REPORT ON MUNICIPAL SOLID WASTE MANAGEMENT IN JAMSHEDPUR

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A B S T R A C T

Municipal Solid Waste (MSW) has become a serious environmental problem in major cities all over world. The problem of solid waste is also influencing the urban environment of Jamshedpur city. Therefore, the present study was under taken to enlist the causes of solid waste generation and possibilities of associated problems. The study was mainly concentrated to investigate the present status of Municipal Solid Waste Management (MSWM) in Jmashedpur city. In order to carry out the study a detailed survey was carried out on existing facilities of Solid Waste Management (SWM) such as manpower resources and management systems. A detailed study comprising the methods of practices associated with generated quantity of waste, collection, transportation, treatment and disposal of (MSW) in Jamshedpur city was conducted. The relevant data was obtained from Solapur Municipal Corporation and individual field visits. The study reveals that there are several lacunas in existing solid waste management system in Jamshedpur city on the basis of Municipal Solid Waste (Management and Handling) rules, 2000.

Keywords :

Municipal solid waste, Municipal Solid Waste (management and handling) rules, 2000 , Jjamshedpur urban agglomeration .

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1.INTRODUCTION

Waste is a continually growing problem at global and regional as well as at local levels. Solid wastes arise from human and animal activities that are normally discarded as useless or unwanted. In other words, solid wastes may be defined as the organic and inorganic waste materials produced by various activities of the society and which have lost their value to the first user. As the result of rapid increase in production and consumption, urban society rejects and generates solid material regularly which leads to considerable increase in the volume of waste generated from several sources such as, domestic wastes, commercial wastes, institutional wastes and industrial wastes of most diverse categories. Management of solid waste may be defined as that discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. In its scope, solid waste management includes all administrative, financial, legal, planning, and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants (Tchobanaglous, G. et al, 1997). Solid wastes have the potential to pollute all the vital components of living environment (i.e., air, land and water) at local and at global levels. The problem is compounded by trends in consumption and production patterns and by continuing urbanization of the world. The problem is more acute in developing nations than in developed nations as the economic growth as well as urbanization is more rapid.

. In the international level the awareness regarding waste began in 1992 with the Rio Conference, here waste was made one of the priorities of Agenda 21*. Here specific attention was given to the environmentally sound management of solid wastes. The Johannesburg World Summit on Sustainable development in 2002 focused on initiatives to accelerate the shift to sustainable consumption and production, and the reduction of resource degradation, pollution, and waste. The priority was given to waste minimization, recycle, and reuse followed by the safe disposal of waste to minimize pollution.

In India, the amount of waste generated per capita is estimated to increase at a rate of 1% - 1.33% annually (Shekdar, 1999). For example, the population of Mumbai grew from around 8.2 million in 1981 to 12.3 million in 1991, registering a growth of around 49%. On the other hand, municipal solid waste generated in the city increased from 3200 tonnes per day to 5355 tonnes per day in the same period registering a growth of around 67% (CPCB, 2000). 1

According to the 2001 census, India had a population of 1027 million with approximately 28per cent or 285 million people living in urban areas. As a result of the liberalization policies adopted by the Government of India is expected to increase the share of the urban population may increase to about 40 per cent of total population by the year 2021. It is estimated that by the year 2011, urban areas would contribute about 65 per cent of gross domestic product (GDP). Urban economic activities are dependent on infrastructure, such as power, telecom, roads, water supply and mass transportation, coupled with civic infrastructure, such as sanitation and solid waste management. Since cities and towns in India constitute the second largest urban system in the world, and contribute over 50 per cent of the country‟s GDP, they are central to economic

growth. For the cities to realise their full potential and become effective engines of growth, it is necessary that focused attention be given to the improvement of infrastructure. 2

Urban economic activities also support uncontrolled growth of the population of the city, mainly due to migration which happens for search of better livelihood. This uncontrolled growth of cities has left many urban areas deficient in infrastructural services such as solid waste management. This problem of management of solid waste is becoming very serious day by day. With waste increasing at alarming rate there is an immense need that the urban local bodies take steps in order to tackle with this growing problem

The government of India started encouraging proper management of solid waste as early as 1960's by giving loans for setting composting plants for MSW. The government of India over the years has taken many initiatives and implemented new technologies and methods. With the rapid urbanization, the problem of the MSWM problem has compounded and India is awakening to the magnitude of the problem. Due to increased public awareness of MSWM, a public litigation was filed and resulted in the Municipal Solid Waste (Management and Handling) Rules, 2000. Government for the first time now has included private organizations in providing this public service. New methods of storage, collection, transportation, processing and disposal are being implemented. It is necessary to evaluate the current process at this stage to understand if the methods being implemented are suitable for the Indian scenario and to identify the lacuna in the methods being adopted.

Municipal Solid Waste

The term municipal solid waste (MSW) is normally assumed to include all of the waste generated in a community, with the exception of waste generated by municipal services, treatment plants, and industrial and agricultural processes (Tchnobanoglous, G and Kreith, F., 2002). In the urban context the term municipal solid wastes is of special importance. The term refers to all wastes collected and controlled by the municipality and comprises of most diverse categories of wastes. It comprises of wastes from several different sources such as, domestic wastes, commercial wastes, institutional wastes and building materials wastes.

Categories of Solid Waste

Table : Solid Waste categories based on source

Source	**Typical facilities, activities, or locations where wastes are generated**	**Types of Solid waste**
Agricultural	Field and row crops, orchards, vineyards, diaries, feedlots, farms, etc	Spoiled food wastes, agricultural wastes, rubbish, and hazardous wastes
Industrial	Construction, fabrication, light and heavy manufacturing, refineries, chemical plants, power plants, demolition, etc.	Industrial process wastes, scrap materials, etc.; nonindustrial waste including food waste, rubbish, ashes, demolition and

		construction wastes, special wastes, and hazardous waste.
Commercial and Institutional	Stores, restaurants, markets, office buildings, hotels, auto repair shops,	Paper, cardboard, plastics, wood, food wastes, glass, metal wastes, ashes, special wastes, etc.
Municipal solid waste	Includes residential, commercial and institutions	Special waste, rubbish, general waste, paper, plastics, metals, food waste, etc.

Source : *(Hester, R. E and Harrison, R. M., 2002)*

Objective of study: To understand different aspects of Integrated Solid waste management taken up by JUSCO. This study does not cover Bio-Medical and industrial waste management.

2.MUNICIPAL SOLID WASTE MANAGEMENT

Management of solid waste is associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. In its scope, it includes all administrative, financial, legal, planning and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants (Tchobanaglous, *et al*, 1997).

Municipal Solid waste management involves the application of principle of Integrated Solid Waste Management (ISWM) to municipal waste. ISWM is the application of suitable techniques, technologies and management programs covering all types of solid wastes from all sources to achieve the twin objectives of (a) waste reduction and (b) effective management of waste still produced after waste reduction.

In the Municipal Solid Waste Management the major issues to be considered are:

- Increasing waste quantities
- Wastes not reported in the national MSW totals
- Lack of clear definition for solid waste management terms and functions
- Lack of quality data
- Need for clear roles in state and local government
- Need for even and predictable enforcement regulations and standards

Legal Framework applicable to Municipal Solid Waste Management

Legislation concerning waste is usually differentiated according to the type of waste. International conventions often cover nuclear and hazardous waste, whereas non hazardous waste, often called solid waste is usually more regulated at the national level. From an environmental angle the following environmental rules, regulations and acts would be the most relevant for MSWM:

- Municipal Solid Waste (Management & Handling) Rules 2000, notified by the ministry of Environment and Forests, Government of India vide notification No. S.O.908 (E) dated 25th September 2000. The guidelines given in this law covers all the functional elements of municipal solid waste management.

- The Water (Prevention and Control of Pollution) Act, 1974. Two aspects have to be kept in mind of this law in regard to MSWM. Firstly, a consent from the state pollution control board for establishment of a sanitary landfill site and compost plant is essential and secondly, no water pollution should be caused by the leachate that is emitted by the sanitary landfill site or a compost plant.

- The Water (Prevention and Control of Pollution) Cess Act, 1977 and amendments thereon. The only aspect that should be considered in this law in regard to MSWM is

provision for levying and collection of cess on water consumed for the sanitary landfilling, composting and anaerobic digesters.

- The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereon. The aspects to be considered in this law with respect to MSWM is the need for obtaining consent from the State Pollution Control Board for establishment of the processing plants and disposal site and from an environmental aspect would be the pollution caused by incineration plants, compost plants and landfill sites.

- The Environmental (Protection) Act, 1986 and its subsequent notifications. The aspect in regard to MSWM would be the EIA notification, 1944, which states that for any project to be authorized an EIA report should be submitted first.

2.1. Impacts of Solid Waste:

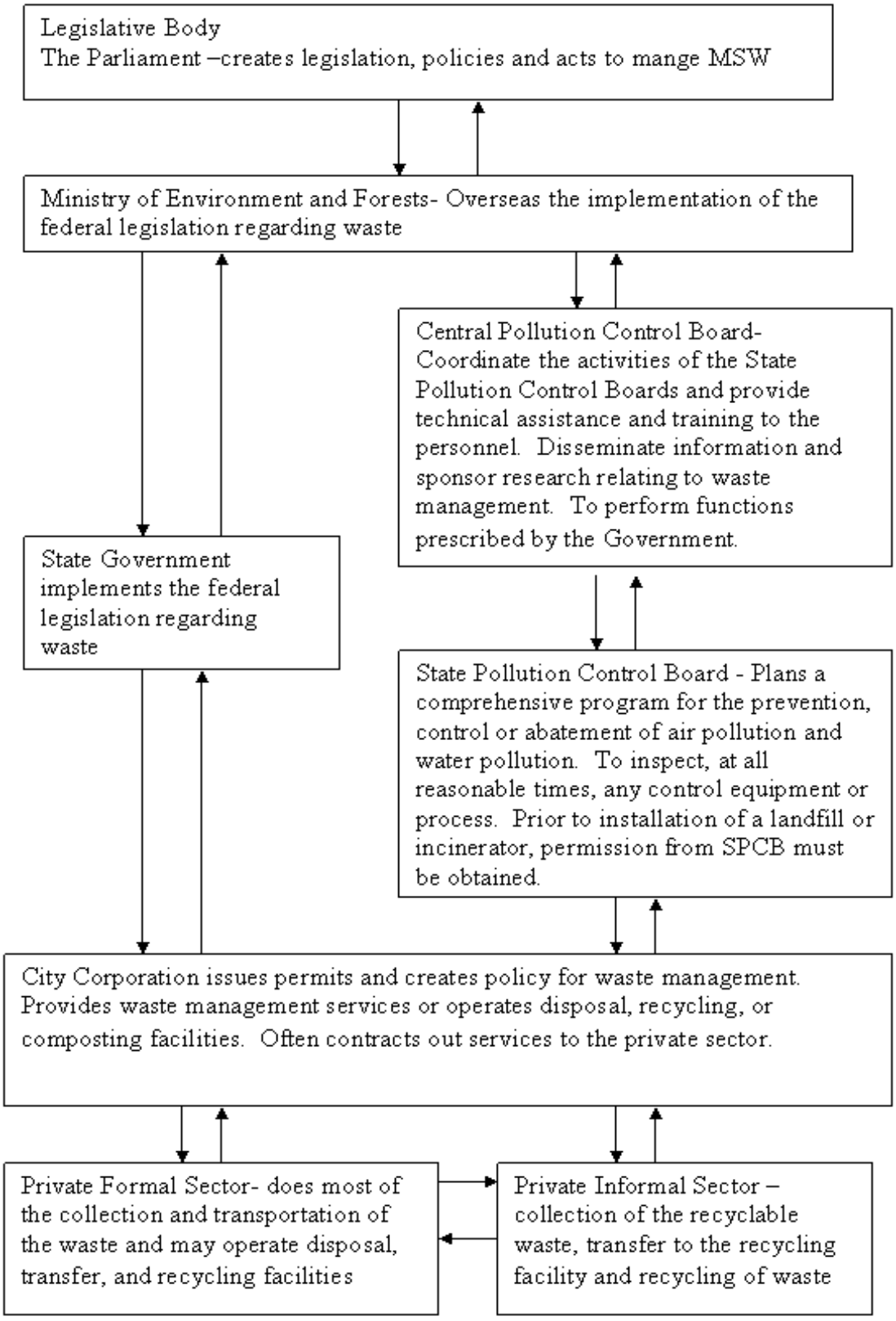
Waste in the area not only takes space but causes other harm also. Waste has negative impacts on the environment and social life while it is economically very useful.

Environmental impact: Different types of waste take different time to decompose and in the process it emits foul smell which is undesirable, thus polluting the air surrounding the place wherever the garbage is dumped. Not only air, Municipal Solid waste affects water as well as the soil. In wet garbage leachate is generated which if not managed properly pollutes the under ground water. Leachate is toxic in composition and this toxicity varies with the type and amount of waste. Also if the garbage is not treated properly and at time then it becomes a big danger to the environment. Due to the toxic nature of the garbage the soil on which the waste is dumped is affected. Basically water and air is affected by garbage.

This in turn affects the human health. Improper handling of solid waste causes severe health hazards. Improperly managed and designed landfills affect the health of the people living in surrounding areas, workers working on site and rag pickers. Direct contact with waste can cause many infectious and chronic diseases. Inappropriate disposal of waste into open areas, rivers and drains, could lead to deaths of living beings due to the contamination of food materials and water. Dumping of untreated waste into rivers, lakes and nearby ecology can contaminate the food chain. to add to all these now a days animals are dying by feeding on the waste as they most of the time eat the plastics which carry food waste, this then chokes their intestines and results in their death. Thus garbage is harmful for the ecology in whole.

Sociological impact: Garbage not only affects the environment physically but the aesthetics of the environment is also hampered by it. one of the biggest social impact of increasing garbage is the birth of “rag pickers” rag pickers are those people who earn their living by selling segregated waste picked from garbage bins or landfills. Rag picking is a very inhumane practice but in order to fulfil basic needs people end up doing this. Rag pickers are the biggest unorganised group thus becoming very vulnerable to everything. From the health aspect they are affected the most as they have direct contact with the waste. Also their earning varies on their collection; sometimes it is very high while at times they get very less.

2.2. Municipal Solid Waste Management System in India



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Economical impact: Waste economically is very useful. If biodegradable waste is segregated then it can be used to make high quality compost. Other items like metal pieces can be recycled and used in other areas. Also plastics and plastic goods can be recycled and reused. Similarly there are many such things which could be properly recycled and reused thus giving some money from the trash. From the primary collection to disposal waste can be segregated and reused to get economic benefits.

3.STUDY AREA:- JAMSHEDPUR CITY

City of Jamshedpur is one of the most important Industrial, Commercial Centre of newly created State of Jharkhand as bifurcation of erstwhile Bihar State. This was formed was formed on November 15, 2000 with Ranchi as its capital. Jharkhand is the 28th state of the Indian Union. Having an area of 79,714Sq. km, The city of Jamshedpur, known as the Steel City, is part of the East (Purba) Singhbhum District of the newly formed state of Jharkhand. Jamshedpur is the headquarters of the East Singhbhum District which was formed by isolating 9 blocks from greater Singhbhum on 16th January 1990. From the industrial growth and mining / quarrying point of view, the district has a leading position in Jharkhand. Jamshedpur city has an area of 56.32 Sq. Kms, bounded on the north by Subarnarekha River, on the west by Kharkai River, on the South by the South Eastern Railway line between Calcutta and Mumbai and on the east by the different villages of the Jamshedpur Block In the urban areas, industries and mines account for the employment opportunity whereas in rural areas agriculture is the main occupation. However, being a part of the Chotanagpur plateau, the soil is full of grovels and red laterite containing sand and silica, which is not suitable for agriculture. The lowland is comparatively fertile and paddy is the main crop of this area. Approximately 49.32% people are engaged in agriculture and agriculture related works and 24.50% people are engaged in the industrial sector.

Location: The city of Jamshedpur is situated at 86.12° E longitude and 22.47° N latitude, on the banks of the rivers Subarnarekha and Kharkai. The city is at an altitude of 159 meters above mean sea level. In the city region, there are locations that are about 933 meters above mean sea level (e.g: Dalma).

3.1.Jamshedpur Urban Agglomeration

The present city of Jamshedpur is spread over the villages of Sakchi, Susnigaria,Jugsalai and Beldih that lay in the Dhalbhum Pargana of the East Singhbhum district.When Jamshedpur started growing rapidly into a populous industrial town, the state government constituted the Jamshedpur Committee to control the envisaged haphazard growth of the town. This Committee was called upon to examine the various problems and to submit recommendations relating to the future administration of the town.

The Jamshedpur Block was established in the 1952 and comprises of rural & urban areas having one Municipality and two Notified Area Committees namely Jugsalai Municipality, Jamshedpur Notified Area Committee and Mango Notified Area Committee. Tatanagar was the sole urban node for many decades till villages within its vicinity transformed into urban agglomerations.

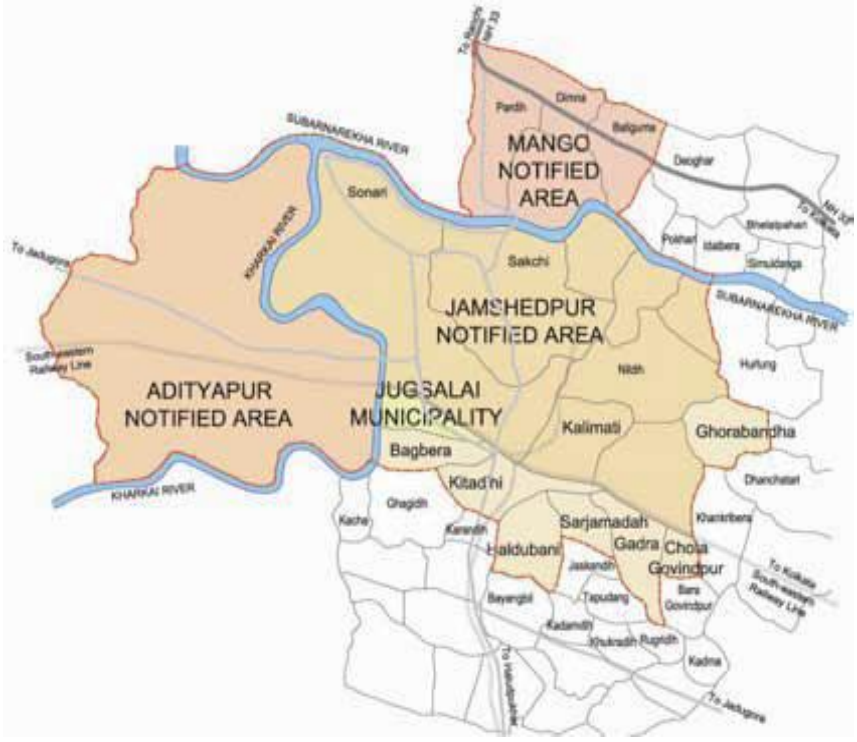
The Jamshedpur Notified Area, Adityapur Notified Area, Mango Notified Area, Jugsalai Municipality and the towns of Parsudih, Ghorabandha, Chotagovindpur, Gadhra, Sarjamdah, Haldubani, Kitadih, and Bagbera, which are a part of the Jamshedpur Block, are proposed to become a part of the Jamshedpur Urban Agglomeration and be administered by a unified municipal administrative body. The total area covered by the proposed JUA is 149.225 Sq. km.

3.2. Climate and Rainfall: The Climate of the city is temperate, typical with three distinct seasons - summer, monsoon and winter. The average annual rainfall is 1200mm to

1400mm(1216.8mm in 2001-2002). This area comes under the path of southwest monsoon so sometimes it receives heavy rain during July to September. During the summer, the maximum temperature goes upto 40° C - 45° C whereas in winter it has recorded a minimum of 6°C.

3.3. Flora and Fauna: In this area deciduous type of forest is found in which Sal, Gamhar, Mahua, Palash, Bamboo, shrubs and grass are the main vegetation. The Gymnosperm, Gnetum scandens is found in the valleys, while the stem less palm, Phoenix acaulis, is abundant on the plateau region. Especially in the area south of Tatanagar, Cassytha filliformis, the green thread like parasite, several species of loranthus and several epiphytic orchids are found. The white barked gouty-stemmed trees of Sterculia urens and Boswellia serrata are very conspicuous against the background of the black rocks. Due to industrialization and large scale of mining quarrying deforestation has taken place. The Dalma wild life sanctuary for elephants, which has a very significant position in the wildlife tourism sector of the nation, is located near the city.

MAP OF THE STUDY AREA :- JAMSHEDPUR URBAN AGGLOMERATION



3.4. Brief History of the City

Jamshedpur is one of the oldest and is considered as the largest existing industrial town in India. It was the benchmark development for post independent Indian industrial cities such as Bhilai, Rourkela and Durgapur, which were established in completely rural areas. A city founded by the late Jamshedji Nusserwanji Tata, probably to support the first private Iron and Steel Company he set up there. In those days, the area was known as Sakchi.

The districts within 150 Kms radius of Jamshedpur are rich in minerals, including ironore, coal, manganese and lime. Sonari is situated at the confluence of two rivers Subarnarekha and Kharkai ensuring a perennial source of water supply to the township, whereas the Kalimati Railway Station on the main railway line located adjacent to Sakchi provides good connectivity to the township. The city was named Jamshedpur in 1919 by Lord Chelmsford, in honour of its founder.

Tata Steel's town division, now under Jamshedpur Utility & Services Co (JUSCO), a 100 per cent subsidiary of the steel major, provides municipal and civic facilities to the city. The track record of urban management by JUSCO is a commentable one.

While the area under TISCO have developed in a planned manner based on all the above expert inputs, the outside areas have continued to grow at fast pace one would expect to see near a major industrial centre. This growth was generally organic in nature as the state or the region did not have a proper plan or development control rules. This has resulted in the present urban agglomeration, which is the area under the current study. Also, as a result, the disparity of the level of infrastructure and services show a large disparity, which is not good for overall growth of the city.

Jamshedpur is a city located in the popular state of Jharkhand in India, founded by the late Jamshedji Nusserwanji Tata. Jamshedpur was the first planned city in India, nurtured by Tata Steel. Jamshedpur is also the first ISO 9005 certified city in INDIA Jamshedpur has one of the highest per capita incomes in the country and is the only town whose municipality is governed by a corporate house. 4

A major part of the city is run by the JUSCO, a 100% subsidiary of Tata Steel, and has resulted in one of the best civic amenities and urban infrastructure being offered to its citizens. Jamshedpur has also been selected as one of the cities for Global Compact Cities Pilot Programme by United Nations, the only one to be selected in India as well as the entire South-East Asia. It was declared the 7th cleanest city of India for the year 2010 according to survey by the India. It is been predicted as the 84th fastest growing city in the world for the timeframe 2006-2020.5

The Jamshedpur Block was established in the 1952 and constitutes of rural & urban areas having one Municipality and two Notified Area Committees namely Jugsalai Municipality, Jamshedpur Notified Area Committee and Mango Notified Area Committee. Tata Nagar was the sole urban node for many decades till villages within its vicinity transformed into urban agglomerations. There are several authorities governing the whole of Jamshedpur Urban agglomeration.

4.ABOUT JUSCO

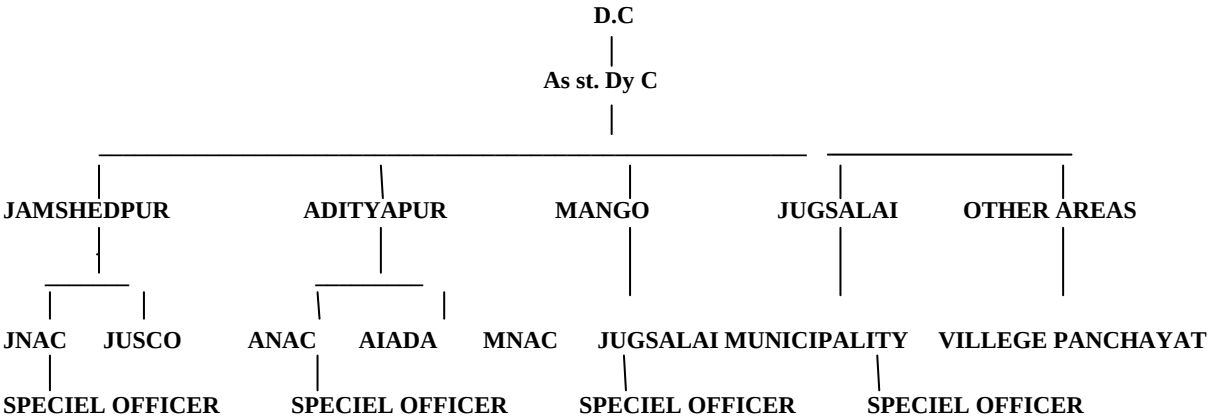
Jamshedpur has an organized waste collection and transportation only in the area controlled by JUSCO through its own team of conservancy workers. The waste in dumped at two sites (total area of 4.1 Ha). About 349 MT is generated every day and this will rise to 749 MT per day in 2031.9

Jamshedpur, the city managed by JUSCO, has been ranked 7th among 441 Indian cities and towns based on their sanitation and cleanliness levels by Ministry of Urban Development, Government of India.10 This says how efficiently the waste has been managed since decades and the system is enhanced by a holistic approach for the management of solid waste by JUSCO.

JUSCO provides following services in the TATA Steel command area.

- Public Health and sanitation
- Municipal Solid Waste Management
- Town Electrical and power services
- Water services Waste water management
- Planning Engineering and Construction
- ICS
- JUSCO Sahyog Kendra

EXISTING SCENARIO OF MULTIPLE AUTHORITIES OF JAMSHEDPUR URBAN AGGLOMERATION



Fig; Multiple authorities of JUA (Source: City Development Plan under JNNURM)

As can be seen from the above diagram the Jamshedpur city gets services from JNAC and JUSCO. While major part is taken care by JUSCO, the areas under JNAC are called “Bagan Area”.

Fact files of TATA Steel command area

Area : 64 sq. km

Population : 7.00 lakhs (2001 census)

Total number of company's flat, quarters and bungalows: 22076 (2006 data)

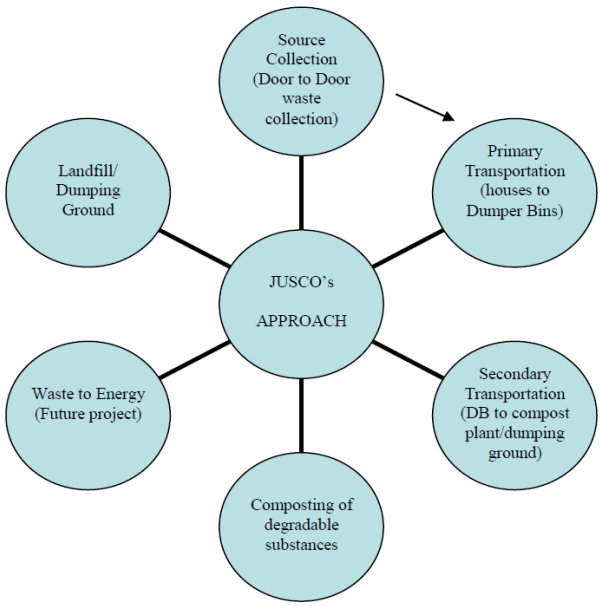
Waste generated per capita per day : 450 to 500 gms

According to a survey conducted by CPCB with the assistance of NEERI for solid waste management in 59 cities (35 metro cities and 24 state Capitals: 2004-05), Jamshedpur having a population of 11,o4,713 covering an area of 64 sq. km generates 338 TPD of waste at a rate of 0.31 kg/c/day.8

The composition of waste generated in Jamshedpur is high on moisture content (48%), with a calorific value of 1009 kcal/kg. About 43.36% of garbage collected is of compostable nature, while only 15.69% of garbage is recyclable. The C/N ratio is about 19.69.8

PRACTICES FOLLOWED IN JUSCO: In Jamshedpur mainly four steps are involved for ISWM. These steps are:

1. Source collection (Door to Door waste collection system)
2. Primary storage and transportation
3. Secondary transportation
4. Disposal:
   a. Composting (vermi composting and aerobic composting)
   b. Waste-to Energy (future project)
   c. Land filling



4.1.Working Norms for Street Sweepers:- The yardstick for cleaning open spaces should be prescribed on the basis of local conditions. However, CPHEEO estimates that a sweeper can cover 30,000 square feet of open space per day. Sweeping norms in running meters of road are as follows:

- High-density area—300 to 350 meters
- Medium-density area—500 to 600 meters
- Low-density area—650 to 750 meters

Street sweeping at Sakchi

4.2. PRIMARY TRANSPORTATION AND STORAGE:

Transportation of garbage is necessary so that the garbage collected is stored at proper place (temporary) from where they can be transferred to the landfill site, thus prohibiting littering of garbage here and there. This transportation is done in two parts; first from households to dumper bins or loader points, second transportation is done from these loader points to dumping grounds/ landfills by heavy capacity vehicles.

In Jamshedpur, after garbage is collected from every locality it is brought in small vehicles which are either motorised or non-motorised and dumped in dumper bins or at loader points. Garbage is also collected from different small bins like the Hume pipe bins, masonry bins kept in locality or housing complexes and also garbage from the cleaned drains is transferred to primary temporary storage depots.

Tilting bin at BELDIH LAKE FLAT

RC BIN NEAR BAGICHA

Dumper bins are huge metallic dustbins with a capacity of 4300 cu meter, while loader points are demarcated open spaces barricaded from three sides and are large enough to accommodate garbage from several places.

Loader Point

These primary storage bins are cleared and emptied everyday ensuring no overflow of bins or spilling of garbage.

4.3.SECONDARY TRANSPORTATION:

As mentioned in the earlier section that transportation in solid waste management is an important aspect in order to avoid littering and spillage of garbage. In secondary transportation high capacity vehicles are used.

Garbage from different places (all five zones) collected in dumper bins and loader points are then collected by different high capacity vehicles and are mainly sent to the dumping ground and that garbage is then covered with a layer of slag. In all these zones garbage is collected from about;

- 60 loader points
- 300 dumper bins
- 120 refuse compactor bins

GARBAGE IN DUMPING GROUND

LIFE AROUND DUMPING GROUND

While garbage from few selected areas like Jubilee Park and Market areas of Sakchi are sent to the composting plant to be treated and converted into compost.

These vehicles are specifically designed and improved in order to handle solid waste. They are of high capacity, covered type and of high efficiency and mainly hydraulic type vehicles. Closed type vehicles are used because open vehicles when carry garbage from residential area to the dumping ground they cause nuisance in the locality like spillage of garbage, spreading of foul smell etc. therefore all the vehicles used for secondary transportation are covered type. Also when dumper bins are carried to the landfill they are properly covered by tarpaulin sheet in order to avoid nuisance by moving garbage and adhering according to MSW management Rules 2000.

Truck carrying covered garbage Twin Dumper placer with covered garbage

Garbage from the western Zone covering, R.D.Bhatta and Northern Town zones is dumped in the "Transfer station"d which is just behind Co-Operative College. This type of arrangement has been made because the dumping ground is very far from these zones and it would take about 2hrs to empty one DB in the dumping ground and at this rate only about four DBs can only be emptied. While with the presence of transfer station about 10 DBs can be emptied in an 8 hr time schedule. Then from this transfer point garbage is transferred to dumping ground by trippers which have a capacity of 6 tons everyday.

Different vehicles used in JUSCO

- Loaders - 5 (JCB)
- Tripper -12, capacity- 5.25 tons
- Dumper Bins - 300, capacity- 4.5 cu.mt
- Dumper placer - 3 single and 2 twin containers

Then if required one or two dumper placer is taken on contract

4.4.Distribution of Vehicle:

1st Set: 1 loader & 3 trippers – To Northern Town, R D Bhatta and Sonari; Morn. - 6.00 am to 1.30 pm

2nd Set: 1 loader & 3 trippers – To Baridih and Burma Mines; Morn. - 6.00 am to 1.30 pm

3rd Set: 1 loader & 3 trippers – To Kashidih and Bhalubasa; Afternoon- 1.30 pm to 5.30 pm

One loader is always engaged in Dumping Ground, one more in transfer station and one is kept for miscellaneous work.

GPS and GIS system is available in all vehicles but is non-functioning except in a few. Due to some technical problem the GPS system is not working properly thus creating problems in tracking and managing the fleet.

(Waste transport vehicles have a useful life of 8 to 10 years; therefore, financial planning is necessary to ensure timely replacement of vehicles.)

4.5.WASTE PROCESSING AND DISPOSAL

- Number of waste processing and disposal sites in the city -1
- Their distances from the center of the city-in the middle of the city (Jubilee park)
- Area of these sites- 2 Acre
- Quantity of waste treated or disposed of at each site-50 MT
- Expected life of each landfill site- 25 years

Financial Aspects

- Operating cost- 8.5 crores/annum
- Cost of collection per ton per day- Rs.180/Tonne
- Cost of transport per ton per day- Rs.390/Tonne
- Cost of disposal per ton per day
- Allocation of revenue and capital budget- Rs.5.5 crore for municipal solid waste management of Jamshedpur city.

Waste Handling, Sorting, Storage, and Processing at the source

Waste handling and sorting involves activities associated with management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection.

- Sorting is an important component of waste management and best-done onsite. However, there are various stages of sorting. These can be identified as the following:
    - At the source or house hold level
    - At the community bin (municipal bin)
    - At transfer station or centralised sorting facility
    - At waste processing site (pre-sorting and post sorting)
    - At the landfill site
- Sorting Operations can be carried out in three ways:
    - Manual sorting
    - Semi-mechanised sorting
    - Fully mechanised sorting
- Onsite storage is of primary importance because of public health concerns. Open ground storage, make shift containers should always be avoided and only closed containers should be used. Processing at the source involves backyard composting. Storage of wastes can be done at three levels:

- At source
- At community level
- At transfer stations

4.6.Collection:- This includes gathering the solid wastes and recyclable materials and transport of these materials to either the processing facility, transfer facility or the disposal site.

Types of Collection

Community bins - they are placed in convenient locations, where the community members carry the waste and throw it in. This method is comparatively cheaper to other methods. This is the most widely adopted method in western countries. For this method to be adopted it is important that the Bins are covered, they are aesthetic, they are attended to regularly, kept clean, easy to handle and separate bins are provided for recyclable, mixed, paper and biodegradable waste.

i. **Door-to-Door collection –** The waste is placed at the doorstep at a set time when the waste collector arrives. In this method, it is the collector of the waste has the responsibility to collect the waste separately. This method is very convenient for the householder, however requires homeowner cooperation and scheduled service for homeowner cooperation.
ii. **Block collection** - the collection vehicles arrive at a particular place or a set day and time to collect waste from the households. Households bring their waste containers and empty directly into the vehicle. This method requires a higher homeowner cooperation and scheduled service for homeowner cooperation
iii. **Curb side collection** – the homeowner is responsible for placing the containers to be emptied at the curb on the collection day and for returning the empty containers to their storage location until the next collection (Tchobanolous, G et al 1993)

important aspect in primary collection is **"Segregation".** Segregation is a process according to which different types of waste are separated and stored in different coloured poly bags or bins. The waste can be segregated into three categories as mentioned below;

Organic Waste	Recyclable	Others
Tea Leaves, Egg shell, Old Food, Henna paste, vegetable peels, meat, and bones. Stored in Green Coloured Bag	Paper, shampoo bottles, glass, note books, wires, safety pins, caps of mineral water bottles. Stored in Red Coloured Bags	PET mineral water bottles, nitrogen sealed packaging for chips, tetrapacks, thermocol, carbon paper, plastic coated visiting cards, and sachets. Stored in Black/Blue Coloured Bags.

Segregation is done at almost every step of waste management but major segregation can be done at the source, mainly at household level. In the household level the garbage is segregated into two types "wet waste" and "dry waste". "Wet waste" is the waste generated from the kitchen totally, which includes food waste, vegetable and fruit wastes, dried or green leaves. While "Dry

waste" is the waste generated otherwise, like polythene bags or any plastic made thing, glass pieces, metal pieces, cloth pieces, rubber, paper, CDs etc.

4.7.Benefits of Segregation:

1. Segregation will help proper disposal, reuse and recycle of garbage. Like, the "wet waste" will be sent to the vermicomposting plant where it can be converted into useful compost. While the dry waste can be recycled or reused for different things, like, the paper can be sent for recycling, plastics can also be recycled and reused (plastic tar roads), glass can be disposed properly etc.
2. There are many hazardous wastes like medicine, chemicals, plastic etc also at times there are glass pieces, metal pieces which can cause harm to the rag pickers (mainly women and children), and employees working in dumping ground. This hazardous things need to be disposed properly and not just dumped in the dumping ground.So there is a need for segregation at source i.e our homes, which would help us to reduce, reuse and recycle waste so that the load on the dumping ground or the landfill is minimised.

4.8. Costing: Major cost component in primary collection are

- Manpower
- utilities
    - ❖ Vehicle
    - ❖ petrol/diesel
    - ❖ Leakage
    - ❖ maintenance

Sweeping: A person has to clean 250 m/ day

Minimum wages of a Sweeper Rs 136/day+Rs 50-60 (other allowances) = Rs 186/day

Utilities given to the worker: Cost at an av. = Rs 16-18/day

- ❖ one time basis: helmet and shoe
- ❖ Regular: Mask gloves, broom, and other devices.

Total cost per person = 186+18 = Rs 205

E.g: suppose a 1000 m long drain has to be cleaned, so;

- number of workers req.- 4 (250 m per person can clean)
- total cost of cleaning that drain = 4* 205 (cost/person) = About Rs 800 per day

Door to Door waste collection:

For door to door collection of garbage (values on estimation)

- One auto should cover 2000HH in a day (8hrs working)
- Manual tricycle should cover 800 HH per day
- A hand cart or trolley should cover 200 HH per day.

- Running of auto from HH to loader points is about 15kms
- Average mileage of an auto is 20km/ltr diesel
- Minimum two people for the collection needed:- 1 driver, 1 Helper

Number of persons per HH average = 5

Garbage generated = 450gm/capita- 450*5 = 2250 gms per HH

From 2000 HH = about 4 ton garbage generated

Capacity of one auto = 1500 kg/trip

Number of trips = 15*3 (1.5ton/trip garbage) = 45km

Amount of diesel needed = 2.2 ltrs

Cost of diesel = Rs 38/ltr*2.2 = Rs 83.6

Cost of Manpower

- Driver salary = Rs 4,500/month = Rs 150/day
- Helper Salary = Rs 3,500/month = Rs 116.66/day

Total = Rs 266.6/day

Total Cost of Utilities per day = Rs 32

TOTAL cost of collection of about 4 ton garbage per day = 266.6+ 83.6+ 32 = Rs 382

So, cost of collection of 1 ton garbage = 382/4 = Rs 95.5

4.9. Field Visits: Ram Das Bhatta and Kashidih

Under Ram Das Bhatta depot there are two A and B clusters and seven muster places and about 295 refuse collection points. There are two bustees, named Gurudwara bustee and New Ranikudar bustee. Door to Door waste collection has been started recently (four months back) in few pockets covering about 450-500 households mainly company quarters. But segregation is not done at household level.

These areas where Door to Door is done are very neat and clean. There is no littering of garbage and the drains are also very clean. Here motorised vehicles are used to collect garbage. There is a driver and one helper who brings garbage from HH and dumps in the vehicle, while there are two more workmen who clean the drains.

From the interviews taken from residents of the area it can be said that;

- backyards are very clean- people can sit and chat in their backyard
- no collection of garbage on streets

- drains often cleaned and are free flowing
- people are happy from the new system

Kashidih is divided into five clusters viz. A, B, C, D and E. Door to Door waste collection is done in L Town area, Bhalubasa and Bhuyandih areas. About 450 HHs are covered in L Town area while in Bhalubasa and Bhunyandih about 1200 to 1300 HHs are covered. The result of implementation of this system can be seen very clearly in the area itself. All the streets are clean and people like this system (as told by few residents) and are happy with the cleanliness. Also in these areas community bins have been removed in phases in order to enhance and expand the door collection system. Removing of bins will also force people to not throw the garbage and collect it for the whole day and give it away the next day. But here also there is no practice of segregation. Kashidih being a totally private area used to face problems of unmanaged waste so the result of implementing such a system was very fruitful.

From the suggestions given by people it can be seen that there is still some discomfort with respect to timing among the people. This problem can be solved by having a detailed discussion with the community otherwise there can be chances of disruption of a smooth flowing system.

Few other suggestions by people:

- Behaviour of the collector should be more polite
- Garbage collecting vehicle should come twice in a day
- Sound of the whistle should be louder
- Create Awareness

Meeting with the Community:

Venue: Bhalubasa Community Development Centre

Time: 4.00 pm to 5.00 pm

Agenda: Discussion about Door to Door waste management, Segregation of waste, Hygiene and use of plastic.

In this meeting only women were called with the pre-notion that in most of the houses women manage in- house waste. Another idea was to mobilise women and make them more aware about the need for proper management of garbage and ensure their involvement.

The discussion started with the community people talking about Door to Door waste collection, are they liking this system or not. In overall people of that area liked this new system of waste management and appreciated it. They did mention about the neatness and cleanliness maintained in the area. Also they strongly affirmed to expand this system in other areas also. Rather there were few women from the areas where this system is not implemented and they wanted it to be started in their area also. One problem came up front that was about the practice of throwing garbage here and there persists in few people.

After explaining about segregation of waste, we asked whether they (community people), will be able to segregate waste and keep and hand over separately then the response was very

affirmative. We can see from the feedback form results also where in both the areas maximum number of people agreed to segregate waste.

Further in the meeting it was also explained what would be done with segregated waste, like the wet waste will be sent to compost plant and wet waste further segregated and recycled or reused according to the type of waste. A discussion on plastics usage was also done. Everyone knew plastic usage is bad but said there is no alternative. People are very unacceptable to carrying cloth bags with themselves. The “no use of plastic” discussion was not very acceptable. This topic should be handled separately and with different strategy.

The meeting and the feedback form strongly say that the people are happy with the new system, would even segregate the waste when needed and they also mentioned need for more awareness programs and meeting to enhance the system and mobilise people.

5.Environmental and Health risk scenarios

Potential hazards of solid wastes are numerous to the living community when it is improperly managed. Solid wastes have the potential to pollute all the vital components of living environment (i.e., air, land and water). Some of the hazards caused by solid wastes are listed below;Uncollected wastes often end up in drains, causing blockages that result in flooding and unsanitary conditions.

1. Open and overflowing bins attract stray dogs, which has been a major cause of the spread of rabies.
2. Open waste bins also attract stray and domestic cattle. Cattle in the city causes nuisance by blocking the traffic on the roads. Cattle that graze on the waste from bins end up eating the plastic along with the vegetable matter, which proves to be fatal for them. The milk obtained from the cattle that feed on waste can be contaminated and can prove to be unsafe for human health.
3. Flies breed in some constituents of solid wastes, and flies are very effective vectors that spread disease.
4. Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tire and other objects. Mosquitoes spread disease, including malaria and dengue.
5. Rats find shelter and food in waste dumps. Rats consume and spoil food, spread disease, damage electrical cables and other materials and inflict unpleasant bites.
6. The open burning of waste causes air pollution; the products of combustion include dioxins that are particularly hazardous.
7. Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing wastes.
8. Uncollected waste degrades the urban environment, discouraging efforts to keep streets and open spaces in a clean and hygienic condition. Plastic bags are in particular an aesthetic nuisance.
9. Waste collection workers face particular occupational hazards, including strains from lifting, injuries from sharp objects and contact with pathogens when manually handling the waste.
10. Dangerous items (such as broken glass, razor blades, hypodermic needles and other healthcare wastes, aerosol cans and potentially explosive containers and chemicals from industries) may pose risks of injury or poisoning, particularly to children and people who sort through the waste.
11. Heavy refuse collection trucks can cause significant damage to the surfaces of roads that were not designed for such weights.
12. Waste items that are reused without being cleaned effectively or sterilized can transmit infection to later users. (Examples are bottles and medical supplies.)
13. Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of water supplies, ponds and lakes. Chemical wastes (especially persistent organics) may be fatal or have serious effects if ingested, inhaled or touched and can cause widespread pollution of water supplies.
14. Waste that is treated or disposed of in unsatisfactory ways can cause a severe aesthetic nuisance in terms of smell and appearance.

15. Liquids and fumes, escaping from deposits of wastes (perhaps formed as a result of chemical reactions between components in the wastes), can have fatal or other serious effects.
16. Methane (one of the main components of landfill gas) is much more effective than carbon dioxide as a greenhouse gas, leading to climate change.
17. Fires on disposal sites can cause major air pollution, causing illness and reducing visibility, making disposal sites dangerously unstable, causing explosions of cans, and possibly spreading to adjacent property.
18. Former disposal sites provide very poor foundation support for large buildings, so buildings constructed on former sites are prone to collapse.
19. Rag pickers working on landfill are prone to many diseases like respiratory infections such as lung impairment. In a study carried out by Chittaranjan national Cancer Institute, Kolkata compared the health of Delhi's rag pickers with that of the control subjects from east Delhi slums. Nearly 75.5 rag pickers from the sample group of 98 had higher frequency of upper respiratory symptoms (sinusitis, running or stuffy nose, sore throat, common cold, fever) and 81.6 per cent showed lower respiratory symptoms (dry cough, cough with phlegm, wheezing, and chest discomfort) and breathing problem.

6.COMPOSTING OF MSW

Composting urban waste in India has a long history. Sir Albert Howard developed the Indore process nearly 75 years ago by systemizing the traditional process that was carried out in India (Howard, 1940). Government intervention to promote this practice can be traced to the 1940s and the early 1970s, when the national government initiated a scheme to revive urban composting (Selvam, 1996). However, centralized large-scale composting plants in urban areas promoted in the 1970s proved to be uneconomical (Dulac, 2001). Only a few installations are currently still operational (UNDP, 1991). Due to high operating and transport costs and the poorly developed market for compost, the expected profits could not be realized as planned. Composting of mixed waste also had a negative effect on compost quality and, thus, on its acceptance by farmers.

From 1990's decentralized composting schemes have been implemented by NGO's with the help of international funding. The decentralized composting schemes became very popular and widespread in a short span of time. Various types of composting have been adopted by these schemes e.g. Bin-composting, Shallow windrow, Pit composting and vermicomposting. However, the maintenance of such schemes proved to be difficult because the household involvement was sporadic, as many people believe that it is the municipal corporation's responsibility to collect waste and do not want to make additional payments. This study states that though decentralized composting has more advantages than centralized composting, the market for MSW compost is limited and is rarely financially competitive to heavily subsidized chemical fertilizers and traditional cow dung or poultry manure (Zurbrügg, et al 2002).

The organic content of Municipal Solid Waste (MSW) tends to decompose leading to various smell and odour problems. It also leads to pollution of the environment. To ensure a safe disposal of the MSW it is desirable to reduce its pollution potential and several processing methods are proposed for this purpose. Composting process is quite commonly used and results in production of a stable product - compost which depending upon its quality can be used as a low grade manure and soil conditioner. The process results in conservation of natural resources and is an important processing method, especially in agricultural and horticultural areas.

Composting is the biological transformation of the organic fraction of MSW to reduce the volume and weight of the material and produce compost, HUMUS like material that can be used as soil conditioner. Almost all organic components can be converted although the rate at which these degrade varies.

The organic fraction of MSW varies food waste, papers, cardboards, grass, textiles, rubber, wood, leather and yard waste.

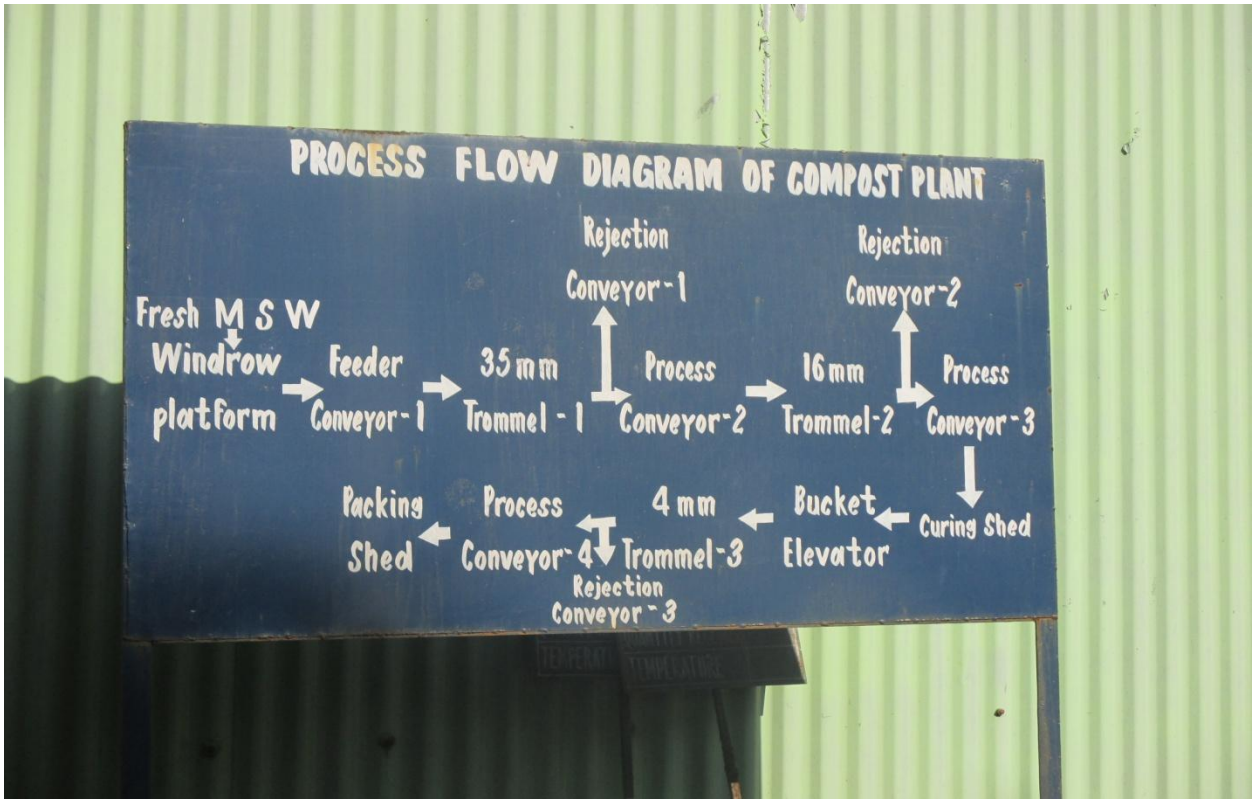
Composting is a process involving bio-chemical conversion of organic matter into humus (Lignoproteins) by mesophillic and thermophillic organisms. There are two process by which composting is done; Aerobic Composting where the organic matter is converted into humus in the presence of air, and Anaerobic Composting where the process is carried in the absence of air.

Windrow Platform Composting Plant

Composting is a biological process of decomposition carried out under controlled conditions of ventilation, temperature, moisture and organisms in the waste themselves that convert waste into humus-like material by acting on the organic portion of the solid waste. If carried out effectively, the final product is stable, odour-free, does not attract flies and is a good soil conditioner. The final product of composting process is a nutrient rich compost which has high agricultural value and is used as a fertiliser, doesn‟t have foul smell (rather it smells like soil) and is free of pathogens.

Composting can be done in the presence of air and in the absence of air. There is one more method of by which the degradable waste can be converted into useful compost, called Vermi Composting, which is another type of aerobic composting.

Aerobic composting: In Jamshedpur an effective and eco-friendly technology has been adopted for bio conversion of organic fractions in Municipal Solid Waste into a useful end product i.e. Bio-Organic Soil-enricher. The composting processes are used mainly for segregated waste but the waste generated in Jamshedpur is very mixed type and difficult to be segregated. So, the technology adopted for composting process here is suitable for both segregated as well as non-segregated waste.



Line Flow Diagram of Compost Plant

Garbage on Windrow Platform

Plate showing information of the heap

The process:

- Fresh garbage is first of all stacked to a certain height on the windrow platforme.
- Then few undesirable things are picked out (as much possible) by workmen from the garbage, like big pieces of log, clothes, shoes etc. Rest gets sorted out after the first screening.

- After this Innoculum mixed with water is put on the garbage heap. Innoculation is done in order to fasten the process of decomposition and have proper decomposition of all organic matters.
- Next is moisture, moisture content of the garbage has to be maintained at 40-45%, less than this level will result in the killing of helpful microbes while more moisture would lead to anaerobic kind of decomposition.
- Then the heap is left to be treated and everyday water is sprinkled on it.
- Next is turning of the heap which is done every week. The heap is turned in a way so that the material on the outer layer becomes the inner core while the inner core becomes the outer layer.
- In this way the whole heap is treated in the presence of air and by the end of fourth week the heap decomposes completely leaving the non biodegradable objects or things which take longer time to decompose (molasses, coconut peals, cloths etc). This non degradable waste is separated from the ready compost by a set of screening. First screening is of 35mm where bigger objects are removed, and then the second screening is of 16mm where further stones and other smaller undesirable particle are removed.
- After this the product is again left for about 15 day for further decomposition then again the same is fed into 8mm screen and then the final product is obtained.

The moisture and the temperature are two most important parameters that have to be constantly monitored in order to get perfect compost. The moisture has to be maintained at 40-45% while temperature has to be maintained at 65-70oC which the heap attains in just couple of days and has to be maintained till the end of this process. At this high temperature the pathogens in the garbage are killed that is why foul smell also doesn‟t come. Proper aeration has also to be ensured.

BRINJAL PLANTS SHOWING THE EFFECT OF COMPOST

7. PLASTIC BECOMING ANOTHER THREAT

- According to studies by the Plastic Development Council under the department of Chemicals and Petrochemicals, India will emerge as the third biggest consumer of plastics in the world by this year end.
- Every year, around 500 billion (500,000,000,000) plastic bags are used worldwide.
- So many that over one million bags are being used every minute and they're damaging our environment.
- India's plastics consumption is one of the highest in the world. Yet, precious little has been done to recycle, re-use and dispose of plastic waste.
- Plastic bags are difficult and costly to recycle and most end up on landfill sites where they take around 300 years to photo degrade. They break down into tiny toxic particles that contaminate the soil and waterways and enter the food chain when animals accidentally ingest them. But the problems surround waste plastic bags starts long before they degrade.
- Plastic bags can be seen hanging from the branches of trees, flying in the air on windy days, settled amongst bushes and floating on rivers. They clog up gutters and drains causing water and sewage to overflow and become the breeding grounds of germs and bacteria that cause diseases. Animals and sea creatures are hurt and killed every day by discarded plastic bags - a dead turtle with a plastic bag hanging from its mouth isn't a pleasant sight but mistaking plastic bags for food is commonplace amongst marine animals.
- Plastic clogs their intestines and leads to slow starvation. Others become entangled in plastic bags and drown. Because plastic bags take hundreds of years to break down, every year our seas become 'home' to more and more bags that find their way there through our sewers and waterways.
- Hundreds of cows die in New Delhi alone every year when they choke on plastic bags while trying to eat vegetable waste stuffed in the garbage.
- Besides choking drains, plastics are highly toxics. When burned they release cancer-causing gases. Lying in the garbage, polythene bags also find their way in gut of cattle, asphyxiating the animals. The cheap bags contain chemicals such as cadmium- or lead-based chemicals that are harmful to health. They leach into vegetables, meat and food.

The Environment Ministry has banned manufacture and use of plastics carry bags less than 8 inches X 12 inches in size 20 micron in width. The ministry has also asked State Governments to register all plastics manufacturing unit, so that these can be regulated. Various States have increased the minimum thickness of plastic carry bags to even higher limits of 40, 50, or 70 microns. These States/ UTs are: Goa (40 micron), Himachal Pradesh (70 micron; HP Cabinet decided to ban plastics in the entire State with effect from 15.08.2009), Maharashtra (50 micron), Meghalaya (40 micron), Punjab (30 micron), Chandigarh (30 micron), West Bengal (40 micron), Kerala (30 micron). An Example of Strict plastic ban

Gandhi Jayanti on October 2, 2010 would mark the commencement of the drive to implement a blanket ban on the use of polythenes at the Ganga river ghats at Kanpur and Allahabad and encourage cloth bags and other alternatives. A Ganga-Suraksha Kosh has been formed wherein

the fine collected from guilty would be deposited and later used for the beautification of the ghat.

The West Bengal government has reconstituted the plastic management committee in September 2010 to give it more teeth and end the menace of plastic bags, once and for all. Three years ago, polythene bags less than 40microns thick were banned all over the state, but the law is flouted openly in every market, neighborhood and on every street. Banned carry bags are manufactured by the tonne and they form the bulk of waste that piles up in the city and clogs drains and sewers. The new-look committee is aiming for a complete turnaround. Its first target will be the 200-odd units in Kolkata that make 2,500 to 3,000 tonnes of banned carry bags a month. Innovation in Recycling Technology Centre for Environment Education (CEE) has been awarded the 'Plasticon 2005 Award' on 1st October 2005 in Mumbai by the PlastIndia Foundation in the category of 'Innovation in Recycling Technology' for its innovation of a **'Polyloom'.** The polyloom is a plastic weaving handloom that helps reuse and recycling of discarded plastic bags (polybags).

The concept of '**polyloom**' has been popularized by CEE's Waste Management Initiative as part of its mandate to address the reuse and recycling of dry waste from domestic garbage. Under this initiative, CEE has established an **'Ecofriendly Reuse and Recycling Unit' (CEE-ERU)** especially for recycling of paper scraps and plastic carry bags. In this unit, paper scrap is recycled by the hand-made paper making method while polybags are reused through the polybag weaving method.

The plastic weaving concept is based on the fact that plastic bags which are thin and flimsy (be it 20µ or less) have an average life time of 2 to 3 hours after which they are discarded. They end up in gutters, dumpsites or on mountain sides and even in the stomachs of animals; they are responsible for clogging, choking, flooding, asphyxiation, landslides, death and destruction. Instead, if they are collected, even from roads, they can be washed, cleaned, dried, cut into strips and woven into the basic plastic textile fabric, which can then be stitched into various products like mats, folders, hand bags and purses. In this manner, both the plastic and paper waste becomes more manageable and less destructive.

The first CEE-ERU was first established in Coorg, Karnataka and subsequently, through various CEE offices, it has also been established in Ahmadabad, Coimbatore, Delhi, Goa, Patna and Tirupathi. Today, the concept has been taken up by many women's self-help groups who gather raw material either by door to door collection or by buying it from rag pickers. This provides them livelihood while taking the plastic carry bags away from the environment.

8.ANAEROBIC DIGESTERS

Biogas is a successful renewable energy technology developed and disseminated in India, second only to improved wood stoves in its spread. Biogas was first introduced to India as an alternative to piped natural gas in 1897 for providing gas-based illumination (Sathianathan, 1990). The superiority of biogas slurry both as manure as well as compost starter and the cleanliness of the process has been emphasized in several publications of the Indian Agricultural Research Institute (IARI) and other agricultural institutions in the country (Chanakya, et al 2002). However, biogas production has been restricted mostly to rural areas (with cattle dung) and in urban areas (with sewage). The anaerobic digesters used in the rural areas are simple in design and to maintain, but they require constant monitoring and are less efficient. The complex digesters on the other hand, are designed to automatically adjust when environmental conditions change, such as would occur with the feedstock. These are used in developed nations to treat unpredictable waste flows and such digesters would be suitable for processing of MSW (Ostrem, et al, 2004). Many studies have been conducted on the use of MSW for production of Biogas. One of the studies suggests that by having decentralized anaerobic digesters in the localities, the odour problem caused by MSW from bins and during long transportation distances can be minimized (Chanakya, et al, 2002). Apart from this (Srinivasan, 2003, Ramasamy, 2000 and Ostrem, et al, 2004) bring out the dual purpose of anaerobic digesters, not only will they provide a solution to the solid waste crisis, but also to the energy crisis.

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. Biogas is mainly composed of 50 to 70 percent methane (CH4), 30 to 40 percent carbon dioxide (CO2) and low amounts of other gases as shown in the table below.

Composition of Biogas:

Substances	Symbol	Percentage
Methane	CH4	50 – 70
Carbon Dioxide	CO2	30-40
Hydrogen	H2	5- 10
Nitrogen	N2	1-2
Water vapour	H2O	0.3
Hydrogen Sulphide	H2S	Traces

Biogas is about 20 percent lighter than air and has an ignition temperature in the range of 650° to 750° C. It is an odourless after burning and colourless gas that burns with clear blue flame similar to that of LPG gas.

Methanogenic Bacteria or Methanogens These are the bacteria that act upon organic materials and produce methane and other gases in the process in an anaerobic environment. As living organisms, they tend to prefer certain conditions and are sensitive to the micro-climate within the digester. There are many species of methanogens and their characteristics vary. The different methane forming bacteria have many physiological properties in common, but they are heterogeneous in cellular morphology. Some are rods, some cocci, while others occur in clusters of cocci known as sarcine. The family of methanogens (Methanobacteriacea) is divided into following four general groups on the basis of cytological differences (Alexander, 1961).

A. Rod-shaped Bacteria

- Non-sporulating, Methanobacterium
- Sporulating. Methanobacillus

B. Spherical

- Sarcinae, Methanosarcina
- Not in sarcinal groups, Methanococcus

A considerable level of scientific knowledge and skill is required to isolate methanogenic bacteria in pure culture and maintain them in a laboratory. Methanogenic bacteria develop slowly and are sensitive to a sudden change in physical and chemical conditions. For example, a sudden fall in the slurry temperature by even 2oC may significantly affect their growth and gas production rate (Lagrange, 1979).

Biodigester designs:- The biodigester is a physical structure, commonly known as the biogas plant. Since various chemical and microbiological reactions take place in the biodigester, it is also known as bio- reactor or anaerobic reactor. The main function of this structure is to provide an anaerobic condition within it. As a chamber, it should be air and water tight. It can be made of various construction materials and in different shapes and sizes. Construction of this structure forms a major part of the investment costs for a biogas plant

Biogas digester at CHAMARIA GUEST HOUSE

However, the global market for CERs as well as VERs looks promising and expertise on the combination of domestic biogas and GHG emission reduction is increasing. At the same time, the demand for renewable energy technology, including domestic biogas, is likely to grow. As carbon revenue can improve the financial, technical and programmatic sustainability of large-scale domestic biogas projects, the option deserves serious attention of project developers.

There are an increasing number of carbon-reduction methodologies applicable for domestic biogas programmes, both for the formal CDM market and the voluntary market, available;

- Expertise, and to a lesser extent experience, on establishing a carbon component in domestic biogas is steadily mounting;
- There seems to be a good demand for both CERs and VERs and;
- Carbon revenue potentially can improve the financial, technical and programmatic sustainability of large scale biogas programmes.

In conclusion:

- There are an increasing number of carbon-reduction methodologies applicable for domestic biogas programmes, both for the formal CDM market and the voluntary market, available;
- Expertise, and to a lesser extent experience, on establishing a carbon component in domestic biogas is steadily mounting;
- There seems to be a good demand for both CERs and VERs and;
- Carbon revenue potentially can improve the financial, technical and programmatic sustainability of large scale biogas programmes.

At the same time:

- The applicable methodologies harbour uncertainties and risks;
- Formulation of carbon projects is complicated;
- Management and monitoring of carbon projects requires a significant, focussed effort, both financially and in terms of expertise;
- There is still no example of a biogas project that has been run through the entire carbon project cycle; in fact, there is no biogas programme registered under currently valid methodologies, and;
- The market for CERs –and to a lesser extent VERs- is only established for the current commitment period, the post-2012 situation is as yet uncertain.

However, as carbon revenue can improve the financial, technical and programmatic sustainability of large-scale domestic biogas projects, the option deserves serious attention of project developers.

9.FUTURE PROJECTS: Engineered landfill

As the holding capacity of the existing dumping ground is to its ultimate level there is an immediate and urgent need of a new landfill site for Jamshedpur. This idea is under consideration and proper sites for landfill are been inspected.

The term „landfill" is used to describe a unit operation for final disposal of „Municipal solid waste" on land, designed and constructed with the objective of minimum impact to the environment by incorporating seven essential components described as follows;

1. A liner system at the base and sides of the landfill which prevents migration of leachate or gas to the surrounding soil.

2. A leachate collection and control facility which collects and extracts leachate from within and from base of the landfill and then treats the leachate.

3. A gas collection and control facility which collects and extracts from within and from the top of the landfill and then treats it or uses it for energy recovery.

4. A final cover system at the top of the landfill which enhances surface drainage, prevents infiltrating water and support surface vegetation.

5. A surface water drainage system which collects and removes all surface runoff from the landfill site.

6. An environmental monitoring system which periodically collects and analyses air, water, soil gas, and ground water samples around the landfill sites.

7. A closure and post-closure plan which lists the steps that must be taken to close and secure a landfill site once the filling operation has been completed and the activities for long term monitoring, operation and maintenance of the completed landfill.

Landfilling is done mainly for the following type of waste;

- Mixed waste which is not found suitable for waste processing.
- Pre processing and post processing rejects from waste processing sites.
- Non-hazardous waste not being processed or recycled.
- Landfilling is usually not done for Biowaste/garden waste and dry recyclables.

Landfills usually minimize the harmful effects of solid waste on the environment by following mechanisms;

- isolation of waste through containment
- elimination of polluting pathways
- controlled collection and treatment of products of physical, chemical, and biological changes within a waste dump-both liquid and gaseous
- Environment monitoring till the waste becomes stable.

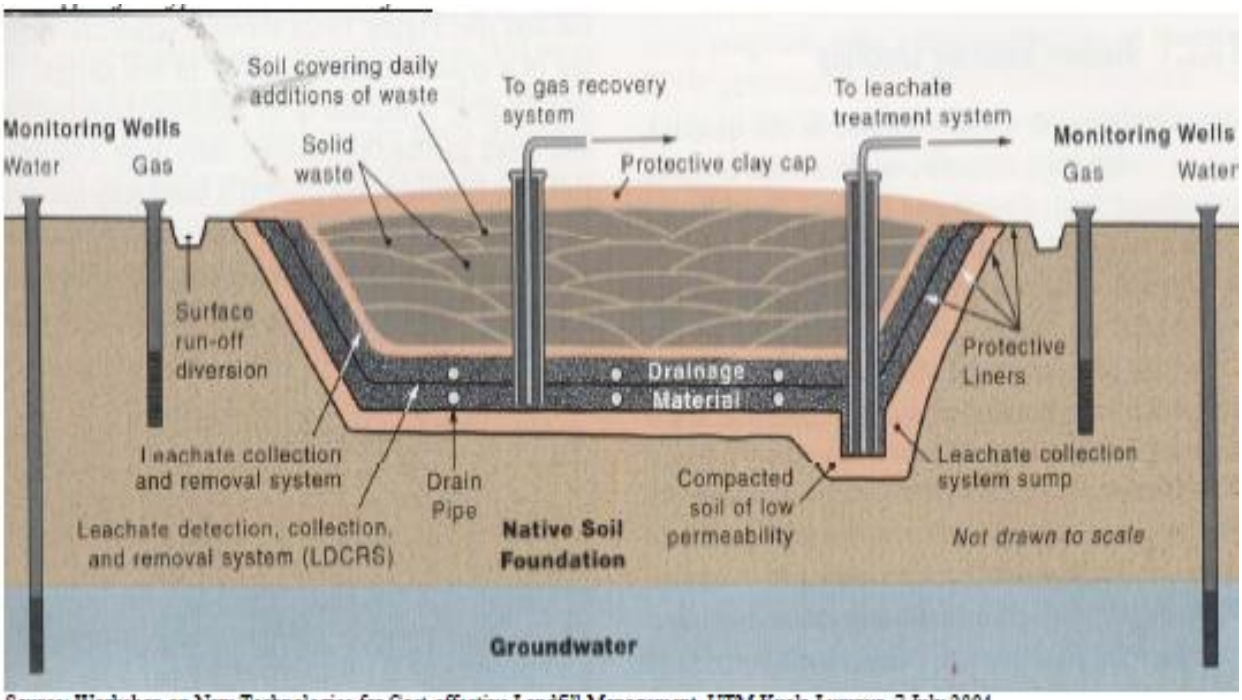
There are three types of landfill;

- Underground
- On ground
- Above ground

Mainly the first two type of landfill are used but the third type is barely used because there is extra high cost involved in raising the platform from the ground level. In underground type of landfill the earth is excavated and then the landfill is made. This could be done only in those places where the water table is very low. According to MSW 2000 rules wherever ground water table is more than 2 mtrs below there only landfill can be made by excavating earth. So, excavated type landfill is made where water table is very low. While on ground landfill is made where water table is not too low.

While making a proper landfill several things are done. First of all a thick layer of clay is spread on the landfill area, then a HDPE sheet is spread all over the area including the sides (in underground landfill). After these two linings big pipes are laid for collection of leachate. There is one header pipe while several branch pipes and all these pipes have 12mm dia (the design of dia of these pipes varies according to the quantum of leachate generation) holes in staggered manner. Then after that a Geo-textile sheet is laid all over the area and above all these a layer of filtering media is spread which is a combination of sand and gravels in order to get leachate collected properly. Then after the landfill gets full it is covered by a thick protective layer of clay and some plants are planted on that area. Those plants are planted whose roots do not penetrate too deep.

Design of a typical MSW landfill:



Source: Workshop on New Technologies for Cost-effective Landfill Management, UTM Kuala Lumpur, 7 July 2004

Landfill under construction

9.1 Costing involved in a Landfill

Costing of a landfill depends on mainly two things;

- First is duration of landfill. It is generally for about 20-25 yrs but not less than 5 yrs.
- Second is the quantity (tons/day) of the garbage coming to the landfill

Total cost of the landfill can be broken into following parts;

a) Initial Cost

i. site acquisition cost

ii. site selection and EIA studies cost

iii. site investigation and characterisation cost

iv. design and detail engineering cost (including laboratory studies)

v. site development costs including infrastructure facilities and leachate/gas treatment facilities (administrative building, rest rooms for workers)

vi. landfill equipment cost (if purchased)

b) operative period-yearly costs

i. phase development cost (including liner and leachate collection system cost)

ii. phase operation cost

iii. phase closure cost

iv. interconnectivity of phases cost

Cost of liner:

- First on the base a 900 mm thick cover of clay is spread which has permeability not more than 1*10-7 cm/sec. Cost is calculated as follows;

  Rs/sq m*thickness (900mm) * base area of the landfill

- Then above that HDPE liner of thickness 1.5 mm is spread also on the slopes of the landfill. Cost calculated as;

  Rs/sq. m* thickness* surface area of the landfill

- Then a layer of Geo textile sheet is given. This is given in order to protect HDPE liner from wear and tear. Cost calculated as;

  gm/ sq cm (standard rate of different companies)

- Then is a layer of drainage media above the sheet which is of gravels and sand. Cost calculated as Rs/ cubic mtr

- After all these layers, HDP pipes are laid to collect leachate.
  1. The header pipes are of 200-250mm OD. This dia can be bigger depending upon the quantum of leacheate generated anf climatic conditions of the area.
  2. Branch pipes are of 110-150 mm OD

These are perforated type of pipe with staggered type of holes of 12mm diameter each. Length of the pipes depends on the base area.

The landfill area should be sloping in order to drain off leachate and at the end a leachate collection tank is made. The collected leachate is pumped and sent to leachate treatment or sewage treatment plant.

c) closure and post-closure period yearly cost

i. vegetative stabilisation cost
ii. . operation cost
iii. monitoring cost
iv. maintenance and repair cost

10. COMMUNITY PARTICIPATION:

Community is the centre of all the activities and specifically in solid waste management. Everything is done for the well being of the community. From Door to door waste collection to disposal of waste in landfill is all done for the benefit of the community. And in this sector the key to success is only community participation. Inspite of such direct and deep relation between the work done and the community it so happens that the community is always left aside while decision making and during implementation of the decisions.

In this type of approach a wide gap is formed between what people want and what the administration from government initiatives. So, it is very important and beneficial to involve the community in all process from decision making till implementation.

There is a lot of scope for developing community participation and involvement in the decision making and implementing processes in Jamshedpur by JUSCO. In the meeting conducted in Bhalubasa development centre with the community did elucidate that the community is very acceptable to the new system started and are almost ready to involve in further ventures. By interacting with people directly it was easier to make them understand the necessity of managing waste and need for their support and involvement. In order to mobilise people in all it is helpful to involve the community people as people play a very vital role in influencing others behaviour and attitude. This thought can be used to spread and influence other people.

There is a requirement to conduct more and frequent meetings with the community. Also it is necessary to also ensure participation of more and more people in these meetings and discussions.

BEST PRACTICES IN JUSCO:

JUSCO is ISO14001; 2004 certified

OHSAS certified 18001; 2007

PH & HS certified by ISO 9001; 2008

MIS System- Management Information System: Under MIS PH&HS maintains the following data;

- Budget:- Revenue and Expenditure
- How Much Garbage Removed
- Compliance to the schedule of garbage removal
- Fuel Efficiency
- Segregation of plastics
- Complaints:- Received and completed
- Top Box analysis:- Feedback of the work (V.Good, Good, Fair)

Safety: Utmost care for safety is taken in JUSCO. From very senior official to the lowest cadre has to be in safety while on field. This could properly be seen as every workman work in full PPE and also fulfil other norms under safety.

QMS: Quality Management System: External Audit done once in a year and renewed yearly. This audit is done departmental wise.

EHSMS: **Environmental Health and Safety Management system**: External Audit done once in a year and renewed yearly. Done for all the departments together and safety audit is also incorporated in this.

M.R meeting- Management Review meeting: This meeting is held among all the managers and Officers of PH&HS department and is held on monthly basis. Main topics of discussion in the meeting is safety, financial, customer relation monitoring (feedback and daily reports), community meeting issues, training programmes, small group activities (Quality circle and Aspire) and if any changes in QMS.

11. RECOMMENDATIONS AND SUGGESTIONS:

1. The dumper bins should be covered type ones in order to prohibit littering of the garbage. Not a single bin in Jamshedpur is of covered type.

2. The loader points should also be barricaded and covered. Barricading should be detachable kind.

3. Segregation of waste at the source of generation (household) necessary.

4. Road Sweepers and garbage collectors should be given two types of bucket (green and black), so that they can put segregated garbage separately.

5. Training to the sweepers for segregation of waste.

6. Two coloured (black and green) bins should be kept so that waste could be segregated at the source and help in segregated primary transportation.

7. There is no indication about what kind of garbage should be put in which type of bin. Bins should be accompanied by banners/ drawings attached to them indicating which waste to throw in the particular bin, so that illiterate or less knowledgeable people can also throw waste properly.

8. In house chutes for waste disposal should be stopped completely because they open up in places were there are chances of waste littering by dogs, cats or cows or other stray animals.

9. Offer incentives- Workers involved in the waste collection and disposal should be given small incentives. Also common people should be given some incentives in order to maintain the cleanliness, like „Best lane/street award", publishing the name in TISCO and JUSCO samachar, gift hampers to the „best performing house in a month" etc.

10. Facilitate separation at disposal site- On the dumping ground we see a lot of rag pickers picking selected waste, some initiative should be taken to bring all of them together and facilitate this with ease and safety not only at the disposal site but can be done in the initial level like primary collection and storage site.

11. Penalty system needed - there is an urgent need for bringing in penalty system, otherwise the whole system can not be maintained for long. As the population will increase waste generation will also increase but workmen in the department might not increase, which would result in work overload which in turn may not ensure 100% cleanliness.

Therefore it is necessary to impose fine on individual, building complexes and lanes so that waste management can be ensured for longer time. Such penalty system can also help in changing people"s attitude and behaviour.

12. Immediate steps to be taken to manage construction waste. Most part of the city faces this problem of here and there disposal of construction waste.

13. Another major step is needed to be taken in order to create public awareness on the necessity to manage waste properly. This could be done by a proper awareness program.

- Working together with TATA Steel community development centre to spread awareness.
- involving local media like newspaper, Cable TV, radio channels to propagate about solid waste management
- Involving local NGOs, Mahila mandals in this.
- Creating a cartoon series (like Mithailal) and publishing in TISCO Samachar and JUSCO samachar.
- Using JUSCO calendar to spread awareness.
- Awareness programmes for vendors also.

12. CONCLUSION:

The whole purpose of ISWM is to make an attempt to reduce the amount of waste going to the landfill as much as possible. In this way we can lighten the burden caused by the trash we throw away, and these other ways should be considered first, rather than looking at landfills as the primary way of taking care of trash. And this effort can show desired results by full involvement of community in all steps of management from planning to implementation.

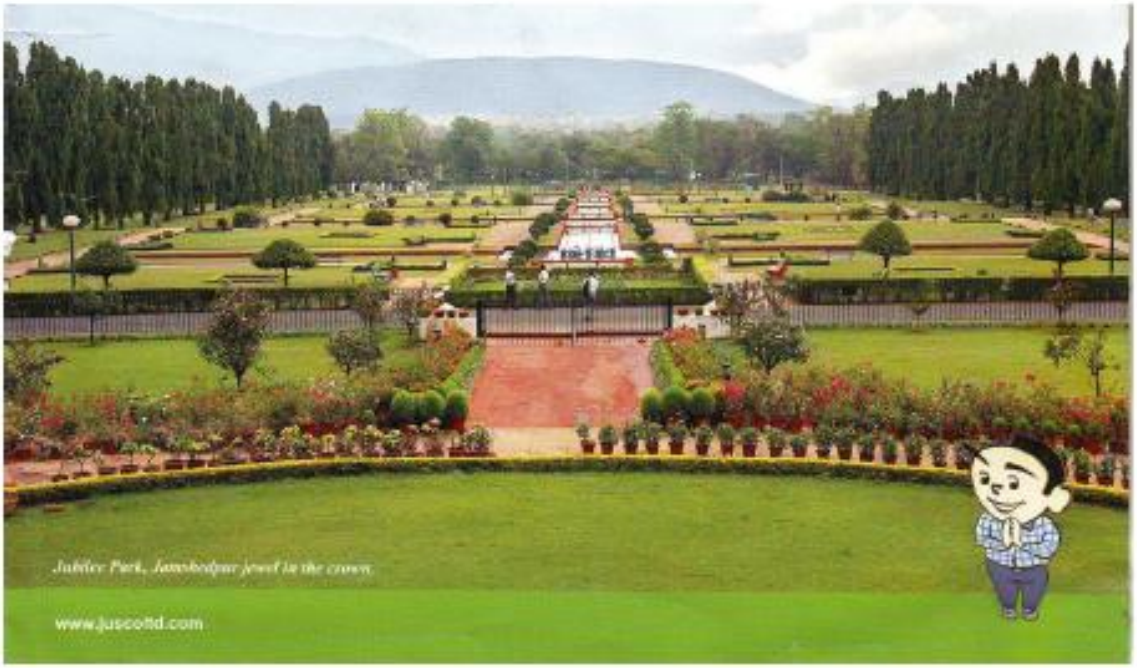
Main objective of adopting an integrated approach towards management of solid waste is to Reduce, Reuse, and Recycle waste to the maximum. Reducing the quantity of waste, that is to be transported and disposed off, should be the primary goal of all municipal solid waste management programs. Waste should be recovered at the source, during transport, or at the disposal site. The earlier the separation, the cleaner the material, and, in the end, the higher the quality and value it will be to its users.

JUSCO has very efficiently implemented all aspects of ISWM in TATA Steel command areas complying with the norms of MSW rules 2000. Thus has built a proper integrated waste management system. From door to door collection to composting plant JUSCO has taken steps on the lines of reducing and reusing the waste.

With the coming up of Composting Plant a major amount of organic waste is now being used properly and compost is recovered. Also the execution of door to door waste collection system has really improved the condition of the localities giving the streets of Jamshedpur a new and cleaner look. Only critical necessity for Jamshedpur is to develop an engineered landfill as soon as possible because the existing dumping ground is not only over loaded but it is also affecting the social (inhabitants) and environmental (river, ecosystem) life surrounding that area.

JUSCO has authority to manage and administer the city (TATA Steel command area) but jurisdictional power is negligible. Non existence of any kind of penalty system deters the efforts by JUSCO which in turn affects the mentality of the workforce as well as the community. Therefore it is needed that JUSCO has the legal authority also in order to sustain the integrated waste management system.

JUSCO‟s efforts towards management of waste are very intensive and appropriately integrated. That is why Jamshedpur, the city managed by JUSCO, has been ranked 7th among 441 Indian cities and towns based on their sanitation and cleanliness levels by Ministry of Urban Development, Government of India.10



13.References:

1. Scenario of solid waste management in present Indian context R. Rajput, G.Prasad and A.K.Chopra, 2009 report

2. http://jnnurm.nic.in/nurmudweb/toolkit/Overview.pdf

3. http://en.wikipedia.org/wiki/Waste_management

4. www.jamshedpur.org.in

5. www.wikipedia.org/wiki/jamshedpur

6. City Development Plan of Jamshedpur Urban Agglomeration under JNNURM

7. Annual Diary of JUSCO

8. http://cpcb.nic.in/wast/municipalwast/Waste_generation_Composition.pdf

9. Jamshedpur City Development Plan Prepared by CEPT University

10. JUSCO Samachar, June 2010

11. CPHEEO manual on Municipal Solid Waste Management

12. DOMESTIC BIOGAS COMPACT COURSE /Technology and Mass-Dissemination Experiences from Asia/Postgraduate Programme Renewable Energy /University of Oldenburg /26 – 28 April, 2011