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JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

NATIONAL COMMISSION FOR THE ENVIRONMENT(CONAMA)
THE REPUBLIC OF CHILE

THE MASTER PLAN STUDY ON INDUSTRIAL SOLID WASTE MANAGEMENT IN THE METROPOLITAN REGION OF THE REPUBLIC OF CHILE

FINAL REPORT
VOLUME I
EXECUTIVE SUMMARY

MARCH 1996

KOKUSAI KOGYO Co., Ltd.
EX. Corporation

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In this report, project cost is estimated at October 1995 price and at an exchange rate of 1 US$ = 102.4 Japanese yen = 416.2 Chilean pesos.

PREFACE

In response to a request from the Government of the Republic of Chile, the Government of Japan decided to conduct a master plan study on Industrial Solid Waste Management in the Metropolitan Region of the Republic of Chile and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Chile a study team headed by Mr. Susumu Shimura, KOKUSAI KOGYO Co., Ltd. and composed of members from KOKUSAI KOGYO Co., Ltd. and EX. Corporation three times between January 1995 and December 1995.

The team held discussions with the officials concerned of the Government of Chile, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Chile for their close cooperation extended to the team.

March 1996

Kimio Fujita
President
Japan International Cooperation Agency

March 1996

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

LETTER OF TRANSMITTAL

We are pleased to submit to you the study report on the Master Plan Study on Industrial Solid Waste Management in the Metropolitan Region of the Republic of Chile. This study contains the master plan for Industrial and Medical Solid Waste Management (SWM) until 2010.

The Industrial/Medical SWM master plan was formulated for the Metropolitan Region based on the field investigation of 200 factories and 90 medical institutions.

The master plan comprises: forecast of future Industrial/Medical SW generation, planning framework with phased goals/targets/strategies, technical systems, institutional systems and estimation of the magnitude of Industrial/Medical SWM business in 2010.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and Ministry of Health and Welfare. And from the Chilean side we also wish to express our deep gratitude to the National Commission for the Environment (CONAMA), CONAMA-Metropolitan Region, the Ministry of Health, the Metropolitan Region Environmental Health Service (SESMA), SESMA-PROCEFF (Stationary Emission Source Control Program), Ministry of Planning-SERPLAC, Superintendent of Sanitary Service (SISS), the Embassy of Japan in the Republic of Chile, and the JICA office in the Republic of Chile.

Finally, we hope that this report will be effectively used for the implementation of the master plan.

Respectfully,

Susumu Shimura
Team Leader
The Master Plan Study on
Industrial Solid Waste
Management in the Metropolitan
Region of the Republic of Chile

The Master Plan Study on Industrial Solid Waste Management
in
the Metropolitan Region

BRIEF SUMMARY

1. Present Situation of Industrial and Medical SWM (Solid Waste Management)

1.1 Issues and Problems

Illegal dumping sites in the order of one hundred exist in the MR (Metropolitan Region). It is strongly anticipated that the illegal dumping causes detrimental environmental pollution in the surroundings. Recycle activities presently receive 56% of ISW (Industrial Solid Waste) generated in the MR. Considerable number of recyclers deploy their activities near illegal dumping sites and after recovery of reusable materials from the ISW received the rest being dumped in those illegal dump sites.

Those which should theoretically be generated as HW (Hazardous Waste) and/or LW (Liquid Waste) are currently dispersed into aquatic and atmospheric environment in the form of waste water discharge and exhaust gas emission. In the course of tightening of environmental regulations, these ISW (HW and LW) are increasingly being generated. Destination of a huge amount of ISW, namely intermediate treatment and final disposal facilities are not established yet at this moment.

On the other hand as for medical SW, incineration at hospitals or sanitary landfill disposal are partially carried out. No clear legislative criteria are established for treatment and/or disposal of medical SW. Appropriate management is not done for the whole medical SW. The Medical Institutions' Survey supports the impression that the present medical SWM generally receives little attention from the management of the medical institutions.

1.2 Present Industrial and Medical SW Generation

Estimation of the present ISW generation amount is carried out by referring to the outcome of the Team's factory survey plus the data from the EWI's RISNOR study converted to the 24 waste classifications proposed by the Team. Based on the generation data of these 425 factories in total, generation ratios of 24 ISW classifications were calculated. The ISW generation amount is calculated multiplying the ratios by the present number of employees for each category of industries.

As a result, the Team's Study verified that ISW generation in the MR at present (1995) is of the order of 939,000 ton/year, which comprises 26,000 ton/year of HW, 45,000 ton/year of LW and the rest being non-HW according to the ISW classification being applied in the CDSI system. HW and LW which are subject to utmost attention and control in view of ISWM count for only 7.6% of total ISW generation. Namely great majority of ISW is non-HW at present.

The present medical SW generation was estimated based on the Medical Institutions Survey by the Team, comparing the data of the EWI's RESHOS Study and data from other countries. As a result, the Team's Study verified that Medical SW generation in the MR at present (1995) is of the order of 23,600 ton/year. Infectious medical SW that are subject to special attention in medical SWM counts for 7,300 ton/year (i.e. 31% of the total).

2. The ISWM Master Plan

2.1 Forecast of Future ISW Generation

Based on the estimated amount of present ISW generation, a forecast of future ISW generation in 2010 was conducted by applying the Standard Unit Method (SUM). Based upon data obtained from the Team's factory survey and EWI's RISNOR study except for sludge and dust, the ISW generation in the year 2010 was the product of "generation ratio in 1995" and "forecasted employee number in 2010" for 36 respective industries' classification. The forecast of sludge and dust generation, on the other hand, was conducted assuming the present installation rate of PCF (Pollution Control Facilities) (2.1 % for air PCF and 48.9 % for on-site water PCF) will become 100 % in 2010.

Generation of ISW highly depends on the assumed water content of sludge. ISW generation in 2010 is forecasted both in the cases of without dehydration at generation sources and with dehydration on-site. In the case of without dehydration at the generation (on-site), i.e. the water contents of C-3: Inorganic Sludge and C-4: Organic Sludge are assumed 90 % and 99 % respectively, an estimated amount of total ISW generation in year 2010 is 8.5 times more than that in 1995 and 8.00 million ton/year. "Organic sludge" generation amount in 2010 is forecasted to be 6.59 million ton/year, which counts for 82 % of the value estimated above.

In the case of with dehydration on-site in order to be received at a final disposal site, an estimated amount of total ISW generated (after on-site dehydration) in 2010 is only 22 % of the above estimation, which is 1.9 times than that in 1995 and 1.76 million ton/year. In this case, organic sludge counts for only 25 % of the total generation. However, increases in dust and sludge (which should be subject to be controlled as HW) generations from 1995 to 2010 are remarkable. Those generations in 2010 are estimated 687,000 ton/year and will count for 39% of the total ISW generation.

Therefore it should be reminded in planning and formulating a proper management system of ISW that ISW generation in the MR in the future will be quite different from that of today both in quantity and quality.

2.2 Outline of the Master Plan

2.2.1 Goals and Strategies

The principal goal of the ISWM Master Plan is to establish a proper management system of ISW till the target year 2010 in the Metropolitan Region. Whereas establishment of the proper ISWM system is essential for ***"preservation of the environment and public health, and sound development of the city"*** and ***"promotion of growth of Chilean industries in gaining the international competitiveness required for compliances with issues of joining the International Market and ISO's stricter standards for environment"***.

In order to achieve the principal goal, the Master Plan proposed to comply the two requirements **(i.e., Establishment of Appropriate On-site ISWM and Formulation of ISWM market mechanism)** in accomplishing "targets" and deploying "strategies". Namely, based on PPP (polluter pays principle), an outline of ISWM that treatment and disposal of ISW be carried out by private sectors should be formulated. Hence, the authorities should prepare systems of legislation, guidelines, monitoring and guidance that promote said formulation. In practice, the Master Plan period was divided into four phases toward the target year 2010. Strategies in respective stages were presented.

2.2.2 Outline of the Master Plan

There is a wide variety of features and characteristics of ISW generated. Consequently technical systems to be applied for the management of ISW have a wide variety in their applications and background technologies. At present, a technical system for ISW in the MR is not established yet. Based on the above-mentioned strategies, as a technical system of ISWM in future, the Study examines and presents appropriate treatment/disposal flows for 24 ISW categories proposed by the Study Team for the authorities' proper management system of ISW. The appropriate treatment/disposal flows will contribute to establish authorities' proper management of ISW in seeking effective and efficient monitoring and guidance to be placed to private sectors activities related with ISWM.

Meanwhile, waste generators could compare costs of collection, intermediate treatment and final

disposal referring to the proper ISW flow, and could select their ISW treatment/disposal flow (technical system) being the most cost-effective and legally appropriate. And ISW handling agents will provide an appropriate technical system, in view of respective treatment demands, legislatively required compliances, facilities site availability, technologies available and manageable and profitability. Namely, the technical system for ISWM in future is to be formulated based upon "economic activities and market mechanisms" of waste generators and handling agents.

As for the institutional system, based on the principle that the technical system shall be formulated by the private sector, the plans of the following items are examined and proposed in view of that the authorities should prepare the institutional system to guide the private sectors for the establishment of a proper ISWM technical system:

- basic principle of legal system;
- institutional and organizational development plans;
- strategy for the short-term administration of ISW;
- human resources development plans;
- executing bodies of the Master Plan;
- procedure to obtain neighborhood consensus;
- appropriate system to promote private sectors related to ISWM;
- monitoring and information system; and
- permission procedures for localization of ISWM facilities and license for ISWM business.

2.3 Evaluation of the Master Plan

One of the principal targets of the Study is to estimate the magnitude of ISWM business in 2010. It is necessary for the estimation to assume the outline of technical system (storage, collection, transportation, treatment and disposal) in 2010, and set up the amount of ISW and unit costs of treatment/disposal in the system. Therefore, the Team, judging from present industries features and economic trends, quantity and quality of ISW, and natural conditions and so on in the MR, assumed intermediate treatment and disposal flows corresponding to 24 ISW and accordingly calculated a rough estimate of ISWM handling cost for the amount forecasted of ISW to be treated and disposed in the year 2010.

As a result, the total ISW handling business market in the MR in the year 2010 is estimated to be around 41.7 million US dollars (October 1995 price) based on handling price. It covers about 0.036% of the forecasted GNP of 114.9 billion dollars in 2010 or 0.067% of GNP in 1995 (62,500 million US dollars). Final disposal business forms the biggest market which is about 62% of the total ISW handling business market. The remaining market is covered by collection and transport (33%) and intermediate treatment (5%).

Based on the ISW handling cost in 2010, "Reasonability of the Cost of Public Administration and Generators for Implementing the Master Plan" and "Benefits of the Master Plan for the Future Chilean Economy" are examined as an economic evaluation. Secondly, "Administrative Measures to be Applied" and "Technical Capability" for the implementation of the Master Plan are studied as a technical evaluation. Finally, as for the environmental evaluation, "Environmental Risks of Improper Flue Gas and Waste Water Treatment in Factory" and "Environmental Risks of Improper Management of ISW" are examined.

As the result of the evaluations, the implementation of the Master Plan is concluded to be feasible from economical, technical and environmental viewpoints.

3. The Medical SWM Master Plan

For the Master Plan it is proposed to predict the future medical SW generation based on the development of the population (linear projection) combined with an assumption of an annual increase of the waste quantity of 1% for the expected impact of improved hospital hygiene and the assumed wider use of disposable equipment. As a result, it is estimated that infectious waste in year 2010 be generated 28.5 ton/day (namely 10,400 ton/year).

The medical SWM Master Plan is formulated with the following planning frames:

- improvement of medical SWM facilities and practices at medical institutions in the MR;
- establishment of a standardized labeling and packaging system for infectious medical SW;
- setting up of a low-cost final disposal option based on safe disposal of infectious medical SW at a controlled landfill for municipal SW; and
- in time, establishment of thermal treatment of infectious medical SW, possibly as co-treatment with ISW.

The medical SW handling market is estimated to be about 2.02 million US dollars in 2010, which is as much as 4.8% of the total ISW handling market in 2010.

As the result of the economic, technical and environmental evaluations on the medical SWM Master Plan, the implementation of the Master Plan is concluded to be feasible from economical, technical and environmental viewpoints.

4. Recommendations

4.1 Unified Classification of ISW to be Established Earlier

The Team understands that the 24 ISW classification proposed for the Study is effective and efficient in "identifying the actual situation of ISW generation (quantity, on-going treatment/disposal)" and "programming intermediate treatment and final disposal plans". On the other hand, ISW classification of CDSI (i.e. 333 classification) is practically being used in SESMA-PROCEFF's monitoring and control and in addition, MS regulations recently drafted requires diffusion of analytical identification of HW in employing its 44 classification.

Inter-ministries coordination should be improved with regard to ISW classification in Chile. The situation should draw utmost attention in establishing a proper management system of ISW.

It is recommended in this regard that:

- authorities' monitoring and control of ISW should be pursued with CDSI classification for the time being,
- with regard to HW, as soon as when laboratorial analytical identification become practiced and prevalent, coordination between CDSI classification and MS classification should be placed as the basis of formulating unified ISW classification earlier.

4.2 Treatment (Prior to Discharge and Emit) to be Obligated

In order to substantiate counter measures for pollution of HW and LW (which draw special attentions in practices of ISWM), inter-relation with "air and water pollution prevention measures" is indispensable to effect HW/LW pollution prevention. A great majority of HW which should be subject to these preventive measures are currently released to the sewer, public water courses or to the air. It should be reminded that treatment (prior to discharge to the sewer, superficial courses or emit to the air) and enforcement of related monitoring is the first step to realize HW pollution prevention.

4.3 Local Authorities to be Strengthened and Administrative Measures to be Legally Empowered

Although establishment of the proper management system of ISW should, in principle, be promoted through private sectors activities, on the other hand strengthening of relative local authorities' organization (which is responsible for monitoring and guidance over the private sectors) is essential for the promotion. For that purpose, legal authorization of authorities' administrative measures should be enforced. A program for the consistent management from the

waste generation to final disposal and its realization should be associated with the permit bound to the obtainment or renewal of the municipal patent.

4.4 Waste Generators' Organizations to be Strengthened

A proper on-site management of ISW is required to be promoted inter-relating with on-site air and water pollution prevention measures and control of hazardous physico-chemical substances. In addition, alteration of production processes are necessitated for pursuing management. To formulate industries' organization (including assignment of qualified technical staff) to fulfill these requirements is a crucial issue to be solved, where it considerably requires industries' intentional efforts for reform. The Government policies for ISWM should also, considering the importance of the issues mentioned, place higher priorities in promotion of waste generators' organizational reinforcement in this regard.

4.5 Human Resources to be Developed

Human resource development both in authorities and waste generators, and also in ISW handling agents is in urgent need of solution. Whereas laboratorial analysis, which is fundamentals for HW management, should be disseminated and practiced, training opportunities for acquiring laboratory analysis technologies should be provided, e.g. through the CENMA project. The CENMA project should be utilized in initial stages as a "reference laboratory" for identifying HW and followingly training courses of technical skills and practices should be included to the project. In addition, the role of the Instituto de Salud Pública (Public Health Institute) be reinforced throughout a study with regard to its use as "reference laboratory" and with regard to the need of coordination with the CENMA project.

Human resource training plays an important role in establishing the proper management system of ISW.

4.6 HW Landfill for the MR to be Realized Soon

In order to formulate an appropriate management system for HW, a final disposal site for HW should be prepared as soon as possible. It is necessary that construction and operation of a HW final disposal site is promoted and realized soon. In order for the realization of abovementioned situation, immediate actions for establishing following standards and systems are required:

- standards for structure and O&M of ISW final disposal site;
- system for neighborhood consensus (including EIA procedure and public participation); and
- system for localization and operation permission of ISW final disposal site (e.g. requirements/regulation for siting to be clarified).

In particular, the public opinion survey revealed that neighbors tend to be distrustful to authorities and promoting sectors through what they experienced in occasions of present landfill operations and localization of new landfills. The communication of the authorities and the promoting sector with the public should be direct and honest.

4.7 Legislative and Institutional System to be Improved Step-wise

Establishment of a proper management system of ISW in the MR requires improvement in related legislative system. It is anticipated that a whole required legislative system to be formulated and improved immediately. However, it is anticipated that several issues, that related authorities can not cope with for the time being, and/or impediments for consensus may delay the formation of required legislative system. In this regard, step-wise manner (e.g., basic obligation to industries/handling agents and authorization of monitoring/guidance be stipulated in earlier stages, penalty against illegal conduct and/or administrative measures be put into practice in later stages) should be employed in improving legislative and institutional system.

4.8 Present Situation to be Identified and Database to be Established

The most fundamental principle of SWM is precise identification of the present situation (of ISW generation and ISWM on-site and outside). Fortunately, the Manifest System is already in operation by SESMA-PROCEFF. The present situation of total 425 was identified. Starting with said identification, it is necessary to elaborate for establishment of the database for a proper management system of ISW by accumulating data/information through further factory visit, on-site inspection and report collection. In order to establish the database through information collection, the corresponding norms and regulations that require such information should be set up.

ISW generation in future is forecasted based on the data obtained by Team's Factories Survey and EWI's RISNOR study both of which were conducted only one time and almost at the same time. Therefore, especially for the forecast of dust and sludge (which are to be managed as HW) generation, various assumptions were made. It should be understood that the forecast is conditional. In order to make the forecast reliable, it is recommended that Chilean authorities conduct periodical factories' survey (in Japan it is conducted every five years.).

4.9 Code of Practice for Medical SWM to be Prepared Soon

The Master Plan for medical SWM, apart from the Master Plan of ISWM, is produced. Among the issues proposed in it, preparation of a Code of Practice of medical SWM should be recognized as the issue to receive high priority in taking urgent actions. Based on the outcome of the Team's investigation, immediate action for the preparation of a Code of Practice should be initiated.

4.10 Disposal System for Infectious Waste to be Improved Step-wise

It is necessary that technical system for infectious wastes be established (i.e., each type of medical SW be separated at generation sources, exclusive collection/transportation and treatment/disposal for infectious waste be practiced.). Thermic treatment by individual small-scale incinerators has problems in air pollution control and O&M features. Meanwhile a centralized incinerator project should overcome problems of inefficient scale and cost recovery. In this consequence, it is proposed that an exclusive section in a municipal landfill site should be allocated for a sanitary landfill for medical SW for the time being. Separate and isolated landfill operation should be employed there. In the future, medical SW should be sent to and incinerated at an incineration plant for HW. When centralized incineration plant is in operation, strict gas emission regulation may possibly start to be imposed on existing individual small-scale medical incinerators.

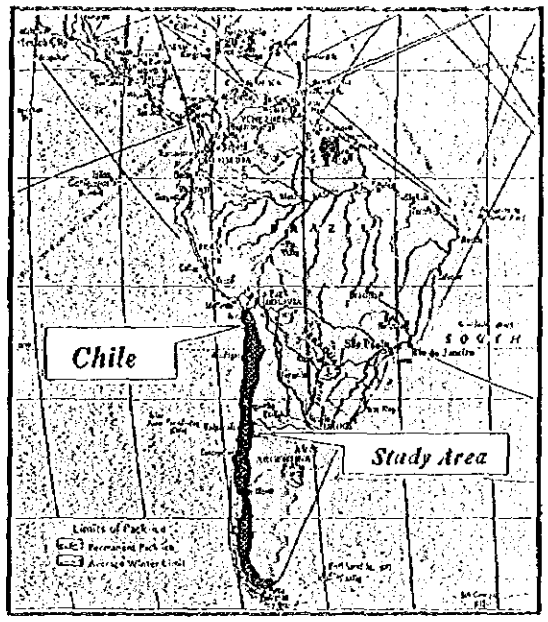
THE MASTER PLAN STUDY
OF
INDUSTRIAL SOLID WASTE MANAGEMENT
IN
THE METROPOLITAN REGION

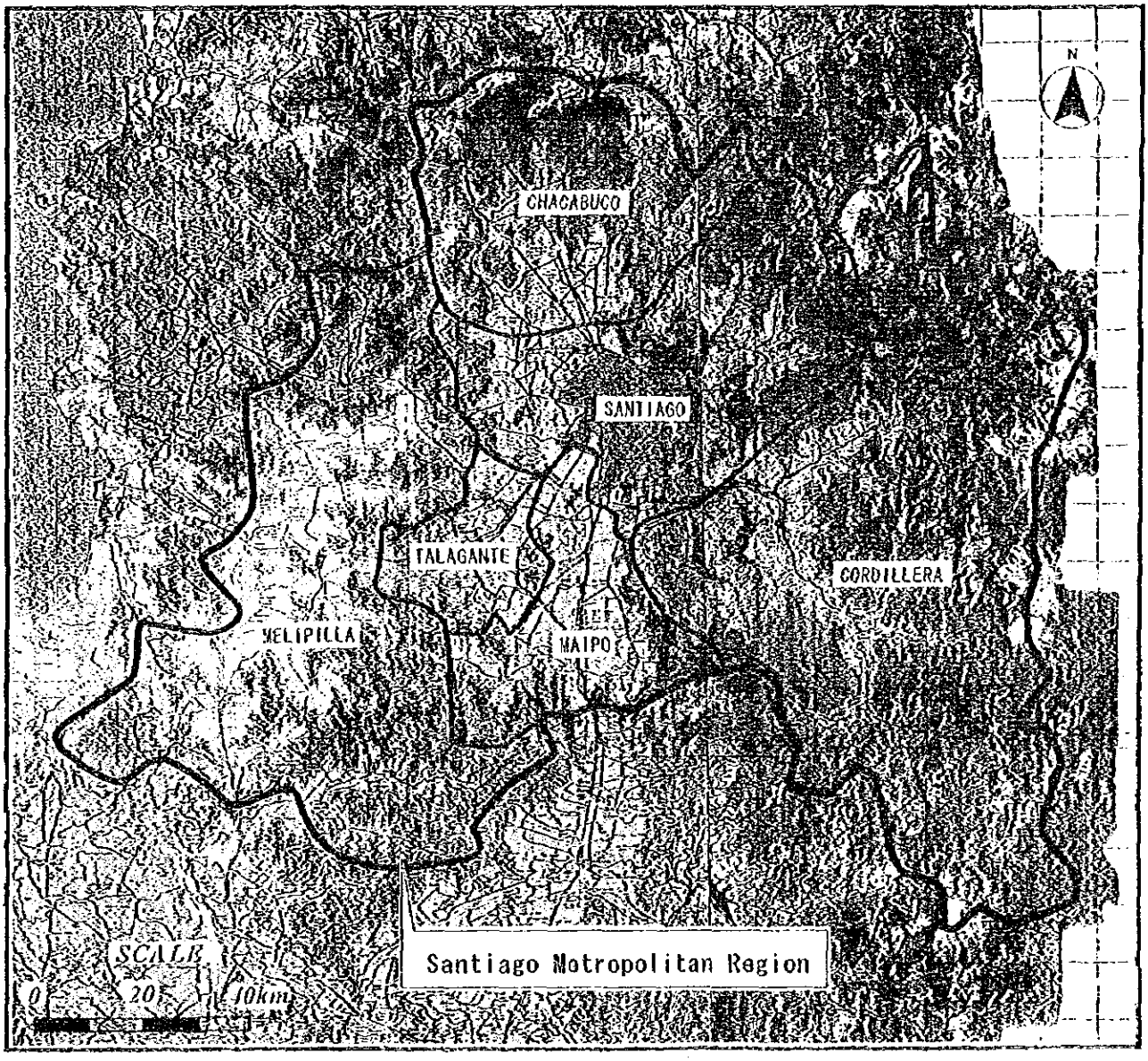
LIST OF VOLUMES

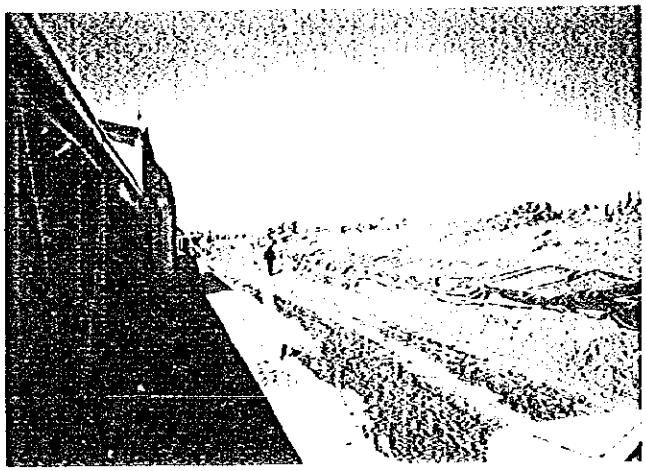
This is the EXECUTIVE SUMMARY.

Location Map of

The Study Area





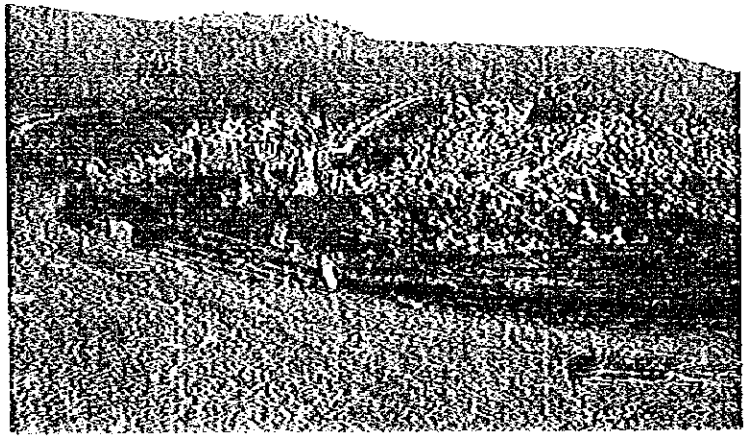


Lo Errazuriz Final Disposal Site (1)

There are 3 authorized municipal SW landfill sites. Lo Errazuriz landfill site, the largest one among them, achieves considerably high level of the landfill management. The line covered by black sheets is leachate collection ditch. Leachate collected are returned to landfilled layers by pumping.

Lo Errazuriz Final Disposal Site (2)

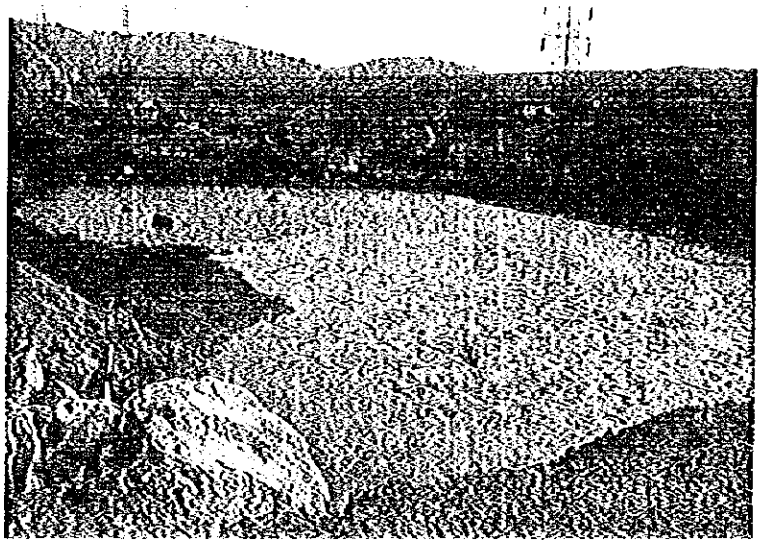
Lo Errazuriz landfill site, covering total 40 hectare, is planned to be closed in December 1995. The picture shows an area where landfill operation was completed and vegetation for park was prepared. The park serves as a public recreational area for the surrounding communities.



Cerros de Renca Final Disposal Site (1)

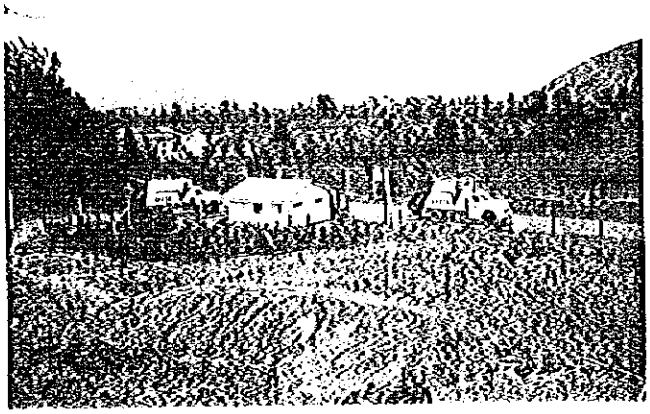
Cerros de Renca landfill site, second largest among 3 landfill sites, is located in the north of Santiago urban area. Although they also employ measures of daily coverage of waste disposed and biogas recovery, their quality of landfill management is inferior to that of Lo Errazuriz.

Plate 1 Present ISWM: Authorized Landfills (1)



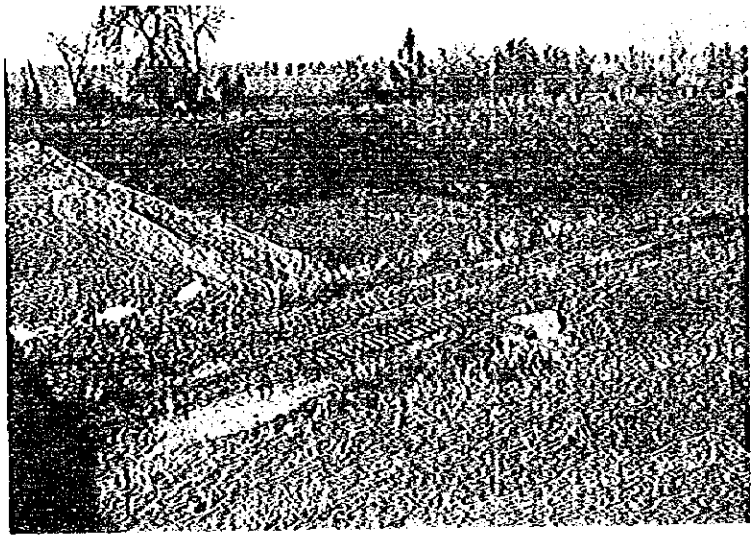
Cerros de Renca Final Disposal Site (2)

Neither intermediate treatment facilities nor final disposal sites for industrial solid waste (exclusively) do exist in the Metropolitan Region. Dumps of industrial liquid waste are found in a corner of Cerros de Renca site.



Lepanto Final Disposal Site (1)

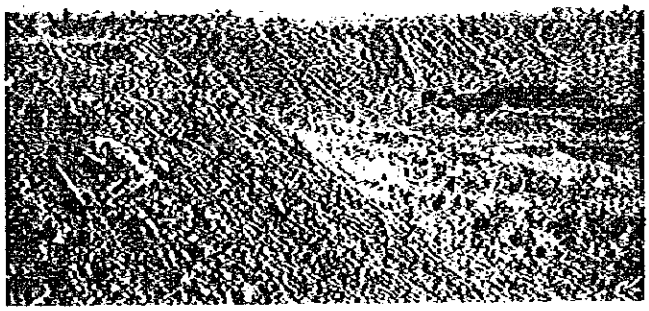
Lepanto site, the smallest among them, is located in the south of Santiago urban area. Although the landfill management of Lepanto is inferior to other 2 sites, daily coverage of waste disposed and biogas recovery are maintained in their practice.



Lepanto Final Disposal Site (2)

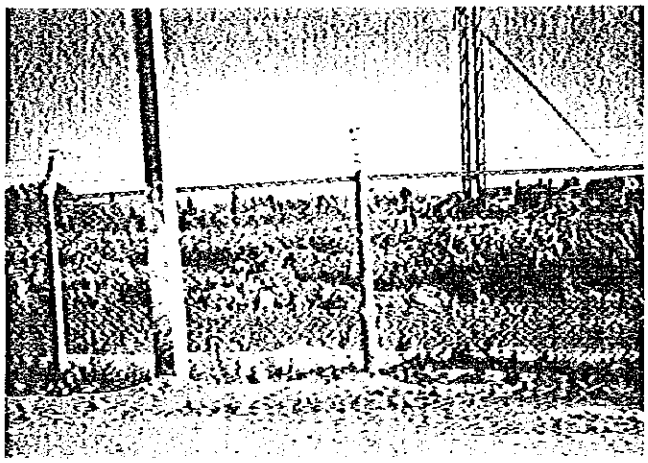
Tipping fee at Lepanto is comparatively cheap and various industrial solid wastes are received there.

Plate 2 Present ISWM: Authorized Landfills (2)



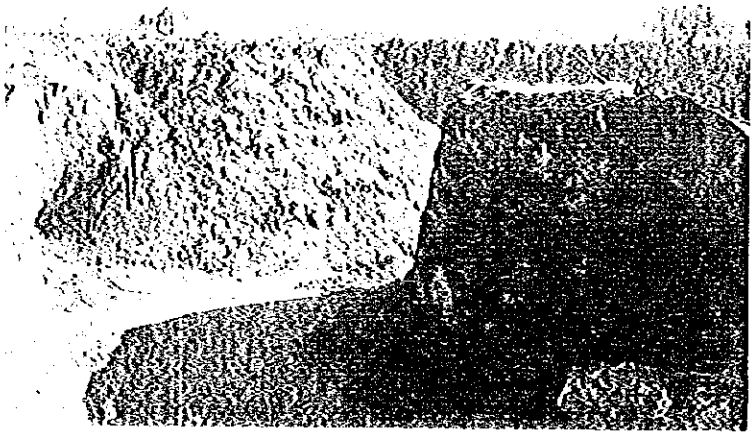
Unauthorized Destinations (1)

Apart from the 3 authorized landfills, there are several unauthorized landfill sites and many illegal dumps in the Metropolitan Region. The picture shows the largest illegal dump next to Lo Errazuriz site. Various types of solid waste are illegally dumped at ex-gravel/sand extraction pits. Great majority dumped are construction solid waste.



Unauthorized Destinations (2)

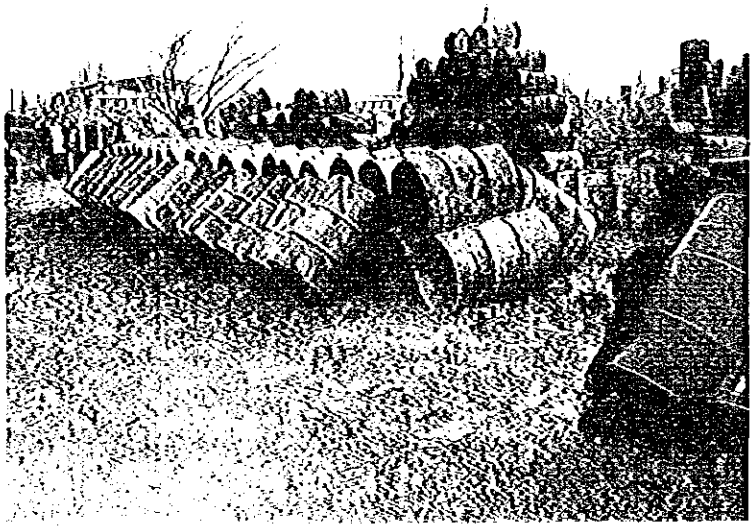
Quite a few scavengers are found in the illegal dump next to Lo Errazuriz site, although scavenging is not allowed in the Lo Errazuriz site.



Unauthorized Destinations (3)

There are many ex-gravel/sand/clay extraction pits in the Metropolitan Region and many of them are subject to illegal dumping. The picture shows an existing extraction pit, which welcomes construction waste disposal. The pit is registered as an unauthorized landfills in the CDSI system of SESMA-PROCEPF.

Plate 3 Present ISWM: Unauthorized Destinations (1)

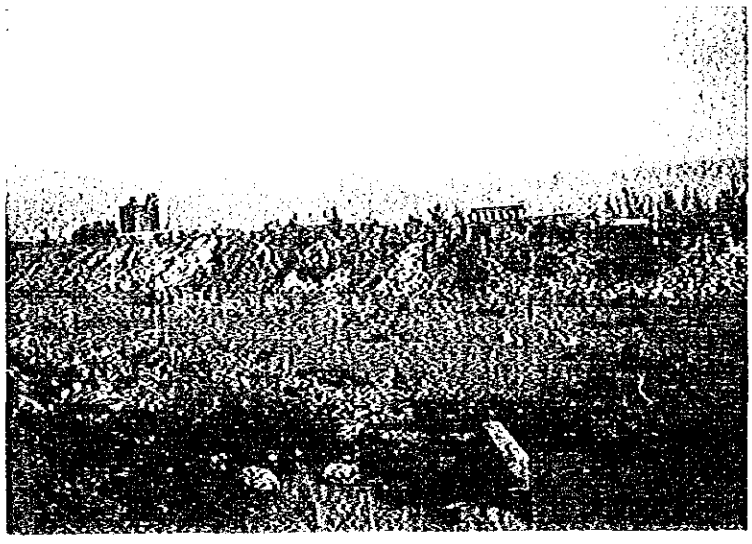


Unauthorized Destinations (4)

It is estimated that more than 50% of industrial solid waste is currently recycled in the region. However, inappropriate practices of recycling are observed in many occasions. The picture shows open burning of discarded drums with extraneous matters for recycling of drums.

Unauthorized Destinations (5)

Many of inappropriate recycling sites are located adjacent to unauthorized landfills. Residues from recycling are finally disposed of at those unauthorized landfills.



Unauthorized Destinations (6)

Small- or micro-scale recyclers recover valuable materials from solid waste they collected. Majority of residues from solid waste after the material recovery are illegally dumped. The picture shows illegal dumping of residues from recycling activities at Rio Mapocho.

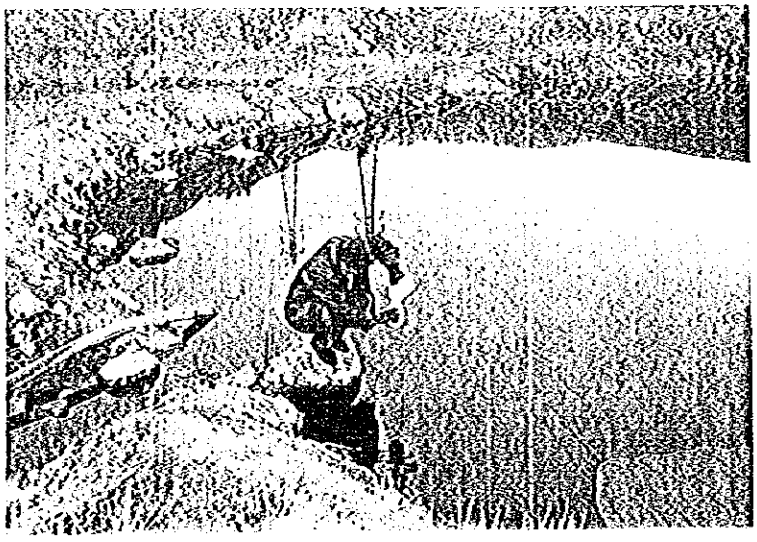
Plate 4 Present ISWM: Unauthorized Destinations (2)

Factory Survey (1)

It was observed in the Team's survey that working environment in factories in general are well put in order and kept clean. However, it was found that on-site management of industrial solid waste are not well established in factories.

Factory Survey (2)

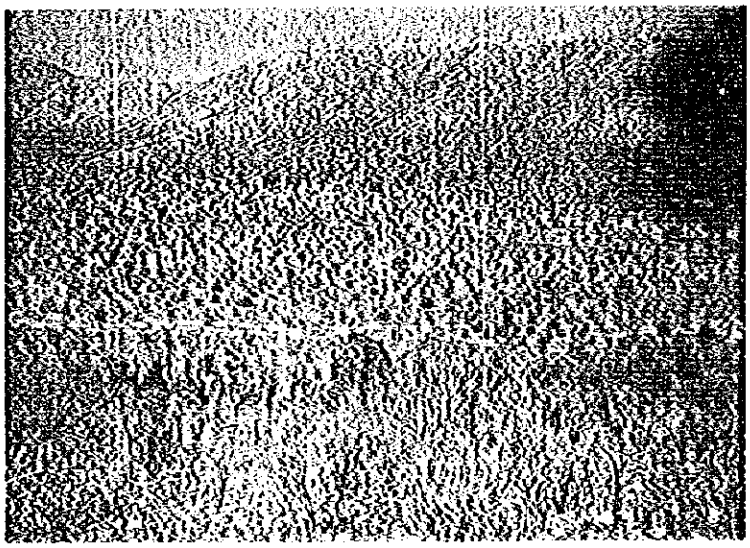
As for the mining industries, there are several ore-dressing in the MR and they produce considerable amount of tailings. However, all of tailings generated in the mining industries are disposed of at their own landfills at present and in future (i.e. closed system). The picture shows tailings disposal site whose capacity is for 100 years of tailings to be generated.



Leachate Quality Survey

The Study carried out the leachate quality survey for 3 authorized landfills. The picture shows sampling of leachate at Cerros de Renca site.

Plate 5 Field Survey (1)

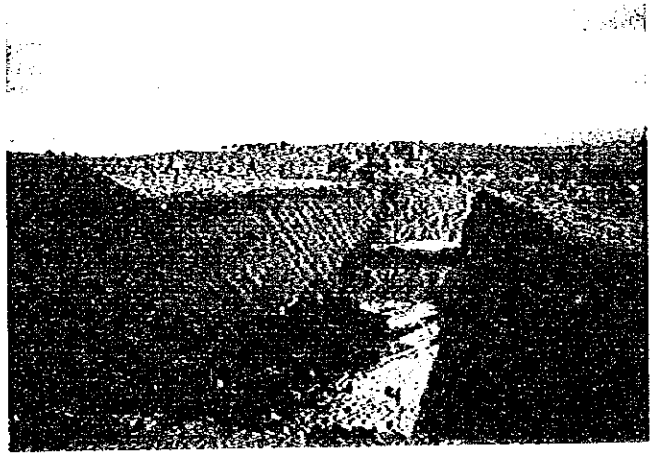


Candidate Site of HW Landfill (1)

The Study carried out comparative environmental evaluation for 11 candidate sites (selected by the counterpart) for hazardous waste disposal. The picture shows the candidate site at Cerro Carneros.

Candidate Site of HW Landfill (2)

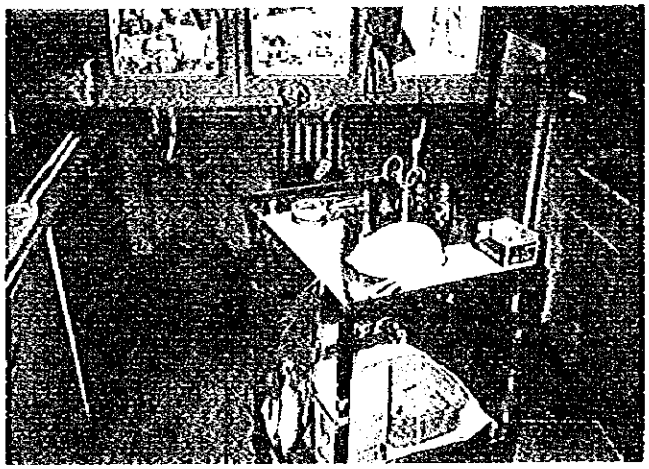
The picture shows the candidate site at Quilapilún.



Field Survey on Industrial/Medical Solid Waste Management in Brazil

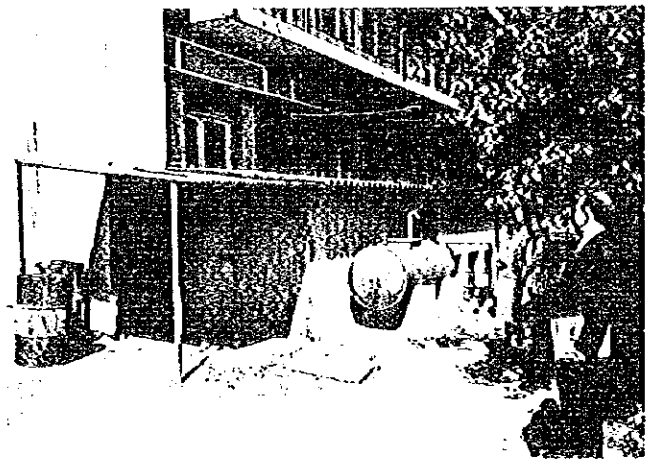
In order to refer the Brazilian industrial/medical solid waste management for the study, Team investigated actual situation of said management in Brazil. The picture shows the hazardous industrial solid waste final disposal site at Saô Jose dos Campos in Saô Paulo state.

Plate 6 Field Survey (2)



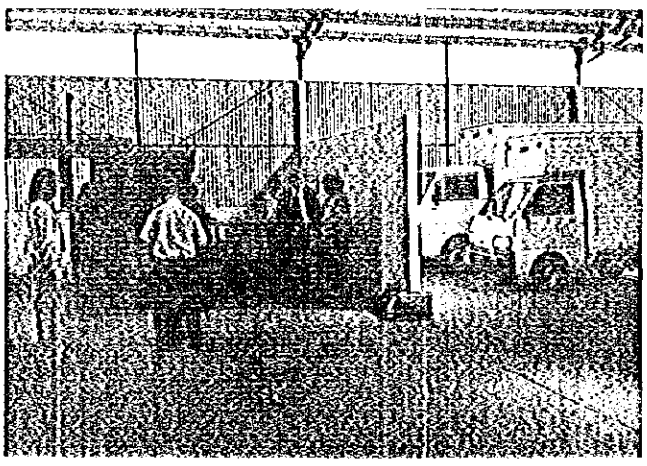
Infectious Solid Waste Separation at Source

Infectious solid waste are to be separated at source as shown in the picture. Some of said waste are incinerated at individual incinerator at medical institutions.



Individual Incinerator at a Hospital

There are 42 hospitals in the Metropolitan Region. 12 hospitals have individual incinerator for infectious solid waste in their premises.



A Medical Solid Waste Handling Agent

A company extends the service of collection and incineration of infectious medical waste in the Metropolitan Region since end of 1994.

Plate 7 Present Medical SWM

THE MASTER PLAN STUDY
ON
INDUSTRIAL SOLID WASTE MANAGEMENT
IN
THE METROPOLITAN REGION

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ABBREVIATIONS

AGCI	:	Agencia de Cooperación Internacional
APC	:	Air Pollution Control
BOD	:	Biochemical Oxygen Demand
CA	:	Competent Authority
CDSI	:	Control de Desechos Sólidos Industriales (Industrial Solid Waste Control)
CEDRM	:	Comisión Especial de Descontaminación de la Región Metropolitana
CENMA	:	National Environmental Center Project
CETESB	:	Campanhia de Tecnologia de Saneamento Ambiental of Sao Paulo Metropolitan Area
CIIU	:	Clasificación Internacional Industrial Unificada (International Standard Industrial Classification)
CIREN	:	Centro de Información de Recursos Naturales
CIW	:	Centers of Industrial Waste
CL	:	Controlled Landfill
CMP	:	Maximum Permissible Concentration
COENNU	:	Comisión Chilena de Energía Nuclear
CONAMA	:	Comisión Nacional del Medio Ambiente
CONAMA-RM	:	CONAMA-Derección Región Metropokitana
CORFO	:	Corporación de Fomento de la Producción
CP	:	Cleaner Production
CPT	:	Cleaner Production Technologies
DF/R	:	Draft Final Report
DIA	:	Declaración de Impacto Ambiental
DS	:	Decreto Supremo (Supreme Decree)
D&M's RISPEL Study	:	Diseño e Implementación de un Sistema de Control para el Manejo de Residuos Sólidos Peligrosos en la Región Metropolitana (Design and Implementation of a Control System of Hazardous Solid Waste Management)
EC	:	European Community
EIA	:	Estudio de Impacto Ambiental (Environmental Impact Assessment)
EMOS S.A.	:	Empresa Metropolitana de Obras Sanitarias, S.A.
EOP	:	End of Pipe
EU	:	European Union
EWI	:	Electrowatt Ingenieros Consultores (Chile) S.A.
EWI's RESHOS Study	:	Estudio de Manejo de Residuos Sólidos de Establecimientos Hospitalarios en la Región Metropolitana (Study on Medical

		Solid Waste Management in the Metropolitan Region)
EWI's RISNOR Study	:	Diagnóstico e Identificación de Tecnologías y Estrategias para el Manejo de Residuos Sólidos No Riesgosos en la Región Metropolitana (Diagnosis and Identification of Technologies and Strategies for the Management of Solid Industrial Non-Hazardous Waste in the Metropolitan Region)
EWI's VIRS Study	:	Proposición de un Plan de Acción para la Eliminación de Vertederos Ilegales y Recuperación de Areas Afectadas en la Región Metropolitana (Action Plan Proposal for the Elimination of Illegal Dumping Sites and the Recovery of Affected Areas)
FGT	:	Flue Gas Treatment
FONASA	:	Fondo Nacional de Salud
F/R	:	Final Report
GDP	:	Gross National Product
GNP	:	Gross Domestic Product
HCP	:	Heat Charge Processes
HPI	:	Highly Potential Industries
HIW	:	Hazardous Industrial Waste
HW	:	Hazardous Waste
IC/R	:	Inception Report
IL	:	Inert Landfill
IEE	:	Initial Environmental Evaluation
INE	:	Instituto Nacional de Estadística
INN	:	Instituto Nacional de Normalización
ISIC	:	International Standard Industrial Classification
ISO	:	International Standardization Organization
ISW	:	Industrial Solid Waste
ISWM	:	Industrial Solid Waste Management
IT/R	:	Interim Report
JICA	:	Japan International Cooperation Agency
LA-CA	:	Legal Acts of the Competent Authority
LA-MC	:	Legal Acts of Multi-ministerial Characteristics
LNG	:	Liquified Natural Gas
LPG	:	Liquified Petrol Gas
LPI	:	Less Potential Industries
LW	:	Liquid Waste
MACAM	:	Sistema de Medición Automatizada de Contaminantes Atmosféricos y Variables Meteorológicas
MIDEPLAN	:	Ministerio de Planificación y Coordinación
M/M	:	Minutes of Meeting

MOP	:	Ministerio de Obras Publicas
MR	:	Metropolitan Region
MS	:	Ministerio de Salud
NGO	:	Non-governmental Organization
O & M	:	Operation and Maintenance
PI	:	Potential Industries
PPP	:	Polluter Pays Principle
P/R	:	Progress Report
PROCEFF	:	Program de Control de Emisión de Fuentes Fijas (Stationary Emission Source Control Program)
PROGRESI	:	Industrial Waste Management Program
RESHOS	:	Residuos Hospitalarios (Medical Waste)
RILES	:	Residuos Industriales Líquidos (Industrial Liquid Waste)
RISNOR	:	Residuos Sólidos Industriales No Riesgosos (Non Hazardous Industrial Solid Waste)
RISPEL	:	Residuos Industriales Peligrosos (Hazardous Industrial Waste)
SCL	:	Strictly Controlled Landfill
SEREMI	:	Secretaría Regional Ministerial
SERNAGEOMIN	:	Servicio Nacional de Geología y Minería
SERPLAC	:	Secretaría Regional Ministerial de Planificación y Coordinación
SESMA	:	Servicio de Salud del Ambiente Región Metropolitana (Metropolitan Region Environmental Health Service)
SNSS	:	Servicio Nacional de Servicios de Salud
SOFOFA	:	Sociedad de Fomento Fabril
SS	:	Servicio de Salud/Suspendid Solids
SISS	:	Superintendencia de Servicios Sanitarios
SW	:	Solid Waste
S/W	:	Scope of Work
SWM	:	Solid Waste Management
TA-CA	:	Technical-normative Act of the Competent Authority
TIS	:	Technical Information System
US-EPA	:	Environmental Protection Agency of United States of America
VIRS	:	Vertidos Ilegales de Residuos Sólidos (Illegal Dumping of Solid Waste)
WP	:	Watering Processes
WHO	:	World Health Organization
WWT	:	Waste Water Treatment

CHAPTER 1 INTRODUCTION

1.1 Background

A rapid growth of economic and industrial activities in Chile brought about serious environmental problems such as air and water pollution and solid wastes, especially in the Metropolitan Regions of Santiago.

In view of the municipal SWM (Solid Waste Management), collection services are realized for most citizens. On the other hand, for ISWM (Industrial Solid Waste Management), the declaration (manifest) system of solid waste generators is completed. Based on that declaration system administrative guidance to each generator has been executed since May 1993 and preliminary researches carried out. However, no substantial measures are planned nor executed regarding treatment and/or disposal of the ISW. Hence, ISW including hazardous waste are transported into the municipal SW disposal sites and illegal dumping is brought about. Consequently **this process *immensely aggravates the urban environment.*** As for medical SW, incineration at hospitals or sanitary landfill disposal are partially carried out. No clear legislative criteria are established for treatment and/or disposal of medical SW. Appropriate management is not done for the whole medical SW.

Related with the more stringent enforcement of the environmental regulations over air and water pollution in the future, polluting substances, which are currently dispersed into the atmospheric and aquatic environment, are to be dust and sludge through treatment and will eminently emerge as mass waste. Furthermore, in accordance with further industrialization and urbanization, issues of treatment and disposal of industrial/medical SW will have to be dealt with the first priority to the solution. In this regard integrated industrial/medical SWM including waste mininization at the production stages and consistent management from waste generation to final disposal need to be programmed and actualized.

Under such circumstances, the Government of Chile officially requested to the Government of Japan to implement the Master Plan Study of Industrial Solid Waste Management in the Metropolitan Region in the Republic of Chile.

In response to the request of the Government of Chile, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, concluded the Scope of Work of the Study with CONAMA of the Government of Chile. Kokusai Kogyo

Co., Ltd. and EX Corporation carried out the Study.

1.2 Scope of the Study

a. Objective of the Study

The objectives of the Study are:

- to formulate a master plan for the proper management of industrial and medical waste in the Metropolitan Region with the target year of 2010; and
- to identify priority projects for feasibility studies.

b. Study Area

The study area shall cover the Metropolitan Region as in Figure 1.2a.

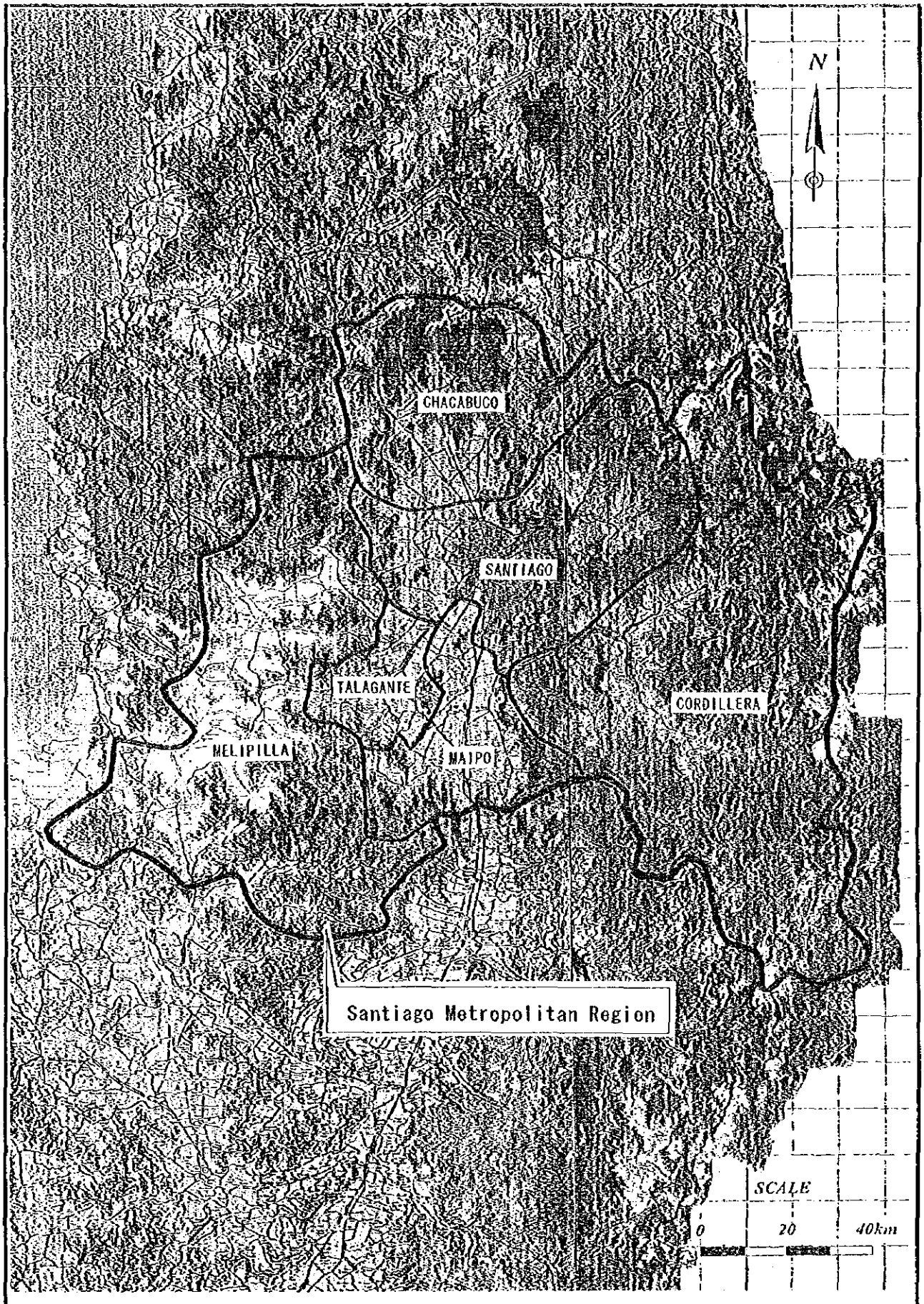

Figure 1.2a Study Area

c. Study Wastes

The wastes to be studied in this study shall cover industrial and medical solid wastes. Construction and agricultural wastes are excluded from the study.

1.3 Basic Policy of the Study

For the successful execution of the Study, the Study Team established the basic policy regarding the following points:

a. Joint Study

Due to the rapid change of the socio-economic situation in Chile as well as her policies on environment, it would be very important to identify the present situation and future change of the institutional system on industrial/medical SWM and to make an appropriate institutional development plan. This task, however, is not an easy task for foreign professionals without the appropriate support from Chilean counterpart and professionals.

With this reason, the Study Team proposed that the Study should be implemented as a joint study and asked for cooperation and active participation of the Chilean side.

b. Workable Plan and Appropriate Technology

Upon careful consideration of the characteristics of the Study, the most workable and implementable industrial/medical SWM master plan shall be formulated for the Metropolitan Region in close cooperation with the Chilean counterpart. Furthermore, the Study Team should develop the most appropriate technology both for technical and institutional systems for industrial/medical SWM in the area. Especially, the proposed plan should present and support a self-sustainable industrial/medical SWM for the Metropolitan Region.

c. Multi-media Approach

An ISWM Master Plan is formulated based on future waste generation. The future ISW generation is expected to increase according to the reinforcement of air and water

pollution control. At the same time, it is also important to consider the degree of waste minimization including source reduction, separation and recycling which depend on legislation and its enforcement, environmental policy, promotion system for environmental protection facilities, consciousness of enterprises and citizens, etc.. It was, therefore, necessary to take a **Multi-media approach** on environment (integrated environmental management) in the process of the master plan formulation.

1.4 Key Assumptions

Key assumptions used in this study area are as follows:

a. Socio-economic Conditions

Items	Unit	Descriptions		
1. Population				
- Projected Population of the Study Area	thousand persons	1995 5,642	2000 6,100	2010 6,930
- Annual Growth Rate	%/year	1.5		
2. Economy				
- GDP	bill. US$	62.5 114.9	in 1995 in 2010	
- Annual Increase Rate of GDP in Real Term	%	5.1		
- Currency Exchange Rate		1 USD	=416.2 Peso =102.4 Yen	

b. Waste Generation

Items	Descriptions
1. Classification of Industry	CIIU (International Standard Industrial Classification)
2. *Targeted Industries*	CIIU code: - Manufacturing Industries (CIIU code 31111 - 39099) - Generation, transmission and distribution of electric energy (CIIU code 41011) - Gasoline filling stations (CIIU code 62536) - Laundries and cleaners (CIIU code 95201) Scale of Industries: Industries with 10 or more employees
3. Classification of ISW	24 Categories compatible with SESMA-PROCEFF 333 ISW categories
4. Data used for the calculation of present generation	ISW generation data: - 236 factories surveyed by EWI's RISNOR Study - 189 factories surveyed by JICA Study Team Data source on industries: INE
5. *Forecast of ISW Generation*	
5.1 Method applied	Standard Unit Method
5.2 Population figure for the forecast	Number of employees
5.3 Forecast of the number of employees	Linear Regression by Least Square Method combined with some variation factors
5.4 Installation rate of PCF (Pollution Control Facilities)	Air PCF: 100% in 2010 On-site Water PCF: 100% in 2010
6. Generation Rate	
6.1 Dust and APC products	Generation ratio of similar categories of industries obtained by the Team's survey are applied to dust generation in 2010.
6.2 Inorganic and organic sludge	"BOD/SS concentration data for respective group-wise industries of Japan" minus "maximum limits of BOD/SS concentration defined in Nch2280". The sludge generated from the removal of dissolved inorganic substances through physical-chemical treatment is not projected.
6.3 Water content	Category : Inorganic Sludge : Organic sludge Before Dehydration : 90% : 99% After Dehydration : 85% : 85%

c. Cost Estimation

Items	Descriptions
1. Principle	For the estimation of the magnitude of ISWM business in 2010, outline of technical system (storage, collection, transportation, treatment and disposal) in 2010 are assumed. Amount of ISW and unit costs of treatment/disposal in the system are set up based on the system.
2. Storage 2.1 On-site 2.2 At Treatment Facilities	 Excluded from the estimation. Included in the tipping fees of treatment facilities.
3. Collection and Transportation	Prepared by referring current collection/transportation costs for municipal SW.
4. Intermediate Treatment 4.1 Service life of facilities 4.2 Loan conditions 4.3 Tipping fees	 15 years. 15 years of payback period and 6% interest rate in real term. Including profits and insurance costs for accidents.
5. Recycling	Recycling ratios of ISW in 2010 are estimated, with reference to empirical data in Japan and results of the Team's factories survey.
6. Final Disposal	Tipping fee including profit, insurance cost, etc. of SCL and CL for ISW are estimated referring to the present tipping fee of municipal landfills in the MR and the fees employed in said landfills in Brazil.

1.5 Work Processes of the Study

The study commenced in January 1995 based on the Scope of Work signed between the Chilean Government and JICA in August 1994, and will end in February 1996.

The study consisted of the following three phases;

Phase 1 : Evaluation of the Present Industrial/Medical Solid Waste Management
Phase 2 : Establishment of a Planning Framework
Phase 3 : Formulation of a Master Plan

1.6 Members of the Study Team

The JICA Study Team consisted of the member listed below.

Name	Title
Susumu SHIMURA	Team Leader/ ISWM Plan
José Felício HADDAD	Organization and Institution Plan (1)
Satoshi SUGIMOTO	Economic Policy/ Financial Plan
Koichi HIRAMATSU	Waste Minimization Plan
Hiroshi KATO	Intermediate Treatment/ Final Disposal Plan
Shunsuke AOYAMA	Environmental Policy (1)
José ARELLANO V.	Organization and Institution Plan (2)/ Environmental Policy (2)
Nils KRISTENSEN	Medical/ Hazardous Waste Disposal Plan
Tadaya YAMAMOTO	Environmental Study (Social Aspects)/ Cost Estimation
Jens Kjems TOUDAL	Environmental Study (Technical Aspects)
Ferran MACIPE C.	Administrative Coordinator

CHAPTER 2 PRESENT SITUATION OF ISWM

2.1 Profile of the Study Area

a. Natural Conditions

The Metropolitan Region of Santiago covers an area of approximately 15,300 km^2, which counts for 2% of the total land surface of the Republic of Chile. Most of the MR falls in the Rio Maipo basin.

The MR area is in a large valley basin and has small precipitation (i.e. 300mm to 600 mm annual). Meanwhile Rio Maipo has its origin in melt snow in mountains and has affluent flows. Wide and fertile agricultural land extends down stream.

b. Environment

The MR forms a valley basin surrounded by mountains, thus air pollution attributed to exhaust gas from automobiles and factories is aggravated. Consequently respiratory problems and illnesses (attributable to air pollution) are increasing and poses serious threats.

As for aquatic contamination in the region, since measures of waste water treatment are not substantiated in most factories, these are discharged together with domestic sewage directly into the Rio Maipo river system. However, water pollution by industrial waste water discharge does not become tangible. The reasons could be:

- major water polluting industries are not located many in the MR;
- affluent flow in the rivers where waste water are discharged; and
- rapid flow in the rivers directly runs into the Pacific Ocean.

c. Land Use

The MR of Santiago comprises 6 provinces. More than 90% of its population and industrial/commercial activities is concentrated in Santiago Province; its area is about 2,000 km^2. INE estimated that urban migration and population growth of the MR will continue and its population of about 5.3 million in 1992 will expand to 6.9 million by the year 2010. According to the Metropolitan Regulatory Plan of Santiago, Santiago

and Cordillera Provinces mainly comprises:

- commercial and old residential areas in the urban district,
- industrial area in its circumference,
- new residential area expanding in the outer area,
- agricultural land use (such as orchard and grainfield) is predominant along the major two rivers i.e. Rio Maipo and Rio Mapocho, and
- area of restriction (by geographical risk and environmental protection) to the urban expansion.

d. Socio-economic and Industrial Situation

The national economy in the Republic of Chile is making fairly steady growth in comparison with all other worldwide economies. Especially the MR is continuously achieving its GDP growth of approximately 10% higher than the Republic's average growth for the past decade. It counts for about 47% of the GDP in Chile.

Industries with 10 or more employees counts for approximately 3,400 companies in the MR, (about 3,000 companies are located in Santiago Province) whose total employees counts for about 280,000 people. Industries in the MR mainly comprise:

- food and beverage production (20% of factories with 10 or more employees) which are commonly found in urban area in all countries;
- textile and clothing industries (27%; as above);
- chemicals, fertilizers, pharmaceuticals production (15%; as above); and
- metal and mechanic manufacturing (19%; as above).

Whereas material industries such as mining, pulp, steel makers are found less frequent in the MR.

In view of ISW generation, large-scale ISW waste generators (e.g. material industries) are not found in the MR. Constituents of current industries in the MR indicate that ISW, in wide variety, are generated including LW (Liquid Waste) and HW (Hazardous Waste). ISWM corresponding to this trend of industrialization is required.

2.2 Field Surveys

a. Factories' Survey

a.1 Objectives of the Survey

The objectives of the survey are:

- to identify the present generation and disposal of ISW on-site ;
- to understand the actual conditions of environmental management system in factories ; and
- to gain an insight into the possible behavior and consciousness on environmental protection of generators.

a.2 Scope of Industries for the Study

The following industries were included for the study following the discussion with the counterpart personnel:

- manufacturing industries (CIIU code 31111 to 39099);
- mining industries (CIIU code 21001 to 29090);
- electricity generators (CIIU code 41011);
- fuel stations (CIIU code 62536); and
- laundries and dry cleaners (CIIU code 95201).

The list of the industries for the Study can be found in section C.2 of the Annex.

a.3 Classification of ISW

Several similar studies for ISWM were conducted prior to the Study and several ISW classification were examined and proposed. Among those ISW classifications proposed, it may be judged that the "333 classification" proposed in the EWI's RISNOR study and the one which SESMA-PROCEFF plans to adopt officially for their ISW monitoring and management (i.e. CDSI system) should be currently most suited to the present state of industries in the region.

As proved in the EWI's RISNOR study, the 333 classification is most suited for management of the declaration (and is advantageous especially in view that both waste generator and authority could identify ISW), however, the diversity of this classification is of great disadvantage and imposes a huge restraint when estimating

total waste generation amount in the MR and for planning treatment/disposal plans based upon the estimated value. Therefore, for the formulation of the Master Plan as the Study requires, it is indispensable that the 333 classification should be divided into categories of wastes, similar in nature. Consequently, the Team proposed the 24 ISW classification, as shown in Table 2.2a, to be used for the Study that is compatible with and is a calibrated version of the 333 classification. The Team produced the matrix-table, as shown in Table I.1.2d in Annex I in order to maintain compatibility of 24 classification and 333 classification. The matrix-table was determined for the Study in order to estimate ISW generation amount and formulate ISW treatment/disposal plans, finally after full and detailed examination of its compatibility by both the Team and the counterpart.

Table 2.2a ISW Classification (24 Categories) Used for Factories' Survey

ISW Code	ISW category
C-1	Ash including from incinerator
C-2	Dust and APC products
C-3	Inorganic sludge
C-4	Organic sludge
C-5	Asbestos
C-6	Acids
C-7	Alkalis
C-8	Solvents
C-9	Oily waste
C-10	Inorganic chemical residues
C-11	Organic chemical residues
C-12	Other liquid waste
C-13	Waste from food production
C-14	Glass and ceramics
C-15	Metal and scrap
C-16	Paper and cardboard
C-17	Plastics
C-18	Rubber
C-19	Textile and leather
C-20	Waste similar to domestic waste
C-21	Wood
C-22	Slag from melting
C-23	Construction waste
C-24	Other solid waste

a.4 Selection of Factories for the Survey

For the selection of factories for the survey, manufacturing industries were classified into "industries with high potentiality of generating hazardous waste " and "industries

with low potentiality of generating hazardous waste". Since data of the latter is available by the EWI's RISNOR study, the Team's survey concentrated on collecting data of the former. Thus, industries with high potentiality of hazardous waste generation were mainly selected, while information from EWI's "non-hazardous industrial waste" was usefully incorporated.

a.5 Outcome and Findings

a.5.1 Database

Data obtained from questionnaires (both the Team's Factory Survey and EWI's RISNOR study) and processed in this Study are compiled in a "database". The "database" contains data from a total of 425 factories (189 out of 199 factories surveyed by the Team, and 236 out of 265 factories surveyed by EWI's RISNOR study.). This "database" is submitted to the Chilean counterpart in form of a floppy disk.

"Identification of present SW generation amount" and "estimation of future SW generation amount" is indispensable to initiate planning of SWM (either municipal, industrial or medical) and to revise the plan based on its monitoring.

The Team strongly wishes that the Chilean side fully utilizes the database submitted for their reviewing current ISW generation in certain intervals, subsequently it would like to enable the Chilean authorities to review the Master Plan periodically and revise and refine their policies regarding the ISWM.

a.5.2 Outcome

The outcome of the survey are presented in the main report, annex and data book in accordance with the information required. The contents of the outcome are listed below.

- General data on industries, i.e. name, address, main products, share capital, number of employees, annual sales, etc.;
- Production process and materials flow, i.e. use of raw materials, production process, pollution control facilities and water/energy demands;
- Waste generation and treatment and disposal methods in the factories;
- Hazardous substances and their storage;
- Present HW management; and
- Future HW management.

Based on the outcome, the findings on the following aspects are presented in the respective sections in this report :

- ISWM on-site
- ISWM outside (factories)
- Present ISW generation
- Present ISW flow

b. Public Opinion Survey

b.1 Objective of the Survey

The objective of the public opinion survey (POS) is to identify the awareness and intention of citizens on environmental protection, and the awareness and possible reaction of citizens to the construction of treatment and disposal facilities for industrial/medical solid waste.

b.2 Selection of the Samples for POS

Since the mass can not answer questionnaires to be prepared for the objectives mentioned above, the target citizens and areas for the POS were selected as shown in Table 2.2b. 308 citizens in total were interviewed.

Table 2.2b Samples for POS

Category of Sample		Number of Samples
Home	Lo Errázuriz	31
	Cerros de Renca	31
	Lepanto	31
	Batuco	30
	Rungue	31
Sub Total		154
Institutions	NGOs	30
	Students	30
	Central Gov.	31
	Local Gov.	30
	Politicians	33
Sub Total		154
TOTAL		308

b.3 Findings of the POS

In general, people in the MR are very conscious and cooperative on environmental protection as indicated by the reply that 96.5% of those interviewed would cooperate in segregating of their waste if a municipality would introduce a separate collection system.

On the other hand, it is concluded that people are opposed the construction of waste treatment/disposal facilities in their residential area, because they are very aware of the negative influences, these places have in the life quality. This is supported by the fact that the people with a strong rejection to the facilities were asked, under what conditions they would accept the construction of facilities and that a very high number (49.1% to total and 61.3% in the homes) insisted that they would never accept the facilities.

b.4 Follow-up Research of the POS

b.4.1 Objectives and Methodologies

In order to investigate and understand "true reasons" deeply-rooted in the people's "strong rejection without exception" and in order to seek keys to the solution (i.e. prerequisite for neighborhood consensus), the "Follow-up Research of the POS" was programmed.

A sociological approach was employed in the following researches to seek "true reasons" of the objections: i.e., free discussion of more or less 8 persons who strongly objected in the questionnaire, moderated by a neutral chairperson.

Session-1: Assemblies for "people living near the present landfills (Lo E-rrazuriz, Renca, Lepanto)"

Session-2: Assemblies for "people living near the candidate landfills (Runge, Batuco)"

b.4.2 Conclusions

As for keys for solutions with regard to "neighborhood consensus", POS and Follow-up Research at least suggested that following three aspects (namely: **improvement of communication, sufficient environmental protection and fulfillment of the agreement (exchanged between promoting sector and neighbor) to be secured by authorities**) should be taken into consideration both for private sectors' preparing

projects and for authorities' permission procedures.

i. Improvement of communication

Poor communication in the past of both public authorities and SWM promoting sectors towards neighborhood community (such as, lack of public hearing, project implementation without notification, broken promises', information concealment, etc.) worsened the situation and induced stronger objections by neighbors.

Meanwhile, since neither information were disclosed nor advance campaigns were not conducted, there are quite a few objections which are mainly based upon their prejudice and mis-conception. It is found that most objections against "incineration facilities" were based upon the prejudice that "incineration means source of smog". Therefore, it is observed that sufficient campaigns and education by promoting sectors are indispensable for establishing "neighborhood consensus" for construction of SWM facilities.

Since the reason why they make "objection without exception and/or strong objection" are considerably attributable to poor and insufficient communication in the past; it is needless to say that improvement of communication is indispensable as one of main prerequisites for the formulation of neighborhood consensus.

ii. Sufficient environmental protection

Although communication is substantially improved, people's fear and anxiety regarding environmental deterioration to be caused by SWM facilities can not be eliminated. In this regard:

- authorities, at the time of a project EIA appraisal, should examine at length whether environmental protection measures proposed in a project is sufficient or not;
- a promoting sector should be obligated to hold public hearings, explain their environmental protection measures to the public fully, and review and/or improve their protection measures reflecting neighbor's opinions;
- authorities, in case where necessary, should call an advisory committee of independent and neutral experts to further examine sufficiency of environmental protection measures; and
- as preconditions of ISWM facilities' siting permission and operation

permission, the promoting sector should be obligated to reach an agreement with neighbors regarding environmental protection measures promised by them.

iii. Fulfillment of the agreement (exchanged by promoting sector and neighbors) to be secured by authorities

Although sufficient environmental protection measures are presented in the planning stage by a promoting sector, neighbors are doubtful and worried whether actual ISWM facilities to be constructed fully comply with what was proposed at the planning stage and whether protection measures will actually be taken place or not. Neighborhood consensus can not be realized without removing neighbors' doubt and worries. For this purpose, the authority should establish a system to ensure that promoting sector complies with the environmental protection measures proposed. Namely, the authority needs to strengthen monitoring and administrative guidance capabilities including on-site inspections to secure the agreement.

It is suggested in practices of authorities' administrative measures that it should be obligated that the promoting sector contract environmental risk insurances and/or funds to provide for contingencies such as accidents.

c. Survey to Private SWM Enterprises

c.1 Objectives of the Survey

In order to understand the actual status of ISWM, a survey was conducted to the private SWM enterprises that are presently registered in the manifest system data base. Upon examining the data presently available regarding the waste amount discharged by the 510 factories, several equivocal points were observed. The survey aimed at clearing the questions and at providing further insight into the actual waste flow after generation at the industries.

c.2 Number of Samples

A total of 59 samples were surveyed. The survey samples were distributed in the following manner among the three types of private enterprises registered in the manifest system:

- transporters: 21 samples

- landfill sites: 12 samples
- recyclers: 25 samples

c.3 Major Findings

The following opinions and facts were obtained through the interview/reconnaissance surveys.

i. The subject of illegal dumping was inevitably addressed and the following were proposed as means to prevent its occurrence:

   - implement a more stringent enforcement over waste generators;
   - devote more human resources towards controlling final disposal practices (both inspectors and police).

ii. The most noteworthy figure is the long-standing existence of most unauthorized sites, ranging from 5 to 21 years into the past. The establishment of some of this sites, therefore, dates back to a period where no authorized landfills existed.

iii. From the visits to all landfills registered in the CDSI system a critical piece of data was obtained. As a result of the closing down of two of these landfills, an increase in final disposal fees is envisaged in the near future due to the distant location of the new landfill. The implications of this are of key importance as industries will then have a renewed incentive for engaging in illegal dumping.

iv. The expected future scenario acquires even further relevance when we consider the present situation regarding unauthorized landfills: in many cases their existence was due to the unwillingness or inability to bear the disposal costs of the authorized landfills.

v. Upon the visits to the unauthorized landfills it was observed that almost 50% of them entailed some kind of recycling activity. This provided a valuable insight regarding the informal conditions under which many recycling activities are still carried out.

vi. Although a large number of individual collectors exist, they are expected to become marginal participants in the waste recycling flow. On the other hand, large size middlemen are fulfilling important tasks such as education

campaigns and human resources investments to obtain uncontaminated recyclable materials.

d. Other Field Surveys

Several field surveys were conducted other than the above mentioned 3 surveys. Those are briefly described below.

d.1 Field Survey on Industrial/medical SWM in Brazil

Since Brazil is one of the most industrialized countries in Latin America, certain advanced industrial/medical SWM have been established. In order to examine the applicability of their management and/or systems to Chile, a field survey on industrial/medical SWM in Brazil was conducted.

d.2 Regulations on Localization of Facilities for SW Treatment/disposal

Of special interest for the Study are the provisions included in the Metropolitan Regulatory Plan regarding "Sanitary Infrastructure" (Title 7, Chapter 2), and specifically those regarding "Final Disposal of Solid Waste". These provisions require that final disposal facilities of ISW include, within their premises, a minimum buffer zone of 600m to the neighboring land. In view of such stringent requirement, the Counterpart requested the Study Team to provide information on similar regulations in other countries (e.g. Japan and Denmark). In response to the request, the Team prepared the report of regulations on localization of facilities for SW treatment/disposal in Japan and Denmark.

d.3 Leachate Quality Survey

Responding to the request of the Chilean side to the Study Team to examine whether hazardous materials are disposed of in the municipal landfills or not, the Team conducted "The Leachate Quality Survey" in June 1995.

d.4 Comments on the Regulations for the Sanitary Management of Hazardous Solid Waste (First Working Draft)

"Regulations for the Sanitary Management of Hazardous Solid Waste - First Working Draft" was produced by the Department for Environmental Programs, Health Programs Division, Ministry of Health, Republic of Chile. Responding to the Chilean counterpart's request for comments for this document, the Team summarized his

comments and opinions through integrating Team member's national/international experiences and comments from the JICA Advisory Committee.

2.3 Present Situation of ISWM Technical System

a. On-site ISWM

It was observed in the Team's factories' survey that the working environment in factories in general are orderly and kept clean. However, it was found that ISWM on-site is poorly established in factories.

First of all, attention should be drawn to: waste water from production process is directly discharged into sewer or watercourse without any treatment in most cases; and exhaust gas from combustion facilities of factories in majority is dispersed into the atmosphere without significant treatment. According to the Team's factories' survey, installation ratios of water- and air- pollution control facilities are 16% and 38% respectively.

Secondly, where a high recycling ratio (i.e. more than 50%) of ISW in the MR was observed, the majority of recycling activities are handled by independent recyclers. It was found on many occasions that inappropriate treatment prevails in recyclers activities. On-site intermediate treatment is scarcely realized (7.3%), technical system found in the MR is only limited to "neutralization (2.8%)", "sorting (1.8%)" and "drying and evaporation (1.7%)". On the other hand, long time storage of HW on-site are scarcely observed (0.8%).

Thirdly, although the Team's survey targeted to investigate potential industries generating HW (i.e. more than 50% of targeted factories are estimated to use hazardous substances), only 8 out of 199 interviewed replied they generate HW. On the other hand, some interviewees answered without hesitation that they dispose of asbestos directly at municipal landfill site and some others answered that they discharge waste acid, waste alkali, and waste organic solvents directly into the sewage line. It clearly indicates that factories consciousness regarding HW are very poor.

Finally, as for interviews regarding the organization of on-site management of hazardous substances and HW, a great majority (80%) answered that they allocate a manager responsible for the control and they maintain distinct isolation (from other materials/ISW), marking and storage. On the other hand, 74% of factories interviewed answered that they do not have facilities on-site to treat HW.

With regard to problems of current HW control on-site, 49% of factories interviewed mentioned that they are in want of knowledge and information for identifying HW from the ISW generated. 45% mentioned that regulations and norms which specify what measures be taken for the control of HW are lacking for the present situation.

As implied above, for both waste generators and administrative authorities, on-site management of HW in the MR are just at the preliminary stages of their practices.

b. External ISWM (outside of the factories)

b.1 Storage

Source segregation is well established in general. Basically, wastes are separated in accordance with the following categories:

- waste to be recycled in the factory;
- waste to be reutilized outside the factory;
- ISW to be disposed of at municipal landfill;
- ISW to be consigned to private contractors; and
- municipal waste.

Generally, factories are well maintained with frequent cleaning. The wastes cleared up are transported from generation places to storage by carts and/or vehicles.

b.2 Collection and Transportation

Due to the difference of the questionnaire used in the two studies (i.e. JICA Factories' Survey and EWI's RISNOR Study) the rate of collection/transportation obtained by the studies is quite different. However, it is concluded that more than 25% of ISW generated, i.e. 240,000 ton/year, are collected, transported and disposed of at the municipal landfills.

It can be said, based on survey to the transporters registered in the CDSI systems, that business magnitude of collection/transportation of ISW represents only 1/5 of municipal SW. This figure (20% of municipal SW) is considered quite small and the business of ISW collection/transportation is not well established.

b.3 Treatment

There are no treatment facilities for ISW in the MR and at present ISW generated in

factories is either recycled or disposed of at landfills including authorized ones.

b.4 Recycling

JICA Team's survey and EWI's RISNOR study reached the same conclusions that the percentage of ISW "recycling" is quite high. The proportion of "ISW recycled" are 56.2% in JICA Team's survey, and 54.1% in EWI's RISNOR study. The outcome of both studies showed approximate values. In this regard, it might be assumed that the values are reliable. Although the rate of ISW recycled is quite high, considerable amounts of ISW collected by recycling agents are treated and/or disposed inappropriately. Attention should be drawn that residues of recycling works are illegally dumped in many occasions.

b.5 Final Disposal

It is concluded that more than 20,000 ton/month of ISW are disposed of at present landfills including unauthorized ones. However, some of ISW consigned to the private ISW collectors and supposed to be disposed of at the 3 authorized landfills are in practice disposed of at unauthorized landfills. It can be said that most of ISW are disposed of at the two authorized municipal landfills, i.e. Cerros de Renca and Lepanto, and the biggest authorized municipal landfill in the MR, Lo Errazuriz, receives very little.

b.6 Illegal Dumping

According to the EWI's VIRS study, 101 illegal dumping sites with a total accumulated volume of about 10 million m^3 of waste have been identified in the Metropolitan Region. Approximate 45-50 of the sites receive ISW. The majority of the dumping grounds are situated in residential areas (50%), while 18% are located in industrial areas and 32% in remote areas. The surface area covered is approximate 7.2 million m^2. Construction waste is the most abundant type of illegally dumped waste. ISW is deemed to cover only 2.2% or 224 thousand m^3.

2.4 ISWM Institutional System

a. Environmental Policy

"Free market economy" is thoroughly adopted and promoted as the national policy in Chile. The same policy is to be applied for the ISWM. Namely, based upon PPP

(polluter pays principle), it is basically intended that public sector will be least concerned in operation of ISWM. The Environmental Basic Law published in 1994 comprises 3 basic principles: "establishment of environmental standards category-wise", "requirements of EIA (Environmental Impact Study)" and "PPP (polluter pays principle)". These basic principles are to be recognized as prerequisites in promoting ISWM.

Urban air pollution attributed mainly to automobile exhaust gas is worsening in the MR. With aims of reducing the gross quantity of emissions of SOx, in 1992 it started to apply the D.S.N°185 of the Mining Ministry, specifying the emission rate of tradable SOx (for facilities and factories related to the mining activity). Where industrial air pollution prevention measures take place in accordance with the emission rate stipulated in the Ordinance 185, dust from exhaust gas emission control facilities will be increasingly generated as ISW.

Regulations for industrial waste water discharge are prepared to be enacted nationwide, corresponding to the worsening situation of water pollution.

In parallel with national enforcement of related regulations, it is planned that individual factories that do not comply with the norms should conduct pre-treatment to comply with the permissible discharge level of sewage. Public sewage treatment plants should cope with domestic waste water and the industrial waste water discharged after complying with the level stipulated.

In this regard, it is estimated that a large amount of "organic and inorganic sludge from individual industries" and "organic sludge from public sewage treatment plants" are generated.

It is envisaged that generation of sludge and dust contaminated with hazardous substances will be rapidly increased as air- and water- pollution prevention measures are enforced. The employment of exclusive treatment and disposal becomes an important issue for the dust and sludge together with other HW, in separation from non-hazardous ISW. In general, control over hazardous substances from factories comprises: "control over hazardous materials", "control of waste water and gas emission", and "control of HW".

However, most industries in the MR are not ready to practice appropriate control over them so far. Therefore, ISWM in the MR should be planned in full relation with measures of air- and water- pollution prevention and hazardous material control.

Substantial functioning of EIA system in Chile started voluntarily in 1994 and it will

become obligatory when it is enforced in the corresponding regulation, probably in 1996. The EIA system in the MR is: a promoting sector should carry out an EIA which should be submitted to CONAMA-RM, meanwhile the project should be made public and opportunity of public participation is given. Approval/disapproval of the assessment should be agreed by COREMA-RM within a certain period. EIA is obligated to a promoting sector for a localization of SW treatment/disposal facilities as well.

The Metropolitan Regulatory Plan permits localization of transfer stations, recycling facilities and incineration plants in the urban area. On the other hand it states that SW disposal sites should be located outside of the urban area. It is assumed that the regulatory plan will have a strong influence in developing the system for the ISW treatment/disposal in respect of facilities localization.

The Ministry of Agriculture had established 8 categories indicating the land use capacity. SW disposal in areas other than categories IV (Land with marginal aptitude for agricultural use with some degree of suitability for livestock raising), VI (Land for livestock raising and forestry), and VII(Land suited for forestry and wildlife) is prohibited. The installation of sanitary landfills is forbidden in the categories I, II and III.

b. Administration and Organization

b.1 Organizations Related to Environmental Policy

Historically, each Ministry regulates its own specific activities that could have an impact on the environment or that have the purpose of protecting it. The Ministry of Health (MS: Ministerio de Salud) is responsible for all matters related to health and environmental aspects. Most recently, the National Environmental Committee (CONAMA: Comision Nacional de Medio Ambiente) was created under the Ministry of National Properties (Ministerio de Bienes Nacionales). Now CONAMA has been transferred to the General Secretary of the Presidency (Secretaria Nacional de la Presidencia). Composed by representatives of Ministries and other bodies, CONAMA should be the supreme council to dictate principles and policies for the environment. In the Metropolitan Area of Santiago and further in each Region, a Regional CONAMA constitutes a bridge between CONAMA and local environmental bodies, and promotes and supplies needs to their activities. CONAMA shall evaluate or coordinate the Environmental Impact Assessment enforced by Law Nº 19.300-General Basis for the Environment.

Ministerio de Salud (MS) is the principal executive and normative body throughout a system of 13 regional components (SEREMI) of national health services (Servicios Nacionales de Salud), and the regulation departments (Depto. de Programas Ambientales). SEREMI Santiago includes 4 health services and the Metropolitan Health Service for the Environment (SESMA).

b.2 Organizations Related to Industrial and Medical SWM

Many other governmental and local bodies are presently involved in environmental administration. Presently, the most important ones are the Health Services (Servicios de Salud (SS)) which belong to the Ministry of Health (Ministerio de Salud). The SS have a medical and an environmental branch and are usually located in the main hospital of the region. The environmental branch of the SS is presently in charge of issuing environmental authorizations.

In the metropolitan area the environmental branch of the SS is named separately and is known as the Metropolitan Health Service for the Environment (Servicio de Salud Metropolitano del Ambiente (SESMA)). SESMA has under its jurisdiction several offices in charge of different environmental issues.

SESMA is a very dynamic body, working in function of programs supported by a small permanent structure, composed by four technical departments. Each program has a coordinator, a technical team and a small Administrative Staff.

c. Legal System

c.1 Legislation

The following is a brief description of the legislation related to the environment which is presently in force:

i. Basic Environmental Act

An environmental act was passed through Parliament in 1994; " the Environment Basic Law" (Ley de Bases del Medio Ambiente), law number 19,300. The act is in its form and content, to a large extent, directed towards regulating enterprises. It defines the conditions for and the contents of Environmental Impact Studies (Estudios de Impacto Ambiental (EIA)) and of Environmental Impact Statements (Declaraciones de Impacto Ambiental (DIA)). However, in order that the system of Environmental Impact Study becomes obligatory, establishment of the regulation which regulates it is necessary.

ii. Act 5081/93 from SESMA

This act establishes a declaration and monitoring system for ISW generated in the MR.

iii. Law 3.133/16 and its Regulation from Decree 351/92

Decree 351 defines the concepts and the industrial activities affected (identified by CIIU code), whose effluents may not be discharged to any aquatic environment, whether natural or artificial, below or above ground level, without authorization. Such authorization is always required when the effluent is harmful to the water for both irrigation and drinking purposes. The requirement is extended to discharges into the sewerage system that may damage the collection or treatment systems, or that infringe the quality standards in force.

iv. Sanitary Code

The Sanitary Code contains several articles related to ISWM. Among these articles, it is important to mention the one indicating that any project related to the construction of facilities intended for the discharge, treatment or disposal of industrial and mining waste (regardless of the type) must be approved by the Health Service (Servicio de Salud).

v. Supreme Decree 745 in 1992 by the Ministry of Health

This decree contains the regulations for Basic Sanitary and Environmental Conditions at the Workplace. It makes some reference to industrial waste and establishes criteria for the on-site storage, treatment and disposal of waste within the industrial site.

c.2 Permit for ISWM Facilities

As mentioned earlier, the Environment Basic Law ("Ley de Bases del Medio Ambiente"), indicates which projects, related with hazardous ISWM and treatment/disposal of ISW, must clear an EIA. The acceptance of the project will then be accompanied by the environmental permits or notification that the government bodies are able to issue at the time.

The following permits or notification will be necessary:

- Change in land use issued by the Agriculture and Livestock Service

(Servicio Agrícola y Ganadero, SAG), which falls under the Ministry of Agriculture.

- Approval by SESMA, under the Ministry of Health;
- Patent obtained at the corresponding municipality where the activities are to be developed.
- Permit from the municipality for the construction of civil works for the facility; and
- Authorization by SESMA for beginning of activities.

2.5 Present Problems and Keys for Solution

a. Problems regarding the Present ISWM

a.1 Non-HW (Non-Hazardous Waste)

Municipal landfills in the MR, where non-hazardous ISW are presently disposed, comply with high level standards of landfill management. Small precipitation enables leachate treatment by recycling in the region. As long as the ISW received in those municipal landfills are non-hazardous and subject to special handling within the landfills, no problems are foreseen technically.

Municipal landfill disposal sites to which these industrial non-HW are disposed will in short complete their service life. Since future municipal landfill sites will tend to be in remote areas, it is envisaged that solid waste disposal cost may considerably be raised as a consequence. Furthermore, disposing of non-hazardous ISW into municipal landfill sites may not be allowed for long. If planning lacks consideration of establishing ISW final disposal facilities through utilization of private sectors, existing final disposal facilities would be in the near future congested and overloaded, resulting in facilities unable to contend with the waste influx.

Although the disposal fee being 3 to 6 US$/ton of present municipal landfill sites and their location being near the urban area, there are quite a lot of illegal dumping sites including locations nearby municipal landfill sites, environmental deterioration including underground water contamination is envisaged. If final disposal sites are to be constructed in remote places and disposal fees are raised, it may easily lead to a rapid increase in illegal dumping.

a.2 HW (Hazardous Waste) and LW (Liquid Waste)

Problems in relation to non-HW are comparatively simple as mentioned previously, thus countermeasures to be proposed might also be rather easy. However, problems foreseen in "HW and LW" are complicated and serious.

Generation of HW (26,000 ton/year) and LW (45,000 ton/year) in comparison to that of non-HW (868,000 ton/year) are small at present. It is understood from its background that since standards for discharged water quality have not yet been enforced and regulations and guidelines for air pollution have just been introduced in Chile, the majority of industries have not commenced air/water pollution protection measures. Under such circumstances, many hazardous substances, not emerging as ISW, are dispersed into the air and water environment.

As for ISW in general, majority of hazardous substances are mainly emitted as contaminants in dust, ash, sludge or liquid waste. However, at present most old, small and medium size factories are indifferent to particular movement of hazardous substances and therefore waste water, exhaust gas and ISW are uniformly disposed without making any distinctive segregation from other solid waste.

Even under such circumstances, problems are not tangible nor eminent. Meanwhile, it is reported that vegetables (such as lettuce) in those river basins are not edible uncooked, since they are contaminated with municipal sewage water. Which implies that soil contamination by heavy metals discharged from industrial sewage and consequently contamination of agricultural products are grave.

However, it is evident that when air and water pollution prevention standards are put into practice in future, generation of HW and LW, which is currently minimal, will rapidly increase and thus problems of ISW shall become more apparent.

b. Keys for Solution

In order to solve the problems foreseen above, the following keys for a solution may have to be considered.

i. Clarification of responsibility

It is necessary to clarify that waste generators are responsible for control and disposal of ISW. Meanwhile, the scope and division of administration (among national, local authorities, etc.) regarding ISWM should clearly be stipulated and

operated within a legislative framework.

ii. Formulation of ISWM framework in relation with air and water pollution regulation

In order to establish management system of ISW at generation, it is essential that ISWM framework closely connected with air and water pollution prevention should be established. It especially is indispensable to practice waste water regulations (i.e., pre-treatment before discharging into sewage).

iii. Identification of the status-quo of the ISWM and establishment of an information management system

It is the basic principle and the first step of ISWM to identify precisely the status-quo of individual waste generators' management, to understand current global situation of ISWM in the MR, and to establish an information management system in this regard. The Manifest System is already in operation by SESMA-PROCEFF. The Team's surveys further contribute to accumulation of data and information regarding the present situation of generation, control and treatment/disposal. It is necessary, in order to understand the status-quo, to establish a framework of information management system by starting with accumulation of data through factory visit surveys by SESMA-PROCEFF and reports submitted by factories.

iv. Establishment of administrative framework to promote ISWM policies

It is necessary to establish an integrated administrative system to formulate national level ISWM policies, and an organization (especially in local authorities) in charge of monitoring and guidance of ISW. Relative to this, legislative support should be realized (e.g. "report collection", "on-site investigation" should be allowed, and "illegal operations" should be prevented with empowerment of administrative orders and measures.). At the same time, in view of industries' air- and water- pollution control, on-site ISWM and control of hazardous materials being inter-linked, cooperation and collaboration among respective authorities related are indispensable. Furthermore, officers capable of monitoring and placing guidance should be trained.

v. Establishment of on-site ISWM

One of the basic principle of ISWM is that industries (as primary waste generators) should establish a system that copes with on-site ISW control and

treatment, and entrusted disposal. In-house management and technology system responsible for ISWM should be established. Therefore industries need to allocate an engineer/manager capable of supervising water and air pollution control, as well as control of hazardous materials and ISW. Meanwhile, it is expected for authorities to take such actions that relative human resource development be promoted (system of training program and/or allocation of technical manager be obligated to industries.).

vi. Establishment of ISW treatment/disposal facilities

Majority of ISW is presently disposed at municipal landfills. It is envisaged that municipal landfills currently in operation will in short complete their service life and new ones will be located in remote areas. Whereas generation of ISW (especially HW) is estimated to increase rapidly in future. Consequently, it is judged that intermediate treatment and final disposal facilities for ISW are urgently needed. Especially among others, establishment of final disposal facilities for HW is an essential issue in formulating ISWM in the MR.

vii. Other Issues

In order to establish an appropriate control system for ISWM in the MR, it is necessary to formulate a system which enables:

- establishment of appropriate on-site ISWM by generators;
- formulation of market mechanism where generators can entrust treatment, disposal and resource recovery of ISW to agents; and
- elimination of illegal treatment/disposal and dumping.

In this context, in addition to the above, issues in variety mentioned below need to be solved:

- technical standards and guidelines which promote appropriate on-site ISWM by generators,
- permission procedure for siting of ISWM facilities,
- EIA system regarding facilities siting,
- promotion of laboratory analysis sectors and ISWM facilities manufacturers who are indispensable to realize analytical identification and monitoring of HW, etc.

2.6 Present ISW Generation

a. Previous Studies on ISW Generation

In order to plan and establish a proper SWM system (irrespective of municipal, industrial or medical), "identification of present SW generation" and "estimation of future SW generation" are indispensable.

However, intrinsic difficulties related with ISW such as those listed below should be taken into consideration and be overcome in **establishing a proper management system of ISW**:

i. extreme variety in kind of industries generating ISW;

ii. wide diversity in types of ISW generated, and in addition, qualitative and quantitative features are quite different even within the same category of industries due to differences in production process, materials and technologies employed; and

iii. integrated and unified classification of ISW is not available at present, various waste classification methods exist.

In the D&M's RISPEL Study, the ISW generation amounts of the year 1992 were estimated by using the INVENT and WHO models. There was quite a large difference between the total generation amount of ISW estimated by INVENT model and by WHO model; i.e. 659,228 ton/month and 28,641 ton/month respectively.

In the EWI's RINSOR Study, based on the survey result of 265 factories, the total discharge amounts of ISW (No Aprovechados: Not Recycled Wastes) from the MR in 1994 and 2004 were estimated at 313,260 ton/year and 667,944 ton/year respectively.

b. Classification of ISW

While the HW classification MS proposed is for the purpose of identifying and controlling HW, it is indispensable to provide standard analysis methods for identification and to facilitate specialized analysis for HW. Under the present situation where analytical abilities are not gained, it is very difficult for industries to declare their waste through the declaration system according to the classification that MS proposed.

On the contrary, the 333 classification of ISW has the list for HW identification and thus may be deemed as an effective tool to be employed for the declaration system and the management of HW, under the present situation of lacking provisions of standard analysis methods and specialized analysis facilities for HW. Therefore, as the Team's conclusion of ISW classifications, both classifications of SESMA-PROCEFF being adopted and MS (drafted) should co-exist.

In order to formulate an efficacious HWM plan in Chile, coordination of both classification of SESMA-PROCEFF and MS (drafted) is indispensable. However, formulation (coordination) requires empirical support of analysis works, which shall take some time.

For the formulation, the Team proposes the following steps to be adopted by the Chilean side:

- main HWM issues for the time being shall be: monitoring and controlling of "Highly Potential Industries" which may be liable to produce LW and HW for the ISW List (namely the 333 classification of PROCEFF).
- in addition, for those industries which are deemed to generate HW and LW listed in the PROCEFF classification, (control system) unless the factory proves their waste is non-hazardous, the waste shall be deemed hazardous (i.e. the industry carries out the required analytical tests of their generated waste based upon the criteria of MS specified in the draft regulations.)
- at the same time, data of HW and LW should be continuously collected and compiled in accordance with the 333 classifications of PROCEFF as well as the 44 categories of MS.
- factory inspections should be carried out in conjunction with laboratory analyses for processing the compiled data to make it more accurate and reliable.
- along with the data compilation, the risk of ISW in accordance with the definition by MS should be easily identified by the data given in the declaration system.

c. Present ISW Generation

Estimation of the present ISW generation amount is carried out by referring to the outcome of the Team's factory survey (189 factories: due to 10 factories among 199 did not reply their number of employees) plus the data from the EWI's RISNOR study (236 factories: due to 28 factories among 265 factories overlapped in the two studies)

converted to the 24 waste classifications proposed by the Team. Based on the generation data of these 425 factories in total, generation ratios (GR) of 24 ISW classifications were calculated.

Statistics available with regard to the industries and their employees in the MR are the data compiled by INE (Instituto Nacional de Estadisticas). The INE data regarding the industries in the MR shows only ranges of number of employees for respective industries as shown in Table 2.6a. The following assumptions were, therefore, made for the calculation of ISW generation amount:

i. Data (numbers of factories and employees) of industries with less than 10 employees were not included in this estimation, since relevant data was not available and its overall contribution towards the total number of employees in the industries within the MR is marginal.

ii. Number of employees referred in the calculation of GR was the total employees including employees in indirect/administrative sections.

iii. Number of employees (in industries with 10 or more employees) used in the calculation of the ISW amount generated are shown in the table below.

Table 2.6a Assumption on Numbers of Employees for the Estimation of Waste Generation

Range of Employees Number	Assumed Employees Number
10 -19	15
20 -49	35
50 - 99	75
100 - 199	150
200 - 499	350
500 - 999	750
> 1,000	1,500

Present ISW generation amount in the MR is estimated in relation to 36 industrial group-wise classification and the 24 ISW classification. The outcome is summarized as shown in Tables 2.6c and 4.1d. As for the mining industries (CIIU code 21001 to 29090), there are several in the MR and they produce considerable amount of ISW. However, all of the generated ISW in the mining industries are disposed of at their own

landfills at present and in future (i.e. closed system). Therefore, ISW generated in mining industries are excluded from this table to avoid confusion due to the huge amount of slags from the industry. ISW Generation amount (in 1995) in total is about 939 thousand tons per year. The largest generation (amounts) of ISW and industry are C-13 Waste from Food Production (219,911 ton/year) and CIIU Code 311 Food Manufacturing (154,850 ton/year).

As for the ISW generation by the waste categories of non-HW, HW and LW, ISW generation amount in 1995 is calculated in the table below. As clearly shown in the table present generations of HW and LW are very small (7.6% in total) due to mainly limited generation of sludge (C-3 and C-4) and dust (C-2).

Table 2.6b ISW Generation Amount in 1995 by Non-HW, HW and LW

Unit: ton/year

ISW Category	Generation Amount	Rate (%)
Non- Hazardous Waste	868,000	92.4
Hazardous Waste	26,000	2.8
Liquid Waste	45,000	4.8
Total	939,000	100.0

Table 2.6c Summary of ISW Generation Amount in 1995 by 36 Industrial Groups

Unit: ton/year

Potential	CIIU Code		Industrial Category	Nos. of Employee	TOTAL
Highly Potential Industries	351		Manufacture of industrial chemical products	1,962	4,500.97
	352		Manufacture of other chemical products	18,512	22,183.80
	354	3540	Oil and coal products	1,360	763.32
	356	3560	Other non-classified plastic products	15,931	7,598.57
	371	3710	Iron and steel industries	4,106	30,348.60
	372		Basic metal industries	2,355	2,531.35
	381		Manufacture of metal products except machinery & equipment	26,602	71,816.61
Potential Industries	3211	3211	Textile processing and materials manufacturing	19,717	11,136.32
	3231	3231	Leather tanning and finishing	1,868	9,114.89
	3232	3232	Fur dressing, dyeing and other fur and skin articles	14	68.31
	3319	3319	Other non-classified wooden products	770	4,787.23
	341		Paper, printing and publishing industries	9,655	67,961.71
	3420	3420	Printing, photoengraving, publishing and the likes	11,734	48,608.29
	355		Manufacture of rubber products	4,751	16,331.29
	362	3620	Glass and glass products	2,163	14,414.85
	3699	3699	Other non-metallic mineral products	1,211	616.10
	382		Manufacture of machinery except electrical	10,477	5,680.46
	383		Manufacture of electrical machinery	4,829	18,821.57
	384		Manufacture of transport equipment	7,402	2,823.04
	385		Manufacture of science, measuring, controlling equipment(inc.lens)	1,094	50,365.86
	390		Other manufacturing industries	2,598	1,028.48
	625	6253	Gasoline filling station	5,115	3,069.00
	952	9520	Laundries and dry cleaners	2,535	4,812.03
Less Potential Industries	311		Food manufacturing	41,357	154,850.18
	312		Other food manufacturing	4,595	6,547.06
	313		Beverage industries	7,696	126,796.61
	314	3140	Cigarettes, cigars and tobacco	167	1,494.69
	3212-3219		Textile industries	13,221	1,985.96
	322	3220	Garment industries	25,525	6,892.97
	3233	3233	Leather products (exc.footwears)	1,158	312.72
	324	3240	Leather footwears	14,785	2,755.23
	3311-3315		Wood and cork industry	3,745	50,118.56
	332	3320	Furniture, fixture and the likes	5,975	9,896.77
	361	3610	Potteries and ceramic products	3,591	105,482.60
	3691-3696		Manufacture of non-metallic mineral products	6,962	72,267.45
	410	4101	Generation, transmission and distribution of electric energy	75	355.26
			Total	285,613	939,138.70

d. Present ISW Flow

In order to identify the current ISW flow, the results of both factories' surveys by the Team and EWI's RISNOR Study were compared as shown in Table 2.6d. According to the table, proportion of "ISW recycled" and "ISW not-recycled"in both studies showed approximate values. In this regard, it might be assumed that the values are reliable. Based on the rates shown in the table, the current ISW flow is presented in Figure 2.6a.

Table 2.6d Comparison of JICA Survey and EWI's RISNOR Study Results

Category of survey	JICA Survey		EWI's RISNOR Study	
	ISW amount	Rate	ISW amount	Rate
Disposal Method	ton/month	(%)	ton/month	(%)
1. Generation	18.632	100.0	10,386	100.0
2. Recycled	10,480	56.2	5,614	54.1
- On-site	NA	-	2,143	20.6
- Outside	NA	-	3,471	33.4
3. Not Recycled	8,152	43.8	4,772	45.9
3.1 Storage	145	0.8	21	0.2
3.2 Disposal	6,725	36.1	4,751	45.7
Disposal at municipal landfills	4,755	25.5	NA	-
On-site disposal	538	2.9	NA	-
Discharge to sewer, etc.	826	4.4	NA	-
Unknown disposal	606	3.3	NA	-
3.3 Others	1,282	6.9	NA	-

The flow indicates that more than 50% of ISW generated are recycled. However, "Survey on private SWM Enterprises"by JICA Team and EWI's VIRS study pointed out that considerable amounts of ISW collected by recycling agents are treated and/or disposed inappropriately. Attention should be drawn that residues of recycling works are illegally dumped on many occasions.

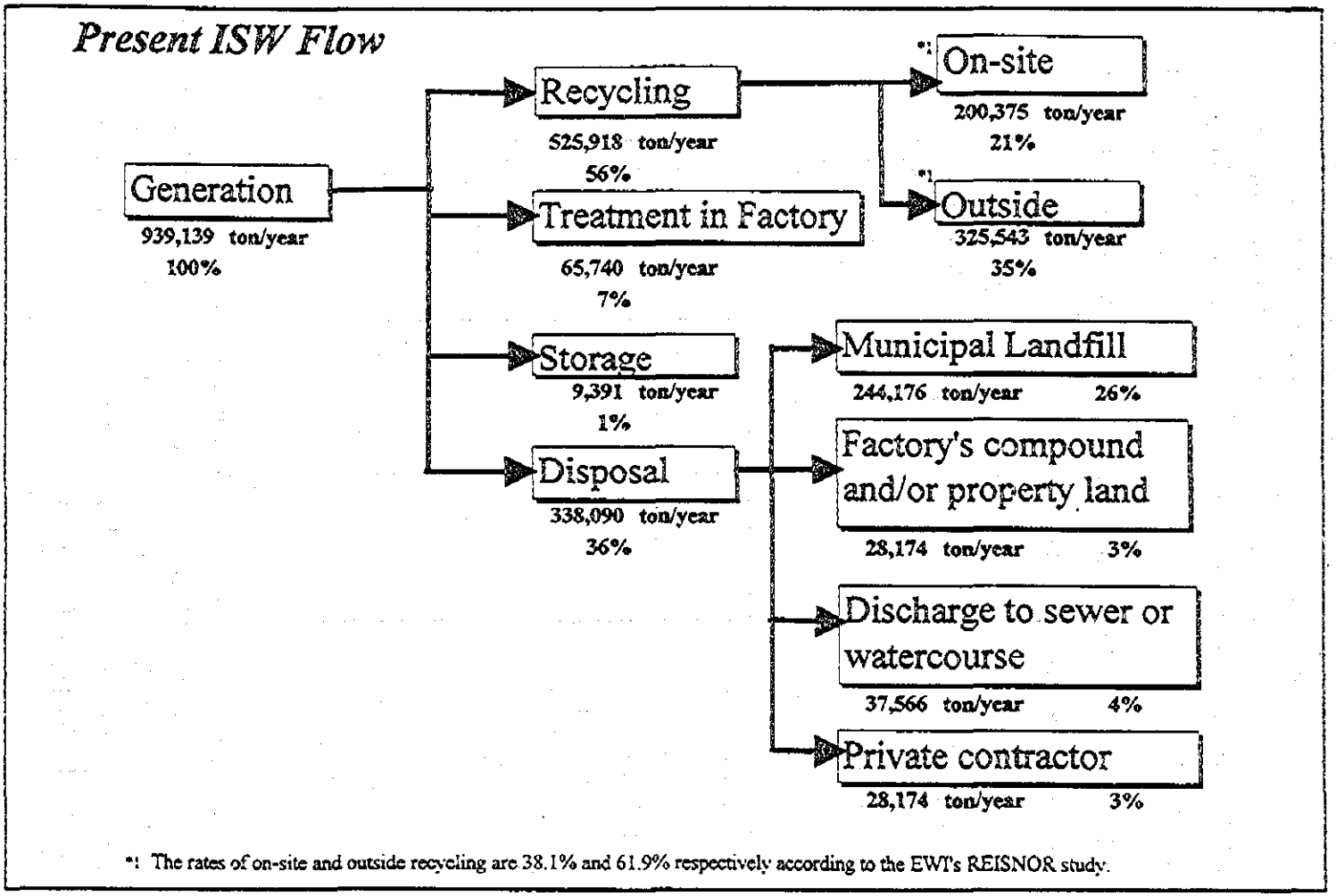

Figure 2.6a Present ISW Flow

CHAPTER 3 PRESENT MEDICAL SOLID WASTE MANAGEMENT

3.1 Medical Institutions Survey

The objective of the questionnaire survey conducted by the JICA Study Team was to provide detailed information on the present medical SWM (routines and equipment, etc.) and to provide information on the perception of the future management system. The survey covered 90 medical institutions in the Metropolitan Region, including all 42 private and public hospitals and a statistical representative sample of 31 clinics.

3.2 Present Medical Solid Waste Management

The medical institutions in the MR is presented in Table 3.2a.

Table 3.2a Medical Institutions in the MR

Category	Number of institutions	Number of beds	Number of medical institutions surveyed by JICA
Hospitals	37	11,598	37
Hospitals belonging to institutions	5	1,340	5
Clinics	47	1,381	31
Maternity clinics	6	198	-
Rural health centers	47	-	12
Rural and urban centers of practitioners	117	-	-
* (laboratories surveyed by JICA)	-	-	5
Total	259	14,517	90

The medical system in Chile is partly privatized and it is reported to be the intention to further develop the private health sector in the future. In general, private medical institutions have more financial resources available. Thus, better conditions for proper medical SWM exist. However, this is not the general situation and large disparities in the handling can be observed within public institutions as well as within private medical

institutions. The typical technical system for medical SWM at the hospitals includes:

- Sorting (classification) of waste at the source of generation.
- Direct disposal of liquid waste types to the sewer (also hazardous waste types in many cases).
- Storage of medical SW at internal central collection point(-s) - many of them in insanitary conditions.
- Disposal of infectious waste in small hospital incinerators.
- Collection of waste similar to municipal SW by the municipal collection service and disposal at a municipal SW landfill.

3.3 Issues and Problems

The Medical Institutions' Survey supports the impression that the present medical SWM generally receives little attention from the management of the medical institutions. Little attention in the sense of provision of basic equipment, maintenance of existing technical systems and implementation/enforcement of internal instructions and guidelines. In many cases considerable improvements could be introduced for little or no extra costs. A typical example is collection of sharps, where applicable hard receptacles often is employed, but due to missing lids, the receptacles are not being properly secured before disposal and the sharps may cause accidents during the subsequent handling.

The survey reveals that incinerators at the hospitals in general are inadequately equipped and poorly operated in terms of minimization of air pollution, burning out of ashes etc. This is a general problem of small incinerators, however, being magnified when incinerators are old and no modifications have been made to update the equipment and the operational parameters. Thus, for upgrading of the present medical SWM in the MR of Santiago, the following requirements can be summarized:

- There is an urgent need for preparation of a Code of Practice to establish unified medical SWM procedures.
- A boosting of the awareness of the hospitals' management is required to ensure maximum attention to proper waste management procedures. A boosting of the awareness among the staff employed in waste handling is also required to strengthen the routines and the awareness.
- Sorting - and wherever possible, the final packaging of medical SW, should take place at the place of production in order to ensure correct classification and to avoid later mistakes and negligence in the handling.

Correct packaging of medical SW requires that suitable receptacles (including a standard labeling system) are introduced.

- The internal collection points need improvements to obey basic hygiene demands. Fencing is one necessary improvement and another typical improvement would be application of haul-up containers to prevent waste being mixed during storage and to avoid manual loading.
- Enforcement of a strict air pollution standard is likely to require significant investments at many existing incinerators. Furthermore, investments will be required at some incinerators for necessary major renewal works due to former negligence of maintenance. This may lead to closing down of hospital incinerators and this makes it necessary to develop a least-cost disposal alternative based on safe landfilling to avoid uncontrolled disposal of medical SW due to high costs of upgraded internal or external incineration.

3.4 Present Medical Solid Waste Generation

ADIMARK's RESHOS Study registered a higher waste generation than reported in EWI's RESHOS Study. The difference is due to the survey methods and due to the fact that ADIMARK's survey included all waste types, also liquid waste. Table 5.4a (Main Report) presents waste generation data obtained by both studies. In Annex I, the generation data from the two studies are compared with data from other countries. It appears that data from ADIMARK's RESHOS Study conform best with the international experience, however, the generation ratio is among the highest of those countries. The observed generation ratio is higher than what would be expected based on the previous investigations conducted by EWI and what would be expected based on the comparison with other countries (the level of the generation ratio is similar to of countries with more developed health sector budgets than in Chile). The latter assumes that higher budgets will lead to higher consumption of disposable equipment and, thus, a higher generation of waste. This assumption is generally valid, however, with exceptions and with limitations when it comes to countries where waste minimization is emphasized as part of a strict government policy for waste minimization.

It is recommended to reduce the waste generation ration observed by ADIMARK in order to account for the uncertainty of the investigation and the possible over-estimation of quantities. A reduction of 25% (which leads almost average ratio of EWI and ADIMARK studies, see Table I.3.2b in Annex I) is recommended in order to prevent extra capacity of the handling system caused by the uncertainty.

The present medical SW generation was estimated based on the Medical Institutions Survey by JICA, comparing the data of the EWI's RESHOS Study and data from other countries. Table 3.4a presents the total medical SW generation estimate for the MR. Concerning the composition of medical SW of infectious waste types from hospitals and clinics, the composition in Table 3.4b is assumed.

Table 3.4a Present Medical Solid Waste Generation, Santiago Metropolitan Region 1995

Source	Units	Total waste generation per unit	Annual total waste generation	Generation of infectious waste types per unit	Annual generation of infectious waste types
Hospitals	12,938 beds	0.75 • 5.32 = 3.99 kg/bed/day	18,800 tons	0.75 • 1.66 = 1.25 kg/bed/day	5,900 tons
Clinics	1,579 beds	0.75 • 5.84 = 4.38 kg/bed/day	2,500 tons	0.75 • 2.06 = 1.55 kg/bed/day	900 tons
Sub-total for hospitals and clinics	-	-	21,300 tons	-	6,800 tons
Rural health centers and rural/urban centers of practitioners	164 units	15 kg/unit/day	900 tons	Approximately 20%	200 tons
Other sources	-	-	1,400 tons	Assumed 20%	300 tons
TOTAL	-	-	23,600 tons	-	7,300 tons

Table 3.4b Assumed Composition of Medical Solid Waste from Hospitals and Clinics (Infectious Waste Only)

Waste type	Composition	Quantity
Pathological waste	10%	680 tons
Cultures/stocks and blood products	15%	1,020 tons
Sharps	5%	340 tons
Infectious waste	70%	4,760 tons
TOTAL (hospitals and clinics)	100%	6,800 tons