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Assessing the Site Selection, Operation and Management of Waste Disposal Site in Islamabad

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Abstract-The purpose of this study is to assess the selection, designing, management and operation of municipal solid waste disposal site in comparison with the international and national site planning parameters. The methodology adopted for the study involves the literature review, semi-structured questionnaire survey and in-depth interviews with the Capital Development Authority (CDA) staff, academia, practitioners and waste scavengers to collect first hand information. The present municipal waste disposal site is situated in the middle ofa residential settlement and as such, does not meet the criteria of appropriate distance from the human habitat. It is discovered from the interviews of the CDA staff that there is neither any development nor any facilities for the staff at site and even paved track is not available to access the tipping area. The limits of waste dumping area are undefined and tipping area changes on need basis. Representatives of the renowned NGOs, private practitioners and the academia have shown serious concerns over the site location, inadequate facilities, inappropriate operation and consequent environmental impacts on the surrounding communities in particular and the twin cities in general. Input of a wide range of interviewees is useful for selection and development of future waste disposal site on sound Town Planning principles to eradicate the adverse impacts on the environment.

Keywords-Municipal Solid Waste, Disposal Site, Open Air Dumping, Unplanned Waste Disposal Sites, Capital Development Authority (CDA), scavengers, waste dumping operation, Islamabad.

I. Introduction

In the wake of rapid urban growth in recent times, it is estimated that 60 percent of the world population will be urban by 2025 [i], which would be mostly in third world developing countries. As a result of similar situation prevailing in Pakistan, 50% of Pakistan population would be urban [ii], residing in just 17 cities more than one million each by 2030. This rapid pace of urbanization and concentration of population in urban centres, severely affects the efficiency and effectiveness of available infrastructure and urban services including municipal waste management and its sustainable disposal directly related with environment and city economics [iii]. 2 billion people would not have access to basic sanitation and approximately half of the population will not have access to adequate solid waste management [iv]. Root cause of 40 human diseases is traced from solid wastes scattered in the settlements. Inappropriate and conventional management of ever increasing municipal waste quantities especially in developing countries has become an uncontrolled and overburdened issue for the concerned departments [v, vi].

For the purpose of this research, municipal solid waste management in Islamabad would be discussed briefly. Current practices of waste disposal and the waste disposal sites in Islamabad would be deliberated.

II. Research Objectives

The key objective of this research paper is to examine the location, design and operation of the waste disposal site in Islamabad. The specific objectives of the study are:

1. To study the historical context of waste disposal sites and mode of waste disposal in Islamabad.
2. To evaluate the advantages and disadvantages of previous waste disposal sites in Islamabad.
3. To scan the efforts of CDA for planning and development of integrated waste disposal site for sustainable municipal solid waste management.
4. To assess the merits and demerits of existing waste disposal site with regards to planning, development and operation.
5. To suggest framework for planning and development of integrated waste disposal site for Islamabad.

III. Research Methodology

The research methodology employed for the case study embraces ocular survey, in-depth interviews, and, questionnaire survey. Interviews were conducted with the planners of the Capital Development Authority (CDA) to know their role and logic for allocation of temporary waste disposal sites in the past and the present site and the site for future. Concerned staff of sanitation directorate CDA have also been interviewed to have their viewpoint regarding location and operation of the waste disposal sites that remained in use for the last 40 years. The sanitation staff deployed at existing waste disposal site were interviewed as well. The purpose was to have first hand information with reference to availability of facilities at the present waste disposal site, waste disposal operation, and health and environmental issues.

Interviews were conducted as well with the representatives of NGOs working in the field of municipal waste management and academia for their notes on the location, working and impacts of the in use waste disposal site on the surrounding areas. Additionally, questionnaire survey was conducted with the scavengers working at waste disposal site and the residents of the settlements in the vicinity of waste disposal site.

Internationally recognized waste disposal site planning and designing indicators have been listed out through extensive literature review to establish a bench mark for the assessment of existing waste dumping site in Islamabad.

IV. Islamabad – The Case Study City

Master plan of Islamabad was prepared by M/S Doxidis in 1960 over an area measuring 906 sq. km divided into five land use divisions of specific nature commonly known as zones [vii]. Zone 1 provides for mixed land use developments and is the area, where municipal waste management service is provided by CDA [viii].

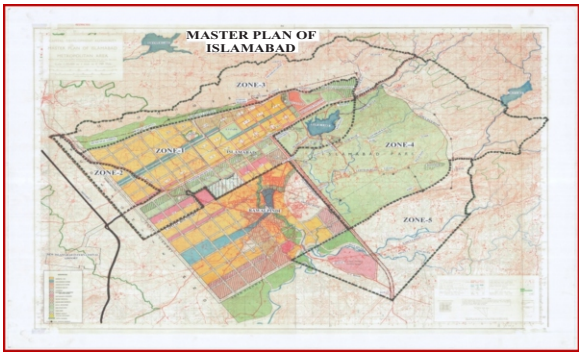


Fig. 1. Master plan of Islamabad
Source: Capital Development Authority, 1960.

V. Solid Waste Generation in Islamabad

As per population census of 1998, population of Islamabad was 0.84 million [xii] and the population of Islamabad in the year 2017 is approximately 2.0 million (2008672) at an annual population growth rate of 4.91% [xii]. Accurate quantity of municipal solid waste in Islamabad is not known like other cities in Pakistan and in this situation, amount of municipal solid waste is calculated relying on population and quantity of municipal waste received at waste disposal site in terms of recorded number of trips of waste transportation vehicles and their capacity. Average municipal waste generation comes out to be 0.81kg/person day, which is higher than the country level waste generation rate of 0.4kg/person/day [v] and in this way, per day municipal waste generation in Islamabad is nearly 1627 ton [xv]. In municipal area of Islamabad, municipal waste generation is 822 tons (urban population 1014825) and municipal waste generation in suburbs and rural area is 803.31 tons (rural population 991747) [xv].

VI. Municipal Waste Composition in Islamabad

There is no updated data available on municipal waste composition in Islamabad other than study [xvi].

TABLE I
Composition of Municipal Solid Waste in Islamabad

Sr.	Type	Component % age
1	Garbage & House Hold	58.0
2	Paper	10.0
3	Plastic & Leather	3.0
4	Wood Straw	20.0
5	Textile	5.0
6	Glass	3.0
7	Others	1.0
Total		**100%**

Source: Waste Characterization Study for CDA's Project, CERES February, 2006 and AHKMT report (2016)

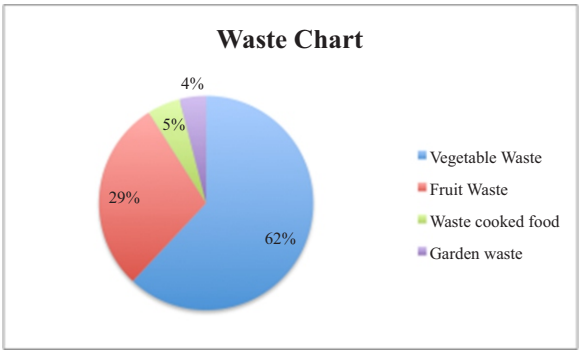


Fig. 2. Organic Waste Composition
Source: Akhtar Hameed Khan Memorial Trust (AHKMT), 2014

From available data as in the table above, it is revealed that the household waste comprises of 58% kitchen waste and 21% recyclables in terms of paper (10%), plastic (3%), textile (5%) and glass (3%). It has therefore, been observed in annual report by Akhtar Hameed Khan Memorial Trust (AHKMT) [v] that the municipal waste in Islamabad has potential for integration of waste reduction strategies in the management of municipal waste prior to disposal to lessen the pressure on waste disposal site and need for additional land.

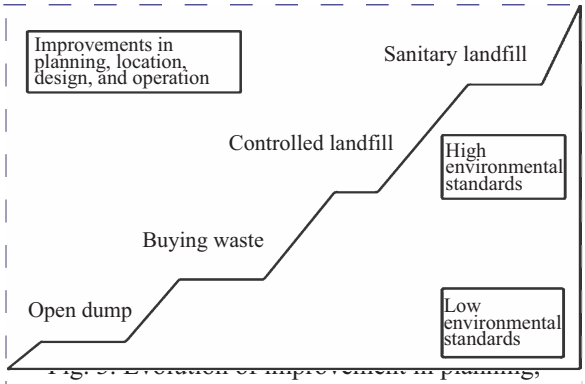
VII. Municipal Solid Waste Management Operation in Islamabad

Municipal solid waste management operation in Islamabad entails door-to-door waste collection, road/street sweeping, waste transfer to communal transfer stations and onward transportation to designated waste disposal site. However, this municipal solid waste management operation by CDA is limited to municipal area of Islamabad whereas this responsibility outside municipal area lies either with Metropolitan Corporation Islamabad or the builders and developers of developments in private sector. Waste reduction strategies or recovery of recyclable materials is either totally non-existent or is in informal arrangement and resultantly, the whole tonnage is to be transported to waste dumping area [xv].

VIII. Municipal Solid Waste Disposal in Developing Countries

Final disposal of municipal waste is the ultimate phase of any urban cleaning system and the most common mode of waste disposal in developing countries like Pakistan is open air dumping. This includes throwing of garbage into water bodies, disposal in open dumps, open air burning, and its use as animal feed. The open air dumping of waste disposal is associated with ecological imbalance, public health problems (insects and rodents spread) and high risk of disease diffusion [xvii].

The most common method used for the final disposal of municipal solid waste (MSW) in the Latin America and Caribbean (LAC) Region is the open dump [xvii]. He has discussed the evolution of improvement of municipal solid waste disposal in the developing countries such as roadside disposal being the most initial stage, uncontrolled waste disposal in small local dumps, uncontrolled dumping, controlled landfill and sanitary landfillas illustrated in Fig. [xvii].



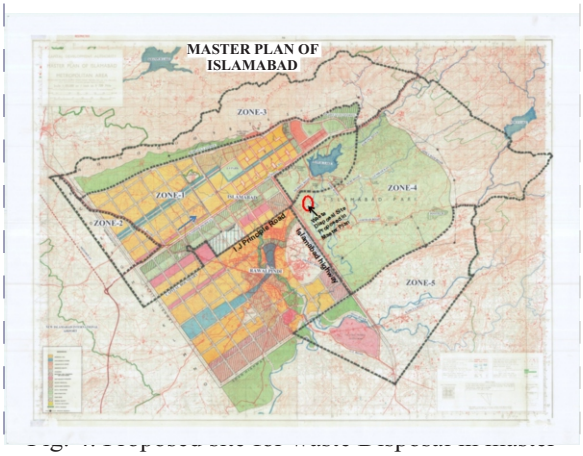
location, design, and operation of waste disposal site
Source; Jaramillo Jorge (2003)

IX. Municipal Solid Waste Disposal in Islamabad

The capital city of Pakistan is confronting with the similar problem of open air dumping at temporarily designated sites and till today, no formal waste disposal/landfill site has been planned and developed in Islamabad. Presently, municipal waste is being disposed of open air with periodical earth cover at a temporarily designated waste-dumping site.

X. Provision of Waste Disposal Site in Islamabad Master Plan

The master plan of Islamabad provides the waste disposal site on east of Islamabad highway in Islamabad National Park Area [vii].



plan
Source: Capital Development Authority, 1960.

But the site provided in the master plan has not been developed so far and even it is no more available on ground on account of haphazard development in the area [xviii].

XI. Site for Integrated Landfill

Planning and development of an integrated waste disposal site was initiated by Capital Development Authority (CDA) as part of project named "Improvement of Environment by Solid Waste Management in Islamabad" in 2002 at a cost of Rs. 1006.783 million. [xiv]. For this project, land measuring 100 acres (845 kanals) was allocated by CDA in zone-IV at a distance of 18 kilometers from zero point. CDA, Civil Aviation Authority, Pakistan Council of Scientific and Industrial Research, Pakistan Environmental Protection Authority (PAK EPA) and Japanese experts recommended the site jointly. However, development of site was firstly halted because of agitation by the locals and litigation and secondly on account of changed development parameters in the area [xxi] and finally, the site was discarded in 2011 [xxii].

Fig. 5. Site for Integrated Landfill
Source: Capital Development Authority, 1960.

XII. Historical Context of Municipal Waste Disposal Sites in Islamabad

In the wake of non-availability of a planned and formally developed waste disposal site in the capital city, focus of the formations concerned with municipal solid waste management in Islamabad, remained on waste collection and its onward hauling to the temporarily designated sites for open air dumping [xv, xix].

Historically, temporary sites in the north of sector H-12 (till 2006), H-10 and H-11 (2011) [xv], sector I-14 (2011) [xx], north of sector D-12 in the foothill (2013) [xxii] and sector I-12 (2012) [xxiii].

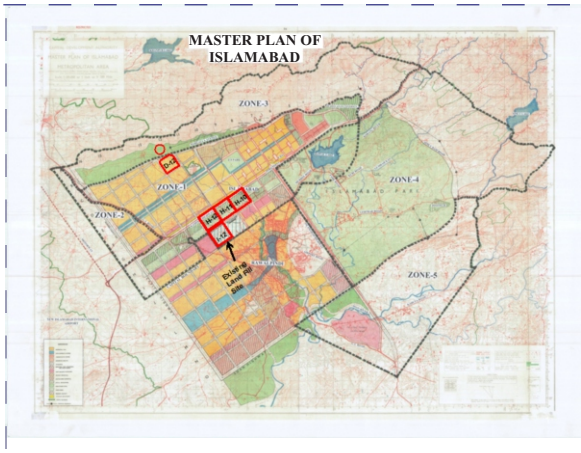


Fig. 6. Previous dumping sites in Islamabad (sectors H-10, H-11, H-12, I-14 & north of sector D-12).
Source: Capital Development Authority, 1960

XIII. Present Waste Disposal Site in Islamabad

On the protest of the residents of an adjoining residential establishment against open-air waste dumping, site measuring 10 acres was approved in an undeveloped sector I-12 initially for 5 years [xxiii]. This temporary arrangement is still continuing and is likely to continue for a number of years to come as there is no plan of development of any properly planned and designed waste disposal site. Though, the present waste disposal site is situated at a convenient distance supportive for efficient waste transportation in terms of more trips but its operation and location has become a big issue for the surrounding settlements of the twin cities.

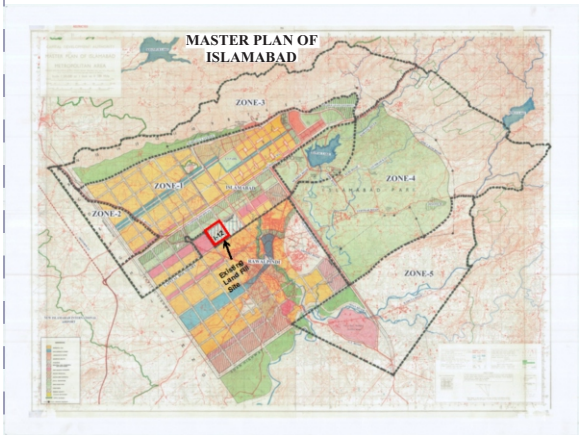


Fig. 7. Present Waste dumping Site
Source: Capital Development Authority, 1960

Although, the Islamabad High Court has issued directions to Capital Development Authority (CDA) in the year 2015 for planning and development of an integrated waste disposal site to meet the requirements of next 50 years but the issue is still pending in CDA [xv].

XIV. Integrated Waste Disposal Site

The increasing amounts of municipal solid wastes in urban areas and its consequences warrant efficient and effective management and disposal [xxv]. Primarily, the waste management restricted to collection, disposal and incineration [xxvi]. Environmental effects of land filling and incineration are significant and these methods of waste disposal are not adequate to manage the massive volumes of municipal wastes produced in urban areas [xxvi]. In developed countries, advance techniques and technologies are in field for management and disposal of municipal solid wastes. In developing countries open air dumping and untreated burial of waste is the most common mode of municipal solid waste disposal. H. A. Hamad has observed [xxix] that hazardous solid waste management is one of the critical environmental issues, which the municipal authorities are facing in developing countries.

Landfill is the most common and the oldest way of orderly waste disposal and would remain in so many places around the world [xxx]. The sanitary landfill is a method of final waste disposal which triggers no public health or environmental risk in the course of operation and it entails the compaction and anticipation of harms originated by the liquids and gases formed in the decomposition of organic waste [xvii]." The most common method used for the final disposal of MSW in the LAC Region is the open dump [xvii]. This situation in developing countries has necessitated the development of a planned, designed and appropriately operated waste disposal site.

Modern sanitary landfill is defined as "facility with safe elements of control with due consideration of selection of appropriate site, its design, its effective and efficient operation and control." [xvii].The known types of sanitary landfill are Mechanized sanitary landfill, Semi-mechanized sanitary landfill and Manual sanitary landfill.

Significant effects of waste disposal sites mostly include air pollution, ground water pollution, and health effects, soil and land pollution, economic costs and landfill fire. Most significant disadvantage associated with waste dumps is that the land cannot be used for any construction other than passive use like park and recreational areas as in Mexico City, Santiago, Buenos Aires [xvii].

XV. Solutions of Landfill Issues

Useful solutions of the landfill option of waste disposal include design and implementation of integrated waste management and waste minimization strategies such as recycle, reuse, and reduce [xxxi]. Landfills managed on environmental standards and constructed on engineering principles can reduce the adverse effects of landfill on air, soil and water [xxxi]. Compliance of design principles regarding location of landfills in environmentally sensitive areas and on-site monitoring can help the control over landfill hazards.

XVI. Fundamental Principles of Landfill

The elementary practices underlined for the construction, operation and maintenance [xvii]are as given below;

1. Construction of landfill to be supervised regularly by a professional engineer to counteract the issues of daily operations.
2. Runoff water should be diverted to control the infiltration in to the landfill/waste dumps.
3. Daily receipt at the waste dump is covered with a layer of 0.10 to 0.20 m of cover material.
4. Compaction of daily deposited waste is to be undertaken to achieve the greater density and prolonged useful life of landfill.
5. Liquids and gases at the waste dumps to be controlled for protection of environment and maintain perfect operating circumstances.
6. A final cover of 0.40 to 0.60 m should be instated capable of supporting the vegetation for ultimate integration of the closed site into the surrounding landscape.

XVII. Benchmarking for Planning, Designing, Development, Operation and Management of Municipal Waste Disposal Site/Landfill

A. Planning of site

- Landfill site should be idyllically situated closer to waste generation source, has appropriate transportation access, is not located in flood plain or low-lying areas, and is supported by underneath geologically firm rock materials [xxxii].
- The participation of stakeholders (local authorities, inhabitants, NGOs, practitioners, land use planner) at the waste disposal site planning stage is significant for successful site selection, site designing, construction, operation and maintenance [xvii].
- Ideally, the waste disposal site should be located in the line of growth of city development and consult the land use plan or development plan [xvii].
- While selecting the waste disposal site, factors like slope of the potential site, current and future land use of the area, communication network, distance from nearby settlements and water bodies (rivers, streams, lakes) and types of waste i.e. solid waste, organic or inorganic waste, are to be kept into consideration [xxv].
- Elements like site capacity, land use of adjoining areas, airports, water bodies, area topography, soil

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composition, local climate, unstable areas, infrastructure availability, flora and fauna, distance of the proposed site from environmentally sensitive areas and distance from urban population and area, are of primary importance in the waste disposal site selection [xxv].

- In Ankara Sincan County, factors like population growth trend, wind direction, geology, transportation costs, and expropriation were given consideration in the waste disposal site selection route [xxxiii].
- Gozde Pinar Yal and HalukAkgun have observed that dumping site namely "Mamak" in Ankara has posed grave risks occurring from improper site selection, lack of proper leachate control system (leachate has been diverted to a close-by ditch causing a threat to adjoining settlements) and operational problem in terms of inadequate information on quantity and quality of waste, substandard compaction of old waste and uncontrolled biodegradation [xxxiv].
- Guiqina W, Lib Q, Guoxuea L, Lijunc C (2009) in a study [xxxv], waste disposal/landfill site selection was acted using 9 different factors with highest weightage to residential developments and lowest to proximity to waste generation areas trailing the order: residential development, surface water, ground water, airport areas, land use, slope, price of land, roads, proximity to waste generation areas. In Sincan municipality, landfill site being situated comparatively closer to the source and lower land price conducted by.
- The environmental standards for selection of modern sanitary/ environmental landfill site include hydrology suitability of the proposed site [xxxvii] (Weiss 1974), visual amenity, distance from dwellings (minimum 200 m) and land use [xxxvi].
- Engineering yardsticks related to solid waste disposal site embrace physical site (at least for 10 years [xxxvii], accessibility (least traffic congestion and public complaints), topography (minimum earth moving and maximum benefit of natural situations), soil (cover for coating and topping is the foremost criteria for guessing the site suitability [xxxix] and climate (rainfall, wind direction) having direct impact on way of operation of landfill.
- The economic yardsticks for landfill site selection involve mode (lease, license, loan basis) and cost of acquisition of land for landfill, cost of site development (right from site selection to infrastructure development), haulage distance and annual cost (operational, maintenance and retiring) aimed at minimization of devaluation of property, dislocation of locals business.
- Prospective sites for waste disposal are measured on a set of criteria comprising of Geo-technical and Hydrological Investigation (soil condition, water table) Environmental (Landfill gas management, odor, nuisance, Local ecological conditions, Risk to ground water contamination, Proximity to water courses, occurrence of flooding) [xxxix], Socio-economical (Life, capacity, land value/use, public acceptability, property lines), archaeological cultural sites [xvii], Technical Operational (Cover material availability, Access road, Distance from the waste consumption, proximity to airports) and Investment/Operating costs (Comparison of capital and operational cost estimates).
- The waste disposal site after getting through the typical site screening queries, qualifies for next stages [xxxvii] which include:

1. Is the distance of proposed site less than 200m from residential settlement and other public areas [xvii]?
2. Are there any zoning restrictions?
3. Is it nearby to an environmentally protected area for flora, fauna?
4. Is the site proposed for landfill, reserved area of archaeological, cultural or historical values?
5. Is it an unapproachable site?

- The ideal site that meets all the yardsticks for the construction of sanitary landfill, does not exist; in practice, it will be necessary to select the best of several alternatives However, important factors in the site selection are access road, hydrological conditions, useful life of the site, availability of cover material, conservation of natural resources, climate conditions, ownership of land, cost of land and of the infrastructure [xvii].

B. Site designing

- Owing to the total generation of MSW, decision can be made for appropriate collection equipment, required staff, routes, waste collection frequency, area requirements for treatment and final disposal, costs, and charges for the service [xvii].
- Once the site is selected, a topographic map of the site is prepared showing the boundary, identification of adjoining lands, location of main road, the access road, natural drainage, location of cover material stock and any other special features [xvii].
- Topography and landscape in the surrounding should be taken into consideration while designing the waste disposal site [xvii, xl].
- For new landfill sites, a total approach encompassing development, filling and after-care stages should be considered at design stage [xl].
- Proper procedures need to be taken with regards to landfill features and climatic settings to control water precipitation, inhibit surface water entering into the landfill collection and handling of leachate [xl].
- Climatic data in terms of rain, evaporation,

temperature, and wind direction are the most relevant factors for working out designing and construction specifications for the sanitary landfill infrastructure [xvii].

- Series of gas pipes ought to be instated at the landfill to aid the gas progression away from the marginal gas collection arrangement [xl].

C. Site Appearance

The negative image of landfills can be changed [xl] by concentrating on few key essential factors such as:

- Landscape and design should be arranged which blends the development in with surroundings and topography.
- Effective implementation of environmental policies and practices.
- Ocular impression of the boundary zone of the waste disposal site ought to be given distinctive consideration in order to minimize probable graphical, noise and odor effects and the present flora should be agitated to the possible limit to create visual barrier.
- Planting with boundary bunds or independently can avert unwanted sights; confine litter, dust and noise problems and further, moderates the effects of built structures.

D. Site Infrastructure

- Infrastructure at landfills includes access (properly designed access road, adequate drainage, video cameras at the entrances to control fly-tipping, site identification and information board with information (name of the site, contact and emergency telephone numbers, license number, site working hours and name, address, and telephone number of the operator), security (appropriate fence), plant and buildings (suitably established buildings for the staff for day-to-day site management and accounting of waste quantities received at the site, water supply and allied scrubbing facilities, toilet, telephone, electricity and sprinkling services at all landfills), waste inspection areas, wheel cleaners, weigh bridges (waste quantities to be recorded, weighbridge to be installed at sites to receive more than 10000 tons annually and at sites where life probability is above five years), quarantine areas (area for storage of discarded and other incompatible waste) and fuel storage [xvii].
- Portable shades/nets should be set adjacent to tipping area to prevent wind driven litter and additionally screening bunds, fencing and buffer zones on site border for protection of nearby properties [xl].

E. Site Operation

- It has been observed, "As far as possible, all infrastructure works should be completed before any waste is unloaded in the new sanitary landfill."[xvii].
- It is to be kept in mind by the administrators and the supervisors that staff would perform better with good motivation and working environment [xvii].
- Operating tools and safety equipment for the workers such as gloves, boots, caps, dust masks and two uniforms are to be made available at the landfill [xvii].
- For day waste disposal operation, area of receiving waste be earmarked considering the expected waste quantity and the compaction level, waste to be unloaded at the working face to avoid long distance movement, spread the waste in thin layers, cover the compacted waste and the area be compacted until uniform level is obtained at the end of working day [xvii].
- An elaborated Environmental management plan [xvii] detail of operator (name and address, site manager, telephone numbers), site sketch (boundaries, topography, hydrological characteristics and local meteorology), types and quantities of wastes, estimates of site total remaining capacity, engineering details (provision of facilities, containment details, leachate drainage, collection, landfill gas control techniques, collection and treatment, fencing, gates and security, site access and minor roads, offices and fuel stores, site weighbridge, surface water control measures, ditches, wheel wash water), operational matters (phasing of filling, water, leachate and gas control methods, site opening and closing timing, access control and waste acceptance practices, equipment to be utilized, cover requirements, monitoring and maintenance processes, operational and safety rules [xvii], litter, noise and dust decline measures, evaluation of settlement in filled areas and appraisal of compacted density), and closure and aftercare (concluding and operational capacity of the waste disposal site, ultimate contours and topography of the site, restoration plan, phasing plan for closure and restoration plan of completed areas, aftercare monitoring, maintenance and other control processes), needs to be developed.
- A comprehensive topographic survey of the waste disposal site needs to be in place to measure the rate of fill [xl].
- Pre-ceding to commencement of waste disposal, the area should be cleared of standing water, vegetation and any other material and disposal of biodegradable material into the wet conditions should be avoided.
- A widespread site records in terms of site drawings (site and structures, as built lining, leachate drainage and collection, capping works, wastes

entering into the site containing the inert material for cover and results of environmental monitoring, should be maintained for whole life of the site, for the closure and rehabilitation periods.

- Annual report needs to be prepared by the site operators which may include annual audit report, quantities and qualities of wastes received at the site, location of cells, environmental supervising and effects of site on the environment, complaints received at site and corrective actions taken, priority of works in the running period and the forthcoming year.
- Waste disposal operation at landfill should be targeted to minimize the attraction of scavenger birds towards the wastes being deposited.
- Scavengers should be prohibited at all landfill sites in order to avoid life risk on account of frequent vehicle movement.

F. Site Management

- It has been observed, [xvii] "Even if the landfill/waste disposal site has been constructed and is being operated complying with the technical standards and recommendations, good management is indispensible. If the manual sanitary landfill does not have good supervision for its operation and maintenance, or the necessary resources, it will very soon become an open dump."
- Personnel having received training in the solid waste management, particularly in the construction and operation of the sanitary landfill; should be deputed otherwise, the absence of skilled workforce will translate into low efficiency and higher costs [xvii].
- Site is managed according to criteria set in Environmental Management Plan, circulated parameters and conditions issued in waste license [xvii].
- A vital element in the efficient management of waste disposal operation at landfills is the control of nuisances.
- Firm application of regulation to the effect that vehicles are covered to prevent litter spreading on access roads and adjoining communities, needs to be guaranteed.
- Qualified managerial staff is to be deputed at the site with clearly designated responsibilities but the site manager to devote considerable amount of time at site for operation supervision [xvii].
- Staff in-charge of the waste disposal site/landfill should be aware of the operations of waste management services and monitor the waste disposal operations at the landfill [xvii].
- The waste disposal site ought to have a designated site engineer having minimum degree standard education and appropriate experience. Duties of the site engineer include usual site visits, checkups and overall developments at site [xl].
- Construction works like lining; landfill gas trenches and leachate collection must be supervised by qualified site engineer for the purpose of quality guarantee of substantial developments like lining and capping system.
- In any case, quality assurance/quality control needs to be employed which ensure the quality designs and execution of these designs.
- Appropriately qualified personnel should undertake high tech installations such as leachate treatment system, gas collection, lining system.
- The site operation is to be administered by permanent site staff and back up staff should be available for appropriate control in case of holidays or sickness. However, this job is never to be assigned to temporarily employed staff.
- Acceptance of waste at disposal waste site should not be left to one person, as this arrangement would be unwanted for health and safety.
- The staff at waste disposal site should be equipped with professional training to familiarize them with mandatory norms of ok, operation, legislative requirements and especially the quality of incoming waste and the benchmarks to fulfill the pre-requisites of national health and safety laws specifically concerning with secure operation of equipment.
- For the purpose of efficient operation, fire control be mandatory at the landfills and fire prevention measures such as training of employees for fire control, noticeable placement of emergency reaction number (fire, police, and ambulance), fixing of fire extinguishers and two way radios, provision of on-site water supply and provision of fire fighting equipment in the site office [xvii].
- At the end of each day, the site be maintained in terms of cleaning of tools, access and internal roads, drainage system within the site, collection of loose litter, desalting of drainage ditches, maintenance of gas vents, up keeping of facilities such as site fence, identification board and the building, sowing of grass and finally to make sure that the site is kept level and having good drainage [xvii].
- Closure of the waste disposal site should be properly publicized for information of all stakeholders in general and the neighboring residents in particular [xvii].

Unsafe working conditions and negligence of the workers have been identified two major root cause of risk at waste disposal site by [xvii] and the recommended action to lessen the problems include the identification of reasons of accidents and remedial measures, setup safety parameters for use of equipment, provision of facilities like

changing rooms and showers for the staff to avoid carrying of contamination, regular medical checkups of the workers, provision of better quality tools and equipment such as gloves, boots, hats and uniforms and maintaining record of emergency situations and their causes to control re-occurrence of similar accidents.

G. Site Development

- The development/construction of landfill depends upon topography along with type of soil and under ground water table [xvii].
- Site preparation is fore most stage of waste disposal site development, which includes site clearing and cleaning, base material treatment (leveling, drainage), cuts and slopes of the site, infrastructure requirements and equipment for a sanitary landfill [xvii].
- Development of landfill site includes the construction of access road, internal roads, boundary wall, availability of cover material and provision of facilities like toilet and lock room for the staff [xvii, xxxix].
- It further includes the separation of waste unloading and working area, provision of appropriate drainage system, and measures such as buffer zone, litter control, and gas vents to control environmental impacts on the surrounding areas [xvii].
- For efficient and effective waste disposal operation, arrangements such as leachate control and treatment, seepage control, steps for control of ground water contamination are integral component of landfill development [xvii, xxxix].
- It has been observed [xvii] that " In landfills, the generation of leachate must be prevented at all costs, but if despite everything a little is generated, it must be kept inside the landfill since it is not practical to treat it."
- Sanitary landfill site should have sanitary facilities like water storage, septic tank, latrine and washrooms for the convenience of the workers, which in dry whether can be utilized for sprinkling the landfill surface for compaction and prevention of dust accumulation [xvii].

XI. Assessment of Present Waste Disposal Site at Islamabad Against Identified Benchmarks

Present waste disposal site at Islamabad is located in a residential sector I-12 at the verge of twin cities and has been planned for a period of five years on temporary basis [xxiii] and none of the benchmarks has been followed. The site has been assessed against the benchmarks identified in the preceding paragraphs as below;

A. Site Planning

- Site is situated in the commercial center of a residential settlement and further at the verge of twin cities surrounded by other residential by other residential settlements.
- The site is very much within 200 m from the human habitat and other public areas.
- The landfill site has been provided on temporary basis for a period of five years but is likely to continue for many years to come [xiii].
- Although, the site is accessible from a highway but it causes fatal accidents on account of frequent movement of heavy vehicles and direct entry/exit of waste carriers [xlii].
- The site has been selected being undeveloped for the planned purpose in the year 2012 without consideration of designed, and potential year 2012 without consideration of designed, and potential capacity of the site and types of wastes to be disposed of [xxi].
- The waste disposal site at Islamabad measures 2.5 hectares and mainly comprises of steep slopes [xiii].

B. Site Designing

- No designing for infrastructure development and provision of facilities has been taken prior to commencement of waste disposal operation [xv].

C. Site Development

- No development in terms of infrastructure and provision of facilities has been taken prior to commencement of waste disposal operation [xv, xxi, xli].
- No paved access road to the tipping area.
- No arrangement for leachate and gas emission management.
- No drainage network is provided instead rainy water ponds in the ditches.

D. Site Appearance

- Heaps of garbage disposed of at the landfill site is visible from the highway.
- Garbage is scattered in and around the waste disposal site and even in the green belt of the highway.
- No plantation or screening measures exist at the boundary of the landfill site to block the unwanted sights [xv].

E. Facilities at Site

- Facilities such as sitting area, toilets, rest areas, video cameras at the entrances, site identification and information board, security fence, plant and buildings for the staff for day-to-day site management and accounting of waste quantities received at the site, water supply, telephone,

electricity and sprinkling services at all landfills, waste inspection areas, wheel cleaners, weigh bridges (to be installed at sites to receive more than 10000 tons annually and at sites where life probability is above five years), area for storage of discarded and other incompatible waste) and fuel storage, do not exist waste disposal site at Islamabad [xix].

- Portable shades/nets are not provided to prevent wind driven litter [xli].

F. Waste Disposal Operation

- On average, approximately 822 tons of municipal waste per day and approximately 200000 tons/year is shipped to landfill at Sector I-12, which is disposed off in the ditches open air [xv].
- The waste is left to rot open air in wet conditions, as there is no drainage network and even the leachate collection and treatment system at landfill.
- There is no manual containing guidelines for operation monitoring.
- Especially in rainy season, the operation is disturbed and waste is thrown any where along access road, which spreads all around [xli].
- There is no arrangement for accurate record keeping of quality and quantity of municipal wastes received at the landfill other than a sanitary worker deployed at the landfill. Further, there is no mechanism for estimation of the site capacity for further quantities of municipal wastes to be disposed off at the site.
- No arrangement for control on dirt, fleeing waste, inert material, overflows, noise, scavenger birds and scavengers. Instead, the scavengers are thought a big support for smooth waste disposal operation.
- Any system for receipt and attendance of complaints at waste disposal site does not exist at all.
- In wet weather, waste is thrown anywhere along road at the sweet will of vehicle operator and the sanitation field staff.
- The field staff has also reported unauthorized disposal of hospital waste and municipal waste from out of bound areas [xix, xv].

G. Landfill Management

- No formal permission containing specific conditions for management of site in Islamabad has been notified, especially to control nuisance and litter spreading in the adjoining communities [xix].
- The CDA sanitary staffs deputed at waste disposal site for waste disposal operation do not have any specialized training in the landfill management. Instead, the most lethargic and inefficient sanitary staffs are assigned this responsibility [xv].
- There is no deployment of qualified site engineer, and managerial staffs at waste disposal site [I].
- The CDA staff is not equipped with any professional training relating to waste disposal operation, legal requirements ant the types of incoming wastes.
- Facilities like fire control, employees training concerning with fire preventive measures, emergency contact numbers (fire, police and ambulance) at prominent location, installation of fire extinguishers and water supply, are non-existent at landfill at I-12 [xli].

H. Environmental issues

- Uncontrolled haphazard municipal waste disposal causes bad odor-a serious environmental problem for the surrounding areas [xliii].
- Attributed to no formal arrangement, waste spreads on access road and surrounding area and leachate ponds resulting in bad odor and ground water contamination [xxi].
- Unmanaged gas emissions and poor fire control at waste disposal site in Islamabad, results in air pollution in the adjoining localities [xliii].
- It has been observed by an environmentalist that "In open air uncontrolled waste dumping at present waste disposal site, leachate percolates into the soil and pollutes the ground water." [xliv].

XVIII. Conclusions

Although, the existing waste disposal site in Islamabad is easily accessible being situated along a major road but in a residential cum commercial development as provided in the master plan of Islamabad surrounded by residential communities in the twin cities. No infrastructure designing and development of site has been carried out for systematic and environmental friendly waste disposal. The waste disposal site has exhausted its planned life of five years and is spreading without defined limits. There exists no manual of corrective events such as ultimate design of the dump, specification of the works, required equipment and workforce, work schedule and cost estimates. The existence of waste dumping site and the waste disposal operation at Islamabad are environmental hazards. On account of in-appropriate waste disposal site, a considerable portion of the collected waste takes its way to unauthorized dumping areas, open pits, water streams and agricultural land.

XIX. Recommendations

A. Short term

In the first instance, remedial measures may be taken by the authorities concerned to control aesthetic, air and water pollution, smooth waste disposal

operation and provision of facilities for the staff at the present site. The corrective measures include the fumigation of site, provision of drainage at the perimeter for appropriate drainage to prevent permeation of surface water and the provision of ditch at the bottom for collection of leachate. Fence be installed to constrain the waste disposal operation after working timing and to inhibit animal entry. Programs like collection of loose litter dispersed in and around the waste disposal site and extinction of rodents, be undertaken on regular basis.

B. Long term

Top priority is to be given to selection of formal waste disposal/landfill site for a longer period of 25 years. In the site, due consideration should be given to factors like that; the site is easily accessible, comparatively closer to waste generation source, located at reasonable distance from residential and commercial developments and natural water sources, away from cultural heritage sites and more significantly the land of lesser economic and utilization value. The proposed landfill site might have nearly fair topography and subject to technical tests of soil composition. Most importantly, waste reduction strategies need to be incorporated in the designing and development of waste disposal/landfill site.

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