Towards Auditing Waste Management

Adopted by the Eighth Meeting of
the INTOSAI Working Group on Environmental Auditing

Frontpage photo: Joe Cavanagh, NAO
Prepress and printing: MacCompaniet as
ISBN 82-90811-41-1

Foreword

At its 2001 meeting in Ottawa, Canada, the Working Group on Environmental Auditing (WGEA) of the International Organization of Supreme Audit Institutions (INTOSAI) adopted waste management as one of the central themes of its 2002-2004 Work Plan.

In 2002, at the first WGEA Steering Committee meeting in London, England, the Office of the Auditor General of Norway presented a proposal for a background paper on waste management in support of SAI environmental audit activities. In January 2003, the first draft of the paper was discussed at the WGEA Steering Committee meeting in Costa Rica. The Steering Committee's comments were incorporated into the second draft that was presented at the eighth WGEA Assembly in Poland in June 2003 and approved as a formal WGEA document.

Toward Auditing Waste Management gives an overview of waste management issues and provides supreme audit institutions (SAIs) with the information they need to conduct audits in this area. This paper is available on the WGEA Web site under WGEA Publications (www.environmental-auditing.org).

We would like to thank the Auditor General of Norway, Bjarne Mørk-Eidem, for having taken on this project as well as the study team under the direction of Øivind Berg Larsen – Lillin Knudtzon, Sissel Iversen, Alfred Martinovits and Frank Ebbesen – for their dedicated work on the development and completion of the paper. We would also like to extend our thanks to the WGEA members and other SAIs for their contributions to the paper.

We believe this paper will be a useful starting point for any audits of waste management.

Sincerely,

Sheila Fraser, FCA
Chair of the INTOSAI WGEA

Johanne Gélinas
Associate Chair for the INTOSAI WGEA

Morten Løberg / Samfoto

Table of Contents

Henrik Sørensen / Samfoto

Executive Summary

Waste is a major concern in all parts of the world

Contamination caused by waste is rated by the United Nations Environmental Programme as an environmental issue that is important or critically important in all areas of the globe. If waste is not handled in a satisfactory manner, it poses great danger to the environment and the well-being and health of humans and animals. Radioactive waste can be lethal and pollute large areas for centuries to come. Medical waste can promote the possible spread of diseases and infections. Hazardous waste may cause illness and loss of life. Illegal dumping and mismanaged landfills are unsightly and smelly, and they can contaminate soil and water. Burning waste pollutes the air.

Pollution does not recognise national borders and this has led to establishing of a number of international agreements. The international accords that are currently in force typically cover nuclear and hazardous waste and regulate the transboundary movement of waste.

Classification and handling of waste

Waste is a product that is no longer suited for its intended use. It may be worn out, or it may be an unwanted by-product of a process. This definition goes further than the more intuitive one because it also includes fully usable substances that are of no use to the present owner.

There are many ways of classifying waste. For the legislator, and thus for the SAI, the distinction between hazardous and non-hazardous waste may be the most important because different regulations usually apply to different types of waste. Special kinds of hazardous waste include clinical/medical waste, electronic and electrical equipment, and radioactive waste. In this paper, the following main types of waste have been used in the presentation: solid, hazardous, and radioactive.

Different kinds of waste require different treatment and final handling, due to both the physical and chemical composition of the waste and the levels of dangerousness. The composition will have an impact on the collection process and on whether the waste can be used for energy-production, composting etc.

Public responsibility

The problems created by waste require practical solutions and policies. Countries regulate the handling of waste with legal measures, and authorities at various levels inspect and monitor the operations of waste generators, transporters and handlers. Nuclear and hazardous waste are often subject to more stringent monitoring than solid waste. Individual citizens, especially in urban areas, do not handle their own waste after the initial stages. Thus, it is important that the waste collection and treatment services be conducted in a fair, effective, efficient, and environmentally sustainable manner.

Supreme Audit Institutions may play a key role in improvement of waste management

Supreme Audit Institutions (SAIs) are put in a unique role when it comes to auditing waste management. Deficiencies in a country's waste management systems are a matter of national importance and therefore of interest to the SAI. By exposing the insufficiencies, the SAIs may help improve the quality of waste management, and through this the national and international environment. This is already recognised, and during the years 1997–99 the INTOSAI members produced more than 100 audit reports on waste, in at least 49 different countries. In 2000, as many as 20 % of the SAIs reported that they were planning audits on waste in the next three years.

Choosing focus for the audits and getting started

For the SAIs that have not yet conducted audits on waste, or for those that want to take a fresh look at the issues, a four-step procedure is proposed. In step one, it is recommended that environmental and health-risk scenarios be developed to determine the areas that have the highest materiality and risk. Then the various actors and their responsibilities should be identified, pursuant to national and international law. The responsible actors may differ with the type of waste.

In searching for the most relevant audits, in step three, it is beneficial to analyse the waste stream, which identifies the eight stages that waste may pass through (prevention, generation, recycle/reuse/recover, collection, transport/export,

treatment/disposal, contaminated sites, and illegal dumping). For each stage in the waste stream, there should be policies and corresponding instruments devised to handle it.

When focusing on which individual audits to perform, the following generic audit topics and questions are suggested:

- The existence of waste policy – are all stages of the waste stream covered by policy documents and are these documents consistent with the general environmental policy?
- Compliance with national environmental policy – have the policies relating to waste management been reflected in concrete terms in legislation/regulations?
- Risk management – are risks sufficiently managed?
- Quality of the implementation process – are the policies implemented effectively? Are environmental impact assessments being carried out?
- Performance of the waste management system – are responsibilities delegated to appropriate bodies? Do the responsible agencies have the necessary instruments? Are these instruments put to efficient use?
- Compliance with national laws and regulations – are the relevant actors complying with the national rules and procedures?
- Compliance with international obligations – are the policies, legislation and practices in compliance with international obligations and agreements?
- Monitoring – are the necessary and required monitoring systems in place and working efficiently?
- Effects of other government activities – are all government activities managed according to the legislation and regulations relating to waste management?

The way forward in the audit of waste management

In 2001, the INTOSAI Working Group on Environmental Auditing decided to make "waste" a second key theme. It also decided to continue the focus on the original key theme of "water". Based on the paper here presented, The Working Group recommends that the Supreme Audit Institutions of the world consider auditing waste management and the systems used to regulate and control this issue in the next work plan period (2005–07). This joint effort will ensure a focus on this world scale problem and will help to improve the environment.

0 Introduction

Waste is a continually growing problem, globally, regionally, and locally. The handling of waste, e.g. through incineration or landfills, usually leads to discharges into the soil, air, and water and is a source of global and local pollution. The problem is accelerated by trends in consumption and production patterns and by the continuing urbanisation of the world. The costs associated with the proper handling of waste make it profitable to ignore waste treatment and to dispose of waste in a way that is dangerous to human health and the environment. Illegal dumping and unauthorised exports are examples of criminal activities associated with the handling of waste.

The problem has been given increased attention by international and national policy making bodies and citizens.

0.1 International awareness regarding waste

At the 1992 Rio Conference, waste was made one of the priorities of Agenda 21[1] with specific attention given to ensure the environmentally sound management of toxic chemicals, including the prevention of illegal international traffic in toxic and dangerous products, the environmentally sound management of hazardous wastes, the environmentally sound management of solid wastes and sewage-related issues and the safe and environmentally sound management of radioactive wastes.

At the Johannesburg World Summit on Sustainable development in 2002, the focus was on initiatives to accelerate the shift to sustainable consumption and production, and the reduction of resource degradation, pollution and waste. The implementation plan was adopted by the Summit[2], and has a paragraph (22) that states the priority to:

"Prevent and minimize waste and maximize reuse, recycling and use of environmentally friendly alternative materials, with the participation of government authorities and all stakeholders, in order to minimize adverse effects on the environment and improve resource efficiency, with financial, technical and other assistance for developing countries. This would include actions at all levels to:

(a) Develop waste management systems, with the highest priority placed on waste prevention and minimization, reuse and recycling, and environmentally sound disposal facilities, including technology to recapture the energy contained in waste, and encourage small-scale waste-recycling initiatives that support urban and rural waste management and provide income-generating opportunities, with international support for developing countries;
(b) Promote waste prevention and minimization by encouraging production of reusable consumer goods and biodegradable products and developing the infrastructure required."[3]

The world faces a number of major challenges to its environment. In Global Environmental Outlook,[4] the United Nations Environmental programme has assessed the relative importance of environmental issues within and across regions. A summary of this assessment is reproduced in figure 1 (next page).

As can be seen the issue of urban and industrial contamination and waste is rated to be critically important or important in all areas of the globe.

0.2 The INTOSAI WGEA[5] recommends auditing waste

Audits help raise awareness of the problems addressed. Auditing waste management systems is a way to help reduce the problems caused by waste in

[1] Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally and was adopted by more than 178 Governments at the UN Conference in Rio de Janeiro. (UN Sustainable Development web page http://www.un.org/esa/sustdev/agenda21.htm)
[2] At the 17th plenary meeting on 4 September 2002
[3] UN Report of the World Summit on Sustainable Development IU, Document A/CONF.199/20, p. 19. (http://www.johannesburgsummit.org/index.html)
[4] Global Environmental Outlook-1, United Nations Environmental Programme, Global State of the Environment Report 1997. (http://www.grida.no/geo1/exsum/ex3.htm)
[5] Working Group of Environmental Auditing

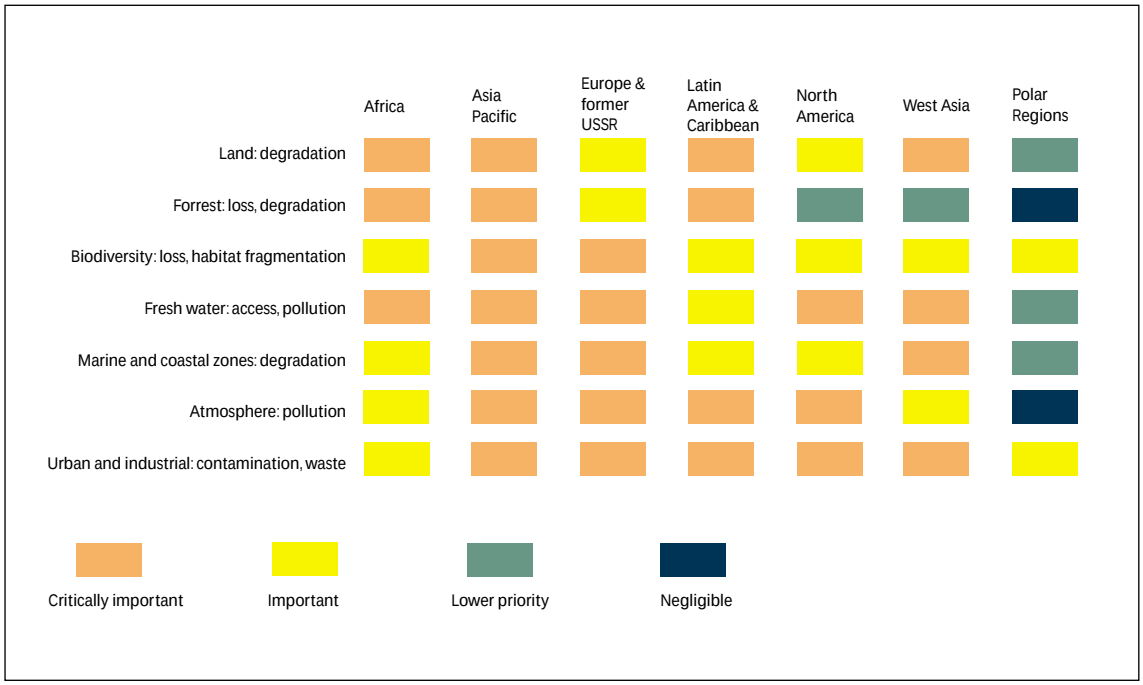


Figure 1: Relative importance of environmental issues within and across regions (Global State of the Environment Report 1997)

a country by revealing the shortcomings of the management system and the responsible actors and identifying areas that need improvement.

Individual citizens, especially in urban areas, do not handle their own waste all the way to final disposal. In most cases, specialised companies owned by or acting on behalf of the authorities do the handling. The monopoly inherent in this situation makes it essential that outside evaluators ensure that the service is provided in a fair, effective, efficient and environmentally sustainable manner.

The INTOSAI Working Group on Environmental Auditing has had "water" as its key theme since 1996. At its seventh meeting in Ottawa, Canada in September 2001, the Working Group decided to adopt "waste" as a second key theme. In the third questionnaire conducted by the Working Group, 65% of the Supreme Audit Institutions (SAIs) identified waste as the most pressing environmental problem together with fresh water (also mentioned by 65%).

Based on the paper presented here, the Working Group recommends that the Supreme Audit Institutions of the world consider auditing waste management and the systems used to regulate and control this issue in the next work plan period (2005–07). This joint effort will ensure a focus on this world scale problem and will help to improve the environment.

0.3 Content and structure of this document

The main objectives of this paper are to increase knowledge about auditing waste management by surveying different approaches to the problem and to inspire more audits in this field. The paper should help lower the threshold for commencing audits and encourage SAIs, with or without prior experience, to audit various aspects of their country's waste management. The paper contains a large selection of problem areas that can be focused on, and it is our hope that it will induce auditors to approach the audit of waste from new angles, and to prompt the many countries that have yet to do waste audits to get started in this important field.

Chapter one presents concepts and definitions related to waste and the environmental and health problems caused by waste. The life cycle of a product and the stages that waste passes through in the waste stream are discussed.

Chapter two presents the key international conventions and standards related to waste, the most important of which is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. Conventions regulating nuclear and non-hazardous waste are also presented.

Chapter three gives examples of the waste management systems in several different countries, and fo-

cuses on how the structures of authority may be established at the national, regional and/or local level. The forth chapter of the paper discusses how to select a focus for an audit of waste management for your SAI. An approach, which includes a four-step-procedure, is presented.

In chapter five, the experiences gained in the INTOSAI community from waste management audits are presented. The problem areas from an audit viewpoint constitute the framework for the presentation of the audits. Financial, compliance, and performance audits are covered.

Appendix 1 provides a thorough background orientation on this subject, including a presentation of important problems related to waste, and a description of waste-handling systems. Concepts and definitions related to waste are discussed.

Appendices 2–8 contain figures depicting organisational charts of waste management systems in Canada, China, Norway, and Poland.

Leachate from sanitary landfill. Kiyoshi Okamoto, IDI

Jørgen Schytte / Samfoto

1 Background Orientation on Waste[6]

1.1 What is waste?

The actual definition of waste can vary from country to country, but most legal definitions of waste can be summarised as a product or a substance that is no longer suited for its intended use. This definition goes further than the layman's definition, which is often restricted to something that no longer functions properly. The legal definition often includes fully usable substances, but defines them as waste if they are to be used in contexts other than their originally intended one.

1.2 Problems caused by waste

Most countries recognise that environmentally sound waste management is an issue of major concern. For both developing and developed countries, waste management is an important factor in safeguarding human health and environmental protection.

Unsatisfactory handling of waste can lead to the contamination of soil, surface water, groundwater and air. Some examples are:

- Soil can be contaminated with toxic components,
- Leachate[7] from waste can pollute surface water and groundwater

[6] Much of this chapter is based on a report from the Norwegian Resource Centre for Waste Management and Recycling prepared for the Office of the Auditor General of Norway. More of the report is found in appendix 1.

[7] Water that dissolves contaminants as it trickles through waste disposed of in a landfill. Leaching may result in hazardous substances entering surface water, ground water or soil.

Henrik Sørensen / Samfoto

- Uncontrolled burning of waste produces toxic and carcinogenic gases
- Leaks of radioactive substances can contaminate the air and soil

Furthermore, insufficient waste handling and emissions can have negative impacts on public health, exemplified by:

- The transmission of diseases and infections by rodents, vector insects, etc.
- Birth defects caused by exposure to polluted drinking water
- Cancer caused by radiation exposure
- Respiratory problems caused by waste sorting, uncontrolled burning of waste, etc.
- Odour, littering, unsightliness, noise, etc.

Sanitation workers and people who come into direct contact with waste can also be directly affected through skin contact. Cuts and bruises allow harmful substances to enter the blood stream, and these substances can also enter the body through the digestion system if a worker's personal hygiene is unsatisfactory.

1.3 Waste categories

Many parameters can be used to describe and categorise waste, and depending on your role with regard to waste, some will be more important than others. For a legislator, the distinction between hazardous and non-hazardous waste may be the most important parameter, since legislation relating to hazardous waste is usually stricter than for non-hazardous waste. Likewise, the distinction is useful for auditors because the different legislation is usually accompanied by different organisational structures and different uses of policy instruments.

Non-hazardous waste is often called "solid waste". Waste in the form of powders, fluids, and gasses is considered hazardous regardless of its toxic properties because it needs special handling to avoid unwanted dispersal. Thus, all waste that is not included under the classification of hazardous may be labelled solid. Although not considered hazardous, solid waste can cause considerable harm and damage, and may lead to diseases and air pollution and the poisoning of water sources for people and animals.

Hazardous waste poses a threat to human health and the environment if it is not handled properly. For this reason, many countries have strict regulations governing the storage, collection and treatment of hazardous waste. Much hazardous waste originates from industrial production.

Clinical/medical waste is a form of hazardous waste and involves waste from the treatment of diseases in humans and animals. This type of waste typically consists of medicines, sharp objects, bandages, body fluids and body parts, and usually contains bacteria and other organisms that can spread harmful diseases if not properly handled.

Electronic and electrical equipment (EE waste) is another type of hazardous waste. The materials used in these products (PCB, lead, quicksilver, cadmium and brominated flame-retardants) can cause damage if not treated properly. This type of waste is relatively new and is rapidly increasing in dispersal and quantity. Insufficient treatment of this waste will cause contamination of the soil, water and air and may pose a special health risk for sanitary workers.

The five symbols in figure 2 are examples of symbols that are used to designate products with hazardous properties.

Radioactivity is a hazardous property, because exposure to radiation can cause serious illness, or even death. Many radioactive substances are also highly toxic. In general, radioactive materials are only available to scientists, nuclear power plants, and other users who have a specific need for radiation in their work. However, stolen or illegitimately sold nuclear/radioactive waste can be a potent weapon in the wrong hands and necessitates high alertness with

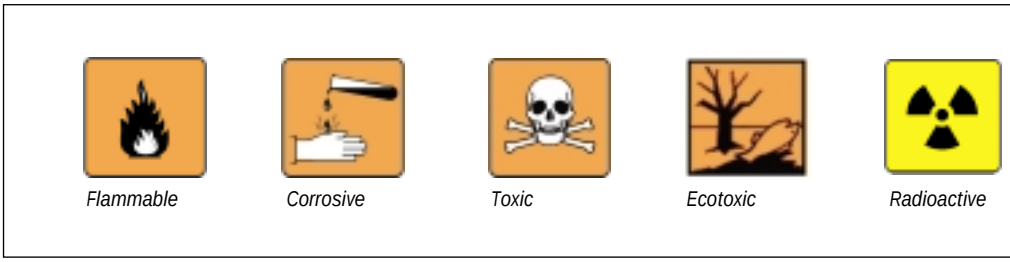


Figure 2: Examples of hazardous properties

regard to security. The management of radioactive waste differs significantly from the management of solid and other hazardous waste. For this reason, radioactive substances are dealt with separately in this paper.

Thus, we have the following main types of waste: solid, hazardous, and radioactive.

1.4 Life cycle of a product

The life cycle of a product is the process in which raw materials are turned into products, consumed, and eventually discarded. Thereafter, the waste can be reused, recycled, or disposed of. Although highly simplified, the principles described below apply to most products and waste, whether hazardous or non-hazardous.

The chart in figure 3, depicts six phases in the life cycle of a product:

In (1) raw materials or natural resources are manufactured into products, which are eventually discarded (2).

(3) Shows reuse, while (4) depicts recycling. Reuse means that a discarded product is reused in the same way as it was used when it was a product. If an empty soda bottle is washed and filled with new soda, that is called reuse, but if it is crushed, melted, and used to produce windowpanes or woven glass fabric, that is called recycling. Waste can also be used as a fuel, to generate energy (5).

In (6) waste is transformed into a natural resource, e.g. when food and/or organic matter is composted. At times (4) and (6) may overlap.

(7) Shows that some waste cannot be reused or recycled, leaving no choice but to dispose of it. In many cases, this means landfills with or without prior treatment, but destruction and/or incineration without energy recovery are also regarded as means of final disposal.

1.5 The waste stream

As we have seen, each product has a lifecycle that generates waste at a certain point in time. In figure 3, the activities related to the products are depicted as arrows. In a corresponding figure based on the waste stream, arrows might be used to indicate the direction between the stages in which waste is handled (figure 4, page 16). The dotted lines indicate illegal or unwanted occurrences.

Figure 4 shows the physical stages through which waste passes and is useful in order to gain an overview of the waste management process. The first stage in the waste stream is prevention. The ambition of preventing waste generation is linked more to waste policy than to actual waste handling, but has a place in the waste stream nonetheless.

The second stage is the generation of waste. Typical waste generators are households, industry, hospitals, commercial businesses, and public entities.

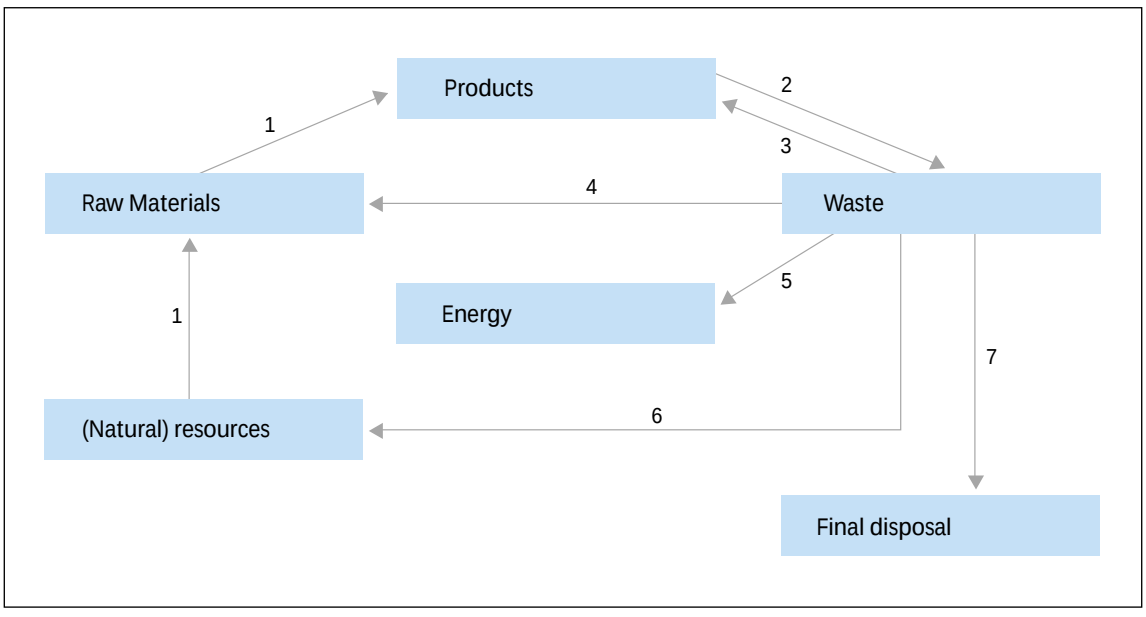


Figure 3: Life cycle of a product

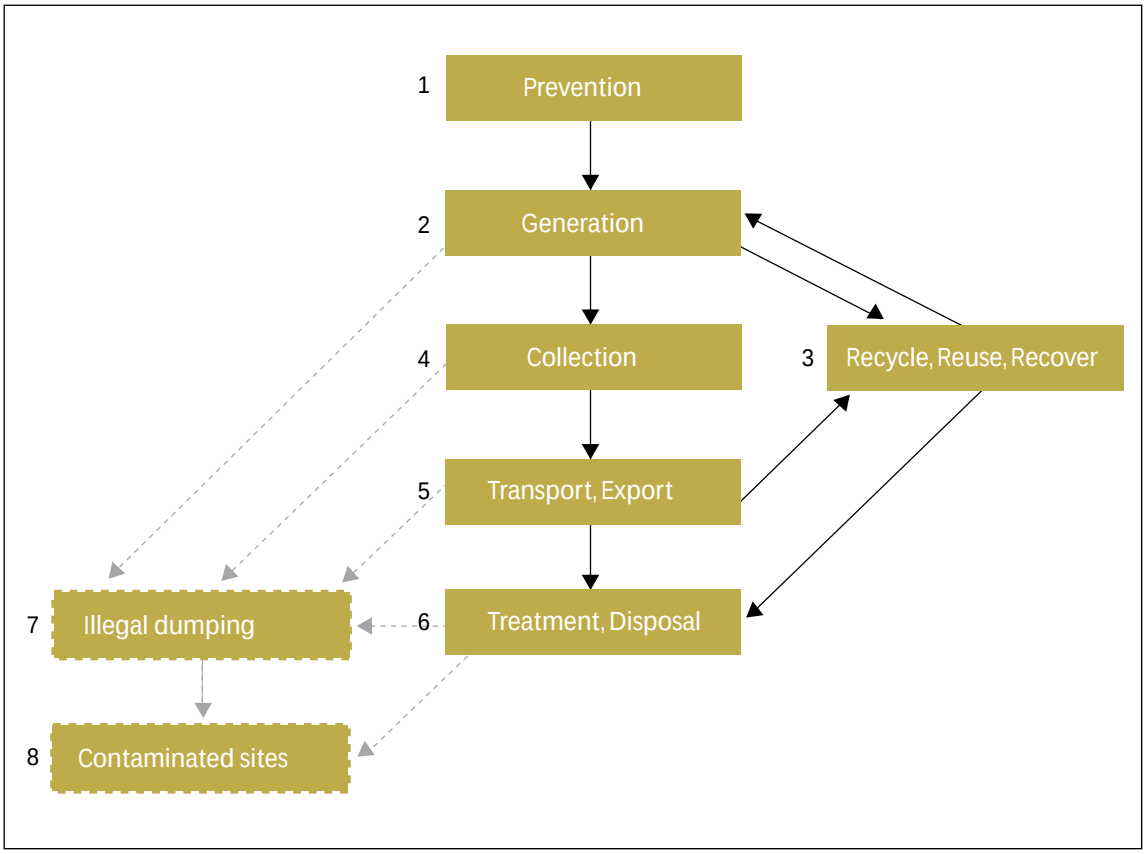


Figure 4. The waste stream

They generate different types of waste with regard to composition and substances.

The third stage of the waste stream covers the three Rs: Recycle, Reuse and Recover. These are approaches to waste treatment and may occur internally within the activities of the waste generator (indicated with the direct arrow between Generation and the three R's), or organised externally after the collection and transport stages. Reusing and recycling are ways of recovering material. In addition, there is energy recovery and recovery of raw materials (composting).

There are several reasons for recovering as much of the waste as possible: it reduces the amount of waste sent for final disposal and thereby reduces the need for transport and disposal; it makes use of valuable resources in the waste and thereby reduces the use of virgin raw materials.

The collection of waste is a stage that applies to only some of the waste that is generated, depending on the producers, and applies mainly to waste from households and small commercial businesses. This stage also includes the return of products to the source. Producer Responsibility is a growing trend and implies, for instance, that electrical and/or electronic devices with hazardous components (EE-waste) can be returned to the producer or to the shop that originally sold them.

Stage five is the transport and export of waste. The waste generators that are not users of the collection of waste, such as large businesses, industries, and hospitals, need to transport their waste to a site for safe treatment. The collected waste also needs to be transported. Some types of waste might be exported. Because of the special properties of hazardous waste, special precautions must be taken during collection and transport, involving the training of the driver and co-driver, the types of packaging to be used, and the labelling of the packaging and the transport vehicle.

The treatment and disposal of waste is stage six. Treatment and disposal often take place at the same physical location, but may also be two (or more) operations that require transport between them. Nevertheless, this is the preferred end station for the waste, and secure handling here is of paramount importance.

To reduce or eliminate the hazardous properties of waste, treatment is required. The two main approa-

Recycling project. Curt Carnemark / Mira / Samfoto

ches are thermal destruction (conversion into harmless components at high temperatures) and chemical treatment (such as the stabilisation of mercury by converting it to a sulphide). Neutralisation is an option in the treatment of acids and alkalis. When mixed in the right proportions acids and alkalis neutralise each other, and the products of this process are often relatively harmless.

Disposal at landfills is the most common solution for handling either all of the waste or the residual waste that cannot be treated as a part of other waste-processing methods, such as composting, incineration, recycling etc. There is a wide range of landfills varying from open, uncontrolled dumps to sanitary landfills that are a fully acceptable environmental solution. The main differences are in the way they are operated and the level of adverse environmental effects they produce.

Sometimes the waste is illegally dumped, and that constitutes stage seven. Illegal dumping may occur at waste disposal sites, on private or public land or in the sea. This may involve the large-scale dumping of inert wastes, such as medical waste or chemicals, or litter in the form of small quantities of non-hazardous waste.

Operator hoists waste in an incineration. Sigmund Krøvel-Velle / Samfoto

Tanks of chemicals for shipping by boat labelled with signs. A numeric code indicates the contents. Espen Bratlie / Samfoto

Illegal dumping of waste will often result in stage eight – contaminated sites. Likewise, if the disposal of waste is not conducted properly the result will be contaminated sites. These sites may still be in use or they may have been used for dumping of waste at some earlier time.

At each of these eight stages, the government may intervene to ensure sound management. A good waste policy should include all of the stages through which waste passes. The waste stream determines the premises for an audit of waste management, as we will return to, in chapter 4.

2 International Agreements on Waste

The environment is of global interest and importance. Pollution does not recognise national borders and is transported freely between countries and continents. The international community has recognised this fact, and a number of attempts to improve the environment have been recorded in ink during the last few decades. The most relevant of these agreements regarding waste will be presented below. These may be regarded and used as a source of audit criteria when auditing waste and waste management systems.

Relevant Internet sites and the Yearbook of International Co-operation on Environment and Development[8] are used as sources in this presentation, and give more details and references to agreements on environment and development.

2.1 Delimitation

Waste can constitute a raw material when recycled and reused. Scrap metal is typically used for new construction. Using this line of reasoning, a specific type of waste may be defined as a "product" or a "good" and thus come under the jurisdiction of the World Trade Organization (WTO). This may be one way of circumventing the strict regulations laid down regarding waste and relegating it to the sphere of trade regulations. Although this paper does not include trade agreements, auditors should bear in mind that they may nevertheless be relevant as a source of audit criteria.

2.2 Agreements including non-hazardous/solid waste

Legislation concerning waste is usually differentiated according to the type of waste. International conventions often cover nuclear and hazardous waste, whereas non-hazardous waste, often called solid waste, is more usually regulated at the national level. However, there are a few international conventions that also cover non-hazardous waste. These are presented below.

2.2.1 The OECD decision C(2001)107/FINAL[9]

The Organisation for Economic Co-operation and Development (OECD) has instituted binding agreements for its member countries (30 states) regulating the transboundary movements of waste destined for recovery operations.

Between 1984 and 1992, eight OECD Council Acts were adopted covering waste identification, definition, and control of transboundary movements of waste. Seven of these Acts are currently being consolidated and updated[10] with the ultimate goal of developing a global control system for waste movements.

The control system aims to facilitate the trade of recyclables in an environmentally sound and economically efficient manner by using a simplified procedure and introducing a risk-based approach to assessing the necessary level of control of materials. Waste exported to countries outside the OECD area, whether for recovery or final disposal, are not subject to this simplified control procedure.

The OECD control system is based on two types of control procedures:

- Green Control Procedure: for waste that poses a minor threat to human health and the environment and are consequently not subject to any other controls but those normally applied in commercial transactions
- Amber Control Procedure: for waste that poses a sufficient risk to justify their control.

The relevant national authorities and customs offices carry out the control of waste shipments when appropriate with notification and movement documents.

2.2.2 London Convention[11]

The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter is a global agreement that was drawn up at the Inter-

[8] Yearbook of International Co-operation on Environment and Development 2002/2003, London, Earthscan Publications Ltd, London. Home page http://www.greenyearbook.org
[9] The OECD home page: http://www.oecd.org
[10] OECD Council Act [C(2001)208]
[11] The London Convention home page: http://www.londonconvention.org

Governmental Conference on the Dumping of Wastes at Sea in London in 1972. The Convention entered into force in 1975. The objective of the Convention is to prevent pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea[12].

In 1993, parties started a detailed review of the London Convention. This review was completed with the adoption of the 1996 Protocol to the London Convention 1972, which, when entered into force, replaces the London Convention. By 31 May 2002, there were 78 Parties to the convention.

2.2.3 The MARPOL Convention[13]

The MARPOL Convention for the Prevention of Pollution from Ships is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 and has been updated by amendments over the years. The Convention was adopted in 1978 at the International Maritime Organization (IMO). It entered into force in 1983. The key objectives of the Convention are:

- To eliminate pollution of the sea by oil, chemicals, harmful substances in packaged form, sewage, garbage and other harmful substances that might be discharged in the course of operations;
- To minimise the amount of oil that could be released accidentally by ships, including also fixed or floating platforms.
- To improve further the prevention and control of marine pollution from ships, particularly oil tankers[14] .

By 31 May 2002, there were 121 Parties to the Convention. Thirty-five states have made exceptions for some of the annexes.

2.3 Agreements regarding hazardous waste

In the late 1980s, a tightening of environmental regulations in industrialised countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheaper ways to get rid of this type of waste, "toxic traders" began shipping hazardous waste to developing countries and to Eastern Europe. Once this was discovered, international work was started to restrict these activities.

2.3.1 Basel Convention[15]

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal is a global agreement addressing the problems and challenges posed by hazardous waste. The key objectives of the Basel Convention are to minimise the generation of hazardous waste in terms of quantity and hazardousness, to dispose of them as close to the source of generation as possible and to reduce the movement of hazardous waste. By 1 July 2002, there were 151 Parties to the Convention.

During its first decade (1989-99), the Convention was principally devoted to setting up a framework for controlling the transboundary movements of hazardous waste, that is, the movement of hazardous waste across international frontiers. It developed criteria for "environmentally sound management". A control system, based on prior written notification, was also put into place.

Environmentally sound management (ESM) is a central goal and means taking all practical steps to minimise the generation of hazardous waste and strictly control its storage, transport, treatment, reuse, recycling, recovery, and final disposal, for the purpose of protecting human health and the environment.

One of the guiding principles of the Basel Convention is that, in order to minimise the threat, hazardous waste should be dealt with as close to where it is produced as possible. Therefore, under the Convention, transboundary movements of hazardous waste or other waste can take place only upon prior written notification by the state of export to the competent authorities of the states of import and transit (if appropriate). Each shipment of hazardous waste or other waste must be accompanied by a movement document from the point at which a transboundary movement begins to the point of disposal. Hazardous waste shipments made without such documents are illegal.

During the coming decade (2000–10), the Convention will build on the framework from 1989–99 by emphasising full implementation and enforcement of treaty commitments. The other area of focus will be the minimisation of hazardous waste generation. Recognising that the long-term solution to the stockpiling of hazar-

[12] London Convention, Article 1
[13] International Maritime Organization (IMO) home page, http://www.imo.org/home.asp
[14] Yearbook of International Co-operation on Environment and Development 2002/2003, Earthscan Publications Ltd, London, page 123
[15] This summary and the paragraph above are extracts from the home page of the Basel convention; http://www.basel.int

dous waste is reduction of the generation of that waste – in terms of both quantity and hazardousness – a ministers' meeting in December 1999 set out guidelines for the Convention's activities during the next decade, including:

- active promotion and use of cleaner technologies and production methods
- further reduction of the movement of hazardous and other waste
- the prevention and monitoring of illegal traffic
- improvement of institutional and technical capabilities – through technology when appropriate – especially for developing countries and countries with economies in transition
- further development of regional and sub-regional centres for training and technology transfer

The guidelines for the Convention's activities led to the Draft Strategic Plan. The plan takes into account existing regional plans, programmes or strategies, the decisions of the Conference of the Parties and its subsidiary bodies, ongoing project activities and process of international environmental governance and sustainable development.

The Basel Convention contains specific provisions for the monitoring of implementation and compliance. A number of articles in the Convention oblige parties (national governments that have acceded to the Convention) to take appropriate measures to implement and enforce its provisions, including measures to prevent and punish conduct in contravention of the Convention.

2.3.2 Bamako and Waigani Conventions [16]

The Basel Convention has clear links with regional hazardous-waste regimes, in particular the 1991 Bamako Convention (which came into force in 1998) and the 1995 Waigani[17] Convention (which came into force in 2001). The Bamako Convention prohibits the

[16] Yearbook of International Co-operation on Environment and Development 2001/2002, Earthscan Publications Ltd, London, page 47
[17] For more information about The Waigani Convention see; http://sprep.org.ws

Transport of chemicals on a ferry. John Petter Reinertsen / Samfoto

import of hazardous waste into Africa, and the Waigani Convention prohibits the import of hazardous waste into Pacific Island developing countries. These regional regimes were partly established in response to the initial failure of the Basel Convention to ban exports from North to South. The Basel Secretariat co-operates with the secretariats of these regional regimes and shares knowledge about institutional procedures and functions. These regional agreements may also assist national implementation of environmentally sound waste management strategies.

2.4 Agreements regulating radioactive waste

Radioactive waste is in an exceptional position, and can be fatal if not handled properly. Despite this fact, which is generally acknowledged, there is still no wi-dely endorsed convention that explicitly addresses the issue of nuclear waste. More states have ratified the general convention that states precautionary principles regarding nuclear management.

2.4.1 Joint Convention

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[18] was the first legal instrument to address these issues directly on a global scale. It entered into force on 18 June 2001. The objectives of this Convention are:[19]

- To achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management, through the enhancement of natioal measures and international co-operation, including safety-related technical co-operation where appropriate
- To ensure that during all stages of spent fuel and radioactive waste management there are effective defences against potential hazards so that

[18] IAEA home page; http://www.iaea.org
[19] Joint Convention, chapter 1, article 1

Handling of radioactive waste. Kjeller.

individuals, society and the environment are protected from the harmful effects of ionising radiation, now and in the future, in such a way that the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations
- To prevent accidents with radiological consequences and to mitigate their consequences should they occur during any stage of spent fuel or radioactive waste management

By 26 November 2002, there were 29 Parties to the Convention.

The Joint Convention applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications and to spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes, or when declared as spent fuel or radioactive waste for the purpose of the Convention by the contracting party. The Convention also applies to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities.

The obligations of the contracting parties with respect to the safety of spent fuel and radioactive waste management are based to a large extent on the principles contained in the International Atomic Energy Agency (IAEA) Safety Fundamentals document "The Principles of Radioactive Waste Management", published in 1995. They include, in particular, the obligation to establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management and the obligation to ensure that individuals, society, and the environment are adequately protected against radiological and other hazards. This can be done by appropriate siting, design and construction of facilities and by making provisions for ensuring the safety of facilities both during their operation and after their closure, etc. The Convention imposes obligations on contracting parties in relation to the transboundary movement of spent fuel and radioactive waste based on the concepts contained in the IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste. In addition, contracting parties are obligated to take appropriate steps to ensure that disused sealed sources are managed safely.

2.4.2 Convention on Nuclear Safety[20]

The Convention on Nuclear Safety is a global agreement that was adopted in Vienna in 1994. Its aim is to legally commit participating states that operate land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which states would subscribe. The Convention entered into force in 1996.

In the Preamble, the Convention states that the contracting parties affirm the need to begin promptly the development of an international convention on the safety of radioactive waste management as soon as the ongoing process to develop waste management safety fundamentals has resulted in broad international agreement.[21]

The Convention is an incentive instrument. It is not designed to ensure fulfilment of obligations by parties through control and sanctions, but is based on their common interest in achieving higher levels of safety, which will be developed and promoted through regular meetings of the parties.

The specific safety obligations in the Convention are based on what are termed "fundamental safety provisions" rather than on highly detailed standards; guidance on the more detailed internationally agreed safety standards are already available, and these are continually being updated. Yet the Convention also includes a series of more detailed obligations. With regard to waste, article 19 of the Convention states:

- Contracting Party shall take the appropriate steps to ensure that the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal

By 12 April 2002, there were 53 Parties to the Convention. For more information about relevant international agreements on nuclear issues see the home page of the IAEA[22].

[20] IAEA home page; http://www.iaea.org
[21] The Convention on Nuclear Safety, preamble viii
[22] http://www.iaea.org

Transport of radioactive waste. Bellona.

3 National Waste Management Systems

All countries experience waste-related problems. These problems require policies and practical solutions. A lack of policy in an area may lead to inadequate regulations, which can, in turn, result in random practices that may be harmful or even dangerous. The solution is a complete management system.

In connection with the establishment of management systems for waste, it is important to take account of the fact that the different kinds of waste can require different systems. Following the categorisation in Agenda 21, radioactive waste, hazardous waste and non-hazardous waste are often managed differently. This has direct implications for how a SAI can audit the waste management system, because different levels of authority may be responsible for the management or regulation of the different types of waste.

Laws regulating radioactive waste are usually determined at the national level. Hazardous waste is also most often regulated at the national level, whereas non-hazardous waste is regulated at the regional or local levels in many countries. This in turn has implications for the feasibility of a SAI carrying out an audit. Whereas some SAIs have a mandate to audit all levels of administration, many SAIs are limited to fields regulated by national (and international) legislation. All audit activities should be within the SAI's audit mandate.[23]

The SAIs' possibility of auditing waste management therefore depends on structures of responsibility at the national, regional and/or local level. Drawing on the national waste management systems currently used in Poland, China, Canada and Norway, essential elements in waste management systems will be presented. The presentation is differentiated according to type of waste, e.g. management of radioactive, hazardous and solid waste. The complete examples from the different countries are presented in appendices 2 to 8.

3.1 Radioactive waste management systems

Most countries have legislation for radioactive and nuclear waste at the national or federal level. The legislative body thus governs the management of radioactive and nuclear waste and provides agencies with regulatory authority. The agencies that manage radioactive waste are usually at the national level, making them natural targets for scrutiny by SAIs.

Radioactive waste is usually divided into two categories: low-level waste and high-level waste, where the latter has a much longer life expectancy. High-level waste consists in the main of spent nuclear fuel. Low-level waste consists of residues from past industrial processes, contaminated material created by power plants or institutions, medical waste, and waste from uranium-mining processes.

As a country that mines and uses radioactive substances, Canada has long had mechanisms to control radioactive waste[24]. Canada practises the principle that the owners or generators of the nuclear waste (with the exception of historic waste) are responsible for the final disposal.

A number of federal agencies and departments or ministries share the responsibility for the different functions that need to be covered in connection with radioactive waste. The following description highlights the functions rather than the actual names, in order to focus on the purpose of the organisation.

An independent agency of the Government of Canada is responsible for regulating the nuclear industry, granting licences to nuclear facilities, carrying out environmental assessments in collaboration with an agency specialised in assessments, and working with the Ministry of Transportation to regulate safe transport of nuclear waste across the country.

A designated office is responsible for the establishment of national policies for low-level waste management. It offers a disposal service (user-paid), car-

[23] INTOSAI Auditing Standards Paragraph 1.0.34
[24] Information found on the UN page presenting Agenda 21: http://www.un.org/esa/agenda21/natlinfo/index.html

ries out the clean-up and remediation of historic waste and uranium tailings, and provides support for clean-up and planning.

Another governmental organisation offers its services to each nuclear energy corporation for the management of high-level nuclear waste disposal. This organisation reports to the Minister of Natural Resources.

Finally, there is a federal corporation that serves as an international nuclear technology and engineering company. Its responsibilities include managing most of the nuclear low-level waste programmes in Canada, owning and operating some nuclear facilities, conducting research and receiving reports from the waste management organisations.

The producers of high-level nuclear waste in Canada are mainly the provincially-owned power generators.

In Poland, the problem of radioactive waste is of minor importance because there are no nuclear power plants. The principles of handling radioactive materials are nonetheless regulated in an act of law and its executive regulations. These regulations establish conditions under which the purchase and possession of radioactive materials are possible and likewise their storage and transport (including transit). They also establish conditions for the location, construction and supervision of nuclear building structures, laboratories, institutions using radioactive material, etc.[25].

In a country like Norway, which has only limited quantities and easily traceable uses of each type of radioactive waste, one ministry is responsible for all aspects of the management of radioactive waste. A governmental agency regulates the use of radioactive substances and fissile material, provides the professional basis for decisions regarding licences for the operation and construction of facilities under the Ministry of Health, and oversees and conducts inspections and monitoring.

3.2 Hazardous waste management systems

Hazardous waste is usually regulated at the national level, but in some countries a regional or provincial authority may be in charge. The national legislation may provide for more detailed regulations and activities at the regional or local level, such as inspection and monitoring. If local or regional authorities are responsible for some activities, this may make it more difficult for SAIs with mandates on a national level to audit them.

In Canada, the federal government's responsibility for hazardous waste is mainly limited to the transport of waste. The provincial/territorial authorities are primarily responsible for managing hazardous waste within provincial/territorial borders, including devising complementary legislation to that at the federal level and issuing permits to disposal facilities. At the local level, authority is delegated to municipalities by provinces and territories using legislation, bylaws and boards of health. The local level may operate or contract out final destinations for waste (i.e. landfills and treatment plants). The bottom-line responsibility for the actual correct handling of the hazardous waste still lies with the producer of the waste and the operator and/or owner of the waste disposal site once the waste has been transported there.

Although the federal level in Canada has limited responsibility for hazardous waste, there is some federal activity and several actors may be involved.

The Ministry of Transportation works with the Ministry of the Environment to control the movement of hazardous waste throughout Canada and across its borders. The Ministry of the Environment is responsible for implementing waste manifest systems, operating notification systems for waste crossing international boundaries, maintaining liaisons on international transport with provinces and territories, and ensuring compliance with legislation.

The Ministry of the Environment manages and disposes of hazardous waste generated by federal facilities on federal lands, controls ocean dumping and co-ordinates the waste management activities of the federal government through the operation of a Waste Management Branch.

The Ministry of Fisheries and Oceans in Canada ensures compliance with the Fisheries Act to prevent deleterious substances from entering fish habitats.

A council of ministers serves as an intergovernmental forum for debate on hazardous waste issues. The council established a Hazardous Waste Task Group to work towards the creation of a nationally harmonised system for managing hazardous waste

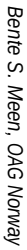
[25] Information found on the UN page presenting Agenda 21: http://www.un.org/esa/agenda21/natlinfo/index.html.

and hazardous recyclable materials by developing guidelines for various treatment facilities, such as incineration and physical-chemical-biological treatment. On request from the Ministry of the Environment, this group also provides advice on whether to develop or update regulations regarding hazardous waste.

In several countries, different legislation regulates different types of waste, but this is not necessarily mirrored in the organisational structure. For instance, in China the same organisational structure applies to both hazardous and non-hazardous waste.

The Chinese National People's Congress (the legislative body) discusses and votes on draft laws and relevant bills, examines and approves the National Economic and Social Development Plan, and monitors and inspects the execution of environmental laws by government departments. The State Council (the central government) issues relevant administrative regulations, mandates the National General Plan of Environmental Protection and implements relevant laws, rules and policies.

The responsibilities are further divided among three government bodies. The State Environmental



Bente S. Meen, OAG Norway

Hospital waste – syringes. Bente S. Meen, OAG Norway

Protection Agency conducts nationwide monitoring of the management of waste, issues administrative rules, systems and standards, sets standards for environmental quality and waste discharge, and organises the implementation of relevant rules, systems and regulations. The State Economic and Trade Commission manages the use of recycled resources and co-ordinates environmental protection by industry and the development of industries related to environmental protection. The Ministry of Construction directs and monitors the construction of urban infrastructures and monitors and manages disposal of urban household waste.

These three government bodies all have a set of local counterparts. In China, there are three levels of local government: Province (Autonomous Region, Central Municipality), City and County. A local government agency is under the governance of the respective level of local government and under the professional guidance of the respective government agency at the next higher level.

The local governments of China have the following responsibilities:
The local environmental protection agencies inspect and manage waste disposal work in the local regions, issue relevant rules and guidelines concerning environmental protection, set local environmental standards, and organise the execution of relevant regulations, rules and mandates.

The local economic and trade commissions manage the comprehensive use of recycled resources and co-ordinate environmental protection and the development of industries related to environmental protection in their respective local regions.

The local environmental sanitation agencies directs and monitor the construction of environmental protection facilities and monitor and manage the disposal of urban household waste in their local regions.

Different local government bodies regulate the actions of the waste producer depending on whether the waste producer is an industry or other commercial producer or a household/small business. Households are obligatory users of municipal waste services and are subject to management by the local agency of environmental sanitation and the local Economic and Trade Commission. Industrial enterprises are responsible for their own waste under the monitoring of the appropriate government bodies, namely the local environmental protection agency and the local economic and trade commission.
The same division of responsibility according to waste producer is found in the Norwegian system. If the producer of hazardous waste is an industry, then the government control and licensing body is involved. This agency provides the professional basis for decisions made by the Ministry of the Environment on pollution issues, issues licences to industrial and treatment plants, monitors activities and conducts inspections. By contrast, if the hazardous waste originates from a household, the municipality is obligated to provide the household with a means of disposal.

3.3 Solid waste management systems

In Poland, the Ministry of the Environment is responsible for general aspects related to waste management, and draws up, and co-ordinates the State Ecological Policy and implements executive programmes of the National Waste Management Plan. The State Inspection for Environmental Protection co-ordinates and draws up national audit programmes on compliance with environmental regulations and on national environmental-monitoring programmes.

The more direct management of solid waste is carried out at the regional level. The regional management board draws up regional environmental-protection programmes, including management programmes. The corresponding regional agency issues waste-management permits and concessions to industrial plants that do not have a significant impact on the environment. The regional inspectorate for environmental protection runs the waste management monitoring system and performs audits of implementation of statutory regulations.

On the local level in Poland, a County Management Board draws up environmental protection programmes, including local waste management plans, and issues waste management permits for other industrial plants that do not have a significant impact on the environment.

In China, solid waste is subject to the same regulatory system as hazardous waste. The waste from industry is under the supervision and regulation of the local environmental protection agencies and the local economic and trade commissions. Household solid waste is managed by the local environmental sanitation agencies and the local economic and trade commissions.

Likewise, in Norway, household waste is managed at the local level, whereas industrial waste is managed at the national level, regardless of whether it is

solid or hazardous waste. In some countries, the waste generated by commercial activities may also be handled by the municipal or local waste disposal systems.

In Canada, most of the activities related to non-hazardous waste management are regulated at regional level by the provinces and territories. These bodies or agencies issue certificates of approval (permits) to operate waste disposal sites, which define the types of waste the facility can accept and the conditions for environmentally sound waste-disposal. All waste-disposal sites must have a permit and comply with its conditions for operating. The agencies develop a waste-exchange programme (policy, not a legislated requirement), which is a database listing waste generators and the types and quantities of waste materials produced, so potential users of waste products can contact them to reuse or recycle their waste. Furthermore, the agencies or regulating bodies legislate off-site recycling programmes that divert recyclables from the waste stream to recycling facilities (paper products, ferrous metals, construction and demolition materials, etc.). The authority is delegated to municipalities using legislation, bylaws and boards of health.

The municipal or local level in Canada provides some waste management services or oversees the contracting out of specific services (e.g. residential curb-side waste collection), may operate waste disposal facilities and may operate centralised programmes and facilities for composting organic materials.

The private sector in Canada does most of the collection and transportation of waste and recyclables and may operate disposal facilities, transfer stations and recycling facilities.

The waste management industry or the private sector may be included in a comprehensive solid-waste management system. They may perform services for commercial/industrial waste generators and/or may work on contract, performing services for the local waste management authority (collection, transfer/recycling plants, and final treatment of the waste). An important framework for this industry is therefore the national and local waste policies, since these can serve as a basis for improvements and investment in waste management systems.

Trygve Bølstad / Samfoto

4 How to Determine Focus for Your Waste Audits

In this chapter, we will suggest an approach for identifying the most pressing areas on which to conduct waste management audits.

This is a four-step procedure, starting with identifying the risks entailed by waste in a country. The next step is mapping out the relevant actors and their responsibility. The third step is taking the waste stream into account, and the final step is choosing a focus for the audits after the consideration of audit topics.

4.1 Step 1 – Identify environmental and health risk scenarios

Auditing is usually about financial risks. In environmental auditing, risks to health and the environment are prime concerns.

The first step in the planning of waste audits consists of creating risk scenarios by identifying the main problem areas related to waste in the country and the risk they pose for public health and the environment. This exercise will give a picture of the danger the waste entails. If there are serious problems at basic levels of waste handling, we argue that this is of national importance and therefore possible for the SAI to address in order to raise consciousness about it.

Issues that are shared by neighbouring countries should be considered, and it should be possible for SAIs to co-operate in identifying the main problem areas within a region.

Good descriptions of the problems related to waste and the specific problems a certain country may encounter may already exist and be available in white papers or other documentation created by a Ministry of Environment or other responsible departments or agencies in the country. If no such description exists it may be the responsibility of the SAI to point this out to the relevant authority.

4.1.1 Assess the seriousness of the possible damage from waste

The seriousness of damage from waste relates to both people and the environment. For people, it may be divided in two aspects: the number of people who may be affected and the severity of the harm they may suffer. Dispersal is an important factor related to the number of people who may be affected. Harmful chemicals and biological waste are most widely dispersed by water and air.

When determining the seriousness of damage to the environment, reversibility is a key factor. If the damage is irreversible, it is especially grave. Habitat is another important dimension for environmental damage. Some species live in, breed in or pass through a few and restricted areas, and may become extinct if these crucial areas are polluted.

When considering risks, the acuteness of the danger is also essential. The acute threats need to be addressed first. When these are under control, it is equally important to prevent future acute situations. Foreseeing and preventing potential crises well in advance is better than having to solve them after they have occurred.

Three examples related to the different types of waste illustrate the point about seriousness.

Example I: Radioactive waste has a huge damage potential. If released it can contaminate a large number of people, and the injury can be very serious. All parts of the natural environment will be damaged, and the damage may persist for years.

Example II: Hazardous waste may be highly toxic and flammable, even explosive. The damage it may cause to all living organisms if poisonous substances are released into water is obvious. Fires set by flammable substances may release toxins into the air, burn down large areas and kill people and all other living organisms in the area.

Example III: Solid or non-hazardous waste may contaminate drinking water through leachate or flooding. If close to a large water source, this may affect millions of people.

Obviously the seriousness of the possible damage caused by poorly handled waste is not dependent on the type of waste. To determine a country's most

serious waste problem the probability of damage must also be considered.

4.1.2 Detect the probability of damage from waste

The inherent and/or potential danger of each type of waste is realised if the waste handling is inadequate. This can be illustrated from the examples above. If solid waste is placed indiscriminately in dumps near water sources and flooding rivers, the risk of contamination of the water will be high. If dumps are located far from water and people, the immediate risks for public health will be lower. If solid waste is burned at incinerators that have equipment for purifying the emissions, the risks of damage to health and the environment will be low.

Hazardous waste needs to be handled in compliance with strict quality requirements. The waste generator should be obliged to manage the waste. Treatment procedures such as thermal destruction, neutralisation or physical stabilisation should be in place, and the vehicles that transport this waste must be constructed for this purpose. Storage sites should be safe. If this is not the case, basic safety requirements will not have been met, and the auditor should seek to find a way to get management and politicians to focus on these dangers.

Radioactive waste is potentially the most dangerous waste because it can kill all organisms and be long-lived. In most countries it is handled by a small number of actors and restrictions are tight. Usually the systems relating to radioactive waste are of high quality, but small faults in the systems can have grave consequences, and so the requirements for the systems must be high.

For all types of waste, there is also a risk of criminal behaviour. Industries, landfill operators and others who are obliged to handle waste and do it safely, may find solutions that are cheaper but less secure. When considering the risk picture, a SAI should consider the likelihood that this may occur.

4.2 Step 2 – Map out the actors and their responsibilities

The second step is to create an overview of the organisational structure of the waste management system. Most likely, there will be different systems for radioactive, hazardous and solid waste. This overview should include the most important actors: authorities at the national, regional and local levels, the waste generators and other actors that may pose a risk through their handling of waste.[26]
The organisational structure for waste management may vary considerably among different countries, but most of the systems have certain functions that need to be fulfilled. It is necessary to map out the appropriate authorities to identify the relevant entities that should be audited. The responsible government bodies and the nature of the accountability relationships between the different actors should be identified.

Most countries have a legislative body responsible for formulating environmental policies and enacting appurtenant laws. International agreements provide directions for the national legislative work. In many countries one government authority, usually called the Ministry of the Environment, is responsible for all of the environmental policy at the federal or national level, including the management of waste. In other countries, several ministries are responsible for different parts of the waste management system. In these countries, it is important to map out which parts of the policy each ministry is responsible for and how they are co-ordinating their work.

A number of important functions come under the responsibility of the ministry (ministries), but these may often be carried out by subordinate agencies. Some countries have few, and some have many. The important consideration is whether the highest governmental authority (the ministry or ministries) has an overview of the activities and makes sure they are performed well.

Many countries have an authority responsible for controlling pollution and for inspecting and monitoring the environment and the activities that have an impact on the environment. If the country has an agency like this, it is necessary to map out the role it plays in the waste management system. If such an agency does not exist, the SAI should identify who is performing these functions. If these functions are not taken care of, it may be the responsibility of the SAI to inform the appropriate authorities.

Depending on the type of waste, the authorities that administer or regulate the waste may be at the regional or provincial level or at the local or municipal level. All actors should be mapped out, even though some of these actors may not come within the core of the SAI's mandate to audit.

[26] A thorough understanding of the waste handlers is obtained when looking closer at the waste stream, which will be suggested under step 3.

The most typical waste handlers should be identified without going into great detail. In a basic chart, the inclusion of waste generators, waste transporters and waste operators is sufficient.[26] All of these actors may be private or public.

Figure 5 is a graphical presentation of relevant actors associated with waste management. It gives a visual depiction of the actors that should be taken into account. In a factual chart, each actor's functions and responsibilities should be described, and feedback obligations and the authority to issue instructions should be indicated. The arrows with question marks illustrate links between actors that the auditor should look for. Examples of different public entities that may have authority over the way waste handlers conduct their activities are shown in boxes. Waste handlers are indicated with circles. In this chart, the role of the SAI is not identified because it varies greatly among different countries and depends on the type of waste.

For a presentation of charts that illustrate the actual waste management systems in China, Canada, Poland and Norway, see appendices 2–8.

4.3 Step 3 – Take account of the waste stream

When the actors and their responsibilities are mapped out the problems related to poor management should be considered. General knowledge related to typical weaknesses in management systems can be applied.

The waste stream, as presented in chapter 1.5, is a good starting point when searching for defects in the waste management system to establish an audit. Using the different stages in the waste stream as a guide, make sure that you cover all of the important factors. The waste policy and the management system should include all of the stages in the waste stream. Some reflections on how governments may exert influence at the different stages are therefore presented.

Stage one in the waste stream is prevention, and the motivation behind this stage is the sustainable use of resources in general. We should use no more of the natural resources than necessary, and the manufacture of products that do not have any useful

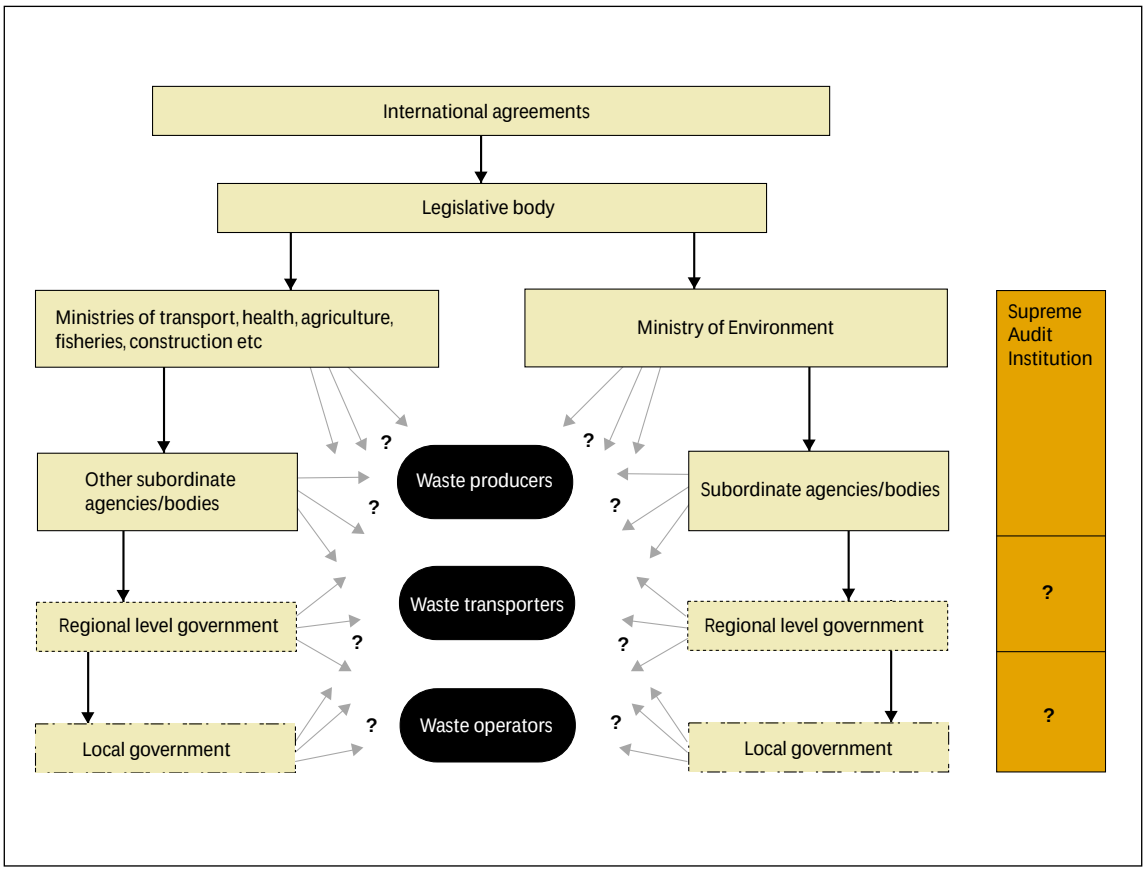


Figure 5. Waste management chart that includes the waste handlers

Accidents may occur when flammables are transported. Odd Steinar Tøllefsen/Scanpix

purpose is generation of waste. An example is unnecessary packaging on products. The objective of preventing waste generation is often included in a country's national waste policy. This is a challenging objective because most countries have a goal of promoting economic growth, and, so far, economic growth has involved an increasing amount of waste.

The second stage is the generation of waste. The government could influence the amount of waste generated through economic incentives, where the efficient use of resources and a limited generation of waste are rewarded. The polluter-pays principle[27] is such an incentive. The obligation on producers to substitute hazardous chemicals with less harmful ones when possible is another possible instrument. Unless the activity that generates waste is a government-run enterprise, the waste-generation process is an internal affair. The authorities must then rely on inspections and internal control systems to ascertain compliance.

The third stage of the waste stream is Recycle, Reuse and Recovery. Some governments have the objective of recycling, reusing and recovering as much of the waste as economically and environmentally feasible. To make this happen, several management moves are usually called for. The different waste materials must be sorted and treated separately. This entails that either waste generators must sort their waste themselves or there must be a sorting procedure after waste collection. To motivate the desired behaviour among waste generators, economic incentives could be used, such as refunds on returns or lower fees for sorted waste than for unsorted. Legislation may also enforce recycling, e.g. through an obligation on the seller of products to accept the return of waste.

The forth stage, the collection of waste, is usually regulated to some extent by local or national autho-

[27] Principle 16 of the Rio Declaration: "the polluter should, in principle, bear the cost of pollution".

rities and may be handled by public or private actors. Again, control is a key instrument.

The fifth stage is the transport and export of waste. There are usually official requirements for this activity. The operators may be either public or private. The transport of hazardous chemicals requires firm regulations to avoid possible accidents. When it comes to the export of hazardous waste, there are strict international rules to be followed.

The treatment and disposal of waste is most often subject to regulations from the authorities. In many countries, an operating permit is required, and inspections are common practice.

The possibility of illegal dumping, stage seven, must be acknowledged, and necessary measures must be taken to deal with this problem. There exist a number of instruments that can be used to implement these measures, such as monitoring and inspections, but their use must be based on a solid statutory basis. Both the permission to conduct inspections and appropriate sanctions must be in place.

Waste that is not properly handled ends up in contaminated sites. These may be the result of poor management in bygone years, which needs to be addressed today. The polluter-pays principle may be applied, but with old damages it may no longer be possible to hold the original polluter responsible.

From the auditing point of view, there are questions that the auditors can ask at each of these stages to assess the quality of the management system related to the waste stream.

In the following section, we will discuss at greater length a number of relevant audit questions that an auditor may raise to assess the quality of waste management and problem areas that may be revealed by audits. Each of the audit topics may be addressed at each of the stages in the waste stream.

The poor subsist by searching for recoverable objects in a waste dump. David Trood / Samfoto

4.4 Step 4 – Consider audit topics – choose focus

Once the most serious risks are identified, the structure of authority established and the challenges related to the waste stream revealed, a focus for the audit may become quite apparent. However, there are a wide range of audit questions that may be asked and approaches that may be chosen.

4.4.1 Consider audit topics

We have clustered key audit questions under headings that capture different ways of evaluating the management system and have called them audit topics. Nine topics with related questions have been identified:

Topic 1 – Existence of waste policy

Is there a waste policy that applies to every stage of the waste stream? Is the waste policy at different stages consistent with the general environmental policy?

Topic 2 – Compliance with national environmental policy

Have the general environmental policy and the waste policy been reflected, specified, and put in concrete terms in instruments such as legislation, plans, budgets and financial tools? Are there any gaps or inconsistencies in the waste legislation?

Topic 3 – Risk management

Are the risks posed by waste for the environment and health being sufficiently managed? Does the government have an overview of these risks and are measures being taken to manage them? For instance, are there reporting systems for incidents from the operating to the executive level?

Topic 4 – Quality of the implementation process

Have policies and regulations been implemented efficiently and effectively? Have there been delays in the implementation and have the resources been well-spent? Did the government conduct sufficient impact assessments or other prior investigations before implementing a new waste initiative?

Street litter in developed country. Jamie Parslow / Samfoto

Street turned into dump in developing country. David Trood / Samfoto

Topic 5 – Performance of the waste management system

Is the structure of the waste management system appropriate for solving the challenges that waste entails? Is there a distribution of responsibility, and, if so, does this influence accountability? Do the responsible agencies have the necessary instruments for fulfilling their obligations regarding waste management? Do the chosen instruments such as legislation, plans, budgets and financial tools ensure the achievement of the policy objectives? Does the system achieve the optimum output – in terms of quantity and quality – from the inputs and actions?[28]

Topic 6 – Compliance with national law and regulations

Do the actions of the government departments, ministries and other relevant agencies comply with the relevant rules and regulations, specifically financial requirements? Are all waste activities and liabilities accurately accounted for? Are there any illegal practices in connection with the waste handling?

Topic 7 – Compliance with international obligations

Do the policies, legislation and practices relating to waste management comply with the international obligations and commitments to which the country has agreed?

Topic 8 – Monitoring

Are there adequate systems for monitoring the waste handling? Is there a system that ensures a necessary overview of the waste handling? Is relevant information gathered, e.g. through reporting systems or registers, and is that information of good quality? Are there control and inspection procedures in place to ensure compliance with requirements, and do these work well? Have necessary sanctions been established, and are they adequately used?

[28] Implementation Guidelines for Performance Auditing Standards Exposure draft, page 10

Topic 9 – Effects of other government activities

Is the waste from other government environmental or non-environmental activities or programmes properly managed? Do the public ministries, departments and agencies manage the waste created by activities under their authority?

4.4.2 Choose a focus

The inclusion of these audit topics in the process of choosing a focus for an audit gives the following three dimensions: type of waste, stage in the waste stream and audit topic. These are visualized in figure 6.

The figure gives the auditors an overview of the most pressing areas to look at and of possible approaches. Examples of questions derived from these three dimensions are:

- Is there a policy in our country for the prevention of hazardous waste?
- Does the legislation relating to the treatment of solid waste comply with the environmental policy?
- Is there adequate monitoring of the disposal of radioactive waste?

In actual audits, usually more than one of these questions is addressed, as is the case in most of the audits that will be presented.

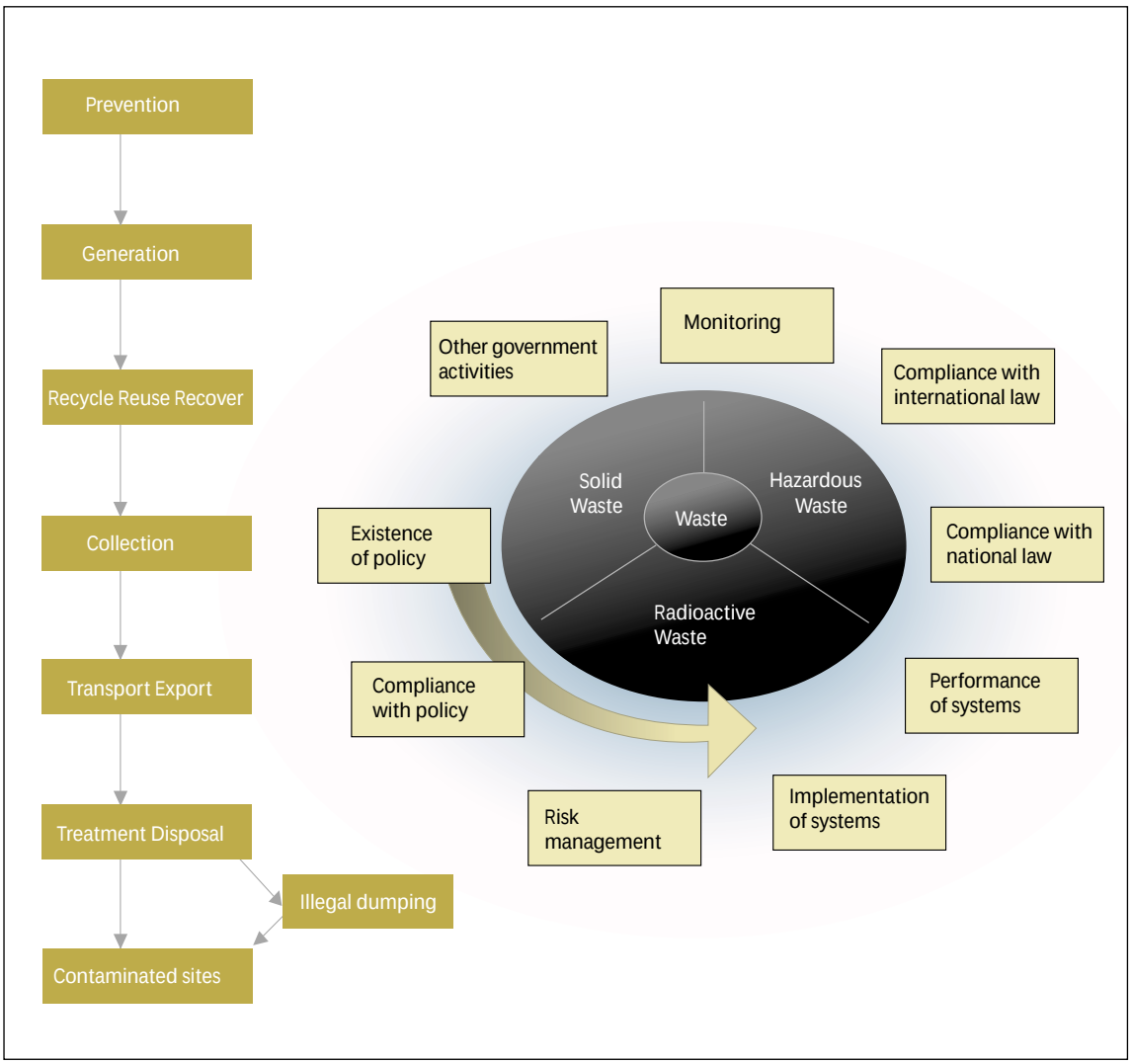


Figure 6. Graphic depiction of the three dimensions behind an audit focus

5 Audits of Waste Management

To facilitate the planning of your waste management audit, it may be useful to see how other SAIs have approached the field, so as to profit from what they have learned. We will therefore present a set of examples of audits that reveal the most pressing problems related to waste management that have confronted a number of SAIs. The examples are grouped under the nine previously presented audit topics. The emphasis in the audits as they are presented here is on the findings.

A significant number of audits have been conducted in the last decade. During the years 1997–99, INTOSAI members produced a total of 103 audit reports on waste in 49 different countries. As many as 20% of the SAIs stated that they were planning audits on waste in the next three years[29].

When reading the audit examples, there are several aspects it is important to be aware of. First, some of the examples are quite old and may no longer give a true picture of the situation today. Secondly, the examples do not present a full description of the audit. In some cases, certain parts of an audit have been emphasised or selected to illustrate a particular audit topic. The focus is on deviation, and many findings related to good practices have been left out. However, the examples here were selected because they are assumed to be relevant and informative for other SAIs.[30]

The topics constitute typical problem areas that audits reveal. Under each topic general considerations when using the approach will be presented. Some of the examples may address more than one of the topics, but are only presented under one topic.

5.1 Topic 1 – Existence of waste policy

It can be argued that the existence of a national waste policy is a prerequisite to any SAI´s examination of waste management, and that without such a policy the SAI lacks a foundation for an audit. At the same time, the existence of a national waste policy is also an issue that a SAI may raise.

Some international conventions oblige national governments to take measures, that may necessitate the formulation of some sort of national policy. The existence of a waste policy may therefore be audited using an international convention or agreement to derive audit criteria.

Both the waste stream and the types of waste may provide good starting points for investigating the existence of a waste policy in a country. Such an audit might reveal an absence of or gaps in the waste policy for one or more of the stages in the waste stream or for one of the types of waste.

It is also important to expose inconsistencies between the waste policy at the different stages in the waste stream and the general environmental policy.

No examples of audits that set out to analyse the existence of a waste policy or the consistency between general environmental policy and waste policy have been found.

5.2 Topic 2 – Compliance with national environmental policy

The parliament or equivalent legislative body decides on a policy, which the executive body is then obliged to specify so as to make the aims of the policy more comprehensible, distinct and operational, often by means of legislation. Fulfilling this obligation is a focal issue for many countries' SAIs.

According to the Rio Declaration, Principle 11, first sentence, states have an obligation to provide this legislation: "States shall enact effective environmental legislation". Although the Rio Declaration is

[29] Information gathered in the third questionnaire conducted by the INTOSAI Working Group on Environmental Auditing in 2000. More information available at http://www.environmental-auditing.org/

[30] Many of the examples presented in the report have been rephrased and edited.
When referring to a Supreme Audit Institution in this document, it will be referred to as the SAI of X or the X'ian SAI instead of using the official name of the institution. This has been done to make the text more easily readable.

not legally binding, it offers guidelines and may serve as an audit criterion on the basis of which the SAI can call attention to the absence of legislation.

The evaluation of compliance also implies the analysis of consistency among the different laws and regulations. For instance, there may be legislation under other ministries that does not incorporate the requirements and goals of the waste policy and legislation.

A question that it may be relevant to ask is whether the country's environmental, health and safety legislation lay down requirements for basic systems for solid waste, hazardous waste and radioactive waste. The absence of such legislation may need to be reported.

The obligation to specify the policy also has implications for the regional and local levels of government or authority. These bodies should make sure that the substance of the regulations and actions complies with the intentions of the policy.

Sometimes the political decisions that are made cannot realistically be implemented in the immediate future, for instance because the required funding is not provided. The policy might be intended to function as a vision. In this case, a strict focus on deviation and unsuccessful practices might subject the countries that have ambiguous goals to the harshest criticism.

Two of the examples below reveal challenges when trying to implement ambitious waste policies. A third example criticizes the government for not setting ambitious goals. Several of the examples under other topics have lack of regulation as one of several findings, but they do not refer explicitly to the lack of compliance with policy.

In an Estonian audit from 2001, the focus was on the prerequisites for implementing the nation's waste policy.
In other words: to what extent are the necessary conditions for the successful implementation of

the waste policy in place? The Estonian waste policy sets the following goals:

- *To prevent waste generation*
- *To reduce the amount and harmfulness of generated waste*
- *To broaden the scope of recovery operations (reusing, recycling, composting and incineration)*
- *To process and neutralise waste in accordance with the relevant standards*
- *To deposit waste and dispose of it in an environmentally sound manner*

The Estonian SAI has concluded that the national, county and local authorities have not established adequate prerequisites for the successful implementation of the waste policy. Shortcomings are related to:

Information/monitoring: the management and accounting of and statistical information about waste management is insufficient and unreliable. There is no precise information about the generation, shipment, recovery or treatment of waste, and the accuracy of the information provided has not been verified.

Strategic framework: there is no national waste management plan to serve as the foundation for the planning of waste management, the refinement of development plans, the decisions to establish waste disposal sites and the determination of financing needs. The lack of such a plan has complicated the planning of waste management by local governments and developers of waste disposal sites and waste treatment facilities.

Financing: under the current financing, the goals for non-hazardous waste disposal will take ten times longer to achieve than the implementation capacity allows.

Management: the management of the waste policy lacks unity and co-ordination. The necessary organisational prerequisites were not established in a timely manner.

The report is available in English at http://www.riigikontroll.ee/

The SAI of the Netherlands published an audit in 1997 focusing on waste prevention.
The SAI investigated the extent to which the objectives of the country's waste prevention policy were met and examined the development, deployment and broader impact of the policy instruments that were employed.

Since 1979, prevention has been given top priority in waste policy, ahead of recycling, incineration and landfills. Furthermore, it is only in this area of waste policy that the central government, rather than the provincial authorities, bears primary responsibility for formulating and implementing the policy. The Consultative Body on Waste co-ordinates the efforts of the central government and the provincial and local authorities.

Achievement of objectives:
The SAI concluded that the Ministry was not sufficiently informed as to whether the overall prevention target and the targets for the priority substances that it investigated were being achieved.

Policy instruments:
The SAI concluded that there had been a shift of emphasis in the development and use of these instruments. The emphasis had shifted from an approach that focused on individual priority waste substances to a more generic approach that targeted the entire waste stream. The generic approach was also an integrated approach because the waste-prevention policy was harmonised with other aspects of the nation's environmental policy.

Prevention policy for priority waste became a permanent feature of target-group talks with industry. These talks between the government and different sectors of industry were designed to produce agreements at the sector level on each sector's contribution to achieving environmental policy objectives (including agreements on waste prevention) and on compliance with the agreements.

Some preparations have also been made for using the expanded powers available under the Environmental Management Act to foster waste prevention through licensing and general rules (regulatory instruments). However, little use has actually been made of these instruments.

The SAI was of the opinion that the Ministry's forecasts concerning the impact of waste disposal capacity and cost on waste prevention were inadequately substantiated.

The SAI also gave a closer look to the broader impact of waste prevention policy on corporate environmental plans and licences in the chemical industry. It concluded that the corporate environmental plans had been drawn up according to agreed

procedure. However, there is still room for improvement with regard to the status of waste prevention in these plans and in licences. In particular, the competent authorities could pay more attention to the substance of the waste prevention measures included in the plans, to their formalisation in licences and to companies that have a passive attitude to waste prevention.

Despite the above reservations, the SAI approved of the stimulatory and regulatory instruments developed to promote waste prevention in companies. However, it commented that there had been too little use of these instruments and that they have therefore failed to have a broader impact. The vast majority of companies had not yet undertaken any waste prevention efforts.

The SAI of Costa Rica audited the solid waste management in two municipalities in 2000.
One of the most significant issues associated with environmental damages in Costa Rica's municipalities is the disposal of solid waste. This problem is characterised by inadequate management by the public institutions that have provided the service in recent decades and by the public offices responsible for the environmental monitoring.

The main objective of this audit was the evaluation of the plans and programmes developed by two municipalities in the metropolitan area. Also evaluated were the management and inspections conducted by the Ministry of Health (MINSA), and the Ministry of Environment and Energy (MINAE), which are in charge of these inspections.

As a result of this study, the SAI has found that the use and management of solid waste is not an integrated process with structural plans and programmes to prevent their negative impact on the environment and human health. The initiatives taken by the institutions have often been isolated and repetitive.

Another finding of this study is that the actions by the institutions mentioned do not heighten people's awareness and do not help encourage good habits with regard to the classification and appropriate disposal of waste. There are no public programmes that provide opportunities to separate waste or recycle or reuse materials.

The massive accumulation of solid waste at the two studied municipalities is a major contradiction given the available modern technologies used in other places to separate the solid waste for possible reuse. On a short-term basis, these two evaluated municipalities are unwilling to introduce strategies for the proper classification and transportation of waste. They thereby limited their possibilities of managing the waste.

The financial support is also unsatisfactory. The budget does not allocate enough resources to cover the costs related to the collection and final disposal of the waste. Furthermore, the planning and technical strategies for achieving these objectives were both inadequate. As a result of these shortcomings, more than 145,000 tonnes of solid waste per year are not under proper management to prevent environmental damage or negative impacts on human health.

The inspections conducted by the public institutions (MINAE and MINSA) do not help overcome this problem, because these actions do not promote better public services according to the environmental standards that protect ecosystems. These two ministries have concentrated their efforts on final disposal, but this approach is partial and does not reduce the high volume of waste treated without separation. Thus, the cities are subjected to negative impacts, such as water pollution, foul odours and hazardous gasses.

5.3 Topic 3 – Risk management

The environmental and health risks posed by waste may be used as a point of departure for an audit. Possible questions that may arise are whether the government has an overview of the risks at each stage in the waste stream and whether measures are being taken to manage these risks.

In general, risk can be defined as the probability and consequences of an unwanted incident. In keeping with this definition, government efforts at risk management can be of two different kinds. First, the government can take steps to reduce the probability that waste will have a negative impact on the environment. Secondly, risk management involves finding ways to limit the negative consequences once it is clear that waste does have an unwanted impact on the environment or public health.

It is also possible to draw a distinction between the risk of negative incidents, and long-term risk. For example, a measure for reducing the probability of an unwanted waste-related incident may be to ensure the safe transport of toxic waste. Then, if a negative transport-related incident actually occurs the

government should be ready to handle the situation. This latter point is strongly associated with preparedness.

With regard to long-term risk, one important question is whether employees that handle waste are informed of the risks inherent in their work, both to themselves and to the environment. Proper information may reduce both the probability that waste will become a problem, and any consequences that may occur. More concretely, if waste is handled in a proper manner, the probability of negative impacts is reduced.

There should be systems to ensure that information about risks at lower levels reach the authority that has the power to improve these conditions.

Several of the audits include the risk associated with a waste management area. Many have mapped out the environmental impacts as a point of departure.

The Japanese SAI conducted an audit in 1996 on the Nuclear Waste Storage Budget Request and Execution. *The focus was on "the Corporation", which runs a centre that performs research and development on the processing and disposal of nuclear waste, among other activities. The centre stores solid radioactive waste in two open-air underground radioactive waste pits built between 1967 and 1972 and in radioactive waste depots. In the open-air pits, the radioactive waste is stored in pit drums. Laws and regulations relevant to nuclear fuel and nuclear reactors stipulate tight control on radioactive waste storage to safeguard the outside environment from damage caused by waste leakage.*

The Japanese SAI became aware of the fact that the Corporation's radioactive waste storage had been deficient for a long time, which resulted in pit drum corrosion. Despite this corrosion, the Corporation had diverted its pit-repair budget to other purposes. In light of the high public concern about this problem, the SAI examined the Corporation's budget requests, execution, etc. The SAI's study showed that despite its deficient radioactive waste storage facilities, the Corporation used its facility repair budget to carry out only minimal temporary repairs and diverted most of the repair budget to other purposes. The SAI concluded that the budget requests and implementation over a number of fiscal years largely failed to address the actual situation and also failed to properly safeguard the radioactive waste stored in the pits. In light of the growing public concern about safety and security at the nuclear facilities, it is essential that the Corporation ensures proper budget requests and implementation, and thereby ensures proper nuclear waste control.

In 1995, the SAI of Israel audited the handling of the disposal of hazardous waste.
The audit focused primarily on the Ministry of Environment's preparations for handling all of the hazardous waste produced in Israel and on the enforcement of the regulations relating to its disposal. The activities of the hazardous waste disposal company that operates the central waste site were also examined.

Some of the findings were:
Until the establishment of the Ministry of Environment in 1988, the handling of hazardous waste was assigned to a large number of official bodies, which were not sufficiently co-ordinated to enforce compliance with the directives relating to the treatment and disposal of the waste and to publish the relevant professional instructions.

With regard to hazardous waste produced in large factories, the Ministry had not completed its arrangements for the treatment of the thousands of tonnes of hazardous waste that had accumulated over the years within the confines of these factories. In addition, not all of the waste was treated and disposed of according to the Ministry's professional directives, as required by law.

The Ministry only had partial information about the amount of hazardous waste produced in Israel and the manner in which it was handled. To operate in an optimal manner, it was necessary to set up a data bank to record all the quantities of hazardous waste produced and the manner of their disposal. The Ministry began to locate and centralise information, but did not complete this information system. The system was unable to provide a basis for a comprehensive system of routine monitoring and supervision and of total enforcement of the law.

One of the findings was related to the absence of regulations. Medical institutions and research institutions annually produce thousands of tonnes of infectious medical waste that could endanger the environment and cause immediate harm to public health. The ways of collecting this waste for treatment and disposal had not been regulated by statute, and, in practice, it was not properly handled. Some of this waste found its way to solid waste disposal sites without proper treatment, and some also ended up in unregulated sites.

The SAI of Israel concluded that the uncontrolled and unprofessional disposal of hazardous waste is liable to cause damage to the environment and to endanger public health. Therefore, it is necessary to take immediate measures to prevent further accumulation of untreated hazardous waste.

The SAI of Bolivia conducted in 1999 an audit of the environmental state of the water and soil at one pit of the sanitary filling. *This included an analysis of the environmental impacts and potentials, and an evaluation of the environmental performance of the entities involved in managing and controlling this pit.*

The main findings were:
The sanitary burying carried out from 1996 to 2000 entailed changes in the environmental state of the water and soil. Different analyses (physical, chemical, bacteriological) of the soil and subterranean water showed the presence of contaminants from the pit, and the current calculations were performed to estimate potential environmental damage.

The audit showed that the pollution of the soil around the pit and the subterranean water directly associated with the pit was caused by the repeated non-compliance with regulations and systematic failures in performance on the part of the firm in charge of the sanitary filling. Partial failures on the part of the municipal office in charge of inspecting the sanitary burying operations also contributed to the negative environmental impacts.

The audit found deficiencies related to the monitoring of watercourses, the covering of waste, the control and treatment of percolating liquids, and the diversion of rainwater and exterior canals. The firm was held responsible for not fulfilling the contract, but the municipal office shared the responsibility for the potential environmental damage, as it had not requested strict compliance with the obligations from the contracted private operator.

The audit also found that the local government had not implemented the regulations related to the treatment of hazardous waste from hospitals in the pit.

The SAI of Colombia conducted in 2000 an audit of the operation and management of the Curva de Rodas landfill. *One of the focuses was on whether the authorities had applied the provisions of the environmental legislation that addressed the risk of serious damage to the environment.*

The Curva de Rodas landfill was designed for the deposit of solid waste. The site commenced operation in November 1984. The landfill was due to complete its working life in 1996, but the local authority decided to extend activities until 2005. Between 1995 and 1999, there was no party responsible for the operation of the landfill other than a local authority. There are no documents or written records of operations from this period, which means that it was impossible to give a precise account of the current condition and stability of the landfill.

The main environmental problems discovered at the landfill site in 2000 are related to the dumping of untreated waste into the Medellín river and Rodas stream:

- *the inadequate disposal of hospital and hazardous waste*
- *the inappropriate management of rainwater*
- *the alteration of the Rodas streambed by the construction of a 1,049–metre-long superstructure*
- *the burning of vegetable matter*
- *offensive odours*
- *the presence of poultry droppings and the uncertainty of their stability*

This has led to opposition, concern and fear in the local community.

Faced with the risk of landslides and other potential disasters caused by the continuing deposit of tonnes of waste, the regional authority insisted that the operators of the landfill draw up a plan for closing the landfill by the year 2001.

The Colombian SAI reported that the regional authority, which has the legal authority to enforce compliance with environmental regulations and to draw up plans to diminish the damage to the environment from various projects, has not been effective in its management. The regional authority continued to delay procedures and had not overseen the comprehensive and appropriate application of the existing legal provisions relating to the operation of the landfill.

Furthermore, the SAI concluded that the environmental authority responsible for overseeing the operation of the landfill site should apply the provisions of the Political Constitution that refer to the monitoring and prevention of cases of degradation of the environment. The authority should also apply

the provisions, which state that if there is a risk of serious and irreversible damage, the lack of absolute scientific proof shall not be used as a reason to delay the adoption of effective measures to address the degradation.

The Colombian SAI concluded that the decision to prolong the working life of the landfill was not justified. Taking into account the precautionary principle, the absence of scientific proof of the serious damage or danger that prolonging the working life of the landfill may entail for the environment and community cannot be construed as an obstacle to taking pertinent action and measures to avoid this damage. The damage would result in higher environmental costs as a consequence of inadequate operation and management of the landfill site.

5.4 Topic 4 – Quality of the implementation process

This topic covers the initial phase of a waste management initiative. Time and resources should be well spent and the goals that underlie the initiative or action should be accomplished. A good selection of instruments is also important.

One obvious goal for a waste management initiative is the implementation of existing legislation. Thus, the construction of a new waste dump that does not comply with the appropriate legislation can be regarded as inadequate in the implementation process.

Before the establishment of a waste disposal activity that may have a negative impact on the environment, an impact assessment should be conducted.

Principle 17 of the Rio Declaration states: "Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority."

Assessing the impact on the environment before intervening is easy to acknowledge as an ideal. It is also in keeping with the precautionary approach. The following examples from Israel and Paraguay focused on the lack of prior assessment of the environmental impact of waste disposal activities.

The SAI of Paraguay conducted an audit of the Cateura dump in Asunción, the capital of Paraguay. *This dump was established in 1985, and the audit was conducted in 1997–98.*

The SAI focused on the environmental administration by the municipality of Asunción, the public authority responsible for the dump, and on the monitoring by the governmental supervision agency, SENASA.

The management and control of the dump was investigated with regard to national health legislation and a resolution concerning the technical regulation of the management of solid waste. In accordance with these regulations, all local authorities are supposed to compile a ten-year plan for urban cleanliness. The municipality of Asunción did not have an urban cleanliness plan, and SENASA had not requested such a plan from the municipal authorities. The investigation concluded that SENASA had neglected its duty as a supervision agency for solid waste for a period of 12 years in the case of Cateura.

The investigation found that when the dump was being established, a large number of problem issues had not been dealt with, resulting in the following serious violations of the legislation:

- *The spread of insects causing the transmission of disease to humans and animals*
- *Leaching of contaminated water with a high content of organic substances*
- *Foul odours*
- *Risk of explosions and fires due to gases generated by the decomposition of waste*
- *Waste was stored in areas subject to flooding, where floodwaters can carry waste away*
- *Sewage was unloaded in an uncontrolled way in a lake inside the dump*
- *Disposal of hospital waste that might lead to severe environmental contamination*

National legislation also prohibits settlements in the dump area, but the SAI found humans living in the Cateura dump.

According to the master plan for management of solid waste, the Cateura dump was to be closed in 1999. However, this was delayed, and instead the municipal authorities of Asunción developed a project for the rehabilitation and expansion of the Cateura dump. This project should have been approved by SENASA, but this was not the case. A study of environmental impacts is also required for this type of project, but it was uncompleted. There were no plans for closing the dump, but there were plans for developing the urban environment and creating an ecological park in the Cateura area, both of which depended upon the closing of the dump.

In 2000, the SAI of Paraguay did a follow-up investigation of the Cateura dump. The local authorities were then following a schedule provided by SENASA. The SAI now found that the sewers opened directly into Lake Cateura, new areas of the dump were being planned in areas affected by flooding, and the authorities still had no control over humans and animals entering and leaving the dump. The SAI observed human settlements with electricity and running water inside the dump, and the representative from Asunción municipality informed them that about 1000 persons worked of the dump. Furthermore, the local representative pointed out that the closing of the Cateura dump depended on the process of buying a new piece of land for a new intermunicipal dump. The SAI of Paraguay recommends that the local authorities speed up this process in accordance with the master plan for the management of solid waste.

in 1991 the SAI of Israel conducted an audit of the disposal of solid waste. *One of its main objectives was to evaluate the implementation of the National Outline Plan for solid waste disposal.*

Among the findings was the revelation that the detailed planning of the disposal and treatment of solid waste had not been completed for all parts of the country. There was a failure to implement the directives issued by the National Planning and Building Council to the district councils to include detailed plans for waste-disposal sites from the National Outline Plan for Waste Management in the district outline plans. There was also a failure to close active dumps that should have been closed. As a result, only one-third of the solid waste produced by the country's population was adequately disposed of.

Furthermore, the waste was removed to many waste disposal sites that were not operated in accordance with proper sanitation requirements, causing damage to surface and groundwater reservoirs. Officials did not ensure compliance with legislation and did not exercise their authority.

There was a failure to plan and implement extensive recycling of solid waste, although several committees of experts recommended recycling and pointed out that it was economically and environmentally beneficial. No comprehensive and updated study was undertaken to determine the feasibility of burning solid waste to produce energy. There was no analysis of the possibility of combining the three methods for disposing of solid waste – burial at waste disposal sites, recycling, and incineration – and of using them in regional and inter-regional waste disposal sites, where this would be possible from an engineering perspective and where it would be economically feasible.

5.5 Topic 5 – Performance of the system

It is the responsibility of a country's SAI to audit the waste management system and determine how well the system is performing. There are a large number of issues that naturally arise here, as to whether the system meets the challenges that waste entails. One important task is to map out the relevant actors and their responsibilities to determine whether all of the necessary functions are managed and the lines of responsibility are clear.

For example, there may be a ministry of environment that has the overall responsibility to ensure compliance regarding waste. If such a ministry does not exist, it may be necessary to map out the partial responsibility held by different government bodies. If there is more than one body in the central administration that has some kind of responsibility, a natural audit question is whether this entails any risk. Concretely, does the scattering of responsibility fragment accountability? This question was raised by the Canadian SAI in an audit presented below, which focuses on the management of radioactive waste. This audit also specifies the criteria that must be fulfilled in order to have sound management.

A focus on the performance of the system also implies the scrutiny of whether the responsible agencies possess the necessary instruments for meeting their obligations and whether these are the most effective and efficient means of so doing.

Within waste management there may be programmes or actions that are one of a kind. Although the audit of such activities may have no impact on future practices, it is nevertheless important to consider them as well.

Several SAIs have performed full-scale audits of their waste management systems, and the audits are presented in the following pages.

The SAI of Brazil conducted an audit of the radioactive waste management programme, published in 1999. *As the result of an accident[31], the National Commission of Nuclear Energy (CNEN)*

initiated efforts to improve control mechanisms to prevent similar occurrences. The objective of the audit was to identify weak points in the programme for refuse/waste control and to consider procedures that could contribute to improvements in performance.

The audit was justified by the potential risk of environmental damage from activities involving radioisotopes. The biggest benefit of any improvement in the programme for radioactive waste management is the reduction of the risk of occurrence of radioactive accidents.

The following audit questions were formulated:

- *Is the register of radioactive installations complete, is it regularly updated, and is it used in the waste management programme?*
- *Does CNEN oversee the waste management as envisaged in the radiation-protection plan?*
- *Do the agencies linked to the sanitary surveillance offices and the environmental supervision agencies participate or will they participate in the control and supervision of waste management? Is there any overlapping and linking of the tasks executed by these entities and CNEN?*
- *Does CNEN plan and execute the collection of the radioactive waste in a timely and efficient way?*
- *Is the short-term storage of radioactive waste carried out efficiently?*
- *What is the service rendered by CNEN to its clients like?*
- *Has the Research Programme on Waste Management achieved the expected results?*

The main findings were:
Evidence was found that the register of users of radioactive materials kept by CNEN is not complete and is outdated.

CNEN is unable to fully comply with the plan for the annual inspection of radioactive installations, mainly due to budgetary and financial restrictions that affect the availability of resources for covering expenditures related to the airfares and per diem of the inspectors.

There is not enough co-ordination of action between CNEN and the sanitary surveillance offices. This undermines the effectiveness of the control of radioactive materials in the country because CNEN does not have the authority to apprehend material, to shut down installations or to fine their owners. Furthermore, from the operational point of view, it has limitations as a result of its centralised structure and lack of resources. Likewise, the sanitary surveillance offices do not have the technical expertise to act on their own in place of CNEN.

It was found that the CNEN refuse depots are almost full and that CNEN is not monitoring the increases in the amount of waste in the deposits and has no routine forecast of the amount of waste that will be deposited annually in each of them. There is a considerable risk that the deposits will reach critical levels and that the Commission will not have any safe options for depositing waste that is produced continuously.

One of the findings was related to weaknesses in the legislation. According to Brazilian law, the use, storage or maintenance of sources of radioactivity in contravention of security rules is criminal. Radioisotopes are one example of such a source. However, there is no clear legislation compelling the users of radioisotopes to deliver the sources of radioactivity to the National Commission of Nuclear Energy and to cover the costs of that delivery. The Commission even disagrees internally over this matter. Therefore, there is no guarantee that the users will deliver the sources of radioactivity when they are no longer in use.

The Canadian SAI conducted an audit in 1995 of the federal management of radioactive waste.
The following general audit criteria were used:

- *Roles and responsibilities for dealing with radioactive waste in Canada should be clearly assigned.*
- *The federal government should identify the problems of managing spent fuel, low-level radioactive waste (LLW) and uranium tailings in Canada, develop a strategy for their management and ensure that plans and budgets are in place to address their management, including their disposal.*
- *Appropriate and timely action should be initiated by the federal government to deal with all classes of radioactive waste in Canada.*
- *Federal initiatives dealing with radioactive waste in Canada should be cost-effective and should include reporting to Parliament on the costs and results of these initiatives.*

[31] The accident occurred in Goiânia. Two scavengers found and opened a caesium canister in an abandoned clinic, provoking a major nuclear disaster. Four people died and more than seven hundred people were contaminated.

– *The government should protect the federal taxpayer from potential liabilities as a result of radioactive waste.*
– *Any issues that remain unresolved in finding a long-term solution to radioactive waste should be disclosed to Parliament.*

With regard to High-Level Radioactive Waste (HLW), the Canadian SAI concluded that this waste is safely stored at reactor sites. However, Canada's inventory of HLW continues to grow. It is anticipated that active reactors will produce a total of over four million bundles of spent fuel by the end of 2033. This volume would be equivalent in size to about seven Olympic-size swimming pools. Although the current wet and dry storage are acceptable interim methods for storing HLW, it is recognized by the Canadian government, operators, experts in the field and regulators in other countries that a long-term solution is necessary. Such a solution is necessary because some of the radioactive material in spent fuel remains hazardous for tens of thousands of years.

The Canadian SAI believes that it is important to have some form of benchmark with which to assess the progress of the Canadian HLW program. At the recommendation of experts in the nuclear industry, they visited Sweden, Finland and France to discuss their radioactive waste management programmes. In the opinion of the experts, these countries had made progress in finding solutions for their highlevel as well as their low-level radioactive waste.

Federal responsibility for managing Canada's radioactive waste, including the search for long-term solutions, is divided among many players. With the exception of the assignment of residual responsibilities for uranium tailings, current federal responsibilities for radioactive waste regulation, storage and research are clearly defined and assigned. However, roles and responsibilities for implementing long-term solutions for high-level and low-level waste are not clearly defined and assigned.

While the various federal players understand their responsibilities, they are not always collaborating with other non-federal players on a common vision and agenda for disposing of Canada's radioactive waste. The federal government, in consultation with major stakeholders, needs to develop this common vision and agenda.

The various efforts of the many federal players involved have not yet resulted in a timely resolution of the difficult national problem of disposing of the HLW and LLW. Today, Canada has no disposal facilities for any of its high-level or low-level radioactive waste. Canada has not kept pace with some other countries in moving toward the implementation of a long-term solution for HLW or in developing operational LLW disposal facilities.

This audit is available in English at http://www.oag-bvg.gc.ca/

The SAI of China audited in 2002 the Management of Medical Waste. *After sampling, the SAI audited four hospitals and one medical waste incineration site in a selected city to obtain general information on medical waste management and disposal in that city and to propose suggestions for improvement.*

Audit findings:
– *The capacity of medical waste collection and disposal is quite inadequate.*
– *No strict internal medical waste control system was set up in hospitals. The hospital cannot determine the amount of medical waste produced, nor can it control the flow of that waste.*
– *The management of medical waste is slack. For example, in some hospitals, warning signs for dangerous waste were not printed on trash bags, transport vehicles or storage sites; medical waste was not sterilized before being canned; some medical trash bags were not leak-proof; many storage sites and transport vehicles were inadequately equipped with no refrigeration or leak-proofing facilities.*
– *Most medical waste incinerators were out-of-date with no mechanical refuse feeding or dust-catching devices. Smoke, dust and residues deriving from incineration exceeded the permitted level, and the residues of mud after wastewater processing did not reach the reprocessing sites specified by the environmental protection authorities, and thereby contributed to repollution.*

Main causes of these problems:
– *Inadequate investment in the infrastructure for the collective processing of medical waste, and no large-scale collective disposal capacity for solid waste has been built*
– *Lack of public awareness of the harm caused by medical waste and limited knowledge of pollution prevention*
– *Defective internal control of medical waste in hospitals*

The SAI of Mauritius audited in 1998 the government's solid waste management. *Mauritius generates some 380,000 tonnes of waste per annum. This represents a waste volume of approx. 1.9 million m^3, which is equivalent to covering the surface area of a football pitch (5000m^2) with waste up to a height of 300 metres.*

The total cost borne by the government relating to the collection and disposal of waste has increased significantly over the years. Although consultants were in favour of a cost-recovery system, the government has not yet reached a decision on this issue.

The strategic plan was prepared more than ten years ago, but there has been a delay in the implementation of the plan.

Control and monitoring were inadequate. The Enforcement Unit of the Ministry issued payments on the basis of only one or two visits to the contractual sites per month. It is therefore uncertain whether adequate services were provided for the money that was spent. Local Authorities have stated that they were not able to ensure effective control and enforcement of the scavenging resulting from a lack of personnel.

Waste storage was inadequate. Some 160,000 to 180,000 households, i.e. 55 to 62% of the total number of households in Mauritius, had no standardised storage receptacle for household waste, even though consultants had been recommending the use of such receptacles since 1994.

The waste collection service was inefficient. Each year 39,600 tonnes of municipal waste, i.e. 15% of the total waste generated in Mauritius, is not collected. According to the Household Census 2001, some 32,480 households have no collection service or only an irregular service. These households must therefore make use of other methods of refuse disposal, such as dumping.

Uncontrolled and illegal dumping is therefore a serious problem in Mauritius. In addition to municipal waste, 7,800 tonnes of construction and demolition waste are disposed of in an uncontrolled and illegal manner each year.

There is no sorting of waste, and no recycling or composting facilities are available to minimise the quantity of waste for disposal. It was reported that a market study of composting showed that the market for recycling is very small, which means that sorting would not be cost effective.

The SAI draws the following overall conclusion: Over the past ten years, the government has done much to improve waste management, but much more still remains to be done, especially in terms of waste collection and disposal. The implementation of the strategic plan must not be delayed any further so that the strategic goals can be attained. The government needs to know the total cost of solid waste management, and this can serve as a performance indicator to aid planning, monitoring and decision-making.

The SAI of Italy reported in 2000 on the management of the extraordinary efforts to dispose of waste matter in Campania.
Seven years ago, the situation with regard to waste in Campania warranted a declaration of a state of emergency, and as a result, a special commission was established to manage the problem.

The management goals consisted of interventions thought to be necessary to cope with the emergency situation:
- *IImplementation of facilities intended for the recovery of materials, fuel and energy from waste matter*
- *Achievement of the collection of waste matter and differentiated collection*
- *Promotion of the transport system for waste matter and establishment of the related rates*
- *Security measures for dumps (some of which were illegal)*
- *Interventions related to environmental clean-up*

The audit revealed that the management is still being conducted as if it were an emergency situation, even though this is no longer the case. Furthermore, the explicit target of collecting 35% of the material by differentiated collection has not been achieved.

The Italian SAI concluded that the results achieved seemed to be inconsistent and surely inadequate with reference to the estimates made by the management, when the time that has elapsed and the resources to which the management had access are taken into account.

5.6 Topic 6 – Compliance with national law

When dealing with environmental issues, the focus is usually on compliance with laws and regulations specific to this domain. However, one should bear in mind that environmental fields need to be conside-

red from other angles as well, such as the perspectives of health and safety and of accounting laws and regulations. Therefore, when dealing with environmental matters, it is important that all of the relevant laws and regulations be considered. Requirements often associated with financial audits have a natural place here. SAIs that do not have a mandate for performance auditing often use compliance with legislation and general quality requirements as a justification for environmental auditing as was done in the Chilean example below.

Furthermore there are laws against eco-criminality that should be considered.

The SAI of Hungary published in 2001 an audit of the operation of the Central Nuclear Financial Fund. *In this audit, the SAI evaluated the lawfulness and expedience of the operation and financial management of the Central Nuclear Financial Fund for 1998, 1999 and the first half of 2000. The audit included a review of the establishment and operation of the storage facilities for radioactive waste and burnt-out fuel.*

The law that governs the safety and protection of the local population and the environment regulates the use of nuclear energy in Hungary. According to this law, it is the task and responsibility of the government to manage and control the uses of nuclear energy. The government has delegated these functions and tasks to the National Nuclear Energy Committee, the National Nuclear Energy Office and a number of ministers. The law also includes provisions concerning the financing of task performance through the Central Nuclear Financial Fund, which had revenues of HUF 22,964 million and expenditures of HUF 8,342 million in the audited period. In order to ensure the safety of the uses of nuclear energy, the government commissioned the national office to set up the Radioactive Waste Management Company as a public company to operate radioactive-waste storage facilities. This company is also in charge of establishing storage facilities.

One of the findings was that resources from the fund were not only spent on research and exploration to select sites for final storage for low and middle level radioactive waste, but also on promotional activity to gain public support. The fund also financed experts who were supposed to find a suitable site for establishing the storage facility for High-Level Radioactive Waste. This research activity was cancelled after the government rejected the idea of deep exploration, because the research could continue from the surface with greater cost efficiency.

Another finding in this audit was that in two regions and in several projects[32], the cost of promotional activities to gain public support for existing and future radioactive storage facilities had been recorded in the accounts among the cost items for research and exploration work. This is in breach of the relevant regulations in the Accounting Act.

The SAI of Chile audited in 1999 the management of waste from households, industries and hospitals *using compliance with national legislation as a justification.*

Solid waste originated by households

The audit revealed that 72% of the country's landfills did not have the required authorisation based on appropriate resolutions. 30% of the landfills were illegally located too close to residential areas, putting local populations at risk.

Audit inspections carried out at specific landfills revealed that 42 % of the contractors of those landfills did not comply with their contracts. The audit also revealed that 65 % of the examined sites did not have a proper register confirming that the collected waste was in fact deposited at the landfill. Another finding was that some regions had non-registered micro-landfill sites, which pose a risk to the populations around them.

83 % of the examined landfill sites had also failed to maintain an updated register of the health service's inspections. The rest of them had not yet established a proper register in which the inspections to which they are submitted can be noted.

It was also found that 54% of the landfills received solid waste from industry and hospitals and also radioactive waste, and 41% of those landfills did not have registers that showed the kind of waste they had received.

The audit also reported that in several regions different critical studies of waste management had been carried out, but the good performance recommendations proposed in the studies had not been implemented. These studies had been financed by national and international aid funds.

Conclusions with regard to household waste

- *The audited regional public health services and municipalities have shown that they have not fully complied with their control obligations, usually because of a lack of resources, institutional policy, a lack of coordination and/or insufficiencies in the legislation.*
- *The regional public health services have not complied with their control obligations related to the minimum sanitary norms that any dumping site must fulfil in order to avoid danger to the sites' workers and the public in general.*
- *The municipalities have not complied with their own control obligations derived from the basic law of Municipalities, which prescribes obligatory measures for developing and preserving environmental quality in their own areas.*

Industrial waste

The Regional Health authorities' registers of industries that generate dangerous waste were insufficient in most regions. In some regions, there was no reliable register. The registers also lacked information about the amount of waste and its relative degree of danger. In some cases, the final destination of the waste was unknown. The regional offices of the Auditor General in Chile confirmed this information by control auditing a sample of 97 industries.

In 33% of the industries visited in the sample, in some cases the waste was transported to illegal dumping sites either by the industry itself or by contractors. In these cases, it was not possible to identify the final destination of the industrial waste. Thirty-five of the 97 audited industries did not have the required sanitary permits for the transport, treatment or final disposal of their waste.

Only a few of the regions provided specially delimited areas for industrial waste disposal at the dumping sites. In most regions, there were no suitable locations for industrial waste at the landfills.

[32] The Fund's investment projects for the intermediate deposit sites for burned-out elements

Given the absence of adequate, legal dumping sites and waste treatment companies in most regions, the industries usually chose to dump their waste at unauthorised sites, causing a diversity of environmental problems and the contamination of the surface and ground water. At some sites, there was a high risk of spontaneous combustion. Furthermore, the industries usually contravened the legal requirements that they declare the kind and amount of waste that they generated.

The audit stated that the health authorities have not required the audited industries to comply with sanitary regulations. Inspection activities are also too infrequent to provide an adequate level of control.

Waste from hospitals

The audit examined 45 public hospitals, approximately 24% of all public hospitals in the country. Another 36 health-care establishments, including private hospitals and clinics, emergency units, medical consulting rooms and policlinics, were also inspected.

Most of the health care services in Chile do not have clear regulations specifying how to manage their waste, other than regulations to prevent and control infections in hospitals and other health care establishments. The investigation revealed that in 1998 a regulation governing waste treatment to prevent infections issued by the Health Ministry's Division of Human Health was abolished three weeks later by the same ministry's Environmental Health Division. After that, the matter had not been regulated again[33].

The study uncovered that biological and surgical waste is often incinerated and then deposited at a municipal landfill, with or without the required permits from the sanitary authorities. Voluminous biological waste is usually buried in a common pit at the local cemetery.

In the public hospitals in two regions, the biological, surgical and chemical waste was incinerated in technically unsuitable incinerators, spewing toxic fumes into the atmosphere. In these regions, there is only one hospital with an adequate incinerator. Unauthorised incinerators were observed in some regions. In addition, some of the regions that did have incinerators did not utilize them in conformity with the regulations.

The hospital waste in one region was disposed of in an abandoned mine, posing risks to the environment and the local population. The place was not properly sealed and sanitarily secured, and no warning had been issued to people in the vicinity. In another region, the audit revealed that a hospital disposed of its waste in an old well in its backyard only two meters from the staff's cafeteria.

Misconduct was also discovered in practices relating to outdated pharmaceutical products. 12% of the sanitary institutions delivered the outdated medicines back to the producer; some users incinerated the outdated products and then disposed of the ashes at a landfill; and others dissolved these products in water and emptied them into the sewer system.

When it came to the control of radioactive substances, the audit revealed that the authorities failed to regularly monitor users, to make sure that the radioactive waste generated and the abandoned equipment had been safely treated and stored.

Other shortcomings that were found included:

- *Poor labelling of boxes containing hospital waste*
- *Defective bins*
- *Insufficient protection of staff responsible for the temporary transport and storage of this waste*
- *Insufficient access control to temporary storage installations and incinerators*

Conclusions regarding hospital waste

The current sanitary legislation includes very few regulations pertaining to the management of waste from hospitals and other health care establishments. The Health Services have not complied with the requirements of the law, and the Ministry of Health has failed to achieve its aims in a properly co-ordinated and unified way as specified in the General Provisions pertaining to Government Administration.

The Austrian SAI published in 2001 a report concerning the waste management activities of the organisation that carries out these activities in Leoben in Austria.

The organisation was established in 1988, and by 1991, 17 communities were members. Since the organisation did not have any treatment facilities of

[33] As of the year 2000

its own, the handling of the waste was delegated to a private company for an unlimited period. Later, the contract was renegotiated, and on this occasion the organisation succeeded in obtaining the cheapest price for the waste treatment in the region.

Due to the delay in payments from the participating counties, the organisation had to draw on some of its reserves. In order to overcome this problem, the SAI suggested the introduction of interest on overdue payments, among other things.

Because of waste separation and preventive measures, residual waste was reduced in the period 1992 to 2000 from 13,300 tonnes to 9,600 tonnes. However, the overall volume of waste increased in this period from 24,500 tonnes to 26,000 tonnes. In this respect, the SAI is of the opinion that the need for separation of waste should be emphasised to those who generate waste.

The Austrian SAI concludes its report by stating that the organisation's structure is in accordance with the requirements and is efficient.

The SAI of the Czech Republic conducted in 1996 an audit of the selection and utilisation of financial instruments in the field of waste management.

One aim of the audit was to verify the collection of revenue in the waste management system and the efficiency of their use for waste disposal together with funds provided from the national budget and the State Environmental Fund. The auditees were government administrative bodies (the Ministry of the Environment, the Czech Environment Inspection, local financial bodies, municipalities) and landfill operators.

The shortcomings ascertained among the auditees were related to violations of waste management legislation and unclear interpretations of some of the concepts used in the legislation. These weaknesses usually developed during the classification of waste and in the process of assessment and the selection of financial instruments. The consequences were under-fulfilment of revenue targets from fees and a low number of charged fines.

The Czech Environment Inspection did not use all of the instruments available during administrative proceedings, such as the separate management of fees and fines. Some of the administrative procedures for landfills were not specified or completed, and not all of the audited landfills were subject to payment. The level of fines resulting from decisions did not correspond to either the amount or the category of actual waste in landfill sites. The Czech Environment Inspection rarely fined landfill operators, even though the latter demonstrably failed to fulfil their obligations.

Audits of the financial bodies involved revealed that they did not keep the required records of fees and fines, and their accounting procedures were faulty. There were errors in connection with the collection of unpaid fees.

Audited district offices categorised some waste in waste plans that the official classification and the catalogue of waste did not allow. They also failed to fulfil other obligations, such as keeping records of waste announcements.

There were cases where landfill operators did not pay fees for landfills, or the fees were not paid in accordance with the regulations. Some landfills were operated without appropriate approval, without operational rules, and without the required records of waste.

The SAI of Malta performed in 1999, a preliminary survey of activities related to the Waste Management Strategy and the collection of revenue at landfills.

The Waste Management Strategy Implementation Department (WMSI) is supposed to implement the waste management policy and guidelines established by the environmental authorities, and it is responsible for the management of landfills in Malta and Gozo and for the collection of revenue from these sites.

The relevant environmental legislation can be interpreted as an expression of the government's "polluter-pays" policy. The legislation also enables the Department to collate statistics regarding waste management and to nurture and regulate the local "waste collection" industry.

The audit revealed a discrepancy between the amount collected and the expected revenue from waste collection activities. This discrepancy arose partly because the Department did not invoice users with the lowest rate-per-tip.

Site inspections at two landfills showed that there were several weaknesses in internal controls for revenue collection and statistical purposes related to the data on users and the type of waste deposited.

A system for the collection of statistics regarding the amount of waste deposited at privately operated sites had not been adopted by the Ministry of Gozo.

The SAI of Malta concluded that the issues highlighted in the report might be hindering the attainment of objectives established by the legislation. The potential loss of revenue to the government is not just disturbing in its own right, but also because the "polluter-pays" principle is not being applied in all instances.

The lack of internal controls at the data-collection stage of operations was also disturbing, since a sound policy of waste management cannot be based on incomplete data and information.

The lack of reliable statistics prevents investment plans for environmentally related sectors from being clearly channelled in accordance with the EU's "acquis" requirements.

5.7 Topic 7 – Compliance with international obligations

International agreements and conventions on waste are important instruments when it comes to preventing damage to the environment: It is therefore imperative that the SAIs keeps parliaments informed of how well executive governments fulfil their international obligations in this respect.

In its most basic form, the audit of compliance with international obligations can address the issue of ensuring that the international obligations signed by a country are fully implemented in national laws and regulations. Furthermore, it is important to evaluate how effectively the obligations are fulfilled and whether required measurement and reporting systems are in place and providing correct and timely information.

The audit of international obligations is an area in which it is especially useful for SAIs to co-operate. Such co-operation might yield economies of scale because SAIs can help each other in the formulation of good audit questions and the collection of background information. It might also be useful for countries – and for the environment – to get an unbiased view of how well a participant is performing relative to other participants or to a group of such countries.

The SAI of Poland conducted in 2000 an audit on the management of hazardous waste. *Among the objectives of the audit was the assessment of:*

- *compliance with the following focal points of the Basel Convention: reducing the amount of hazardous waste generated, ensuring the availability of facilities for the disposal of hazardous waste and minimising the transboundary movement of waste.*
- *progress in the implementation of the National Environmental Policy in the field of priority tasks aimed at reducing the impact of hazardous waste on the environment*
- *performance by the regional government in the area of granting permits to economic entities for the generation and disposal of hazardous waste, performance by the regional authorities in the area of the collection and redistribution of fees for the storage of hazardous waste and fines for the violation of regulations or administrative decisions relating to the storage of hazardous waste*
- *supervision exercised by the regional environmental protection inspectorates of compliance with the administrative decisions and environmental regulations relating to protection against hazardous waste on the part of entities that generate and receive hazardous waste.*

Among the findings were irregularities in the functioning of the system of supervision and control of international movement of hazardous waste. There were cases where the export of waste through border checkpoints and/or the transport of waste by carriers other than those specified in the permit had been allowed. Another problem was related to the transit of waste: the customs authorities did not keep complete transit registers.

The audit indicates insufficient compliance with regulations relating to the protection of the environment against hazardous waste by the administrative sectors of government and self-government administrative bodies and by the parts of businesses involved in activities related to the generation and/or disposal of hazardous waste.

The entities that generated or received hazardous waste often conducted their activities without the necessary permits for the generation and/or disposal of this waste. The regional authorities did not have sufficient information about the economic entities that were obliged to hold such permits and lacked sufficient information about the entities that were obliged to pay fees for the storage of waste.

The audit also indicated the need for strict enforcement of regulations related to hazardous waste management by economic entities as well as go-

vernment and self-government administrative bodies. It is necessary to strengthen the supervision by the Environmental Inspection of economic entities with regard to hazardous waste management and likewise the supervision by the Customs Authorities and the Environmental Inspection of the international movement of hazardous waste.

A summary of the audit is available in English at http://www.nik.gov.pl/intosai

The SAI of Canada published in 1997 a report on the control of the transboundary movement of hazardous waste. *The international agreements used as audit criteria were the Basel Convention, the Canada–USA Agreement on the Transboundary Movement of Hazardous Waste and the OECD decision on the transboundary movement of hazardous waste.*

The SAI concluded that Canada does not know how well it is meeting its international obligations to prevent illegal traffic in the transboundary movement of hazardous waste.

The Ministry of Environment in Canada is not always sure whether shipments of hazardous waste reach their final destination or are properly disposed of, or recycled. While the ministry has made a start in establishing a regime to control the legal transboundary shipments of hazardous waste, there is little chance of detecting illegal traffic of hazardous waste at border points. Customs officers need more training to enable them to recognise hazardous waste shipments. Effective sampling of potentially illegal exports and imports is very limited.

The SAI concludes that it is even more difficult to detect the presence of hazardous waste at rail yards or marine ports. Relatively few rail containers are examined, whether they are imports or exports. There are no targeted inspections of containers exported by ship.

The SAI also commented that it has taken five years for Environment Canada to begin to enforce the Export and Import of Hazardous Waste Regulations

In auditing this area, the SAI used the following definitions of the terms "enforcement" and "compliance". Compliance means the state of conformity with the law. Compliance is secured through two types of activity: promotion and enforcement. Measures to promote compliance include the communication and publication of information, consultation with parties affected by an act, technical assistance and technology development.

Enforcement activities include:
- *inspection and monitoring to verify compliance*
- *investigations of violations*
- *measures to compel compliance without resorting to formal court action, such as directions by inspectors, ticketing, and ministerial orders*
- *measures to compel compliance through court action, such as injunctions, prosecution, court orders upon conviction, and civil suits for recovery of costs*

For the purpose of the audit, the SAI distinguished between illegal traffic and administrative non-compliance, which is also illegal according to the Basel Convention. Illegal traffic is essentially a serious environmental crime capable of producing dangerous impacts, including threats to human health. Administrative non-compliance can occur through error, ignorance, and technical or relatively minor administrative breaches.

The SAI observed that there are real incentives for illegal traffic. There is considerable money to be made, a low chance of detection, and an even lower chance of receiving administrative, civil or criminal sanctions. The disposal of a legal truckload of hazardous waste, typically 22 metric tonnes, may easily cost ten thousand dollars. There are also costs for liability insurance and brokerage, and an approximately 35 to 40-day waiting period for completion of the required paperwork. Illegal shipments involve no paperwork and no recycling or disposal costs, whether disposed of in Canada or abroad. There is little chance of getting caught, given the volume of traffic at the border and the variety of substances that are potentially hazardous waste. Even if violators are caught, infractions of the Export and Import of Hazardous Waste Regulations have not resulted in large penalties.

This report is available in English at http://www.oag-bvg.gc.ca/

The SAI of the United Kingdom published in 2002 a report addressing pollution from ships. *Among the issues covered was the question of whether the government has ensured that ports and harbours have waste management plans and waste reception facilities. The MARPOL convention was used as basis for developing audit criteria.*

Since January 1998, all port and harbour authorities have been required to have a waste management plan and appropriate waste reception facilities for dealing with oil residues and oily mixtures, noxious liquids and garbage from vessels using their ports. The Ministry of Transport issued guidance on what should be included in the ports' waste management plans.

The responsible government body, the Maritime and Coastguard Agency (the Agency), initially identified over 600 ports that would be subject to these requirements. In order to prioritise its work, the Agency drew up a list of 36 major ports, each having a throughput of more than two million tonnes of cargo a year; 75 intermediate ports where there was substantial shipping activity; and around 500 small ports.

The Agency set itself a target of approving the plans for all major and intermediate ports by December 1999, and for small ports by March 2001. It substantially achieved its targets.

The UK SAI also addressed the issue of whether the Agency has ensured that waste reception facilities are adequate.

The Agency does not have statutory responsibility for ensuring that ports and harbours maintain adequate waste reception facilities; maritime legislation places the responsibility for this on the harbour authority. However, the Agency commissioned an independent survey of waste reception facilities at 35 UK ports in July 2000 to assess compliance with the port waste-management requirements, and the results of this survey were satisfactory. The Agency also voluntarily visits a sample of ports each year to assure itself that the required facilities are in place.

The use of port waste facilities is usually covered by the fees that port and harbour authorities charge vessels for using their ports. The master of a vessel faced with inadequate or no reception facilities should bring the alleged inadequacy to the attention of the port concerned and of the Agency for investigation. Seven cases were reported to the Agency over the two years from April 2000 to March 2002. The Agency identified deficiencies in four cases and required the operators of the ports to improve their waste-handling procedures. The facilities were found to be adequate in the other three cases.

The full text of this report is available in English at http://www.nao.gov.uk

5.8 Topic 8 – Monitoring

The term monitoring covers the activities of governments to oversee practices related to waste handling at different levels and the different instruments that governments use to ensure compliance with legislation, concessions and goals related to waste.

First, there is need for information. There has to be a system that provides the government with relevant, reliable, valid information about the different activities related to waste management. This may imply the existence of a system that ensures a satisfactory flow of information, such as reporting procedures. Furthermore, the information needs to be of sufficient quality with reference to the purpose. If the information is statistical, the quality of the procedures for collecting the basic material and punching and processing the data must be satisfactory. The Bolivian example below reveals inadequacies in the general system of monitoring.

Secondly, monitoring implies a system of control. Inspections or the physical presence of people controlling waste sites such as installations, plants, landfills etc. are a core activity in this respect. Monitoring may involve checking systems of internal control. These systems require good procedures and must be put to use in a proper manner. They can be subject to supervision by relevant government bodies. If the monitoring agency does not have the capacity to inspect all agencies and activities, the decisions on what to inspect must be based on a calculation of the risks entailed for the population's health and the environment.

The German audit below emphasises the insufficiency of setting goals without establishing control routines and criteria for measuring the attainment of those goals.

The third element of monitoring is the use of policy instruments when noncompliant practices regarding legislation and good management are discovered. These can be information or recommendations, but can also be coercive measures such as fining, closing a waste site, withdrawal of a licence or permit or instructions for further practices. Agencies may have the authority to enforce licence terms and to prosecute those who are handling waste illegally. The Norwegian audit focuses on the unwillingness of the responsible government body to employ coercive measures.

- ***The SAI of Norway audited in 2001–02 the management of old hazardous waste sites,*** *studying in particular whether the clean-up of sites had resul-*

ted in the fulfilment of the goals set by the government and whether the environmental authorities ensure that the liable owners clean up their sites.

Considerable amounts of hazardous waste have been stored without the necessary safeguarding or control at various sites around the country over the years. Hazardous substances have contaminated the environment through leakages and spills from industrial activities. The clean-up of such pollution became a government priority in the early 1990s. A nationwide survey of polluted sites was undertaken in 1989–91, and about 2,500 locations where identified. Since then, another 1,000 sites have been identified.

The sites have been classified into four groups, depending on the severity of the pollution. The SAI of Norway studied the sites classified as "the most severely polluted", a total of 151 cases. The audit showed that a number of sites were incorrectly classified or overlooked in the original survey. In addition, several cases were described as "closed", even though the sites had not been sufficiently cleaned up.

The audit also revealed that the environmental authorities have revised and scaled down their goals for cleaning up these sites several times. In the goals adopted in 1999, one of the major objectives was to clean up the most severely polluted sites by the end of 2005. However, the audit questions whether this goal will be met.

In many cases, the actions imposed on the liable owners by the environmental authorities were not implemented. The SAI of Norway's investigation established that the environmental authorities are reluctant to use the coercive measures specified in the Pollution Control Act.

The SAI of the United Kingdom published in 2002 the audit "Protecting the public from Waste"
The Environment Agency (the Agency) regulates the management and disposal of over 170 million tonnes of waste produced by homes, commerce and industry in England and Wales each year. Around 45 % of this waste goes to landfills, including 80 % of the household waste; the rest is recycled or incinerated. The audit report focuses on the Agency's inspection and licensing work in England.

The Agency was established in April 1996, taking over responsibility for waste regulation from 83 local waste regulation authorities. It regulates waste within a legal and policy framework established by the Department for Environment, Food and Rural Affairs (the Department) and reflecting European Union legislation. This framework sets out the responsibilities of producers and handlers of waste, and requires the more significant waste sites and activities, such as landfill sites, to be licensed. Other sites and activities must be registered with the Agency, providing much less control than a licence.

Some 7,700 waste sites and activities are currently licensed, and a further 54,000 sites and 67,000 waste carriers and waste brokers are re-

Thomas Tolstrup / Samfoto

gistered with the Agency. The legal framework provides for the Agency to regulate waste in three main ways: by setting out how waste should be managed, e.g. in terms specified in licences; by monitoring to check compliance with licences and the law, primarily by inspecting waste sites and activities; and by dealing with problems, e.g. by prosecuting those disposing of waste illegally.

Recent European Union legislation has increased the Agency's workload, and more is expected to do so in the near future. The Agency is therefore seeking to modernise its approach to waste regulation in order to release staff to help to deal with this new work.

The Agency has made much progress since 1996 in creating a single organisation providing consistent and professional regulation across the country. Nonetheless:

- *The Agency could make better use of the resources it uses to inspect waste operators, improve the effectiveness of regulation, and reduce unnecessary regulatory burdens, by carrying out fewer but more comprehensive and in-depth inspections.*
- *The Agency needs to deal more effectively with operators that persistently fail to comply with their licences. The Agency has become increasingly active in prosecuting waste offences but needs to use its enforcement powers more effectively*
- *The Department recognises that controls over sites exempt from the requirement to be licensed need to be changed, e.g. to bring some currently exempt types of sites within the scope of licensing, and to exempt others that are currently licensed, but it has taken too long for the Department to complete a review of these controls.*
- *The Agency needs to look for ways of reducing the time taken to deal with licence applications.*
- *Taxpayers may end up paying for dealing with problems caused by abandoned waste sites; particu larly landfill sites, because operators' financial provisions are either insufficient or unavailable.*
- *Evidence pointing towards an increase in fly-tipping following the introduction of the Landfill Tax in 1996 is anecdotal, and the Agency's records do not show a clear trend. However, the Agency estimates that each year there are around 50,000 fly-tipping incidents, costing local authorities some £50 million to £150 million to deal with.*

This report is available in full text in English at http://www.nao.gov.uk

***The German SAI conducted in 1996 an audit focusing on the fulfilment of environmental requirements tied to investment grants** for reducing environmental pollution and promoting investments in pollution reduction (report VII 7-3002/96).*

1. A centre for waste treatment applied for a government grant designed to promote innovative practices in waste disposal, arguing that their concept of waste utilisation was unique.

Insofar the German SAI concludes:

- *The project received grants from the government, even though the government environmental agency (UBA) did not regard any of the technical components as groundbreaking or innovative*
- *The innovative nature of their concept could be seen in the unique combination of components, but the audit showed that neither the combination of components nor the way in which they were operated were of an innovative nature.*

2. Two of the targets of the project were extensive public presentation of the means of operation and the optimisation of sorting and intermediate storage of problematic waste. These targets also constituted requirements for the grant.

The communication between the company and the government environmental agency (UBA) was not found to be sufficient with regard to how the goals should be attained and how effectiveness should be checked in connection with both of these targets.

When the centre's technical components had been in use for a while, the degree of attainment of some of the goals was studied and reported by the company. For example, public relations activities had been carried out in collaboration with the county authorities. For many other targets, the SAI was unable to establish that government environmental agency (UBA) had followed up the goals or tested goal effectiveness. Insofar, the German SAI concludes, that:

- *The project targets had not been researched.*
- *No control of effectiveness was carried out*

The German SAI considers this to be a necessary condition for measuring success and profitability in accordance with the federal budget regulations. In addition, it is emphasised that it is insufficient to set goals without establishing criteria for measuring the attainment of those goals and proposing control routines.

The SAI of Bolivia conducted in 2001 an audit of the environmental performance of the responsible entities *involved in the final disposal of solid waste in one sanitary filling pit in the city of Cochabamba. The major findings were:*
The mayor did not have a programme for monitoring biogas, leachate to subterranean waters, etc. The monitoring activities performed by the municipal waste service firm did not comply with the environmental standards and were insufficient and inadequate.

In the first half of 1999, the waste service firm did not manage hazardous hospital waste adequately. In the second half of 1999, it started to place hazardous hospital waste in a special cell, but the environmental standards were still not satisfied because of certain operational factors.

The audit also revealed that there were discrepancies with regard to the reception and treatment of tannery sludge. The inadequate disposal of dry tannery sludge had caused changes in the ground beneath the sludge. The regional association had only partly implemented the Inter-Institutional Convention for an integral solution for the treatment and final disposal of tannery waste. Some of the necessary construction had not been built, and the technical supervision of the treatment of sludge was insufficient.

5.9 Topic 9 – Effects of other government activities

Most economic activities create residues of some sort. Experience has shown that government activities are not necessarily any more environmentally friendly than other economic activities. In many countries, each ministry is responsible for all aspects of the activities under their jurisdiction. When ministries or public enterprises are involved in investment projects, production or the delivery of services it is unavoidable that waste will be generated. This waste has to be managed in a professional manner. Typical sectors in which government activities produce waste include: transport, defence, the construction

River polluted from household waste. Fredrik Naumann / Samfoto

of public buildings and infrastructure, oil and energy production, and the provision of hospital and other health-related services. It should also be noted that even the government bureaucracy generates waste from offices, etc. The SAI should perform audits to ensure that the government as a producer complies with the applicable laws and regulations relating to the minimisation and disposal of waste in a way that is as efficient and economic as possible.

Another problem that may be addressed is to ensure the inclusion of waste management costs in budgets and specifications. In compliance with Principle 16 of the Rio Declaration, nations should take "into account the approach that the polluter should, in principle, bear the cost of pollution". This is also called the polluter-pays principle and constitutes a sound approach to economic activity in general – the clean-up costs should be acknowledged and visible in accounting documents. In countries that only practice cash-based accounting, it is particularly important that future costs of waste management are made visible to the decision-makers and taken into account when decisions are being made. The SAI should make sure that this is indeed the case.

The SAI of the USA examined in 2001 the environmental clean-up costs of ongoing operations of the Department of Defense (DOD). *Clean-up costs are costs associated with hazardous waste removal, containment, or disposal and include decontamination, decommissioning, site restoration, site monitoring, closure, and post-closure costs. With the exception of training ranges and weapons systems, the review included all ongoing and inactive/closed operations at six active installations known to result in hazardous waste and subject to federal, state and/or local laws or regulations requiring removal, containment or disposal of that waste.*

The objectives were to determine:
- *The scope of ongoing DOD operations with potentially significant clean-up costs*
- *The potential magnitude of costs to clean up and dispose of the hazardous waste resulting from those operations*
- *The availability of data for developing clean-up cost estimates*

The audit showed that DOD has not developed policies, procedures and methodologies to ensure that the clean-up costs required for all of its ongoing and inactive or closed operations are identified, consistently estimated and appropriately reported. As a result, DOD's financial statements and environmental reports continue to underreport environmental liabilities and related long-term budgetary needs.

The military installations that the auditors visited comprised a total of 221 sites with estimated clean-up costs of USD 259 million. Of these sites, only 45 with estimated clean-up costs of USD 61 million were being reported in the Defense Environmental Restoration Program Annual Report to Congress, and only that amount was likely to be included in DOD's financial statements.

The auditors also found that DOD was not reporting 149 sites related to ongoing operations and 27 inactive and closed operations.
This report, GAO-02-117, is published in English at http://www.gao.gov/

Background Orientation on Waste[1]

[1] This text is written by a team from Norwegian Resource Centre for Waste Management and Recycling under the supervision of the Office of the Auditor General of Norway.

1 Definition of waste

This chapter describes some of the difficulties in distinguishing between product and waste. In a household or a small business, the definition of waste is relatively straightforward, but in a processing plant, the distinction between product and waste is not always clear.

Most of us would probably define waste as a product or substance that is either damaged beyond repair or is no longer usable. In other words, waste is something that is no longer of any use to you, so you might just as well part with it.

This definition is fine as long as you are only dealing with goods that are intended for consumption, but in the processing and manufacturing industry this definition soon becomes unusable. Here, large quantities of a wide range of substances flow into, out of and between plants, making it difficult to distinguish between raw material, by-product and waste.

In many cases a substance that is no longer usable in one plant, can be used for a totally different purpose in another plant, with excellent results. With regard to the definition given below, it could be argued that the substance is no longer usable for its intended use, and hence should be regarded as waste. The holder of the waste, on the other hand, would argue that the used substance is a product (i.e. not waste) since it is usable in another plant. If the holder of the waste gets paid for the product, it is even harder for him to regard the substance as waste. Most people are used to thinking that something that you can get paid for must be a product.

To sort this out, a legal definition is needed. Most countries have adopted some form of definition of waste, which varies throughout the world. It would be beyond the scope of this project to list all the definitions that are in use today, but in general they are all based on the term "discard", i.e. something which the holder intends to get rid of or has got rid of. In the Basel Convention (www.basel.int) waste is defined as "substances or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law". Another definition of waste is a product no longer suited for its intended use. The value of the object plays no role in defining whether an object is waste or not.

One of the most extensive definitions can be found in the European Union, where waste is defined in directive 75/442/EEC as "any substance or object set out in annex I which the holder discards or intends or is required to discard". Annex I contains 16 categories of waste, numbered from Q1 to Q16. Some examples are:

Q2 Off-specification products
Q6 Unusable parts
Q7 Substances, which no longer perform satisfactorily
Q13 Any materials, substances or products whose use has been banned by law

These definitions may seem relatively straightforward at first glance, but several factors complicate the picture. In the example above, we saw that it is not natural to regard something that is most definitely useful as waste. Another complicating factor is that a substance can be defined as waste at one point in time and as a product at another time, if there is a demand for it on the market.

The example of timber illustrates a well-known problem in the processing industry: a large number of chemical components can be extracted from timber. Since the chemical composition of timber is relatively constant, the amounts of components as well as the relative quantities in which they are produced remain constant. In Scandinavia, the wood-processing industry has developed an "eco-system" between various components derived from the log flow between plants on opposite sides of country borders. As long as there is a demand on the market for a certain component, it can be sold as a product. If the demand diminishes or ceases completely, the producer has to get rid of it in other ways, i.e. he may have to pay to have it destroyed as waste. In other words, a fluctuation in the market means the same substances can be products at one time and waste at another.

If you consider a processing plant as a black box that consumes raw materials in one end and gene-

rates one or more products in the other, not all the raw materials will come out as products. The fractions of the raw materials that have not been used or that have been chemically transformed into components for which there is no use can be classified as waste or by-products depending on market demand and/or legislation. In general, the authorities regulate waste more strictly than products. This is especially true when waste is to be moved from one country to another. If a use can be found for a substance that has hitherto been treated as waste, the holder of the waste can face major difficulties in convincing the competent authorities that the substance is no longer waste, but a product that should be moved freely without restrictions.

2 Classification of waste

This chapter describes various ways of classifying waste. Most often, waste fractions are classified according to generator and/or hazardous properties, but classification can also be based on composition and chemical/physical properties.

2.1 Introduction

Many parameters can be used to describe waste, and depending on your role in the waste theatre, some will be more important than others. For a legislator, the distinction between hazardous and non-hazardous waste may be one important parameter, since legislation regarding hazardous waste is usually stricter than for non-hazardous waste. For a treatment plant, composition may be more important, simply because some types of waste are not treatable in that specific plant.

The most common parameters used to classify waste are:

1. Hazardous properties
2. Generator
3. Chemical and physical properties
4. Organic/inorganic
5. Composition

These parameters will be discussed in more detail below. When reading the description, bear in mind that in many cases the parameters overlap and are dependent on each other. The hazardous properties of waste are highly dependent on the composition of the waste, which is again dependent on the producer of the waste, and so on.

2.2 Hazardous properties

Hazardous waste is waste that can be harmful to people or the environment. Examples of hazardous properties are listed at the back of appendix 1. Waste that does not display any of these characteristics is classified as non-hazardous.

In many cases the distinction between hazardous and non-hazardous is not intuitively obvious. For instance, diesel fuel is regarded as flammable, whereas paper is not, even though paper burns vigorously. Ordinary table salt (NaCl) is not considered toxic, but intake of large amounts of salt is nevertheless lethal. The reason for this can in many cases be found in the testing methods that are used to determine whether an object is hazardous or not.

Bjørn Rørslett / NN / Samfoto

International classification standards

In the 1980s, two international organisations developed classification systems for hazardous waste. They are the Basel Convention (www.basel.int)[2] and the OECD (www.oecd.org).

The Basel Convention is an international diplomatic convention that has been ratified by most countries in the world and has thus become a de juro standard. The convention governs international transport and disposal of hazardous waste and includes a list of 45 waste streams ("Y-numbers") and hazardous constituents that should be controlled.

OECD (The organisation for economic co-operation and development) is an international organisation that helps governments tackle the economic, social and governance challenges of a globalised economy. OECD has established a far more extensive list, which also includes non-hazardous waste. With reference to traffic lights, waste is divided into three categories; green, amber and red. The green list includes non-hazardous waste products such as paper, plastics, glass and metals in their reduced state. The amber list includes most hazardous waste, while the red list is reserved for highly hazardous waste such as PCB, PCT, asbestos and lead containing anti-knock fuel additives. It is worth noting that for certain types of waste to be included in the green list, they have to be in a non-dispersible state. This means that powders and liquid solutions are considered hazardous even if the solid material itself is not hazardous.

Physical / chemical hazardous properties

Some types of waste have properties that can be harmful to people, living organisms and / or the environment. Common examples of hazardous properties are flammable[3], toxic, explosive, corrosive, ecotoxic and infectious. Such waste is called hazardous waste.

Chemical waste is an inaccurate term that is often used to describe the hazardous fraction of industrial waste. It is a synonym for hazardous waste.

Hazardous waste. Car batteries and battery oil. Ove Bergersen / NN / Samfoto

Hazardous waste is not necessarily more harmful as waste than when it was a product, but if hazardous waste is not taken care of properly, it may pose a threat to human health and the environment. For this reason, many countries have strict regulations on the storage, collection and treatment of hazardous waste.

Some waste may need special treatment because of its physical properties, even though it does not have hazardous properties. Three such properties are liquid, gaseous or powder. Such waste needs special handling to avoid unwanted dispersal of the waste. One good example is an ordinary household fire extinguisher. It consists of a metal cylinder filled with a non-toxic gas and a powder. If released in a confined space, the gas will offset the oxygen balance in the room and may lead to fatal breathing difficulties. If the gas is released quickly the cylinder itself can be cooled down to a point where touching it can lead to serious frost injuries. Finally, the powder, although not toxic, can be harmful because it clogs the pores in the lungs and prevents oxygen from entering the blood stream.

Asbestos is another example. Asbestos is a group of naturally occurring minerals that have none of the hazardous properties mentioned above, and when exposed to sun and rain asbestos minerals will weather away quickly. The real danger with asbestos is that it is fibrous and that the tiny strands of the mineral can cause lung cancer if inhaled.

Radioactivity

Technically speaking, radioactivity is a hazardous property, because exposure to radiation can cause serious illness, or even death. Many radioactive substances are also highly toxic. In contrast to "other" substances with hazardous characteristics, radioactive substances are not readily available to the general public. In general, radioactive materials are only available to scientists, nuclear power plants and other users who have a specific need for radiation in their work. Because of this, radioactive substances are dealt with separately below.

Radioactivity is a naturally occurring process, which is caused by instabilities in the core (nucleus) of an atom. Each atom in the universe has a core that consists of one to about 115 protons. In addition, there will be a number of neutrons in the core, ranging from zero to about 200. Only certain proton/neutron combinations are stable, and an atom with an "illegal" proton/neutron ratio is unstable. To regain stability, the atom can either emit energy (gamma radiation) or it can get rid of the overload by offloading excess particles in the core. This is called particle radiation.

Releasing a particle or a gamma unit is called disintegration. One disintegration per second equals one Bequerel (Bq). Bq is a measure of the activity of a radioactive component and is often expressed relative to mass, volume or surface units, such as Bq/g or Bq/l.

Examples of particle radiation are alpha, beta (electrons) and neutrons. The "softest" type of radiation, alpha, will not even go through a single sheet of paper. If inhaled, however, it can cause lung cancer. At the other end of the scale, high-energy gamma radiation is able to penetrate several feet of lead. In addition to the hazards connected to radiation, many radioactive materials are also highly toxic.

Each individual atom will continue to emit different types of radiation several times until it has reached stability and the radiation eventually dies out. Since radioactivity is so closely connected to the conditions in the interior of the atom, there is no way to destroy it. The only way to treat radioactive waste is to separate the highly radioactive fractions from the less radioactive fractions, place the waste in tight containers and store them until the radiation has reached a non-hazardous level. Depending on the type of atom this process can take anything from microseconds to millions of years. Storage usually means storage in stable geological formations several hundred metres underground.

Although many people associate radioactivity with nuclear power plants and atomic bombs, radioactivity is a natural process that has existed ever since the universe came into existence. For instance all types of life, including human beings, contain radioactive components.

Typical sources of radioactive waste are

- Nuclear warheads
- Waste from nuclear power plants
- Build-up of low-radioactive deposits in tubes (scale)
- Waste from hospitals (cancer treatment, etc.)
- Other scientific and technical uses

[2] The Basel Convention on the control of transboundary movements of hazardous waste and their disposal adopted by the conference of the plenipotentiaries on 22 March 1989.
[3] It may be worth noting that the words "flammable" and "inflammable" have the same meaning in English – to catch fire and incinerate.

Waste from the two first sources are normally under tight political and regulatory control, and most countries have established systems not only to take care of the waste, but also to guarantee that radioactive materials will not get into the wrong hands.

Legislation regarding the other types of waste can vary from country to country, but in most countries, all activities associated with radioactive materials (production, ownership, usage, storage, etc.) require a permit from the competent authorities. People who possess radioactive materials are also required to take necessary steps to prevent radiation. This includes proper storage and handling of waste. Since radioactivity is a naturally occurring phenomenon, legislation also includes limits for when the radiation level is so low that legislation no longer applies.

Infectious waste. Clinical and medical waste

This is waste from treatment of diseases in humans and animals. This type of waste usually consists of medicines, sharp objects, bandages, body fluids and body parts (from amputations and surgery). This type of waste usually contains bacteria and other organisms that can spread harmful diseases if not taken care of properly. It can be said that clinical waste is "alive" and therefore needs special treatment such as incineration or high-temperature treatment to kill or disable the bacteria.

2.3 Waste generators

Waste can also be classified according to who generated it, for instance:

- Household/domestic
- Commercial (from offices/small businesses)
- Industrial
- Mining

The main reasons for this distinction is that **households** generate relatively small amounts of waste with a heterogeneous composition and because most councils/counties provide a system for collection and transportation of waste. The term includes all waste from the household's day-to-day activities, such as paper, plastics, food, etc. as well as larger items like clothes, utensils, furniture, etc.

Industrial waste, on the other hand, comes in larger quantities and generally has a more homogeneous composition that reflects the type of activity it originates from. A sawmill will generate large amounts of sawdust, and it can be worthwhile establishing special routines to handle the waste. The amounts can often be so large that the council/municipality is unable to take care of the waste. Handling of industrial waste is often the responsibility of the owner/producer. Large, homogeneous quantities of waste have a high potential for recycling, and are rapidly becoming lucrative business in many places.

The composition of **commercial** waste can vary between the two aforementioned extremes depending on the type of business. In many cases, waste from small businesses has the same composition as household waste, and the two can often be handled together.

Mining waste consists of large amounts of rock fragments that are deposited outside the mine. The size of the fragments ranges from millimetres to metres. The life span of a mine can be more than a hundred years, and in that period several thousand cubic metres of masses will be drilled out and deposited. In some cases the waste consists of relatively harmless rock fragments, but in other cases large amounts of harmful heavy metals (which occur naturally in all types of rock) can be released into the environment. Examples of such metals are mercury, cadmium, lead and copper.

2.4 Chemical and physical properties

It is important for treatment plants to have knowledge of the physical and chemical properties of the waste, so that they treat it properly. Some important properties are:

Calorific value: the amount of energy per kilogram of waste. The higher the energy content, the more valuable the waste is as a fuel. It also means that the waste is less likely to be reused or recycled, for economic reasons. Selling the waste as a fuel is usually more lucrative than having it recycled.

Density: the ratio between the mass and volume of the waste. This is important for most aspects of handling and design of treatment plants. Light waste requires large storage volumes and more vehicles to transport it.

Grain size: An important parameter for all aspects of handling. Small grains are more prone to be swept away by the wind and thus more difficult to keep in place.

Moisture content: water content in percent. High water content usually means higher treatment costs, since the waste will be less useful as a fuel, and because in most cases the water needs to be treated before it can be released to sewage or a recipient.

Solubility: the amount of matter that can be dissolved in one litre of solvent, usually water. If waste is soluble in water, landfilling can be complicated because rainfall will transport the waste out of the landfill.

Specific weight: see Density.

Viscosity: a measurement of the toughness or pumpability of the waste. Syrup has a higher viscosity than water.

2.5 Organic/inorganic

The distinction between organic and inorganic matter is fundamental in chemistry, and hence also for waste treatment.

The formal difference between organic and inorganic matter is that organic matter contains carbon[4], whereas inorganic matter does not. The reason why the term "organic" is used is that in the past chemists distinguished between components derived from living ("organic") and non-living organisms. In most cases, components derived from living organisms contain carbon, whereas components from non-living organisms do not.

The greatest diversity and complexity is found in organic components, which can range from relatively simple components such as sugar, through highly complex structures such as human DNA. Both can easily be broken down by bacteria, and are not considered hazardous. Another example is PCB (polychlorinated-biphenyls), which has a relatively simple chemical structure, but is highly toxic and can only be destroyed through incineration at temperatures above 1100 ˚C.

Table 1 summarises the major differences between organic and inorganic components.

For other parameters, such as chemical stability, toxicity and irritability, few generalisations can be made.

Figure 1 on page 70 shows the composition of hazardous waste in four different parts of the world, with organic/inorganic as the main parameter.

Although this is a relatively simple presentation, some information can be deducted from the figure. For instance, the high percentage of organic waste in the richest parts of the world (OECD) is a sign of a highly industrialised society, where the industry refines organic raw materials into complex and highly specialised products.

2.6 Composition

In short, composition is a description of the contents of the waste. A large number of terms can be used, which vary from general terms to more specific terms. In addition to providing important information to the people that are going to handle the waste, the composition of the waste can also tell us more about the people who originally generated the waste.

The compositional terms that are used can vary a lot, from relatively simple descriptions in terms of organic/inorganic to more complicated schemes, using many or all the constituents, such as paper, plastics, glass, metals, etc.

For other purposes, it can be useful to look more closely at the specific components of the waste. This is becoming increasingly important now that more and

Feature	Organic	Inorganic
Major constituents	Carbon	Metals are common
Chemical complexity	Varies from quite simple to highly complex	Usually simple (with the exception of silicate minerals)
Energy content	Usually high (with the exception of water). Chlorinated components often require energy (i.e. high temperatures) to be destroyed.	Usually low, but can be reactive.
Flammability	Flammable	Not flammable, but certain components containing oxygen can support combustion and are highly reactive because of this.
Type of treatment	Incineration, chemical or biological.	Physical or chemical.

Table 1: Summary of major features of organic and inorganic components.

[4] By contrast, carbonate (CO_3) is not considered an organic component.

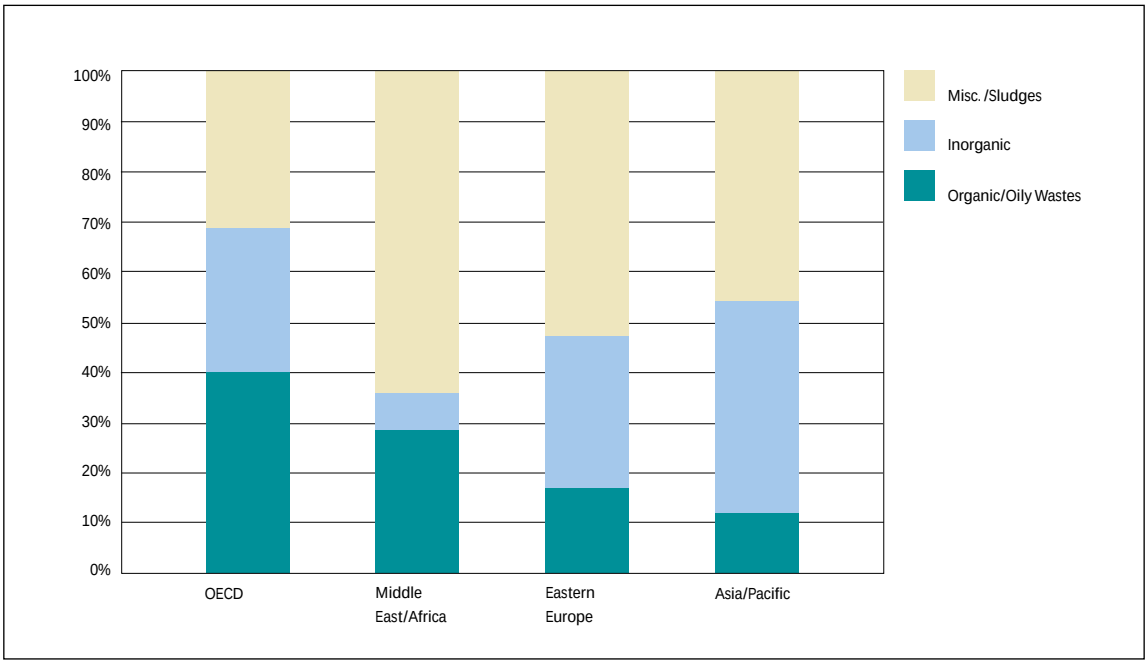


Figure 1: Composition of hazardous waste in various parts of the world. Source: the ISWA/UNDP report "Waste Management", ISBN-92-807-2194-2.

more waste streams are recycled and/or the generator is assuming responsibility for the proper handling of the waste. Some examples of components where it can be useful to study their individual contribution are:

Non-hazardous components:

- Paper
- Plastics
- Glass
- Metals
- Beverage cans

Hazardous components:

- Waste oil (used lubricants with an energy content comparable to heat oil)
- Electronic and electric equipment (EE waste)
- Lead acid batteries

To illustrate some of the information that can be deduced from information on composition and amounts of waste, we will start by looking at Table 2 that shows the average composition of household waste for low, medium and high-income countries.

	Parameter	Low-income countries	Medium-income countries	High-income countries
Contents:	Organic (putrescible), %	40 – 85	20 – 65	20 – 30
	Paper, %	1 – 10	15 – 30	15 – 40
	Plastics, %	1 – 5	2 – 6	2 – 10
	Metal, %	1 – 5	1 – 5	3 – 13
	Glass, %	1 – 10	1 – 10	4 – 10
	Rubber, leather, etc., %	1 – 5	1 – 5	2 – 10
	Other, %	15 – 60	15 – 50	5 – 20
Physical and chemical properties:	Moisture content, %	40 – 80	40 – 60	20 – 30
	Specific weight, kg/m3	250 – 500	170 – 330	100 – 170
	Calorific value, kcal/kg	800 –1100	1000 – 1300	1500 – 2700

Table 2: Relative composition of household waste in low, medium and high-income countries (modified from the Asian Development Bank/Norwegian Agency for Development Co-operation (NORAD) project Phnom Penh, Cambodia 2002, available from NORAD).

	Low-income countries	Medium-income countries	High-income countries
Mixed municipal waste, large city	0.4 – 0.65	0.5 – 0.95	0.7 – 2.0
Mixed municipal waste, medium city	0.3 – 0.55	0.4 – 0.75	0.6 – 1.5
Residential waste only	0.2 – 0.45	0.3 – 0.6	0.5 – 1.0

Table 3: Waste production (kg/person/day) in low, medium and high-income countries. Source: Asian Development Bank/Norwegian Agency for Development Co-operation (NORAD) project Phnom Penh, Cambodia 2002, available from NORAD.

The most striking difference in waste composition between high and low-income countries can be seen in the contents of paper and plastics, but also the content of metals and glass are higher in high-income countries. The relative content of organic matter is usually much higher in low-income countries. This reflects differences in consumption patterns, as well as cultural and educational differences. People in high-income countries, where levels of literacy are high, tend to read more newspapers and magazines, thus producing more waste. Paper, plastics and cardboard in household waste have mainly been used to wrap goods, and with higher levels of consumption, the amount of packaging also increases.

The moisture content is closely linked to the content of organic putrescible matter, reflecting the high water content in this type of organic matter. Plastics, paper, metal and glass all contain little water. When they become more abundant at the expense of organic matter, not only does the moisture content go down, but also the calorific heat increases since paper and plastics both have a high energy content. Table 2 also shows that the specific weight of the waste is lower, the higher the income. This comes as a result of the higher percentage of paper and plastics in the waste. These materials not only have lower density, but in many cases they also increase the porosity, i.e. the volume of air, in the waste. Table 3, which shows average values for the daily waste generation per person (kg/day/person), in low, medium and high-income countries, further illustrates how waste statistics can be used to describe the people who generated the waste.

Table 3 shows that societies with higher incomes and more money to spend buy more products, which eventually end up as waste.

2.7 International statistics on waste

Two well-known sources of international waste statistics are OECD and the Basel Convention. Both

Espen Bratlie / Samfoto.

present waste statistics on their web-sites, **www.oecd.org** and **www.basel.int**.

In many cases, the statistics on these web-sites are presented using data formats and classification codes that require knowledge of their classification systems, and for this reason they are of limited value for this paper. International waste statistics often have the following shortcomings:

- In many cases, the lack of common, international classification standards makes it difficult to compare figures. It is thus not always clear what types of waste are included in the statistics.
- Some member countries do not report, report too late or provide insufficient or incompatible data.
- Data are not always up-to-date.

3 Environmental issues related to waste

Waste that is not properly collected stored or treated not only gives rise to harmful environmental effects, but also poses a risk to public health.

3.1 Public health

The most serious problem related to waste is the negative influence it may have on public health. This holds especially true for hazardous waste. Not being aware of the fact that improper waste management may cause adverse health problems may be one reason why waste is not managed better in many countries.

Transmission of diseases and infections

In most developing countries, waste collection is inadequate. This leads to waste being disposed of on streets, in backyards, in canals/rivers, etc. Since many types of waste contain edibles, it will be a source of food for rodents and dogs and also be a breeding ground for insects. Rats for instance, have a long history of spreading serious infections, such as the plague. Night soil and/or toilet paper in the waste can spread infections such as parasites and worms. Flooding combined with a lack of proper storage bins can create a bacterial soup in the streets where children play.

Healthcare waste, for instance, is as example of a waste stream with a high potential for spreading diseases. It contains a wide range of hazardous and toxic materials as well as infectious materials.

Working environment

Figure 2 illustrates how infections and diseases are transmitted along with waste. People working with collection, sorting or treatment of waste are naturally more likely to be exposed than others. A report

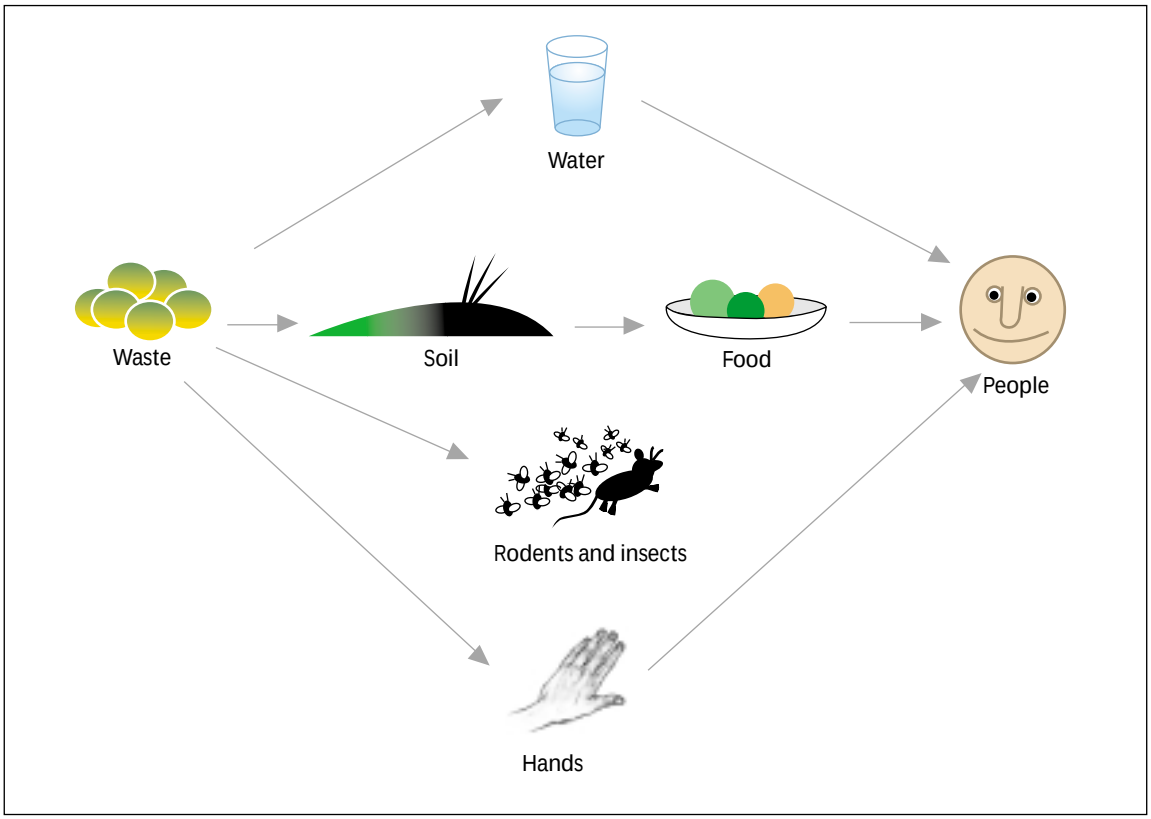


Figure 2: The way infections are spread. Source: Asian Development Bank/Norwegian Agency for Development Co-operation (NORAD) project Phnom Penh, Cambodia 2002, available from NORAD.

Collection of waste entails hard physical work, and workers are often exposed to cuts and bruises from sharp objects, as well as back and joint injuries from heavy lifting. Some of these problems can be reduced by using bins instead of bags for storage (see section 4.1) and implementing a collection system where the manual work is reduced through the use of hydraulic lifting equipment. Where waste is sorted manually, this ought preferably to be done on an elevated conveyor belt and in a room with proper ventilation. The machines used should have a good filtering system, and cabins should be overpressurised.

Hazardous waste can pose an especially serious threat to the working environment. Workers who are not wearing protective clothes and a gas mask may run the risk of serious injury, for instance as a result of skin burns from acids or inhaling organic solvents that can injure the lungs, the liver and other internal organs. Explosions are also known to have occurred as a result of handling hazardous waste.

3.2 Environmental problems

As we saw in section 2.2, hazardous waste has properties that make it a threat to the environment if not taken care of properly. One example is waste oil. If released into a water body, it can damage the protective coat of birds' feathers and eventually kill them.

Paradoxically enough, treatment of waste can also be a source of contamination. Improper handling of waste can pollute soil, water and air. This is one reason why most countries have regulated the establishment of treatment plants for all types of waste; i.e. waste treatment plants need a permit to operate.

Erkki Laine / Gorilla / Samfoto

from Vietnam[5] has showed that infant mortality rates can be as much as seven times higher among waste workers than in other professions. Waste management authorities must be aware of the problems and implement working routines that reduce exposure, train workers to handle waste safely, and stress the necessity of using protective equipment such as gloves, proper shoes, respiratory masks etc., in order to reduce the risk of people being exposed to infections and diseases from the waste.

Odour, littering, unsightliness, etc.

Some of the problems entailed by waste are related to nuisance. One example is the bad odours that originate from containers or waste left on streets, and this is one of the reasons why waste must be collected frequently. Frequency depends on a number of factors, including climate and type of waste. A warm climate and waste with a high-organic content require more frequent collection. Frequency normally varies from daily to once a week.

Waste treatment plants, especially landfill sites, can also be a source of odour problems. During decomposition of organic waste, methane, carbon dioxide

5 "Health & Social Needs of Waste Pickers in Vietnam", Nguyen H.T.L., Chalin C.G., Lam T.M., Maclaren V.W.

and a large variety of other gases are released. Some of these are organosulphur compounds, which have a very low threshold for odour. A landfill can cause loss of amenity and nuisance several kilometres away from where it is located.

Littering from waste is more an aesthetic problem than an environmental problem per se. However, consequences of littering may include waste blocking drainage pipes and causing secondary environmental problems such as flooding.

Soil

Dust, leachate water and use of products such as pesticides or depositions can cause contamination of the soil by emissions caused by uncontrolled burning of waste. Heavy metals are known to have effects on the nervous system, injure the kidneys and cause mental disorders. Other toxic components such as persistent organic pollutants (POPs such as DDT, dioxins, PCBs, etc.) remain in the environment and bioaccumulate through the food chain, posing a risk of adverse effects on human health and the environment.

Polluted soil can also damage flora and fauna by being toxic itself or by releasing toxic components into the food chain.

Surface and groundwater

Rain or surface water seeping through waste will absorb hazardous components and carry them into surface and groundwater. This water may then be used for recreation, drinking, breeding of fish, etc., resulting in negative health effects.

Air, local and global problems

In many countries, there was and often still is a habit of setting fire to waste. This may be done in each household, to communal dumps along streets or at regular dumpsites. The result is incomplete combustion, which gives off in toxic and carcinogenic emissions of PAH (polyaromatic hydrocarbons), dioxins, etc. This habit is one of the major sources of emissions that are harmful to human health and the environment in general. Scavengers at landfills often set fire to the waste to make it easier for them to find metals. Uncontrolled fires in landfills due to self-ignition (often caused by illegal dumping of hazardous waste) are also a major source of emissions to air.

Old or badly operated incineration plants can also be a source of hazardous emissions such as heavy metals (mercury, cadmium, etc.) and dioxins. Anaerobic degradation of waste (without oxygen), which normally takes place at landfills, creates a landfill gas that typically consists of 55% methane (CH_4), 35% carbon dioxide (CO_2), some nitrogen (N_2) and a number of other gases in small amounts. Emissions of methane are a substantial contributor to the total emissions of green house gases (GHG). It is estimated that emissions of methane from landfill sites in the OECD countries contribute to around 3 % of total GHG emissions.

4 Storage, collection and transport

An efficient system for storage and collection of waste is the key to preventing risks to human health, environmental problems and other nuisances. There is a strong interrelationship between the type of waste container used and the collection and transport system that ought to be used. Collection and transport is normally the most expensive part of a waste management system and typically represents two-thirds of the total cost in most countries. Lack of technical and financial resources in developing countries often leads to insufficient use of storage bins and low collection frequency, if there is any organised waste collection at all.

Most countries require that hazardous waste is handled separately from non-hazardous waste, and for this reason some additional information on the handling of hazardous waste is presented in section 4.3.

4.1 Storage before collection

To reduce problems such as vectors, rodents, scattering of waste, etc. connected to the storage of waste before it is collected, containers or bins should be used. As far as possible these should be:

- Weatherproof, water tight and with a lid
- Animal and insect proof
- Washable and robust enough for daily use
- Easy to handle and transport, and compatible with the collection vehicle used

The type of storage container used depends on the rate of waste generation (family size, etc.), type of waste to be collected, frequency and system of collection, and ability to pay.

The use of temporary containers such as cardboard boxes, plastic bags, etc. is common in low-income countries. They do not normally meet the requirements listed above and therefore create problems. More permanent containers like plastic bins, oil drums, etc. reduce the environmental problems but are more costly.

Fixed storage points such as depots – masonry enclosures (covered/uncovered) where people bring their waste from their home and where it is stored before it is collected – are commonly used in developing countries. This system creates environmental problems as well as resulting in unhealthy and time-consuming collection. Portable bins/containers ranging from 0.2 to 30 m^3, which are loaded mechanically directly onto the vehicle, create fewer problems but require specialised vehicles and are therefore more expensive.

4.2 Collection and transport

This includes all steps from storage to final treatment or disposal and involves labour and vehicles. Since this is the most expensive part of a waste management system, it is important to undertake a proper evaluation of possible collection systems based on calculations and time studies before deciding which system to use.

The following factors must be taken into consideration: type of waste (categories, characteristics (high/low density), generation rate), climate, population density, roads and traffic conditions/accessibility, type of storage containers used, vehicles (availability, spare parts, maintenance costs, fuel cost and consumption, load capacity, etc.), final treatment (type and distance from collection area), labour cost, willingness and ability to pay.

Waste collection can be carried out in different ways, such as:

- Communal collection, where the waste generator brings his waste to a dedicated collection point.
- Block collection, i.e. residents bring their waste to the vehicle, usually at a signal from the vehicle.
- Door-to-door collection, which means that the collector visits the premises and brings the waste to the vehicle.

A combined system, whereby a primary collection system brings the waste to a transfer station where some sorting and/or treatment can take place before it is transferred to other vehicles that transport the waste to the final disposal site, has proven itself to be a rational and affordable system in many places. There are two main reasons for doing this:

to increase the efficiency of costly trucks and to establish an acceptable system for waste collection where accessibility is bad. A third reason is that the distance from the collection area to the final disposal site can be long and the vehicle used for collection might be unsuitable for long-distance transport (for instance, because the load capacity is too small, the speed is too slow, the road conditions are bad, or it is impossible to transport waste by road). This normally means either using larger trucks or containers that can be transported by road, railway or boat to the final disposal site.

Waste removal by horse. Arne Strømme / Samfoto

The distance from the initial collection area to the final disposal site must normally be more than approx. 40 km before it is economical to establish a transfer station. However, this has to be calculated individually for each case, since local conditions can vary greatly.

4.3 Special precautions for hazardous waste

Because of the special properties of hazardous waste, special precautions must be taken during collection, transport and storage, both before and after transportation.

Several systems exist for collection and transportation of hazardous waste, and it may be that some of the points below do not apply in all cases. Large generators, such as the chemical industry, will sometimes transport their waste directly to the destruction plant, while small businesses can bring their waste to intermediate stores or have it collected by an authorised collector. Similar systems also exist for hazardous waste from households.

An increasing trend is that specific systems are implemented for specific types of waste. This is also referred to as Producer Responsibility. For instance electric/electronic devices with hazardous components can be returned to the producer or to the shop that once sold them.

Storage before collection

Before collection, precautions must be taken to ensure that hazardous waste is not allowed to come into contact with other waste (hazardous or non-hazardous), does not lead to pollution, and is not made available to children or unauthorised personnel. This can be achieved through storage in tight containers, in locked rooms or behind fencing.

Hazardous waste is not only generated by industry. In households, hazardous waste such as lead acid batteries, insecticides and detergents can cause harm to children and animals if not stored properly.

Collection

At the collection point, it is absolutely necessary to determine the type of waste and its hazardous properties to avoid damage to personnel and equipment. In addition to being dangerous on their own, many types of waste can react vigorously with each other and it is important to keep these away from each other. All packaging should be inspected, making sure that it is clearly labelled according to local and international laws, free from spill and tightly capped.

Transportation

Most types of hazardous waste are also dangerous goods and should be transported in accordance with the UN Recommendations on the Transport of Dangerous Goods. The Convention, in combination with local laws, regulates among others:

- Training of driver and co-driver
- Types of packaging to be used
- Labelling and marking of packaging and vehicle
- Equipment on the vehicle (absorbent, stop blocks, fire extinguisher, flash light, etc.)

Storage before treatment

Finally, storage of hazardous waste awaiting treatment requires more from the facilities than storage of non-hazardous waste. Here are some points to consider when establishing storage for hazardous waste:

- The storage point should be located a safe distance from residential areas
- Incoming waste must be inspected before it can be stored
- All waste should be stored under a roof, protected from rain and wind
- The floor should be made of asphalt or concrete, to avoid pollution of soil and groundwater
- In the event of spills, absorbents and spare packaging material should be available
- Only authorised personnel should have access to the storage facilities
- Protective clothes and first-aid kits must be available, as well as emergency showers
- A log should be kept, listing types and quantities of waste in the store at any time
- The local fire department should be notified of the storage and should be invited to inspect it

Tore Wuttudal / NN / Samfoto

5 Approaches to waste handling

Knowledge of the characteristics of the waste and proper monitoring of the waste quantities being generated are important in order to choose the best way to approach waste handling. This chapter describes various ways of treating waste, depending on the composition of the waste.

5.1 General

A list of priorities (the waste hierarchy), which has been adopted in most countries, is shown in Figure 3. Pyramids are often used to describe the goals for a process; the higher up the pyramid you are, the closer you have come to your goal. The three R's (Reduce, Reuse and Recover) of waste management cover the upper three stages of the pyramid and should be the goals for handling of waste.

However, the economic situation in the region will often decide what actually happens to the waste. In many countries, the price of landfilling (or leaving the waste at open dumps) is low compared with the cost of implementing the three R's. This results in landfills and dumps being the most common solution. Thus, even if open dumps are the least desirable solution, this is actually the most commonly used method of waste disposal in many countries.

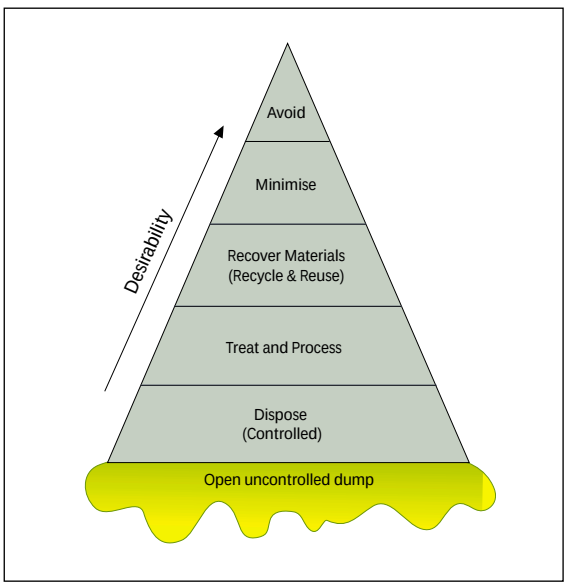


Figure 3: The waste hierarchy

Since a treatment plant is also a potential source of pollution, most countries have legislation that makes it illegal to establish a new waste processing or treatment facility without a permit. Normally, the permit will include requirements on how to operate the plant. The European Union, for instance, has issued a number of directives that the member states and associated member states have to observe, which include minimum standards for permissions to establish an incineration plant or a new landfill. Such systems are implemented in most industrialised countries but are absent or not being implemented in many developing countries.

5.2 Recovery (recycle and reuse)

Recovery is a term that covers many aspects of utilising the material and energy resources of waste. Recovery can be subdivided into:

Material recovery:
- Reuse (beverage bottles are reused for beverages)
- Recycling (bottles are melted down, compost is produced, etc.)

Energy recovery:
- Incineration (production of hot water, steam or electricity)
- Use directly as a fuel
- Gasification (produce gas that can be used to produce hot water, steam or electricity)

There are several good reasons for recovering as much of the waste as possible: this reduces the amount of waste sent for final disposal and thereby reduces transportation and disposal costs, it makes use of valuable resources in the waste and thereby reduces the use of virgin raw materials, and waste handlers can earn money from the sale of recovered/recycled materials.

When considering how to recover waste, it is important to know:

- The composition of the waste (percentage of paper, plastics, glass, etc.)
- The physical characteristics of the waste (density, moisture content, size distribution, etc.)

- The labour costs and market situation for recovered fractions (cash value locally, export value and possibilities, etc.)
- The requirements on cleanness of waste to be recycled
- The alternative treatment costs for unsorted waste

The waste that is to be recovered can either be collected source separated (paper, glass, food waste, etc. in separate containers) or mixed in one container. When it is collected mixed, it can be difficult and costly to separate it for material recovery. Separation can be done manually or mechanically. Manual sorting of mixed waste can cause health and safety problems for the workers, but is usually the cheapest and best way to achieve a clean product. For this reason, it is commonly used where labour is cheap. Mechanical separation, however, seldom gives a clean enough product for material reuse and can be capital intensive and costly to operate.

5.3 Composting – treat and process

To be able to exploit the assets in waste (as a material or energy resource), the waste normally has to be treated and/or processed. One way of treating and processing is composting.

Composting means decomposition by living microorganisms of the biodegradable solid waste (organic compounds) under aerobic (with oxygen) conditions. Composting is the most common way of treating sewage sludge, park and garden waste and food waste. As seen in section 2.6, the organic components often make up the bulk of household waste, especially in low-income countries, and treating this as a separate fraction by composting has many benefits. It increases diversion of waste from final disposal and thus reduces disposal costs, it enhances recycling operations (included incineration) by removing organic matter from the waste stream, and it produces a valuable soil amendment (which represents a potential income). Furthermore, it is flexible for implementation at different levels (small-scale; each household, decentralised; at community level,

and large centralised plants), it can be done at a relatively low capital and operation cost, and it can be a way to avoid negative health effects resulting from organic waste (i.e. dengue fever).

However, there are also some disadvantages that we must be aware of. Attention to and knowledge of the biological processes and their requirements are absolutely necessary. Successful composting is dependant on parameters such as: sufficient oxygen, correct moisture content (50-60%), correct content of nutrients for the micro-organisms to work, sufficient micro-organisms, temperature (ideally between 55 and 65 ˚C and below 75 ˚C), pH in the range 6-8, porosity, structure, texture and particle size, curing and final conditioning. There is a nuisance potential (odour, insects and rats) if the composting process is not managed properly. And finally, there is often a lack of vision and marketing plans for the final compost product. Such plans are crucial to make composting a good alternative. Establishing the need for compost in the market and the possible price for the compost is essential.

It is also important to know that a composting plant can only treat a portion of the waste stream and has to be supplemented with other treatment facilities.

5.4 Energy from waste – treat and process

As described in section 2.6, waste contains various amounts of combustible fractions such as organic matter, paper/cardboard, plastics, etc. Some fractions, such as waste oil and organic solvents, can be used directly as a replacement for other fuels. It is desirable that as many as possible of these components be recycled and used to produce new or similar materials. However, the market value and recycling possibilities vary and there is an economic limit to how much of the waste it is feasible to recover. The residuals can then be utilised for energy production. How this is done is dependent on a number of factors, including moisture content. If the moisture content is low (< 55-60%) it can be incinerated. If it is higher it can be used for biogasification and the gas produced used for energy production.

Incineration (all types of waste)

Controlled incineration of waste in dedicated plants must not be confused with the uncontrolled burning of waste that takes place in open dumps, in private homes, on streets, etc.

Incineration has been a common treatment process for decades in many industrialised countries, mainly as a way to break down waste. Little or no interest was paid in earlier days as to the adverse environmental emissions the incineration led to. Old incinerators were a major source of emissions of dioxins and heavy metals. In later years, however, the technology has been refined and more attention has been paid to reducing the emissions. Strict regulations now have to be met when establishing a new incineration plant. Recovery of energy has now also become a main reason for establishing incineration plants.

Illustration 1. Incinerator. Source: MARTIN GmbH für Umwelt und Energieteknik.

The advantages of controlled incineration are:

- It is an efficient way to reduce waste volume and thereby the need for landfill space
- Energy recovery (as heat and/or electricity) from waste, which can be regarded as a renewable energy source, can replace the use of fossil fuel such as oil or coal
- The climate emissions from alternative treatment methods such as landfilling will be reduced

However, there are also some disadvantages to incineration:

- It involves heavy investments and high operational costs
- It is a technically complicated process that requires skilled personnel
- It is best suited for waste high in energy and low in moisture and it must be supplemented with other methods since it can treat only a portion of the waste
- If not done properly, incineration can be a major source of pollution

These disadvantages mean that incineration of waste is a totally inappropriate option in most developing countries.

Use of waste as a fuel substitute (hazardous waste)

Some types of hazardous waste, such as waste oil and organic solvents have a high-energy content, and can in many cases replace other types of fuel. The difference between incineration and use as a fuel is that incineration is done in a specially constructed plant. When used as a fuel, however, the waste directly replaces other types of fuel in an existing furnace or kiln.

The most common case is burning waste oil in a furnace or cement kiln originally designed to burn heating oil. With a little adjustment, most furnaces and kilns can be converted for burning waste oil. In many cases, waste oil is cheaper than heat oil while having almost the same energy content. This creates a market for waste oil as an energy source.

The problem with waste oil is that it is contaminated with both heavy metals and organic substances that are hazardous to the environment. For this reason, waste oil is classified as hazardous waste in most countries, and normally tighter control is applied on the people that handle it. Most of the organic components will be destroyed when the oil is burned, but the remainder, along with the heavy metals will leave the furnace along with the exhaust gases and pollute the environment. To cope with this problem, many countries require that only plants with a permit and sufficient filtering of the exhaust gases be allowed to burn waste oil.

Gasification (organic, non-hazardous waste)

Another way to treat biodegradable solid waste (organic compounds) and also night soil, manure and sewage sludge is to establish a digester. A digester that operates anaerobically (without oxygen) can be used to produce methane gas. Since methane gas has a high energy content, it can be used to produce energy like hot water, steam and electricity.

A digester can be built in many ways, and it can be more or less advanced. It can be operated as a small-scale facility or a large-scale facility. However, it requires more investments than composting and is a little more complicated to operate than a composting plant. Two reasons for establishing a digester rather than composting the waste are a need for energy and a lack of market for compost as a product.

Gasification, like composting, is a treatment method that can only utilise a portion of the waste and therefore has to be supplemented with other treatment facilities.

5.5 Treatment of hazardous waste

To reduce or eliminate the hazardous properties of waste, different alternatives can be used. The two main approaches are thermal destruction and chemical treatment, which is often used on inorganic hazardous waste. There are a large number of techniques available, but the most common ones are neutralisation and stabilisation.

Thermal destruction

For many types of waste, especially organic hazardous waste, it is impossible to recycle or reuse the waste, leaving us with no choice but to have it destroyed. There can be many reasons for this. Some examples are PCB (banned in most countries), mixtures that are impossible to separate and reuse (e.g. combinations of paints and solvents) or there is simply no use for the waste. Being organic, the waste can be converted into harmless components such as carbon dioxide and water as long as the temperature is high enough. Because halogens such as chlorine and bromine are very strongly bound to the carbon atoms, tearing the bindings apart requires a supply of external energy. Energy is usually supplied by mixing the energy-consuming

waste with energy-yielding waste, and burning the mixture either in a designated destruction plant or in a plant where the excess energy can be utilised, e.g. in a cement kiln. To have a proper destruction of for instance halogenated compounds, a temperature above 1100 degrees C is required.

Neutralisation

This type of technique is most commonly used on corrosives, such as acids and alkalis. When mixed in the right proportions acids and alkalis neutralise each other, and the products of this process are often relatively harmless. Precipitates from the process can often be landfilled on a site for non-hazardous waste, while liquids from the process can be led to a recipient. Depending on the original waste, it may be necessary to remove hazardous components from the liquid.

Physical stabilisation

Some types of inorganic hazardous waste can be treated by a process called stabilisation. In short, the process seeks to immobilise the hazardous components by "locking them in place", usually by mixing the waste with gypsum, concrete or even molten glass and casting it into blocks. After completion, the mobility of the hazardous components is reduced to a level where the blocks can be landfilled at an acceptable risk.

Miscellaneous

In addition, there are a number of highly specialised techniques for various types of hazardous waste. Two examples are destruction of cyanides through oxidisation with sodium hypochlorite and stabilisation of mercury by converting it to a sulphide (HgS) which is insoluble in water and chemically very stable.

5.6 Landfilling

Earlier in this chapter, we described different ways of recovering, processing and treating waste. These methods are designed to handle only specific types of waste and therefore have to be complemented with other methods, normally a landfill, to be able to take care of the disposal of the total waste stream.

Sludge is what is left after water has been drained from fluid or pumpable waste. Sewage sludge is the result of draining water from sewage. In low-income/developing countries, sludge is often pumped into canals/rivers or brought to a landfill/dumpsite, while most industrialised countries have built dedicated treatment plants. Depending on the industrial process, sludge from industry is often characterised as hazardous waste.

Landfills

Landfilling is the most common solution for handling either all the waste or the residuals that cannot be treated as a part of other waste processing methods, such as composting, incineration, etc. There is a wide range of landfills that vary from open dumps that create adverse environmental problems to both soil, water and air to sanitary landfills that are a fully acceptable environmental solution. Landfills are usually divided into three different categories:

- Sanitary landfill
- Controlled dump
- Open uncontrolled dump

The main differences are the way they are operated and the level of adverse environmental effects they have.

Environmental impacts of landfills

A landfill can have a number of environmental impacts. Contaminated water called leachate (water that has been contaminated by seeping through the waste) can contaminate soil as well as ground water and surface water. Emission of landfill gas normally consists of approx. 50 % methane, which has a green house gas effect 21 times stronger than CO2. Uncontrolled fires and toxic emissions are quite common if the landfill is poorly managed and are a major source of pollution. Furthermore, landfills often cause littering problems, poor aesthetics, odour, rodents, insects, traffic and noise.

There are a variety of different actions that can be taken to prevent the negative impacts mentioned above. This can be daily/regular covering of the waste (this will reduce many problems like odour, littering, extensive uncontrolled fires, vectors, etc.), collection (and preferably purification) of the leachate, preventing water from entering the landfill and seeping through the waste (reduced amount of leachate), and extraction of landfill gas and preferably conversion into effective energy since the methane has a high energy content (it can be used to produce electricity, hot water, etc.). Setting up gates and fences around the landfill will prevent unauthorised people and animals from entering the area. Strict monitoring of the kind of waste being received is also precautionary.

5.7 Costs

The more that is done to reduce adverse environmental impacts, the more expensive it will be to establish and operate all treatment plants, including landfills. Unfortunately, there is neither the will nor the financial ability to pay adequate attention to the

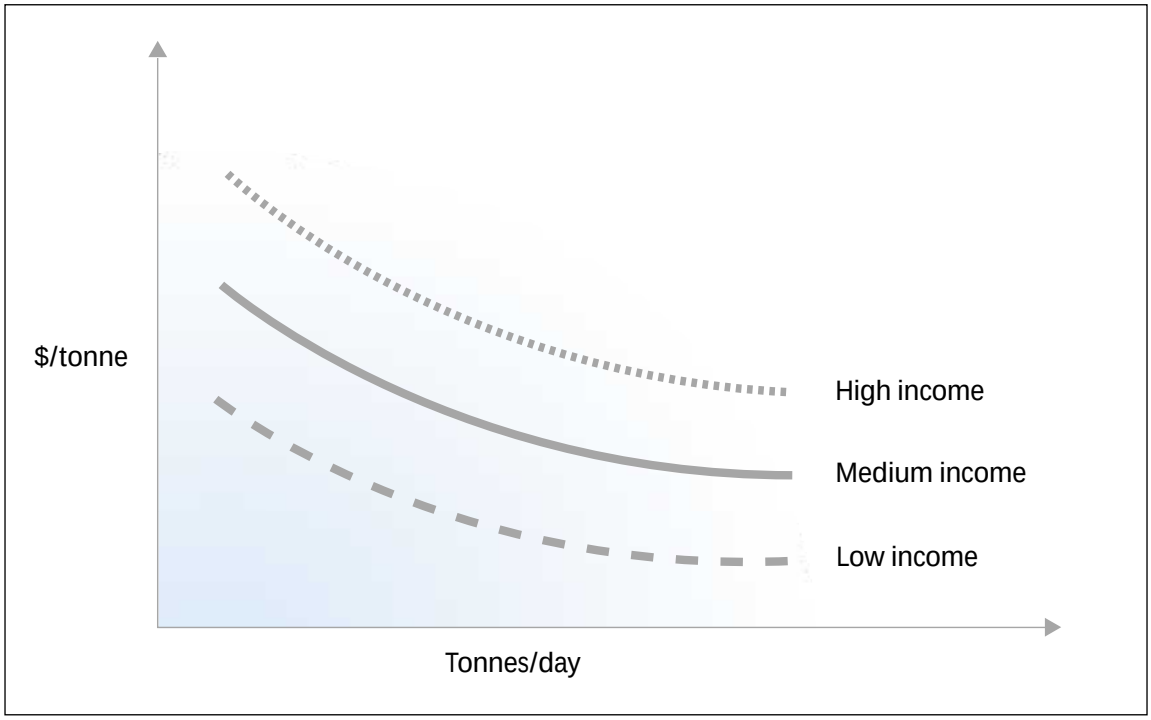


Figure 4: Correlation between capacity and cost

environmental problems that dumps create in many countries. Therefore the least desirable alternative for treatment of waste is actually the most commonly used method in many countries.

There is a strong relationship between the capacity of a landfill and the cost in price per tonne. This correlation can be seen in Figure 4.

The cost of different waste processing and treatment alternatives varies widely. The cost is one important parameter that will affect what alternative it is realistic to choose.

Table 4 shows how prices can vary between different alternatives.

As seen in Table 4, crude dumping is very cheap. As long as this is accepted, it is hard to climb the pyramid seen in figure 3 (page 81). Strict environmental regulation (which makes dumps prohibited) is therefore needed as an instrument to improve overall waste management. An economic instrument that is implemented in many Western countries is a waste tax on all waste being landfilled. This increases the cost of landfills and thereby makes it more profitable to recover and process the waste instead of leaving it all to a landfill.

Technique	**US $ / tonne**
Crude dumping	1 – 3
Sanitary landfill	6 – 12
Sanitary landfill, reclamation area	12 – 24
Composting at landfill	30 – 60
Biogasification	60 – 100
Incineration	30 – 120

Table 4: Typical cost of different treatment methods. (Source: ADB/NORAD project Phnom Penh, Cambodia 2002).

6 Summary

Waste management is an important part of modern infrastructure as it ensures the protection of the environment and of human health. It is not only a technical and environmental issue but also a highly political one. Waste management is closely related to a number of issues such as urban lifestyles, resource consumption patterns, employment and income levels, and other socio-economic and cultural factors.

A vast majority of countries, especially developing countries, are still struggling with such basic issues as ensuring sufficient collection services and implementing a minimum degree of control at disposal sites at the same time as they are facing increasing quantities of waste and a change in waste composition due to increasing urbanisation. They also lack the technical and financial resources to safely manage solid waste – which includes adequate provisions for storing the waste at the point of generation, efficient and sufficient collection services as well as satisfactory final disposal.

It is important to be aware of the fact that improper waste management may cause adverse health problems by spreading infections and diseases and may cause severe environmental problems by polluting the air and the soil, surface water and groundwater.

Lack of proper waste collection and dumping of waste at uncontrolled dumps often leads to uncontrolled burning of waste dumped along streets or at dumpsites to destroy the waste and to "get rid of the problem". The result is incomplete combustion, which results in toxic and carcinogenic emissions of PAH (polyaromatic hydrocarbons), dioxins, etc. This habit of waste disposal is one of the major sources of emissions that are harmful to human health and the environment.

Reducing the amount of waste being generated and reusing and recovering as much as possible of the waste are important general goals that will help reduce the problems the waste generates. Hazardous waste should be collected and treated separately. A controlled landfill, where open burning of waste is banned and where polluted water and gases can be taken care of is normally the best solution for treating the fractions of waste that are not suited for recovery. Sending waste to energy plants is normally a treatment method that is more readily applicable in high-income countries.

Tanker loaded with oil. Tore Wuttudal / NN / Samfoto

Properties of wastes which render them hazardous[6]

H1 Explosive
Substances and preparations that may explode under the effect of flame, or are more sensitive to shocks or friction than dinitrobenzene.

H2 Oxidizing
Substances and preparations that exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

H3-A Highly flammable
Liquid substances and preparations that have a flash point below 21 °C (including extremely flammable liquids): substances and preparations that may become hot and finally catch fire in contact with air at ambient temperature without any application of energy; solid substances and preparations that may readily catch fire after brief contact with a source of ignition and that continue to burn or to be consumed after removal of the source of ignition; gaseous substances and preparations that are flammable in air at normal pressure; substances and preparations that, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

H3-B Flammable
Liquid substances and preparations that have a flash point equal to or greater than 21 °C and less than or equal to 55 °C.

H4 Irritant
Non-corrosive substances and preparations that, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5 Harmful
Substances and preparations that, if inhaled or ingested or if they penetrate the skin, may involve limited health risks.

H6 Toxic
Substances and preparations (including very toxic substances and preparations) that, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

H7 Carcinogenic
Substances and preparations that, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

H8 Corrosive
Substances and preparations, that may destroy living tissue on contacts.

H9 Infectious
Substances containing viable microorganisms or their toxins, which are known or reliably believed to cause disease in man or other living organisms.

H10 Teratogenic
Substances and preparations that, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

H11 Mutagenic
Substances and preparations that, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

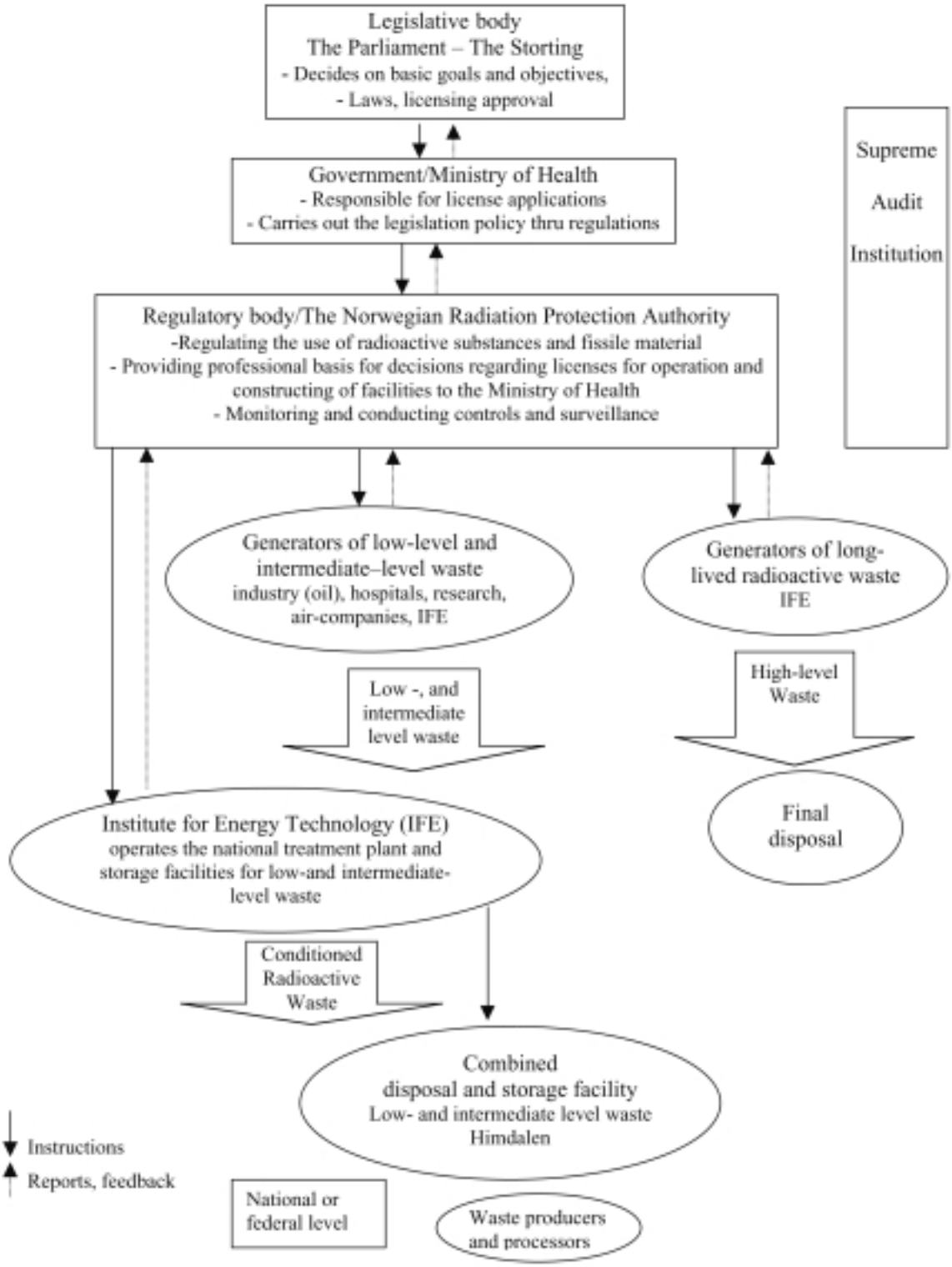
H12
Substances and preparations that release toxic or very toxic gases in contact with water, air or an acid.

H13
Substances and preparations that are capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

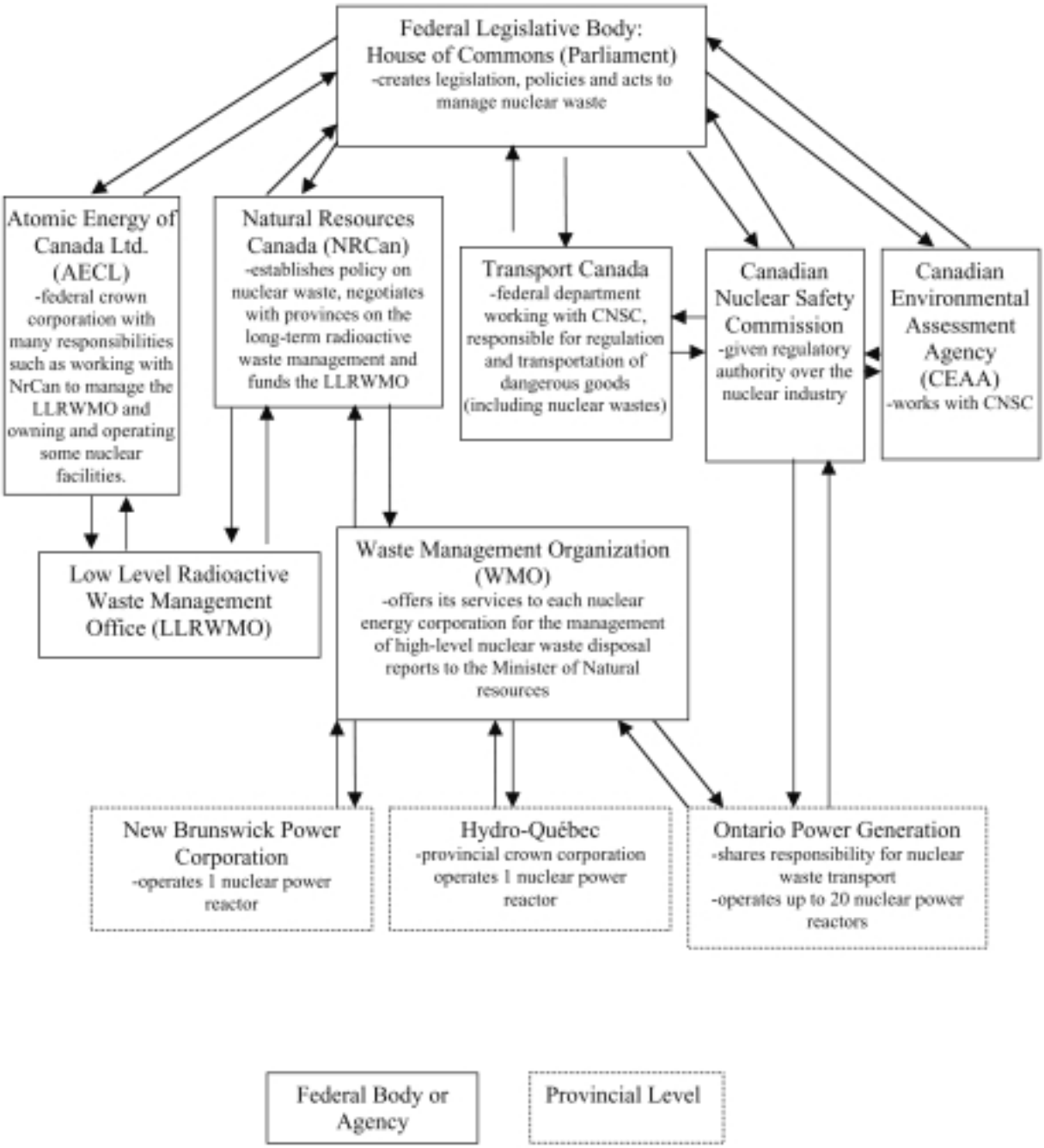
H14 Ecotoxic
Substances and preparations, that present or may present immediate or delayed risks for one or more sectors of the environment.

6 Taken from council directive of 12 December 1991 on hazardous waste (91/689/eec) The council of the European communities.

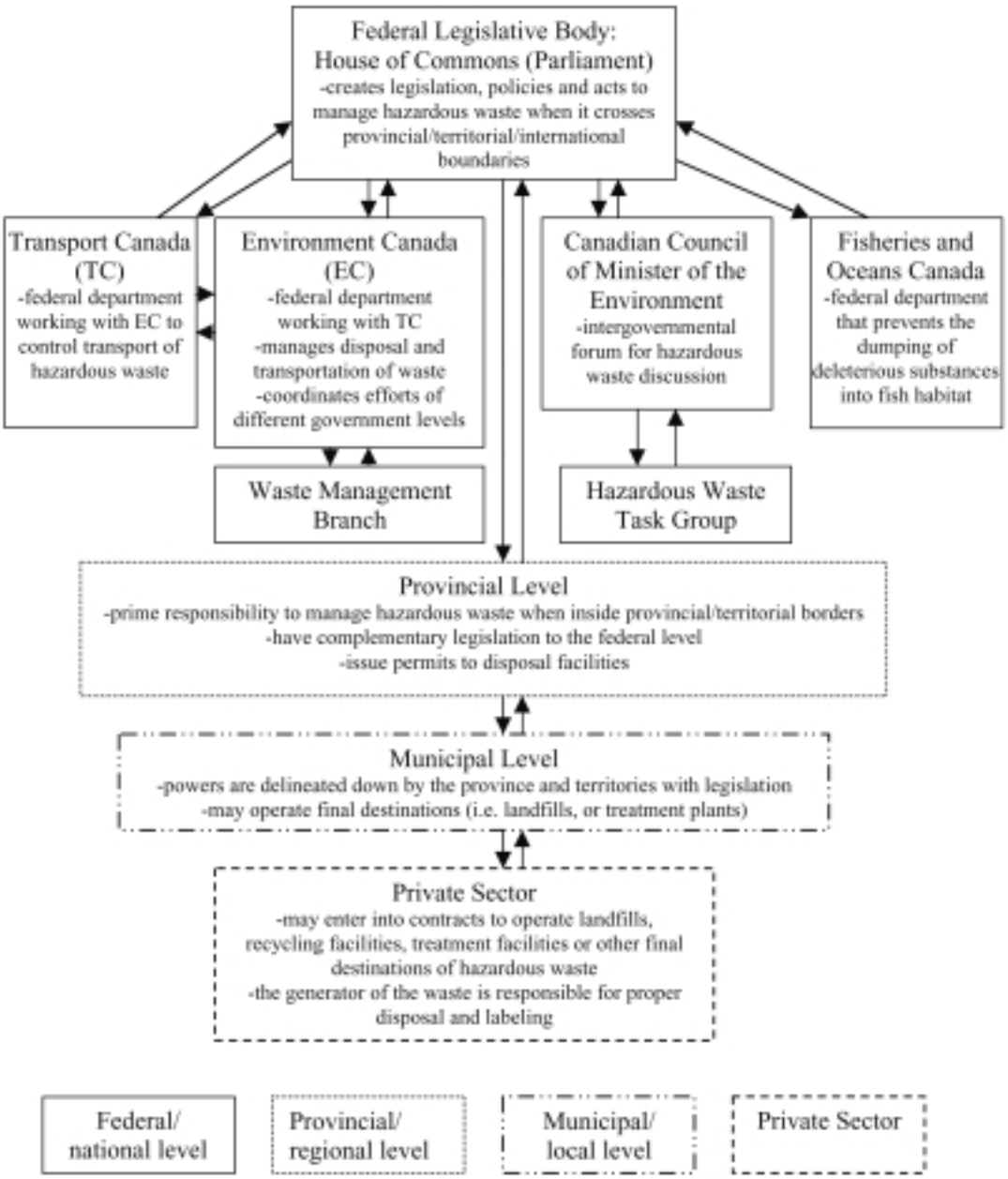
Appendix 2: Norwegian Radioactive Waste Management System



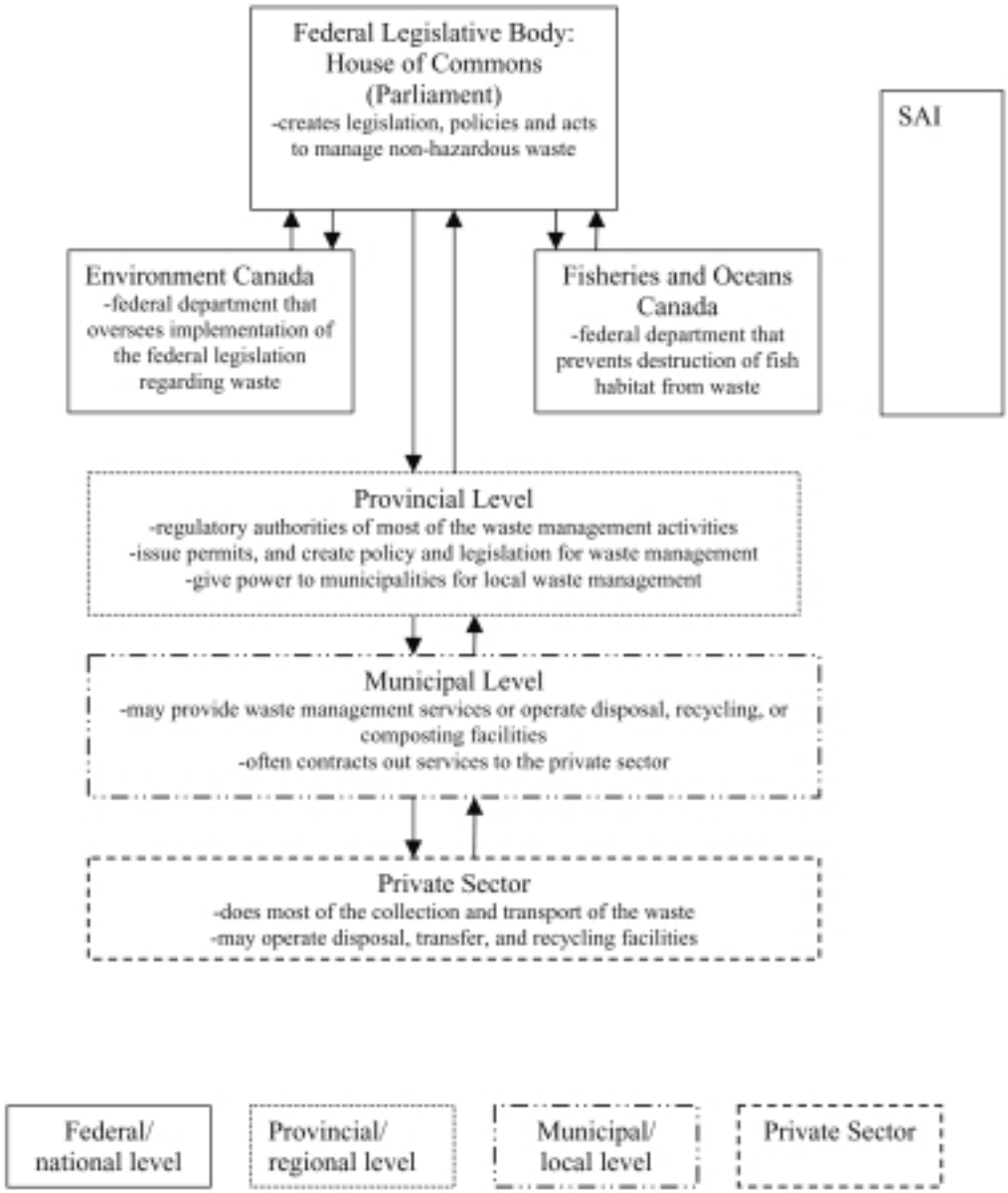
Appendix 3: Canadian Radioactive Waste Management System



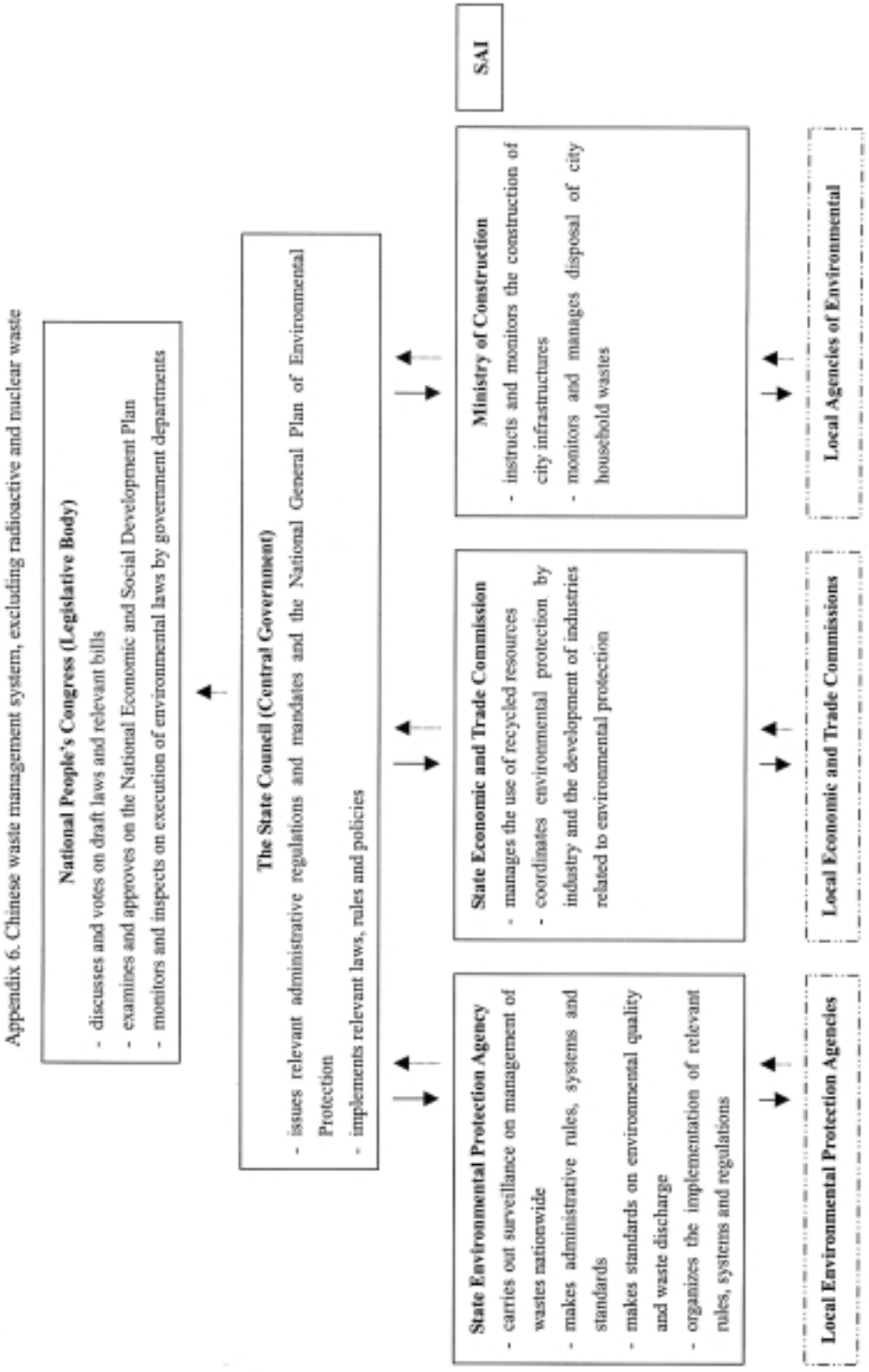
Appendix 4: Canadian Hazardous Waste Management System

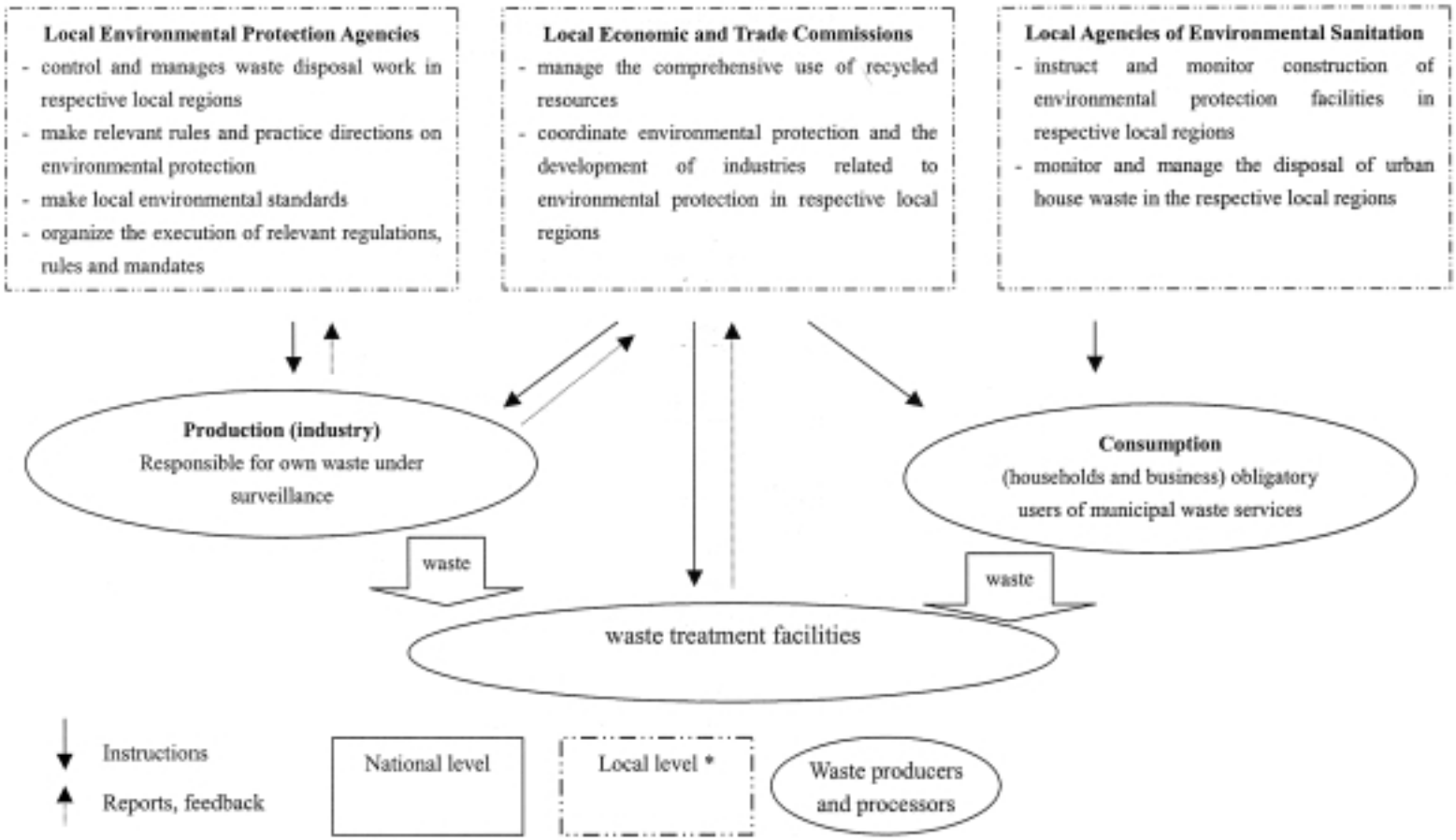


Appendix 5: Canadian Non-hazardous Waste Management System



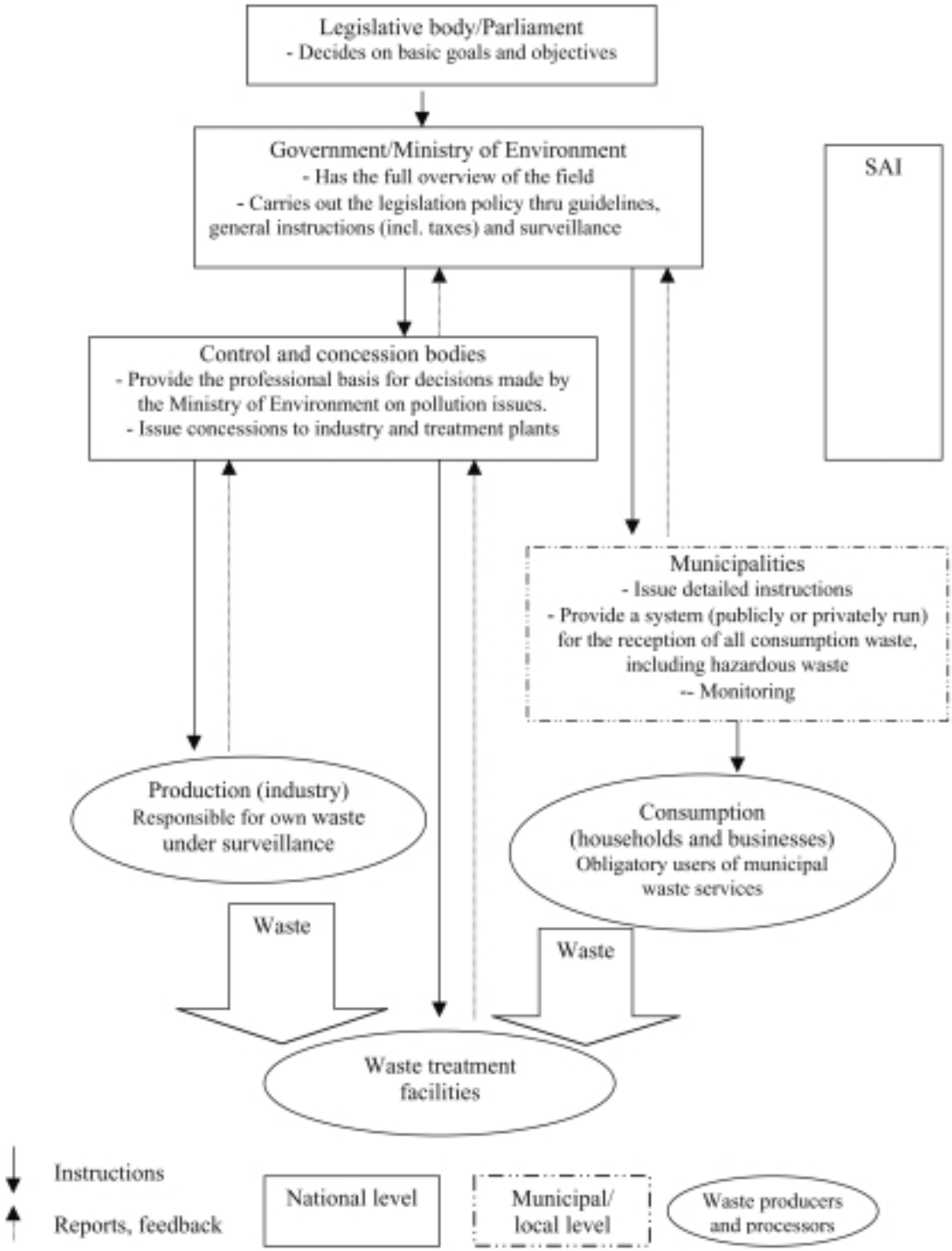
Appendix 6: Chinese Waste Management System, excluding Radioactive Waste





*In China, local governments include three levels of Province (Autonomous Region, Central Municipality), City and County. A local government agency is under the leadership of the respective level local government and the professional guidance of the respective government agency at the next higher level.

Appendix 7: Norwegian Hazardous and Non-hazardous Waste Management



Appendix 8: Polish National Waste Management System