 Inventory, the new Inventory results show an increase in mercury releases, mainly as a consequence of the sustained economic growth experienced by the Republic of Panama in recent years. Inventory results reported the highest release value for the subcategory 'Batteries with mercury', with an amount of 15,583.12 kg of mercury released as waste. Secondly, the subcategory 'Informal waste dumping sites' showed an annual release of 1,786 kg of mercury which was released to 'land' factor. Thirdly, releases from 'Cement production' amounted to releases of 146 kg of mercury per year. Two subcategories were identified as the fourth largest sources of releases: 'Mercury dental amalgams' accounted for 0.123 tons released as waste and other 0.123 tons released to

treatment or the specific sector factor, while 0.261 tons of Hg released as waste originated from 'Manometers and gauges with mercury'.

It is interesting to note that total releases to the environment from the largest source (batteries) amounted to 18,278.7 kg, whereas the second largest source (informal waste disposal) released 2,233.4 kg of mercury, a much lower amount.

Panama reported some difficulties in gathering all the data necessary to feed UNEP's Toolkit. Some of these difficulties were:

- Incomplete data obtained from the tariff system of the National Customs Authority
- Reluctance by government, commercial and industrial sectors to provide certain information
- Incomplete data from the health sector, specifically on medical activities, since the mercury content in each device is unknown

2.2.3. Survey and analysis of possible temporary storage locations in the country.

Subgroup #3 of the NWG (described in 2.2.4 ahead) was responsible for the "evaluation and analysis of potential sites for temporary storage of mercury in the country".

A list of potential sites for the temporary storage of mercury waste in Panama was drafted by the Subgroup. Five potential sites and a group of facilities have been proposed. Specific information has been provided for each site, including the main activity, address, land use, type of soil, and hydrogeological characteristics. After a first evaluation of the various options, three field visits of potential sites were organized in order to assess the characteristics of the proposed facilities for the purpose of the project.

The preliminary list of potential sites included one lamp crusher/battery collection facility, two municipal waste disposal sites (one sanitary and one controlled landfill), one university campus, and a series of concrete bunkers that were used as military structures when the Panama Canal was administrated by the United States of America. These bunkers, under the responsibility of the Ministry for Safety, are located in the Panama and Colón Provinces, along both sides of the Panama Canal (see Figure 2.4).

Figure 2.4. Samples of bunkers proposed for elemental mercury storage.
Source: *Project for storage and disposal of mercury in Panama*. Final report. August 2013

The following table resumes the characteristics for each of the five site options:

Site	Possible use	Current use	Location/comments
Bunkers	Storage of existing elemental mercury	No current use	Panama and Colon Provinces. Nearly 100 bunkers in the two provinces.
Cerro Patacon sanitary landfill	Storage of waste contaminated with mercury	MSW disposal and certain HW using landfill technique. Receives MSW from Panama, San Miguelito and part of Arraijan municipalities	Province of Panama. It has an area of 132 hectares.
EMAS future landfill	Treatment and temporary storage of waste contaminated with mercury	To remove cover material to be used in the Playa Leona landfill. It is not yet being used as a disposal site for MSW from the municipalities of La Chorrera, Capira and part of that generated in the municipality of Arraijan	Private company holding an approved Environmental Impact Assessment for the construction and operation of a landfill next to the current controlled dump. Large enough area for temporary storage of mercury waste.
Technological University of Panama (TUP). Tocumen	Storage of waste contaminated with mercury	University research and workshop facility	Province of Panama. It has a fairly large area.

extension grounds			
Ecologic S.A.	Treatment of mercury-contaminated waste and batteries and cells contaminated with mercury	Treatment of fluorescent lamps and used/ damaged cells and batteries.	Province of Panama. Not enough space to accommodate all mercury waste, but interested in acquiring another site.

Table 2.3. Potential sites for the temporary storage of elemental mercury/mercury waste in Panama.

Source: *Project for storage and disposal of mercury in Panama. Final report*. August 2013

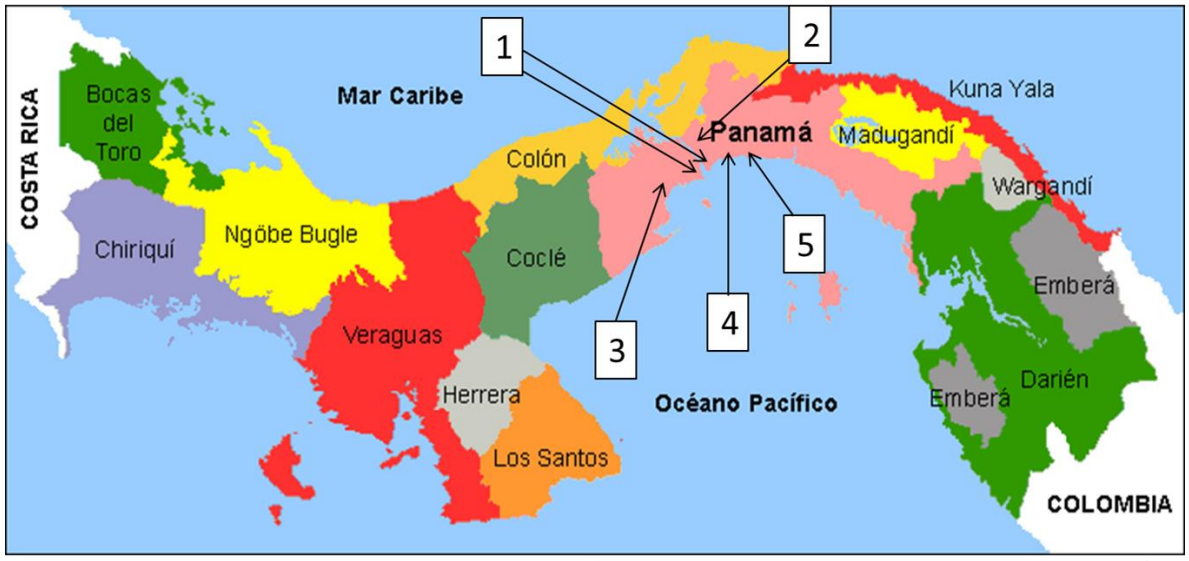
It is important to note that, for security reasons, the NWG decided to identify two potential sites, each for a different purpose: one for the storage of elemental mercury and another for the storage of mercury containing waste. The analysis of the potential sites and their characteristics allowed the NWG to make the following conclusions regarding the selection of the most suitable options for the storage of elemental mercury/mercury waste:

1. The most suitable potential sites for the temporary storage of **elemental mercury** waste are the bunkers, whatever their location.

2. The most suitable locations for the temporary storage of **mercury-contaminated waste** are the EMAS company´s landfill, the Cerro Patacon landfill and the Tocumen extension of the Technological University of Panama.

3. The initiative of the company Ecologic S. A. should be considered, regardless of the fact that their current location is not the most appropriate, since their representative expressed an interest in considering another location that would meet environmental standards and site selection criteria taken into account under this project

Figure 2.5. shows the location of all sites considered in Panama as potential sites for the temporary storage of mercury and mercury waste.



1. Bunkers
2. Cerro Patacón sanitary landfill
3. EMAS controled dump
4. Panama's Technological University grounds
5 Ecologic S.A.

Figure 2.5. Location of potential sites in Panama.

Source: *adapted from Project for storage and disposal of mercury in Panama. Final Report*. August 2013

2.2.4. Establishing a decision-making process.

Panama invited stakeholders from the public and private sector as well as civil society to participate in the NWG. Stakeholders were grouped under the following three categories: Government (including academia such as public universities), the Private Sector, and Civil Society. A total of 19 institutions from these sectors were invited to participate, with representatives from ten subsectors attending the NGW meetings, mainly representatives from the national government (environment, health, commerce and industry, agriculture, national police, energy, industry, and customs), associations of municipalities, academia, professional associations (the dental society), mining associations and Civil Society Organizations (CSO).

The overall objective of the Working Group was defined as "Assisting the implementation of the project: Storage and Disposal of Mercury in the Republic of Panama". The following objectives were identified for the NWG:

1. Validate the information processed by the national consultant for the topics:
   - Mercury inventory update
   - Legal framework update
   - Evaluation and analysis of potential sites for temporary storage in the country

- Basic management options
- Process for decision making
- National Action Plan for storage and disposal of mercury
- Project progress reports and Final report

2. Contribute to the following activities:
- Location and visit of potential sites for temporary storage in the country
- Preparation of the basic management options
- Development of the process for decision making
- Preparation of the National Action Plan for the storage and disposal of mercury

3. Participate in meetings of the various subgroups

The NWG met on five occasions in 2012 and 2013. Eight subgroups with different tasks and responsibilities were established. The following tasks were assigned to these subgroups:

1. Update of releases inventory
2. Update of regulatory framework
3. Analysis of potential sites for mercury waste storage
4. Assessment of basic management options
5. Definition of decision making process
6. Development of National Action Plan
7. Development of progress report
8. Development and submission of final report

In addition to its regular meetings, the Subgroup in charge of the analysis of potential sites carried out three field visits in order to assess and validate the characteristics of these previously documented sites. Another outcome of the NWG was the draft National Action Plan (NAP) for the environmentally sound management of mercury and mercury wastes, which is later described in section 2.2.5.

2.2.5. Technology status/Assessing basic management options.

Several factors were taken into account when discussing management options in Panama. One of them is the relatively small size of the country compared to other countries where a similar project took place (i.e. Argentina, Mexico). Secondly, the most relevant sector in Panama´s economy is represented by services, rather than industry. This has a direct influence on the mercury waste streams.

In order to assess Panama's basic management options, the NWG evaluated the following items:

- The current situation in terms of mercury waste management at the national level
- The geographical location of the sites generating the largest share of mercury waste in the country
- The results of the regulatory framework analysis applicable to mercury waste

As has been pointed out in 2.2.2, Panama has developed a limited infrastructure for HW management, consisting mainly of a few incinerators for outdated pharmaceutical drugs and international waste. Additionally, a private contractor operates a facility which collects fluorescent lamps from private businesses. Moreover, the Cerro Patacon sanitary landfill receives some HW for disposal.

As regards HW other than medical/international waste, Panama lacks an adequate infrastructure for environmentally sound treatment/disposal. Elemental mercury generated at health care centers is frequently placed in glass jars and stored in working areas either in pre-made shelves, improvised deposits or under desks in the work areas. Panama acknowledged that this is a very outdated and insecure storage method.

Given the previously described conditions prevailing in Panama and in accordance with the management options assessment, the NWG decided to identify one site for elemental mercury storage and another for mercury waste storage, mainly due to commercial and safety reasons. Existing concrete bunkers were selected as potential sites for the storage of elemental mercury. Aboveground storage, mainly at sanitary landfill premises, was identified as a suitable option for the storage of mercury waste, with a university campus considered as alternative.

The exporting of mercury containing waste for treatment abroad has not been explored in Panama, other than a potential export in late 2013 of PCB contaminated equipment and mercury-contaminated lamps to France for treatment and/or disposal.

2.2.6. Developing a national storage and waste management action plan.

As reported in 2.2.3 above, eight subgroups were established within the NWG, each one with different responsibilities. The subgroup in charge of the NAP prepared a draft version of the Plan which was presented to the NWG members during their fourth meeting. At this meeting, the draft NAP was discussed and improved and a final version resulted. The proposed National Action Plan for the Management of Mercury was presented at the

Regional Workshop on Project Results, held in Mexico City on July 3 and 4, 2013. Panama's NAP features three general components:

- A Legal framework
- Promotion and awareness of mercury management
- Intersectoral partnerships

For each one of these elements, the NAP includes the following concepts: objectives, activities, assumptions and responsible entities. These concepts are shown in Table 2.4 reflecting the NAP contents in Panama.

Component	Objectives	Activities	Assumptions	Responsible
A. The Legal framework	1. Implement the National HW Policy 2. Ratify the Minamata Convention. 3. Strengthen the regulatory framework on mercury and mercury-containing products, as well as the ability to control the flow of substances and products.	1.1 Creation of an intersectoral and interagency Committee for Waste and Hazardous Substances 1.2 Identification of priorities of the National HW Policy applicable to elemental mercury and products containing mercury. 2.1 Submission of the Minamata Convention by the National Assembly 3.1 Development of the necessary regulations for the integrated management and control of elemental mercury and mercury-containing products. 3.2 Development of standards or adequacy of existing guidelines for the management of mercury waste (selective collection, transportation, treatment, storage and disposal). 3.3 Development of a legal provision to ensure that users of products that generate mercury-contaminated waste return them to the sellers/producers once these have no value to the users, thus ensuring recovery of most mercury waste.	1. Waste of mercury and mercury-containing products that deserve an environmentally sound management are generated annually. 2. Most waste collection of elemental mercury and mercury-contaminated waste is not done selectively. 3. In some cases, selective waste collection of elemental mercury and mercury-containing products is carried out voluntarily. 4. There is a policy on HW that has not been implemented. 5. There is not a recycling or reuse	Ministry of Health and National Customs Authority, in coordination with other stakeholders.

		3.4 Development of a legal provision that makes it attractive to people who scrap equipment to release mercury-contaminated waste in exchange for monetary compensation. 3.5 Development of a legal provision to establish requirements and procedures to control the importation of mercury-containing products by the appropriate authority.	culture. 6. There is little awareness of risks to health and the environment.	
B. Promotion and awareness of mercury management	1. Disseminate timely information on: a) current status of mercury, and b) the draft Minamata Convention, including its benefits and obligations. 2. Support efforts for differentiation and optimization of elemental mercury management and mercury-contaminated waste. 3. Sensitize and train stakeholders	1.1 Development and dissemination of informational materials to the relevant actors. 1.2 Development of a dissemination plan to different media. 1.3 Disclosure to the stakeholders on the results of potential sites for location, qualification and/or construction of the warehouses for temporary storage of waste contaminated with mercury and for elemental mercury waste. 2.1 Evaluation of models applied in other countries. 2.2 Feasibility study on implementation of any of the models used in other countries. 2.3 Keeping updated information on the amount of mercury products entering the country. 3.1 Definition of groups of interest and contents of awareness and training programs.	1. There are companies and NGOs who may be interested or others that are actually working in the management of mercury-contaminated waste. 2. The importation process of mercury products has deficiencies related to the classification of merchandise in the various tariff codes. 3. There is not a recycling or reuse culture. 4. Potential sites for the location of the temporary storage of elemental mercury and mercury-contaminated	Ministry of Health and National Environmental Authority

	about the risks and management of elemental mercury and mercury-contaminated waste.	3.2 Training of public officials and representatives of private sector. 3.3 Design and implementation of a national awareness plan. 3.4 Approaching authorities of Urban and Household Sanitation, National Police, Technological University of Panama and EMAS company to sensitize them about options and benefits of temporary storage of elemental mercury waste and waste contaminated with mercury.	waste had been identified.	
C. Intersectoral partnerships	1. Promote public-private partnerships to implement solutions for the comprehensive management of elemental mercury and mercury-contaminated waste. 2. Coordinate and encourage private sector and NGOs to identify options and interests for the management of mercury wastes.	1.1 Identification of potential stakeholders and strategic partners. 1.2 Selective presentations of the information campaign. 1.3 Establishment of the joint action plan with the participation of partners and stakeholders. 2.1 Identification of NGOs and potential companies that are interested in the management of mercury waste. 2.2 Encourage selective waste collection and pretreatment, in order to reduce the volume of waste contaminated with mercury as well as its temporary storage or disposal, with participation of private sector.	1. There is a Cleaner Production program. 2. There is no recycling or reuse culture.	Ministry of Health and National Environmental Authority.

Table 2.4. Panama's National Action Plan

Source: *Project for storage and disposal of mercury in Panama. Final Report*. August 2013

No timing/deadlines, performance indicators or resources needed were provided for the different activities listed in this Plan.

3. ANALYSIS OF FINDINGS AND RECOMMENDATIONS

This chapter presents a number of findings and recommendations for both Mexico and Panama, derived from the results that have been described in the preceding sections of this report.

3.1 Mexico.

3.1.1 Review of regulatory framework.

Mexico started developing a comprehensive regulatory framework on HW management more than thirty years ago that has allowed for the environmentally sound management of HW generated in the country (and imported HW as well). Nevertheless, the recent signature of the Minamata Convention might bring about the need to review the regulatory framework, in light of the most significant provisions included in the Convention, especially those on control measures.

As previously mentioned, the NWG has identified the prohibition to store HW for a period exceeding six months as problematic given the scope of the project. As the concept of temporary storage (within this project's framework) goes far beyond the six-month term, it is recommended for Mexico to evaluate the need for modification of this legal instrument, so as to enable the environmentally sound storage of mercury and mercury waste for a longer period.

Mexico also reported a lack of legal instruments on maximum limits and characteristics for waste receiving pre-treatment before final disposal. It is recommended to fill this gap, as legal instruments are necessary in this field to assure the environmentally sound management of mercury waste.

In order to address the difficulties encountered in obtaining accurate and solid information on mercury trade as well as the import/export of mercury containing products, a review of the current legal instruments regarding these activities is recommended.

3.1.2 Mercury waste data in Mexico.

One application for defining the amounts of mercury waste through an inventory, or other methodology, is that results can be used to establish the space requirements for the storage of mercury/mercury contaminated waste. Where different numbers are obtained from different sources, it is recommended to use the highest value as reference for designing the storage facility. Three main sources of information were consulted in order

to get official data on the current situation of mercury waste in Mexico: the 2004 mercury releases inventory, the Mexican PRTR, and the North American Commission for Environmental Cooperation.

As it was reported in 2.1.2, there are some differences between the results provided by these sources. This is to be expected where different methodologies are applied in each case. It is therefore not advisable to compare the results for mercury waste production. It should also be taken into account that baseline years used in this exercise are also different. Furthermore, the PRTR data was supplied by the different sources in the register which were responsible for the mercury releases. Nevertheless, since data obtained from the releases inventory is almost ten years old and several important mercury release sources are missing, it is recommended for Mexico to update its inventory using the most recent version of UNEP's Toolkit for the Identification and Quantification of Mercury Releases. This version would allow Mexico to include those sources that were not included in the 2004 inventory. Updating this information will provide Mexico with recent and more reliable data in making decisions considering the guidelines in the Minamata Convention.

Finally, it is strongly recommended for Mexico to assess the situation in terms of ASGM and primary mercury mining - two activities apparently taking place in Mexico, but not formally assessed or reported by official sources. It is important to obtain reliable data on the extent and characteristics of these two activities, since both of them are considered to be potentially important sources of mercury waste. Including this activity in the NAP was therefore appropriate.

3.1.3 Survey and analysis of possible temporary storage locations in the country.

As Argentina did in the previous project, Mexico selected security landfills (two in this case) as potential sites for the temporary storage of mercury waste. These exhibited similar advantages; the most important one is their ongoing activity in the field of HW treatment and final disposal, as both sites are authorized to continue these activities for several years.

From a technical point of view, either of the two sites could serve as a potential temporary storage facility for the purpose of this project, although the information provided on treatment methodologies is more detailed for one of them than for the other. This consideration is supported also because the sites are located relatively close to each other (around 100 Km.), in the Northern part of Mexico. In this regard, both sites are relatively

far from important HW generators in the center and south-southeast regions of the country.

It is important to have further discussions with the owners/operators of the two pre-selected landfills in order to gain an understanding of the kind of treatment or pre-treatment which they offer for mercury waste. Both firms have already provided some technical information on their treatment methodologies, but it is still necessary to obtain further information in order to select the most suitable site. It would also be useful to define their interest, taking into consideration this project's objective.

Finally, it would be useful for Mexico to continue the assessment of geologic formations as potential sites for the permanent storage of mercury waste.

3.1.4 Establishing a decision-making process.

It is strongly recommended to keep the group involved in the elaboration of the definitive National Action Plan and to strengthen the relations between the different institutions involved in this process, including the assessment of any need for new bodies (e.g. expert panels, inspection teams, etc.). For this purpose, it will be necessary to establish the required mechanisms or instruments to keep the Group working, especially at a time when Mexico has signed the Minamata Convention.

As has been explained, the NWG in Mexico was only able to meet on a few occasions due to special circumstances in governmental institutions. This was insufficient for the achievement of significant advances in developing the NAP, among others. It is therefore recommended for Mexico to continue working on pending items as regards its National Action Plan.

Right now, it is imperative to work on the definition of performance indicators, timeframes and resources needed for each of the twenty-three activities included in the Plan. For this purpose, it is necessary to define the next activities and to increase the involvement of all relevant stakeholders in this process.

3.1.5 Technology status/Assessing basic management options.

As has been described in 2.1.2, Mexico has an elaborate infrastructure in place and the necessary regulatory framework to offer HW treatment/disposal options to national generators. Meanwhile, very limited possibilities exist for the stabilization/solidification (S/S) of elemental mercury.

Mexico offers mercury waste treatment by means of a retort. This has rather been an answer to market conditions from the private sector than a mercury waste policy from environmental authorities. HW regulations created a certain demand for a specific service (retorting/distillation) that did not exist in Mexico before 2013. In this regard, it is recommended to evaluate the needs for this kind of service in the near future in order to anticipate the demand from waste generators.

As regards mercury waste (sludge) from the chlor-alkali sector, the only option currently envisaged is dewatering and final disposal in a security landfill.

It is recommended that Mexico clearly defines the available treatment capabilities for mercury containing waste, especially regarding technologies dealing with stabilization /solidification. Depending on the results of this activity, decisions should be made on the viability of the treatment options.

3.1.6 Developing a national storage and waste management action plan.

As described before in 2.1.4, the NWG in Mexico was formed at a late stage of the project development. Thus, there was but one opportunity for the Group to meet before the Results Workshop in July 2013. It was not until this Workshop that the Group discussed and proposed several guidelines to be considered in Mexico's NAP. Under these constraints, Mexico presented a list of elements to be considered in preparing its NAP, consisting of a list of six components or areas of interest which should be considered in the NAP, as well as several activities corresponding to each of these sectors.

As already described, the NAP Guidelines do not consider performance indicators, the required resources (material, human, economic), deadlines, or institutions responsible for the development of each included activity. It is therefore recommended for Mexico to keep the NWG as an active entity until the pending tasks are achieved and to proceed in the development of the formal NAP, defining detailed activities for each of the six components. Also, for each of the listed activities, it is essential to fix dates for NWG meetings, to define the specific amounts that are necessary for the required financial and human resources, to define responsible institutions/persons, and to establish detailed timeframes.

Important items, such as awareness raising, training and education, etc., are missing. It is recommended for the NWG to incorporate them in the final version of the NAP in the near future.

3.1.7 Summary of recommendations for Mexico.

It is recommended that Mexico will:

- Review the regulatory framework for HW and produce the appropriate legal instruments, taking into consideration the provisions in the Minamata Convention and the objectives of this project.
- Update the 2004 mercury releases inventory.
- Proceed in the discussions with the two potential site owners/operators and investigate their interest relative to this project's objective. Also, request from them the necessary and detailed information on their treatment methodologies, mainly related to stabilization/solidification.
- Assess the current status of ASSGM and primary mercury mining in Mexico, and publish the resulting data.
- Continue the assessment of geologic formations as potential sites for the permanent storage of mercury.
- Evaluate the need to increase the mercury distillation (retorting) capacity for mercury containing products in Mexico.
- Maintain the NWG and involve its members in the process of elaborating the complete and definitive Mexico's NAP.

3.2 Panama

3.2.1 Review of regulatory framework.

Panama has reported a total of 43 legal instruments related to solid and HW management, among others. At the same time, it was also reported that although several of these instruments have already been passed, they have either not been implemented, or enforcement is frequently absent. It is recommended for Panama to proceed with the implementation of all relevant regulatory instruments. Also, Panama itself recommended the development of a rule establishing an institutional coordination to address the issue of mercury and its wastes.

Moreover, in order to solve the problems encountered during the data collection for the inventory assembly, the necessary legal instruments need to be adopted in order to have more efficient import controls of elemental mercury and mercury-containing products. These should require importers of such products to provide a minimum of relevant information to maintain an updated inventory in the future.

It is also recommended for Panama to:

- Consider the passing of the necessary legal provisions applicable to developing a Pollutant Release and Transfer Register.
- Prepare a legal instrument for HW storage facilities, including all types of mercury waste, and not only medical waste.

According to Panama, the necessary legal instruments to control medical waste among others are already available. Nevertheless, it is recommended that the authorities take action in order to create the necessary mechanisms to stop the disposal or burning of these wastes in sanitary landfills or open dumps in the entire country. These include law enforcement and encouraging the production of the necessary infrastructure for the sound management of medical waste, such as autoclaving and incineration, among others.

Finally, Panama should continue reviewing the corresponding regulatory framework, taking into consideration the most significant elements included in the Minamata Convention, especially in terms of control measures.

3.2.2 Mercury waste data.

Panama reported difficulties in getting the data necessary to produce its mercury releases inventory. As new and more reliable information is available from the different sources, a periodic update should be conducted and a validation of the inventory results using the new data obtained. The figure obtained for releases from end-of-life batteries seems disproportionately large when compared to other categories. It is therefore recommended to revisit this category when updating the inventory.

It is recommended to continue and strengthen the ongoing initiative of several private companies and NGOs involved in the recycling of HW, including waste from batteries, fluorescent lights and computers. Exploration of possible public/private partnerships is also recommended.

In order to control and avoid informal elemental mercury storage in health facilities belonging to the government (currently being placed in glass jars and stored in working areas either in pre-made shelves, improvised deposits or under desks), an effort should be made to minimize the associated hazards to human health and the environment (a training course addressing sound practices for small volumes of mercury storage is recommended). A similar reasoning applies to dental amalgams, which are currently being disposed of at MSW disposal sites without any pretreatment and other mercury containing devices and products.

3.2.3 Survey and analysis of possible temporary storage locations in the country.

The selection of bunkers for the temporary storage of elemental mercury in Panama offers important advantages, since it is not necessary to build new facilities and given that they are solid concrete structures adequate for the purpose mentioned. It will nevertheless be necessary to adapt the selected bunker(s) for mercury storage purposes. Also, given that the shelters were built many years ago, a thorough structural evaluation of the finally selected bunker(s) should be carried out.

Options for mercury waste storage included four potential sites: Cerro Patacon sanitary landfill, EMAS future sanitary landfill, Tocumen TUP grounds, and Ecologic, a private waste (spent lamp/battery) treatment facility currently in operation. The EMAS landfill is not in operation yet and will be located close to an operating controlled dump. This could be a serious disadvantage for this potential site. Although Ecologic has offered to look into expanding its premises, for the time being it lacks the necessary space for the storage of mercury waste.

Given these conditions, the most suitable options are the Cerro Patacon landfill and Tocumen TUP grounds, since these are the only two options currently available. The Cerro Patacon landfill has the advantage of being a facility already authorized to receive MSW, whereas the TUP's is currently being used for academic/research activities.

It is recommended that the owners/operators of all potential facilities be contacted in order to determine whether there is an interest and a possibility of using these sites, thus determining whether these are likely to become part of the project.

3.2.4 Establishing a decision-making process.

The Inception Workshop in Panama City was a good opportunity to start organizing the National Working Group in Panama. This allowed Panama to consolidate a Group and organize five meetings where important matters were discussed.

Pending issues and activities include involving the group in the elaboration of the final National Action Plan and strengthening the relations between the different institutions involved in this process. It is also advisable for the NWG to continue with the process of selecting the best storage option for mercury waste, both for elemental mercury and for mercury contaminated waste. First, they should select -among the nearly one hundred bunkers in Panama and Colón Provinces- the structure(s) in the best condition for

elemental mercury storage. Second, the most suitable option from among the two landfills and the University grounds should be identified.

It will be necessary for Panama's national coordination to set the necessary mechanisms to keep the Group working on pending issues, such as the gathering of all the required information from the owners/operators of all potential sites in making the final selection.

3.2.5 Technology status/Assessing basic management options.

As a first step in assessing available management options in the country, Panama reviewed the current situation regarding the management of mercury waste at a national level. It was decided to use two separate facilities, namely one for elemental mercury waste and a different one for mercury containing waste. This decision has of certain advantages, but it is likely that this will result in additional capital and operational costs.

It is important to take into account that elemental mercury waste from certain sources - mainly from hospitals and other health care centers- will be stored in the bunker(s) previously selected for this purpose. As Panama has reported that the health sector no longer imports mercury containing thermometers, it is likely that demand for the storage of elemental mercury waste will be decreasing in the coming years.

In its basic management options assessment, Panama does not consider the recovery of elemental mercury from end-of-life products (such as lamps, thermostats and others). As of today there is no infrastructure in Panama to separate elemental mercury contained in these products (current available technology allows only the separation of 'white' powder in lamps and storing it at the treatment facility). It is recommended to explore the possibility of incorporating distillation (retorting) technology in order to make a more efficient use of the future elemental mercury storage facility. Demand could be limited and is likely to decrease in time, as some mercury added products will be prohibited and will eventually disappear from the market. Meanwhile, it is likely that the consumption of some mercury added products will increase, as in the case of compact fluorescent lamps.

3.2.6 Developing a national storage and waste management action plan.

Panama has outlined three elements to be considered in its national action plan: 1) A regulatory framework, 2) Promotion and awareness of mercury management, and 3) Intersectoral partnerships. This is a reasonable way for Panama to approach its NAP, as for instance there are no economic sectors in Panama with significant releases, such as mining or chlor-alkali plants. This approach differs from the one followed by Mexico in which a more sector-oriented/waste stream approach was applied. Being a smaller

country than Mexico, Panama has chosen a useful approach in line with its characteristics, with sectors and waste streams included in Panama´s NAP under its three main elements.

Public sector institutions (government ministries) are the sole entities responsible for activities listed in the NAP. In this regard, it is recommended to involve additional stakeholders be involved as co-responsible entities along with the central government branches.

A further recommendation for Panama is the same as for Mexico: to continue the work within the NWG and to keep the group involved in the elaboration of the definitive National Action Plan.

3.2.7 Summary of recommendations for Panama.

It is recommended that Panama will :

- Review the regulatory framework for HW, and produce the appropriate legal instruments (including the necessary legal provisions applicable to developing a Pollutant Release and Transfer Register), taking into consideration the provisions in the Minamata Convention.
- Continue working on the mercury releases inventory as new and more solid data becomes available, including on sources not considered in the current inventory.
- Assess the structural conditions of the bunker(s) that are selected.
- Contact the owners/operators of the potential sites and inquire about their interest and the possibility of their becoming a storage facility.
- Explore the possibility of incorporating distillation (retorting) technology in Panama.
- Involve other stakeholders as co-responsible entities along with the central government branches in the drafting of the NAP.
- Maintain the NWG and involve its members in the process of selecting the best storage options, and elaborating the complete and definitive Panama's NAP.

4. CONCLUSIONS

A number of important results have been obtained via the implementation of the Mercury Storage and Disposal Two Countries Project in Central America (Mexico and Panama).

Some of these conclusions are similar to those obtained for the Argentina/Uruguay project, given that the same methodology was applied in both projects: First, in line with a key objective of the project, a pre-selection of potential sites for the temporary storage of mercury waste has been conducted. In Mexico, two existing waste management facilities have been identified as potential sites. In Panama, several sites were characterized as having a large potential of serving as facilities for the temporary storage of mercury waste: One site each was sought for elemental mercury and for mercury contaminated waste. It is important in this context to take into account that elemental mercury has to be separated from other waste (glass, metals, plastic, etc.) contained in the different mercury containing devices before being stored. It is therefore important to assess the need to establish/expand the necessary infrastructure for the separation of elemental mercury from mercury waste.

Each country has established the basis from which it can develop a comprehensive National Action Plan for the environmentally sound management of elemental mercury and mercury waste. Alternative approaches have been followed by each country. These variations reflect the existence of significant differences between Mexico and Panama in terms of their regulatory framework, number of waste generators, number of potential facilities, country extension, and so on.

Further important results include the acquisition of a more profound knowledge on the gaps and needs in terms of regulatory instruments in both countries. It is necessary to address these in order to ensure the environmentally sound management of mercury and mercury waste.

Panama has been able to update its 2004 Mercury Releases Inventory with data from 2011, applying the most recent version of UNEP's Toolkit for Identification and Quantification of Mercury Releases. In Mexico, it was important to bring together available data on mercury waste generation and compare the results obtained from different sources. Hence, there is a need to update available data. It is also important for Mexico to include representatives from the HW management private infrastructure in the discussions on potential solutions for the management of mercury waste.

It was also important for Mexico to include in its NAP a couple of activities which will prove crucial having signed the Minamata Convention. Moreover, the situation regarding primary mercury mining and ASSGM should be assessed.

Finally, it is important to stress the need to move ahead in the development and implementation of the National Action Plans in both countries, but especially in Mexico, engaging the stakeholders involved in each of the activities designed for the action plans.

ANNEXES

ANNEX A. FACILITY INVENTORY MATRIX

FACILITY INVENTORY FOR (COUNTRY NAME**):**	
General population data	
Population (number of inhabitants)	
Year and reference for population data	
GDP (Gross Domestic product)	
Year and reference for GDP data	
Main sectors in the economy of country (list)	
Contact point responsible for inventory	
Full name of institution	
Contact person	
E-mail address	
Telephone number	
Fax number	
Website of institution	

PRODUCTION AND PROCESSING FACILITIES WITH INTENTIONAL MERCURY USE

Manufacturing processes in which mercury is used	A. Address	B. Type of location	C. Land use	D. Type of property	E. Seismic zone	F. Geologic faults	G. Floodplains	H. Type of Aquifer	I. Type of soil	J. Vulnerable facilities	K. Cultural landmarks	L. Current Hg activities	M. Access
Chlor-alkali production with mercury-cells													
1													
2													
…													
VCM production with mercury catalyst													
1													
2													
…													
Acetaldehyde production with mercury													
1													
2													
…													
Other													
1													
2													
…													

COLUMN HEADINGS & CODES

A. Address. Write the postal address of facility

B. Type of location. Specify whether the facility is located in area type: urban 1, semiurban 2, rural 3

C. Land use. Land use where facility is located corresponds to: households 1, commercial 2, agricultural 3, industrial 4

C. Type of property. Specify if the facility is owned by a: private 1, public 2

D. Seismic zone: Is facility located in a seismic zone? Yes 1, no 2

E. Geologic faults. Is facility located on a geologic fault? Yes 1, no 2

F. Floodplains. Is facility located in a floodplain? Yes 1, no 2

G. Local aquifer. Is the aquifer under the facility: shallow? 1, deep? 2

H. Type of soil. The soil where the facility is located is: permeable 1, impervious 2

J. Vulnerable facilities. Are there any schools, hospitals, etc. near the facility? Yes 1, no 2

K. Cultural landmarks. Are there any cultural heritage, ancient ruins, etc. near the facility? Yes 1, no 2

L. Current Hg activities. Is facility currently carrying on any kind of Hg management? Yes 1, no 2

M. Access. Is access to facility (by road, railroad, etc): difficult? 1 adequate? 2

PRODUCTION AND PROCESSING FACILITIES WITH INTENTIONAL MERCURY USE

Manufacturing of Mercury-added products	A. Address	B. Type of location	C. Land use	D. Type of property	E. Seismic zone	F. Geologic faults	G. Floodplains	H. Type of Aquifer	I. Type of soil	J. Vulnerable facilities nearby	K. Cultural landmarks	L. Current Hg activities	M. Access
Hg thermometers (medical, air, lab, industrial etc.)													
1													
2													
…													
Electrical switches and relays with mercury													
1													
2													
…													
Light sources with mercury (fluorescent, compact, others:													
1													
2													
…													
Batteries with mercury													
1													
2													
…													
Manometers and gauges with mercury													
1													
2													
…													
Biocides and pesticides with mercury													
1													
2													
…													
Paints with mercury													
1													
2													
…													
Skin lightening creams and soaps with mercury chemicals													
1													
2													
…													
Dental amalgam with mercury													
1													
2													
…													

ENERGY CONSUMPTION & FUEL PRODUCTION

Energy consumption													
Coal combustion in large power plants	**A. Address**	**B. Type of location**	**C. Land use**	**D. Type of property**	**E. Seismic zone**	**F. Geologic faults**	**G. Floodplains**	**H. Type of Aquifer**	**I. Type of soil**	**J. Vulnerable facilities**	**K. Cultural landmarks**	**L. Current Hg activities**	**M. Access**
1													
2													
Other coal uses													
1													
2													
Combustion/use of petroleum coke and heavy oil													
1													
2													
Combustion/use of diesel, gasoil, petroleum, kerosene													
1													
2													
Use of raw or pre-cleaned natural gas													
1													
2													
Use of pipeline gas (consumer quality)													
1													
2													
Biomass fired power and heat production													
1													
2													
Charcoal combustion													
1													
2													
Oil extraction													
1													
2													
Oil refining													
1													
2													
Extraction and processing of natural gas													
1													
2													

Primary metal production	A. Address	B. Type of location	C. Land use	D. Type of property	E. Seismic zone	F. Geologic faults	G. Floodplains	H. Type of Aquifer	I. Type of soil	J. Vulnerable facilities	K. Cultural landmarks	L. Current Hg activities	M. Access
Mercury (primary) extraction and initial processing													
1													
2													
Mercury (secondary) extraction													
1													
2													
Production of zinc from concentrates													
1													
2													
Production of copper from concentrates													
1													
2													
Production of lead from concentrates													
1													
2													
Gold extraction by methods other than mercury amalgamation													
1													
2													
Alumina production from bauxite (aluminium production)													
1													
2													
Primary ferrous metal production (iron, steel production)													
1													
2													
Gold extraction with mercury amalgamation - without use of retort													
1													
2													
Gold extraction with mercury amalgamation - with use of retorts													
1													
2													
Other materials production													
Cement production													
1													
2													
Pulp and paper production													
1													
2													

HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES

TREATMENT FACILITIES	A. Address	B. Type of location	C. Land use	D. Type of property	E. Seismic zone	F. Geologic faults	G. Floodplains	H. Type of Aquifer	I. Type of soil	J. Vulnerable facilities	K. Cultural landmarks	L. Current Hg activities	M. Access
Thermal													
Incineration of municipal/general waste													
1													
2													
...													
Incineration of hazardous waste													
1													
2													
...													
Incineration of medical waste													
1													
2													
...													
Medical waste Autoclaving/microwaving													
1													
2													
Sewage sludge incineration													
1													
2													
Pyrolisis													
1													
2													
Physico-chemical													
1													
2													
Other													
1													
2													
RECYCLING FACILITIES													
1													
2													
TRANSFER STATIONS													
1													
2													
STORAGE FACILITIES													
1													
2													
FINAL DISPOSAL FACILITIES													
Sanitary landfills													
1													
2													
Security landfills													
1													
2													
OTHER: INDUSTRIAL WAREHOUSES,													
1													
2													

ANNEX B. REGULATORY FRAMEWORK MATRIX

REGULATORY FRAMEWORK ON MERCURY															
	A. Environmental standards	B. Mercury/products-waste/processes									C. Facilities				
Instrument type	Air, water, soil, biota	1. Source register	2. Import/ export	3. Trade	4. PRTR	5. Treatment/ recycling	6. Transport	7. Storage	8. Final disposal	9. Phase out	1. Releases	2. Land use	3. Authorization procedure	4. Inspection	5. EIA/ Risk
Local															
National															
Regional															
International															

A. ENVIRONMENTAL STANDARDS

Air, water, soil, biota. Refers to maximum Hg concentration limits in air, soil, water, biota (quality standards)

B. MERCURY/PRODUCTS-WASTE/PROCESSES

1. Source register. Refers to a register for all generators of hazardous waste, waste mercury

2. Import/export. Refers to regulations related to mercury/waste mercury import and export

3. Trade. Refers to domestic commercial operations for mercury and products with mercury

4. PRTR. Refers to a Pollution Release and Transfer Register which would include mercury.

5. Treatment/recycling. Refers to instruments related to these activities involving mercury/waste mercury

6. Transport. Refers to regulations related to mercury/waste mercury transportation

7. Storage. Refers to regulations related to any kind of mercury/waste mercury storage

8. Final disposal. Refers to regulations related to final disposal facilities for mercury/waste mercury

9. Phase out. Refers to regulatory measures establishing the phase-out of mercury containing products/processes involving mercury

C. FACILITIES

1. Releases. Refers to regulations related to maximum limits for Hg concentrations in releases to air, soil, water (emmission standards).

2. Land use. Refers to regulatory instruments related to land use, zonification, etc.

3. Authorization procedure. Refers to a procedure which defines the necessary steps to authorize a mercury/waste mercury management facility

4. Inspection. Refers to regulatory instruments stating the need to inspect a mercury /waste mercury management facility

5. EIA/Risk. Refers to regulation stating the need to elaborate an Environmental Impact Assessment and Risk Analysis studies for a mercury /waste mercury management facility

ANNEX C. STAKEHOLDERS' LISTS

Mexico

Name	Institution
M. ALEJANDRA ALTAMIRANO PACHECO	SECRETARÍA DE ECONOMÍA
ING. ALEJANDRO MERÍN	QUÍMICA WIMER
DR. ALEJANDRO RIVERA BECERRA	SECRETARÍA DE RELACIONES EXTERIORES
ING. ANA LILIA ALONSO MURILLO	CÁMARA NACIONAL DEL CEMENTO
DR. ARTURO GAVILÁN GARCÍA	INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
ING. ARTURO GUEVARA	CÁMARA NACIONAL DE MANUFACTURAS ELÉCTRICAS
ING. AYAX SEGURA PERALTA	CÁMARA NACIONAL DEL CEMENTO
ING. CÉSAR REYES LÓPEZ	COMISIÓN FEDERAL DE ELECTRICIDAD
M. ERICK JIMÉNEZ QUIROZ	COMISIÓN PARA LA COOPERACIÓN AMBIENTAL DE AMÉRICA DEL NORTE
M. en C. FAVIOLA ALTÚZAR VILLATORO	INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
ING. FRANCISCO DE JESÚS CAFAGGI FÉLIX	SERVICIO GEOLÓGICO MEXICANO
BIÓL. FRANCISCO NAVA NAVA	PROCURADURÍA FEDERAL DE PROTECCIÓN AL AMBIENTE
M. FRINEÉ KATHIA CANO ROBLES	INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
ING. GABRIEL E. MIRANDA GALINDO	COMISIÓN FEDERAL DE ELECTRICIDAD
LIC. GABRIELA MILÁN	SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES
DRA. GEORGINA FERNÁNDEZ VILLAGÓMEZ	FACULTAD DE INGENIERÍA
M. en I. GUSTAVO SOLÓRZANO OCHOA	CONSULTOR INTERNACIONAL PNUMA
ING. JESÚS IGNACIO LÓPEZ OLVERA	DGGIMAR-SEMARNAT
ANTROP. JOSÉ CASTRO DÍAZ	CONSULTOR AMBIENTAL
ING. JUAN OCTAVIO VALDIVIA GARCÍA	GRUPO CYDSA

Name	Institution
ING. LUIS ARTURO ESCORCIA LÓPEZ	SISTEMAS DE TRATAMIENTO AMBIENTAL
M. en C. LUIS EDUARDO DE AVILA RUEDA	SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES
LIC. MARÍA ASUNCIÓN CASTILLO PEDRAZA	SECRETARÍA DE ECONOMÍA
DRA. MARÍA EUGENIA RODRÍGUEZ GURZA	SECRETARÍA DE SALUD
ING. MARIO ALBERTO NÚÑEZ DÍAZ	PETRÓLEOS MEXICANOS
DR. MARIO ALBERTO YARTO RAMÍREZ	CONSULTOR NACIONAL DEL PROYECTO
ING. MARIO HERRERAMORO CASTILLO	COLEGIO DE INGENIEROS GEÓLOGOS DE MÉXICO
M. en B. MARTHA RAMÍREZ ISLAS	INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
LIC. NAYHELY PÉREZ BÁEZ	SECRETARÍA DE ECONOMÍA
ING. PEDRO MARTÍNEZ MURILLO	SERVICIO GEOLÓGICO MEXICANO
ING. ROBERTO AYALA PERDOMO	SECRETARÍA DE SALUD
ING. SALOMÓN ROJAS P.	TECNOLOGÍA AMBIENTAL ESPECIALIZADA
ING. TONATIUH R. GARCÍA ALDANA	ASOCIACIÓN MEXICANA DE PILAS
M. en C. VÍCTOR ALCÁNTARA CONCEPCIÓN	INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO
BIÓL. YENI BETZABET AYALA FERNÁNDEZ	SECRETARÍA DE SALUD DEL GOBIERNO DEL DISTRITO FEDERAL

Panama

Entity	Stakeholders	Area of Interest/competencies
Government	Ministry of Health (MINSA)	The area of interest is public health. The competencies include the governance and regulation (issuing policies, standards, surveillance and control) of hazardous wastes in order to protect human health and the environment. Must develop and implement policies on hazardous wastes in coordination with the National Environmental Authority.
	National Environmental Authority (ANAM)	The area of interest is the environment and its competencies include establishing of principles and rules for the protection, conservation and recovery of the environment, thus promoting sustainable use of natural resources. In addition, it regulates environmental management, integrating it to social and economic objectives in order to achieve sustainable human development in the country. This is done through the development of standards for the management of hazardous waste as well as the monitoring of its implementation and the control of environmental pollution. In coordination with MINSA it develops and implements policies on hazardous wastes.
	Ministry of Commerce and Industry (MICI)	The area of interest is the international and domestic trade and its competencies are related to the development and implementation of policies to facilitate trade in accordance with international guidelines; likewise, it has the authority to establish technical standards through the General Directorate of Technical Standards (DGNTI) in coordination with relevant institutions.
	National Customs Authority (ANA)	In charge of the exchange and foreign trade relations of the Republic of Panama. Its responsibilities are to enforce customs duties, regimes and customs procedures and to implement policies related to customs control, and protection of health, environment, intellectual property, national heritage and others that are applicable to foreign trade, including rules on customs provided by international trade agreements or treaties, either bilateral or multilateral. All that in compliance with national laws and in coordination with the competent authorities or authorizing agencies.
	Ministry of Public Security	Its mission is to determine the country's security policies, as well as plan, coordinate, monitor and support the efforts of all security and intelligence agencies that integrate the Ministry. Its responsibilities include maintaining and defending national sovereignty, ensure security, peace and public order in the country and protect the life, honor and property of their nationals and foreigners under their jurisdiction.
	National Assembly	The area of interest is the benefit of the Nation. Their responsibilities are to issue the necessary laws for fulfillment of the purposes and exercise of the State functions declared in the Constitution.
	Authority of Urban and Household Sanitation (AAUD)	In charge of the urban and household sanitation. Its responsibilities are to manage, plan, explore, exploit, investigate, inspect and audit services related to urban sanitation, commercial and household as well as landfills. It is also responsible for the comprehensive management of solid wastes, including its handling, exploitation, utilization and disposal; and the development of a waste policy as a guideline for the prevention and control of pollution of the environment and the protection of public health.
	University of Panama (UP)	The interest of the UP is to generate and disseminate knowledge, research, comprehensive training, scientific, technological and humanistic. Its responsibility is the academic management of the university studies.
	Technological University of	The interest of the UTP is scientific and technological higher

	Panama (UTP)	education. Its competency is to organize and implement careers for the formation of professionals of technical levels, undergraduate, graduate and any other that is characteristic of higher education, adjusting their plans, programs and activities for the purposes and needs of the Panamanian social reality.
Private entreprise	Industrial Union of Panama	It represents and defends the interests of national industry. Its competency is to provide communication, information and education among and to its affiliates, facilitating orientation of the national industry to today´s changing world, and improving their competitive advantages.
	Chamber of Commerce, Industry and Agriculture of Panama	The interest is to unify efforts in an organized manner in order to achieve the improvement of commercial and service activities in the country. Its responsibility is to provide various services to its members that contribute to the full development of their business activities. Among other services, the Chamber defends the interests of members in relation to measures affecting the principle of free enterprise and entrepreneurship.
	National Council of Private Enterprise	The interest is to unite, coordinate and represent business organizations to strengthen the private sector. Its responsibilities are to boost the economy and promote social, economic and political transformation in the country and its international projection.
	Mercury waste generators	The interest is to provide services to the community, which may be commercial or industrial. As generators of hazardous wastes, its competency is to manage waste in an environmentally sound manner, using the services of a company engaged in the business of collection, transportation, treatment and/or disposal.
Civil society and NGOs	Panamanian Dental Association	Nonprofit association that regulates private and institutional practice and represents the interests of organized dentistry nationally. Its aims are a) betterment of the dentistry profession in all its aspects, b) promote the oral health of the community and c) encourage professional and guild relations among all the dentists in the country.
	NGOs	Nonprofit civil organizations, usually of environmental and social nature. Among their responsibilities are the promotion of information, training, and partnerships with private companies and communities, including partnerships with other NGOs, with the aim of instilling a comprehensive management of solid, hazardous and toxic waste and recyclable materials and serve as reference point wherever possible for similar initiatives in other countries.
	Associations, environmental organizations and civil society in general	They typically are of a social nature. They can review and be consulted on projects that may affect human health and the environment based on the authority granted by the General Environmental Law.