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A STUDY OF RECLAMATION OF BANDHWARI LANDFILL SITE, GURGAON, HARYANA

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Abstract: This article describes landfill-mining tests, including excavation, screening, and fraction characterization, carried out in Bandhwari, Gurgaon landfill for municipal solid waste (MSW) in India. The excavated waste this site was 15-20 years old, respectively. The main part of Bandhwari was affected by degradation, and during excavations substantial amount of biogas was detected. Excavated waste taken from different depths was also analysed and compared in relation to composition, calorific value, and leachate constituents.
Keywords: Municipal Sold Waste Management, Bandhwari Landfill Site, Gurgaon, Haryana, India, Landfill Mining and Reclamation.

I. INTRODUCTION

Municipal Solid Waste management is one of the most important aspects of urban infrastructure. It is directly and indirectly related to numerous other aspects such as Sanitation, Health and Hygiene, Environment and Aesthetics. The accelerated growth of urban population, increasing economic activities and lack of training in modern solid waste management practices in the developing countries complicate the efforts to improve this service sector. Historically, open dumps were commonly located on the fringe of urban development and as the cities developed, the urban fringe moved beyond the open dumps bringing residential and commercial development within their close proximity of the open dump. This brought about a conflict in land use, with dumps being considered incompatible with these uses raising community and regulatory concerns calling for its rehabilitation. Some of the adverse impacts of uncontrolled dumping in open lands are Open burning, Leachate pools, Bird menace, Landfill scavengers, Stray animals, Foul odor, Rodents and fly infestation, Methane emission (a significant contributor to global warming), etc. Nowadays, awareness about Health, hygiene and environment are increasing among the residents. Thus, there is now a pressure on the Urban Local Bodies to find new and innovative ways to manage the MSW. Also, the escalating costs of monitoring and remediation of the existing dumpsites would provide the impetus needed to develop and implement a sustainable approach to the management of solid waste and landfills. The problem in Gurgaon and Faridabad is especially grave because of a generation about 1200 TPD of MSW and at present, there are only limited resources for upgrading or replacing this dumpsite and, equally, limited funds and technical competence to operate and maintain land disposal sites. The attainment of highly complex landfill design and construction as practiced in the developed world may not be possible immediately.

II. LANDFILL MINING AND RECLAMATION: A PLAUSIBLE SOLUTION

Landfill mining and reclamation (LFMR) is a method whereby solid wastes that have beforehand been landfilled are excavated and processed. The task of landfill mining is to lessen the sum of landfill mass summed up within the closed landfill and/or momentarily remove dangerous material to let defensive measures to be taken prior to the landfill mass is replaced. In the method mining recovers precious recyclable materials, a flammable fraction, soil, and landfill space. The airing of the landfill soil is a secondary benefit about the landfills future use. On the whole appearance of the landfill mining method is a series of processing machines laid out in a functional conveyor system. The operating principle is to dig up, sieve and sort the landfill material.

The Dan Region Authority next to the City of Tel Aviv, Israel, commenced the idea of landfill mining as early as 1953 at the Hiriya landfill functioned. Waste has several resources with elevated value. The most distinguished of which are non-ferrous metals like aluminum cans and scrap metal. The concentration of aluminum in a lot of landfills is more than the concentration of aluminum in bauxite from which the metal is derived.Technically, dumpsite mining employs the method of open cast mining for sorting out the mixed material from the landfill according to their size by using a screening machine. The oversized materials are prescreened by another sorting machine, which separates the larger objects like tyres and rocks from cardboards and other smaller unearthed materials. The objectives of landfill mining are summarized hereunder:

- Conservation of landfill space
- Reduction in landfill area
- Elimination of potential contamination source
- Rehabilitation of dumpsites
- Energy recovery from recovered wastes
- Reuse of recovered materials
- Reduction in waste management costs
- Redevelopment of landfill sites

Every landfill has its own unique set of circumstances that affect the economics of a potential project. Landfills come in different shapes and sizes. The amount of decomposition varies with climate and age; rural landfills have different compositions then urban landfills. Some landfills may have accepted more construction and demolition wastes, while others contain more industrial wastes. Some landfills have serious environmental problems while others are benign. Bandhwari Landfill site has been operational for the past 20 years. It lies at the eastern side of Gurgaon and falls under the category of Uncontrolled Solid Waste Disposal Facility. The volume of wastes deposited on the site till 2015 was approx. 7,00,000 tons.

Table 1: Characteristics of Wastes at Bandhwari Landfill Site

S.No	Waste Composition	% by weight
1	Plastic	18.0
2	Stones	12.0
3	Rubber/Leather	1.2
4	Cloth	2.8
5	Glass	1.4
6	Metal	0.8
7	Rest Soil	63.8
	Total	100.0

The other characterization revealed that the temperature of the wastes increases as the depth from the top increases, the average density of the wastes is 817 Kg/m^3 and the average moisture content of the dried waste has been found to be 28.3%. The organic content of waste present at the Bandhwari Site has been found to be in the wide range of 39.6 to 81.4%. The variation in organic contents is due to variation in depth and decomposition of waste

III. METHODS

A. Process Description:

The Project was a pilot project wherein initially approximately 300 tons of MSW was excavated and transported to waste drying/stabilizing platform. The leachate levels in the landfill were very high and hence the waste had very high moisture content. Therefore, the waste was first dried and stabilized under aerobic conditions on a non-permeable concrete platform. It was placed in 2 windrows of size 28.0 m (L) X 8.3 m (W) X 1.4 m (H) each for a day. Windrows were periodically turned using a bob cat or front end loader with backhoe arm to provide proper aeration and temperature control. After one week, wastes were transferred to the monsoon shed and placed in the windrow of size 21.0 m (L) X 8.3 m (W) X 1.4 m (H) and left for further stabilization. As reported, approximately 20% reduction in volume occured during this process. After this, the waste was segregated and refined. From the windrow platform, waste was fed into the refinement section for intermediate screening. A three stage screening had been proposed with screens of 60 mm, 16 mm and 4 mm. This was adopted to achieve maximum screening efficiency. Cascading action in trommel ensures better screening of the lumpy and highly heterogeneous material. The materials below 4 mm consisted of stabilized organic compost and earth and can be used as a soil conditioner. The rejects from trommel consisted of inert and recyclables from which polythene, plastics, metals and glass were separated and sold / used (polythene & plastics) to make RDF. The screened final product was stored on a paved area for 45-60 days so that it attained final maturation. After that it was transported to other facilities. Landfill mining used the method of excavating and sorting the material from the existing site and using various processing steps in order to segregate the dumped waste. The success of materials recovery was dependent on the composition of the waste, the effectiveness of the mining technology and the efficiency of the technology. More important landfill mining from the existing and abundant open dumping site could be a positive opening for future landfill management and resource and energy recovery.

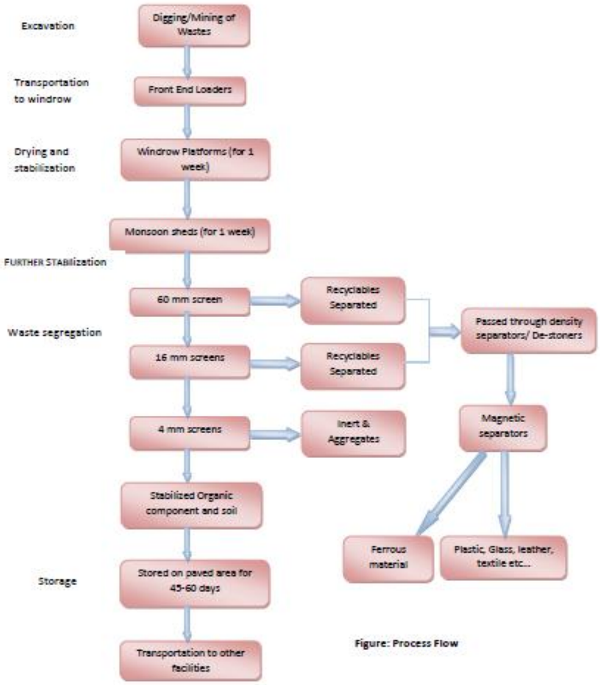

Figure: Process Flow

IV. RESULT AND DISCUSSION

A. Recommended Reclamation Process

It was proposed to take the excavated wastes to windrow platforms for aerobic stabilization, but this is not required here as the landfill has accumulated wastes since 20 years and most of the wastes will already be in decomposed state. The wastes were excavated, segregated manually and then through sieves of various sizes using a trommel and materials wererecovered. The process helped in recovering numerous materials of use as approximately 40-50% of the useful material was reclaimed from landfill reclamation process. These included plastics, polythenes, stones, rubber, leather, cloth, glass, metals and organic soil. The Soil reclaimed had the properties of low quality compost and can be used as:

- Soil Conditioner,
- Can be mixed with compost in Composting plant and sold,
- Can be used as soil cover for other landfills,
- Can be used as a fill material in construction.

The valuable metal components like iron, steel, aluminum, copper etc. were sold in market. A few were sent directly to industries that generate steel from scrap metals. Recovered Plastics was proposed to be recycled and those that cannot be recycled can be converted to Refuse Derived Fuel (RDF) along with textile and leather waste. There is a proposed Integrated Solid Waste Management Facility at the Bandhwari Landfill site. It also has a proposed RDF based Power Plant. This plant can be given most of the recovered waste that has good Calorific Value. Recovered glass can also be recycled. Approximately 15% of stones may be recovered from the landfill reclamation activity. The recovered stones can be used in construction activity or crushed for filling in road construction. It is expected that about 15-20% of the recovered material will not be marketable and will need to be put back in the landfill. The following Table 4 gives the recoverable materials, their estimated quantities and their probable uses.

Table 2- Recoverable materials, their estimated quantities and their probable uses from Bandhwari Landfill

S.No	Recoverable Materials	Possible Use	Estimated Volume
1	Plastics	Can be Recycled / Used for RDF preparation	12% of 4.55 million cum = 0.55 million cum
2	Stones	Can be used for construction of road as WBM	14.4% of 4.55 million cum = 0.65 million cum
3	Rubber / Leather	Can be used to prepare RDF	0.9% of 4.55 million cum = 0.041 million cum
4	Cloth	Can be used to prepare RDF	3.2% of 4.55 million cum = 0.146 million cum
5	Glass	Can be recycled	0.2% of 4.55 million cum = 0.009 million cum
6	Metal	Can be recycled	0.7% of 4.55 million cum = 0.032 million cum
7	Rest Soil	Can be used as: Soil Conditioner, Soil Cover in Landfill, Low quality Compost, and as filling of low lying areas	68.6% of 4.55 million cum = 3.12 million cum
8	Reclaimed Land	Can be used to construct an engineered landfill or for other developmental purposes	

Table 3 – Material Recovered and their Utilization (Salability of Mined Products)

S.No	Recoverable Materials	Potential users
1	Plastics	Recycling industries, Mixing with bitumen for road construction,
2	Stones	Construction Industries and/or for road construction as WBM
3	Rubber / Leather	As raw material for RDF
4	Cloth	As raw material for RDF
5	Glass	Recycling industries, Handicrafts cottage industries
6	Metal	Recycling industries, Small and Medium Scale Steel and alloy making plants
7	Soil	Organic farms, Construction industries
8	Reclaimed Land	Municipal Authorities, Real Estate Agents

V. DIRECT BENEFITS OF THE PROJECT

Extending landfill capacity at the current site:
Landfill reclamation extends the life of the current facility by removing recoverable materials and reducing waste volume through combustion and compaction.

Generating revenues from the sale of recyclable materials:
Recovered materials, such as ferrous metals, aluminum, plastic, and glass, can be sold if markets exist for these materials.

Lowering operating costs or generating revenues from the sale of reclaimed soil:
Reclaimed soil can be used on site as daily cover material on other landfill cells, thus avoiding the cost of importing cover soil. Also, a market might exist for reclaimed soil used in other applications, such as construction fill.It can also be used as a soil conditioner.

Producing fuel in the form of RDF:
Combustible reclaimed waste can be mixed with high CV wastes to produce Refuse Derived Fuel.

Reducing landfill closure costs and reclaiming land for other uses:
By reducing the size of the landfill “footprint" through cell reclamation, the facility operator may be able to either lower the cost of closing the landfill or make land available for

other uses.

Retrofitting liners and removing hazardous materials:
Liners and leachate collection systems can be installed at older landfills. These systems can be inspected and repaired if they are already installed. Also, hazardous waste can be removed and managed in a more secure fashion.

Indirect Benefits of the Project:

- Open dumpsites release a lot of Methane, which is a very potent green house gas emission of this gas would decrease substantially from the site as a long term consequence of the project
- These sites emanate foul odor that causes discomfort to the nearby commercial and residential areas. The project would remove most of the collected wastes from the site, leaving only unusable inerts, thereby significantly reducing this problem.
- Due to the organic material present in the landfill sites, a lot of leachate is generated. Not only does this pollute the ground water, but it also contaminates the surface water sources nearby due to surface runoff. The project would sufficiently reduce this leachate and moreover, if an engineered landfill develops at the site, then it would have elaborate gas and leachate collection systems.
- The project proposes to have a green belt around the site, which would further add to the potential positive effects of the project.
- It would sufficiently reduce the bird menace, rodent and fly infestation affecting the area.
- The project would improve the aesthetics of the site and increase the social acceptance of the waste management facilities.
- It would formalize the existing informal recycling industries and generate permanent employment for the rag pickers.
- It would set an example for the other waste management facilities all over the country.

VI. CONCLUSIONS

Based on the few analyses reported thus far, the heavy metal content and other characteristics of the recovered soil fraction indicated that the fraction can be suitable for landfill cover material. However, it should be emphasized that the characteristics of the recovered materials are substantially a function of the composition of the buried waste - including concentrations of heavy metals and of other toxic compounds. Some organic materials may be recovered that may have a use as a refuse-derived fuel. Low-quality ferrous scrap was readily recovered, but its utility had only been demonstrated to a limited degree. The percentage of recovered materials and their characteristics and properties are functions of the composition of the landfilled material and the configuration and operating conditions of the landfill mining process. The concept of landfill mining and reclamation and related technology merits serious consideration. It may be relevant to consider the incorporation of the concept into landfill design so that the landfilled waste can be readily accessible for mining.

The cost benefit analysis of landfill mining & reclamation is shown in the following Table:

BENEFITS	COSTS
Increased disposal capacity ***Avoided or reduced costs of:*** - Landfill closure - Post-closure care and monitoring - Purchase of additional capacity or sophisticated systems - Liability for remediation of surrounding areas **Revenues from:** - Recyclable and reusable materials - Combustible waste sold as fuel - Reclaimed soil used as cover materials ,sold as construction fill, or sold for other uses Land value of site reclaimed for other uses	**Expenses in curred in project planning** ***Capital costs:*** - Site preparation - Rental or purchase of reclamation equipment - Rental or purchase of personnel's a fety equipment - Construction or expansion of materials handling facilities - Rental or purchase of hauling equipment **Operational costs:** - Labor - Equipment for land maintenance - Land filling non-reclaimed waste or non combustion blefly and bottom ash if waste material is sent to offsite for final disposal - Administrative and regulatory compliance expenses - Worker training - Hauling costs

VII. FUTURE DIRECTIONS

The Potential Drawbacks of the Project include the following:

Managing hazardous materials:
Hazardous wastes that may be uncovered during reclamation operations, especially at older landfills, are subject to special handling and disposal requirements. Management costs for hazardous waste can be relatively high, but may reduce future liability.

Controlling releases of landfill gases and odors:
Cell excavation raises a number of potential problems related to the release of gases. Methane and other gases, generated by decomposing wastes, can cause explosions and fires. Hydrogen sulfide gas, a highly flammable and odorous gas, can be fatal when inhaled at sufficient concentrations.

Controlling subsidence or collapse:
Excavation of one landfill area can undermine the integrity of adjacent cells, which can sink or collapse into the excavated area.

Increasing wear on excavation equipment:
Reclamation activities shorten the useful life of equipment, such as excavators and loaders, because of the high density of waste being handled.

If the drawbacks are sufficiently taken care of, this project can serve as an example of using waste as a resource.

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