Report of the
High Power Committee

Urban Solid Waste management in India

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PREFACE

The interactive interdependence *of* health, environment and sustainable development was accepted as the fulcrum *of* action under Agenda 21 at the Earth Summit at Brazil in 1992. The essence and essentials of health programmes include control of communicable diseases and reduction of health risks from environmental pollution and hazards. The interdigitation of primary environmental care and primary health care is therefore obvious, as is the substantial synergy that exists between poverty alleviation and environmental protection. While a governmental action can provide the much needed initial trigger, its further amplification depends upon the involvement of people, both individually and collectively as NGOs, who must assume the burden of civic responsibility which is the core requirement for a successful culmination of such endeavours.

A comprehensive conceptual framework of environmental sanitation must include not only the methods of disposal of human waste but also of liquid and solid waste to which industries, hospitals and several other sources contribute in varying measures. Population growth and pace of urbanisation pose huge additional environmental challenges for large cities. The constitution of the High Power Committee on Urban Solid Waste Management (USWM) was therefore a step towards seeking realistic solutions to the existing and emerging problems.

The key reference point for the deliberations of the Committee included a review of existing technologies for urban solid waste collection, transportation and disposal and to suggest the most appropriate and feasible eco-friendly and cost-effective technology options, keeping in view the cost-benefit, waste characteristics, socio-economic stratum and demographic structure of the community.

The report of the Committee not only provides a broad framework for the identification and solution of the intricate problems of urban solid waste management at the local, regional and national levels, but also recommends the use of microsystems so designed as to adequately and effectively meet local environmental, economic and institutional needs. While ^reduce, reuse and recycle' provide the base and balance for sustainable development, it needs to be strongly reiterated that in implementing source reduction and recycling, every effort must be made to avoid risk transferance from one source to another e.g. groundwater to air. In any holistic choice of technological options, reduction of potential risks to human health and environment, conservation of energy or its generation from non-conventional sources, and slowing down the depletion of non-renewable natural resources, constitute the key determinants. The ultimate goal must be the development of balanced healthy settlements in which people, especially the underprivileged and underserved, can exercise their right to human dignity.

The arousal of health-environment consciousness of the people may become frustrating and counterproductive if not matched with effective legislative measures regulating industry, hospitals, nursing homes and town planning. Whereas environmental-impact assessment of technology transfer agreements in the development of new industry is now an essential prerequisite, a similar consideration is equally imperative for health-impact assessment. This assumes particular significance in the context of hazardous toxic wastes being increasingly generated by the industry and affecting the health of the people.

The implementation of recommendations, as unanimously endorsed by the Committee, would require major outlay for urban development during the Ninth Plan. In the meanwhile, urgent action needs to be initiated through the allocations made in the Eighth Plan for the promotion of infrastructural development in Mega cities. Sanitation, sewerage and drainage, and solid waste management are eminently eligible for funding under this new centrally sponsored scheme. Task is gigantic and time is of the essence.

May I take this opportunity to express my deep appreciation to the Deputy Chairman, Planning commission in asking me to Chair the High Power Committee, and to my colleagues (Dr.J.Patil, Dr.D.Swaminadhan, and Dr.S.Z.Qasim) in the Planning Commission who along with other distinguished scientists agreed to serve on this committee. Significant contributions made by each one of them added to the quality and content of the present report.

The task of the Committee was considerably facilitiated by the administrative and technical support provided by the Adviser, Deputy Adviser and other members of the staff of the Division of Health and Family Welfare in the Planning commission. Their assistance is acknowledged with pleasure.

(J.S. Bajaj)
Member(Health),
Planning Commission, and
Chairman, High Power committee on
Urban Solid Waste Management in India

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EXECUTIVE SUMMARY

l. INTRODUCTION

1.1 India's population has expanded from 342 millions in 1947 to 846 millions in 1991. Census 1991 has shown that 220 million out of 846 million Indians reside in about 4000 urban agglomerations. Though the entire country is affected by the increase in population and its ecological consequences, the impact has been much higher in the urban areas as the urban population has expanded at a much faster pace due to urban migration. The population in 23 Metro Cities, having a population in excess of one million, account for more than one third of the total urban population. Forty percent of urban population are poor and live in slums or foot paths without any access to safe drinking water or sanitation facilities.

1.2 It is estimated that India's population will cross the one billion mark by 2000 AD; sixteen additional cities will have population of over 1 million by 2000 AD. The Standing Committee on Population has projected that the country's population will be 1003.1 million in 2001, 1082.2 millions by 2006 and 1250 millions by 2015 AD. The lure of employment in urban areas and consequent urban migration are expected to continue for foreseable future. The urban population is expected to grow to 470 millions by 201 5 AD; what is of great concern is the estimate that about 150 million of the urban population will be living in slums. Indian cities will be among the most densely populated among the cities of the world.

1.3 Over the years, there has been a progressive decline in the availability of essential services as well as in the quality of life in urban areas; urban poor have been the worst affected segment in this change. The health and environmental consequences of increasing population density, lack of safe drinking water and inadequate urban sanitation are likely to become further aggravated unless steps are initiated to improve the situation through increased intersectoral coordination and appropriate and innovative technologies for safe management of both urban solid and liquid waste management.

1.4 Urban Solid Waste Management (U.S.W.M.) continues to remain one of the most neglected areas of urban development in India. The sheer immensity of the problem, the financial and infra-structural constraints including non-availability of land for safe disposal of generated waste and the lack of awareness and apathy at all levels have come in the way of efficient, safe management of urban solid waste. There has been a progressive decline in the standard of services with respect of collection and disposal of household, hospital and industrial wastes, as well as measures for ensuring adequacy of environmental sanitation and public hygiene. In most cities nearly half of solid waste generated remains unattended. This gives rise to insanitary conditions especially in densely populated slums which in turn results in an increase in morbidity especially due to microbial and parasitic infections and infestations in all segments of urban population, with the urban slum dwellers and the waste handlers being the worst affected. Periodic out breaks of food borne, water borne and vector borne diseases occur in all cities; adverse health and environmental consequences of ground and subsoil contamination have also been recorded. It is therefore imperative that steps to improve urban solid waste management, environmental hygiene and sanitation are initiated without further delay so that the adverse health and environmental consequences of the rapid urbanization are minimized. Time is of the essence.

1.5 There has been no major effort to build up informed community awareness either about the likely perils due to poor waste management or the simple steps that every citizen can take which will help in reducing waste generation and promote effective management of solid wastes generated. The degree of community sensitization and public awareness generated recently because of focal epidemics of

malaria, Japanese encephalitis, the media attention on plague, the expressed concern regarding fly, mosquito and rodent menace in and around slums needs to be harnessed towards participatory management aimed at the implementation of sound solid waste and sewage management policies, with the ultimate objective of improving environmental sanitation and public health. A situation analysis of the existing state of solid waste management in the Indian cities and towns would lead to the inevitable conclusion that better sanitation standards could have been achieved in most of our cities and towns by prudent and planned allocation of available resources to develop and support the application of appropriate low cost eco-friendly technologies.

1.6 The Planning Commission constituted a High Power Committee on Solid Waste management under the Chairmanship of Prof. J.S. Bajaj, Member, Planning Commission to undertake an in-depth review of the multi-dimentional issues concerning Solid Waste Management in India and suggest suitable model(s) for the development of cost-effective and environment friendly approach(es) to promote sanitary methods of collection, transportation and disposal of solid wastes in Indian cities and towns, especially those with a population size exceeding one million inhabitants. The Committee had three meetings, in addition to site visits and interaction between the sub-groups of the Committee. The summary of the observations, recommendations and action plan suggested by the Committee are summarised in the following pages:

2. MANAGEMENT OF URBAN SOLID WASTE-CONSTRAINTS AND CONCERNS

2.1 Introduction

2.1.1 Urban Solid Wastes consist of household wastes, construction and demolition debris, sanitation residues, industrial and hospital wastes. Industrial waste and hospital wastes are considered as hazardous wastes as they may contain infectious and toxic agents.

2.2. Municipal Solid Waste

2.2.1 In India the amount of waste generated by individuals is quite low-between 300 and 600 g/person/ day. On the basis of available data, it is estimated that the nine major metropolitan centres in India are presently producing 8.5 million ton (mt.) of solid waste per annum; the figure is expected to reach 12 mt. per annum by the turn of this century. Solid waste from Indian cities contains high proportion of organic matter and have high moisture content. The organic food content attracts flies and rodents. The high ambient temperature and humidity favour rapid bacterial growth and decomposition of the waste and consequent foul smell. The garbage has low combustible material content; calorific value is usually less than 1500 kcal/kg. Average density varies between 500-600 kg./metre

2.2.2 There is no system of segregation of organic, inorganic and recyclable wastes at household level. Door-to door collection is not practiced in most of cities and towns.

2.2.3 The community collections bins are not well designed and do not have two separate compartments for recyclable and organic wastes; often they are just roadside open dumps. Their locations are not based on any rational consideration. The net result is that large proportion of waste is deposited outside the bin rather than in it. Night soil, hazardous industrial and infectious hospital wastes are all dumped in the municipal collection bins, thereby rendering all the garbage potentially hazardous.

2.2.4 The waste is transported from the community bins to the disposal sites by vehicles which are not designed for the purpose. There is no synchronization between collection and transportation. The transport operation is not scientifically planned. As a result all the wastes from collection bins/open road side dumps are not transported to the disposal sites regularly and expeditiously.

2.2.5 The common method of disposal of the waste is by unplanned and uncontrolled open

dumping at the land fill sites. In these sites, ragpickers often pick recyclable materials; rats, dogs and cattle forage for food; flies, mosquitoes and rodents swarm and thrive in these dumps. Sub- soil water contamination due to leachate is another potential problem in these dumping grounds. In places where composting is done by local bodies, the methodology adopted is inefficient and unhygienic.

2.3. Health Consequences of Poor Solid Waste Management

2.3.1 The association between poor solid waste management and increased health problems in all the sections of the population has been well documented. Poor collection and disposal of solid waste can trigger off epidemics of some vector borne or food borne infections. Leachates from dumping grounds may contaminate ground water and lead to health hazards. Rag pickers and conservancy staff have higher morbidity due to infections of skin, respiratory, gastro-intestinal tract and multisystem allergic disorders, in addition to a high prevalence of bites of rodents, dogs and other vermin. In India there is no national database providing comprehensive information on the magnitude and the nature of these adverse health and environmental consequences associated with poor solid waste management.

2. 4. Industrial Solid Waste Management

2.4.1 The industrial solid waste can be broadly classified as biodegradable, non-biodegradable and hazardous waste. In most of the cities industrial wastes constitute a large proportion of all the solid wastes generated; of these approximately 10-20% is hazardous wastes from chemical industries.

2.4.2 Some data exist in respect of small, medium and large scale -ndustries and the extent of consumption of raw materials. However, precise and well documented national data base on the current disposal practices of hazardous wastes is not available.

2.4.3 Currently there is no organized effort for separation of hazardous and non-hazardous wastes at source and for providing specific treatment of hazardous waste at source before disposal. The wastes are often handled manually. Many small scale industries surreptitiously deposit hazardous wastes in the community bins. Industrial waste is often transported in the same vehicles as other wastes and disposal is often done by uncontrolled land filling.

2.4.4 There is a dearth of well conducted epidemiological studies documenting the nature and extent of the health and environmental impact of currently existing poor practices of industrial solid waste management.

2. 5. Hospital Waste Management

2.5.1 Hospital wastes have always been considered as potentially hazardous in view of the inherent petential for dissemination of infection. In recent years wider variety of potentially hazardous ingredient including antibiotics, cytotoxic drugs, corrosive chemicals and radioactive substances have become a part of the hospital waste.

2.5.2 Apart from the major hospitals, patient care both in urban and in rural areas is being provided in small hospitals, outpatient clinics, nursing homes, primary health centres (PHCs), subcentres, and also within domiciliary setting; the practitioners of indigenous system of medicine also provide health care to large number of persons. A substantial proportion of waste material related to patient care is currently being generated by small clinics and hospitals.

2.5.3 It is estimated that in-patient hospital services in India generate between 1-2 kg of solid waste per person/day. Over 85 per cent of hospital waste is non- hazardous. There is no standardised system of segregating hazardous from non-hazardous waste in majority of the hospitals. Mixing of hazardous with non-hazardous components results in increased quantity of hazardous wastes that require safe disposal.

2.5.4 Very often the hospital wastes are

dumped along with the Municipal wastes. Some big hospitals are provided with incinerators, but very often these are improperly operated or remain non-operational.

2.5.5 Infections continue to be the most common health hazards associated with poor hospital waste management. The rising HBSAg prevalence among medical and para medical personnel working not only in " high risk areas" such as dialysis unit, trauma centre, casuality and obstetric departments but also among those working in general "low risk" areas is a warning signal that needs to be heeded. In addition the increasing prevalence of hospital acquired infection bears testimony to the inadequacy or inappropriation of infection control measures. There are however no reliable epidemiological data regarding the magnitude of the health problems due to poor waste management in different health care settings.

3. RECOMMENDAT10NS FOR SAFE MANAGEMENT OF URBAN SOLD) WASTE

3.1 Urban Solid Waste Management

3.1.1 Urban solid waste management is an essential municipal service for protection of environment and health of the citizens. Therefore, the least cost, most appropriate technological option(s) for safe management should receive the needed funding. Individual citizen, industries, hospitals and NGOs should cooperate with the Municipal authorities to ensure safe management of urban solid waste.

3. 2. Municipal Waste Management

3.2.1 Collection and Transportation

3.2.1.1 Segregation of inorganic recyclable materials like plastic, glass, metals, papers at the source should be promoted and every effort should be made to provide collection of these in separate containers I or bags in each house.

3.2.1.2 As far as practicable solid waste should be collected and transported from house to house every day. Private agencies/ NGOs, ragpickers or their cooperatives may be involved in primary collection of solid waste from house holds/ community bins.

3.2.1.3 Pedal tricycle of appropriate design should be promoted for house to house collection. Direct transfer of garbage from primary collection carts to the covered transportation vehicles would reduce vehicle's waiting time and make the system cost-effective.

3.2.1.4 Daily collection and transport of waste to disposal site is essential.

3.2.1.5 From the vegetable and fruit markets, the refuse should be collected at least twice a day, and transported to composting facilities. In larger market complexes, onsite treatment and .disposal facilities for production of cattle feed or biogas may be developed. Large restaurants/ hotels should be encouraged to develop their own onsite treatment and disposal facilities (bio digesters/ composting/ cattle feed production).

3.2.1.6 The vehicles for transporting solid waste from the ward level transfer point to the disposal ground should be of appropriate design, suiting the waste characteristics, and should have adequate arrangement for hydraulic tipping and quick loading. All garbage transport vehicles should be adequately covered to prevent spillage and air pollution. For cities and towns with varying size and densities of population site specific software should be developed for working out optimum transport routing, number and location of transfer points and for the planned optimisation of the whole system.

3.2.2 Disposal of Solid Waste

3.2.2.1 Sanitary landfills would be the major option for disposal of Urban Solid Waste in major metropolitan cities as well as smaller towns. It would be prudent to adopt an incremental approach wherein progressive upgrading of the landfill sites with improved operational control and environmental protection measures are introduced with consequent reduction of health and environment hazards

3.2.2.2 The major city and metropolitan area

development authorities must have adequate provision of appropriate land for landfills sites on regional basis in their land use planning. Small and medium towns might have to share trans-municipal land disposal facilities which should be managed by metropolitan development authorities or other appropriate regional management authorities.

3.2.2.3 Composting alongwith land disposal of non-compostables appears to be the next preferential option for solid waste disposal and could take care of upto 20-25% of municipal solid waste (organic fraction). Depending on the size and population of the town, compost plants should have appropriate degree of mechanization using aerobic and anaerobic methods. For smaller towns, low cost labour intensive Wind- Row type compost plants with minimum mechanization should be adopted.

3.2.2.4 Urban solid waste from Indian cities has low calorific value and high moisture content with high percentage of non-combustible materials; hence it is generally unsuitable for thermal technologies. However, application of technologies such as incineration, pelletisation, cofiring, pyrolysis -gasification should be evaluated through R&D/ pilot spale studies. Such R & D efforts should preferably be taken up as joint collaborative effort with Private Sector/ Municipal Authorities and Research Institutions with expertise and experience in these areas.

3.3.Hazardous Industrial Waste Management

3.3.1 Urban Development Authorities/ State Pollution Control Boards should create a database identifying industries producing hazardous solid waste, their locations, the quantity and characteristics of the waste generated by them. Some of the existing National Institutes such as All-India Institute of Hygiene and Public Health (Calcutta), ITRC (Lucknow), NEERI (Nagpur) and NIOH (Ahmedabad) need to be strengthened so to act as regional centres to develop an inventory of chemical industries, a reporting system on toxic and hazardous waste management and documentation of the health and environmental impact of industrial waste management practices.

3.3.2 These centres should be developed as Sentinel centres who will provide early warning of potential problems so that health hazards associated with improper disposal of toxic waste can be minimized. They should also act as R & D. centres undertaking/evaluating innovative hazardous waste management projects.

3.3.3 Industries producing potentially hazardous solid waste should be brought under the purview of Pollution Control Laws.

3.3.4The pre- treatment and detoxification of the hazardous industrial solid waste should be the responsibility of the industries and only after treatment, such waste would be disposed off at landfill sites; landfill sites should be carefully chosen and operated with all necessary safeguards against environmental pollution.

3.4. Hospital Waste Management

3.4.1 The potentially infected waste should be collected in leakproof plastic bags/bins; decontamination of the potentially infected material should be done right at the site of collection under supervision of medical/paramedical staff generating the waste.

3.4.2 Safe incineration of the hazardous hospital waste should receive due attention. Large hospitals and nursing homes should have their own incinerators of appropriate design; the smaller establishments may pay a disposal charge and utilize the common facility constructed and operated by the municipality/private operator.

3.5. Resource Recovery and Recycling

3.5.1 Materials for recycling should be segregated at source. The present system of scavenging of recyclable matters from roadside dumps and disposal grounds by the informal sector of urban poor should be replaced by organized Ward-Level recovery centres for recyclable material connected with the transfer stations where pri-

mary collection carts transfer their collection to the transport vehicles. These recovery centres could be managed by cooperatives of the rag pickers or NGOs. Alternatively, the ragpickers could be employed by the Municipal Authorities for recovery of recyclable material.

3.5.2 Industries engaged in processing the recyclable wastes like paper, plastics, glass, metal should be given financial assistance to upgrade their technology so that the products are of better quality, cost of production is less and marketability of the product improves.

3.5.3 It is necessary to assess the state of art of the present technologies used for recycling garbage and undertake R &D/Pi-lot scale studies to develop new technologies and upgrade the existing ones.

3.5.4 Necessary legislative and administrative measures should be taken for promoting consumption of products made out of recycled waste paper, plastics or glasses.

3.5.5 Recycling and waste processing industry should be given some incentive both from the State and Central Governments, such as exemption of plant/machinery from taxes and duties.

3.6. Legal and Financial Aspects

3.6.1 While creation of public awareness on the need for collection & disposal of urban solid waste in a safe sanitary manner is the key to the sustained successful management of USW, this needs to be supple meted by a legislative frame work. Each State has to review the existing Municipal Bye-laws, existing Town and Country Planning Act and other relevant legislations so that adequate provision is in-built in the legal framework for taking effective and prompt action against defaulters.

3.6.2 It is necessary to incorporate in the Town and Country Planning Act mandatory clauses requiring all urban development projects of new townships/housing estates to have in-built and adequate provision for solid waste management including land allocation for disposal. All urban development authorities and metropolitan development boards must have within the framework of its long-term land use policy adequate provision of landfill sites of appropriate location on regional basis. It may be necessary that smaller municipalities would have to pool and share common facilities for disposal of their solid waste. Necessary legal and administrative provisions need to be made in this regard and financial assistance should be provided from Central/State Governments.

3.6.3 For proper solid waste management, it is very necessary to prescribe regulatory measures and provide legal powers to local authorities. The Municipal laws should lay down detailed list of obligatory and discretionary duties of local authorities; specific standards have to be laid down for the collection, storage, transport and disposal of solid waste. Responsibilities of the individual, local self Government organizations, NGOs, commercial organization in respect of these steps need to be defined and penalties for non-compliance specified.

3.6.4 Municipal bye-laws should have a mandatory clause that licences to operate nursing homes, hospitals, dispensaries and industries will be issued/renewed only after making sure that these institutions carry out safe disposal of potentially hazardous waste.

3.6.5 Under the new Centrally Sponsored Scheme for promoting infrastructural development in Mega cities, projects have been initiated in Bombay, Calcutta, Madras, Bangalore and Hyderabad. Several facets of infrastructural requirements of the mega cities like water supply, sewerage and drainage, sanitation, city transport, land development, slum improvement and solid waste management are eligible for funding under this scheme. It should be possible to make use of the available resources from the Mega City Scheme for operationalising some of the salient recommendations of the High Power Committee for effective and safe urban solid waste management. In view of the serious consequences of inadequate and

insanitary disposal of solid waste on the community health and environment, adequate funding should be made available for solid waste management to the local self-governments including small and medium sized municipalities.

3.6.6 R & D efforts are necessary for developing suitable cost effective designs for small size incinerators using gas, coal or electricity to suit the needs of small nursing homes, private clinics.

3.6.7 The industries and product manufactures should include the cost of appropriate disposal of product/packaging material as a part of the cost of the product. Individuals and industries may be subjected to a Disposal Tax for part generation of resources for solid waste management. Funds so generated through this effort will be made available to the Municipalities for safe disposal of urban solid waste.

3.7. Human Resource Development

3.7.1 Analysis of present status of solid waste management in Indian cities and towns indicates that better sanitation standards could be achieved in most cities with moderate additional investment provided availability of trained manpower at critical level is ensured.

3.7.2 There is an acute shortage of requisite trained manpower in municipalities, particularly the small and medium ones. Appropriately designed modules for continuing education for different categories of professional staff in USWM need to be designed by institutes with adequate expertise in USWM. Apart from providing appropriate and adequate technical information, efforts should be made to utilize the multi- professional education approach in these training courses so that the persons not only acquire the knowledge but also learn to work as a team with related professionals from allied sectors.

3.7.3 A comprehensive manual covering various aspects of collection, transportation and disposal of solid waste in urban areas should be prepared on priority basis and widely disseminated to the municipal agencies. Simultaneously, necessary action should be taken to revise the curricula of existing formal courses to incorporate pertinent aspects of Urban solid waste management.

3.7.4 Reliable data on a national scale on generation, and management of urban solid waste including its health and environmental impact are not available. Existing institutes with experience and expertise in this area need to be strengthened, and entrusted with the task of generation of appropriate national data base, and evaluation of ongoing and proposed R & D/pilot projects for Urban solid waste management.

3.8.Awareness Creation

3.8.1 The role and responsibility of the people in ensuring a safe and sanitary management of urban solid waste needs to be communicated to the general public, opinion builders, industrialists, hospital personnel and policy makers, planners and civic administrators. Municipal authorities, NGOs and citizen organizations should be involved in a multimedia campaign to create awareness on the crucial role of the individual in promoting appropriate solid waste management.

3.8.2 The health consequences of poor urban solid waste management should be adequately documented and information disseminated to the public, the administrators and the decision makers. USWM can be introduced into school curricula. Youth bodies, NGOs may be encouraged to address important environmental issues including USWM. Industry should be encouraged to play a bigger role in this campaign by providing appropriate tax incentives and other concessions.

3.9. Operationalisation of the Programme for USWM

3.9.1 Urban solid waste management falls under the purview of several departments; in order to ensure cohesion, coordination and convergence of all such efforts it might be essential to evolve a National Policy as well

as Action Plan for Management of Solid Wastes.

3.9.2 The major thrust of the recommended policy are:

(i) waste reduction through concerted 1EC

(ii) segregation of different types of waste at source - at home, in the hospital and in the industry

(iii) resource recovery and recycling so that waste is turned into useful material for use in daily life.

(iv) appropriate technology for safe collection, transportation and disposal of solid waste.

3.9.3 The major components of the National Action Plan of Urban Solid Waste Management shall include:

(i) awareness generation at all levels- community, industry and hospitals.

(ii) legal enactment to supplement and support the efforts generated through IEC.

(iii) human resource development for better management of Urban Solid Waste.

(iv) research and development for evolving and evaluating appropriate technology for waste management.

(v) pilot projects preferably in the joint sector for utilisation of proven technological option for urban solid waste management.

(vi) strengthening the existing services for urban solid waste management.

(vii) establishment of rag pickers cooperatives in association with NGOs.

3.9.4 It is imperative that there is intersectoral coordination and adequate resource mobilisation both in terms of funds and in terms of well trained manpower to carry out the National Action Plan. This could be attempted as a Mission Mode Project with different departments developing closely interlinked Mini Missions. However in this approach it might be difficult to assign appropriate priority between competing activities, and provide adequate financial support.

4. ACTION PLAN

4.1 Taking into account existing resources and manpower constraints, the following areas have been identified by the High Power Committee as priority areas requiring immediate funding during the remaining period of the Eighth Plan.

4.2 A Centrally Sponsored Scheme for infrastructural development in Mega cities was approved in 1993. Under the scheme, 25% of funding comes from the Central share, 25% from the State and remaining 50% from market or instutional borrowings. In this project there are the following three areas of direct relevance to Urban Solid Waste Management:

(i) removal of sewerage/drainage/solid waste disposal system

(ii) solid waste disposal scheme and setting up composting plants

(iii) environmental improvement and sanitation.

Some of the specific recommendations of the Committee can be implemented immediately in these cities utilising the funds under Mega City Project. For maintenance of services a service charges can be levied as a part of municipal taxation so that overall viability of ther project may be ensured. Similarly provision for USWM in the remaining 17 cities with more than 1 million population and the 16 growing cities where population of 1 million is expected to reach 1 million by 2000 A.D. should receive immediate attention. In addition appropriate models for USWM in smaller cities and municipalities need to be developed.

4.3 Appropriate land allocation for urban solid waste management should be made as part of urban town planning in cities of varying size as well as upcoming satellite towns. Specific earmarked allocation of land for landfill sites as well as composting and other processing facilities should be a part of town planning and must be made a mandatory prerequisite for approval of new urban settlements.

4.4 Recycling should get due recognition and

support as a method of converting waste into useful articles; recycling industry should get assistance for technological upgradation to improve the quality of the product, reduce cost and minimize potential health hazards.

4.5 A review of current Municipal bye-laws and town and country planning Act should be undertaken and necessary modifications to ensure safe disposal of urban waste including hazardous industrial and hospital wastes should be taken up immediately.

4.6 It is essential that coordination of the activities required for proper management of urban solid waste is entrusted to one Agency/Cell. This Cell can be located in any of the concerned Ministry and should coordinate and oversee the solid waste management activities including Human Resource Development, collect, collate and report data pertaining to different aspects of solid waste management, assess and propose projects for safe management of solid waste by various municipalities, propose and obtain necessary financial outlays as well as steer appropriate legal Enablement Legislation.

4.7 It is essential to create a network of regional centres who could take up the research & development studies related to safe management of urban solid waste in-cluding hazardous and toxic industrial solid wastes, assess health and environmental impact of existing procedure for disposal of urban solid waste, undertake pilot studies of economically viable procedures for safe disposal. To begin with 4 centres who are involved in R & D work in related fields, namely AHHPH, Calcutta; NEERI,Nagpur; ITRC, Lucknow; and NIOH, Ahmedabad may be requested to draw up specific proposals indicating the support that they would require in order to take up this activity.

4.8 In view of the lack of trained and skilled manpower especially in smaller municipalities and towns, it is essential that special training courses for in service personnel is taken up on a priority basis in institutions that have adequate background and experience in the area. AIIHPH and NEERI may be requested to make a realistic appraisal of the need and prepare an action plan to remedy the deficiency in trained manpower.

4.9 Rag pickers play an important role in the recycling of urban solid waste and could play a even more productive role in ensuring a sustainable system of house to house collection of the solid waste. There is a need to create a cooperative for rag pickers in the cities so that the middlemen are eliminated and the rag pickers get due financial reward for their work. Incidentally, such a cooperative could also provide facilities for improved hygiene such as community toilets, baths, conducts programmes for non-formal education and vocational training for the rag pickers.

4.10 Appropriate efforts should be directed to improve the awareness of the industrial management, health care personnel and general public of their respective role in ensuring safe disposal of potentially hazardous waste material.

5. PILOT/ R&D PROJECTS

5.1 The pilot or R&D projects in the following areas require support. Agencies with interest and expertise in each of these areas may be requested to submit appropriate proposals for scrutiny and processing.

5.2. Pilot Project*

(i) Separation of waste at source, in community bins and transport.

(ii) Improvement of existing dumping ground in a phased manner so that they become sanitary landfills.

(iii) Recovery of Methane gas from landfills.

(iv) Aerobic Composting - labor intensive, low mechanisation of composting for small towns/ satellite cities.

(v) Biodigesters for hotel and market waste.

(vi) Non-hazardous Industrial Waste Management based on recovery of by-products.

(vii) Hospital Waste Management with separation and decontamination at source.

5.3. Research & Development Projects

(i) Appropriate Software Development for optimization of transport and total system for urban solid waste management.

(ii) Appropriate vehicle development for transportation at various levels.

(iii) Health impact assessment of currently prevalent poor USWM, industrial and hospital waste management practices.

(iv) Effect of Nutritional and Genetic makeup on the health hazard associated with exposure to infectious and toxic wastes.

(v) Identification of appropriate liners for leachate control and recycling.

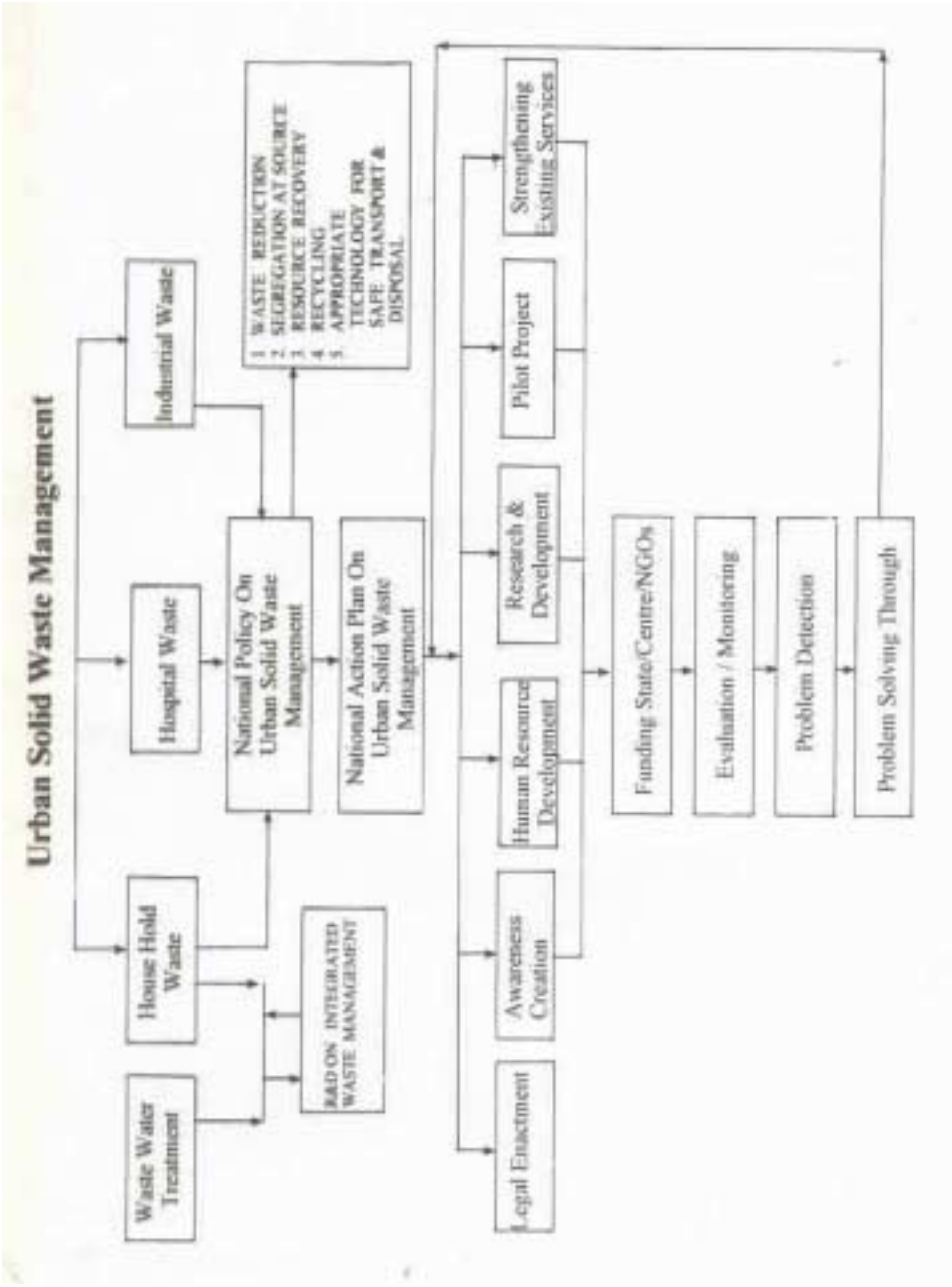
(vi) Assessment of the present status of recy cling industry and upgrading the same.

(vii) Development of small scale Incinerator for small clinics.

(viii) Decontamination at source and Disposal of hospital/clinic waste .

(ix) Data base for Industrial Solid Waste from small industry.

(x) Immobilization of Heavy Metals in industrial solid waste.



1. INTRODUCTION

Constitution Of The Committee

1.1 India's population has expanded from 342 millions in 1947 to 846 millions in 1991. Census 1991 has shown that 220 million out of 846 million Indians reside in about 4000 urban agglomerations. Even though the entire country is affected by the increase in population and its ecological consequences, the urban areas had been the worst affected because the urban population has expanded at a faster pace due to urban migration; the population in 23 Metro Cities alone comprises one third of the total urban population. Forty percent of urban population are poor and live in foot- paths and urban slums without any access to safe drinking water or sanitation facilities (Annexure-I).

1.2 It is estimated that India's population will cross the one billion mark by 2000 AD; sixteen more cities will have population of over 1 million by 2000 AD. The Standing Committee on population has projected that the country's population will be 1003.1 million in 2001, 1082.2 millions by 2006 and 1250 millions by 2015 AD. The lure of employment in urban areas and consequent urban migration are expected to continue over the foreseeable future. Proportion of the urban population is expected to grow to 470 millions by 2015 AD; what is even more worrying is the estimate that about 150 million of the urban population will be living in urban slums. Indian cities will be among the most densely populated among the cities of the world (Annexure-II).

1.3 In India town planning, waste management, public hygeine and public health had recieved due attention right from the dawn of history. The excavations at Harappa and Mohanjodaro clearly indicate that these early civilisations had excellent system for water supply, sewage and solid waste disposal; personal and environmental hygiene was given due attention in planning houses as well as in town planning. Environmental sanitation and public health continued to recieve adequate attention until the last century, when rapid urbanisation and rapid population growth resulted massive changes and rendered it difficult for the city, citizens and the environment to cope with the massive increase in urban waste production. Continued urban migration, congregation of urban poor in slums without safe water supply and sanitation facilities and increasing resource constraints have all led to rapid deterioration in quality of life, environmental sanitation and public health. Over decades there has been a progressive decline in the availability of essential services as well as quality of life in urban areas; urban poor have been the worst affected segment in the change. The health and environmental consequences due to increasing population density, lack of safe drinking water and essential urban sanitation are likely to become further aggravated unless steps are initiated to improve the situation through increased intersectoral coordination and appropriate and innovative technologies for safe management of urban waste both solid and sewerage.

1.4 Urban solid waste management (USWM) has remained one of the most neglected areas of urban management in India. The sheer immensity of the problem, the financial and infrastructural constraints including the lack of land for safe disposal of waste generated, the lack of awareness and apathy at all levels have come in the way of efficient, safe management of urban solid waste. Over years there has been a progressive decline in the standard of services with respect of collection and disposal of house, hospital and industrial wastes, as well as measures for environmental sanitation and public hygiene. In most cities nearly half of solid waste generated remains unattended. This gives rise to insanitary conditions especially in densely populated slums. This in turn has resulted in increase in morbidity and mortality especially due to infections in all segments of urban population (Annexure-III & IV), with the urban slum dwellers and waste handlers being the worst affected. Periodic out breaks of food borne, water borne and vector borne diseases occur in all

cities; health and environmental consequences of ground and subsoil contamination have also been recorded. It is therefore imperative that steps to improve urban solid waste management, environmental hygiene and sanitation are initiated immediately so that the adverse health and environmental consequences of the rapid urbanization are minimized.

1.5 There has been no major effort to build up community awareness either about the likely perils due to poor waste management or the simple steps that every citizen can take which will help in reducing waste generation and promote effective management of solid wastes generated. The degree of community sensitization and public awareness generated recently because of focal epidemics of malaria, Japanese encephalitis the media attention on plague, the issues raised regarding fly , mosquito and rodent menace in and around slums needs to be harnessed towards participator[1],' management aimed at the implementation of sound solid waste and sewage management policies, with the ultimate objective of improving environmental sanitation and public health. A careful analysis of the present status of solid waste management in the Indian cities and towns would lead to the inevitable conclusion that better sanitation standards could have been achieved in most of our cities and towns by prudent and planned allocation of available resources to develop and support the application of appropriate low cost eco- friendly technologies. Accordingly the Planning Commission constituted a High Powered Committee on Solid Waste management under the Chairmanship of Prof. J.S. Bajaj, Member, Planning Commission (Annexure V). The terms of reference of the Committee were:

(1) To assess the impact of the present system(s) of Solid Waste Management on community health and suggest remedial measures aimed at minimizing health hazards and adverse health outcomes.

(2) To identify the potential hazardous wastes in cities and towns including hospital wastes, and the associated health risk.

(3) To assess the quantum and characteristics of domestic, trade and industrial solid wastes in towns exceeding one million inhabitants (1991 census).

(4) To review the existing technologies for solid waste collection, transportation and disposal and suggest the most appropriate and feasible ecofriendly and cost-effective technology option(s) keeping in view the cost-benefit, the waste characteristics, socioeconomic status and demographic structure of the community.

(5) To consider any other relevant issues.

1 .6 The Committee commenced its work on 12th December, 1994 when it held its first meeting in Yojana Bhavan, New Delhi under the Chairmanship of Prof. J.S. Bajaj, Member(Health), Planning Commission. Second meeting of the Committee was held on 3rd April, 1995. The Draft Report was discussed in detail, finalized and endorsed by the Committee in its final meeting held on 29th May, 1995.

1.7 In the first meeting of the Committee the Members considered the broad issues of Urban Solid Waste Management. As preparatory step to this meeting, the Planning Commission prepared/obtained, background status papers/documents/reports relevant to the terms of reference of the Committee and mailed them to all the Members. Subsequently several additional documents on various aspects of urban solid waste management were obtained and were used during discussion in the subsequent meetings of the High Power Committee (List of documents given in Annexure- VI).

1.8 In order to facilitate expeditious completion of the tasks defined under the terms of reference, the High Power Committee in its first meeting decided on a parallel track approach and constituted three Sub-groups to look into specific aspects of solid waste management:

(i) Sub-Group A on ecofriendly and cost effective Technological Options (Annexure-VII);

(ii) Sub-Group B to study the existing technology on urban solid waste disposal as practiced in some major cities (Annexure-VIII) and

(iii) Sub-Group C on Hazardous Waste Management including Hospital Waste Disposal (Annexure-IX).

Several members took part in the work of more than than one Sub-group.

1.9 The Sub-Group B undertook site visits to innovative pilot and R &D plants for solid waste management in Bombay and Bangalore. In Bombay, site visits were done to the Pelletisation, Vermiculture and Composting Pilot Plants. In Bangalore the pilot Pelletisation plant and the Composting plant were visited (Annexure-X). In addition, the Sub-Group members collected information on the ongoing/ proposed pilot / R & D solid waste management plants in the country. Summary of the information collected by the site visits/ inquiry was provided as an input to the Subcommittee B on Technological Options for Solid Waste Management and was also utilised in the preparation of the report of the High Power Committee.

1.10 The Sub-group C met in New Delhi on 3rd April, 1995 wherein a status paper prepared in Health & Family Welfare Division , Planning Commission and two background papers prepared by the Members were discussed with the Chairman of the High Power Committee, appropriate modifications were suggested and the recommendations finalized . The recommendation of the Sub-Group on Hazardous Waste Management including Hospital Waste Management was extensively utilised in the deliberation of Sub-committee Band in preparation of the relevant chapters of the report of the High Power Committee.

1.11 The Sub-Group A deliberated on the Technological Options in its meetings held on 3rd April, 1995, 21st April, 1 995, 3rd May, 1995 and 12th May, 1995. The Sub-group reviewed the existing technologies relating to collection, transportation and disposal of urban solid waste utilization the findings and recommendations of the other two Sub-Groups. They then made their recommendations on appropriate technological options which were utilised while finalizing the report of the High Power Committee.

1.12 The second meeting of the High Power Committee was held on 3rd April 1995 and considered progress of work of the Sub-Groups. A sharply circumscribed and structured agenda with defined issues focused on collection, transportation, disposal, financing, legislative measures and role of voluntary organizations regarding urban solid waste management was discussed. A draft report containing inputs provided by Sub-groups and additional background documents were circulated for consideration of the Members of the Committee. The Committee deliberated on these in detail and gave specific directions for the further modification of the report of the High Power Committee. These suggestions/modifications incorporated in the draft report considered in the Third and final meeting of the High Power Committee.

1.13 The Third and final meeting of the Committee was held in New Delhi on 29th May 1995. The Committee had detailed discussions on the draft report on urban solid waste management including the recommendations. The members endorsed the report and authorized the chairman to review the final report for incorporations of suggestions made by the members during the final meeting. The Committee then prioritized the Recommendations taking into account existing resource and manpower constraints and suggested Action Plans and Pilot/R&D projects on solid waste management to be taken up during the 8th Plan period and during the planning phase of the 9th Plan.

2. MUNICIPAL SOLID WASTE MANAGEMENT - CONCERNS AND CONSTRAINTS

2.1 Nature and Quantum of Municipal (Household) Solid Wastes

2.1.1 Urban solid waste includes household garbage and rubbish, street sweeping, construction and demolition debris, sanitation residues trade and industrial refuse and hospital solid waste. The quantity and contents vary according to the socioeconomic and cultural habits of the people, urban structure, density of population, extent of commercial activity and degree of salvaging at source.

Household Waste

2. 1.2 Available data indicate that at the moment in India the amount of waste generated by individuals in households is quite low. The quantity increases with increase in standard of living. The household waste mainly consists of readily biodegradable organic waste material, inert grit and recyclable material; most of latter is collected and recycled by private sector operators.

2.1.3 The quantity of municipal solid waste is usually expressed on a per capita basis and includes the waste produced both from residential and commercial areas. In most municipal areas accurate estimate of the amount of waste generated is not available. Available data is also incomplete as pertains only to the amount collected and disposed off by the municipal authorities and not the amount of waste generated; it is estimated that 10 - 40% urban solid waste remains in different cities. The municipal authorities in most of the towns do not weigh the refuse vehicles. Municipal estimates of the quantities of waste transported is based on the capacity, of the refuse vehicle transporting the waste and number of trips made to disposal site. In some cities NEERI, Nagpur has accurately determined the actual quantity transported on a day, on the basis of quantity tran-sorted per trip and the number of trips made per day.

2.1.4 Based on the available data from different sources it is estimated that the quantity of solid wastes generated per person per day in the urban areas in India ranges between 300 and 600g. In the most densely populated metropolitan cities of Calcutta and Bombay, solid waste generation rates are more than 500g/capita/day. In Delhi, which has a higher level of per capita income, but much lower density of population, the estimated solid waste generation is only 300g/capita/day (Table-2.1).

Table 2.1
COLLECTION OF URBAN SOLID WASTE IN SOME INDIAN CITIES & TOWNS

Sl. No.	Name of the Municipality/ Corporation	Population	Density of Population (per Sq Km.)	Total Quantity collected per day (tonnes)	Per Capita Collection per day (kg)
1.	Delhi	5,500,000	23,000	1,600 - 1,800	0.3
2.	Calcutta	3,300,000	32,000	1,600 - 1,800	0.50
3.	Howrah	670,000	25,000	320	0.50
4.	Kanpur	1,300,000	-	700	0.55
5.	Bangalore	2,000,000	-	1,000 - 1,100	0.55
6.	34 Suburban municipal town, in Calcutta Metropolitan Districts	3,500,000	2,000 20,000	750	0.22

Source : Studies on itute of Hygiene and Public Health between 1982-90. Sponsored by Calcutta Metropolitan Development Authority and Funded by World Bank.

It is estimated that in most of the cities in India, the quantity of combined city refuse reaching municipal collection systems at the present level of development would not be more than 400g/capita/day in areas with a density of population less than 20,000/sq.km. The figure might be between 500 and 600g/capita/day in the more densely populated areas. In unsewered areas the quantity may be higher due to the presence of surface drain sludge. For future planning, an average annual growth rate of 1% of urban solid waste may be used.

2.1.5 On the basis of available data, it is estimated that the nine major metropolitan centres in India are presently producing 8.5 million ton (mt.) of solid waste per annum; the figure is expected to reach 12 mt. per annum by the turn of this century.

Characteristics Of Urban Solid Waste fa India

2.1.6 Few local authorities in India carry out a regular analysis of the refuse collected, and therefore, authentic information regarding the composition of urban solid waste in different cities is not available. Refuse from Indian cities contains a high compostable and low combustible matter. The quantity of ash and earth is also high, particularly in suburban and peripheral area of the metropolitan districts. This may be due to the presence of surface drain sludge and silts. Paper, plastic and metals are present in very low quantities because (a) many of these are separated at source and sold by the householder to kabadis; (b) even those which are considered as worthless and thrown with the refuse by the householders are salvaged from garbage dump sites by rag pickers (Table-2.2). The calorific value of urban solid waste is low, less than 1,500 k.cal/kg in most cities, because paper, plastic and wood have already been removed and used for recycling.

2.1.7 The average dens ity of refuse varies between 500 and 600 kg/meter cube. Density is lower(250 kg/m.cub.) at collection; Density is higher(500 kg/m.cub.) at the disposal points due to picking, scavenging and eating of vegetable matter by cattle, food by dogs. In view of the high density, compaction trucks are usually not needed in India.

2.1.8 Most of the Indian household garbage has very high moisture (over 50%) and organic content. Heat and humidity accelerate bacterial growth and decomposition. This results in foul smell. Because of the high organic content (Table-2.3) especially vegetable and food waste, flies and rodents throng the garbage collected - outside home or at the dumps.

Table 2.2 COMPOSITION OF URBAN SOLD) WASTE (PERCENTAGE BY WEIGHT)

Name of City	Paper & Card	Met-als	Glass	Tex-tiles	Plastic Leather & Rubber	Wooden Matter Hay& Straw	Bones etc.	Stones etc.	Fine Earth & Ash etc.	Fer-men-table	Density Refuse (Kg cum)
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Lucknow	1.66	0.20	0.66	2.91	4.20	3.02	0.18	5.27	21.59	60.31	407.60
Kanpur	1.35	0.18	0.38	1.57	0.66	1.00	0.21	18.38	22.93	53.34	500.00
Madras	5.90	0.70	-	7.07	-	.	.	13.74	16.35	56.24	-
Delhi	5.88	0.59	0.31	3.56	1.46	0.42	1.14	5.98	22.95	57.71	-
Calcutta	0.14	0.66	0.24	0.28	1.54	-	0.42	16.56'	33.58	46.58	600.00
: Bangalore	1.50	0.10	0.20	3.10	0.90	0.20	0.10	6.90	12.00	75.00	578.00
Ahmedabad	5.15	0.80	0.93	4.08	0.69	1.50	0.12	8.77	29.01	48.95	-
Bombay	3.20	0.13	0.52	3.26	-	17.57	0.50	-	15.45	59.37	-
34 Municipal town* in Calcutta Metropolitan District 0.90		Negli-gible	0.50	1.50	0.36	2.80	.	6.59*	60.99	26.36	562.00

Source : As in Table 2.1

2.1.9 Moisture content is a function of food waste soil/animal dung is included with garbage. Moisture content is also dependent on the fact whether refuse is dumped in open or enclosed at community collection points. Moisture content is high in India even in dry season. The refuse has an average moisture content of over 50%; in rainy seasons the moisture content is much higher.

Collection of solid waste from the individual houses is not generally practiced: In some specific areas house to house Collection of garbage is made by refuse collectors employed by the local authorities. In some big towns welfare associations or neighborhood societies take the responsibility of house-to-house collection of solid waste on specified monthly payment to be made by the households. In some cities hand-carts or pedal tricycles are used for

Table 2.3

CHEMICAL COMPOSITION OF URBAN SOLID WASTE IN INDIA

City /Town	Moisture	PH	N	Pas P2O5	Kas K2O	Organic Matter	C	C/N Ratio	Calorie Value
1.	2.	3.	4.	5.	6.	7.	8.	9.	16:
Calcutta City									
(a) Residential	40-45	7-7.3	0.5-0.6	0.5-0.6	0.35-0.4	31-35	17.5-19.5	31-37	2,000-2,500
(b) Market	43.65	6.90	0.57-0.58	0.42		39.20	21.80	48.16	-
(c) Commercial	40.20	7.21	0.43	0.62	0.312	39.00	21.60	50.80	-
(d) Industrial	51.35	7.16	0.676	0.575	0.675	40.14	22.30	32.94	-
Delhi City									
(a) Residential	16.00	8.50	0.60	0.65	0.40	36.00	21.00	34.00	2,550
(b) Commercial (including market)	16.00	8.40	1.12	0.84	0.64	42.35	24.56	21.92	3,000
(c) Industrial	14.25	8.55	0.66	0.68	0.31	31.90	18.50	30.90	2,400

Note: All values are calculated on dry weight basis except moisture and all values are given in percentage except pH, C/N and calorie value.
Source: As in Table 2.1

2.1.10 Even though the organic component which is responsible for combustibility may be around 60% on dry basis, the refuse in Indian cities is not readily combustible. This is due to the high moisture content (40-80%) and quantity of grit and inorganic sandy dust (over 20%), and low combustible matter such as paper.

2.2 Current Practices Of Municipal Solid Waste Management

Collection and Transportation

2.2.1 In urban areas in India, it is the responsibility of the local authorities to collect and dispose of the solid waste.

collecting the garbage from the houses and for transferring it to on-road collection points. In other cities there are arrangements for collection of garbage from the bins located in the narrower streets by the employees of the municipalities using wheel barrows which are then placed in a large bin on the main road from where the trucks collect the waste matter. In market areas and public places the sweepers on the payroll of the municipalities collect the garbage from the place of origin and take it to a central bin, from where it is transported.

2.2.2 The garbage is collected by the municipalities from the road side collection sites and carried away to the place of disposal by means of mechanized transport. In most of the towns the collection and transportation of solid waste to disposal site is not done regularly. It is estimated that only 30 to 40% of the garbage generated daily is collected and sent to disposal site on that very day (Table-2.4 & 2.5).

2.2.3. Various types of vehicles, varying from bullock carts to compactors, are used for transportation. However, the general-purpose open body trucks of 5 to 7 tonnes capacity are the ones most commonly used. In the smaller towns, noisy, inefficient tractor-trailers are used. In a few

Table 2.4
TRANSPORTATION OF WASTE TO VARIOUS DISPOSAL SITES
(CALCUTTA METROPOLITAN DISTRICT)

	Average Haulage km.	Average number of Trips per Day	Weight Carried Per Trip Per Truck (tons)	Cost per Tons Per km (In Rupees)
Calcutta Corporate	>n			
Maximum	19.53	2.56	2.98	1.26
Minimum	3.68	1.84	2.59	1.02
Average	17.41	2.18	2.79	1.15
Municipal Towns				
Maximum	12	6	2.5	21.00
Minimum	1	2	1.2	1.00
Average	3	3	1.75	6.00

Source: As in table 2.1

Table 2.5

TRANSPORTATION OF URBAN SOLID WASTE

Name of Municipality/ Corporation,	Population (in thousands)	Type and Number of Transport Vehicles	Average Haulage (KM)	Average Number Trips per Vehicle per day	Average Number of Vehicle Running Every Day	Carrying Capacity Per 10,000 population (Tons of Refuse)
Delhi	5,500	OT-140 CC-10 150	15	2-3	120/130	5 "*
Calcutta	3,400	OT-200* CC-5 205	17	2-3	130	5
Howrah	670	OT/rr-50	16	2	30	5
34 Municipal towns in Calcutta Metropolitan District	3,500	OT- 40 TT- 134 AC- 60 234	3	2-3	144	2.37

SOURCE: As in Table 2.1 * including about 80 private trucks.

QT= Open Truck; TT= Tractor-Trailer; CC= Carrier container; AC*Animal Carrier.

cities compactor vehicles are also being used. Because of the nature of urban solid waste in India these vehicles are able to I provide a compaction ratio of only 1 .25 to 1.50. Their capital cost is high and they require extensive maintenance costs. The recent trend is towards the use of container-carriers and dumper placers wherein the containers of the vehicle are themselves used as community bins. A refuse collection vehicle with an empty container reaches the collection point, leaves the empty container, lifts the container full of solid waste and carries it to the disposal site. In such a system the vehicles make 5 to 6 trips per day as compared to 1 to 2 trips per day made by the other vehicles as the former uses the truck as a prime mover, instead of tractor.

2.2.4 When the transportation distance is large, the waste is transported by using large capacity refuse vehicles. This is both economical and convenient. Transfer of waste from smaller vehicles to larger size vehicles is carried out at the transfer stations. Such transfer stations are in place only in a few metropolitan cities.

Current Practices Of Waste Disposal Land Filling (dumping)

2.2.5 Land filling is the most commonly used method of disposal of the urban solid waste. However the principles of sanitary landfills by use of appropriate technology and its implementation through careful supervision are usually conspicuous by their absence. The solid waste from the urban areas is commonly disposed of in the nearest available low lying areas. These sites are often improp-i erly selected leading to pollution of ground and surface waters. The disposal of wastes at these sites is done without following any systematic procedure moreover the garbage is not covered with earth and compaction is not done. These improperly operated landfills lead to a number of ; health and environmental problems. In a few metropolitan cities organized tipping of waste, use of mechanical equipment to level and compact the wastes and a final covering with earth followed by further compaction is practiced. This does reduce fly, rodent, animal and human intrusion into the garbage and their environmental and health consequences. However in these sites, the leachate control and biogas utilisation is not carried out. Thus, the existing landfill practices are poorly organized, insanitary, cause pollution of ground water and if the waste is burnt in these sites it can cause air pollution. In some cities, like Bombay landfill technique has been used to reclaim low lying land for habitation purposes.

Composting

2.2.6 Manual composting of municipal solid wastes is commonly practised in small towns. Anaerobic composting in pits along with night soil (trenching) is commonly adopted. The produced compost can be sold and the system is normally operated on no-profit, no-loss basis. Because of the unhygienic conditions under which these are carried out the workers are at the risk of acquiring a variety of infection of skin, gastrointestinal and respiratory tract. Moreover, due to the absence of any controls over the process, the produced compost is often of poor quality. Studies carried out at NEERI, Nagpur have shown the existence of intestinal parasites such as ascaris and trichuris in the compost. It is, therefore, necessary to systematize this process to ensure that the workers do not incur health risks and a stable compost free from any pathogenic organism is supplied to the farmers.

2.2.7 Under Central scheme of solid waste disposal, ten mechanical compost plants were set up in the larger cities during 1975 and 1980. Out of these only one plant is presently in operation. The composting plants were found to suffer from a number of problems such as over mechanization, absence of consumers in the nearby areas who are willing to purchase compost at the sale price.

Major Deficiencies in Urban Solid Wastes Management System Source

Segregation and Storage

2.2.8 Major problem is that there is no system of segregation of recyclable, organic and inorganic wastes at household level and storing them separately until collection.

Primary Collection

2.2.9 System of primary collection of wastes is not appropriately designed. No door-step collection facility exists nor bins at short distances are provided for community collection and disposal of wastes; as a result streets are being treated as a receptacles of waste. Hazardous industrial and infectious hospital wastes are not collected and disposed separately.

Street sweeping

2.2.10 All streets are not swept daily. Many are swept occasionally or not at all. Even those which are swept regularly are not swept on Sundays and public holidays. Tools given to sweepers are inefficient and outdated. No yardstick for street sweeping work has been prescribed. Thus some sweepers are sweeping no more than 200 mtrs. while others have to cover over 5 kms road length.

Community Storage of Wastes

2.2.11 The community storage facility i.e. dust bins are ill designed and inadequately provided. Open dust bins, masonry bins, cement concrete round bottomless dust bins used for storage of waste are unhygienic. People cannot go close to these bins and hence throw waste from a distance. As a result more waste is seen outside the bins than inside it. This system also necessitates double handling of waste.

Transportation

2.2.12 The transportation system does not synchronize with primary collection system necessitating multiple handling of waste. Transportation fleet is not adequate. Old outdated vehicles are used. Repair and maintenance gets low priority. USWN ve-hicle maintenance facility is poor. Because of all these transport of waste on daily basis is not possible; the waste backlog thus created results in decomposition of waste, foul smell, environmental pollution and health and sanitation problems.

Waste Disposal

2.2. 13 The current practice is to dispose of the waste by open dumping at the land fill sites. The poorly managed land fill sites are essentially uncontrolled dumping grounds; they pose a threat to health and environment; sub-soil water contamination due to leachate is another potential problem in these dumping grounds. In places where composting is done by local bodies, the methodology adopted at most of the places is inefficient and unhygienic.

Institutional Weakness

2.2.14 Municipal solid waste management is looked upon as a job of municipalities and not as a collective responsibility where every citizen, voluntary organization, private entre-preneurs should play an appropriate role. Many urban areas do not have an appropriate structure to look after the Solid Waste Management. Multiple agencies are involved; there is very little coordination between agencies. They lack technical know how and need training support. The existing laws for solid waste management in the cities are neither adequate nor effectively enforced.

Financial

2.2.15 There is a lack of adequate resources being made available on an assured continuous basis; poor utilisation of existing resources is also a contributory cause. A careful analysis of the present status of solid waste management in the Indian cities and towns would lead to the' inevitable conclusion that better sanitation standards could have been achieved in most of our cities and towns by prudent and planned allocation of available resources to develop and support the application of appropriate low cost eco friendly technologies.

2.3. Health Consequences of Poor Solid Waste Management

2.3.1 There is unequivocal evidence that the poor waste management is associated with increased health problems in all the sections of the population (Annexure III and

Annexure IV). The poor solid waste management may at times trigger off epidemics of some vector borne or food borne infections. It is also possible that the leachates from dumping grounds may lead to adverse health consequences due to ground/ subsoil water contamination. It is however difficult to quantify the health hazards posed by poor urban solid waste management because very few epidemiological studies have been undertaken to obtain the data. Problems such as infections due to pathogenic organisms, vector borne diseases, ground/subsoil water pollution - can all be readily avoided or controlled by proper waste management.

2.3.2 Realizing the health implications of proper waste management, sanitation and hygiene were initially under the domain of Health Ministry. The extremely institutions providing health care and rapidly increasing waste generation. Mounting accumulation of decomposed, often contaminated garbage right from, near the households, at road side collection sites, during transport and at poorly managed disposal sites, inevitably resulted in health hazards affecting not only the workers involved in waste disposal but also the entire population of the city. Indiscriminate dumping of potentially hazardous hospital and industrial wastes with non-hazardous waste further added to the health hazards associated with improper waste management in these areas.

2.3.3 Health hazards among workers involved in waste disposal, Rag-pickers as well as to the general community are

Table -2.6
PERCENT OF TOTAL POPULATION IN URBAN AREAS BY SIZE OF TOWNS
(All India)

Class and size of town in terms of Population	1951	1961	1971	1981	1991*
Class I: 1,00,000 & above	7.62	9.08	11.17	13.83	16.40
Class II: 50,000 - 99,999	1.70	1.98	2.13	2.66	2.75
Class III: 20,000-49,999	2.68	2.99	3.12	3.28	3.32
Class IV: 10,000-19,999	2.33	2.25	2.14	2.18	1-95
Class V: 5,000- 9,999	2.21	1.21	0.86	0.82	0.65
Class VI: Less than 5,000	0.53	0.14	0.09	0.12	0,07
Urban Population as Percent of Total Population	17.29	17.97	19.91	23.34	25.72
Total Population (Million)	361.09	439.24	548.16	683.33	846.30

Size class-wise percentage do not add up to percentage of total urban population as data on Assam and Jammu & Kashmir are excluded in the size class-wise distribution.

* Provisional Source : Registrar General of India, Decennial Census Reports.

rapid growth of urban population (Table 2.6) led to formation of separate department looking after urban development, which also took over the responsibility of water supply and waste disposal.

However, investment (Table 2.7) and infrastructure never kept pace with the growing population, growth of industry, mainly due to presence of human excreta, presence of waste from hospitals and clinics and unauthorized disposal of hazardous waste from small scale industries along with municipal solid, waste.

2.3.4 Only a few Indian cities are completely sewered and human excreta is often deposited and is collected alongwith

Table 2.7
TOTAL PLAN OUTLAY VIS-A-VIS PLAN OUTLAY UNDER WATER SUPPLY AND SANITATION SECTOR SINCE FIRST FIVE YEAR PLAN -URBAN

(Rs. in Crore)

Plan Period	Total Public Sector Plan Outlays	Total Plan Outlay under Water Supply and Sanitation sector		Plan Outlays under Urban Water Supply and Sanitation sector	
		Amount	% of Public sector outlays	Amount	% of public sector outlays
1.	2.	3.	4=Col.3x100 / Col. 2	5.	6=Col.5x100 / Col.2
1. First Plan (1951-56)	3360.00	49.00	1.46	43.00	1.28
2. Second Plan (1956-61)	6750.00	72.00	1.07	44.00	0.65
1 third Plan (1961-66)	8573.00	105.70	1.23	89.37	1.04
4. Annual Plans (1966-69)	6664.97	106.42	1.58	NA	NA
5. Fourth Plan (1969-74)	15902.00	437.00	2.75	282.00	1.77
6. Fifth Plan (1974-79)	39303.49	1030.68	2.62	549.44	1.40
7. Annual Plan (1979-80)	12549.63	430.22	3.43	197.93	1.57
8. Sixth Plan (1980-85)	97500.00	4047.00	4.15	1766.68	1.82
9. Seventh Plan (1985-90)	180000.00	6522.47	3.62	2965.85	1.65
10.Eighth Plan (1992-97)	434100.00	16711.00	3.85	5981.00	1.38

municipal solid waste. The municipal workers handle this waste without using protective devices such as hand- gloves or gumboots. During sweeping of streets, dust containing various infectious agents get airborne leading to increased airborne infections and allergies. The workers are also exposed to infection during transfer of MS W from houses to handcarts, handcarts to community bins, community bins to transport vehicles and from vehicles to the disposal sites because all these transfers are manually done by workers who are not wearing any protective clothes. Infections occur through direct contact, through skin - intact or with abrasions as well as through the dust that is airborne and inhaled by the workers. These worker's hands are often contaminated with pathogenic organisms, or chemicals in the waste. Because of lack of awareness and lack of facilities for adequately washing hands many workers do not properly clean their hands even prior to eating; they are therefore at higher risk of gastrointestinal infections and problems associated with ingestion of chemicals. Available data indicate that prevalence of infections of skin, respiratory tract and gastrointestinal tract are higher among workers involved in waste disposal as compared to matched controls from similar socio-economic status (Table-2.8, 2.9 & 2.10).

Infections

2.3.5 There are four possible routes of transmission of infection :

(i) through the skin via broken skin, cuts, scraps or puncture wounds.

(ii) through mucous membrane via splashing onto the mucous membrane of the eyes, nose or mouth.

(iii) by inhalation

(iv) by ingestion.

2.3.6 The workers at the collection, transport and disposal sites are exposed to the infectious agents present in the waste due to fact that night soil and hospital wastes are dumped along with non-hazardous municipal waste. In India risks to workers by skin contact with wastes is several folds higher than in the industrialised countries because waste contains pathogens and protective clothings are not worn. Reducing occupation related morbidity due to infections in waste disposal workers is dependent upon strict implementation of the basic policy of segregation of hazardous waste and night soil right at source. Solid waste should be stored, collected and transported in a containerised system and in landfill site waste should be covered with a layer of soil or other suitable material of at least 15 cm in thickness. Protective clothing for the concerned workers is necessary, and should include rubber boots, gloves and overall which are changed and washed regularly. Toilet and bathing facilities for the staff at disposal site need be provided, to improve their hygienic standards and the risk of infections and accidental chemical ingestions can be reduced.

Insects

2.3.7 The eggs of flies often get deposited in the wastes before they arrive at collection point or disposal site. If the wastes are not covered and eggs are not buried deep in the wastes, the eggs survive. Near the surface, the eggs will hatch into larvae. It is estimated

Table 2.8
STOOL SAMPLE ANALYSIS OF REFUSE WORKERS

	Test		Control	
	No.	%	No.	%
Total No. of persons examined	50	-	70	-
Total positive	49	98	23	32.9

Source: PHERI(NEERI) Report(1971)'Studies on health of refuse workers in Trivandrum.

Table 2.9
PARASITE LOAD
(Ascaris, Ankylostoma and Trichuris)

Intensity and Municipality of infection	Test				Control			
	No.		%		No.		%	
Low (+)	-		-		16		22.9	
Medium (++)	2		4		4		5.7	
Heavy (+++)								
Single	5		10		1		1.4	
Double	16	47	32	94	-	3	-	4.3
Triple	26		52		2		2.9	

SOURCE : Same as Table 2.8

Table 2.10
HEALTH STATUS OF THE REFUSE WORKERS

	Refuse Workers		Control Group	
No. Examined	50		70	
	Incidence		Incidence	
Disease	No.	%	No.	%
Anaemia	12	24	11	16
Gastrointestinal Diseases	19	38	18	26
Respiratory Diseases	31	62	17	24
Skin Diseases	16	32	10	14
History of Jaundice	21	42	4	6
Trachoma	11	23	-	-
Eosinophilia				
Below 5%	14	28	6	9
6 -10 %	10	20	8	12
11 -20 %	22	44	4	6

Source: Same as Table 2.8

that in exposed garbage as many as 70,000 flies are formed in a week in 0.03 m.cub. If the garbage contains night soil, the pathogens especially enteropathogens such as shigella, salmonella, entamoeba adhere to the feet of these flies; flies alight on the food kept open and readily transmit the infection to people who eat contaminated food. Apart from the health hazards swarms of flies that haunt the houses in the vicinity of the garbage dumps is a nuisance.

2.3.8 Provision of adequate and suitable covering after dumping garbage and compacting it will prevent emergence of flies. Another advantage of covering is that flies that are already at the site are denied access to the waste. This not only prevents spread of infection through flies but also prevent continuous cycles of fly breeding on exposed wastes at the site, which is a major problem in open dumps.

2.3.9 Many parts of the cities and towns in India have open drains. Due to improper collection and lack of proper storage facilities, and solid wastes often get into drains and obstruct free flow of water through drains. Stagnant water in the drains provide ideal breeding site for mosquitoes. In the garbage dumps there are often small open cans or discarded tyres; water collects in these especially during rainy season and provides sites for mosquito breeding. Mosquitoes are vectors for several diseases including malaria, malaria and dengue fever.

2.3.10 It is essential to ensure that open drains do not get clogged with solid waste. Open cans and tyres should not be allowed to lie on the surface in dumping grounds; every day the dumping site should be covered with earth and then compacted to

prevent mosquito and fly breeding problems and their attendants health hazards, both to the workers and to the general population. If these measures are not effective, it might be necessary to temporarily use insecticides to control insect breeding.

Rodents

2.3.11 Rodents may be attracted from surrounding farms, or they may be delivered to the site in a load of wastes. They eat the food available in the garbage rapidly multiply and spread to the neighboring areas. They destroy property, bite people and transmit a variety of infections either by themselves eg. leptospirosis or through the vectors they carry eg. plague.

2.3.12 A clean, unbroken and relatively smooth surface of covering material on the dump site allows a burrow to be instantly detected and recognized. Regular inspection should be made and if the beginning of rat infestation is observed, a baiting programme should be carried out by an experienced exterminator.

Air Borne Dust

2.3.13 During long dry periods the surface of the landfill can become very dusty; air-borne dust make the working conditions unpleasant; infections and allergic disorders especially of the respiratory tract are common under these conditions. Watering on the surface may reduce this problem.

Health Hazards Due To Hazardous Chemicals

2.3.14 In India, potentially hazardous industrial wastes especially from small in-dustrial units are dumped along with mu-nicipal waste. These contaminate the municipal waste and pose health hazards. Many of these chemicals cause skin irrita-tion and respiratory problem in workers handling the garbage and transporting them to the disposal sites. In most cities the disposal sites are no more than the dumping grounds. Chemicals dumped in these leach out and can contaminate ground and subsoil water and cause major health problems. The well documented episodes of arsenic contamin-ation of water in West Bengal is but the tip of the iceberg of health hazards associated with poor management of industrial waste. There had been reports of episodes when sacks, cardboard cartons and paper envelops contaminated with chemicals packed in them were burnt in winter to get warmth and led to emanation of irritating fumes; but the magnitude of this type of problem is not known.

2.3.15 During the last decade increasing attention has been focussed on the potential genetic damage due to environmental toxins and their health consequences. Genetic ecotoxicology is defined as the study of chemical or radiation induced changes in genetic material of natural biota. Changes may be direct alteration of genes and gene expression or selective effect of pollutants on gene frequency. The magnitude or nature of health hazards associated with genetic alteration due to the presence of Toxics in environment due to industrial waste disposal practices are not yet been clearly investigated and documented. Building up such a data base should receive high priority.

2.3. 16 There is very little information on the factors affecting the health consequences of exposure to infectious waste or toxic chemicals. It is imperative that research studies are taken up to study the effect if any of the genetic and nutritional status on health consequences of exposure to these substances.

Health problems in Rag Pickers

2.3.17 Health hazards in ragpickers stem from two aspects poverty and their occu-pation. Rag pickers come from the poorest, least organised and most deprived segments of the urban population. Under-nutrition, growth retardation, anaemia, tuberculosis, bacterial and parasitic diseases are very common in Rag Pickers. These children are exploited by the middle men who employ them and buy ;he recyclable material that they pick; the dull drudgery of work under very poor working condition make them long for escape and so they often fall a prey to several evils such as gambling, drinking,

using drugs and drug trafficking.

2.3.18 Ragpickers are exposed to some specific health hazards owing to their occupation. Broadly these are:

a) Infections and Infestations from coming into contact with garbage which contains animal and human excreta, sputum dead animals and potentially infectious hospital waste dumped in refuse dumps. Infection of the skin, respiratory tract and gastro intestinal tract are reported to be more common among rag pickers than controls form the same socioeconomic group.

b) Gastro intestinal infections because of eating stale or spoilt food found in the garbage.

c) Chemical poisoning including pesticide poisoning because of coming into contact with empty containers of chemicals or using these as containers for food or water, or burning such containers as a source of warmth in winter have been reported. Several anecdotal pesticide poisoning cases have been documented in children who have used discarded pesticide tins as a glass for drinking water; lead poisoning in families where discarded lead acid battery containers were used as fuel have been documented.

d) Rat bite, snake bits, dog bite and bites and stings from other vermins and insects are common among rag pickers who scavenge in the refuse dumps.

e) Injuries, cuts and bruises of the hands and feet by sharp objects in the refuse occur frequently. If these injuries are not treated they can lead to non-healing ulcers. HBV and HIV infection as well as a host of bacterial infections may occur if they get injured by contaminated sharps from hospital wastes.

f) They have higher rates of skin and respiratory allergy because they are exposed to chemicals in refuse dumps. Of all these problems, the infections and infestation are probably the most important and widely prevalent health problems in rag pickers.

2.3.19 The most important solution to . the problem of health hazards of rag pickers is to ensure that all recyclable material is segregated at source and collected separately. The rag pickers can assist the population by collecting .all waste properly segregated in two bags/containers deposit the organic waste in collection site and sell the recyclable waste. Attempts may also be made to ensure that these children wear some affordable protective gear such as plastic gloves and covered foot wears. Improved waste collection and disposal practices in areas will substantially reduce health hazards to rag pickers.

2.3.20 Presently informal sector of rag pickers is contributing substantially to the recovery of recyclable material from urban solid waste. However, ragpickers mostly women and children live under and work in extremely unhygienic conditions. It is essential to improve the present system of collecting and utilizing the recyclable material. The rag- pickers could be organized to set up cooperatives. These workers can then collect recyclable material right at the household level; incidentally they could also collect at the same time the organic waste material from the household and deposit at the road side collection sites. This would get rag pickers the recognition that they are an essential link in urban solid waste collection and recycling system. This will also prevent health hazards associated with rag picking in the garbage dumps and provide them better working conditions and possibly better economic returns.

2.3.21 It might in the long run be worth while to attempt to organize rag pickers cooperatives, so that in addition to getting a fair wage for their work they also can benefit from the non-formal education and learn skills that will be of use as they grow older. Such a measure would, to some extent alleviate their boredom and save them from acquiring alcohol/drug habits and gambling. It is also possible that their intimate insights into the recycling trade make them the best

suited to make optimal use of the recyclable and some day their cooperatives may grow into small scale reprocessing units which are profitable and at the same time useful in reducing the burden of non-degradable urban solid waste.

2.4. Future Technological Options for Safe Management Of Urban Solid Waste In India

Innovative Pilot Projects On Urban Solid Waste Management Currently Operating/ Proposed

2.4. 1 A concept of integrated solid waste and sewerage management has been developed. This has been advocated as a feasible and viable technological option for management of wastes which is : ecologically sound, allows recycling of water, generation of compost and biogas especially in developing colonies and satellite centres. So far the techno economic feasibility of this option has not been tested out by pilot projects.

2.4.2 One major constraint in the development of satellite town has been transport bottlenecks. In this context, improving connectivity in urban areas by rapid mass transit systems, developing each satellite town as a self contained habitation with education, health care, recreation facilities should receive due attention by town planners.

2.4.3 Karnataka Compost Development Corporation Ltd., is operating a composting plant at Bangalore converting municipal solid waste into compost manure. The garbage is spread over specially prepared concrete floor, stacked into Windrows I with the help of payloaders. A specially developed slurry is sprayed to speed up the aerobic decomposition and the dumps turned over every 5 days. It is reported that it takes 30 days for total decomposition. The plant is not operating under full capacity. Non-availability of sufficient and suitable garbage is cited as a reason for its under utilisation (Annexure X).

2.4.4 Excel Industries, Bombay has developed a solid waste microbial degradation process which within few hours eliminates all odour from the waste and helps in rapid decomposition of the waste. The process is exothermic and fermentation and therefore the treated wastes become free of bacterial contamination; fly and mosquito problems are also prevented. It is reported that utilizing this technology a plant handling 300 tonnes per day (TPD) of solid waste will be economically viable taking into consideration the operating cost, transport cost and present selling rates for compost (Annexure X).

2.4.5 Anaerobic digestion is being projected as a possible alternative for urban solid waste disposal. It is claimed that 500 TPD garbage can generate 3 MW of electricity. Western Paques (India) is reported to have offered to put up plants at their cost if a municipality/corporation offers to give the following:

(i) land on long lease

(ii) the specified quantity of garbage at the site daily

(iii) agree to buy back the power generated at an agreed price.

With an estimated captive power consumption 0.5 MW in the plant, the surplus energy available for sale may be about 2.5 MW. Assuming the commencement of work by 1995, the plant will go into commercial production in 1997; the estimated cost of electricity generated will be Rs. 3/-per unit.

2.4.6 The palletisation process developed by CMC Limited is in operation in a pilot plant in Bombay (Annexure X). The pilot plant is not operating at full capacity at present. Large areas of land are required for drying the waste; the process remains to be tried out on a commercial scale. The technology for obvious reasons cannot be used during monsoon in Bombay.

2.4.7 In the pelletisation process used by Shiv Shankar Engineering, Bangalore, there is provision for substantial amount of mechanical drying which would imply that this plant could function, though at reduced efficiency, even during rainy season. The

pilot plant is only being used as a demontration plant now and is not fully operational. (Annexure X).Ucal Power Systems Ltd., Madras are planning to embark on a project in Madras for using municipal solid waste for electricity generation by a modified version of the Shiv Shankar pelletisation (Annexure X).

2.4.8 New Delhi Municipal Council has been operating a composting plant at Okhla since 1985. The plant is at present operating in single shift and is handling about 60 tons of garbage/day. The compost produced is supplied to horticultural department of NDMC; in addition it is supplied to other Governmental and private consumers, both in bulk and in retail packets. NDMC has initiated steps to run a second shift in the plant, thereby increasing its garbage handling capacity. Action for overhauling equipment which have been in use for a decade and augumenting the plant and machinery to meet the needs of the second shift have been initiated.

Recovery Of Biogas From Landfill Sites

2.4.9 The organic matter in the waste deposited at landfill sites is known to undergo decomposition anaerobically leading to evolution of methane and carbondioxide, commonly known as biogas. This biogas is usually allowed to escape from such sites resulting in potential fire and explosion hazards besides emitting foul smell. Efforts have been made to recover the biogas and utilise its energy potential at Timarpur landfill site in Delhi. The Delhi Energy Development Agency has put up a demonstration unit to recover the biogas which is used for cooking and heating purposes at Balakram Hospital and nearby staff quarters.

Present Status of Recycling System

2.4.10 Even though totally unorganized, recycling systems are well established in India mostly as a private sector unorganized effort. Newspapers, old bottles, metals are sold from or reused in households. Ragpickers sort recyclable/saleable materials from the refuse heaps/vats. Scavengers/waste collectors spend 25-30% of their time sorting saleable materials from the refuse both at the collection point and during transport. Communities living in the vicinity of the dumping site or disposal ground scavenge recyclable material for their, livelihood. Rag-pickers and waste collectors sell the assorted materials to middleman buyers who often perform some simple sorting and cleaning. Middleman buyers sell to wholesalers or big dealers and hence, back to primary industries.

2.4.11 In terms of the extent of the recycling process, India has set an example for developed countries. 250 thousand tonnes of waste paper are recycled each year, accounting for roughly l/3rd of paper production, and plans are underway to import more paper waste for recycling. Paper, plastics, glass and textiles are also reprocessed leaving virtually no recyclable material in urban solid waste. Obviously waste pickers are playing a pivotal role in this recycling system but the income of the scavengers actually depend on the middleman buyers.

2.4.12 Rag picking activity has come up spontaneously as the demand for the recycling of the waste emerged owing to the high cost of the raw materials. Waste recycling is to be encouraged and strengthened; the salvaged material is free of any material cost except the cost of collection.

2.4.13 The growing cities will have evolve their mechanism to solve waste disposal problem economically in the near future. The mounting cost of the raw material and for prevention of environmental degradation, waste recycling is important and should be encouraged and promoted at all levels. Considering these and the huge cost of waste disposal in the city, which is increasing day by day, the ragpickers theoretically contribute to the urban economy by providing the labor to cleanse the city of utilizable, recyclable material and provide material for several industries. In the light of these, the ragpickers become an •"' important occupational group and deserves

to be considered with respect, and organized.

Collection & Transport

2.4.14 The existing system of Municipal Corporations/ Municipalities arranging collection through their health/conservancy departments is not effective and satisfactory in most places. Participation by local citizens committees, NGOs and private organizations is needed for ensuring effective garbage collection and transportation. An awareness programme which will highlight all aspects of the urban solid waste management should be drawn up covering all the stages, starting from the waste generating places like residential houses, commercial establish-ments, public places and industries.

2.4.15 The need for, and the possibility of, segregating different types of waste, right at the generation points, should be emphasized. Over a period of time it should be possible to havt segregation of waste starting right at source. Apart from all other benefits this step is essential as a part of community awareness building and community participation which are essential for sustaining the efforts to ensure continued utilisation of appropriate technologies for waste disposal.

2.4.16 Pilot projects on house to house collection of appropriately segregated organic, inert, inorganic and recyclable solid i waste should be initiated.In metropolitan cities this could be taken up by a variety of agencies; municipalities can take up this activity in areas where they are already attempting house to house collection; private agencies, or NGOs local community cooperatives can all play a role in ensuring house to house collection of the garbage on a day to day basis. Separate bins, or most probably separate plastic bags will have to be used by the householders to i collect organic, inert and recyclable wastes. In many areas, existing ragpickers could be organized to take part in this house to house collection; they would get the recyclable material separated right at source without undertaking the unpleasant and hazardous task of separating and collecting recyclable material from garbage dumps. The householder would get the benefit of assured daily collection at doorstep. The municipality will benefit in term of reduction in the quantity of solid waste to be transported to the dumping site.

2.4.17 Wheel barrows, hand carts and tricycles may be used for house to house collection and for reaching the refuse to road side collection points. It is essential that each of these vehicles is provided with two separate containers so that the separated wastes from houses are transported separately and are put into the appropriate receptacle at the collection point.

2.4.18 From these collection points these can be taken by trucks to the disposal site.Manual handling should be minimized to the extent possible. The collection arrangements have to be streamlined to ensure that road side collection points are cleared daily. Tractor trailers, ordinary trucks and tipper trucks may be used to transport garbage to the disposal site. It is essential to ensure that these vehicles are covered to prevent blowing away and spillage of garbage during transport. The emphasis should be on using more of tipper trucks.

2.4.19 Surveys are to be conducted regarding peak waste dumping times of the day and convenient collection/transportation times. The optimum route for carrying the waste from various collection points to the disposal site should be scientifically worked out using well accepted principles of transport management and strictly adhered to; this would ensure both efficiency and economy in transport of the refuse. Most of the waste transportation should take place during lean traffic hours.

Technologies For Waste Disposal

2.4.20 The current practice of simply dumping of all urban solid waste collected from different locations in variety of vehicles ranging from hand carts to covered lorries in open areas identified for such purpose should be discontinued in view of the adverse health and ecological

consequences of this practice.

Sanitary Landfill

2.4.21 In most of the metropolitan cities the sanitary landfills will continue to be the major option for management of urban solid waste materials. Improvement of existing garbage dumps so that they become truly sanitary landfill sites with adequate operational control and safeguards against pollution of ground water and adjoining environment should receive very high priority.

2.4.22 It is not possible to convert the existing uncontrolled garbage dumps into model sanitary landfill centres overnight. It is essential to adopt an incremental approach where in every day some improvement is attempted which reduces the risk and improves the quality and the process is continued until the current garbage dumps are converted into proper sanitary landfill sites.

2.4.23 To begin with, the existing garbage dumps should be made to comply with some minimum essential requirements. Garbage material from the lorries should be dumped in a well-defined area, spread, and compacted by mechanical means - preferably by Bulldozers at least in larger cities. Immediately a layer of earth should be spread on the garbage and this again should be compacted. Use of bulldozers will serve the twin purposes of compaction as also spreading. The entire operation should be carried out systematically, under proper supervision with mini-mum mechanical handling. Such systematic dumping of garbage, covering it with earth and compacting it on a day to day basis will reduce fly and rodent menace. Foul smell due to decaying of organic matter will also be substantially reduced. Such a procedure would also discourage ragpickers from handling potentially contaminated garbage. Street dogs and cattle searching for food in the garbage dumps will also be minimized; all these incidentally will prevent contamination of garbage with night soil from animals and human beings. Soil contamination through leachates will still be there, but the environmental contamination will be much less as compared to the uncontrolled dumping.

2.4.24 Depending upon the local topography, the chosen landfill site might be an excavated cell/trench, a low-lying area or a canyon or natural depression. In all these sites it is essential to adopt the following precautions:

(i) Liners, usually successive layers of compacted clay designed to prevent migration of landfill gases and leachate should be used.

(ii) All the waste dumped should be compacted and covered every day with 15-30 cms of native soil to prevent insect breeding, rodent menace, cattle or dogs scavenging for food prevention of disease vectors breeding and preventing blowing away of garbage; this step would also prevent entry of water into the landfill and prevent leachate formation and subsoil water contamination.

(iii) Providing final landfill cover layer to prevent migration of landfill gas and to limit the entry of surface water into the landfill.

It is essential that environmental monitoring by analysis of gas and water samples to monitor the movement of landfill gases and leachate at landfill sites is initiated and sustained .

2.4.25 During the next few years it will be possible to develop sanitary landfill centres into bioenvironmental engineering facilities, for effective disposal of urban solid waste. These centres will be designed and operated not only with the objective of minimizing the adverse public health and environmental consequences of urban solid waste, but also as a major facility to recycle wastes as an economically viable proposition capable of becoming self sustaining in the long run.

Land fill Gases

2.4.26 Due to anaerobic conditions prevalent in landfills, the organic constituents in USW undergo slow decomposition and produce gas mainly comprising of methane (45-60%)

and carbondioxide (40-60%). The amount of gas depends upon the amount and type of organic matter, moisture content, nutrients available and the degree of initial compaction of landfill. Reported rates for gas generation ranges between 60-250 liters / kg solid waste. The gas production starts within 3 months, reaches a peak within 2 years and then slowly tapers off, continuing for many years in some cases even upto 25 years or more. This gas can be extracted through a network of bore hole pipes and utilized for thermal energy or for power generation through gas engines.

2.4.27 Efforts to improve the landfill sites will have to continue until the existing dump sites are transformed into active waste management centres. Well designed sanitary landfills constructed on the basis of sound scientific principles of waste management operated efficiently and monitored carefully on a day to day basis will ensure safe disposal of urban solid waste; in addition landfill mining for bio fertilizers, leachate collection and treatment, and biogas recovery and utilisation for energy generation can be practiced in the modern landfill center. Funding for this transformation of urban waste dumping sites into active waste management centres will not only result in prevention of health hazards associated with poor management of urban solid waste but provide an ecologically, environmentally sound and economically viable option in the long run. This type of efficient garbage disposal system will also ensure longer life of the existing landfill sites for continual garbage disposal and thus save precious urban land.

2.4.28 Total lack of land use planning in metro cities has resulted in acute shortage of land available for solid waste disposal. One of the primary tasks of today's city planner should be to identify and earmark potential solid waste disposal (SWD) sites as a part of the long term urban planning for the next 3-4 decades. As and when new townships or colonies are planned it is essential that decentralized, ecologically friendly solid waste disposal planning is done. In new townships, segregation of waste at source, privatised collection from households and transport to transfer station should be advocated. After collection of wastes recyclable wastes are to be processed, organic material should go for com-posting and the inorganic non-compostable fraction should be used at landfill sites These practices are to be initiated right from the beginning in these new townships

Composting

2.4.29 The physical characteristics and chemical composition of Indian city refuse makes it very suitable for composting and producing good quality manure and soil conditioner. Considering the need, scope, value and importance of conversion of urban solid waste into organic manure in the interest of agriculture, sanitation and health the Ministry of Agriculture provided financial support for setting up large mechanical compost plant in a number of cities during the 60s and 70s. Most of these plants failed to run profitably and almost all of them are now not operational. The major reason was the economic non-viability of the project. Careful analysis. however, revealed that unnecessary and avoidable mechanization pushed up the cost of organic manure produced while the lack of sales promotional effort on the part of municipality was responsible for the difficulties in selling the product. This programme which was based on sound principles failed mainly because of inade-quate planning, use of inappropriate tech-nology and poor management. If these mistakes are avoided , composting would represent a viable techno-economic solution to the disposal of urban solid waste in smaller cities as well as satellite towns of metropolitan cities.

2.4.30 Mechanical composting can be advocated for larger and non - mechanical for smaller towns. While assessing the suitability of composting, the areas where it has to be utilized need to be identified and a mechanism developed for delivery of the

product at affordable cost. The appropriate degree of mechanization consistent with characteristics of the waste should be used. For example, in India pulverization and magnetic separation are not required. Composting as a method of disposal of urban solid waste should receive adequate assistance and should be given due priority as it is the most suitable solid waste management procedure after sanitary landfill under Indian conditions. In smaller and medium sized towns where the quantity of solid waste is less, the existing trenching grounds which constitute a potential health hazard should be converted into manually operated Windrow composting sites. This change will result in improvement of operation and minimize health and environmental hazards associated with trenching. The local self government would require financial support initially so that this conversion takes place rapidly. This technology is the appropriate one for smaller municipalities in and around metro cities and could be adopted in future for the satellite towns which are built around metro cities. In the newer cities night soil should not be used for composting; aerobic and anaerobic culture should be used for composting. The possibility of mixing sewerage sludge with urban solid waste may also be explored in the newer colonies /satellite towns to produce a more nutritive compost product and simultaneously ensuring proper disposal of sewerage sludge.

Vermiculture

2.4.31 This is another system that is advocated for rapid conversion of waste into manure through the functioning of earth worms in specified conditions. The area required for this process is reported to be larger as compared to the dry composting. There is very little information on the usefulness of this technology in varying conditions. R&D efforts may have to be undertaken to find out appropriateness of this technology in different ecological setting.

Other Technological Options

2.4.32 Considering the acute shortage of land and the rapid increase in population and urbanization, it is essential to explore the possibility of developing methods of solid waste processing, treatment and recycling which will reduce the land requirement substantially. Some of the technologies which require consideration and R & D efforts and testing out as pilot plants are considered below.

Thermal Treatment

2.4.33 Thermal treatment include pelletisation, incineration and pyrolysis. In view of the low calorific value, the Indian urban solid waste is usually not suitable for self sustained combustion, and hence these technologies in most cases might be uneconomical. However, incineration will continue to be a method of choice for disposal of hazardous wastes including hazardous industrial and hospital wastes.

2.4.34 It has often been suggested that incineration of solid waste can be used for power generation. Experience of developed countries in this regard need be critically reviewed. The available information based on pilot projects in India also requires periodic evaluation from the techno-economic feasibility, environmental impact and economic viability. Specific R&D projects on use of incineration technology for situations with higher calorific value refuse should be supported in suitable areas. These technologies may be particularly suitable for selected urban areas where the waste may have high calorific value. Innovative methods of using the heat generated by incineration to dry the USW so that it can be readily incinerated. Co-firing with pulverized coal, wood or rice husk may be tested out in suitable sites with appropriate research projects as alternative strategies for management of USW.

Co-firing with Urban Solid Waste

2.4.35 In places where there are thermal power plants in the vicinity, using 1 0 to 35 per cent of dressed organic solid waste for co-firing with coal in thermal plants might be a worthwhile option to be tested as a

research effort. This could potentially be a useful method of getting rid of some part of urban solid waste and a fuel saving measure for the power plant. Yet another area that would require R&D efforts is the possibility of using pulverized coal or rice husk as a co-firing agent with urban solid waste in incineration and electricity generation.

Pelletisation

2.4.36 Experience with palletisation technology in this country for management of urban solid waste is meager. It is desirable to obtain detailed performance data on already established pilot plants utilizing this technology both in India and abroad. R & D efforts especially with private sector participation should be encouraged.

Pyrolysis (Gasification) of I Refuse

2.4.37 Pyro lysis is an engineering process involving thermal degradation of organic materials. When organic waste is heated in partial availability of air upto 900 degree C., it gets converted into combustible gases, aqueous mixture of organic acids and char as solid component. The product distribution between gases, liquids and char depends upon type of waste and the processing conditions of temperature and rate of heating.

2.4.38 Hot gases from gasifier can be burnt clean and used for drying of waste, or produce steam for power generation. Power generation through steam route has been reported to be an economical proposition at several MW range. The clean gases can be used for generation of power by employing conventional Diesel Generating Units. This might be an economical route for generating captive power to be used at landfill sites or active waste management facility for activities such as mechanical composting, lighting and running the gasification/pyrolysis system.

2.4.39 Liquids are produced during pyrolysis only when the gases are cooled and cleaned for their use in gas engines. These consist of aqueous and non-aqueous fractions. The non- aqueous portion known as tar can be utilized either as fuel or sold as a pigment for making black paint. The aqueous fraction has been reported to have germicidal properties and might be useful in disinfecting the surrounding areas of landfill.

2.4.40 Solid products of pyrolysis are mainly carbonaceous mixtures, which can be further gasified to produce clean combustible gases for power generation. Alternately briquette can be made using clay as binder; these may be used as smokeless domestic fuel.

2.4.41 Though theoretically pyrolysis route of recycling garbage appears to be a viable option, there are very few reports on use of this technology. It is essential to sort out and remove inorganic content (waste dressing) and use only organic rich fraction of garbage for pyrolysis.In developed countries there is no requirement of char ; in fact it is considered as a nuisance and hence pyrolysis is not widely practiced. It is possible that in India the char might be a useful byproduct as a smokeless solid domestic fuel a substitute either for firewood or charcoal.

2.4.42 There is very little information on the use of this technology in the country. R & D efforts will have to be undertaken to find out appropriate conditions under which pyrolysis could be used in urban solid waste management in the country. It is advocated that these high technology areas of solid waste disposal (incineration with or without co- firing, pelietisation and other thermal technologies) can be taken up as a R & D efforts preferably as joint sector operation in collaboration with private sector agencies. It is expected that such pilot projects would provide data on the potential of these technologies for energy generation as well as the cost and feasibility of such efforts in different settings. It has been suggested that the energy so generated may be used to dry municipal solid waste or when available on sufficiently large scale could be utilized to generate electricity which could be fed into the grid at the peak load period during the day. Results of these R & D efforts with effective private participation should be periodically reviewed by experts/research

institutes with expertise in evaluation of such projects, so that appropriate information on cost and techno-economic feasibility of different technologies through assessment by independent agencies is available.

Refuse Dressing

2.4.43 Enrichment of US W into organic constituents in dried state is imperative in order to adopt recycling technologies of incineration for power production, gasification to get combustible gases, smokeless domestic fuels and refuse derived pellets. Segregation of refuse without drying is also essential for making high grade manure by composing. Although unit under operations of size separation, screening, air classification and drying are employed. Yet these are still not effective and standardized. R & D projects to evolve an integrated system which is mechanically sound, reliable and efficient for dressing of USW from Indian cities should be carried out.

Systematic Collection And Recycling Of plastic Carrier Bags

2.4.44 The use of plastic carrier bags is increasing. Even though majority of these bags are collected by the rag pickers and are reprocessed, but still a considerable number of these bags find their way to garbage dumps and also responsible for littering everywhere. This is a common phenomenon not only in cities but has extended to small towns and villages. Apart from being an ugly sight, these bags are also responsible for choking of natural drains and other water ways. Under the existing conditions it is difficult to either ban or restrict the use of these bags or replace them with biodegradable and recyclable paper bags. If however an awareness campaign is created to ensure that all plastic bags are collected separately and given to appropriate agencies along with other material for recycling, the problem associated with plastic bags disposed in an indiscriminate fashion can be eliminated.

Financial Resource Mobilization

2.4.45 For effective implementation of the safe urban waste management technologies, adequate monetary inputs are essential. The Municipal bodies are spending a large portion of their revenue on collection and transport of solid waste; adequate attention is not being paid to the safety of these operations as well as ultimate disposal of the waste by appropriate technology . In view of this it is hardly surprising that the environmental and health consequences of poor solid waste management are increasingly felt by the urban population.

2.4.46 The benefits from the present level of expenditure itself can be increased manifold by following better methods of collection and segregation at source with community participation and efficient transportation involving appropriate technology, better management practices and motivation of workers. It is desirable to establish, a "Fund " at National level to which cities could have access for funding innovative efforts in these areas. The estimated requirement of funds for capital expenditure will be Rs. 1 71 2.20 crores for the year 1995, Rs. 2242.00 for the year 2001 and Rs. 3416.75 crores for the year 2011 (Table-2.1 1). The problem should be seen from an environment angle and not merely for getting economic benefits.

While calculating the requirement of funds for capital expenditure the following points were considered.

(i) Solid waste management services are being provided in all urban centres. However, additional expenditure will .be injured mainly to remove the inadequacies and to improve the system performance to the desired level.

(ii) The increase in population results in increased quantities and the inadequacy of the existing system increases. Hence additional funds will have to be provided.

(iii) With the passage of time the per capita quantity increases at 1 .33 percent per year and as additional quantities have to be taken care of, the cost per capita will increase.

(iv) Unlike other municipal services (like

Table 2.11
ESTIMATED REQUIREMENT OF FUNDS FOR CAPITAL EXPENDITURE

Year	Urban population (in million)	Cost/capita/year (Rs./capita/year)	Total cost (Rs. in crores)
1995	244.600	70.00	1712.20
2001	295.000	76.00	2242.00
2011	395.000	86.50	3416.75

Note:Per capita SW generation to increase @1.33% per year - The costs are based on prices as in 1995.

water supply, sewerage etc.) the items on which the capital cost is incurred in solid waste management have a short life i.e. the collection equipment has a life of upto 3 years while the life of transportation vehicles is 7 years. The equipment at the processing and disposal site and civil works will have a longer life. However, majority of the expenditure has to be incurred on the collection and transportation equipments having a shorter life.

(v) The capital expenditure to be incurred in different years has been given in Table for representative years. However for the reasons mentioned above the provision for expenditure in years between those given in the table will be more or less of the same magnitude.

(vi) In addition three major activities that require funding through the Central Sector in the remaining period of the Eighth Plan , are:

a. Human Resource Development: Rs.2 crores

b. Innovative Pilot Projects for USWM : Rs.10 crores

c. R&D Projects for USWM: Rs.8 crores

Operationalisation Of The Programme For USWM

2.4.47 Urban solid waste management falls under the purview of several departments; in order to coordinate and focus the efforts it might be essential to evolve a National Policy as well as Action Plan for Management of Solid Wastes. It is imperative that there is intersectoral coordination and adequate resource mobilisation both in terms of funds and in terms of well trained manpower to carry out the programme in order to improve waste management and minimise environmental and health consequences of poor waste management in rapidly growing urban areas . This could be attempted as a Mission Mode Project with different departments developing closely interlinked Mini Missions. However in this approach it might be difficult to assign appropriate priority between competing activities, and provide adequate financial support . Alternatively Urban solid waste management may be taken up as a Centrally Sponsored Scheme with earmarked funding, both in the Central and State plans; the budget support for R&D and Pilot/ Demonstration programmes may have to be supported by Central funding.

3. INDUSTRIAL SOLID WASTE MANAGEMENT

3.1 Introduction

3.1.1 The industrial solid wastes can be broadly classified as non-hazardous biodegradable and non-biodegradable wastes and hazardous wastes. By far the largest proportion of industrial wastes consists of rubbish from production processes, office waste, and possibly garbage from worker canteen. The rubbish includes floor sweeping, rags, discarded cardboard and wooden packaging materials, broken glass, metal offcuts, and swarf, while the office waste is mainly paper and cardboard. Food firms can give rise to appreciable quantities of organic waste (stale or contaminated food). Slaughter houses generate a large volumes of highly odorous and potentially infected animal wastes.

3.1.2 Industrial wastes can be hazardous or non-hazardous depending upon the industry. Hazardous and non-hazardous solid wastes from large industries in urban area can be identified and their safe disposal can be ensured. However, there are several problems in identification , segregation and safe disposal of waste generated by large number of small scale and house hold units. These industries are difficult to identify and monitor. Very often their wastes get dumped the nearest waste collection depot, enter into the common urban solid waste disposal system and may produce harmful and toxic effects.

3.2 Nature And Quantum Of Industrial Solid Waste

3.2.1 Some of the major non-hazardous industries in the urban areas producing substantial amount of solid waste and their current waste disposal practices are described below.

Biodegradable Wastes

3.2.2 Cotton textile mills produce large amounts of cotton dust in the cotton blowing section of the mill. It is estimated that about 20,000 - 30,000 tonnes of cotton dust is generated in the country every year. The waste consists of unrecoverable cotton fibers and broken seeds. The sieve analysis of waste has shown that 54% of the material to be finer than 0.707 mm, 13% between 0.707 and 2 mm, and remaining of a size larger than 2 mm. The waste is non-hazardous and is usually disposed off with other sweepings, used as fuel in boilers, as inexpensive filling material in quilts and blankets, or for the preparation of compost.

3.2.3 Paper mills in India produce a lot of nonhazardous solid waste . The nature of solid waste generated in paper mills depends on the raw materials used in different units/processes in the plant. In India bagasse is used in combination with wood, for the manufacture of paper. All solid wastes from paper mills are biodegradable or recyclable and are non hazardous. They can be disposed either with the urban solid waste or be incinerated in view of their combustible nature and good calorific value.

Non-Biodegradable Wastes

3.2.4 Refineries, steel mills and thermal power plants are some of the major industries producing solid npn- biodegradable wastes of non-hazardous type in urban areas. The waste from refinery operations can be grouped as:

- Inert dry solids, e.g. Trash, silt and spent catalyst
- Combustible dry solids, e.g. Trash, Waste paper
- Sludges from water treatment plants
- Sludge containing solids, oil and water from effluent treatment plant
- Sludge containing oil, e.g. spent clay, and storage tank bottom

3.2.5 When the sludges containing solids and water come in contact with oily water, solids get coated with oil. It desirable to avoid this situation. Sludges should not be allowed to flow in oily water drains but dewatered in sludge thickeners and ponds. The quantity* and composition of sludges

depend on the crude which is used in the refinery. The treatment of effluent water also generates sludges. The large quantity of sludge generated by refineries is stored in specially constructed sludge lagoons and then disposed off on land. The land disposal of oily sludges is normally practiced in all the refineries in the country. Studies carried out at NEERI showed that oily sludges are biodegradable to a large extent and optimum temperature for biodegradation is 28 - 30 degree celcius. Large groups of oil degrading micro- organisms attack the different hydrocarbons present in the oily sludges and reduce the pollution load.

3.2.6 Steel plants produce solid wastes in the form of slag and dust. The amount of slag and dust produced is about 500 kg and 25 kg, respectively per tone of pig iron produced from blast furnaces. Pig iron is converted to steel through open hearth furnace or oxygen furnace producing about 22 kg of dust per tonne of steel.

3.2.7 A portion of the dust is used by recycling through sintering plant. The blast furnace slag can be recycled in many ways.

(i) Air cooled slag can be used as aggregate for portland cement concrete (replacement of gravel upto 30 - 40%)

(ii) When slag is cooled in controlled quantity of water, a porous light product is obtained which is crushed, graded and used as light weight aggregate for concrete.

(iii) When cooled in large quantity of water, granulated slag (slag sand) is obtained which is usable in cement and glass manufacture

(iv) The slag can also be used as aggregate for road construction and trickling filter media in waste treatment plants

(v) Crushed and graded slag can also be used as insulating material

3.2.8 Thermal power plants, using coal for combustion in boilers, produces a fine residue known as fly ash. The ash content of Indian coal ranges between 25% and 40%. About 40 x 10 tonnes per year of fly ash is generated from the coal fired thermal power plants. The bottom ash, which is about 20% of the fly ash, is slur ried in water and allowed to flow through pipes. The fly ash is collected in dry form. The fly ash has a density of 29 tonnes/m i.e. one tonne fly ash requires 0.035 m area. Fly ash is used in the manufacture of cement and bricks depending on the carb-on content.

Solid Waste From Hazardoui Chemical Jn-duttriet

3.2.9 Chemical industry is the fourth largest manufacturing industry in India and as per estimates in 1 991 it accounts for 10% of the GNP amounting to Rs.20,000 crores per annum. India has experienced a five fold increase in industrial production in the last three decades and at present:

(i) 4000 medium and large chemical industries are in operation

(ii) Alkali industries have grown ten fold since 1947

(iii) Dye-stuff production has increased 2.5 folds between 1975 and 1989

(iv) Total installed capacity of pesticides manufacture is 78,000 tonnes per annum and many of them have toxic pesticide in high concentration

3.2.10 Hazardous chemicals may be generated as waste products from large, medium or small scale chemical industries. The last category is by far the largest in number and are most difficult to identify and monitor. In developing countries, like India environmental protection laws are not stringently enforced. There is very little information on the type or quantity of hazardous chemicals generated as solid wastes from small factories and large industrial complexes. These wastes especially from very small scale industries are dumped surreptitiously in the nearby waste dumps and pose substantial health risks not only to those who are occupation-ally

exposed but also to the general population.

3.2.11 The industrial processes employ hundreds of chemicals and many of these wastes can enter the body through skin or respiratory Tract and cause serious health problems. They can also cause ground water pollution by leaching from dumping sites. No systematic assessment of the quantity and pollution potential of hazardous waste has so far been made in India, only small scale studies have been undertaken by some State Pollution Control Boards, DOEn, NPC and NEERI. Some of the small scale industries and type of solid wastes generated by them are given in Table-3.1.

Types of Wastes Generated

3.2.12 In chemical industries with no effluent control, the main toxic wastes are likely to be waste lubricating oil, cutting oil, small amounts of organic solvents and empty containers with small amounts of concentrated acids and alkalis, organic solvents, oxidizing agents they had contained. Tanneries give rise to flesh and

Table 3.1
HAZARDOUS WASTE IN SOME SMALL SCALE INDUS TRIES

	INDUSTRY	BROADLY HAZARDOUS WASTES
1.	Electroplating and metal finishing shops	Plating and cleaning bath have hazardous solid constituents of asbestos, chlorinated hydrocarbon, cyanide, arsenic & heavy metals like chromium, nickel, copper, cadmium and zinc.
2.	Engineering workshops and Automobile Workshops	Solid wastes contain mixed heavy metals, heavy oils rags, cyanides and flammable solvents, soaked rags.
3.	Storage battery &Repair shops	They produce sedimentary sludge containing high percentage of Lead Sulphate and other Lead compounds.
4.	Foundries	The sludge is mostly inorganic but contain heavy metals like Lead, Zinc.Copper.Manganese, Nickel, Chromium as we 11 as Iron.
5.	Textile dying & processing	These industries are notorious formore liquid pollutant than solid wastes but do produce solid waste as filter cakes etc. containing harmful chemicals of various types.
6.	Paint & Allied products	Paint waste containing metal oxides and other organic components.
7.	Petroleum product refining	Acid & Alkali sludge and contaminated mobile oil filter clays.
8.	Inorganic chemical processing	Inorganic pigments and soluble & insoluble salts process sludges containing harmful heavy metals.
9.	Organic chemicals	Filter cakes and sludges containing toxic organic compounds like pesticides industrial organics etc.
10.	Pharmaceuticals	Wastes normally are contaminated with filter cakes, filter papers, carbons with halogenated & non-halogenated solvents, etc.
11.	Leather tanning & finishing	Sludges from treatment tanks have trivalent Chromium, Lead, Zinc & Copper

cuttings contaminated with sulphide and hide chromium salts. In paint industries some parts of paint wastes may not be discharged with the waste waters and hence would require disposal as a sludge. Large quantities of really toxic materials are unlikely to be generated as wastes in chemical industries, although contaminated or off-specification raw materials discarded as wastes may occasionally require safe disposal . In chemical industries implementing effluent control measures, the occurrence of lubricating oils, cutting oil, organic solvents (both inflammable and chlorinated ones), and paint wastes would increase substantially. In addition, depending on the nature of the industry, there could be plating liquors or sludges from metal finishers containing cyanides and cadmium, chromium, nickel and copper salts, sludges from the treatment of textile dyeing wastes can contain toxic dyes and heavy metals; varying quantities of concentrated acid or alkaline wastes are waste products in many chemical industries.

3.2.13 Thus industrial solid waste can contain a large number of both organic and inorganic chemicals which may have a wide range of toxic effects on many life forms. Some of the chemicals like lead, arsenic, cadmium, mercury and pesticides particularly organochlorines, can cause serious health problems. The toxic effects can be acute and at times fatal; but more often prolonged exposure at a lower dose occur; It has been shown that these chemicals have many carcinogenic, mutagenic and teratogenic effects. Being largely non biodegradable, the management of such wastes pose special problems.

Inflammable and Explosive Waste

3.2.14 Inflammable hazardous wastes are also identified as hazardous chemical wastes. The dual grouping is necessary because of the high potential hazard in storing, collecting, and disposing of flammable wastes. They in addition should also be considered as hazardous chemicals. Explosive hazardous wastes are mainly ordinance materials and the wastes resulting from ordinance manufacture. Some industrial gases are also included in the group. Though inflammable wastes may be in liquid, gaseous, or solid form, but most often they are liquids. Typical examples include organic solvents, oils, plasticizers and organic sludges.

3.2.15 Inflammable and explosive wastes are usually not the concern of urban 'solid waste management. However, the presence of inflammable and explosive substances even occasionally can cause serious accidents. In politically troubled regions with upsurge of terrorist activities the waste dumps have also frequently served as dumping sites of explosive articles, placed either intentionally or unintentionally. Explosions in waste dumps have caused serious injuries and deaths of poor children playing in the dumps, ragpickers and the civic staff employed in waste picking. Public education of the dangers of these risks are essential so that children and unauthorized persons do not pick up suspicious objects from dumps; this will to some extent reduce the risks.

Slaughter House Wastes

3.2.16 Waste from slaughter houses consist of fat, rumen and casing content, as well as the semi-liquid manure and blood. This waste is estimated as about 10% of the live weight of the animal, of this 1 5% waste has volatile solid content. The waste may contain potential pathogens and have to be handled in a way so that there is no accidental spread of infection either to the workers or to the general population living in the vicinity.

Quantum Of industrial Solid Waste in Cities

3.2.17 It is estimated that the industrial waste generated in major cities are of the same order as the total domestic waste generated in the metropolitan area. There are however substantial difference in the contribution of industrial waste in different

locations of the city. For obvious reasons industrial and commercial areas generate lot more industrial solid waste than residential areas. The quantity of waste produced per year by one employee varies considerably from one industry to another. It is dependent upon many factors, including number of shifts, degree of automation, and the production process. It is difficult to assess quantities of waste generated under different conditions in the same industry and between industries.

3.3 Current Practices Of Industrial Solid Waste Management

Collection And Transport Of Wastes

3.3.1 Manual handling of industrial waste is the usual practice in developing countries; there are very few mechanical aids for waste management. Wastes are shovelled by hand into storage containers and loaded manually onto lorries. The people undertaking salvaging do so mainly by hand, picking out useful items, usually not even wearing gloves. Although there may not be a health risk in handling clean waste paper, people handling or salvaging waste without protective clothing are at risk when waste is mixed with chemicals. Apart from the likelihood of cuts caused by broken glass or sharp metals, sorting through waste contaminated with hazardous chemical materials could cause skin burns, excessive lacrimation, or even loss of consciousness; chronic hazards include respiratory problems from dust inhalation, and potential carcinogenicity from toxic chemicals present in discarded containers or surface deposits on other waste. Personnel handling waste from tanneries or hide processors may also be exposed to such diseases as anthrax. These precautions will reduce and minimize hazards associated with manual handling of industrial wastes. Personnel handling hazardous wastes should wear appropriate protective clothing. Mechanical methods for handling waste should be adopted wherever possible, and people should be educated about the dangers of manual handling of hazardous waste.

Storage & Transportation

3.3.2 The storage of industrial solid waste is often one of the most neglected areas of operation of a firm. Very little attention is paid to proper storage and heaps of mixed waste piled against a wall or on open ground are a common sight in many factories. Concrete bays or disused drums are also often used for storage. Sludges originating from holding tanks or interceptors do not present storage problems; no separate sludge storage is required, because the sludge is retained in the tank until sufficient quantities are collected.

3.3.3 Waste is rarely covered, protected from vermin or pretreated in any manner. There are no restrictions on .access and employees are often encouraged to sort through the waste and take away any useful material or articles they find. Waste is regarded as an unwanted product by firms and very often no senior person is assigned for its control.

3.3.4 Transportation of industrial wastes in metropolitan areas of developing countries is generally not by purpose-built vehicles such as skip-carrying lorries, but by open trucks. The wastes are not covered during transportation. It is typical for a firm not to have any standing arrangements with one contractor, but to allow collection by whoever is the contractor quoting lowest rates. It is rare for special arrangements to be made for hazardous wastes; they are usually collected together with the other wastes. Contractors who carry hazardous waste do not need to be licensed, and consequently, there is little control over either the types of firms engaged in carrying hazardous waste or the vehicles used. Drivers are not given a list of precautions to be taken; there is no manifest or labeling system of wastes during transport. Fly-tipping is often prevalent and wastes are often taken to disposal sites inappropriate for the type of waste concerned.

Disposal of fed us trial Solid Waste

3.3.5 Industrial waste, whilst presenting the same disposal problems as domestic waste, also contains hazardous waste, thereby exacerbating the difficulties of disposal. Fortunately, the types of industrial wastes generated in a municipal area of a developing country are such that there are not usually large quantities of particularly hazardous wastes for disposal. In the past there has been little control over the disposal of industrial wastes; indeed, it has only been during the last decade that even developed countries have brought in legislation to curb the uncontrolled and environmentally unacceptable practices that were widespread previously. Without this legislation disposal is almost always by uncontrolled landfill at sites which often pose a threat of water pollution due to leachates. Some of the existing methods for disposal of hazardous solid waste is given in Table-3.2.

3.4 Health consequences Of Poor industrial Waste Disposal

3.4.1 The solid waste generated from industrial sources contains a large number of chemicals, some of which are toxic. The waste is considered toxic, if the concentration of the ingredients exceeds a specified value. Although the levels of some ingredients may occasionally exceed the permissible level, the waste as such is considered to be toxic only if the average value of ingredients exceeds the toxicity level. Various criteria and tests have been devised by different agencies to determine the toxicity of a given substance. It is necessary to know the properties of the waste so as to assess whether its uncontrolled release to the environment

Table 3.2
HAZARDOUS WASTE DBF OS AL PRACTICES IN INDIAN CHEMICAL INDUSTRIES

Product	Quantity & Nature of Solid Waste	Mode of Disposal
Petrochemical waste	Biological sludge, oily sludge & other solids	All sludges and solid wastes from plantare collected & sent to a disposal site outside the factory
Orthochloro aniline	300kg/t Product (resinous mass containing Polymeric chloroamines	Open pit burning
Ethanolamine	Poryethanolamine sludge 5kg/t and ethanolamine sludge 250 kg/t product	Contained in drums & stored underground/ disposed off by incineration
Paints, Varnish, Lacquers	1.5 kg/t product - floor cleaning filter sludge containing phthalic anhydride TiO2 chromes, pigments, etc., & 5 TPA of redundant or date expired paint	solid waste is collected at point of generation in barrels & given to contractor for disposal. Date expired paints are sold to different parties Waste treatment sludges are disposed off along with other solid wastes
Naphthalene based dye intermediates, H-acid, C-acid, peracid	9 tonnes/day consisting of gypsum cake & Iron powder contaminated with organics	Manually collected & disposed in low tying areas.

Source: Hazardous waste scenario in India, Journal IAEM, vol.18, 49-58,1991

would lead to toxic effects on humans or other living organism in ecosystem. This evaluation is carried out using criteria such as toxicity, phytotoxicity, genetic activity, and bio-concentration. The potential toxic effects also depend on quantity of the toxic constituents. Substances are classified as hazardous or otherwise depending on the dose, exposure, and duration of exposure.

3.4.2 For a chemical to affect human health it must come in contact with or enter the human body. There are several ways in which this can happen.

Skin contact: Chemicals that cause dermatitis usually do so through direct contact with skin. Some chemicals like corrosive acids can damage the skin by a single contact while others, like organic solvent, may cause damage by repeated exposure.

Inhalation: Inhalation is the most common source of workplace exposure to chemicals and the most difficult to control. Air pollutants can directly damage respiratory tract or gets absorbed through lung and cause system/systemic effects. An adult male will breathe about 10 cubic meters of air during a normal working day.

Ingestion: Ground water and sub soil : water contamination from leachates from refuse dumps, and poorly managed landfill sites can result in ingestion of toxic chemicals by population groups who live far away from the factory sites and decades after the dumping.

3.4.3 There are very few Indian studies on specific health problems resulting from accidental exposure to toxic industrial solid waste. All India Institute of Hygiene and Public Health has documented high arsenic content in water following uncontrolled discharge of arsenic containing industrial wastes in West Bengal. There had been reports that sacks, cardboard cartons and paper envelopes contaminated with chemicals packed in them were burnt and the irritating fumes from these caused respiratory problems. There had also been reports of skin or respiratory irritation following exposure to corrosives chemicals. There has been no efforts to systematically investigate and obtain reliable epidemiological data on health consequences of exposure to hazardous industrial wastes in different States.

3.4.4 Waste from slaughter house is potentially infectious and hence should be treated as hazardous waste All precautions to ensure that potential pathogens do not gain a foot hold in the workers in the slaughter house and in the general population, have to be taken during collection, storage and disposal of the slaughter house waste.

3.4.5 Wastes from nonhazardous industries can at times produce health problems not only among the workers and handlers of waste but also general population. One example of this category is the cotton dust. Cotton waste are generally non hazardous; however they may, in susceptible individuals provoke respiratory allergic reactions; allergy may be due to inhalation of dust containing cottons wastes or fungus or other contaminants in the waste dust.

3.5 Future Technological Options For Management Of Hazardous Industrial Waste

Collection, Storage and Transport

3.5.1 The unsatisfactory state of storage of hazardous wastes can be remedied to a large degree by such low-cost measures as restricting access, fencing off the storage area to minimize any wind-blown nuisance, providing separate covered storage for putrifiable or hazardous wastes, and ensuring regular and frequent collection.

3.5.2 There are certain measures a municipal authority can take to control the transportation of industrial wastes, even if it does not want to become actually involved itself. For instance, contractors should be licensed to ensure only technically competent and environmentally aware ones; are allowed to handle industrial wastes. Labeling and coding of hazardous waste load can be made mandatory so that in the event of an accident, the emergency services

know how to handle a spillage. Municipal authorities can be given the responsibility to monitor the contractors to minimize cases of fly-tipping and ensure that industrial wastes are disposed at the appropriate sites.

3.5.3 If a municipal authority can also collect industrial waste; industries will pay the charge which will be based on the quantity and nature of the waste. This might minimize the quantity of waste produced by industry and at the same time the programme financially viable and self sustaining. The principle 'the polluter pays' should be adhered to in all cases.

Disposal Of Hazardous Industrial solid Waste

3.5.4 For thousands of years, man has disposed the waste products in a variety of ways, the disposal method might reflect convenience, expedience, expense, or best available technology. There were no major ecological or health hazards associated with these practices until the last century. Explosive increase in the amount of chemical waste produced and the indiscriminate dumping of hazardous industrial waste in the last few decades has created health and ecological crisis in many areas of the world. In many instances, leachate from the wastes dumped by one generation haunts the later generation in the form of ground water and subsoil water contamination. The recent discovery that of volatile organic chemicals from landfills and industrial disposal ponds is disturbing because many of these chemicals are known or suspected carcinogens and are not removed easily by natural geochemical processes.

3.5.5 The risk of the contamination of groundwater supplies due to leachates from landfills depends on several factors: toxicity and volume of the contaminant generated at each site, the nature of the geologic medium underlying the site, and the hydrologic conditions dominant in the area.

3.5.6 In the past, the least expensive and most widely used waste management option for both municipal and industrial waste has been the sanitary landfill, where wastes are compacted and covered with earth. In any geographic area other than arid zones, the fill is subjected to percolating rainwater or snowmelt, which eventually flows out from the bottom of the landfill site and moves into the local groundwater system. Leachate is a liquid that is formed as infiltrating water migrates through the waste material extracting water-soluble compounds and paniculate mater. The mass of leachate is directly related to precipitation, assuming the waste lies above the water table. Much of the annual precipitation, including snowmelt is removed by surface run off and evaporation; it is only the remainder that is available to form leachate. Since the landfill cover to a large extent and controls leachate generating, it is exceedingly important that the cover be properly designed, maintained and monitored in order to minimize leachate production. Fortunately many substances are removed from the leachate as it filters through the unsaturated zones, but leachate may pollute groundwater and even streams. These leachates, can contain large amount of inorganic and organic contaminants. At some sites, the leachate is collected and treated. But even in the best engineered sites, some leachate escapes into the groundwater system because no permanent engineering solution has been found to isolate the leachate completely from the groundwater.

3.5.7 It is now recognized that the interaction between leachate and soil are actually very complex and depend both on the nature of soil and on the leachate. When leachate percolates through solid wastes that are undergoing decomposition, both biological materials and chemical constituents are picked up. Recent research in the U.K have, however, shown that chemical and biological phenomena in landfill such as micro-biological process; neutralization; precipitation and complexation; oxidation and reduction; volatilization; ad sorption reduce the quantity and quality of polluting leachate from landfill site and achieve some

degree of on-site treatment or immobilization. In spite of all these leachate often pose severe disposal problem at a landfill site. Two of the most economic but efficacious purification methods are spraying over grassland or percolation through an aerobic bed of sand or gravel.

3.5.8 In general, it has been found that the quantity of leachate is a direct function of the amount of external water entering the landfill. In fact, if a landfill is constructed properly, the production of measurable quantities of leachate can be eliminated. When sewage sludge is to be added to the solid wastes to increase the amount of methane produced, leachate control facilities must be provided. In some cases leachate treatment facilities may also be required.

3.5.9 The pollution of static water ditches, rivers or the sea can occur when a sanitary landfill adjoins a body of water. The normal source of the leachate causing this pollution is rain falling on the surface of the fill, percolating through it, and passing over an impermeable base to water at a lower level. The quantity of leachate can be substantially increased when upland water drains across the site of the landfill, but the worst case is when a stream crosses the site. The solutions to these problems lie in appropriate site engineering such as:

(i) diversion or culverting of all water courses which flow across the site,

(ii) diversion of upland water by means of drainage ditches along appropriate contours,

(iii) containment of leachate arising from precipitation by the construction of an impermeable barrier where necessary, such as a clay embankment adjoining a river,

(iv) grading the final level of the site so that part of precipitation is drained across surface, thereby reducing percolation below the level needed to produce a leachate.

3.5.10 Works of this nature will obviously add to the cost of a sanitary landfill project. However, when capital expenditure is spread over the life of the project, the cost/ton of waste disposed might be less than for any alternative method of disposal. Furthermore, some of these forms of expenditure, such as culverts or river walls, represent capital assets of continuing value when the reclaimed land is handed over for its final use, perhaps for agriculture or recreation.

3.5.11 Incineration of hazardous industrial waste has been advocated in developed countries. Guidelines for safe incineration of hazardous chemical waste these have been drawn up by US Environmental Protection Agency. Incineration of hazardous waste is a process requiring sophisticated expensive incinerators and a high degree of technological expertise for satisfactory operation. The capital cost of incinerator is high, especially if it is intended for hazardous wastes and gas-scrubbing equipment is required. Some wastes such as oils and organic solvents can be readily treated by incineration. If financial constraints come in' the way of purchasing sophisticated incinerators then the utilisation of open pit incinerator under careful technical supervision can be considered as an option. Some of the preferred options for management of hazardous industrial waste is given in Table-3.3.

Table-3.3

PREFERRED OPTIONS FOR HAZARDOUS SOLID WASTE STORAGE, TREATMENT AND DISPOSAL

Waste	**Storage**	**Treatment/Disposal**
Boiler Ash Spent Solvent	Collected separately Collected in drums & stored on site	Brick manufacturer Incineration is advised for non-halo-genated solvents.
Effluent	Dried on sand	Landfills
Treatment Plant Sludge	(sludge drying) bed	
Tarry residues	Collected in drums & stored on site	Incineration with offgas monitoring for products of incomplete combustion especially dioxin
Spents activated carbon & solid residues having high calorific values	collected in bags on site	Incineration with off-gas monitoring for products of incomplete combustion especially dioxin
Contaminated metal oxide sludges	Stored in lined pond	Secure landfills with impervious clay soil

Source: NEERI Re ports.

4.HOSPITAL WASTE MANAGEMENT

4.1 Introduction

4.1.1 Hospital wastes have always been considered as potentially hazardous and there was due emphasis on safe collection storage and disposal at site to minimize if not eliminate the health hazard. The major identified hazard was that of infection, because over millennia communicable diseases had been the most common cause of morbidity and mortality in the community and majority of persons receiving treatment in the hospitals were suffering from communicable diseases. Disinfection right at source and disposal by incineration which completely destroyed micro-organism of all types has been the time tested and most widely advocated method for safe management of hospital waste. The advent of antibiotics led to complacency regarding infection control and safe disposal of hospital waste. The rising prevalence of HBV and HIV infection in the community, and among health care providers has led to an increasing awareness about the risks associated with this lackadaisical practice and the need to evolve and implement strategies for safe, and sustainable methods of disposal of waste material generated at different sites in health care delivery system.

4.1.2 Over the second half of the present century, there had been tremendous changes in the disease profile in the community, as well as drugs and technology used for management of diseases in the health care systems. In the hospitals and research establishments a wide variety of drugs including antibiotics, cytotoxic drugs, corrosive chemicals and, radioactive substances are being used for a variety of purposes. All these become a part of the hospital waste. It is essential that effective methods for safe collection, storage and disposal of all these are evolved and implemented.

4.1.3 In the allopathic system, apart from the major hospitals, patient care both in urban and in rural areas is being provided in small hospitals, out patient clinics, nursing homes, subcentres, and at patient's own home . Substantial number of persons also receive health care from the practitioners of indigenous systems of medicine. A substantial proportion of waste material related to patient care some of which are likely to be hazardous is currently being generated in the small relatively unorganized sector of health care. Most of the practitioners in these sectors tend to dump patient care related waste in the nearest garbage dump. This practice could result in the contamination of the entire garbage in the collection site, in the transport vehicle; and in the disposal site.

4.1.4 It is therefore essential that appropriate, affordable and safe methods of disposal of waste generated during patient care is evolved and tested out; proven strategies for safe and sustainable methods of waste disposal at different sites of health care delivery can then be implemented vigorously. Awareness creation holds the key to success in this effort; the general public, all health care seekers, health care providers, public health experts, policy makers and programme managers should be aware and consistently discharge their duties to achieve this effect.

4.2. Nature And Quantum Of Hospital Waste

Type of Health Care Facilities in India

4.2.1 During the last five decades a vast infrastructure has been developed to take care of the health and family welfare needs of the population both in the Governmental and in the private sector. Three major categories of health care facilities exist in India:

i) The largest in number are the small purely outpatient facilities. These are called clinics or dispensaries in the private sector. In the public sector the Sub-centres manned by the Auxiliary Nurse Midwife (ANM) is the most peripheral health facility in rural areas; some of the Primary Health Centres (PHCs) also have only outpatient facilities. In urban areas dispensaries, mobile dispensaries and health and family welfare posts provide outpatient

care in the Govt. sector. In addition to these allopathic outpatient services, practitioners of Indigenous System of Medicine and Homeopathy belonging to governmental and private sector also provide patient care mainly as out -patients.

(ii) Outpatient and inpatient care is provided in some of Primary Health Centres and small private nursing homes. The network of Community Health Centres with 30 or more beds is the most important peripheral health facility that provides inpatient care in rural areas.

(iii) The next tier of hospitals ranging from sub-divisional and District hospitals, medical college hospitals, speciality hospitals and super speciality hospitals in public sector and similar hospitals in private sector both inpatient and outpatient care. Bed strength in these hospitals range from 30 to over 1000.

4.2.2 In this vast network of health infra-structure in the Government sector and private sector (Tables 4.1-4.5), catering to the health care needs of the population, the large hospitals are relatively small in number while the small outpatient care providing centres outnumber all other facilities . All of these facilities generate wastes which require safe disposal.

Table 4.1

RURAL HEALTH SERVTCES

	As on 1.4.92	8th Plan Target
Sub-Centres	131464	17030
Primary Health Centres	20719	4450
Community Health Centres	2193	1269

Source: Annual Plan 1993-94

Types Of Wastes From Health Care Systems

4.2.3 Several terms are currently in vogue to describe patient care related waste products. The most commonly used term is hospital wastes which means all waste coming out of hospitals. It is estimated that in most health

Table 4.2

NO. OF HOSPITALS AND BEDS IN RURAL & URBAN AREAS

(As on 1.1.92)

	Rural		Urban		Total	
	Hospitals	Beds	Hospitals	Beds	Hospitals	Beds
Total No (In all States & UTs);	3568	126474	7606	515729	11174	642103

Source: Health information of India 1992, Ministry of Health & Family Welfare.

Table 4.3
NO. OF DISPENSARIES & BEDS IN RURAL URBAN AREAS
(As on 1.1.92)

	Rural		Urban		Total	
	Dispen-saries	Beds	Dispen-saries	Beds	Dispen-saries	Beds
Total No.	11670	13133	15761	8799	27431	21932

(In all States & UTs)

Source: Health information of India 1992, Ministry of Health & Family Welfare.

Table 4.4
NO. OF HOSPITALS & BEDS ACCORDING TO OWNERSHIP
(As on 1.1.92)

Government		Local Bodies		Pvt&Voluntary Orgns		Total	
Hospi-tals	Beds	Hospi-tals	Beds	Hospi-tals	Beds	Hospi-tals	Beds
4411	411868	346	23347	6417	206888	11174	642103

Source:Health information of India 1992, Ministry of Health & Family Welfare

Table 4.5
NO. OF DISPENSARIES & BEDS ACCORDING TO OWNERSHIP
(As on 1.1.92)

Government		Local Bodies		Pvt&Voluntary Orgns		Total	
Dispen-saries	Beds	Dispen-saries	Beds	Dispen-saries	Beds	Dispen-saries	Beds
8587	13378	2481	1617	16363	7063	27431	21032

Source: Health information of India 1992, Ministry of Health & Family Welfare.

care settings, about 85% of the waste generated is non-hazardous , about 10% infectious wastes, and 5% non-infectious but hazardous wastes. The term Medical wastes is used to describe any waste which is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological. Clinical wastes is defined as any waste coming out of medical care provided in hospitals or other medical care establishments. This definition does not include medical wastes resulting from medical care in the home. Pathological wastes include human tissues, organs and body parts and body fluids that are removed during surgery or autopsy or other medical procedures, and specimens of body fluids and their containers. Infectious wastes include all kind of wastes which may transmit viral, bacterial or parasitic diseases. In addition to infectious medical wastes it includes infectious animal wastes from laboratories, and veterinary practices.

4.2.4 It is essential to realize that the 'non hazardous waste' similar to household waste consisting mainly of kitchen waste products and excreta forms over 85% of all hospital waste. This waste has to be segregated at source and disposed through the usual channels of household waste disposal. It is essential that this waste is not allowed to get mixed with potentially hazardous waste.

Hazardous Wastes

4.2.5 There are two broad categories of hazardous waste: potentially infectious and potentially toxic.

I. Potentially infectious waste from patient care include:

(a) Dressings, swabs, contaminated with blood/body fluids.

(b) Laboratory Waste including Laboratory samples, Cultures stocks of infectious agent, Laboratory Glassware.

(c) Instruments used in patient care: These range from diagnostic equipment such as endoscopes, ultrasound probes, Syringes

and Needles, Sharps and Other instruments

(d) Potentially infected materials: Placenta, tissues, tumors, organs or limbs which are removed during surgery.

(e) Potentially infected animals - used in diagnostic or research studies.

In all these wastes the major concern is to prevent potential accidental transmission of infection.

II. Potentially toxic wastes include:

(a) Radio-active waste: These may be solids, liquids and gases used for analytical procedures, body organ imaging and tumor localization, and treatment. Both use and disposal of radioactive wastes should be carried out with great care. In India the responsibility for ensuring safety with respect to use and disposal of radioactive materials is with the Bhaba Atomic Research Centre.

(b) Chemical waste: These may be hazardous -toxic, corrosive, flammable, reactive or genotoxic. They require safe disposal which will ensure that human or environmental problems do not arise during storage, transport and final disposal.

(c) Pharmaceutical agents: These may enter hospital waste because there was surplus stock, spillage or contamination was detected or expiry date has been over. Apart from the usual care needed for safe disposal of these chemicals, special attention has to be paid to ensure that they do not get recycled and are disposed off in a manner that there is no ecologically undesirable side-effects.

Quantum Of Waste

4.2.6 The quantum of waste generated will vary depending upon the type of health problem, the type of care provided and the hospital practices. There are no reliable figures available on the quantum of waste generated per person/day either in outpatient or inpatient care in Indian hospitals. Available data from developed countries indicates that even in these countries there is a wide range of waste generated; 1 to 5 Kg of solid waste per head per day. There are substantial inter country and inter speciality

differences in the quantum of waste generated. Available meager data on quantum of waste generated in some developing countries indicate the range is essentially similar, but the figures are substantially lower than the figures from developed countries. It is estimated in developing countries that most in-patient may generate between 1-2 Kg of waste.

4.2.7 Waste generated in developing countries contain much less disposable articles and plastics than wastes generated in developed countries. The differences are partly due to differences in use of disposables in health care and partly due to life styles of the population.

4.3. Current Practices Of Hospital Waste Management

Management Of Non-hazardous Waste

4.3.1 Since the general wastes coming from hospitals are no more hazardous than normal domestic wastes, they are being handled and disposed of in the same way as domestic wastes. Paper and packaging waste, containers and food waste from hospitals are often sold to merchants for recycling. This practice may pose no problems as far as the general waste is concerned, but there may be problems if the staff who arrange these transactions are tempted to increase their income by selling materials that should be treated as hazardous. For this reason, it may be preferable that all trading -of wastes should be done officially and in a tightly controlled way.

Hazardous Waste - Segregation at Source

4.3.2 There is no well established system of segregating hazardous from non hazardous waste in most hospitals; even in tertiary care institutions there are usually no clear cut guidelines on source segregation of hazardous from non hazardous waste. Technical problems of the poor segregation of hazardous wastes at source might also be due to lack of awareness or due to the low education of personnel in charge.

This lack of segregation results in the mixing up of hazardous with non-hazardous waste; this practice results in increase of the hazardous component requiring safe disposal from being less than 10% to 40% of the total hospital waste.

Collection and Storage:

4.3.3 In the pre-antibiotic era hygienic disposal of hospital waste received due attention. Due attention was paid to collection of waste at the site; for instance sputum was usually collected in utensils which do not spill and were filled with appropriate antiseptic. All soiled linen were decontaminated and then washed. For disposal of all hospital waste incineration or burial in a deep pit containing lime or bleaching powder was advocated. With widespread use of antibiotics the fear of infection waned. Potentially infectious waste materials today are often collected in buckets without any precautions. Dressings, linen soaked with blood, body fluids and excreta are dumped in a corner. Disposable syringes needles and I.V. sets get mingled with household waste and potentially infectious blood body fluid contaminated dressing; all waste materials are collected together without sorting. The sharps are mixed up with the waste and this is the cause of the numerous injuries among waste handlers.

Disposal Of Hospital Waste

4.3.4 Very frequently hospital wastes are dumped together with municipal garbage. Even when hospital incinerators are used, all types of hospital waste are dumped into the incinerator. Very little attention is paid to the temperature attained or duration of incineration. Most of the incinerators appear to be out dated in design and technology. No attempt is made to scientifically investigate the type and quantum of waste requiring incineration and procure an appropriate one. There is hardly any supervision of the operations of the incinerator. In many situations incinerators do not operate satisfactorily or not at all in operation.

4.3.5 Most of the smaller hospitals do not have any incineration facility. Nor do they have access either a common incineration

facility for disposal of hospital waste or to an assigned open land for digging deep pits and burying the waste material on day to day basis. Many of them dump the waste material in garbage dumps, without segregating potentially infectious material from household waste and recyclable plastics. From these dumping sites, rag pickers often pick out plastics which have not been decontaminated prior to disposal and therefore incur the risk of accidental infection through non intact skin. Anecdotal reports reuse of these plastics without even washing have been published and represent a potential risk of spread of infection to other health care seekers. Where the wastes have a resale value, much greater attention must be given to supervising the waste at all stages, to ensure that laborers or others do not steal, or allow access to, the potentially hazardous waste to which they have access. The potential for profit from the waste greatly magnifies the risks posed by medical waste in India. For example drug addicts who have no access to sterile syringes may use discarded syringes; discarded drugs may be used inappropriately by unqualified people or repacked and enter the spurious drug trade; scavengers or rag pickers are at risk from sharps, pharmaceuticals, and chemicals, and from direct contact with infected materials if they are dumped along with other garbage in collection sites. Items, such as syringes and needles, that they salvage and sell, may spread contamination to society at large if they are not properly cleaned and sterilized before they are sold.

4.3.6 Sharps waste that is generated in the home based health care needs special attention. These wastes may arise as a result of a doctor's visit or self treatment (e.g. by diabetics). A careful publicity programme should warn all users of needles and syringes that they should never be deposited with domestic waste, but should be stored in containers with appropriate disinfectant and then washed and disposed.

4.4. Health Hazards Associated With poor Hospital Waste Management

4.4.1 There are no reliable epidemiological data from developing countries on the health impacts of poor hospital waste management. The problems identified are:

(i) injuries from sharps to all categories of hospital personnel and waste handlers,

(ii) nosocomial infections in patients from poor infection control and poor waste management

(iii) risks of infections outside hospitals for waste handlers, scavengers, and (eventually) the general public.

(iv) risks associated with hazardous chemicals, drugs being handled by persons handling wastes at all levels.

(v) "disposable "being repacked and sold without being even washed.

(vi) drugs disposed being repacked and sold to (unsuspecting) buyers

4.4.2 Infections remain to be the most common health hazards associated with poor hospital waste management. The advent of HBV and HIV have made it imperative that hospital infection control and waste disposal system are improved. The major focus is on the potential risk of transmission of infection during patient care and safe disposal of potentially infected wastes. There is very little epidemiological data on this aspect from the Indian health care settings. However, the rising HBSAg prevalence among medical and paramedical personnel working not only in " high risk areas" such as dialysis unit, trauma center, casualty and obstetric departments but also among those working in general "low risk" areas is a warning signal that needs to be heeded. The problem that major hospitals faced when AIDS cases where first admitted clearly indicates that even in these premier institutions infection control and waste management systems were sub-optimal and both the staff and the patients were worried about potential accidental transmission of infection. HIV has extremely limited viability outside a living host, although live virus survival time may depend upon the environment and virus concentration.

Therefore, except for those persons within the health care setting, the potential to develop HIV infection from medical waste contact is relatively remote. Because HBV remains viable for an extended time in the environment, the potential for HBV infection following contact with medical waste is likely to be higher than that associated with HIV.

Route Of Transmission Of Infection From Potentially infectious wastes

4.4.3 There are four possible routes of transmission of infection from potentially infected waste. These are

(i) Through non-intact skin (preexisting cuts, raw areas) or by cuts and puncture of the intact skin.

(ii) Through mucus membranes such as splashing into eyes,

(iii) Inhalation of dust particles containing germs.

(iv) By ingestion through contaminated unwashed hand, contaminated water or food stuffs.

Categories Of Persons Exposed To Risk Of Infection

4.4.4 The category of person exposed to potential risk of infection from these wastes which are not properly disposed include:

(i) Other patient attending the health care facility

(ii) Medical and paramedical person providing health care

(iii) Person involved in collecting and disposing the waste material

(iv) Those involved in cleaning the instruments, floor, surfaces and washing of glassware and linen

(v) If potentially infectious waste get mixed with solid waste from other activities, the entire chain of workers/persons involved in solid waste disposal.

(vi) If some of the disposable items are introduced in the market as sterile without being sterilized, die patients who receive treatment are at risk.

4.4.5 Among all the hospital wastes the sharps pose the greatest threat for accidental infection. Firstly, syringes and needles are very often used both for diagnostic and therapeutic purposes and hence form the bulk of potentially infected waste. Used needles can act as reservoirs in which the pathogens may survive for a long time because of the blood that is present. Sharps can provide a direct route into the bloodstream by puncturing the skin. Syringes are in demand for a number of reasons, and so scavengers and others often try to sort through medical waste to find them.

4.4.6 Risk of infection through accidental injury with needles, sharp instruments appears to be most feared problem in the hospital waste disposal management. The workers most frequently injured in the health settings are doctors, nurse's aides, registered nurses, and maintenance personnel. There is no reliable data available on the magnitude of this problem in India. Reports from developed countries indicate that the annual injury rates for these occupations vary from 10 to 20 per 1,000 workers. Of all workers who may contact medical waste, sanitary services workers (e.g. refuse workers) report the highest rate of on-the-job injuries. In USA it was computed that the overall injury rate in sanitary service workers was 1 80 per 1 000 workers per year more than double that of the entire US work force combined. Ranges of estimated medical waste related injuries from sharps occurring annually for hospital employees are: 100-500/1000 workers/year. Estimated annual numbers of medical waste related HBV infections resulting from above quoted injuries are in the range - 50/1000 workers/year.

4.4.7 There are no well documented studies on health hazards associated with poor hospital waste management on the infection rates among patients. However the progressively increasing hospital infection rates, with organisms resistant to a wide variety of commonly used antibiotics is a warning signal that the hospital infection

control measures including waste management are sub- optimal in most setting and need be improved. It is essential that studies are initiated to find out and document the infection rates among various categories of workers and patients attending the hospital. Such studies can, to begin with, be initiated in teaching hospitals and will provide the data which will generate the awareness and later act as the stimulant to ensure proper waste management in hospitals.

4.5. Future Technological Options For Safe Disposal Of Hospital Waste

Collection And Storage

4.5.1 General hospital hygiene is a pre-requisite for good medical waste management; it will be useless in terms of prevention of nosocomial infections to start improving hospital waste management if the hospital does not have a reliable supply of safe water, and basic sanitation facilities accessible to hospital personnel, patients and visitors. Most hospitals in India lack these basic amenities. It is vital that the whole hospital be kept clean and in a satisfactory state of hygiene to prevent spread of infection from patient to patient, patient to health care provider and health care provider to patient. In terms of prevention of the spread of infection outside the hospital, careful management of wastes from the point of generation to safe disposal is of paramount importance.

4.5.2 Segregation at source and safe storage is the key to whole hospital waste management process, because it is at this stage that wastes are segregated into different streams; incorrect classification of wastes can lead to many problems at a later stage. It is also at this stage that all sharps should be put into containers containing appropriate decontaminants; the containers should be leak and puncture proof; failure to do this properly can lead to injury and potentially fatal infections. It is unfortunate that this stage involves the largest number of personnel, most of whom are concerned with patient care, often in conditions of urgency and under pressure; for these doctors, nurses and ancillaries, the management of the waste that they generate may seem to be of little importance. Unless they have been well trained, most hospital staff probably know little about what happens to the waste when it is taken from the ward or surgery, and probably rarely think about the hazards that are posed by the material they discard. In a very real sense, the safety and well-being of staff who handle wastes, and of scavengers picking waste, depend on the training, motivation and supervision of the doctors and nurses who produce the waste.

4.5.3 Segregation of waste at source is of great importance, because it allows special attention to be given to the relatively small quantities of potentially hazardous waste that needs special care at collection, storage and disposal. Poor segregation may not only result in risks to staff and public, but may also increase handling and disposal costs of hospital waste considerably, because if small amount of hazardous waste gets mixed with larger quantity of nonhazardous waste the entire larger quantity of mixed waste has to be given special treatment. If source segregation is ensured only the small (10-1 5% of all hospital waste) amount of hazardous waste needs special treatment and this will considerably reduce the costs and improve safe disposal.

4.5.4 It is essential that all sharps (whether infected or not), infected waste not containing sharps, chemicals and pharmaceuticals other than cytotoxic drugs, other hazardous waste are segregated at source by medical and paramedical personnel using these and are kept separately in readily identifiable preferably color coded containers. Radio-active wastes, cytotoxic drugs, and high-pressure containers require a special handling and disposal channels.

4.5.5 For each of these categories there should be a clearly distinguished receptacle, and all staff should be able to recognize the appropriate container for each particular type of waste. The best system is to use colored plastic bags/containers for each

category of waste. It is preferable that the source of waste (identification of the ward or OT) is also clearly indicated on the bin/ plastic container.

4.5.6 Hospital managers may prefer to use plastic or metal bins for waste storage in order to save on the cost and paperwork of buying large numbers of one-trip sacks. However, since the cost of hospital waste management is found to be significantly less than 1% of the hospital budget in many cases, the small saving in money spent on waste storage may be regarded as being insignificant, and the extra expenditure involved in buying plastic bags is justified on the grounds of improved hygiene and convenience.

4.5.7 If reusable containers are to be used, considerable thought should be given to methods of cleaning and disinfecting them - an unpleasant task that would tend to be avoided unless there is a high degree of supervision. The containers should be smooth and well rounded on the inside to allow effective and complete cleaning; any seams or sharp corners would be very difficult to clean. Failure to clean the bins effectively would not only leave potentially infected residues but also lead to unpleasant odors and problems with insects.

4.5.8 The size and number of receptacles should be appropriate to the expected amount of wastes produced in the room, assuming that collection takes place twice a day, or more often in operating theaters or intensive care rooms. The containers should not be too heavy when full; a maximum size of 100 litres is recommended for dry wastes, and 50 litres for wet wastes, so that the containers can be conveniently handled by one man. Each receptacle should be clearly labeled to show the ward or room where it is kept. In the case of reusable bins, the location of that bin should be written clearly on the side, and it should always be kept in the same room.

Disinfection

4.5.9 All potentially Infectious waste must be disinfected before being sent from the OPD or ward to prevent dissemination

of virulent microbiological pathogens in the environment. If disinfection is reliable, most hazardous medical wastes could even be handled as normal municipal wastes after they have been disinfected.

4.5.10 Recycling of waste is on the agenda of sustainable development in recycling decontaminated hospital wastes. It might be preferable to develop industry -hospital tie ups to ensure that all disposable material collected from the hospitals are recycled and do not enter into the market in their original form.

Transport To Collection Site

4.5.11 Twice a day (more often for operating theaters and intensive care rooms) the waste bags and/or containers should be sealed and carried to a special waste storage room where they will be placed in separate piles according to the type of waste they contain. This storage facility should be secure, so that unauthorized people cannot gain access to the waste. It should also be possible to wash the room down in the event of a spillage.

4.5.12 Unwanted pharmaceuticals should be returned to the pharmacy that initially provided them, for safe disposal. A waterproof container should be used for the storage of chemicals and pharmaceuticals except cytotoxic drugs. It is usual in small hospitals to get rid of chemicals and drugs by washing them into the sewer system with a large flow of water; this may be accepted if total quantities of chemicals so disposed are small and dilution is effective; but if large amounts are flushed, this practice may disturb the operation of the sewage treatment plant or create chemical pollution of the environment. Hence this practice should be discouraged in larger hospitals. Cytotoxic drugs must never be discharged into the environment.

4.5.13 The general non-hazardous waste can be taken directly to an outside container to be either picked up by the municipal waste collection service or disposed of by

the hospital itself. Personnel carrying the waste should wear sensible protective clothing; both for hygienic reasons and to prevent skin puncture.

Transport

4.5.14 Carts and vehicles used to transport the waste should be carefully designed so that they are stable, quiet in operation, and transportation can be achieved with the minimum of effort and inconvenience. The opportunities for contact with the bags or bins should be kept to the minimum. Trolleys or carts should be large enough so that waste is not piled up on them in an unsafe way, and they should be stable, to minimize the risk of tripping over. No compaction vehicles should be used; the waste should be disturbed as little as possible during loading and transport.

4.5.15 Large hospitals may have their own disposal system on-site and so may not need to transport their wastes far, but smaller establishments will probably need to use a facility at some distance, and so road transport must be provided. Hazardous hospital waste, even after decontamination should never be transported with general municipal wastes. Special covered vehicles must be used such that they prevent access to, and direct contact with the waste by the transportation operators, rag pickers and the public.

Treatment Of Hazardous Hospital Waste Prior To Disposal

4.5.16 The term treatment refers to processes that modify the waste in some way before it is taken to its final resting place. Treatment is mainly required: to disinfect or decontaminate by chemical disinfection of the waste right at source, so that it is no longer the source of pathogenic organisms. After such treatment the residues can be handled safely, transported, stored and disposed. This is an essential prerequisite to safe management of hospital waste in India.

Disposal Of Hazardous Hospital Waste Incineration

4.5.17 Incinerators operate at their maximal efficiency when their capacity is large, and when the wastes they burn have a sufficiently high calorific value (that is, when they burn they produce a sufficient amount of heat to evaporate the moisture in the wastes and raise the temperature of the burning wastes without the addition of extra fuel). In order to ensure complete combustion - so that odours and smoke are kept to a minimum, the temperature must be high (higher than temperatures commonly achieved in municipal incinerators), and the wastes must be held at this high temperature for sufficient time, and agitated or turned sufficiently to ensure that all the mass is burned. In the industrialized world, standards required of hospital incinerators have been rising rapidly. The most modem types often have rotary kilns which guarantee sufficient turbulence by causing the wastes to tumble over as they burn. There is usually a secondary combustion chamber fired by auxiliary fuel to encourage complete combustion and minimize smoke and odours. Temperatures of about 1 000 C are attained in the secondary combustion chamber. Finally, equipment (scrubbers, cyclones etc) is fitted to clean the flue gases before they are exhausted to the atmosphere. At the high temperatures attained in such incinerators even needles may disintegrate. Hospitals in the industrialized world make extensive use of "disposable" items which are discarded after one use, most of these items are made from plastic or paper, and so medical waste in these places has a very high calorific value.

4.5.18 In most hospitals in India simple incinerators, often installed years ago or those built without reference to modern standards or modern technology are in use. They generally attain much lower temperatures, especially when wet wastes with low calorific value are fed into the combustion chamber consequently they emit smoke and unpleasant odours. The siting of the plant and the height of the chimney must be carefully considered (with respect to prevailing wind directions and surrounding elevations) to minimize problems caused by

the emissions. The lower calorific value of wastes in India (where there is less paper and plastic in the waste because items are reused for reasons of economy) may also necessitate a larger requirement for auxiliary fuel than in the industrialized world. Most small, simple incinerators do not operate continuously because they must be allowed to cool each day for the removal of ash and residues. Such incinerators usually require frequent repairs because the refractory or brick linings of the combustion chamber deteriorate quickly because of the large daily changes in temperature.

4.5.19 In a large town or city it may be appropriate to install one incinerator to serve a number of medical establishments in the area. If this is the case, care must be taken to ensure that the method of transport of the wastes to the central facility is safe and reliable. For all hospital incinerators, it is important that the method of loading the waste into the plant does not expose the operators to any avoidable risks. Incinerators may burn all hazardous waste except radioactive waste or pressurized containers. It would be unwise to use the incinerator to burn all the wastes corning from a hospital because the fuel bill will be very much higher; more over this practice means that hazardous medical wastes from other sources could not be burned. Ashes from incineration may be buried in the municipal dump

4.5.20 The numerous requirements listed above suggest that currently available incinerators are not the best available technology to treat hospital waste in India. However, efforts are under way to design small-scale hospital incinerators that are suited to the nature of hospital waste in tropical countries.

Small Scale Incinerators

4.5.21 Large-scale incinerators for large hospitals are commercially available. However, there is a need to develop small-scale incinerators for hospital wastes, which are suitable for nursing homes, clinics, field hospitals, rural dispensaries and health centres. These could be based on electricity/liquid or solid fuels; they should be efficient and environmentally compatible. Capacity can range from 1 kg to 50 kg in batch mode.

Pharmaceutical Waste Management

4.5.22 Pharmaceutical and organic chemical wastes may be incinerated together with infectious waste, or they may be destroyed together with industrial chemical wastes if special incinerators exist. In any case good management of medical and laboratory activities would minimize the production of chemical and pharmaceutical wastes at their source. In some countries hospitals send back outdated medicines to their central supplier; in other countries there is a collecting service for chemical waste but in most cases there is nothing available in developing countries to get rid safely of small quantities of chemical waste. Hospital managers are then left with two alternatives: the first one is dilution and discharge to the sewers or to the natural environment with the risk of damaging the sewage treatment plant operations and polluting surface and ground water resources; the second alternative will be to store or bury those chemicals (however this will present the risk that buried or stored chemicals may be scavenged or stolen and then illegally recycled with all the consequent risk of toxic accidents). A solution may be to establish at national level an agency to collect, store and process discarded chemicals including pharmaceuticals. At hospital level, it is only when a high temperature incinerator is available that disposal of pharmaceuticals, other chemicals and even cytotoxic drugs becomes easy.

Other Treatment Processes

4.5.23 Cytotoxic drugs may be burnt or chemically degraded by well-qualified specialists, but should never be diluted and discharged to sewer. Radioactive materials may be sent back to the nuclear industry that supplied them. Most radio- active wastes from medical establishments have a fairly low level of radioactivity and a short half-

life. It may be possible to store such wastes under carefully controlled conditions until the level of radioactivity is so low that they may be treated as other waste. Special care is needed when old equipment containing radio-active sources is being discarded. Expert advice should be sought in such cases.

4.5.24 High pressure containers should be buried or sent back to their manufacturer but never burnt or processed mechanically.

Use Of Municipal Waste Disposal Facilities

4.5.25 If there a municipal incinerator nearby, the hospital may consider getting its waste burnt there provided that special loading facilities are provided for the infectious wastes to prevent any risk of the spread of infection, unauthorized recycling, or contact with recognizable items by the general work force. Incinerators have proved unsuitable in most situations in India because the nature of the municipal waste - it is too high in moisture and organic content so that the waste has a low calorific value, such that it will not burn without the addition of an auxiliary fuel. It follows that burning hospital wastes in a municipal incinerator is not an option in Indian conditions as of now.

4.5.26 If decontamination at source is ensured in potentially infected hospital waste, then it can theoretically be disposed through the municipal waste disposal system. However there are some problems associated with this practice and hence this should not be the preferred mode of disposal of the decontaminated hospital waste. The main problem associated with disposing of decontaminated hospital waste on a municipal disposal site is the difficulty in control and supervision. Drivers and laborers involved in transporting the waste to the site may be tempted by cash or threat to allow scavengers access to the waste. The recommendation for a well-run landfill is that hazardous wastes should be immediately covered by a meter thickness of ordinary wastes and always be placed more than two meters from the edge of the deposited waste. Such a requirement appears to be of little use in many landfills in developing countries because the standards of operation and control are generally very low.

Awareness Creation For Safe Management Of Hospital Waste

4.5.27 As in many other areas the most crucial factor needed for successful management of hospital waste is the knowledge and commitment of all personnel involved in the process. The human element is far more important than the technology. Almost any system of treatment and disposal that is operated by well trained and well motivated staff can provide more protection for staff, patients and the community than an expensive or sophisticated system that is managed by staff who do not understand the risks and the importance of their contributions.

4.5.28 Unfortunately, this is often very difficult for decision-makers to understand - some of them seem to think that spending a large sum on complex technology guarantees a safe and successful system, but the large number of inoperative incinerators around the world testifies that this is not so.

4.5.29 The management of medical waste requires diligence and care from a chain of people, starting with the nurse or doctor who use the equipment and supplies that become waste, continuing through the porter or laborer who provides clean sacks or containers and carries away the waste, on to the mechanics and technicians who keep the vehicles and equipment in good condition, and finishing with the person responsible for ensuring that residues are disposed of in the correct way. If any of these are careless in their work, or allow scavengers access to the waste, the chain is broken and dangers follow.

4.5.30 Training and motivation are both important. All staff, whatever the position in the chain, need to know what is expected of them, and why it is important. This will require extra effort where there is a high turnover of manual workers. Training must be effective. Particular attention should be

given to illiterate workers. Regular refresher courses are helpful, and monitoring should be carried out to identify those requiring further training. Training should not be solely to explain routine procedures, but should also cover emergency procedures, such as what action should be taken as a result of a spillage of particular types of waste, or any injury involving a needle.

4.5.31 Motivation is more difficult, but essential. It starts with the senior medical personnel, who must show by word and example that they believe in the importance of correct waste management procedures. Motivation can be assisted by a full discussion of the hazards posed by medical wastes, so that staff understand the significance of the steps that they are being asked to take. Supervision is essential to back up the words, to identify needs for further training, and to bring to light carelessness and deception. Finally, there must be the will to investigate any failures in procedures and to punish any deliberate failure to comply with prescribed practices.

4. 5.32 It is a common practice to hold the generator (or source) of the waste responsible for that waste wherever it is - in storage, in transit, when being processed, and when it is disposed. This allocation of responsibility encourages the generator to

(i) Check on the practices and standards of the contractors he uses.

(ii) Define solid hospital wastes, including definition of the different component fractions, especially those that, because of their hazardous nature, require special management.

(iii) Establish standards for the control of the occupational, health, and environmental risks associated with the handling of solid hospital wastes as well as emergency procedure standards.

(iv) Establish incentives for reducing the quantity of wastes produced and promotion of recovery and recycling of materials, when done without health risks to personnel, hospital population, and the community.

(v) Standardize the requirements for each alternative for proper handling of hospital solid wastes.

(vi) Establish a pricing system for services provided by third parties.

(vii) Establish effective surveillance and control of the sanitary handling of hospital solid wastes.

(viii) Establish a system of documentation to verify that minimum standards have been met.

Other Aspects Of Hospital Waste Disposal

4.5.33 As with all activities, the economic aspects must be considered. It is clear that good hospital waste management is not free of charge but if effective segregation of hazardous waste at source and immediate decontamination at source are practiced effective safe disposal of hospital waste represents only a very minor part of the total hospital costs - probably less than 1% of the hospital total running costs in many situations - therefore, savings on this item are of little significance in proportion to the total expenditure.

4.5.34 Management has a responsibility of gathering and using information relating to hospital waste management. Information on the type and quantities of the different types of waste and the exiting practices of segregation and treatment at source are essential if sound management decisions are to be made regarding subsequent procedures of safe disposal of hospital waste. The incidence of accidents, injuries and infections should be carefully monitored. Possible routes of infection should be studied; this will involve investigating the habits and interests of scavengers and recycling merchants. All staff, including those in waste disposal, should have regular medical check-ups, and information generated by these check-ups used to evaluate procedures and precautions. Information on disposal practices and facilities should be disseminated and used, for the guidance of others and where there is a possibility of co-ordination or sharing facilities.

5.RECOMMENDATIONS

5.1 Urban solid waste management is an essential social service for protection of environment and health of the citizens. Therefore, a least cost, most appropriate technological option for safe management should receive the needed funding. Industries, institutions, non-government agencies and individual citizen should all cooperate with the Municipal authorities in ensuring safe management.

5.2. Municipal Waste Management

Collection and Transportation

5.2.1 Segregation of inorganic recyclable materials like plastic, glass, metals, papers at the source should be promoted and every effort should be made to collect the same in separate receptacles or bags in each house. In the case of Middle and High Income areas, the residents may be requested to provide their own containers separately for collecting of household recyclable and other waste. In the case of Multi-storied buildings, the owners should bring down the waste in suitable containers and arrange to store it until collection within their premises at ground level.

5.2.2 As far as practicable solid waste should be collected from house to house every day. Private agencies/ NGOs, rag-pickers or their cooperatives may be involved in primary collection of solid waste from households.

5.2.3 For providing house-to-house collection service, every household may be charged on monthly basis. The amount to be charged should be affordable. It may vary with the status of the property from where the refuse is collected. In the case of low income and slum areas, the residents/their cooperative societies should be encouraged and helped in collection of their wastes and its transport to Municipal Containers. They may be provided with necessary implements and token financial assistance.

5.2.4 Pedal tricycle of appropriate design should be promoted for house to house collection. Direct transfer of garbage from primary collection carts to the covered transportation vehicles would reduce vehicle's waiting time and make the system cost-effective.

5.2.5 Community-Bins should have two separate compartments one for organic and another for recyclable matters.

5.2.6 Daily collection and transport of waste to disposal site is essential.

5.2.7 From the vegetable and fruit markets, the refuse should be collected atleast twice a day, and transported to Composting facilities. In larger markets, onsite treatment and disposal facilities for production of cattle feed or biogas may be developed. Large restaurants/ hotels should be encouraged to develop their own onsite treatment and disposal facilities (bio digesters/ composting/ cattle feed production). In Office Blocks, the recyclable waste should be separated from organic waste at source. Segregated refuse should be collected daily and transported to road side collection centres. Construction and demolition site waste should be collected separately and straight away used/dumped at landfill sites. In all commercial establishments and industrial areas, privatisation should be encouraged for collection, transport and disposal of waste and the work contracted out. Solid waste from zoological parks should be collected and disposed locally through composting.

5.2.8 The vehicles for transporting solid waste from the ward level transfer point to the disposal ground should be of appropriate design, suiting the waste characteristics, and should have adequate arrangement for hydraulic tipping and quick loading. Indian garbage does not require compacting. Compactors are costly and are uneconomical. These are not needed in India. All garbage transport vehicles should be adequately covered to prevent spillage and air pollution. Softwares should be developed for cities and towns with varying size and densities of population for optimum transport routing and number and location of transfer points.

5.2.9 Adequate maintenance facilities for minor preventive and routine maintenance of vehicles should be provided at Municipal levels. Appropriate accountability should be laid down to ensure adequate maintenance. Major repairs of vehicles which require large investment on infrastructure, adequately trained manpower and maintenance of spare parts inventory can preferably be carried out through private agencies.

Disposal Of Solid Waste

5.2.10 The aim of the solid waste management system should be to utilize to the maximum possible extent all the waste; the non-compostable matter should be used to level the ground in low lying areas; organic component should be used for bio-fertiliser or energy production and the re-cyclable material for producing appropriate recycled products.

5.2.11 In view of the well-documented adverse health consequences associated with the practice, open dumping should be discontinued with immediate effect.

5.2.12 Sanitary landfills would be the major option for disposal of Urban Solid Waste in major metropolitan cities as well as smaller towns. It would be prudent to adopt an incremental approach wherein progressive upgrading of the landfill sites with improved environmental protection measures and operation control are introduced with consequent reduction in health and environment hazard.

5.2.13 The major city and metropolitan area development authorities must have adequate provision of appropriate land for landfill sites on regional basis in their land use planning. Small and medium towns might have to share trans- municipal land disposal facilities, which should be managed by metropolitan development authorities or other appropriate regional management authorities.

5.2. 14 Composting appear to be the next most appropriate option for solid waste disposal and could take care of upto 20-25% of municipal solid waste (organic fraction). Depending on the size and population of the town, compost plants should have appropriate degree of mechanization using aerobic and anaerobic methods. For smaller towns, low cost labor intensive Wind-Row type compost plants with minimum mechanization should be adopted.

5.2.15 Urban solid waste from Indian cities has low calorie value and high moisture content with high percentage of non-combustible materials; hence it is generally unsuitable for thermal technologies. However, application of technologies such as incineration, pelletisation, cofiring, pyrolysis or gasification should be evaluated through R & D/ pilot scale studies. Such R & D efforts should preferably be taken up as joint collaborative effort between Private Sector/Municipal Authorities and Research Institutions with expertise and experience in these areas.

5.2.16 Private participation in setting up pilot plants utilizing any of these technologies for Urban Solid Waste Management should be encouraged; the Government may consider providing some incentives in the from of assured supply of garbage, availability of land near the dumping site, and possibly buy back agreement for purchase of electricity generated. If and when private industries evince interest and are willing to invest in building processing plants, it is worth while to explore the feasibility of assisting them with, Build, operate and transfer (BOT) or build own and operate (BOOT) type of MOUs. Such an approach may encourage private parties to come forward and invest in this important area.

5.3. Hazardous Industrial Waste management

5.3.1 Lack of awareness regarding health hazards and about appropriate technology available for safe disposal of potentially hazardous industrial solid wastes are two important factors that come in the way of effective, safe disposal of solid wastes. Appropriate efforts should be directed to improve the awareness of the industry,

health care personnel and general public of their respective role in ensuring safe disposal of potentially hazardous waste material in urban areas.

5.3.2 Urban Development Authorities/ State Pollution Control Boards should create a data base identifying industries producing hazardous solid waste, their locations, the quantity and characteristics of the waste generated by them and their disposal practices. Public Health Departments should monitor health hazard associated with improper solid industrial waste management. Some of the existing National Institutes such as All-India Institute of Hygiene and Public Health (Calcutta), ITRC (Lucknow), NEERI (Nagpur) and NIOH (Ahmedabad) may be strengthened as regional centres to develop an inventory and reporting system on toxic and hazardous industrial waste and document the health and environmental impact.

5.3.3 These centres should be developed as sentinel centres who will provide early warning of potential problems so that health hazards associated with improper disposal of toxic waste can be minimized. They should also act as R & D centres undertaking/evaluating innovative hazardous waste management projects.

5.3.4 There is very little information on the factors affecting the health consequences of exposure to toxic chemicals. It is imperative that research studies are taken up to study the impact if any of the genetic and nutritional status of the population on health consequences of exposure to toxic substances.

5.3.5 Industries producing potentially hazardous solid waste should be brought under purview of Pollution Control Laws.

5.3.6 Careful precautions are necessary to minimize hazards associated with manual handling of industrial wastes. Personnel handling hazardous wastes should wear appropriate protective clothing. Mechanical methods for handling waste should be adopted where possible, and people should be educated about the dangers of improper waste handling.

5.3.7 The pretreatment and detoxification of the hazardous industrial waste should be the responsibility of the industries and only after that such treatment, waste would be disposed off at landfill sites. Safe disposal of solid waste produced is the responsibility of the industry. In large and medium industries, it will be possible to ensure safe disposal of waste produced on the site or take up procedures so that wastes are rendered non-hazardous, before they are transportation and safely disposed of at a suitable site. Small scale and very small scale industry may form cooperatives or hire services of waste disposal experts for safe disposal of their wastes. Such services on payment may be provided by firms specializing in waste management who have adequate staff with experience and expertise in the field. Alternatively the civic authority may build such a nucleus and provide services for safe disposal of industrial waste on payment. Landfills should be carefully chosen and operated with all necessary safeguards against environmental pollution.

5.3.8 Incineration might be the appropriate method for disposal of some of the hazardous chemical wastes. In some instances the appropriate incinerator required to safely dispose of the hazardous waste might be prohibitively expensive. Under these circumstances a group of industries from the same locality may pool their resources for purchasing the requisite model of incinerator. Yet another option is to hire the services of independent waste disposal experts who have the incinerator.

5.3.9 In all centralized large slaughter houses, waste should be biodigested near the slaughter house. Thermophilic biodigestion kills the pathogens which may be present in the wastes. Biogas produced in the process can be used directly in the slaughter house for heating water, and for electricity generation. Electricity so generated can be used for refrigeration. For smaller slaughter house, the wastes could be collected everyday and dumped in special areas

through controlled sanitary land- filling with and without generation of landfill gases.

5.4. Hospital Waste Management

5.4.1 The potentially infected waste should be collected in leak proof plastic bags/bins; decontamination of the potentially infected material should be done right at the site of collection under supervision of medical/ paramedical personnel generating the waste. Since they know the risks involved, it is expected that appropriate decontamination procedure will be followed and prevent any problem even if there are slip ups at other subsequent points of collection, storage and disposal. Bleach solution in appropriate concentrations (0.1% - 2.0%) is the most suitable and affordable method of decontamination of all potentially infected hospital waste.

5.4.2 The Laboratory glass waste and biological material left after the laboratory tests has to be decontaminated by complete immersion in 10% bleach solution. j Keeping a closed bucket half filled with { 10% bleach solution and putting all biological material in the laboratory into it throughout the day and allowing it to stand over night might represent the most feasible method of ensuring decontamination right in the laboratory. Next morning the decontaminated material in the bucket may be sent for incineration with other waste or discharged into sewerage system.

5.4.3 Following the advent of Hepatitis and later HIV infection special attention is now being paid to precautions in handling instruments used in patient care. Decontamination is advocated for all disposable items including disposable syringes, needles, I. V. drip sets and catheters. The physicians and paraprofessionals who use them should take the responsibility of immersing them in 1% bleach solution for at least 1 hour. Then these decontaminated plastic articles can be safely utilized by the recycling industry.

5.4.4 All biological material from labor rooms laboratories, and operation theater are potentially infected and require safe disposal. It is preferable that these material are burnt off using appropriate type of procedure for incineration. In small peripheral clinics or in PHC/subcentres, incineration may not be possible; in such places these may be immersed in 10% bleach solution overnight for decontamination. Subsequently they maybe disposed of using appropriate methods such as burning, burial in deep pits, or even for disposal along with other non-infectious waste materials from health care facility.

5.4.5 After preliminary decontamination, large hospitals should incinerate the hospital wastes using appropriate incinerator. The loading as well as operation of the incinerator should be done under the supervision so as to ensure that all waste material is completely burnt To cater to the needs of smaller hospitals, nursing homes and dispensaries centralized common incinerators located at convenient sites may be have to be created; a system for collection of the decontaminated wastes from these hospitals on daily basis and safe incineration has to be developed. The institutions may avail this facility on payment.

5.4.6 In view of the fact that the current practices of collection and storage of hospital waste in the clinics and in the hospital wards are not streamlined and decontamination procedure are poorly followed, it is essential that guidelines for decontamination of all the items at source by medical and paramedical personnel using the facility are drawn up and widely distributed.

5.4.7 R & D efforts are necessary for developing suitable cost effective designs for smaller incinerators using gas, coal or electricity to suit the needs of small nursing homes, private clinics.

5.5. Resource Recovery and Recycling

5.5.1 Materials for recycling should be segregated at source. The present system of scavenging of recyclable matters from roadside dumps and disposal grounds by the informal sector of urban poor should be replaced by organized Ward-Level recycling and recovery centres which should be attached to the transfer stations where primary collection carts are transferring their collection to the transport vehicles.

These recovery centres could be managed by cooperatives/NGOs of the rag pickers. Alternatively, the rag pickers could be employed for this purpose by the Municipal authorities.

5.5.2 Industries engaged in processing the recycled garbage like waste paper, plastics, glass or metal should be given financial assistance to upgrade their technology so that the products are of better quality, cost of production is less and marketability of the product improves.

5.5.3 It is necessary to assess the state of art of the present technologies used for recycling waste and undertake R &D/Pilot scale studies to develop new technologies and upgrade the existing ones.

5.5.4 Necessary legislative and administrative measures should be taken up for promoting consumption of products made out of recycled waste paper, plastics or glasses.

5.5.5 Recycling and waste processing industry should be given incentive both from State and Central Governments, such as exemption of plant/machinery from taxes and duties.

5.6. Legal Provisions

5.6.1 While awareness in disposing of urban solid waste in a safe sanitary manner is the key to the successful management, this need be supplemeted by a legislative frame work. In the development of new towns and housing estates care has to be taken to see that the problems of urban solid waste management do not accumulate and reach a stage , where large investment become an inevitable prerequisite for any remedial action and the problem virtually intractable. The existing Town and Country Planning Act, the Municipal Laws should be so framed as to supplement general awareness being coupled with action taken against those indulging in deliberate and persistant default.

5.6.2 For proper solid waste management, it is very necessary to prescribe regulatory measures and provide legal powers to local authorities. The existing legal provisions have to provide enough powers to the local authorities to take action against the offenders. The Municipal laws should lay down detailed list of obligatory and discretionary duties of local authorities, specific standards have to be laid down for the collection, storage, transport and disposal of solid waste. Responsibilities of the individual, local self Government representatives, NGOs, commercial organization in respect of these steps need to be defined and penalties for non-compliance specified.

5.6.3 Depositing or throwing away any solid waste in contravention of provisions of the Act or bye-laws should be punishable with fine. The quantum of fine imposed should be a deterrent to other potential offenders.

5.6.4 The local authority should have the powers to clean the areas or premises which are kept in filthy and unwholesome condition at the cost of the owner or occupier of the property.

5.6.5 It is necessary to incorporate in the Town and Country Planning Act that the urban development projects of new townships/housing estates have adequate provision of solid waste management including adequate land for disposal. All urban development authorities and metropolitan development boards must have within the framework of its long-term land use policy adequate provision of land fill sites of appropriate location on regional basis. It may be necessary that smaller municipalities would have to share common facilities for disposal of their solid waste. Necessary legal and administrative provisions need to be made in this regard and financial assistance should be provided from Central/State Governments.

5.6.6 Debris from construction activities should not be mixed with city waste; it is the responsibility of builder to dispose it off at earmarked sites.

5.6.7 Ministry of Environment and Forests has recently prepared the draft Bio-medical Waste (Management and Handling) rules, 1 995 (Annexure XI) for improving Hospital Waste Management (HWM). It is expected

that the rules will come into force shortly and will enable the rapid improvement in HWM. Municipal bye-laws should have a mandatory clause that licences to nursing homes, hospitals, dispensaries and industries will be issued/renewed only after making sure that these institutions have mechanisms for safe disposal of potentially hazardous wastes generated.

5.6.8 A directory of industries of small, medium and large size in the city with all the details of the chemicals they use and their methods of waste disposal should be made available in the city.

5.6.9 Industries producing potentially hazardous solid waste should brought under the purview of Pollution Control laws. It should be made mandatory that all industries whether small, medium or large should ensure safe disposal of hazardous solid wastes.

5.6.10 Local inspector of factories will monitor disposal of industrial solid waste on a day to day basis and initiate appropriate action if any shortfall is detected.

5.7 Financial Aspects

5.7.1 Under the new Centrally Sponsored Scheme for promoting infrastructural development in mega cities, presently cities of Bombay, Calcutta, Madras, Bangalore and Hyderabad have been included. Under the Scheme the Central and the State Govt meet 50% of the cost of investment, the balance being raised through the financial institutions/ capital markets. Several facets of infrastructural requirements of the mega cities are eligible for funding, like water supply, sewerage and drainage, sanitation, city transport, land development , slum improvement and solid waste management. Through innovative means it should be possible to make use of the available resources from the Scheme for operatioanalising the Recommendations of the High Powered Committee for effective and safe urban solid waste management. In view of the serious consequences of inadequate and insanitary disposal of solid waste on the community health and environment, adequate funding should be made available for solid waste management to the local governments including small and medium municipalities.

5.7.2 In view of the serious consequences of inadequate and insanitary disposal of solid waste on the community health and environment, adequate funding should be made available for solid waste management to the local governments particularly small and medium municipalities. It is worth while considering a minimum earmarked allocation for solid waste management; individuals, NGOs and Commercial organizations should all continue to provide inputs in ensuring ecofriendly safe waste disposal.

5.7.3 Transport vehicles carrying the solid waste may be exempted from excise and other duties.

5.7.4 Congenial environment necessary for the private sector companies to enter the area of solid waste management by way of tax holidays, accelerated depreciation and by other legal and financial assistance may have to be provided.

5.7.5 It is essential that appropriate financial incentives/disincentives are provided so that all segments of population co-operate in the efforts to reduce waste generation and increase use of biodegradable, ecofriendly material.

5.7.6 The industries and product manufactures should be made to include the cost of appropriate disposal of products/packaging material as a part of the cost of the product. This would promote utilisation of material which could be readily disposed at a lower cost especially for packaging. Individuals and industries may have to pay charges for disposal of solid wastes, depending upon quantity and nature of the waste requiring disposal. This . again might help in reducing quantity of waste, promotion of recycling and use of ecofriendly material. Funds so generated through this effort will be made available to the Municipalities for safe disposal of urban solid waste.

5.8. Human Resource Development

5.8.1 Analysis of present status of solid

waste management in Indian cities and towns indicates that better sanitation standards could be achieved in most cities within all the existing constraints, if there was trained manpower at critical level. Prudent and planned allocation of available resources to support and develop appropriate, low cost, eco- friendly technologies and effective implementation of the technology are essential for sustained safe disposal of urban solid waste. There is an acute shortage of trained manpower with most municipalities particularly the small and medium ones. Appropriately designed modular continuing education courses for various level of professional staff for USWM should be conducted by institutes with adequate expertise in USWM. Apart from providing appropriate and adequate technical information, efforts should be made to utilize the multi- professional education approach in these training courses so that the persons not only get the knowledge but also learn to work as a team with related professionals from allied sectors.

5.8.2 A comprehensive manual covering various aspects of collection, transportation and disposal of solid waste in urban areas should be prepared on priority basis and widely disseminated to municipal agencies. Simultaneously, necessary action should be taken to revise the curricula of existing formal courses to incorporate aspects of U.S. W.M.

5.8.3 Reliable data on a national scale on generation, management, health and environmental impact of urban solid waste are not available. Existing institutes with experience and expertise in this area need to be strengthened.They can be entrusted with generation of national data base, and evaluation of ongoing and proposed R & D/Pilot projects for Urban Solid Waste Management.

5.8.4 Rag pickers play an important role in the recycling of urban solid waste and could play a even more productive role in ensuring a sustainable system of house to house collection of the solid waste. There is a need to create a cooperative for rag pickers so that the middlemen are eliminated and the rag pickers get due financial reward for their work. Incidentally, such a cooperative could also provide means for improved hygiene (community bathing facilities) non-formal education and vocational training for the rag pickers.

5.9 Awareness Creation

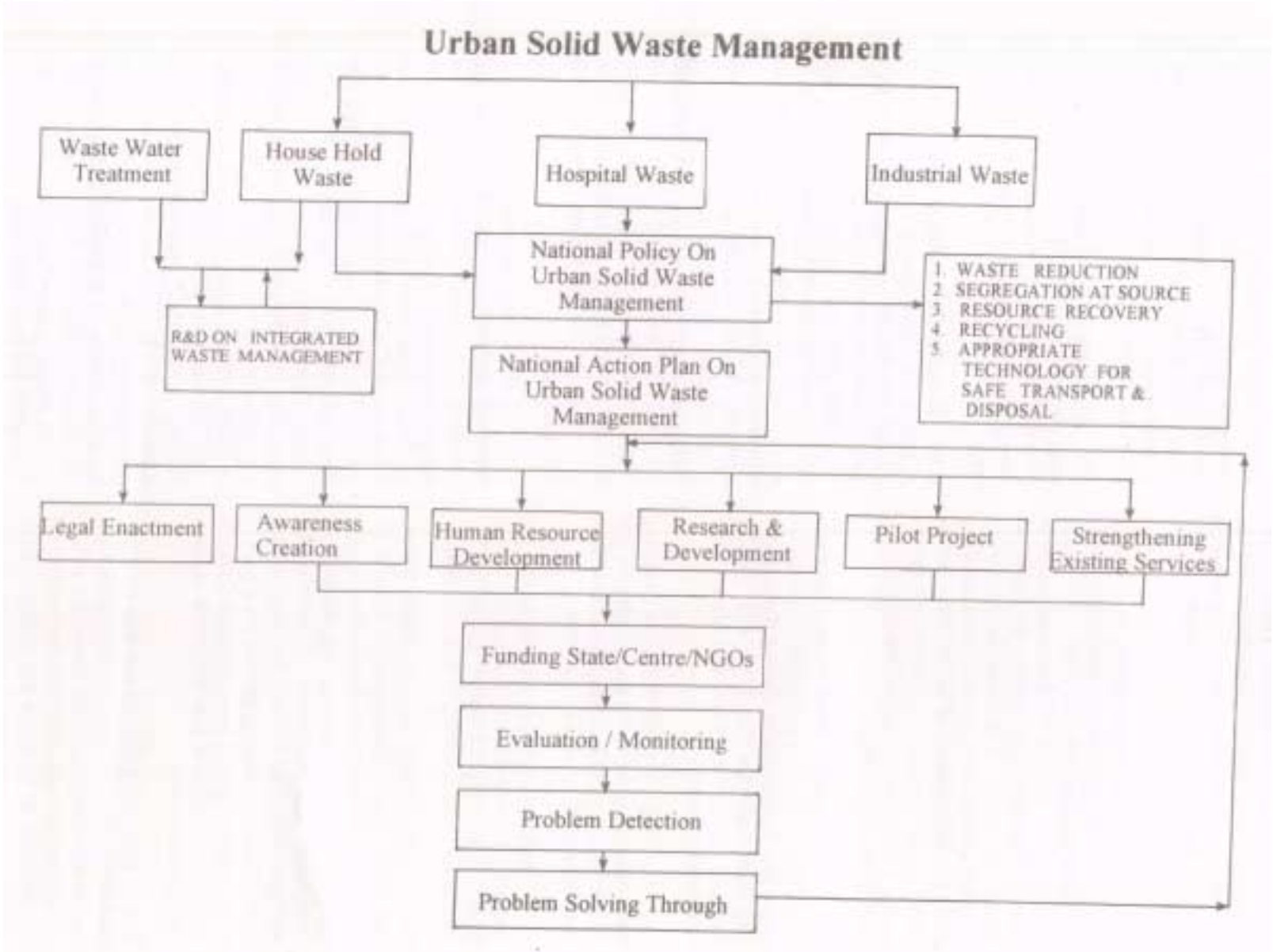
5.9.1 The role and responsibility of the people in ensuring a safe and sanitary management of urban solid waste need to be communicated to the general public, industrialists, hospital personnel, policy makers and programme implementors. Municipal authorities, NGOs and citizen organizations should be involved in a multimedia campaign to create awareness on the crucial role of the citizens in ensuring the cities and its environment clean and appropriate solid waste and sewerage disposal practices. Door to door campaign by local NGOs may also have to be tried.

5.9.2 The health consequences of poor urban solid waste management should be adequately documented and information need be disseminated to the public, the administrators and decision makers.

5.9.3 Industry should be encouraged to play a bigger role in this campaign by providing appropriate tax concessions and other type of incentives.

5.9.4 "Do it yourself campaign to motivate the people to keep their city clean and improve their parks, gardens and surroundings shall help.

5.9.5 Urban Solid Waste Management can be introduced into school and college curricula. Sanitation should be included as one of the subjects in school and college curriculum to educate the children on personal hygiene and sanitary habits. Youth bodies,NGOs may be encouraged to address important environmental issues including Urban Solid Waste Management.


Urban Solid Waste Management
Waste Water Treatment
House Hold Waste
Hospital Waste
Industrial Waste
National Policy On Urban Solid Waste Management
R&D ON INTEGRATED WASTE MANAGEMENT
1. WASTE REDUCTION
2. SEGREGATION AT SOURCE
3. RESOURCE RECOVERY
4. RECYCLING
5. APPROPRIATE TECHNOLOGY FOR SAFE TRANSPORT & DISPOSAL
National Action Plan On Urban Solid Waste Management
Legal Enactment
Awareness Creation
Human Resource Development
Research & Development
Pilot Project
Strengthening Existing Services
Funding State/Centre/NGOs
Evaluation / Monitoring
Problem Detection
Problem Solving Through

6. ACTION PLAN

6.1 Taking into account existing resources and manpower constraints, the following areas have been identified as priority areas requiring immediate funding during; the remaining two years of the eighth plan.

6.2 Estimated requirement is between Rs.10-20 crores/year for solid waste management during the 8th plan. All mega city projects should be reviewed and necessary financial allocations be made to meet this need. The need for sustained support should be taken into account at the time of formulation of Ninth Plan. Minimum outlay needed will be Rs. 100 crores to Rs. 1 50 crores for each of the mega cities during the Ninth Plan.

6.3 Seventeen more cities, currently have over 1 million population, would require Rs. 3-5 crores/yr. during the remaining years of the 8th Plan and similar amount in the 9th Plan for urban solid waste management.

6.4 By 2001 , 16 more cities are expected to have more than 1 million population and in the 9th plan each of them would need an investment of Rs. 3-10 crores/yr.

6.5 Smaller cities will also be facing the impact of urbanization during the Ninth Plan. The required outlay might be between Rs. 1 to 2 crore per city per year.

6.6 Appropriate land allocation for urban solid waste management should be made available as part of urban town planning in cities of varying size as/ well as upcoming satellite towns. Specific earmarked allocation of land for landfill sites as well as composting should be a part of town planning and must be made a mandatory prerequisite for approval of new urban settlements.

6.7 Recycling should get due recognition and support as a method of converting waste into useful articles; recycling industry should get assistance for technological upgradation to improve the quality of the product, reduce cost and minimize potential health hazards.

6.8 A review of current Municipal bye-laws should be undertaken and necessary modifications to ensure safe disposal of urban waste including hazardous industrial and hospital wastes should be taken up immediately. Appropriate modifications of the Municipal bye-laws taking into account local regional variations should be taken up as early as possible.

6.9 A review of town and country planning Act is also required so that necessary provisions for long-term urban solid waste management is made right in the beginning.

6.10 It is essential that appropriate nodal agencies for coordinating the activities required for proper management of urban solid waste is entrusted to one agency/cell. This cell can be located in any of the concerned Ministry and should coordinate and oversee the solid waste management activities including human resource development; collect, collate and report data pertaining to different aspects of solid waste management; assess and propose projects for safe management of solid waste by various municipalities; propose and obtain necessary financial outlays as well as steer appropriate legal Enablement Legislation.

6.11 It is essential to create a network of regional centres who could take up the research & development studies related to safe management of urban solid waste including hazardous and toxic industrial solid wastes, assess health and environmental impact of existing procedure for disposals of urban solid waste, undertake pilot studies of economically viable procedures for safe disposal. To begin with 4 centres who are involved in R & D work in related fields, namely AIIPH, Calcutta; NEERI.Nagpur; IRTC, Lucknow; and NIOH, Ahmedabad may be requested to draw specific proposals indicaf ing.the support that they would require in order to/ take up this activity. It is expected that during the remaining 8th Plan each of these institutions might require between Rs. 50 lakhs to 1 crore for such activities.

6.12 In view of the lack of trained and skilled manpower especially in smaller

municipalities and towns, it is essential that special training courses for in service personnel is taken up on a priority basis in institutions that have adequate background and experience in the area. AHHPH and NEERI may be requested to make a realistic appraisal of the need and prepare an action plan to remedy the deficiency in trained manpower. It is estimated that for this effort each of these institutions might require about Rs. 25 lakhs during the eighth plan period.

6.13 There is a need to create a cooperative for rag pickers so that the middlemen are eliminated and the rag pickers get due financial reward for their work.

6.14 Appropriate efforts should be directed to improve the awareness of the industrial management, health care personnel and general public of their respective role in ensuring safe disposal of potentially hazardous waste materials.

7 R AND D PILOT PROJECTS

7.1 The pilot or R&D projects in the following areas require support. Agencies with interest and expertise in each of these areas may be requested to submit appropriate proposals for scrutiny and processing.

7.2 Pilot Project

7.2.1 Separation of waste at source, in community bins and transport .

7.2.2 Improvement of existing dumping ground in a phased manner so that they become sanitary landfills.

7.2.3 Recovery of Methane gas from landfills.

7.2.4 Aerobic Composting - labor intensive, low mechanization composting for small towns/ satellite cities.

7.2.5 Biodigesters for hotel and market waste.

7.2.6 Non-hazardous Industrial Waste Management based on waste product recovery.

7.2.7 Hospital Waste Management with separation and decontamination at source.

7.3 Research & Development Projects

7.3.1 Appropriate Software Development for optimization of transport for urban solid waste management - NEERI.

7.3.2 Appropriate vehicle development for transportation at various levels — IIT Bombay.

7.3.3 Health impact assessment of currently prevalent poor USWM, industrial and hospital waste management practices.

7.3.4 Effect of Nutritional and Genetic make-up on the health hazard associated with exposure to infectious and toxic wastes.

7.3.5 Identification of appropriate liners for leachate control and recycling — NEERI.

7.3.6 Assessment of the present status of recycling industry and upgrading the same.

7.3.7 Development of small scale Incinerator for small clinics.

7.3.8 Decontamination at source and Disposal of hospital/clinic waste --NEERI.

7.3.9 Data base for Industrial Solid Waste from small industry -- ITRC.

7.3.10 Immobilization of Heavy Metals in industrial solid waste- IITs/IICT.

ANNEXURE-I

STATUS OF URBAN WATER SUPPLY AND URBAN SANITATION

(POPULATION '000)

Sl. No.	STATE/UT	Popln. as per 1981 Census	Coverage as on March 1981				Popln. as per 1991 Census	Coverage as on December 1991			
			Water Supply		Sanitation			Water Supply		Sanitation	
			Popln.	%age to 1981 Census	Popln.	%age to 1981 Census		Popln.	%age to 1991 Census	Popln.	%age to 1991 Census
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1.	Andhra Pradesh	12488	6910	55.33	1400	11.21	17813	11070	62.15	3313	18.60
2.	Arunachal Pradesh	41	20	48.78	20	48.78	105	NA	NA	NA	NA
3.	Assam	1702	530	29.74	300	16.84	2471	881	35.65	368	14.89
4.	Bihar	8719	5530	63.42	1740	19.96	11369	8381	73.72	4660	40.99
5.	Goa	323	NA	NA	60	18.58	480	439	91.46	210	43.75
6.	Gujarat	10602	9430	88.95	4370	41.22	14164	13908	98.32	12956	91.47
7.	Haryana	2827	1130	39.97	350	12.38	4045	3864	95.53	2304	56.96
8.	Himachal Pradesh	326	326	100.00	50	15.34	445	NA	NA	119	26.74
9.	Jammu & Kashmir	1260	1230	97.62	100	7.94	1839	NA	NA	195	10.60
10.	Karnataka	10730	9530	88.82	3620	33.74	13850	12966	93.62	7985	57.68
11.	Kerala	4771	2850	59.74	300	6.29	7676	6300	56.02	1780	23.19
12.	Madhya Pradesh	10586	7100	67.07	540	5.10	15348	13554	88.31	1313	8.55
13.	Maharashtra	21994	20870	94.89	8420	38.28	30496	NA	NA	24218	79.41
14.	Manipur	375	260	69.33	NA	NA	506	454	89.72	60	11.86
15.	Meghalaya	261	60	24.90	NA	NA	329	NA	NA	65	19.76
16.	Mizoram	122	10	8.20	NA	NA	317	134	42.27	11	3.47
17.	Nagaland	120	70	58.33	NA	NA	210	120	57.14	10	4.76
18.	Orissa	3110	1070	34.41	290	9.32	4233	2025	47.79	1747	41.27
19.	Punjab	4648	3050	65.62	1640	35.28	6001	4354	72.55	3677	61.27
20.	Rajasthan	7211	4060	56.30	300	4.16	10040	NA	NA	1021	10.17
21.	Sikkim	51	24	47.06	NA	NA	37	NA	NA	NA	NA
22.	Tamil Nadu	15952	12900	80.87	7400	46.39	19027	11173	58.72	7508	39.46
23.	Tripura	226	110	48.67	10	4.42	419	183	43.68	39	9.31
24.	Uttar Pradesh	19899	13990	70.31	2560	12.86	27653	27377	99.00	9770	35.33
25.	West Bengal	14447	8670	60.01	2240	15.50	18622	14418	77.42	7779	41.77
26.	A & N Islands	50	50	100.00	20	40.00	75	NA	NA	NA	NA
27.	Chandigarh	423	NA	NA	480	113.48	575	NA	NA	NA	NA
28.	D & N Haveli	7	NA	NA	NA	NA	12	NA	NA	8	66.67
29.	Daman & Diu	29	<------ Included under Goa ------>				48	48	100.00	31	64.58
30.	Delhi	5768	4700	81.48	3700	64.15	8427	NA	NA	7500	89.00
31.	Lakshadeep	19	NA	NA	NA	NA	29	NA	NA	NA	NA
32.	Pondicherry	316	180	56.96	120	37.97	517	417	80.66	326	63.06
	GRAND TOTAL	159463	114660	72.25 @	40030	25.25 @	217178	130082	78.95 @	98973	60.07 @

SOURCE: PLANNING COMMISSION

@:Including states for which figures are not available

ANNEXURE-II

URBAN POPULATION GROWTH AND DENSITY IN SELECTED CITIES

Urban Population (% of total)				Urban Population Annual Growth rate (%)		Popln. in cities of >1 mil. (as % of Urban)	Popln. in Major city largest with highest city population, (as % of density Urban)
	1960	1991	2000	1960-91	1991-2000	1990	1980 City Popln./sq.km.
Hong Kong	89	94	96	2.4	1	100	100 Hong Kong 5048
Singapore	100	100	100	1.7	1	100	100 Singapore 4160.
Thailand	13	23	29	4.6	4	57	Bangkok 3486
China	19	33	47	3.8	4.9	27	6 Beijing 4039
Egypt	38	47	54	3.1	3.6	52	39 Cairo 29393
Pakistan	22	32	38	4.3	4.6	42	21 Karachi 3990
India	18	27	32	3.6	3.9	32	6 Calcutta 88135
Bangladesh	5	16	23	6.8	6.2	47	30 Dhaka 9930
Japan	63	77	78	1.6	0.5	36	Tokyo 13973
USA	70	75	77	1.3	0.9	48	New York 8722

Source: HUMAN DEVELOPMENT REPORT, 1993.

ANNEXURE-III

MORTALITY, SAFE WATER AND SANITATION IN URBAN AREAS IN SOME SELECTED COUNTRIES

COUNTRY		Under-5 Mortality Rate		IMR		Total % Popln. (million) 1992	Urban Popln. with access to safe water	%Urban safe sanitation	ORT Use Rate	% Popln. Urbanised
		1960	1992	1960	1992					
1.	Bhutan	324	201	203	131	1.6	60	50	85	6
2.	Pakistan	221	137	137	95	124.8	80	55	34	33
3.	Nepal	279	128	186	90	20.6	67	52	14	12
4.	Bangladesh	247	127	151	97	119.3	82	63	24	18
5.	India	236	124	144	83	879.5	87	53	37	26
6.	Myanmar	237	113	158	83	43.7	37	39	19	25
7.	Malaysia	105	19	73	14	18.8	96	96	47	45
8.	USA	30	10	26	9	255.2	-	-	-	76
9.	UK	27	9	23	7	57.5	-	-	-	89
10.	Japan	40	6	31	4	124.5	100	85	-	77

Source: State of World Children UNICEF, 1994

ANNEXURE - IV

Estimated burden of disease from poor household environments in demographically developing countries, 1990, and potential reduction through improved household services

Principal diseases related to poor household environments a)	Relevant environmental problem	Burden from these diseases in developing countries (millions of DALYs per year)	Reduction achievable through feasible intervention (percent)b	Burden averted by feasible interventions (millions of DALYs per year)	Burden averted per 1,000 population (DALYs per year)
Tuberculosis	Crowding	46	10	5	1.2
Diarrhoea c)	Sanitation, water supply. hygiene	99	40	40	9.7
Trachoma	Water supply, hygiene	3	30	1	0.3
Tropical cluster d)	Sanitation, garbage disposal, vector breeding around the home	8	30	2	0.5
Intestinal worms	Sanitation, water supply hygiene	18	40	2	1.7
Respiratory infections	Indoor air pollution, crowding	119	15	18	4.4
Chronic respiratory diseases	Indoor air pollution	41	15	6	1.5
Respiratory tract cancers	Indoor air pollution	4	10 e)	*	0.1
All the above		338	-	79	19.4

* Less than one.

Note: The demographically developing group consists of the demographic regions Sub-Saharan Africa, India, China, Other Asian islands, Latin America and the Caribbean, and Middle Eastern crescent.

a) The diseases listed are those for which there is substantial evidence of a relationship with the household environment.
b) Estimate derived from the product of the efficacy of the interventions and the proportion of the burden of disease that occurs among the exposed. The efficacy estimates assure the implementation of improvements in sanitation, water supply, hygiene, drainage, garbage disposal, indoor air pollution, and crowding of the kind being made in poor communities in developing countries.
c) Includes diarrhoea, dysentery, cholera, and typhoid.
d) Diseases within the tropical cluster nest affected by the domestic environment are schistosomiasis. South American trypanosomiasis, and Bancroftian filariasis.
e) Based on very inadeouate data on efficacy.

Source: WORLD DEVELOPMENT REPORT 1993

Annexure-V(A)

No. 4(6)/94-H&FW Govt. of
India Planning Commission,

Yojana Bhavan, Sansad
Marg, New Delhi-110001
October 31,1994

OFFICE MEMORANDUM

Subject: URBAN SOLID WASTE MANAGEMENT IN INDIA
Constitution of a High Power Committee

Indian cities, wherein approximately one-fifth of India's total population lives,'are being subjected to a progressive decline; in the standard of services with respect to collection and disposal of house and trade wastes, as well as measures for environmental sanitation and public hygiene. The present level of services especially in areas with high population density pose a potential threat to environment as well as to public health and human well-being. Furthermore, a careful analysis of the present status of solid waste management in the Indian cities and towns would lead to the inevitable conclusion that better sanitation standards could have been achieved in most of our cities and towns by prudent and planned allocation of available resources to develop and support the application of appropriate low cost eco-friendly technologies. The degree of community sensitisation and public awareness generated recently because of resurgence of plague, needs to be harnessed towards participatory management aimed at the implementation of sound solid waste management policies, with the ultimate objective of producing requisite impact on public health.

It has, therefore, been decided to constitute a High Power Committee to look into various aspects of Solid Waste Management i in India and suggest suitable model(s) for the development of cost-effective and environment friendly approach(es) to promote sanitary methods of collection, transportation and disposal of solid wastes in Indian cities and towns, especially those with a population size exceeding 1 million inhabitants.

The composition of the Committee will be :

1. Prof. J.S. Bajaj, Member, Planning Commission..... Chairman

2. Dr. D. Swaminadhan, Member, Planning Commission.... Member

3.	Dr. S.Z. Qasim, Member, Planning Commission	..... Member
4.	Dr. Vasant Gowarikar, Past President, Indian National Science Congress, Pune	..... Member
5.	Dr. P.M. Chacko, President, The Institution of Engineers (India) Thampy Building, M.G. Road, Cochin - 682011	..... Member
6.	Dr. M. Ramakrishnan, Vice President National Academy of. Medical Science & Professor - Emeritus, Dr. MGR Medical University, 25 Nageswara Rao Road, Nungamakkam, Madras - 600 034	.... Member
7.	Dr. P.N. Khanna, Director, National Environment Engineering, Research Institute, Nagpur	..... Member
8.	Dr. K.J. Nath, Director, All India Institute of Hygiene, and Public Health, Calcutta	..... Member
9.	Shri Baleshwar Rai, IAS, Administrator , New Delhi Municipal Committee, New Delhi	..... Member
10.	Dr. Bindeshwar Pathak, Sulabh International, New Delhi	..... Member
11.	Shri Srinivas Shetty, Vice-President, Computer Maintenance Corp. Ltd. Bangalore	..... Member
12.	Dr. P.O. Grover, Professor of Chemical Engineering, Indian Institute of Technology, New Delhi	..... .Member

Adviser (Health), Planning Commission will be the Secretary of the Committee.

The Terms of Reference of the Committee are as follows:-

(1) To assess the impact of the present system(s) of Solid Waste Management on community health and suggest remedial measures aimed at minimising health hazards and adverse health outcomes.

(2) To identify the potential hazardous wastes in cities and towns including hospital wastes, and the associated health risk.

(3) To assess the guantum and characteristics of domestic, trade and industrial solid wastes in towns exceeding one million inhabitants (1991 census).

(4) To review the existing technologies for solid waste collection, transportation and disposal and suggest the most appropriate and feasible eco-friendly and cost-effective technology option(s) keeping in view the cost-benefit, the waste characteristics, socio-economic status and demographic structure of the community.

(5) To consider any other relevant issues.

The Committee may invite other experts for assistance and may undertake site visit(s) to inspect the available working models and assess their efficiency and effectiveness.

The Committee shall give its report within three months of its constitution.

The members of the Committee will be entitled for TA/DA as: per Government of India Rules.

Sd/-
(Gurjot Kaur)
Deputy Secretary to Govt. of India

Chairman & All Members of the High Power Committee

Copy to:
OSD to Deputy Chairman, Planning Commissioon
PPS to Member-Secretary,
PSs to Members, Planning Commission,
Secretaries of the concerned Ministries.

Chief Secretaries of all States/Union Territories Copy also for information to all Advisers/Heads of Divisions, Planning Commission.

Annexure-V (B)

No. 4(6)/94-H&FW
Govt. of India
Planning Commission

Yojana Bhavan,
Sansad Marg,
New Delhi-110001
November 21, 1994

OFFICE MEMORANDUM

Subject: Urban Solid Waste Management in India- Constitution of a High Power Committee

In continuation of the Planning Commission's O.M. of even number dated October 31, 1994 on the subject mentioned above, it has now been decided to include Dr. Jayant Patil, Member, Planning Commission as a member of the aforesaid committee.

2. The terms of reference of the Committee indicated in the Planning Commission's O.M. of even number dated October 31, 1994 remain unchanged.

Sd/-

(Gurjot Kaur)

Deputy Secretary to Govt. of India

Chairman & All Members of the High Power Committee

Copy to:-

OSD to Deputy Chairman, Planning Commission,
PPS to Member-Secretary
PSs to Members, Planning Commission
Secretaries of the concerned Ministries

Chief Secretaries of all States/Union Territories

Copy also for information to all Advisers/Heads of Divisions, Planning Commission.

ANNEXURE-V(C)

No.4(6)/94-H&FW

Government of India
Planning Commission

Yojana Bhavan,
Sansad Marg,
New Delhi - 110 001.
Date:06.06.1995.

OFFICE MEMORANDUM

Subject: Urban Solid Waste Management in India - Constitution of a High Power Committee.

In continuation of the Planning Commission's O.M. of even number dated October 31, 1994 on the subject mentioned above, ex-post facto approval of the competent authority has been accorded to include Dr.A.D.Bhide, National Environment Engineering Research Institute, Nagpur, India as a member of the aforesaid Committee w.e.f. 31.10.1994.

The term of reference of the Committee indicated in the Planning Commission's O.M. of even number dated October 31, 1994 remained unchanged.

sd/-
(Gurjot Kaur)
Deputy Secretary to the Govt. of India

Chairman & all members of the High Power Committee.

Copy to:
OSD to Deputy Chairman, Planning Commission
PPS to Member-Secretary
PSs to Members, Planning Commission
Secretaries of the concerned Ministries
Chief Secretaries of all States/Union Territories

Copy also for information to all Advisers/Heads of Divisions, Planning Commission.

Annexure V(D)

No. 4/6/94-H&FW
Govt. of India
Planning Commission
(Health & Family Welfare Division)

Yojana Bhavan,
Sansad Marg,
New Delhi-110001
Dated 28.4.1995

OFFICE MEMORANDUM

Subject:- Urban Solid Waste Management in India - Constitution of a High Power Committee

In continuation of the Planning Commission's Office Memorandum of even number dated October 31st, 1994 and the subsequent O.M. of even number dated 7.2.1995 on the subject mentioned above, it has been decided to extend the term of High Power Committee upto 31st May, 1995.

Sd/-
(N.K. Malhotra)
Deputy Secretary to the Govt. of India

Chairman and All Members of the High Powered Committee

Copy to:

OSD to Deputy Chairman, Planning Commission,
PPS to Member Secretary,
PSs to Members, Planning Commission,
Secretaries of the concerned Ministries,
Chief Secretaries of All States/Union Territories.

Copy also for information to All Advisers/Heads of Divisions, Planning Commission.

ANNEXURE-V(E)

LIST OF PARTICIPANTS IN THE VARIOUS MEETINGS OF THE HIGH POWER COMMITTEE ON URBAN SOLID WASTE MANAGEMENT IN INDIA

I. PARTICIPANTS IN THE FIRST MEETING

1. Prof. J.S. Bajaj, Member, Planning Commission

2. Dr. D. Swaminadhan, Member, Planning Commission

3. Dr. S.Z. Qasim, Member, Planning Commission

4. Dr. Jayant Patil, Member, Planning Commission

5. Sh.P.M. Chacko, President,
The Institution of Engineers (India) Thampy Building, M.G. Road, Cochin

6. Dr. K.M. Ramakrishnan, Vice President
National Academy of Medical Science & Chairman, Board of Studies,
Dr. MGR Medical University, 25 Nageswara Rao Road, Nungamakkam, Madras

7. Dr. A.D.Bhide, Dy. Director,
National Environment Engineering-Research Institute, Nagpur

8. Dr. K.J. Nath, Director,
All India Institute of Hygiene & Public Health, Calcutta

9. Shri Baleshwar Rai, Special Officer,
New Delhi Municipal Committee, New Delhi

10. Dr. Bindeshwar Pathak, Founder,
Sulabh International, New Delhi

11. Shri Sreenivasa Setty, Vice-President,
Computer Maintenance Corpn. Ltd. Bangalore

12. Dr. P.D. Grover, Professor of Chemical Engineering,
Indian Institute of Technology, New Delhi

II. PARTICIPANTS IN THE SECOND MEETING

1. Prof. J.S. Bajaj,
Member, Planning Commission
2. Dr. D. Swaminadhan,
Member, Planning Commission
3. Dr. S. Z. Qasim,
Member, Planning Commission
4. Dr. Jayant Patil,
Member, Planning Commission
5. Sh.P.M. Chacko, President,
The Institution of Engineers (India) Thampy Building, M.G. Road, Cochin
6. Dr. K.M. Ramakrishnan, Vice President
National Academy of Medical Science & Chairman, Board of Studies,
Dr. MGR Medical University, 25 Nageswara Rao Road, Nungamakkam, Madras
7. Dr. A.D.Bhide, Dy. Director,
National Environment Engineering-Research Institute, Nagpur
8. Dr. K.J. Nath, Director, All India Institute of Hygiene & Public Health, Calcutta
9. Shri Baleshwar Rai, Special Officer,
New Delhi Municipal Committee, New Delhi

10.	Dr. Bindeshwar Pathak, Founder, Sulabh International, New Delhi
11.	Shri Sreenivasa Setty, Vice-President , Computer Maintenance Corpn. Ltd. Bangalore

III. PARTICIPANTS IN THE THIRD MEETING

1.	Prof. J.S. Bajaj, Member, planning Commission'
2.	Dr . D . Swaminadhan , Member, Planning Commission
3.	Dr. S.Z. Qasim, Member, Planning Commission
4.	Sh.P.M. Chacko, President, The Institution of Engineers (India) Thampy Building, M.G. Road, Cochin
5.	Dr. A.D.Bhide, Dy. Director, National Environment Engineering-Research Institute, Nagpur
6.	Dr. K.J. Nath, Director, All India Institute of Hygiene & Public Health, Calcutta
7.	Shri Baleshwar Rai, Special Officer, New Delhi Municipal Committee, New Delhi
8.	Shri Sreenivasa Setty, Vice-President , Computer Maintenance Corpn. Ltd. Bangalore
9.	Dr. P.O. Grover, Professor of Chemical Engineering, Indian Institute of Technology, New Delhi

ANNEXURE-VI

A. Background papers prepared by the Members of the High Power Committee:

- Bajaj, J.S,
  Multi-professional education as an essential component of effective health services
- Bhide A.D.
  Background paper on urban solid waste
- Bhide A.D,
  Health status of refuse workers
- Bhide A.D.
  Projected capital costs for urban solid waste management
- Bhide, A.D,
  Health hazards from municipal solid waste
- Chacko, P.M.
  Urban solid waste management
- Grover, P.D.
  Identification of potential hazardous wastes in cities & towns and their associated health risks
- Khanna, P
  Municipal and industrial waste management in India
- Nath K.J.
  A discussion paper on urban solid waste management
- Nath K.J,
  Resource recovery from urban solid waste: problems & prospacts
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  Metropolitan solid waste management in India
- Nath K.J,
  Health risk associated with hazardous and toxic solid waste and their management
- Pathak, B.
  A review of existing technologies for solid waste collection, transportation & disposal of proposed low cost eco-friendly technologies
- Setty, S.
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B. Background papers provided by the Members of High Power Committee:

- Anderson, S. L. and Wild G. C.
  Linking genotoxic responses and reproductive success. Ecotoxicology Environmental Health Perspectives 102 (suppl.12): 9-12 (1994)

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- Washington Metropolitan Regional Sanitary Advisory Board: Summary report on sanitary sewers and waste water disposal in the Washington Metropolitan Region

C. Other background papers/documents consulted:

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  ISHA, Bangalore, 1990. p.p. 72-75

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- Excel Industries Ltd, Bombay:
  Technical document on the process.

- Newam Power Company, Madras :
  Refuse derived fuel cum power project (RDF)

- Report on Vermiculture Technology, Bombay

- Report of the Karnataka Compost Ltd., Bangalore

- Report of the Shiv Shankar Pelletisation Plant, Bangalore

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  Review Committee Report on Garbage processing plant at Bombay

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  Solid Wastes Management with community participation - pilot project

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- UCAL Power Systems Limited, Madras:
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Annexure-VII

No. 4(6)/94-H&FW
Govt. of India
Planning Commission

Yojana Bhavan Sansad Marg,
New Delhi-110001

January 31st, 1995,

OFFICE MEMORANDUM

Subject:- Constitution of a Sub-group of the High Power Committee on Urban Solid Waste Management in India

As decided in the first meeting of the High Power Committee on Urban Solid Waste Management in India held on 12th December, 1994 the undersigned is directed to constitute a Sub-group on Disposal of Urban Solid Waste. The composition of the sub-group will be as under:-

1.	Dr. D. Swaminadhan, Member, Planning Commission	Chairman
2.	Shri P.M. Chacko, President, The Institution of Engineers (India) Ltd., Cochin	Member

Adviser (Health), Planning Commission will be the convener of the sub-group. The Deputy Adviser (Health) will assist and co-ordinate the day-to-day activities of the sub-group.

The terms of reference of the sub-group are as under:-

(i) To look into technological aspects of urban solid waste.

(ii) To review the existing technologies for solid waste collection, transportation and disposal and suggest the most appropriate and feasible eco-friendly and cost-effective technology options.

The sub-group may invite other experts for assistance and may undertake site visits to inspect the available working models and assess their efficiency and effectiveness.

The Members of the sub-group and other experts invited by the sub-group will be entitled for TA/DA as per Government of India Rules.

Sd/-
(Gurjot Kaur)
Deputy Secretary to the Govt.of India

Chairman & All Members of the High Power Committee

Copy to:
OSD to Deputy Chairman, Planning Commission,
PPS to Member-Secretary
PS to Members, Planning Commission
Secretaries of the concerned Ministries
Chief Secretaries of All States/Union Territories

Copy also for information to all Advisers/Heads of Divisions, Planning Commission

Annexure-VIII

No. 4(6)/94-H&FW
Govt. of India Planning Commission

Yojana Bhavan,
Sansad Marg,
New Delhi-110001
January 31st, 1995

Office Memorandum

Subject: Constitution of a Sub-group of the High Power Committee on Urban Solid Waste Management in India

As decided in the first meeting of the High Power Committee on Urban Solid Waste Management in India held on 12th December, 1994 the undersigned is directed to constitute a sub-group on Urban Solid Waste Management System. The composition of the subgroup will be as under:-

1.	Dr. Jayant Patil, Member, Planning Commission	Chairman
2.	Shri P.M. Chacko, President, The Institution of Engineers (India) Ltd. Cochin	Member
3.	Dr. Bindeshwar Pathak, Sulabh International, New Delhi	Member

Adviser (Health), Planning Commission will be the convener ' of the Sub-group. The Deputy Adviser (Health) will assist and co-ordinate the day-to-day activities of the Sub-group.

The terms of reference of the sub-group are as under:-

(i) To study the garbage clearing system in Bombay and Sulabh International Bio-gas Plant in Delhi and to suggest a model approach for inclusion in the report of the Committee.

(ii) To review the existing technologies for solid waste collection, transportation and disposal and suggest the most appropriate and feasible eco-friendly and cost-effective technology option (s) keeping in view the cost benefit, the waste characteristics, socio-economic status and demographic structure of the community.

The sub-group may invite other experts for assistance and may undertake site visits to inspect the available Working Models and assess their efficiency and effectiveness.

The Members of the Sub-group and other experts invited by the Sub-group will be entitled for TA/DA as per Government of India Rules.

Sd/-

(Gurjot Kaur)

Deputy Secretary to the Govt. of India
Chairman & All Members of the High Power Committee
Copy to:-
OSD to Dy. Chairman, Planning Commission,
PPS to Member Secretary
PSs to Members, Planning Commission
Secretaries of the concerned Ministries
Chief Secretaries of all States/Union Territories
Copy also for information to All Advisers/Heads of Divisions,
Planning Commission

Annexure-IX

No. 4(6)/94-H&FW
Govt. of India
Planning Commission

Yojana Bhavan
Sansad Marg,
New Delhi- 110001

January 31st, 1995

OFFICE MEMORANDUM

Subject: Constitution of A Sub-group of the High Power Committee on Urban Solid Waste Management in India

As decided in the first meeting of the High Power Committee on Urban Solid Waste Management in India held on 12th December, 1994 the undersigned is directed to constitute a Sub-group on Health Hazards Care. The composition of the Sub-group will be as under:

1. Dr (Mrs.) K.M. Ramakrishnan,
Vice-President,
National Academy of Medical Science & Chairman, Board of Studies,
Dr. M.G.R. Medical University,
Tamil Nadu, Madras ..... Chairman

2. Dr. P. Khanna, Director,
National Environment Engg. Research Institute
Nagpur ..... Member

3. Dr. K.J. Nath, Director,
All India Institute of Hygiene &
Public Health,
Calcutta ..... Member

Adviser (Health) Planning Commission will be the Convener of the Sub-group. The Deputy Adviser (Health) will assist and coordinate the day-to-day activities of the Sub-group.

The terms of reference of the Sub-group are as under:-

(i) To identify the potential hazardous wastes for the cities and towns including hospitals/nursing home waste and associated health risk.

(ii) To review the existing technologies for disposal of solid waste garbage including hospitals/nursing home wastes.

The Sub-group may invite other experts for assistance and may undertake site visits to inspect the available working models and assess their efficiency and effectiveness.

The Members of the Sub-group and other experts invited by the Sub-group will be entitled for TA/DA as per Government of India Rules.

Sd/-
(Gurjot Kaur)

Deputy Secretary to the Govt. of India

Chairman & All Members of the High Power Committee Copy to:
OSD to Deputy Chairman, Planning Commission
PPS to Member Secretary
PSs to Members, Planning Commission
Secretaries of the concerned Ministries
Chief Secretaries of All States/Union Territories

Copy also for information to all Advisers/Heads of Divisions Planning Commission.

ANNEXURE-X

Site Visit of Sub-Committee to Bombay

Date of visit: 21.2.1995

Members of the site visit team:

Dr. J.S.Bajaj, Chairman, High Power Committee on Urban Solid Waste Management

Dr. Jayant Patil, Chairman of the Sub-Group of the High Power Committee

Dr. P.M.Chacko, Member of the High Power Committee

Dr. B.Pathak, Member of the High Power Committee

Dr. B. Rai, Member of the High Power Committee

The Group visited the following sites:

(1) Excel Industries Plant at Amboli,

(2) Chincholi Dumping Grounds

(3) CMC Palletisation Plant, Deonar and

(4) Vermiculture Centre, Deonar.

Excel Industries Plant:

Excel Industries has developed a solid waste microbial degradation process (with a mixture of azobacter Chromococcus, Azospirillum Braziliense, Trichoderma Viridae, Psuedomonos Striata, Aspergillus Terrus and Rhisobium Malitosis; the citronella and orange peel extracts are added to this mixture) which within few hours eliminates all smell emanating from solid waste and helps rapid decomposition of urban solid waste. The process is exothermic fermentation and therefore the treated wastes become free of bacterial contamination; fly and mosquito problems are also prevented. It is reported that bioconversion process is completed in 6 to 8 week's time. The degraded biomass is processed using indigenously designed mechanical sieves, gravity separators and vibrating sieves to remove non-degradable substances. The final product is subjected to quality control for microbial parameters, analysis and standardisation. The final product is a soil enricher, which can be used as fertiliser in agricultural operation. It is being packed in 50, 5 and 1kg packets and are distributed through the dealers. The plant at Bombay is currently treating 300 tonnes of solid waste. The end product is also being supplied to Bombay Municipal Corporation for use in the Municipal gardens.

It was stated that the exothermic reaction generates Temperatures upto 70-75 degree celcius; this energy can be tapped by heat exchange boilers. This is being looked into by the firm.

It was stated that the technology is flexible for application to various waste generation capacities in different Municipal areas. The firm stated that the Plants handling 300 tonnes of solid waste per day will be economically viable. One of the important considerations is the availability of the consumers of the fertilisers in the nearby areas so that the transport costs can be reduced and economic viability ensured.

The representatives of the Company indicated that they had already drawn up proposals for solid waste management plants in other cities including Bhopal and that during the next year some of these projects may be initiated.

Fuel Palletisation Plant operated by CMC at Deonar

This Pelletisation plant was started in June 1991 with the funds provided through the Department of Science and Technology and is being currently operated and maintained by CMC Limited. The plant was commissioned on a plot of approximately 3500 sq.mt. at Deonar Dumping Ground. The garbage received in trucks is unloaded in the specially prepared floor for sun drying so that the moisture content is reduced to 40 to 60 per cent. Further drying is done by rotary dryers to achieve a reduction in moisture to 10 per cent. Biomass from garbage is used as a fuel for drying . After drying, the inert and metalic particles are removed by sieve and by magnet . The final material is crushed and mixed with binders and fed into the pelletiser. Fuel pallets of 30, 20 and 8 mm are manufactured. Calorific value of the pellet is 3500 to 4000 K.cal/kg. The market for the pellets is domestic medium scale industrial furnaces. It is estimated that for every 100 tonnes of raw garbage 20 tonnes of pallets will be produced.

Currently the plant is processing about 50 tonnes of garbage daily and is producing 10 tonnes of pellets. The plant was not in operation at full capacity at the time of the visit. The sub-committee noted that large areas of land are required for drying the waste. The technology for obvious reasons cannot be used during monsoon in Bombay. The proposal that the plant will be operated in two shifts as well as the feasibility of providing alternative method to remove excess moisture have not yet been implemented. The process is yet to be tried out on a commercial scale.

The Sub group suggested that CMC may draw up a proposal for full operationalisation of the plant in two shifts and request for necessary funds to carry out the same so that the technoeconomic feasibility of the process could be assessed.

The treatment of garbage by Vermiculture

The project is being undertaken in consultation with IIT Bombay. The initial proposal envisaged that every day, 200 tonnes of organic waste from the city markets will be processed in the area of about 10 hectares in Deonar dumping grounds and that for every tonne of the garbage 150 Kg of vermiculture material will be produced. The organic waste mostly in the form of vegetable waste is to be mixed with ordinary soil and earthworm eggs in the form of culture. The earthworms feed on the garbage and in that process convert it into vermicompost, which can be used as a fertiliser.

The project has not yet become fully operational. It was stated that in order to speed up the process of vermiculture, sufficient watering and provision of shade are essential and trees are being planted for this purpose. The Consultant from IIT also stated that the dumping ground soil, contained too much of non biodegradable material and soil conditions have to be improved in order to get better re-, suits. As the project is yet to become operational even on a pilot basis the Committee could not evaluate the same.

Site Visit of Sub-Committee to Bangalore

Date of visit: 10.4.95

Members of the site visit team:

Dr. J.S.Bajaj, Chairman, High Power Committee on Urban Solid Waste Management

Dr. K.M.Ramakrishnan, Chairman of the Sub-Group of the

High Power Committee

Dr. P.M.Chacko, Member of the High Power Committee

Dr. B.Pathak, Member of the High Power Committee

The Group visited the following sites :

(1) Pelletisation plant operated by Shiv Shankar Engineering, Bangalore

(2) Karnataka Compost Development Corporation Ltd., Bangalore

Pelletisation plant operated by Shiv Shankar Engineering,

Bangalore

Pelletisation process used by Shiv Shankar Engineering, Bangalore, is essentially similar to the process used at the CMC plant at Bombay which had been described under section dealing with the site visit 'to Bombay; it however overcomes one of the drawbacks of the CMC scheme, i.e. primary' dependence on sun for drying the waste by utilising heat for drying of the solid waste. In the Bangalore model, there is "'provision for substantial amount of mechanical drying which would imply that this plant could function, though at reduced efficiency, even during rainy Season.

The pilot plant has not been in operation for a while and is now mainly being used as a demonstration plant; hence technoeconomic feasibility and viability of the project on a "commercial scale operation could not be assessed.

The team could not see the plant during the operation as there was a power failure in the city and hence the plant was not in operation. However during the discussions the "firm's representatives stated that though the present plant was only a pilot project, they had been utilising the experience gained and were planning to utilise the technology with suitable modifications in different cities .

For instance Deal Power Systems Ltd., Madras are planning to embark on a project in Madras for using municipal solid waste for electricity generation. The fuel preparation will be a modified version of the Shiv Shankar pelletisation. Instead of pelletising, dry waste will be pressed to a degree sufficient for easy combustion as a fuel for boiler operation. 500 tons of solid waste are expected to generate about 5 MW of power, of which 1.25 MW would be utilised for internal consumption, leaving 3.75 MW for sale or other use. The cost of electricity produced has been worked out to be Rs.2.40.

Karnataka Compost Development Corporation Ltd.

Karnataka Compost Development Corporation Ltd., is operating a composting plant at Bangalore converting municipal solid waste into compost. The garbage is spread over

specially prepared concrete floor, stacked into Windrows with the help of payloaders. A specially developed slurry is sprayed to speed up the aerobic decomposition and the waste mass is turned over every 5 days. It is reported that it takes' only 30 days for total decomposition.

The plant is not operating under full capacity. Non-availability of sufficient and suitable garbage is cited as a reason for its under utilisation. As the project is not operating under full capacity, the Group was not able to assess the commercial viability of the project. The members made several useful suggestions both regarding improving the operations and also on how to attractively package and sell /the compost so that there is a ready market for the compost c and the project readily becomes economically viable.

ANNEXURE - XI

MINISTRY OF ENVIRONMENT AND FORESTS
NOTIFICATION

New Delhi, the 24th April, 1995

S.O. 378(E) - The following draft of certain rules which the Central Government proposes to make in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), is hereby published for the information of the public likely to be affected thereby and notice is hereby given that the said draft rules will be taken into consideration on or after the expiry of sixty days from the date on which copies of Gazette of India in which this notification is published in the Official Gazette, are made available to the public.

Any objections or suggestions which may be received from any person with respect to the said draft rules before the expiry of the period specified above will be considered by the Central Government. Objections or suggestions, if any, may be addressed to the Secretary, Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, Lodi Road, New Delhi.

DRAFT_RULES

1. Short title and commencement :—

(a) These rules may be called the Bio-Medical Wastes (Management and Handling) Rules, 1995.

(b) They shall come into force on the date of their final publication in the Official Gazette.

2. Application :—

These rules shall apply to all bio-medical wastes other than the radio-active wastes which are covered under the provisions of Atomic Energy Act, 1962 (33 of 1962) and the rules made thereunder.

3. Definitions :—

In these rules the context otherwise requires -

(a) "Act" means the Environment (Protection) Act, 1986 (29 of 1986);

(b) "appropriate authority" means an appropriate authority nominated under rule 5;

(c) "Authorization" means the Authorisation granted under rule 7;

(d) "authorised person" means any generator or operator of a bio-medical waste facility in whose name Authorisation has been granted;

(e) "bio-medical waste" means any solid, fluid or liquid waste including any intermediate product, which is generated during the diagnosis treatment or immunisation of human beings or animals in research pertaining thereto or in the production or testing biologicals and the animal waste from slaughter houses or any other like establishment including the wastes listed in Schedule-I;

(f) "biologicals" means preparations made from organisms or from products of metabo-

lism intended for use in diagnosis, immunisation or the treatment of human beings or animals or in research activities pertaining thereto ;

(g) "bio-medical waste facility[1] means any location wherein treatment disposal of bio-medical wastes or processes incidental to such treatment or disposal are carried out;

(h) "disposal" means discharge, deposit, dumping land-filling or placing on land of any bio-medical waste;

(i) "export" means taking out of India to a place outside India;

(j) "Form" means form annexed to these rules;

(k) "gentrator" means any person in charge of a hospital nursing home, clinic, dispensary, laboratory, animal house, slaughter house including those established by or under the control of Government, which generates or causes to be generated, handles or causes to be handled any bio-medical wastes;

(1) "import", means bringing into India from a place outside India;

(m) "incineration" means a process whereby cumbustible materials are converted into non-combustible residue or ash, achieving a reduction volume or weight;

(n) "operator of a bio-medical waste facility" means a person or an institution owning or providing the facility for collection, segreation, storage, transportation, treatment and disposal of any bio-medical waste and authorised as such by the appropriate authority.

(o) "Schedule" means the Schedule annexed to these rules;

(P) "segregation" means separation of different types of wastes by sorting;

(q) "specified areas" means any area designated exclusively for the storage of bio-medical wastes;

(r) "storage" means the holding of bio-medical waste for such period of time at the end of which the waste is treated and disposed of;

(s) "treatment" means a method, technique or process designed to change the physical, chemical or biological characteristics or composition of any bio-medical waste so as to render such a waste non-hazardous to health and environment;

(t) words and expressions used in these rules and not defined but defined in the Act shall have the same meanings, respectively, assigned to them in the Act.

4. Bio-medical wastes to be handled only according to these rules - No person shall handle or dispose any bio-: medical waste except in accordance with these rules.

5. Appropriate authority : —
A State Government shall by notification in the Official Gazette, nominate any person incharge of the Directorate of Health Services or Directorate of Animal Husbandry or Veterinary Sciences or of the Pollution Control Board of that State as an appropriate authority for the purpose of granting Authorisation under these rules :

Provided that different officers may be nominated as appropriate authorities for the purpose

of granting Authorisation for different stages in the handling of bio-medical wastes.

6. Bio-medical wastes not to be generated without Authorisation:—

(1) No person shall generate or cause to be generated handle or cause to be handled any bio-medical waste or operate or cause to be operated any bio-medical waste facility unless he has obtained an authorisation from the appropriate authority.

(2) Any person who intends to generate or cause to be generated, handle or cause to be handled any bio-medical wastes or intends to operate or cause to be operated any bio-medical waste facility, shall make an application in Form-I to the appropriate authority provided that no Authorisation shall be necessary in case of any person generating or causing to be generated, handling or causing to be handled any bio-medical wastes or operating or causing to be operated any bio-medical waste facility immediately before the commencement of these rules for a period of six months from the date of such commencement.

(3) An Authorisation granted under sub-rule (1) may also authorise a hospital, nursing home, clinic or a clinical laboratory including a blood bank, to operate a bio-medical waste facility.

7. Power of appropriate authority to grant Authorisation:

1. The appropriate authority shall on receipt of an application for the grant of Authorisation, make such enquiry as it deems fit and if it is satisfied that the applicant possesses appropriate facilities, technical capabilities and equipment to handle bio-medical wastes, grant an Authorisation.
2. The Authorisation under sub-rule (1) shall be issued in Form-II and shall be subject to conditions laid" down therein.
3. An Authorisation shall, unless sooner suspended or cancelled, be in force for a period of two years from the date of issue or from the date of renewal.
4. An application for the renewal of Authorisation shall be made in Form-I before its expiry.
5. The appropriate authority may, after giving reasonable opportunity of being heard to the applicant and for reasons to be recorded in writing, refuse to grant an Authorisation.

8. Power to suspend or cancel Authorisation:

(1) The appropriate authority may cancel an Authorisation issued under these rules or suspend it for such period as it thinks fit, if in its opinion the authorised person has failed to comply with any of the conditions subject to which the Authorisation was granted or with any provisions of the Act or these rules:

Provided that no Authorisation shall be cancelled or suspended without giving a reasonable opportunity of being heard and without recording the reasons thereof.

(2) Upon suspension or cancellation of the Authorisation and during the pendency of an appeal under rule 15, the appropriate authority may give directions to the person whose Authorisation has been suspended or cancelled, for the safe storage of the bio-medical wastes and such person shall comply with such directions.

9. Responsibility of Generators and Operators of bio-medical waste facility :—

(1) A generator or an operator of a bio-medical wastes facility shall take such:

(a) measures as the Central Government may, with a view to preventing damage or adverse effect to the environment and the life sustained in it, notify in the Official Gazette from time to time in this behalf;

(b) other practical steps to ensure that such wastes are properly handled, treated and disposed of.

(2) A generator or an operator of a bio-medical waste facility shall give in the month of June and December every year a bi-annual detailed information about the types and quantities of bio-medical wastes collected or handled by him during the preceding six months to the appropriate authority in form-Ill.

10. Segregation, packaging, transportation and storage :—

(1) An authorised person handling any bio-medical waste shall segregate all categories of such wastes prior to its storage or transportation off-site.

(2) An authorised person handling bio-medical wastes shall ensure that :-

(a) the packaging of all bio-medical wastes is done in sturdy leak resistance containers conforming to the specifications prescribed in Schedule-II;

(b) the container in which such bio-medical wastes are packed display prominently a label in red colour with details of bio-medical wastes as specified in Schedule-Ill.

(3) No bio-medical wastes shall be transported on-site or off-site in any vehicle other than those designated by the authorised person for this purpose.

(4) No bio-medical wastes shall be stored in any place where it is generated beyond a period of three days;

Provided that if for any reason it is necessary to store any such bio-medical waste beyond the period of three days, the authorised person shall take such measures to prevent decay by putrefaction of such bio-medical wastes.

(5) All hospitals, nursing homes and clinical laboratories including blood banks shall earmark specific areas within their premises away from the general service area for the purposes of storing bio-medical wastes.

11. Treatment and Disposal:

(1) All bio-medical wastes shall be treated and disposed of in accordance with the treatment options specified in Schedule-IV.

(2) All bio-medical wastes which are required to be totally destroyed by incineration according to the treatment option specified in Schedule-IV shall be treated and disposed of only in a facility authorised under these rules.

(3) Every hospital, nursing home, clinic by whatever name called, having more than

thirty beds or catering to more than thousand patients per month shall install an incinerator in its premises.

(4) Hospitals, nursing homes and clinics to which sub-rule (3) does not apply, shall set up a common incinerator facility in accordance with the directions given by the appropriate authority.

(5) Every veterinary institution, animal house or slaughter house generating more than 200 kilograms of bio-mass waste per day, shall install an incinerator in its premises.

(6) All bio-medical wastes which are not incinerable shall be pre-treated, disinfected and shall be disposed of in an environmentally sound manner by the authorised person in such sites identified by the appropriate authority for this purpose.

(7) All bio-medical wastes arising from handling of living or non-living natural pathogens and genetically engineered organism or products there from shall be treated and disposed of by such methods as the Central Government may, notify in the Official Gazette.

(8) No person shall dump, discharge or dispose or cause to be dumped, discharged or disposed any bio-medical waste in any place other than a site identified for the said purpose by the appropriate authority.

(9) Every authorised person shall take all precautions and safety measures including the provision of protective clothing, masks, gloves and such other protective gear as may be necessary for affording protection, to all the persons engaged in handling bio-medical wastes or exposed to such wastes, against infections due to handling or exposure to bio-medical waste.

(10) No person shall re-cycle or re-use of cause to be re-cycled or re-used any bio-medical wastes except glassware.

12. Records and returns:

(1) Every authorised person shall maintain records containing such particulars specified in Form-IV,

(2) Every authorised person shall file annual returns in Form-V to the appropriate authority.

13. Accident reporting and follow up:

Where any accident occurs at any location or side where bio-medical wastes are handled or in a bio-medical waste facility or during transportation of such bio-medical wastes, the authorised person shall report the accident in Form-VI to the appropriate authority forthwith.

14. Import and export of bio-medical wastes:

The appropriate authority shall not grant an Authorisation under these rules if it is of the opinion that such Authorisation is likely to be used to export but of or import into India any bio-medical wastes.

15. Appeal:

(1) An appeal shall lie against any order of suspension, cancellation of an Authorisation or against the refusal to grant an Authorisation by the appropriate authority, to the State Government.

(2) Every appeal shall be in writing and shall be accompanied by a copy of the order appealed against and shall be presented within thirty days from the date on which cancellation, suspension or refusal is communicated to the person aggrieved.

Schedule - 1
Categories of Bio-Medical Wastes

Waste Category	Waste Class	Waste Description
No,l	Hunan Anatomical Wastes, blood and body fluids	Waste consisting of human tissues, organs, body parts, body fluids, blood and blood products and items saturated or dripping with blood, body fluids contaminated with blood and body fluids relieved during/after treatment, surgery oir autopsy or other medical procedures.
No, 2	Animal Waste	Waste consisting of animal tissues, organs, body parts, carcasses, beeding, fluid blood and blood products, items contaminated with blood and fluids, wastes from surgery treatment, and autopsy and wastes of experimental animals used in research, Haste generated by veterinary hospitals, coleges, animal houses and livestock farms.
No. 3	Microbiol-ogy	Wastes from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes and production of biologicals, dishes and devices used to transfer of cultures,
No. 4	Waste Sharps	Wastes consisting of sharps such as needles, syringes, scalpels, blades, gloass etc. that are capable of causing puncture and cuts. This includes both used and unused sharps.
No, 5	Highly infectious wastes	Waste containing highly infectious living and nonliving pathogens and exposure to it could cause disease.
No, 6	Isolated waste	Biological wastes from discarded materials contaminated with blood, excertion exudates or secretions from human and animals isolated due to communicable diseases,
No.7	Discarded Medicines	Wastes comprising of outdated, contaminated and discarded medicines,
No.8	Discarded Glasswares	Wastes generated from glass-ware and equipments used.
No.9	Solid Waste	Wastes generated from soiled cotton, dressings, liners, beddings including the packaging materials,
No.10	Dispos-ables	Wastes generated from disposable items other than the waste sharps.
No.11	Liquid wastes	Wastes generated from laboratory and washing, cleaning, house-keeping and disinfecting activities.
No.12	Bio-technology	Wastes generated from activities involving genertically engineered organisms or products and their cultures not declared to be safe,
No.13	Slaughter House wasted	Wastes generated in the form of animal tissues, blood and body fluids.
No.14	Incinera-tion wastes	Ash from incineration of any Bio-medical wastes.

SCHEDULE - II
TYPES OF CONTAINERS TO BE USED

Type of Containers	Type of Waste
Reusable container (Metal/Sturdy Plastic)	Non-Infectitious Wastes
Single-use Containers	Infectious Wastes
Sharp Containers (Sturdy P last ic/S lass/Metal)	Sharps & Needles
Plastic Holding Bags	Cotton, Dressings Etc.
Cardboard Containers	Bottles, Glasswares

COLOUR CODING FOR CONTAINERS

Colour (Containers)	Types of Wastes
Yellow	Clinical waste for incineration only.
Yellow with black stripes	Clinical waste which is suitable for landfill disposa
Light blue or transparent with light blue lettring	Waste for autoclaying or equivalent treatment before final disposal.
Red	Human anatomical wastes
Orange	Animal wastes
Black	Normal household waste

SCHEDULE - III

LABEL FOR BIO-MEDICAL WASTNTAINERS

BIOHAZARD SYMBOL

BIOHAZARD

CYTOTOXIC HAZARD SYMBOL

CYTOTOXIC

HANDLE WITH CARE

Waste category No. _____ Date of generation Oay/Month/Year

Waste Class _____

Waste Description _____

Sender's Name & Address

Phone No. _____

Telefax No. _____

Telex No. _____

Contact Person _____

Receiver's Name 8 Address

Phone no. _____

Telefax No._____

Telex No. _____

Contact Person _____

In case of emergency Please contact:

Name & Address _____

Phone No. _____

Note:

1. Background Colour shall be Fluorescent Yellow.
2. Bio-hazard Symbol shall be in RED colour.
3. Label shall be of non-washable material

SCHEDULE - IV

TREATMENT & DISPOSAL OPTIONS

Waste Class	Treatment & Disposal Options
Human Anatomical Waste	Disinfection and incineration/Burial
Animal Wastes	Disinfection and burial
Micro-biology	Disposal in special container
Human blood & Body fluids	Dilution with disinfectant Disposal in special drains
Waste sharps	Disposal in special containers and landfill
Highly infectious wastes	Special decontamination, packing in specially designed containers and final disposal on secured landfill.
Isolated wastes	Secured landfill disposal after suitable treatment.
Discarded medicines	Incineration
Discarded glassware	Decontamination, destruction
Soiled-waste	If infectious to be disposed of as infectious waste, if no infectious to be disinfected and disposed.
Disposables	Packaging in appropriate containers and incineration dispo on secured Landfill.
Liquid Wastes	Disinfection and discharge in special drains.
Bio-technology waste	Packaging in special containers and disposal on land.
Slaughter house waste.	Disinfection and disposal on land for solid and treatment and discharge for liquid.

SOURCE: THE GAZETTE OF INDIA (EXTRAORDINARY) NO. 233 DATED 25TH APRIL, 1995, NEW DELHI