DISSERTATION-II

SOLID WASTE MANAGEMENT OF JALANDHAR CITY

Submitted by

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in partial fulfillment for the award of the degree of

MASTER OF TECHNOLOGY

IN **ENVIRONMENTAL ENGINEERING**

Under The Guidance of

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ABSTRACT

This dissertation work considers the solid waste management system in Jalandhar city, Punjab, India, in order to develop a framework for sustainable solid waste management in future. The objectives of this thesis were:

1) To describe and explain the current waste management system and practices in Jalandhar;

2) To identify factors that influence waste management in the City area

3) To propose recommendations for development and improvement for waste management system.

The objectives were addressed primarily through semi-structured interviews and discussions with various stakeholders along with non-participatory method tools.

The study analyzed the current solid waste management system and identified the strengths and the weaknesses of the system. It was observed that the current solid waste management system practiced in Jalandhar is not properly managed. There is no provision for the segregation of waste. The collection and transportation of waste is inadequate and inappropriate. Officially, there is no provision for composting or recycling of the waste. Majority of the waste is dumped in open landfill and people are not involved in solid waste decision making process or the solid waste management system. Further, the study also analyzed the newly proposed solid waste management system. The proposed waste collection and transportation system is an improvement on the current system. Composting of biodegradable waste is an important feature of the proposal. The proposed system, however, omitted critical points which need to be addressed in order to develop a sustainable solid waste management system. The study also identified and analyzed the factors that influence the solid waste management system in Jalandhar setting. It was found that the factors are:

1) Existing decision making system. Basically the decision making process is top-down and bureaucratic, which dissuades people from participating in the solid waste management process,

2) People's perception of wastes as a problem vis-à-vis other existing problems. Even though many people regard wastes as a threat, they would rather have other problems such as employment, safe drinking water etc., solved before solving of waste problem,

3) Gap between decision makers and people in terms of information transformation. Most of the people are not informed about the decision undertaken by the authorities,

4) the relationship between political stability and governance. Plans and processes initiated by one set of people in power is often abandoned mid-way when a new set of people come in power. For instance, an Integrated Solid Waste Management process started by the previous board was bunged by the new board altogether, and

5) presence of self-organized grass root level organization called samaj. These

organizations can influence the solid waste management in a positive manner by involving and ensuring public participation in various programs

.

Taking all the issues and factors into consideration the thesis makes some recommendations for developing a sustainable solid waste management system for the future. Some of these recommendations are:

i) Involving people for consultation with respect to solid waste management decision making process.

ii) Promotion of reduction, reuse and recycling,

ii) Promotion of community based composting,

iii) Doorstep collection of segregated waste and,

iv) Responsible bureaucracy.

v) Introduction of Landfill

The thesis summarizes that the current solid waste management system is not sustainable and not proper. The proposed system can be improved on following the list of recommendations mentioned in the thesis. The thesis concludes that people in Jalandhar city area are willing to participate and contribute towards the development of a sustainable system. Finally, a set of recommendations have been provided for laying the foundation towards good solid waste management system in Jalandhar City

ACKNOWLEDGEMENT

I take this opportunity with much pleasure to express my sincere thanks and gratitude to the faculty and concern department. This research paper is made possible through the help and support from everyone, including: parents, teachers, family, friends and in essence, all sentient beings. Especially, please allow me to dedicate my acknowledgment of gratitude toward the following significant advisors and contributors:

First and foremost, I would like to thank Assistant Professor Kirti Goyal for her most support and encouragement. She was kind to read my paper and offered invaluable detailed advices on the work progress and the theme of the paper.

Second, I would like to thank the engineering staffs of Pollution Control Board, Zonal Office of Jalandhar for providing valuable data for the work progress of the report and the HODs of my department for updating the requirement of writing the report.

Finally, I sincerely thank to my parents, family, and friends, who provide the advice and financial support. The product of this research paper would not be possible without all of them.

Thank you

ChaobaNingombam

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TERMINOLOGY USED

1. MSW-Municipal Solid Waste
2. SW- Solid Waste
3. BMW- Biomedical Solid Waste
4. HS- Hazardous Waste
5. 3Rs- Reuse, Reduce and Recycle
6. WHO- World Health Organization
7. CPCB- Central Pollution Control Board
8. PPCB- Punjab Pollution Control Board
9. C/N- Carbon Nitrogen ratio
10. MC- Municipal Cooperation
11. TPD- Tones per day
12. TPA- Tones per annum
13. WTE- Waste to Energy
14. ULBs- Urban Local Bodies
15. TSDFS- Treatment Storage and Dumping Facilities
16. NOx- Oxides of Nitrogen
17. Sox- Oxides of Sulphur
18. CDM- Clean Development Mechanism
19. GHG- Green House Gases

CHAPTER- 1

1.1 INTR0DUCTION

Solid waste in a simple way can be term as waste generated from any human activities which may include the domestic waste, waste from industries or may be generated from animals, etc. They are basically semi-solid or solids in nature. Solid wastes are the discarded or useless materials which people usually terminate by throwing or burning. Waste generated of industries or factories are known as industrial waste and waste that are generated from domestic households and any commercial sites are known as municipal solid waste. As the population increases day by day the concern and rise of solid waste increases and it required proper management of solid waste. The maximum wastes are generated from residential area and they come under municipal solid waste. The domestic waste may include both bio-degradable and non-biodegradable materials. These wastes cannot be reuse unless they are segregated and treated properly before using. We can say that generation of solid waste is both natural and manmade process. The human and animal excreting solid waste or the dead plants and animal can be come under natural process whereas the wastes which are generated from industries or any other manmade defects which are useless and discarded are term as manmade solids waste. It can be term that the useless solid waste generated of a particular area is directly equivalent to the population of that area. If the population is less, then there will be less generation of solid waste on that area. Many researchers are studying the outcome of this waste and development has been done to improve the living standard. If the waste are not check properly it may cause various health effect to both the animals and plants. As India is the second largest populated country in the world, it usually generates million tonnes of solid waste and hazardous waste which required proper management. The number of stations which deals with the generation of hazardous waste in India is 12000(approx.).

The safe disposal of solid wastes of a particular society is not a big problem, if the population is less and the area available for treating the solid waste is vast. Mostly the developing countries are the one which generate larger solid waste as compare to developed nations. It required good governing laws and techniques to reduce the ill effects of solid waste in a society.

In past years there was no serious concern over the solid waste management which also includes the techniques like incineration or proper disposal in land. People used to dump the wastes on the roadsides of highway and water bodies like ponds, rivers, seas, etc. And this leads to creation of many air borne and water borne diseases which are harmful to both humans and animals.

1.1 TYPES AND SOURCE 0F S0LID WASTE

According to the sources and their harmful effects the solid waste are divided into certain group. The generation of solid waste are differ from where it is generated. Some content high amount of degradable material whereas some content non-bio-degradable and toxic in nature. Following are the types an source of solid waste:

i. MUNICIPAL SOLID WASTE OR DOMESTIC/RESIDENTIAL WASTE

They can be defined as the wastes which are generated from residential household activities or any commercial sites. The commercial site consists of the market of any domestic uses and vegetables stores, shops, etc. Some of the components of municipal waste are as follows:

*Food waste- Which generally includes the cooking waste, rotten vegetables, residue, garbage, etc.

*Rubbish-It consists of papers, plastics, rubber, leather, metal can, etc.

*Construction and demolition waste- which consists of construction waste like stone, aggregates, bricks, electrical parts and metals.

*Special waste- They are the dead animal or useless vehicles.

*Waste generated from treatment plant-which consist of solid and semi-solid materials taken out from waste water treatment plan.

ii. INDUSTRIAL WASTE

Waste usually generated from industries which may content toxic of chemical. They may be harmful to humans and plants. Typical industrial waste may include the demolition and construction waste, special wastes and hazardous waste. The waste generated from this kind of source required special attention because it may led to disturbance to nature thereby disturbing the environment creating nuisance.

iii. BIOMEDICAL WASTES

They are basically the waste generated from hospitals and includes human waste, anatomical discard of both humans and animals, expired drugs, tissue cultures discard, fluids from the body, human excreta, disposable syringes, etc.

They required special treatment before disposal and if not treated well they are highly infectious and cause serious problem to human health. Estimated waste generated from hospital is 0.5-1kg per bed per day.

iv. HAZARDOUS WASTES

They can be define as the waste generated from any industries which are not easily disposable before treating properly and poses instant danger which can harm human when contacted directly. The basically poses the following characteristics:

*Toxicity

*Highly reactive

*Corrosively

*Ignitability

Before the hazardous waste were grouped into radioactive substances, chemicals, biological waste, explosive, etc. The main sources of hazardous waste are from hospitals, chemical industries and research facilities.

v. AGRICULTURAL SOLID WASTE

This type of waste is related to agriculture. They may cause serious harmful to human and plants. Basically they include the excess nutrients, pesticides, insecticides or veterinary medicines. When they come in contact or accumulate in our body it causes serious harmful to human health. In a serious concern, if there is more farming then it may emit ammonia and methane. After they will cause acidification and add to produce of more greenhouse gas emissions.

vi. RADIOACTIVE WASTE

Radioactive wastes are mainly generated from the nuclear power plant or any other chemical industries. As in many developed countries nuclear plant are built in order to generate electricity for fulfillment of human need. Radioactive wastes take hundreds to thousands of years to neutralize or decay into harmless substances. It is very dangerous when human are expose near it and it required keeping far away from any residential area.

Table1.1: Type of municipal waste and time taken to degenerate.

Municipal Waste	Time taken to degenerate
Paper	2-4 weeks
Cloth made from cotton	2-6 months
Waste of Organic (left food, rotten vegetables, fruits, etc.	1-2week
Wood	10-15 years
Metal like aluminum plate, can, steel etc.	100-500 years
Plastic items	Non degradable and takes millions of years to degenerate.
Construction items (cement, bricks, etc.)	100-300 years
Glass items mirror, glass bottles, glass windows, etc.	Non degradable

1.2 OPTI0N FOR DISPOSAL OF WASTE

Non-control disposal

Generally used and practice throughout the country. It is the disposal of the solid waste without proper checking or treating directly towards the landfill. Many disease causing pathogens and mosquitoes breeding ground are generated and ultimately resulting in the human health of the particular area.

Sanitary landfill of solid waste

This is the control and revised dumping of solid waste. Itt basically reduces the breeding of fly and mosquitoes because the waste before dumping was engineered and treated before the final disposal on the dumping site. It is one of the most commonly used method of the solid waste management.

Composting of the waste

When the temperature or the moisture content of a solid waste are set in a favorable condition for the breed of decomposing bacteria then, the micro-organism helps in decomposition of the waste. It can be term as biological process because the decomposition is done by living organism. The composting of solid can be done from the residential or start initiating from the household level. The final compost material have high nutrient value a can be used for agriculture needs.

Waste Incineration

The solid waste materials which are combustible in nature are burnt in this process. The temperature rises from 800-11000’C for burning and the end product are usually the ash and some non-combustible material for the final disposal.

Pyrolysis

It is the method used to recover any chemical constituent or chemical energy from the solid waste material by using the technique of destructive distillation. They are somewhat similar with the Incineration but they work in low temperature which is around 450’C.

Plasma gasification

Gasification of plasma is alternative method of management of waste. The plasma are charged electrically at initial stage or they should be highly ionized gas. Lighting is one type of plasma which produces temperatures that exceed 12,610 °F . With this method of waste disposal, a vessel uses characteristic plasma torches operating at +10,050 °F which is creating a gasification zone till 3,000 °F for the conversion of solid or liquid wastes into a syngas. In this kind of treatment the molecular bonds of the waste are broken down due to the heat generated in the elemental components and the vessel. Because of this process dangerous waste can be destructed easily. This form of waste disposal provides renewable energy and an assortment of other fantastic benefits.

Vermicomposting of the MSW

The waste which are usually generated from the domestic as well as commercial sites or the municipal solid waste content high value of organic and vermicomposting is an alternative method for composting the waste. Here the worms are survive by eating the organic matter present in the waste and in return produces manure which are very rich in nutrient content.

Application of the Reuse and Recycle method

In order to achieve this goal segregation is very must necessary in order to identify the product which can be reuse or recycle back again. If the material can be reuse again then there will be raise in economic growth and most importantly the solid waste will be minimize accordingly. The application of the four R's that is Refuse, Reuse, Recycle and Reduce plays an important role in the waste management.

Refuse- It can be defined as using which are available from before without targeting the new one or buying new product of the same kind.

Reuse –It can be term as using the discarded material like can of soft drink for making pencil or pen stand. This will minimize the increase in solid waste generation

Recycle- One of the most commonly used method for minimizing the waste generation. Here the recyclable material are collected and recycle back for using again. Materials which can be recycle back are paper, glasses, etc.

Reduce- It can be defined as the reduction of unwanted solid waste from the source of generation

1.3 SC0PE OF THE STUDY

1. Management of solid waste reduces and eliminates various adverse impacts on the environment as well as human health and gives economic development or stability and improved life standard.
2. The generated solid waste which are produce from domestic and commercial sites can be segregated and either recycle for other uses like
   *Using as manure or fertilizer.
   *Civil engineering utilization by transforming the discarded material into bricks.

3.Reduction of Air borne and Water borne diseases by minimizing the Presence of pathogen and other harmful microorganisms from the waste.

4.Giving awareness and proper management can lead to good living standard and development of the Nation.

The main problem to be solve in Solid waste management are :

-To generate clear and quality data for assessment

-Help in minimizing the waste by introducing new methods.

-Government funding and awareness.

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1.4 OBJECTIVES OF THE STUDY

1. To study the management of solid waste-(A case study of Jalandhar city)

2. To identify the different zone generating the maximum amount of solid waste.

3. Characterizations of that waste physically, and applying Reduce, Recycle and Reuse techniques wherever applicable.

4. To describe and explain the current waste management system collection, transportation practices in Jalandhar city Area.

5. To identify the factors that influence solid waste management in and around the city of Jalandhar.

6. To assess the new solid waste management system with integrated SWM system.

7. To propose useful recommendations for development of a sustainable solid waste management system.

8. Learning the role of rags picker and creating awareness to minimize the health effects toward the people handling the solid waste.

9. To study the importance of public participation and scientific solid waste management.

CHAPTER-2

REVIEW OF LITERATURE

Solid waste management

In a developing country, the problems associated with solid waste management are more acute than in a developed country. Lack of financial resources and infrastructure to deal with solid waste creates a vicious cycle; lack of resources leads to low quality of service provision which leads to fewer people willing to pay for said services, which in turn further erodes the resource base and so on . The problem is further complicated by rapid growth in population and urbanization, which adds greatly to the volume of waste being generated and to the demand for waste retrieval service in municipal areas. However, more often than not, an increase in population is not matched with an equal increase in revenue for the local municipalities for waste management. Besides this, rapid urbanization means rapid growth of shanty dwelling units that are largely unplanned for, and add to the waste, health, and hygiene problems.

Amongst the various problems Jalandhar faces today, solid waste management is on top of the list. The severity of waste problem in Jalandhar can be assessed from the fact that currently how much waste they are producing every day or per annum.

The basic theme and objective can only be achieved by analyzing the published papers related to the topic and going through the books which deals with the aspect of the research which is going to be conducted. From here the various information can be known in order to execute the work without any objections. The composition and characteristics of the municipal solid waste was analyzed by various researchers around the world. These reviews show and prove the various problem faces by the people in urban areas due to rise in solid waste. In international level, organization like World health Organization(WHO) under United Nation gives funding for improvement of human living life style. Municipal solid waste management of various urban and rural areas has been broadly studied by the scientists and researcher around the world. From them we come to know the important of waste management and its effects towards mankind. The following are their finding; methodology used and results of the paper which I have gone through for the initiation of my dissertation paper.

Yusof et.al., 2002 studied and carried out the determination of waste generation in Taman Perling, Johor Bahru, Malaysia[2]. The roles of socio-economic and cultural influences are discussed in their paper. The methods approaches are data collection, quantitative and qualitative analysis. They concluded by finding that the family size and the population are the root cause of the increase in the solid waste thereby creating the urban and rural area a bad place for development.

Hayashi,et,al, 2006 The evaluation of the practice of solid waste management in Japan was done. The research analysis was carried out by collecting sample and data were analysis from the municipal board[1]. They found that almost 21% of overall wastes which are generated are disposed off in landfill. More than 75% gross amounts of solid waste generated annually are incinerated. The strategies adopted recently by Japan are recovery, refuse transformation, reduce and finally disposal.

Lester et.al., 1999; Reported the used of recycling process in national and state level and stated the failure of its application due to varying in population and bad management system. It is considered that the techniques used for recycle were costly and was easy to dispose off in landfill[10]. Finally they concluded that proper awareness of waste minimization will ensure the reduction of waste thereby decreasing the problem faced by the locality. The MSW policies for recycling should be evaluated by seeing the cost of the community more generally.

Rajput et.al., 2OO9; Conducted the study and analysis of municipal solid waste generation. The main theme was to find out the collection strategies of the waste by applying the handling rule 2000. The methodology approaches include, the analysis of past data, statistic representation of the waste generation with the current scenario[14] . The works showed different trend with the development of the economic features. They also reported that, in India the waste generation ranges from 150-550kg per capita per day and the efficiency of collection is 40-80 percent.

Zeng et.al., 2005 ; Sanitary landfill used and sorting are done. Geographical study of the landfill area of the Columbia landfill. The methodology used are data collection of the waste generated in and around the urban area , analysis of the landfill area by taking the arithmetic mean differences between the area available and the total waste which is going to dispose[20]. They found out 32

waste components from the waste which has been generated. The urban area isgiven applicable measure to tackle the situation.

Sivapalan et.al., 2002; The chemical characteristics of the waste generated at kuala lumpur city. The segregation helps in resorting the useful substances from the waste available. The approaches include analysis of the current and past data in order to compared the growth of solid waste management in the city of the particular area[13]. They concluded by studying the effects cause by the presence of high amount of the heavy metals in the soil or the leachate of the various landfill situated on that area. They also cause serious concern over the health of the human as well as the environment.

Ogwueleka,et.al, 2009; In this current scenario the municipal management of the solid has become very important. He summaries and study the generation of waste in developing countries especially in Nigeria[23]. Various problem can be face and required measure to counter the effects are discuss. The methodology followed were, study of the past data and characterization of the component present in the waste which may affect the soil and the water bodies. Awareness was discuss and methods are implemented for better disposal of the municipal solid waste which the generated in large quantity.

Deshpande,et.al, 2006; To discuss the accurate assessment of the waste load. Emphasis on using the available resources in order to cut down the cost and helps in stability of the economic status. The methodology used includes source quantification specifically and then the solid waste from the municipal were characterize accordingly[14]. Due to this it helps in more access to available resources thereby decreasing the cost and helping the economic status. The important of the characterization and quantification were known because of their findings.

Mufeed Sharholy,et,al.2006; Due to increase in population there is rapid economic growth and proportionally there is increase in the municipal solid waste. The mishandling or improper evaluation may cause serious damage to the area concern. They find out the Qualitative and quantitative characterization of the solid waste of municipal[17]. The methodology include surveying of the residential area, questionnaire survey, analysis of the data .The per capita generation were check accordingly in order to find out the trend of municipal solid waste generation. They further recommend the segregation technique

before disposal of any waste in the landfill or before treating for minimizing the cost of operation.

Sahu,et,al. 2007; Working on the present situation and nature of the waste generated. Due to increase in the generation of the solid waste there are adverse effects like release of methane gases due to acidogenesis[7] and also release of hydrogen sulfide gas. The work approaches include study of chemical present in the solid, checking qualitative measures. Finally they found that due to increase in the population and availability of landfill area was less but people started constructing building without proper precaution. So the dumping ground should be checked properly before any further construction.

Sahasrabuddhe,et,al. 2003; Urbanization and its impact towards the water bodies .Due to development many industries arises causing serious problem of solid waste, which improper management led to pollution of water bodies due to dumping of waste in the drainage system or sewage. The methods followed for analysis are field visiting of the studying area, surveying and case study of the past and present data of the Pune city[24]. They finally come to the end that due to development the quality of soil and water deteriorate due to presence of harmful and untreated chemical which was present in the municipal solid waste.

Puri et,al.2008; Solid waste management in the Jalandhar city was done to know the ill effect towards human health. The community health were disturb due to presence of highly untreated chemical in water which may causes diseases related to water. The research methodology approaches are dividing the area into zone, characterization of the chemical component in the waste generated from industries and domestic household. He concluded that there is rise in water borne disease due to presence of unwanted material on the water bodies. The responsible substances causing the harmful to the human and plant are from solid waste.

Anand et.al., 2006; studied the present of bacteria of Yamuna River(Delhi). The water quality of the river is effected due to dumping of highly toxic substances and solid waste generated from domestic as well as commercial sites. Even the industrial waste are directly dump without prior treating of the water effluent before disposing to the water bodies. The methodology followed are checking quality parameter in laboratories, determining the source of generation.

The result shows the increase in microbial population in the water bodies which ultimately result in causing water borne diseases.

Sabahi et.al., 2009 ;Due to presence of chemical substances in the solid waste and when they are dump in soil the leachate helps in making the ground water pollutes and dead of plant. The dead of plants occurred when they suck up nutrients along with the harmful chemical there life cut short. The research method used are checking the parameters of physio-chemical concentration, data analysis and surveying. The result of this study indicates the present of waste cause pollution and arises health risk.

Amusan et.al., 2005;Study the soils and crops uptake of metals of solid dump sites in Nigeria.The crops may uptake the metals or any other harmful substance and bio-accumulate which in turn transfer to human bodies causing harm. The methodology approaches are observation of the data, testing of soil and concentration of metal in it. The result shows that plant uptake of metal are more from the soiland bio-accumulate take place by the crop.

Oyelola et.al., 2009; Olusosun dumpsite, Lagos, Nigeria was studied to find the solid waste disposal utility. The health Implication has serious concern over this disposal site. The methodology includes checking the parameter of the sample physio-chemically. Due to presence of unwanted smoke, odor and dust, it raises problem of irritation in eyes, breathing problem, etc. The percentage of ill effects to human workers of dumpsites and the rag pikers are irritation of eyes 85%, breathing problem 67%, lungs problem 48%, coughing 60%, pneumonia 10%, malaria 11%, water borne typhoid 42%, dysentery 44%, cholera 42% and fatigue 94%. It clarifies that due to open dumping this kind of health risk may arises as found out from the study.

Naresh Kumar Batish et.al.,2014; As due to development and increase in rapid population the industrialization takes place and helping the economic growth of the developing Asian countries. The methodology is based on primary and secondary date collection of the government publication. The generation of solid waste in whole Punjab was 3018 tones per day and out of this 28% were generated from industrial area. The main objective of the work was to find out the alternative for decreasing the waste and safe disposal of the solid waste.

Shantanu K Dutta et.al.,2006; Solid waste which are hazardous are considered to be highly toxic and before disposal they should be treated properly inorder to reduce the possible environmental hazards. The methodology used includes

reprocessing, inventories and recycling processes. Hazard may be of different type solid or liquid and this study give the details of the hazardous waste management in India according to the handling rules prescribe by the CPCB. The characterization of hazardous waste is discussed too with the probable impact on environment. The hazardous characteristics include Flammable/explosive, oxidizing, poisonous, corrosives, and infectious substances, toxic and organic peroxides. The various chemical are also segregated like cadmium, lead, mercury, etc.

Shalini Sharma et.al.,2008;The government hospital of Agra like Sarojini Naidu Medical college, District hospital and Lady Lyall Maternity were observed for the waste management/biomedical waste. The methodology includes the collection of available data from the hospital, questionnaires of the people living around the areaand assessment of the knowledge available[16]. They concluded that there is lack of practice for the treatment of the liquid biomedical waste. The solid wastes are treated with the optional technologies like autoclaving, incineration and microwaving. The generation and recommendation of the management of waste should be set up and awareness should be given in order to kno the ill effect of the waste which are generated from this area.

B.Ramesh Babu et.al.,2009;The theme of the study was to compile the existing management rules and biomedical handling waste. It also gives emphasis on categorization of the biomedical waste and definition regarding the coding of colors in the different waste[21]. The methodology include the segregation of the waste and studying of the different waste form generated in the hospital. The generation of the waste range between (31-36%)waste which are infectious, syringes which are disposable (0.4-.6%), general which includes food (41-46%)

Solid waste is broadly comprised of non-hazardous domestic, commercial and industrial refuse including household organic waste, hospital and institutional garbage, street sweepings, and construction wastes (Zerboc 2003). Domestic solid waste includes all solid wastes generated in the community and generally includes food scraps, containers and packaging, discarded durable and non-durable goods, yard trimmings, miscellaneous inorganic debris, including household hazardous wastes (for instance insecticides, pesticides, batteries, left over paints etc., and often, construction and demolition debris.

A report prepared by World Bank (1999) lists eight major classifications of solid waste generators:

1. Residential: Includes waste generated in household units, such as food and fruit peels, rubbish, ashes etc.

2. Industrial: Has two components hazardous, which is toxic; corrosive; flammable; a strong sensitizer or irritant and may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Non-hazardous which includes inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable

3. Commercial: Waste produced by wholesale, retail or service establishments, such as restaurants, stores, markets, theaters, hotels and warehouses.

4. Institutional: Waste that originates in schools, hospitals, research institutions and public buildings.

5. Construction and demolition: Waste building material and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements and other structures

6. Municipal services: Sludge from a sewage treatment plant which has been digested and dewatered and does not require liquid handling equipment etc.

7. Process: Treatment plant wastes principally composed of residual sludge and

8. Agricultural: Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes.

CHAPTER-3

MATERIALS AND METHODOLOGY

RESEARCH METHODOLOGY

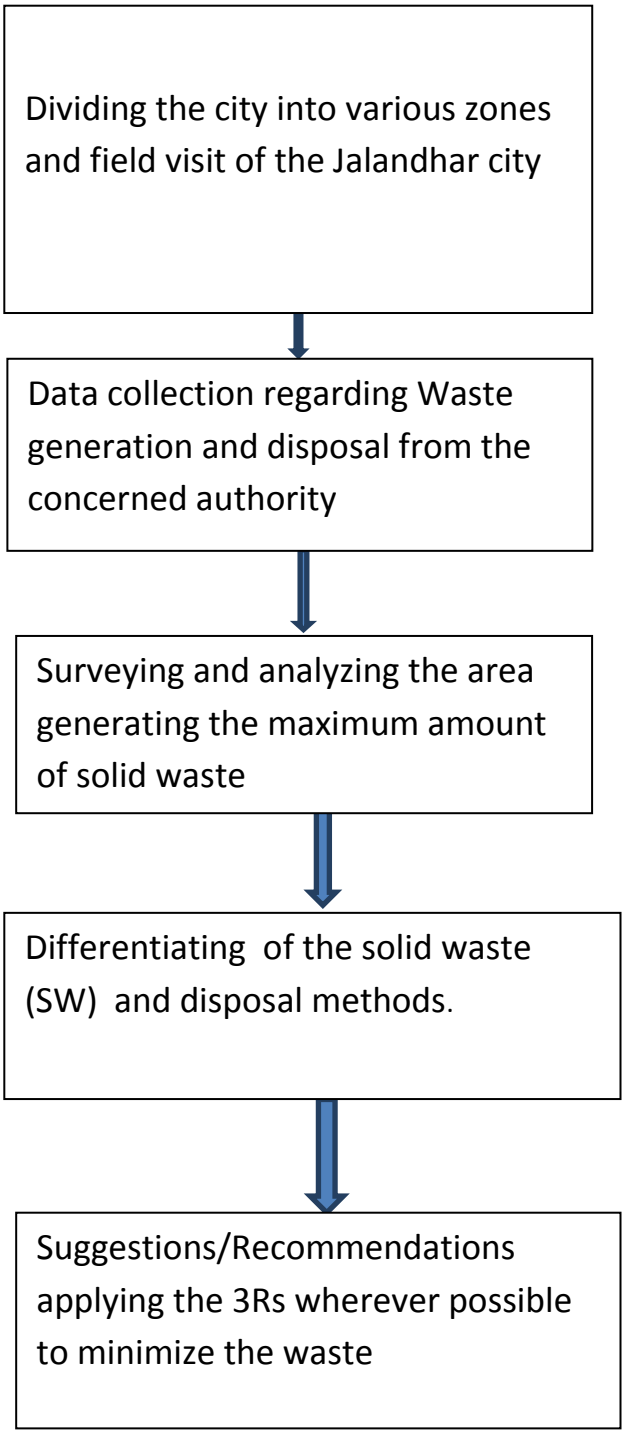


Fig.3.1. Flow chart of the methodology of work

3.1 RESEARCH APPROACHES

Case Study Approach

I used Jalandhar city as a case study. The research objectives were met through the collection of primary data through PPCB, interviews, workshops, and literature review. Secondary data was used (wherever available) to further enhance the understanding and to verify the quality of information gathered.

Participatory approaches to research

Data was collected concurrently (i.e. both primary and secondary data was collected at the same time) (Creswell 2003). The researcher relied on participatory research and drew upon the methods of participatory rural appraisal (PRA); semi-structured interviews, and non-participant observations (Chambers 1994) for data collection. In addition, the researcher undertook review of published materials, reports, key informant interviews, applicable policies, laws (if any) pertaining to the research purpose.

Methods used for the study involved open-ended interviews with different stakeholders, which allowed the study to incorporate a variety of views on the waste problem. Secondary was used for cross checking the findings wherever necessary and available. Current management practice was assessed in consultation with the localpeople, municipal administration, and district authorities. Data were collected through direct observation by the researcher as well. By doing so, this study has been able to find out the nature and characteristics of waste management system; along with other strengths/constraints of the current waste management system (detailed methods have been discussed in Chapter 3.

3.2 ZONE DIVISION

Most of the sources of solid waste are generated from domestic household, commercial sites, construction and demolition sites, municipal service, etc. The area distribution of Jalandhar city into various zone are listed below:

i. Residential household zone 86-%
ii. Industrial area-10%
iii. Small and big factories -3550(approx..)in no.
iv. Trading unit- more than 1100 in no.

v. Commercial shops-3600 in no.
vi. Industries of electroplating -3 in no.
vii. Hospital of private sector-more than 45
viii. Health care center in the area -10

As Jalandhar is consider as one of the largest city, the solid waste generation per day is around 350 tonnes and they are municipal solid waste. The two existing disposal site as per Punjab pollution control board data are :

-SuchiPind and the area cover are 2 acres.

-Village Wariana and the cover area are 14 acres.

In order to find out the quantity of municipal solid waste the two main important things which is done is collecting and transportation to the treatment site or landfill for final disposal. Collecting generally include collection from domestic residential household, sweeping of roads, road side bins , big bins of community, etc. Here the segregation technique can be introduced for minimizing the waste. Segregation is important because the solid waste which is collected may consist of different degradable or non-degradable substances. It can cause various problem to future because if any metallic waste are dump along with the biodegradable waste it will take time to decompose.

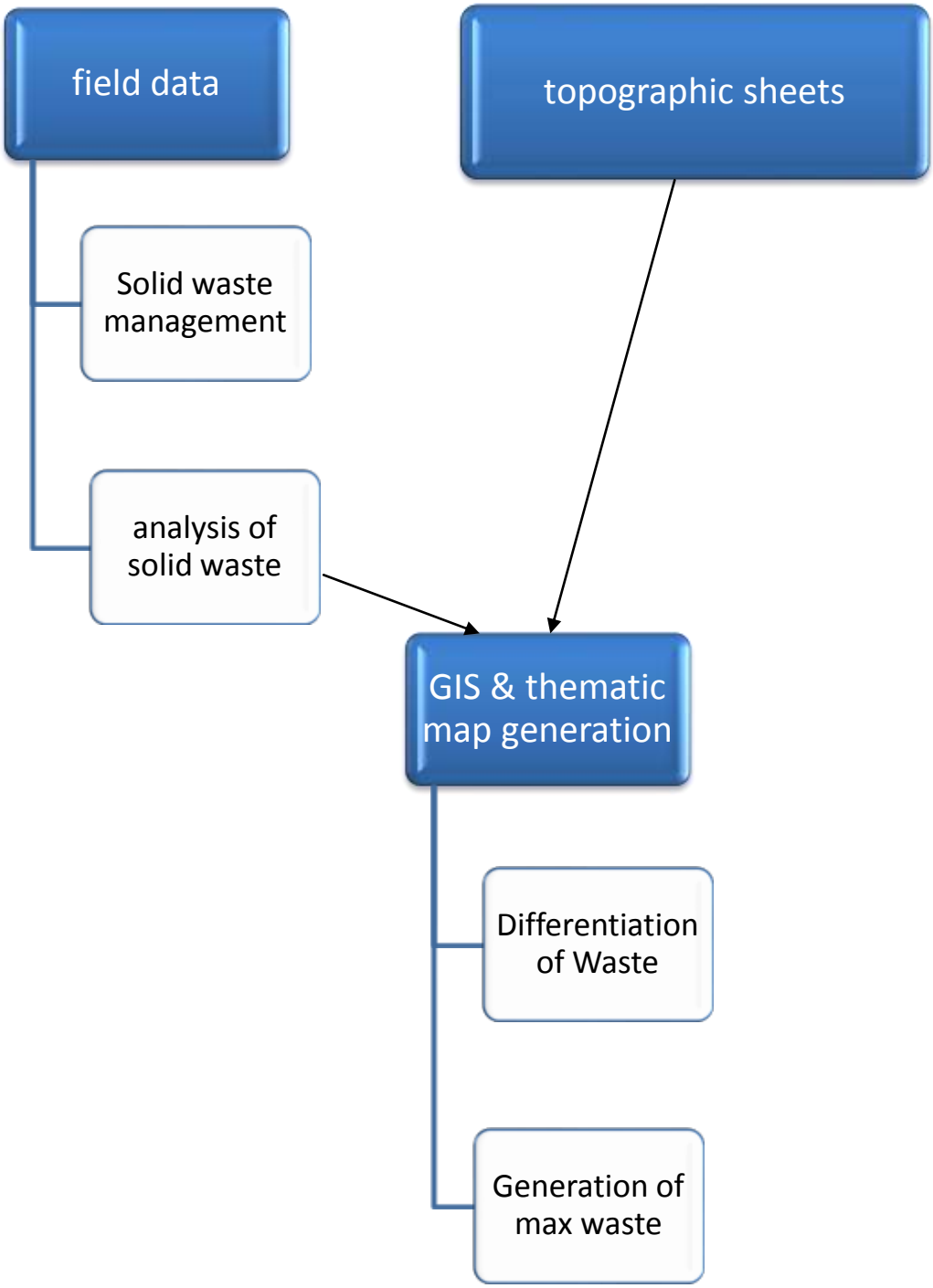


Fig3.2: Methodology for GIS plotting

3.3 METHODOLOGY FOR GIS PLOTTING FOR SOLID WASTE

The source map of the area was imported into the software through the steps of scanning, import, creation of coordinate system and geo-referencing. The borehole locations captured using GPS were located on the digitized. The various spatial features (well location) were digitized. Interpolation operation used to prepare vulnerability maps different quality parameters.

Toposheets of Jalandhar districts were scanned and the raster image is formed in the arcGIS (arcMaps 10.1). Then the image is geo referenced. Then digitization is done for the spatial feature i.e. well locations. Then spatial variation was done for various parameters and finally a quality map was prepared for all the parameters.

The figure 3.2 below shows the general methodology adopted for the GIS mapping of the parameters.

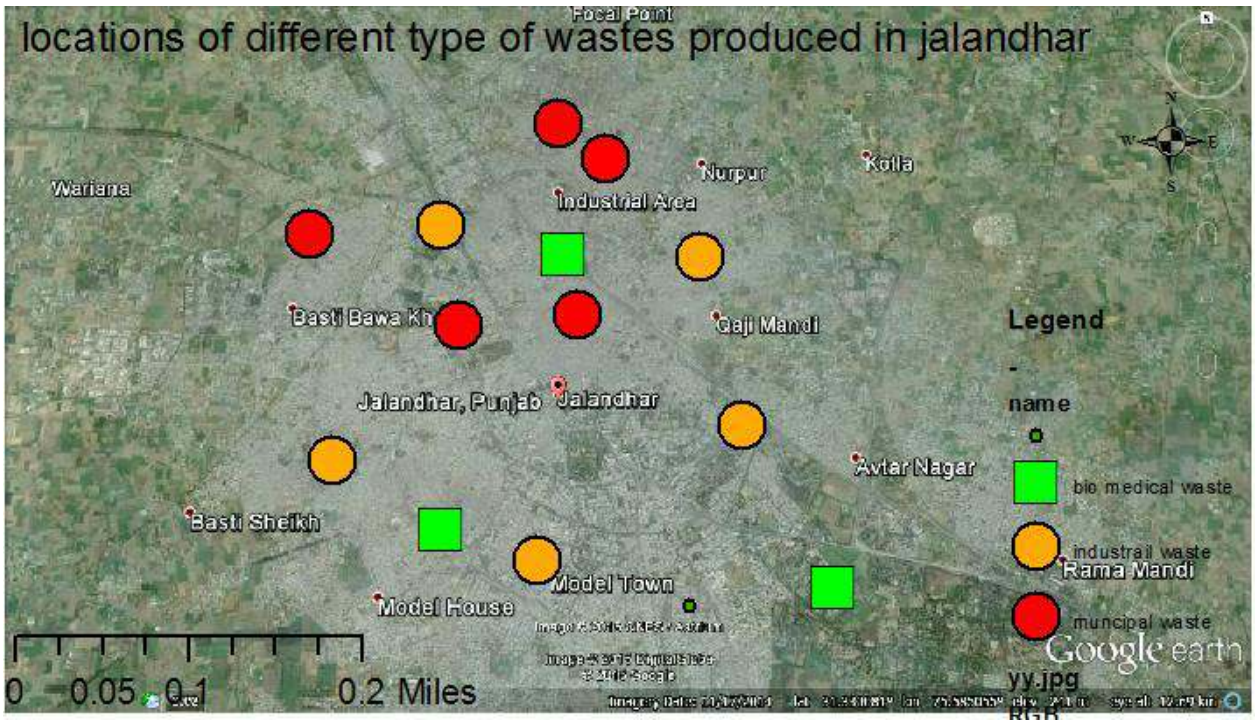


Fig.3.3: Map of Jalandhar city indicating location where different type of solid waste are produced.

DISTRIBUTION IN ZONES

Fig.3. 4: Jalandhar city Map showing distribution of land used

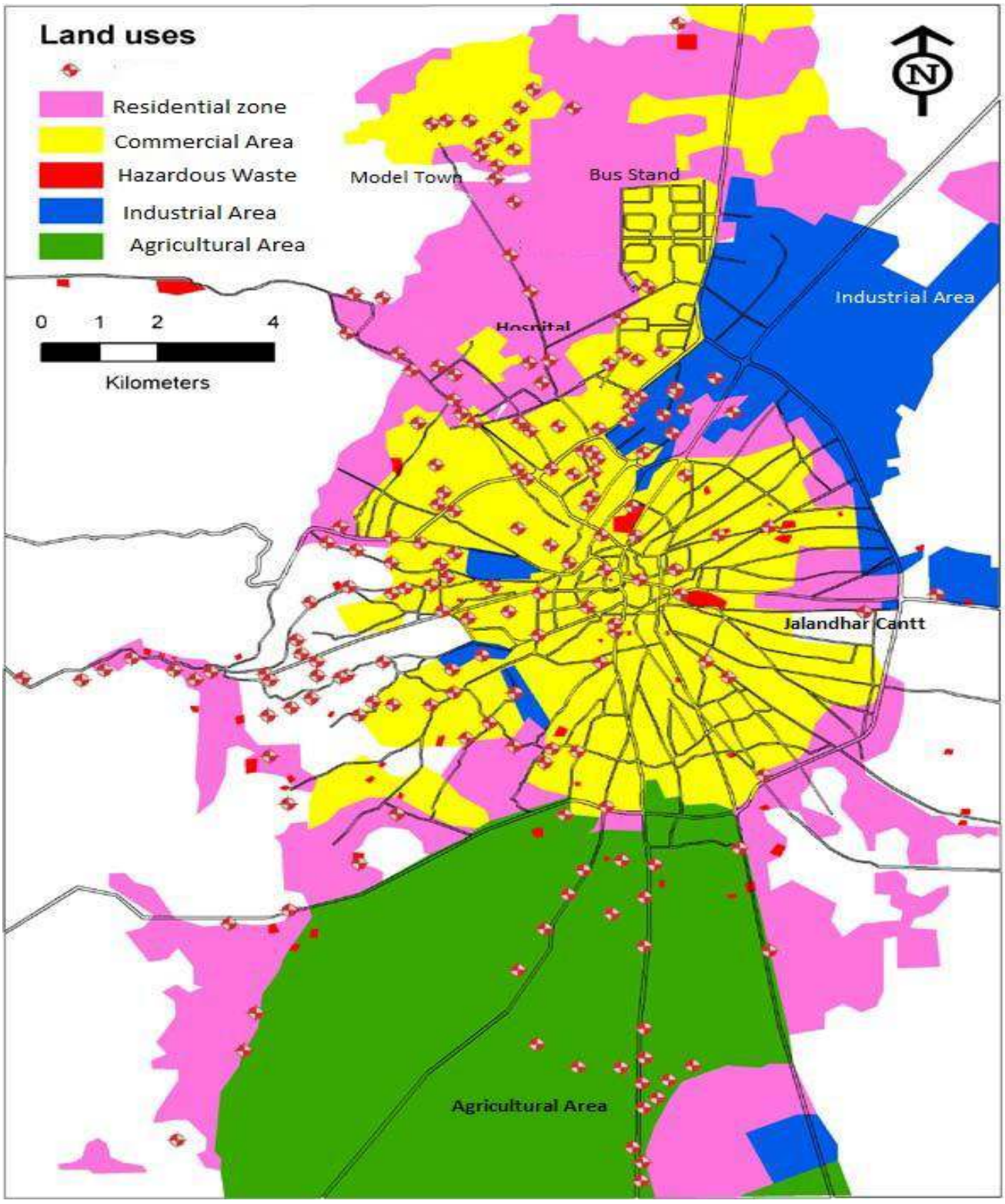
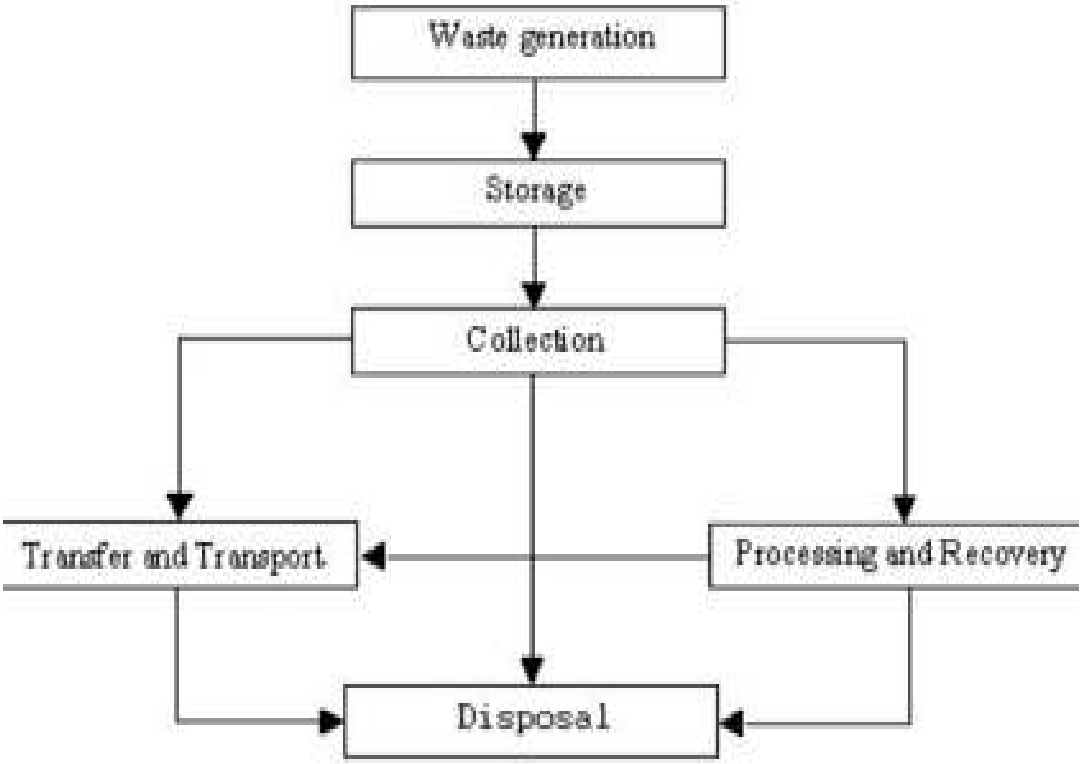


Fig.3. 5: Flow chart showing collection and transportation of MSW.



3.4 CHARACTERIZATION OF SOLID WASTE

The municipal solid waste can be characterize into three different types i,e Source of waste generation, Physical characteristic on wet basis and finally the chemical constituents and parameter. It helps in knowing the type of the solid waste and their uses. By determining the content of chemical or nutrients in the waste which are generated from the domestic or any commercial area then they can be decompose and used as manure for agricultural purposes.

Table.3.1. Waste generation sources

Substances	Content	Generation sources
Garbage	cooking food and domestic discard and useless vegetables	Residential, Hotel, motel, etc.
Rubbish	Markets refuse rags, cloth, rubber leather	Departmental store, shopping mall, market, etc.
Ashes	Residue form	Burning of combustible material
Heavy waste	Auto parts, Tyres, etc.	Automobile workshops
Road side refuses	Dust and dirt	Destructive road and sweeping
Hazard	Hazardous harmful chemical	Chemical industries and hospital waste

Table.3.2. Physical parameter on the basis of wet source –by PPCB

Parameter which need to check	Percentage content
Ferrous metal	0.015
Non-ferrous metal	0.14
Earthen bricks, stone, etc	5.18
Ceramics or glasses	0.58
Papers and cardboard	3.45
Wooden item	0.1
Litter or rags	3.9
Leather and rubber	1.33
Plastic material	7.45
Content of moisture	44.53

CHEMICAL PARAMETER WHICH NEED TO EVALUATE ARE

- Content of organic carbons
-Ammonia nitrogen
-Phosphorous
-Hydrogen
-C/N
-Matter which are compostable
Calorific standard value
-pH
-Matter which are volatile

CHAPTER 4

4.1 MUNICIPAL SOLID WASTE

PARAMETERS USE FOR COLLECTION OF MSW :

1) Collection of municipal solid wastes
2) Segregation of municipal solid wastes
3) Storage of municipal solid wastes
4) Transportation of municipal solid wastes
5) Processing of municipal solid wastes
6) Disposal of municipal solid wastes

Table 4.1:

STATUS OF LAND FOR DISPOSAL OF MSW JALANDHAR CITY

Name of Municipal Committee	Class of the M. C.	Population of the Town /City	Quantity of Solid waste generated	Area of existing landfill	Age of land developmentof land site
Municipal Corporation, Jalandhar	A	7,00,000	350 TPD	(i)2 Acres (low lying land near SuchiPind)(operational) (ii) Near DAV College (closed) (iii) Vill. Waryana approx. 14 acres almost full	2 year

DESCRIPTION:

total waste generated – 350 TPD

Biodegradable - 80 TPD

Non-biodegradable – 230 TPD Organic waste – 40 TPD

4.1(a)WASTE GENERATION SOURCE:

Table 4.2:

Substances	Content	Generation sources
Garbage	cooking food and domestic discard and useless vegetables	Residential, Hotel, motel, etc.
Rubbish	Markets refuse rags, cloth, rubber leather	Departmental store, shopping mall, market, etc.
Ashes	Residue form	Burning of combustible material
Heavy waste	Auto parts, Tyres, etc.	Automobile workshops
Road side refuses	Dust and dirt	Destructive road and sweeping
Hazard	Hazardous harmful chemical	Chemical industries and hospital waste

i. Residential household zone-86%
ii. Industrial area-10%
iii. Small and big factories-1200(approx.)
iv. Trading unit-more than 230 in nos.
v. Commercial shops-3200
vi. Hospital and clinic of private sector-more than 45
vii. Health care centre in the area-11

4.1(b) METHODS AND DISPOSAL:

1	Nos. of waste processing plants (treatment facilities) (Specifies nos. whether mechanical compost/ vermicompost / pit compost / RDF / Bio-gas / incineration / etc.) a) Plants operational b) Plants set up , waiting for operation c) Plants proposed	2 2 Nil 1 cluster
2	Nos. of Landfill sites a) Nos. of open dumping b) Nos. of Sanitary Landfill Operational c) Nos. of Land fill ready, waiting for use d) Nos. of Land fill being constructed e) Nos. of Land fill site identified	 12 Nill Nill Nill 3
3	Waste –to energy projects a) WTE project operational b) WTE project being constructed c) WTE project under plan	 Nill Nill 2
4	Any other information	As per attached annexure

Table 4.3: Methods and Disposal

MANAGEMENT OF MUNICIPAL SOLID WASTE:

Table4.4

Sl. No	Parameters	Status and operations
1.	Collection of Municipal Solid Waste	Yes, collection is being done.
2.	Segregation of municipal Solid Wastes	ULBS are segregating their waste into biodegradable and non-biodegradable waste.
3.	Storage of municipal solid Wastes	Open landfill
4.	Transportation of municipal solid wastes	12 ULBs are transporting their waste using covered vehicles and 1 ULBs are not using covered vehicles to transport their waste.
5.	Processing of municipal solid wastes	3 ULBs in Jalandhar is partially processing their waste
6.	Disposal of municipal solid Wastes	1 ULBs have proper disposal of organic waste only and 12 ULBs have open landfill disposal without segregation.

- ULBs: Urban Local Bodies

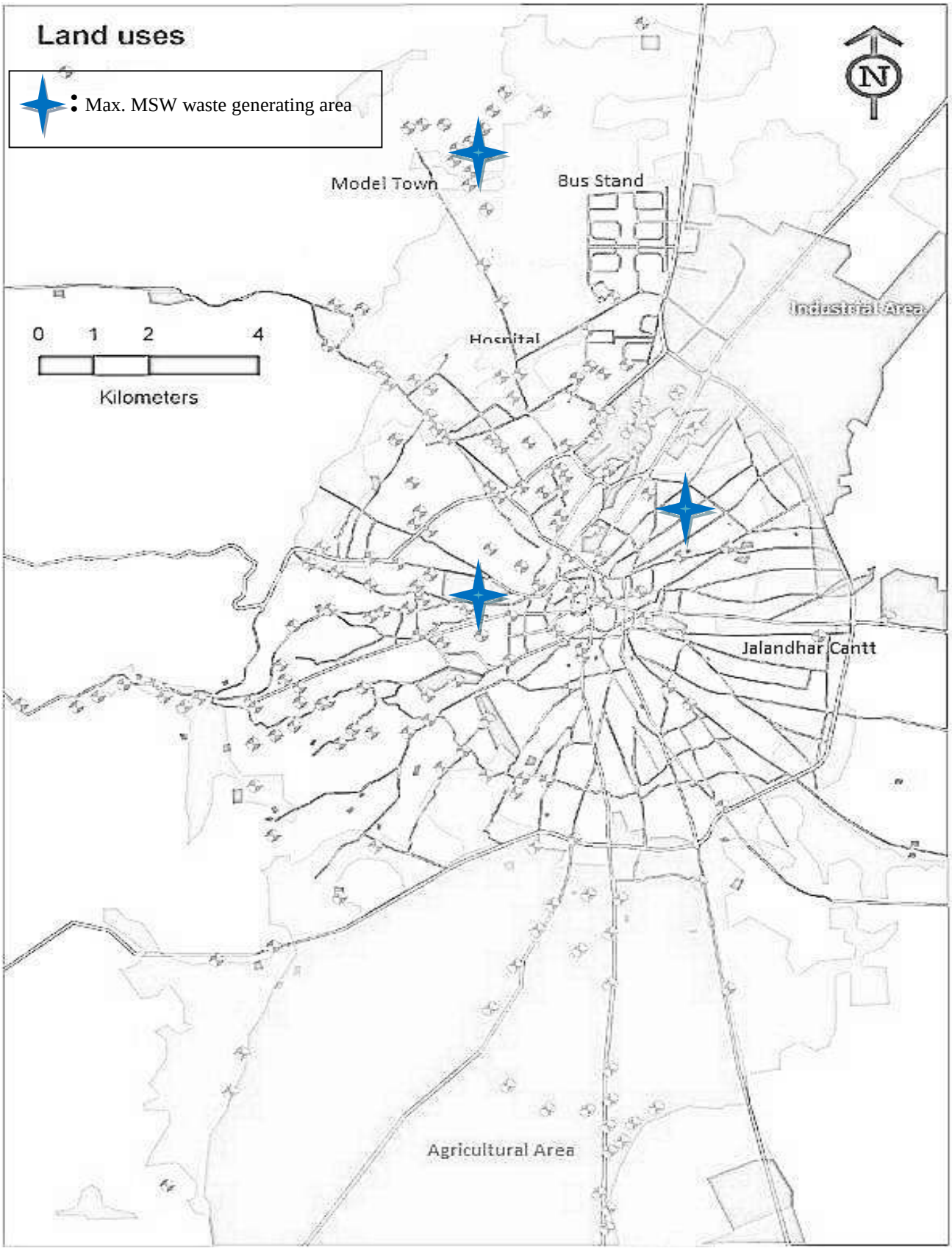


Fig.4.1: Max MSW generating points.

4.2 HAZARDOUS SOLID WASTE:

4.2(a) GENERATING SOURCES OF HAZARDOUS WASTE

i. Expired medicines from Hospital-25%
ii. Automobile repairing shops-16%
iii. Dry cleaning shops -1.2%
iv. Processing of Photos-0.4%
v. Exterminators-10.4%
vi. Manufacturing of chemical (pesticides and insecticides)-19%
vii. Companies of electroplating-17%
viii. Refineries of oil-11%

LIST OF HAZARDOUS WASTE

- Paints and solvents
- Automotive wastes (used motor oil, antifreeze, etc.)
- Pesticides (insecticides, herbicides, fungicides, etc.)
- Mercury-containing wastes (thermometers, switches, fluorescent lighting, etc.)
- Electronics (computers, televisions, cell phones)
- Aerosols / Propane cylinders
- Caustics / Cleaning agents
- Refrigerant-containing appliances
- Some specialty Batteries (e.g. lithium, nickel cadmium, or button cell batteries)
- Ammunition
- Radioactive waste (some home smoke detectors are classified as radioactive waste because they contain very small amounts of a radioactive isotope of americium.

4.2(b) METHODS OF DISPOSAL:

Final disposal of hazardous waste

In historical time the hazardous waste are generally disposed off in the landfill which generally affects the soil and ground water when they penetrate or infiltered. These chemicals from the hazardous solid waste eventually entered natural systems of the hydrology. Many of the landfills are currently require counter and alternative measures to tackles against groundwater contamination, an example being installing of a barrier along the foundation of the landfill to contain the hazardous substances that may remain in the disposed waste. Currently, hazardous wastes must frequently be stabilized and solidified in order to enter a landfill and many hazardous wastes undergo different treatments in order to stabilize and dispose of them. Most flammable materials can be recycled. One example they can be recycled into is industrial fuel. Some materials with hazardous constituents can be recycled, lead acid batteries are one example.

Recycling

Many hazardous wastes can be recycled into new products. Examples might include lead-acid batteries or electronic circuit boards where the heavy metals these types of ashes go through the proper treatment, they could bind to other pollutants and convert them into easier-to- dispose solids, or they could be used as pavement filling. Such treatments reduce the level of threat of harmful chemicals, like fly and bottom ash, while also recycling the safe product.

Portland cement

For the treatment of hazardous waste the commonly used treatment is cement based stabilization and solidification.By improving physical characteristics and decreasing the toxicity and transmission of contaminants, cement play an important role to treat the hazardous waste. The cement produced is categorized into 5 different divisions, depending on its strength and components. This process of converting sludge into cement might include the addition of pH adjustment agents**,** phosphates, or reagent of sulphur to minimize the settling or curing time, increase the strength of compression, or reduce the leach ability of contaminants.

Incineration, destruction and waste-to-energy

The hazardous waste can be destroyed for example by the help of incinerating with high temperature. Waste which are flammable can sometimes be burned and make as source of energy. Like for example cement kilns are burn with hazardous wastes by using oil and solvent. Now days treatments by incineration not only reduce the quantity produced due hazardous waste, but they also create and produces energy throughout the released of gases in the process. The environment can be disturbed due to this burning or combustion process thereby producing unwanted gases which affects the living being and organism. However, due to development in current technology there are more efficient units of incinerator which can control these emissions to a point that this treatment is considered a more beneficial option. There are different types of incinerators and they vary depending on the characteristics of the waste. Incineration due to starved is another method used to treat hazardous wastes. Just like in common incineration, burning occurs, however controlling the amount of oxygen allowed proves to be significant to reduce the amount of harmful byproducts produced. Starved Air Incineration is an improvement of the traditional incinerators in terms of air pollution. Using this technology it is possible to control the combustion rate of the waste and therefore reduce the air pollutants produced in the process.

Hazardous waste landfill (sequestering, isolation, etc.)

A HW may be sequestered in a HW landfill or permanent disposal facility. "In terms of hazardous waste, a landfill is defined as a disposal facility or part of a facility where hazardous waste is placed or on land and which is not a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit

Pyrolysis:

Some hazardous waste types may be eliminated using Pyrolysis in an ultra high temperature electrical arc, in inert conditions to avoid combustion. This treatment method may be preferable to high temperature incineration in some circumstances such as in the destruction of concentrated organic waste types, including PCBs, pesticides and other persistent organic pollutant

DETAIL OF HAZARDOUS WASTES GENERATING AREA IN JALANDHAR

Table 4.5:

Sl no	Description	Jalandhar
1	Total no. of hazardous waste generating units	515
2	Total hazardous waste generating(TPA)	7851.1
a)	Recyclable	1794
b)	Incinerable	140
c)	Disposable to Treatment, Storage & Disposal Facility	5914.1
3	Status of TSDFs in operation	
a)	No. of TSDFs in operation	0
b)	No. of TSDFs under construction	0
c)	No. of sites notified	0
d)	No. of sites identified	0
4	Status of incinerators (with location detail)	
a)	No. of common incinerators operation	0
b)	No. of captive incinerators in operation/under installation	2
5	Action taken as per Supreme court directions	
a)	No. of hazardous waste generating units	515
b)	No. of hazardous waste generating units for which authorization has been granted	141
c)	No. of hazardous waste generating units for which authorization is under process	51
d)	No. of hazardous waste generating units not applied for authorization or for renewal	168
e)	No. of hazardous waste generating units running without valid authorization	123
f)	No. of hazardous waste generating units for which closure directions	16
g)	No. of hazardous waste generating units for which closure directions were revoked since October 2008	8
h)	No. of hazardous waste generating units closed since October,2003 by the board or itself closed	13
i)	No. of hazardous waste units displaying information at the entrance in the prescribed size of the display Board	515

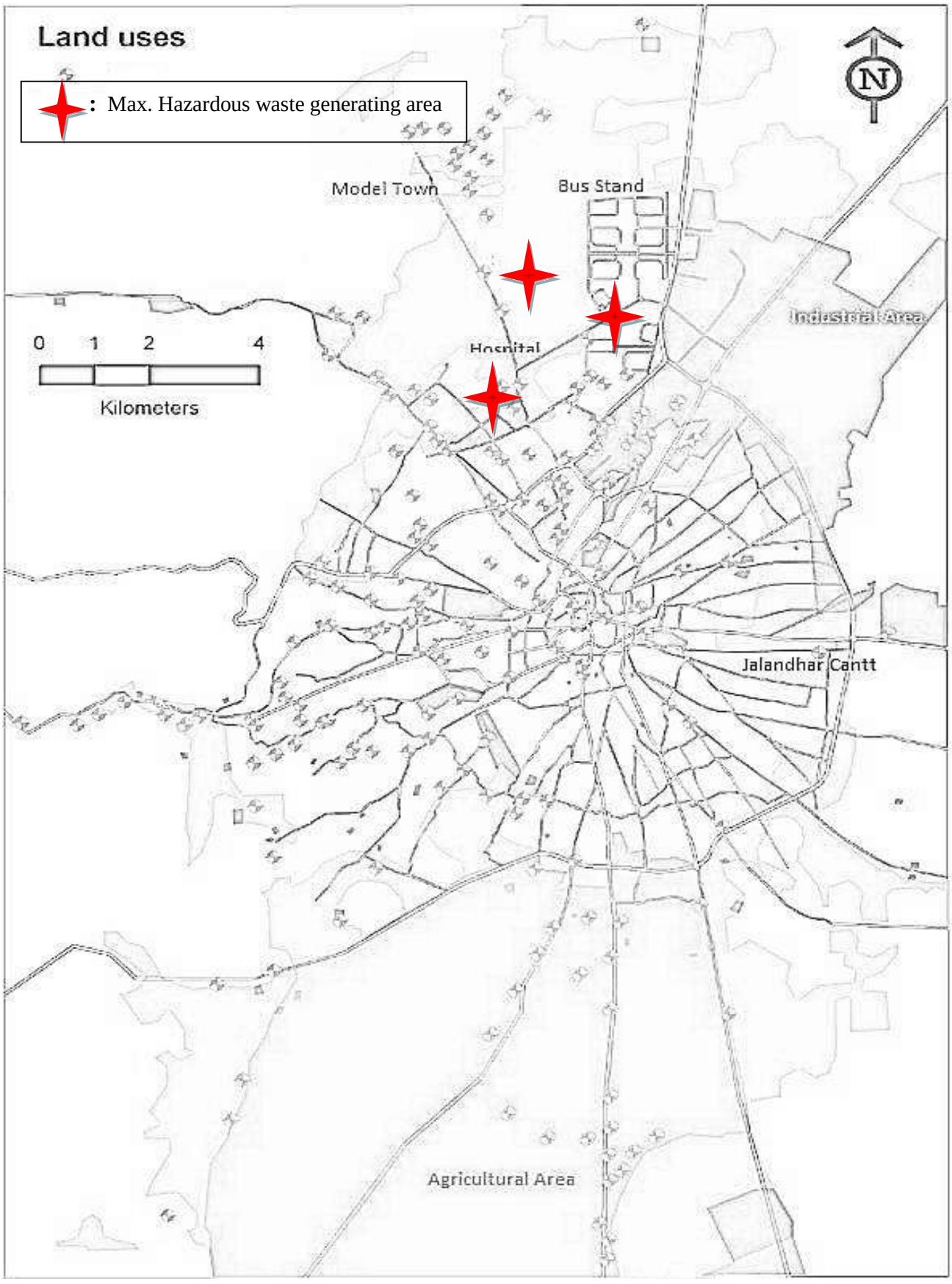


Fig.4.2:Max HW generating points.

4.3 BIOMEDICAL WASTES

They are basically the waste generated from hospitals and includes human waste, anatomical discard of both humans and animals, expired drugs, tissue cultures discard, fluids from the body, human excreta, disposable syringes, etc.

They required special treatment before disposal and if not treated well they are highly infectious and cause serious problem to human health. Estimated waste generated from hospital is 0.5-1kg per bed per day.

Waste may be generated in these facilities during:

- Diagnosis of a disease.
- Treatment of a disease.
- Immunization for disease.
- Related biomedical research

4.3(a) SOURCE AND TREATMENT PROCESS

Category No.	Category type	Treatment option
1.	Human anatomical waste	Incineration/ Deep burial
2.	Animal Waste	Incineration/ Deep burial
3.	Microbiology and biotechnology waste	Autoclaving/ Microwaving/ Incineration
4.	Waste sharps	Disinfection/ Shredding

5.	Discarded medicines & cytotoxic drugs	Incineration/ Secured landfill
6.	Soiled waste	Incineration/ Autoclaving
7.	Solid waste	Disinfection/ Shredding
8.	Liquid waste	Discharge into drains
9.	Incineration Ash	Disposal in landfill
10.	Chemical Waste	Secured landfill

Table 4.6:Source and Treatment process

TREATMENT PROCESSES:

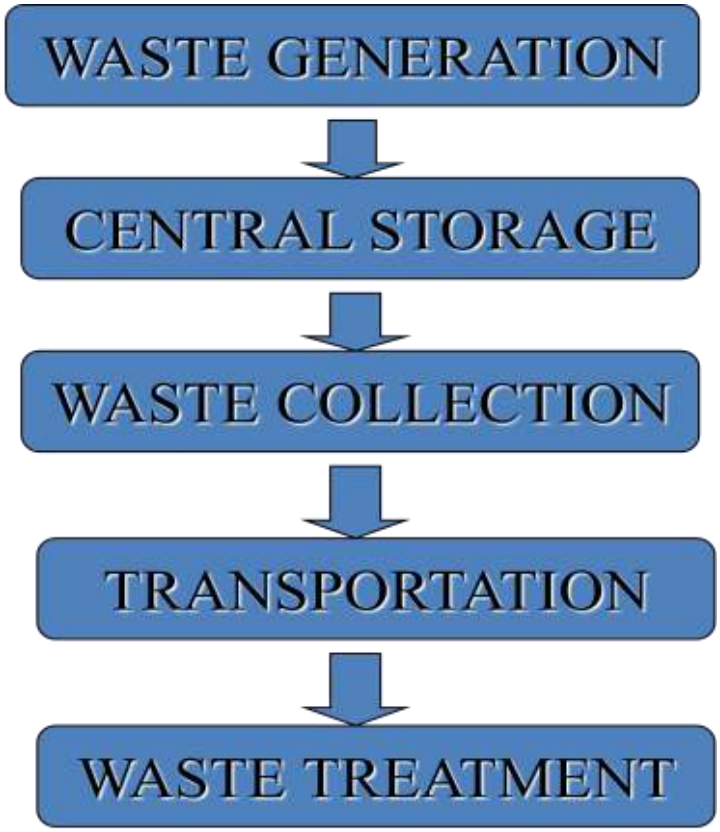


Fig 4.3: Treatment Process

TRANSPORTATION OF BMW WASTE

On site transportation

- Waste is collected from the initial storage point to an assembly storage area by means of trolleys or handcarts.
- Trolleys should be designed to prevent leakage, be easily cleaned.
- Waste route must be designated to avoid the passage of waste through patient care areas.

Off-site transportation

The design of the vehicle should afford the general public, protection from the waste in case of any accident. The driver's cabin in vehicles should be separated from the waste. Vehicles should display prominently the biohazard symbol. It should be equipped with suitable spill controls.Vehicles must be easy to load, unload and clean

Table.4.7: Color coding

METHODS OF TREATMENT

Few methods for the treatment of biomedical waste used in Jalandhar city

- Chemical treatment
- Shredding
- Needle Cutter
- Incineration
- Autoclaving
- Microwaving
- Hydroclave

Chemical treatment

Chemical disinfection is done to treat solid infectious waste that is undergoing shredding like plastic bottles, needles. Chemical disinfection is done with 1% hypochlorite solution which is prepared by dissolving 10gm of salt in 1 litre of water in plastic bucket. All the items are disinfected for 30 to 60 minutes

Shredding

Shredders are used to destroy plastic waste like bottles,syringes .Waste is fed into the hopper, the revolving blades which cut the waste into small pieces.It should be disinfected periodically.

Needle cutters

Needle cutters are used for the destruction of needles. The equipment may either shear the needle or completely destroy it leaving a residue of steel. The sheared needles should be handled as sharps and should be disinfected before their final disposal.

Incineration

Double chambered incinerators are used for the treatment of biomedical waste. Temp. of the primary chamber is 800-900 deg.C. One time loading of the waste is about 100-150kg.Temp. of the secondary chamber is 1000-1500 deg.C Diesel oil used in incinerator have low sulphur content.Height of the chimney should be 30m Emissions from the incinerator are toxic like NOx,SO2,,dioxins,furans,Hg and other SPM so its mandatory to install air pollution control equipment like venture-scrubbers ,air scrubbers. Out of the total waste incinerated only 2% of ash is produced which is dumped after it gets cooled.

Autoclave

The process of autoclaving is used for the sterilization of biomedical waste at very temperature and pressure steam.

Typical operating conditions for an autoclave are of at least 121deg.C at pressure of 105 kPa for a period of at least 60 minutes.

Information on Common Biomedical Waste Treatment Facilities

Table4. 8:

Sl/no	Name and Address of the CBWTF	Name and Cities/Areas covered by CBWTF	Total no. of HCFs being covered	Total no. of beds covered	Total quantity of BMW collected, treated and disposed of (in kg/day)	Cost of treatment of BMW charged by the CBWTF operator (Rs per kg or Rs per day or Rs per bed per day)
	1M/s Rainbow Environment Pvt.Ltd, Village Balyali Mohali	SasNagar,Rupnagar, NawaShahar and partially from Jalandhar and Kapurthala districts	1483	9470	3000	OPD less than 1000 patient/month=R 500 Upto 10 beds=Rs850 From11-20 beds=Rs 2.50-3.50 per bed per day From 21 and above=Rs 3.50-4.50 per bed per day
2	M/s BMWT Trust,Vill. Pangoli,Defence Road, Pathankot,DisttGurdaspur	Distt. Pathankot&Distt. Gurdaspur, Jalandhar City 50%+GT Road Dasuya,Tanda,Mukerian and Kapurthala city	590	6137	1200	OPD less than 1000 patient/month=Rs 500 Upto 10 beds=Rs 850 From 11-20beds=Rs 2.50=3.50bed/day From 21 and above=Rs3. 50-4.50 per bed/day

Treatment equipment/facilities installed at CBWTF			Air pollution control systems attached with the incinerator(s)	Method of Disposal of treated wastes (Incineration Ash/sharps/plastics)	Compliances Status
Equipment	Nos.	Total installed capacity			
Incinerator	2	150kg/hr& 65kg/hr		Incineration Ash: Secured landfill at TSDF	No.of Show cause notices/Direction issued: 2 show cause notice issued
Autoclave	2	2600Ltr/hr&350Ltr/hr	Wet Scrubber		
Hydroclave	0	0		Sharps: Dumped in sharp pit	No. of Court cases:0
Microwave	0	0			
Shredder	3 (1 no. Not working)	80kg/hr			
ETP	1	5KLD		Plastics: Recycled	Others
Deep burial	0	0			

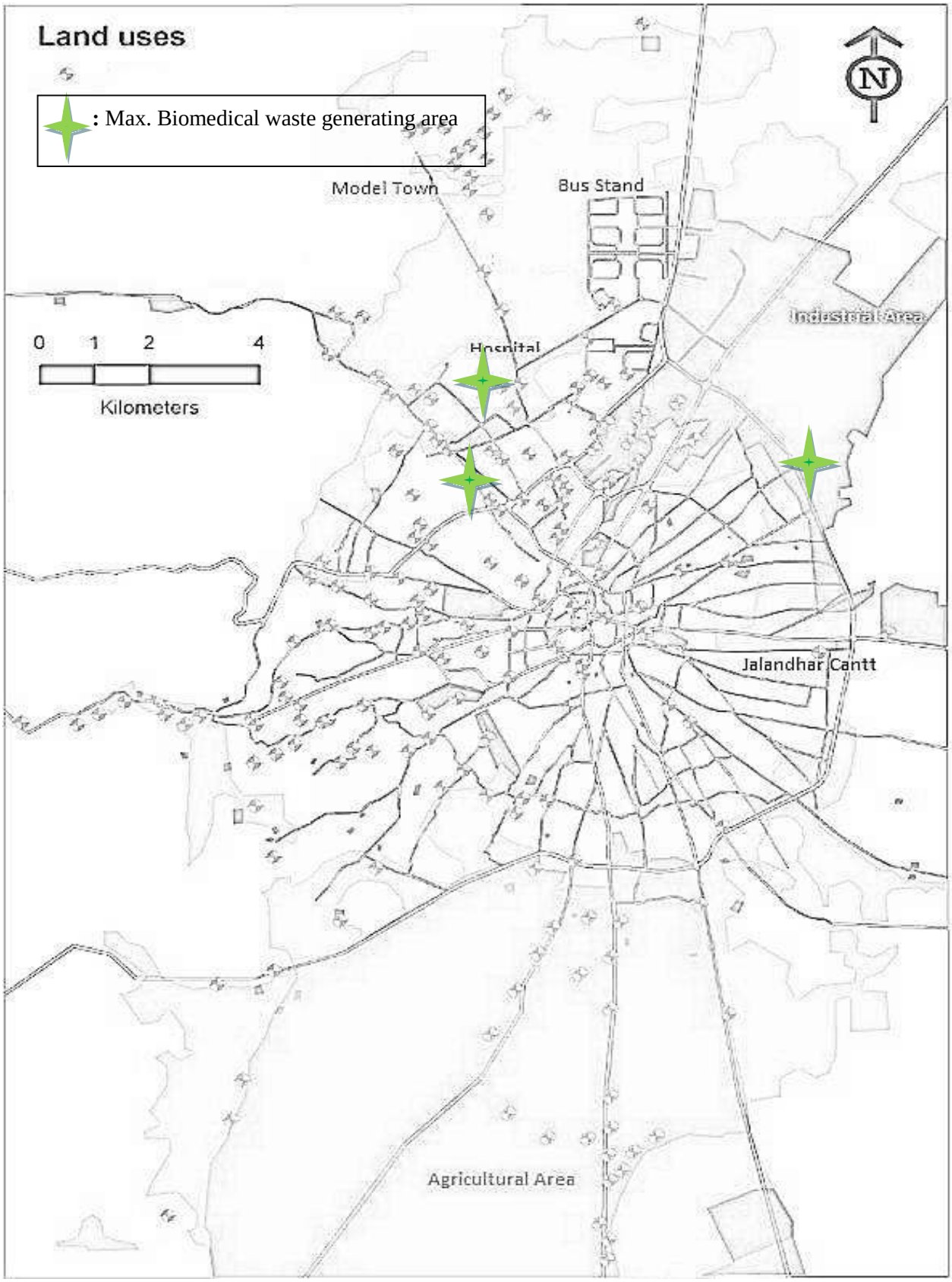


Fig.4.4: Max BM Waste generating points.

CHAPTER-5

RESULT AND DISCUSSION

5.1 PRESENT MANAGEMENT OF SOLID WASTE AND RECOMMENDATION

Generation and composition of MSW

For any management of solid waste there is a huge back up from urban local bodies. In the urban areas like Jalandhar city area ,the residential household, offices ,Bus stands, public markets, center of shopping, etc the waste generated are generally dumped outside of the house or in a common dumping site or collection site. They are further collected by the Municipal cooperation from the site. Public dumped the wastes in open ground or side of the market without proper segregation which is difficult for the municipal cooperation to collect. Due to improper dumping of the waste there is increase in pollution of water and soil. In this city the sites for dumping of the wastes are not properly manage or planned.

Other solution for MSW

Management of solid waste and disposal of MSW because of the modern lifestyle is very important and the waste produced id increasing proportionally. Good and healthy management can be achieved by checking the waste generation data regularly as per the interval of time or periodically. The management which should be check periodically includes Generation of MSW, Collection, Disposal of waste etc . The good and most efficient application of waste management can be done and achieved by applying '3 Rs' methods. '3 Rs' principle (Reuse, Reduce, Recycle) '3 Rs'. The particular goal of these principles is to minimizes the waste generation. These "3 Rs" are the most basic and simple strategies which should be adopted for the wisely management of the solid waste. .

AWARENESS OF PUBLIC AND BEHAVIOR

The modern and development in life style has changed the standard of living and increase in composition of MSW. In major area which income are high public started using more package for day to day used. People should be given well awareness about the environmental impact of the solid waste and its ill effect on the population. There should be formation of the NGO's group, campaign should

be organize periodically to make them aware about the diseases and the impact of the solid wastes. Community should organize themselves by providing areas for the dumping and treatment of the waste.

Reducing biodegradable MSW at source

Composting and vermi-composting using microorganism is one of the best techniques for minimizing the organic biodegradable material. Composting can reduce more than 51% of biodegradable organic components of MSW on-site. Composting decreased the residential MSW between 39 and 56%. The life-time of landfills can be extended by composting. The process of composting can minimizes the area for landfill more than half of the area or 51%.In developing countries like India the composting of the waste are done in the household level I,e not in large scale or municipal level. For example, in Dhaka, Bangladesh, composting of solid waste was more efficient and useful in small-scale plants than in large-scale. The main reasons were effectiveness in operation and maintenance cost, well separation of SW, and effectiveness in marketing. Zurbrugg et al. found that composting in decentralized system could recover costs and yield a profit.

Waste to Energy (WTE)

Some developing countries in Asia are trying to change SW into energy. Philippines and Thailand have converted waste to energy. A pilot plant of 150 ton/day capacity of municipal SW produced 14,000 m3 of biogas, with 55-65% methane product, which was equivalent to 1.2 MW. In the Philippines the Clean Development Mechanism (CDM) was implemented with a WTE project in Payatas. This plant generated electricity of 60 kW to 70 kW, which was supplied to 20 residents. Almost similar in Thailand, the anaerobic digestion tanks have been operated in three areas. The anaerobic digestion tanks have capacity from 10 tons/day to 300 tons/day MSW which generate electricity from 625 kW to 2.5 MW. Landfill as final disposal site has the potential to emit greenhouse gases (GHGs). GHG emissions, which contribute to climate change, are another environment issue which has to be coped with. Asuwei landfill site, located in Beijing City was the earliest and the biggest landfill site to capture GHGs. It had a capacity of 2000 tons/day. The landfill gas has captured after 2001. It is currently used to generate electricity.

SWM inter Partnerships

The exchange of ideas and technologies is very must required for achieving a common goal. For all the activities of SWM mainly in municipalities areas, partnership includes the residents, institutions or local government and the private sector, such as micro companies. In Yala, Thailand, a program of recycling and garbage reducing was established through a relationship between poor communities and the municipal administration. Similarly to in India, the government had the cooperation with private sector and citizen in recycling SW. On the other hand, initiatives of the private sector (citizen and enterprises) such as public-private-community partnership also help to increase the efficiency of waste management system. Cooperation is built between governments, research institute, NGOs, stakeholder, and people participation to solve the problem in SWM.

Table 5.1: Roles of various actors as envisioned in this study

Objectives		Municipality	Service users	Business establishments	Local organizations and NGOs
Planning and management	*Strategic planning*	Develops the plan in collaboration with people, NGOs and community organizations	Actively participates throughout the planning process	Actively participates throughout the planning process	Provides backup and support and monitors the whole process
	Legal and regulatory framework	Developed by municipality in collaboration with other actors	Actively participates and shares ideas	Actively participates and shares ideas	Gives inputs and monitors the process throughout
	Public participation	Involves people and NGOs and community organizations for the decision making process	Actively participates	Actively participates	Assist in sensitizing people regarding the plan, provide back up and monitor the whole process
	Financial management	Provides scope for community level management of funds	Actively participates in ward level committees	Actively participates in ward level committees	Monitors the whole process
Planning and management	*Institutional Arrangement*	Facilitators and provides specialists and support	Becomes part of the decision making body	Becomes part of the decision making body	Facilitators, provides coordination
	Disposal facility	Responsible for operation and maintains in collaboration with other actors	Participates in identification and operation of local compost sites	Participates in identification and operation of local compost sites	Monitors local compost site, coordinates collection and employment of workers for compost sites.
Waste generation	*Waste characterization*	Promotes three stream waste characterization	Segregates waste into degradable, recyclables and garbage	Segregates waste into degradable, recyclables and garbage	Promotes waste segregation and monitors the process at community level

Objectives		Municipality	Service users	Business establishments	Local organizations and NGOs
Waste generation	*Waste minimization*	Promotes reduction, reuse and recycling	Segregates waste into degradable and non-degradable	Segregates waste into degradable and non-degradable	Promotes reduction, reuse and recycling and monitors the process
Waste handling	*Waste collection*	Door step collection	Segregates waste, takes degradable to local compost sites.	Segregate waste	Involves informal sector for collection of recyclables
	Transfer treatment and disposal	Overall in-charge for collection and transfer of non-degradable, non-recyclable and hazardous wastes	Disposes waste after proper segregation	Disposes waste after proper segregation	Collaborates for marketing of compost and recycling with informal and private sector.
	Special wastes	Overall in-charge of harmful and hazardous waste. Treats scientifically	Takes proper precaution and segregates harmful and hazardous wastes	Takes proper precaution and segregates harmful and hazardous wastes	Monitors overall process

5.2 Introduction of Landfill

The process of land disposal will be analyst for a particular region by dividing into three parts:

- Part A: This part will deals with the key principles including dumping of uncontrolled waste of all kinds of a landfill site
- Part B: In this part, constructionsof a proper municipallandfills for the co-disposal of hazardous wastes is analyst.
- Part C: This will be the part which focuses on reviewing the propose-designed of a landfill site which includes multi-disposal of hazardous wastes. The control of stabilize hazardous wastes to secure the landfill is also discuss in this part.

Current status of Landfill:

The process of open dumping is still practice by many industrializing countries. Again disposal of uncontrolled hazardous waste is common on municipal and sanitary landfills.In economic developing areas the standard of land disposal are

very poor where the landfills are unlined and have no control of leachate or surface water run-off. In the course of sound management of hazardous wastes, land disposal has a vital role to play at the bottom of the waste management hierarchy.

In every country, land disposal is always needed since waste minimization and recycling can never entirely eliminate waste and treatment processes themselves generally create residues which need disposal. The encouragement of existing practices to eliminated uncontrolled dumping and introduce land disposal into the hierarchy of acceptable options is the short term priority in developing economies. Meanwhile, Landfill should not be considered as a cheap disposal option. A skilled profession is required for siting, design, construction, operation and closure of land disposal sites. If there is poor operational standards of sites or not properly built and operated, it can be a threat to public health and environment. The impact of such threat is not only contaminate the disposal site and surrounding area, but it can even affect a distant community through groundwater or other pathways.

Part A: Landfill site's key principles

To reach the standard of sanitary landfill, it will be considered to upgrade a site which is currently an open dump through processes like designated dump and semi controlled landfill. But at present it is probably not suitable for hazardous waste disposal. It is impossible to upgrade an open dump in one night. It should be approach through stages as follows:

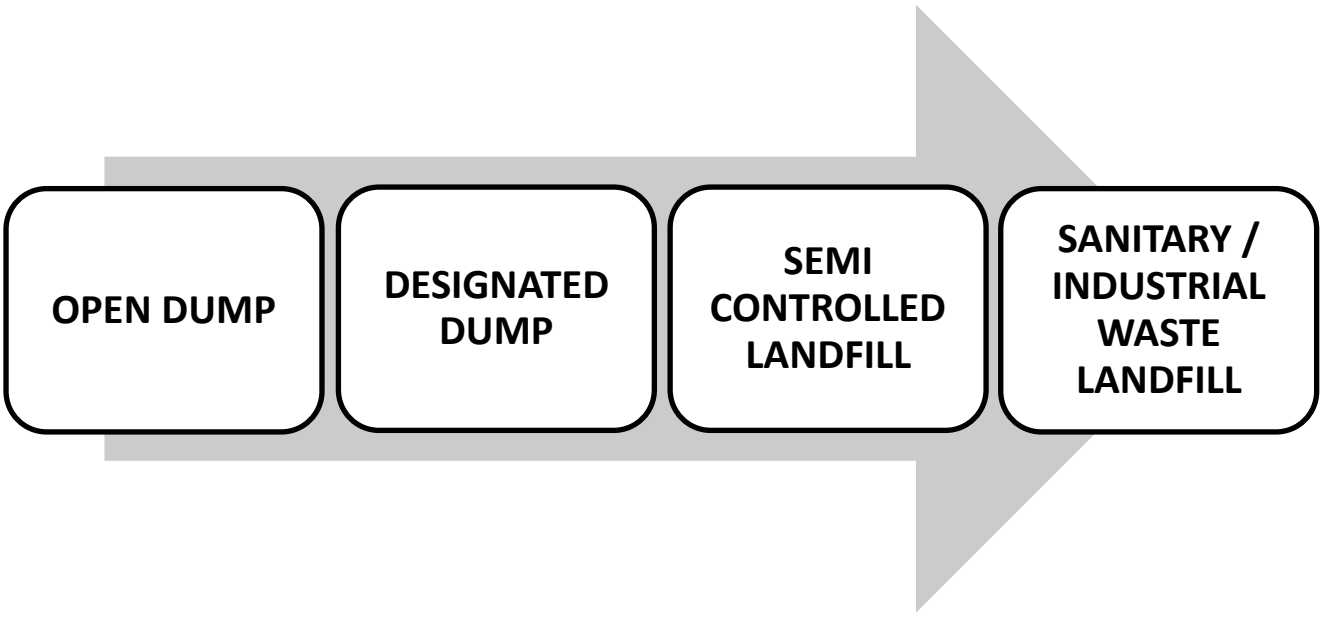


Fig 5.1: Flowchart of different dumps

Here the figure shows the main steps that much be taken in consideration to improve an existing facility and the level of control at each stage. It allows site users to become familiar to the new regime apart from site surveys and assessments to be undertaken of made of pollution. There is a possibility of upgrading a site if the dump is in an area where there is no risk of groundwater pollution.

Apart from the process of opening a dumping site, there are also many stages which will be necessary in closing a dumping site. Simply abandon the site will not enough for closing a dumping site. Various types of measure will be taken while dumping to ensure that wastes will not continue to be deposited at the site. There are some simple remediation measures that should be taken. They are:

a) Limiting the infiltration of water by capping the site
b) Putting a drainage system in place around the parameter.

In the areas where waste are unstable, the measures to stabilize the site should be undertaken.

Components of landfill operation:

The following will be the essential components of a properly constructed and well managed landfill site:

a) Appropriate site : It should be well chosen and properly designed
b) Bottom Line : This will protect the soil and groundwater
c) Leachate collection and treatment : This component will prevent from contamination of groundwater
d) Gas management: the gas management will prevent from damage of soil and escape to air.
e) Waste placement in cells: With this cell, it will control the operation and reduce rainfall infiltration
f) Waste compaction: it will limit the access by vermin and reduces the risk of fire
g) Intermediate cover and
h) Final cover

A well-chosen site and good engineering are not enough without a proper maintenance of the components in the landfill operation. The best-designed site will even poses environmental hazards unless sufficient priority and resources are devoted to proper management and operation of the landfill site, including supportive services such as training of personnel.

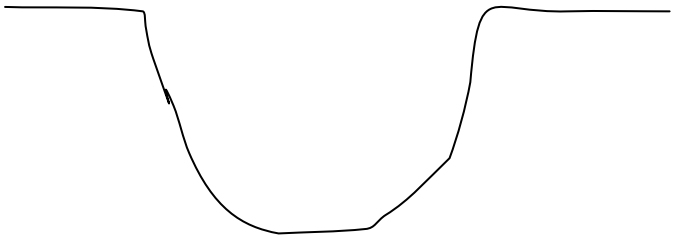
Choosing of landfill site:

Depending on the availability of sites, the geology and the geographical region of the possible site, the land disposal site can be selected from three main areas.

They are

1) Depression 2) above ground 3) Slope

1) Depression:
   If it is possible , a depression area in used because it offers the most stability.
   Eg: gully, abandoned quarry, etc.



2) Above ground:
   Here above ground level, land disposal sites will be constructed where there is no risk to the water table or where no suitable depression exists. But there may be a greater risk of the landfilled material shipping.

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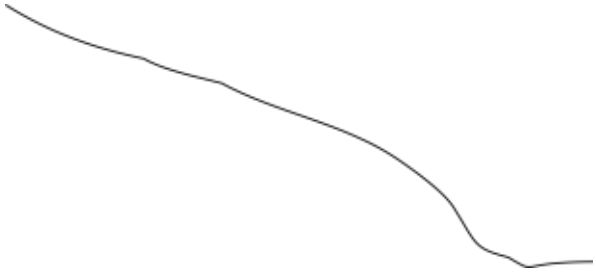
3) Slope :

   To construct a landfill site using a slope, it should be carefully assess about the stability of the land itself and the waste. The major contributor to landslides in landfills is the seepage of water and placing a landfill close to or on a slope may alter the natural pattern of surface water, exposing the site to greater risk. More consideration should be always taken into account about the rainfall levels and the capacity of the drainage system.



Apart from these three alternatives, some land disposal uses underground storage in caves, salt mines or deep wells. While deciding suitability, the character and type of the rock formation is very important.

Municipal landfill improvement practice: site consideration

Whether upgrading dump sites or identifying new sites, factors like geological and hydrological characteristic of the area will be taken into consideration. The level of environmental protection and the design of the site will be influence by this factor. The sources of any drinking water should be identify in the vicinity of the propose site. If the operation is new , the facility should be placed as far as possible away the region. When choosing for a new site, areas liable to flooding or erosion should be avoided. Those site which contain a thick layer of clay or one which is above unusable groundwater such as saline aquifer is the most favorable site for landfill practice. Other influences on the selection of new sites and the operation of existing ones include the proximity to urban areas. The construction , operation and closure of the site will impacts the local community which include transport, noise, and dust as well as the visual impacts. Measures to minimise the adverse impacts should be set out at planning stage for new sites. A comprehensive safety and emergency plan must form part of the operational procedures, to ensure effective response to protect the community in case of accidents or leaks.

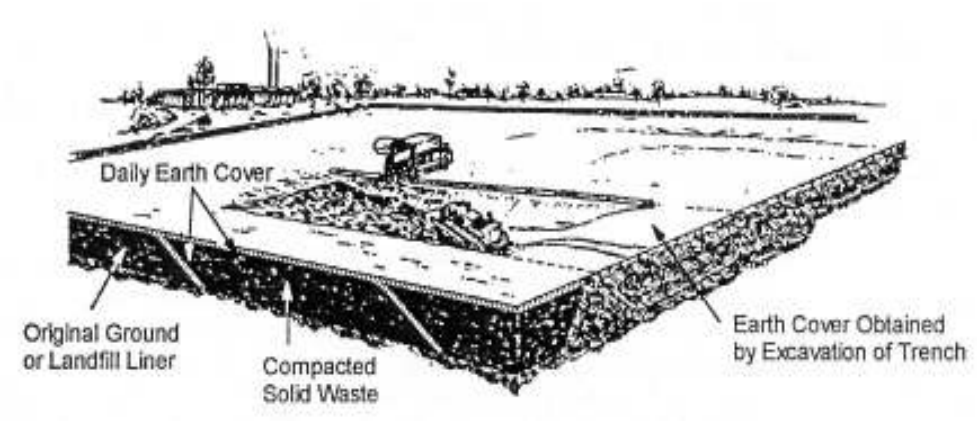


Fig 5.2: Typical image of Landfill

Site design - liner system:

After selecting a suitable site, construction should be base on the specific characteristic of the site and the waste which will be dispose of within it. The bottom liner is one of the important design features in order to contain leachate. It should be design to remain impermeable during long term storage of waste. Multiple liner system will always be chosen so that if the upper liner leaks, escaping materials can be detected and caught at a lower level. The liner system is key to ensuring the isolation of the waste whether it is single, double or triple layer. Permeability is influenced by the soil or rock in the base of the site, and the chosen liner. The aim is to control the escape of contaminants from the site into the surrounding environment.

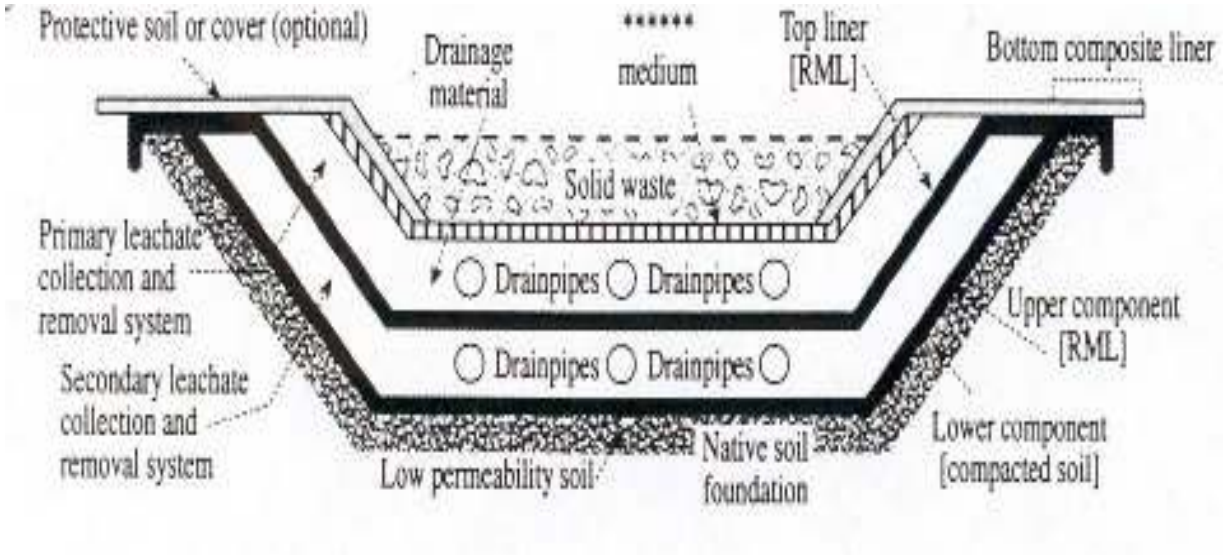


Fig 5.3: Landfill showing cross-section

Site sign - leachate control:

The landfill site which is design to minimize leachate is one of the objective for efficient site design. Leachate seeps into the surrounding land where landfills are unlined.. lining the site enables the leachate to be collected. The above picture shows a collection system installed in a site.

Site design - landfill gas management

At engineered site, landfill gas management is necessary. Landfill gas is potentially explosive and contains a mixture of methane (~60%) and carbon dioxide (~40%) plus a number of trace gases. It is produced by the decomposition of organic material in the waste.

Site preparation:

There are various additional stages in the preparation of a site apart from preparation of the landfill void space and the gas collection and leachate control systems. These includes:

* construction of access roads - upgrading or improvement of existing roads or tracts to enable vehicular access

* installation of utilities - power for lighting, and to operate equipment; water supplies for use by personnel in washing, preparing meals, cleaning vehicles

*fencing to prevent unauthorised access to the site, and to control litter. Low litter fences should be erected close to the landfilling operations and moved as the tipping face moves.

Once the site is in operation, signage should be provided to manage the vehicle movements and make clear where users should deposit waste loads.

Site operation:

The well-designed site will not be an improvement on an open dump unless it is properly managed and operated.

The key operation aspects for sanitary landfill are:

a) waste placement in cells

b)waste compaction

c)Daily and intermediate cover

d) Final cover

Cellular structure:

The design and operation od a site based on a series of discrete cells has several advantages. It allows a limited working face which improves management control. It also reduces the infiltration of rainwater and thus leachate generation. Such a cellular structure is also used on hazardous waste sites, enabling different waste to be kept separate.

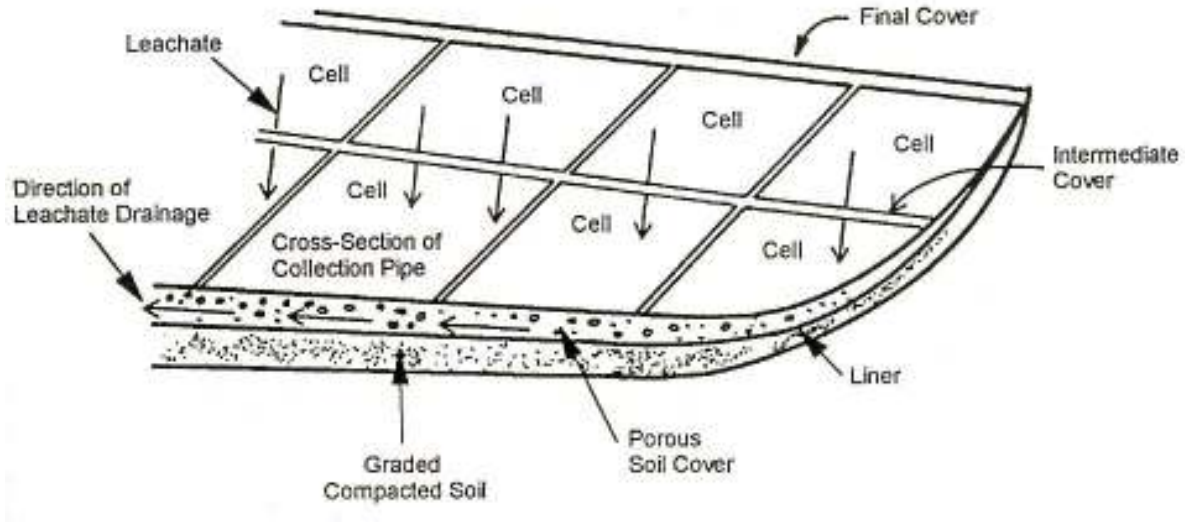


Fig 5.4: Showing cell representation

Part B: Handling industrial wastes in municipal landfills as an interim solution - Co-disposal

In many developing economies, the starting point is that much industrial waste is currently going to the municipal landfill. A better-controlled solution is available rather than banning it before an alternative. It is better to control and improve the practice as an interim solution.

The objective is to reduce the environmental and public health risks associated with the industrial waste while at the same time planning for a long term solution.

In order to achieve this, the three basic requirements are:

1 To control the waste that comes in, and to require the pretreatment of some wastes while excluding others eg flammable liquids. Wastes must be tested and detailed records kept.

2 To improve the physical arrangements for receiving and managing the wastes.

3 To employ skilled, trained staff.

Compatibility of hazardous wastes:

Testing and sampling will ensure that wastes are compatible with one another and with the site liner. Compatibility of the wastes themselves is also important if unwanted reactions are to be avoided. Such reactions might include the generations of heat or the emission of toxic or flammable gases.

Co-disposal:

The process of disposing of small amounts of hazardous wastes together with larger quantities of other wastes is discuss in Co-disposal of landfill sites. It relies on the physical, chemical and biological degradation of the waste material, and the attentuation of the hazardous materials by the non-hazardous components. Co-disposal should only take place under controlled conditions in an engineered and managed landfill site.

A properly designed and managed co-disposal site should not be confused with the existing widespread practice of uncontrolled disposal of hazardous wastes at municipal waste dumps.

Co-disposal - consideration & status:

Co-disposal of different types of wastes in the landfill must be undertaken with great care because of the variability and complexity of both the hazardous wastes and the municipal wastes with which it will be placed.

It is difficult to predict all the chemical reaction products that might be produced. For example, both organic and inorganic wastes may be subject to

oxidation, reduction, combination and decomposition reactions involving hazardous constituents inside the landfill.

The complexity of these reactions combined with the varying degree of biological activity within the site make it difficult accurately to predict results.

In addition, other parameters such as temperature and pH are important influences on biological or chemical reactions, and these in turn influence the rate of production, and the complexity, of leachate.

Co-disposal is suitable for treating solid, liquid and sludge wastes, and although it was never recommended in some places due to previous bad experience with uncontrolled sites, it has been widely practised in a large number of countries. Notable among these is the UK where co-disposal has been used for the last 30 years.

While there is an increasing trend for co-disposal to be phased out in many developed countries, it may still have a valuable interim role in industrialising countries.

Components of co-disposal operation:

Some of the most important factors for sound co-disposal of hazardous wastes with municipal wastes in an engineered and managed site are:

- A continuing supply of municipal waste
- Trained operational manager and staff
- Sufficient mobile equipment for site preparation
- No scavenging should be permitted
- No direct burning of waste on site
- Ensure only suitable waste types are deposited - need to test all wastes prior to acceptance
- Check and record waste types and their origin at the site entrance
- Supervised disposal at landfill face or in trenches or pits dug into MSW at least 6 months old
- Regular inspections on site

Hazardous waste placement - practicalities

From sanitary landfill, the practical aspects of operating a co-disposal site is different. Small quantities of hazardous wastes can be disposed at the working face of the land disposal operation. Trenches can be dug into the MSW alternatively which has already been placed.

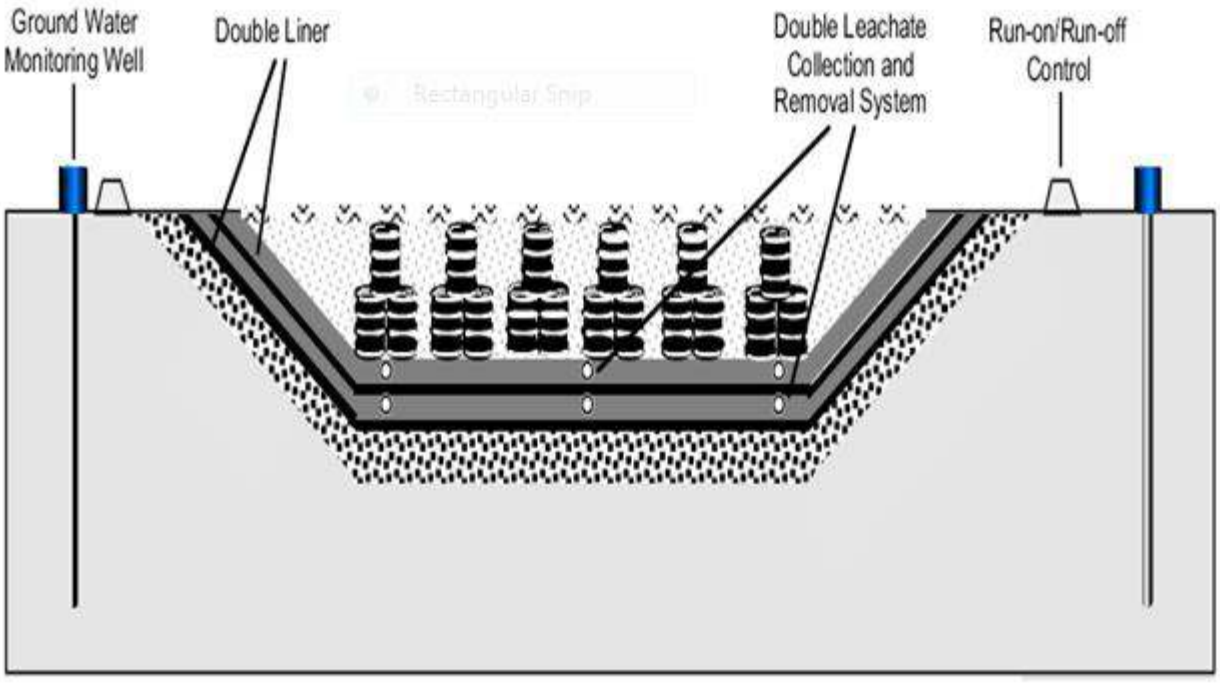


Fig 5.5: Cross-section of Landfill

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

This research responds to the need for an assessment of Solid Waste Jalandhar city.The objectives of this research were:

i)To describe and explain the solid waste management system and practices inJalandhar;

ii) To identify the factors that influence solid waste management ;

iii) To assess the newly proposed solid waste management system, and

iv) to propose recommendations for development of a good solid waste management system.

We found out that for every addition of year the generation of solid waste increases and it is proportional to the population too. By seeing and observing the past trend there is 11% increase of solid waste for every 5 years which is a serious concerns and required immediate focus from all the sides which includes the general people, politician, stakeholders, NGOs and businessmen. The recommendation of introducing a Landfill also has been done by discovering a waste land area in which it should be away from residential and educational institutions areas. It will control the disposal under open dumping which we found to be a common problem which we encounter in our day to day life. The segregation techniques and applications of 3Rs will also significantly effects the solid waste management in future. The analysis of data should be done and checked for every month in order to minimize the generation of waste. Municipal waste becomes the highest generating waste among the three main important solid waste products which are complicated to treat and disposed off easily. The Biomedical waste are treated from the producing sites itself and the hazardous waste are difficult to dispose off. Various researchers and scientists has been studying broadly how to manage this solid waste because one day due to this there will be health disaster which would not be easy to control and cure easily. So it is necessary to study the waste management and prevent the ill effects of this so called solid waste.

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