Measurement of Ground Water Level and Effect of Municipal Solid Waste: A Case Study of Pirana Site in Ahmedabad

Krisha Talati, Chirag Shah, Shivani Pancholi, Megha Fulwadiya, Hardi Patel

Government Science College, Maninagar, Ahmedabad, Gujarat, India.

Abstract:

The qualities of leachate and its plausible dangers on groundwater contamination were researched following the examination of some compound parameters of the leachate produced in the Pirana landfill site, Ahmedabad, India. Three examples of the groundwater were gathered from the various areas around the Pirana landfill site. The research centre test results on groundwater tests show high convergence of TDS (2103 mg/lit), Total hardness (743 mg/lit), Sulphates (473 mg/lit), Calcium (199 mg/lit) and Magnesium (103 mg/lit) and have extremely high potential for debasing ground and surface water. The information gathered from the Ahmedabad Municipal Corporation likewise indicates high convergences of TDS (2275 mg/lit), Total Hardness (843 mg/lit), Sulphates (473 mg/lit), Chlorides (821 mg/lit), nitrates (671 mg/lit) and Iron (8.53 mg/lit). The surface water tests around the landfill site seem, by all accounts, to be tainted, most likely, through the flood of leachate. Groundwater parameters don't fulfill drinking water quality standard so it is hurtful if consumpted without legitimate treatment. Organic treatment through Reverse Osmosis improves the nature of groundwater essentially. The water ought to be utilized for drinking and cooking yet simply after its filtration through RO framework as it evacuates very nearly 95 % of the broke up solids.

Keywords:

Groundwater, Leachate impact, Solid waste, Landfill, Qualitative Assessment. Municipal solid waste.

Introduction:

Developing industrialisation, changing life style and rapid growth of population are the root causes of increasing solid waste generation in most of the developing countries. Due to human activities about 0.18 million tonnes of solid waste are generated daily in India. According to favourable economics, common method to dispose municipal solid waste is considered as Landfill but due to this method Groundwater pollution has increased. Open dump yard creates unhygienic environment and foul smell. Hence the landfill has to be managed efficiently as it creates major threats to human lives as well as the environment. This is because 90% of wastes are dumped directly into the landfill. Ahmedabad is the 1st largest Metropolis in Gujarat with a population of 55.7 lakh and spread over an area of 464

Sq Km. Solid waste production in Ahmedabad city is almost 4200 tonnes/day. Currently, about 2.01 billion metric tons of municipal solid waste are produced annually worldwide. The World Bank estimates overall waste generation will increase to 3.40 billion metric tons by 2050.As estimated 13.5% of today's waste is recycled and 5.5%is composted. The solid waste, in this dumping process, undergoes slow, anaerobic decomposition and generate substantial amount of leachate with decomposition products, heavy metals and a variety of hazardous pollutants which may seep from the landfill site into underground aquifers and thus polluting much needed urban water resources. There are also possibilities of surface runoff and/or overflow of the leachate to the surrounding agricultural lands, ponds, canals and rivers causing surface water quality deterioration. If this big amount of MSW will not be managed properly, it will have a severe impact on environment. The waste management policies and strategies are still struggling with the conflicts arising between developmental and environmental goals. The dissolution of solid waste combined with rainfall produces a large quantity of polluted water in the form of leachate. Present work shows the study of, the influence of physio-chemical parameters of the ground water thoroughly by collecting the water samples around the dump yard boundaries and then testing them for various parameters such as Total Hardness, Total dissolved solids, pH, Calcium and Magnesium Hardness, Sulphate, Chloride, Nitrate and also collected various values from the official such as Ahmedabad Municipal Corporation. Groundwater is the major source of potable water supply in the study area and its contamination is a major environmental and health concern. This study was therefore undertaken with the objective of assessing the possible impact of leachate percolation on groundwater quality of an unlined MSW landfill site at Pirana in Ahmedabad city.

Study Area:

Ahmedabad is the modern capital of Gujarat which lies on 23° 02′ N scope and 72° 57′ E longitudes on the bank of River Sabarmati. It is situated in the upper east of the Arabian Sea, with a height of 53m above mean ocean level. A design of Ahmedabad in Gujrat (India) map with Pirana Landfill site has appeared in Fig. 1. Ahmedabad's climate is hot and humid with typical characteristics of a semiarid region with annual rainfall of 750-800 mm, mainly occurs during the south-west monsoon (June to August).

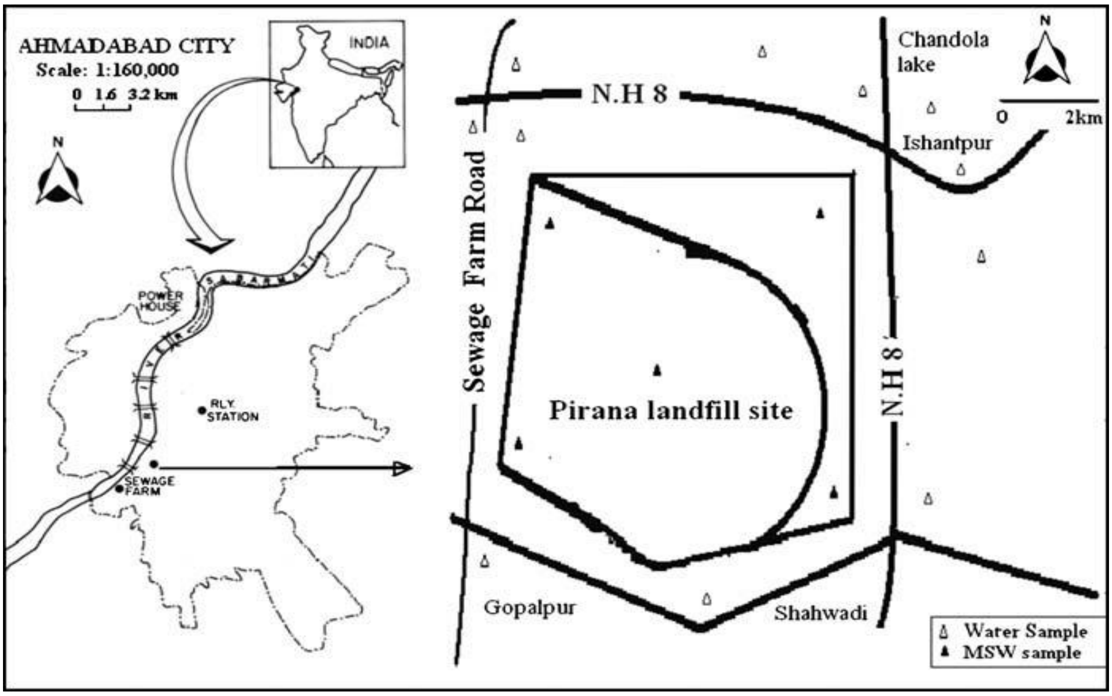


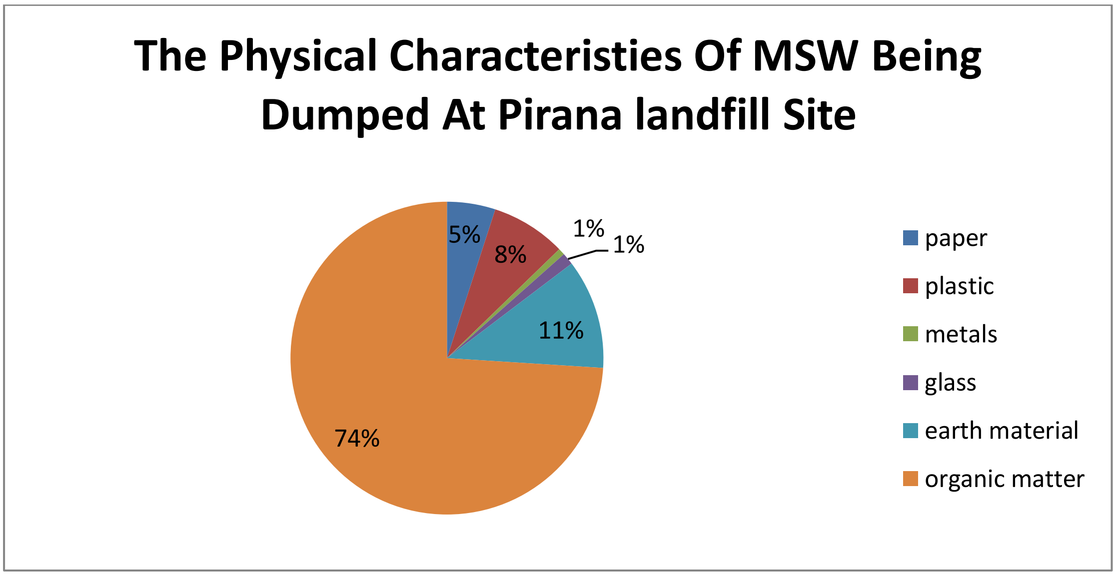
Fig. 1 A layout of Pirana landfill site with its location in Ahmadabad city and India, including sampling Locations.

Ahmadabad is underlain by thick alluvial stores of Quaternary age. Lithologs of the city show that alluvium involves substituting beds of sand, sediment, mud and rock. There are a few sand layers down to the profundity of roughly 50 m. These are sprinkled with focal points of sediment and mud yet are basically in direct water driven correspondence with each other and perhaps treated as a solitary unconfined spring. When all is said in done, a 20–25 thick residue/earth layer isolates the deeper(depth>100 m) spring from the upper unconfined gathering of springs. The more profound springs have huge areal degree and directly supply the greater part of the water expended in the city (NEERI Report 1994; Nema et al. 2001).Ahmedabad has got most extreme number of substance and material ventures and is seventh biggest generator of absolute metropolitan waste in India, in light of per capita creation its position is fifth in India (Fig. 1). Pirana is the main landfill site present in Ahmedabad city with 84 sections of land of land which gets metropolitan strong waste for around 35 years. Absolute strong waste produced from around the city is very nearly 4000 tons/day (Source: Supervisor Ahmadabad Municipal Corporation).

At present, the community body gathers 4000 metric huge amounts of strong waste day by day. Of which around 1900 metric ton gets reused at various plants, with around 100 metric huge amounts of material being recuperated at the decline move station once a day (Mukesh Gandhvi, Deputy Municipal Commissioner AMC). A specific strong waste transfer strategy not utilized at Pirana landfill site. The waste is being dumped and consumed which produces Methane gas in high sum and influences the adjacent local locations. These methane gas cause ailments and mischief to human wellbeing. In storm, the scent of the gas produced spreads everywhere throughout the city region and makes an upsetting Environment. The physical qualities of MSWbeing dumped here is appeared as a pie outline, demonstrating high natural and earth material substance.

Materials and Methods:

The samples of solid waste, leachate and groundwater were taken in June, 2018. and on an average about 4200 tons/day of waste is dumped on the site with the waste filling heights varying from 150 to 200 meters and spread over 84 acres of land since 1982 and this size and height keep on varying. The wastes dumped into this site are largely from domestic and commercial sources. Nearly 75-80% of the accumulated waste is collected from municipal bins and street sweeping. More than 15000 workers are employed by AMC and they work on all 365 days of a year and twice a day – 6:30 am to 11:30 am and 3:00 pm to 6:00 pm. The site is a non-engineered open pit and the waste brought here by collection trucks from different parts of the city are dumped haphazardly without segregation. AMC has identified more than 2000 locations as waste collection points.



The solid waste samples (up to depth 0–25 cm) were collected with help of quadrate area 1×1 m. Five MSW samples were taken, i.e. one sample from each corner and one from the centre of landfill site. Homogeneous steps were applied to the samples in order to derive representative laboratory samples to be used for the following experiments. The help of municipal bulldozer was taken for digging. Stainless steel trowel was used for collecting solid waste samples. These samples were collected in air tight plastic bags to avoid any chemical contaminations. The groundwater samples were collected from sources scattered around the landfill sites. There were 11 groundwater samples, 5 samples of MSW and 1 leachate sample taken in total. All sampling bottles were soaked with 1:1 HNO_3 after washing with detergents. These bottles were then rinsed with double-distilled water. At the time of sampling, sampling bottles were thoroughly rinsed two to three times using groundwater to be sampled. Electrical conductivity (EC) and pH were measured in situ with help of Orion pen electrode. Alkalinity, expressed as HCO_3, was quantified in situ by titration with 0.05 N HCl, and methyl orange as an indicator. Water samples were filtered using 0.45 µm Millipore filter paper and acidified with nitric acid (Ultrapure

Merck) for cation analysis and with HBO3 was used as preservative for nitrate analysis. Samples were stored below 4°C prior to analysis.

Groundwater And Leachate Analysis:

Significant cations like Ca2+, Mg2+, Na+ and K+ were dissected on AIMIL Flame Photometer (PE I). Groupings of Cd, Cr, Cu, Ni, Pb and Zn were controlled by Shimadzu nuclear ingestion spectrometry (AAS). The compound investigation was done according to the standard methodology given in APHA (1995). Nitrate examination was performed utilizing Brucine Method utilizing UV Spectrophotometer (Cecil, model no. 594). Chloride was resolved with Thermo-Orion Benchtop Ion Selective Electrodes.

Sampling Of Leachate:

In an effort to study the extent of groundwater contamination, three sampling points were selected around the landfill site from where the solid waste samples were taken. The pure water from RO then passed through these samples. The water obtained after passing through the waste was collected in 500 ml plastic bottles.

Physio-chemical Analysis Of Leachate:

The leachate samples were transported to the laboratory and all the samples were analysed for relevant physio-chemical parameters according to the accepted procedures and standard methods. The parameters analysed in the leachate samples include pH, total dissolved solids (TDS), total hardness (TH), sulphates, chlorides, acidity, magnesium and calcium. All the experiments were performed in the laboratory of environment department of L. D. Engineering College, Ahmedabad. The results of the tests are listed in table 1.

Sr. No.	**Parameters**	**Sample 1**	**Sample 2**	**Sample 3**
1	pH	6.8	7.3	7.1
2	TDS	2103	1873	1813
3	Total Hardness	743	703	683
4	Calcium Hardness	493	473	450
5	Magnesium Hardness	253	233	233
6	Sulphates	433	393	473
7	Chlorides	203	293	313
8	Acidity	103	123	103
9	Calcium	199	191	183
10	Magnesium	103	95	95

Table. 1: Characteristics of the landfill leachate

MSW characterization and heavy metal analysis Three replicates of each sample were analysed: pH and electrical conductivity (EC) were measured in a suspension characterized by a solid/water ratio of 1:5 (w/v), after 1 h stirring. Majority of the major and trace elements were analysed by the “B” solution prepared by the acid digestion method, which is a modified procedure of Shapiro and Brannock (1962).

In this method of solution preparation, 0.5 g of sample powder (−200 mesh size) was taken in a cleaned Teflon crucible and to this 10 ml of conc. HF, 5 ml conc. HNO3 and 1 ml HClO4 were added and heated at a temperature of about 85–90°C with the lid on for about 5–6 h on a hot plate. After 5–6 h the lid was removed and the solution was evaporated to dryness. In the second phase, 5-ml conc. HF, 10-ml conc. HNO3 and 1 ml HClO4 were added and again evaporated to dryness. In the third phase, 10 ml of HNO3 was added to remove the traces of HF and the solution dried completely. Finally, 25 ml of 2 N HCl was added and heated to about 100°C to bring the digested sample into solution. After regular swirling, the solution was transferred to a 100-ml volumetric flask and made up diluted sample solution (200X) was prepared. This solution was directly used for the determination of trace elements such as Ni, Cr and

Cd. An aliquot of this solution was further diluted 20 times (4,000×) was used for major element analyses.

Data From AMC:

AMC officials had collected the groundwater samples from four sampling points. The samples were taken from the borewells of UPL Plant, Chiripal Industries Limited, Techno Industries and Samruddhi Industries located near the Pirana landfill site. The collected samples were given to **Envisafe Consultants** for testing against various parameters. The parameters include pH, TDS, total hardness, sulphates, chlorides, iron and nitrates. The results of the tests are listed in table 2.

Sr. No.	**Parameters**	**UPL Plant**	**Chiripal Industries Ltd.**	**Techno Industries**	**Samruddhi Industries**
1	pH	7.38	7.56	7.43	7.17
2	TDS	2141	1213	2049	2275
3	Chlorides	636	441	561	821
4	Sulphates	310	99	473	127
5	Total Hardness	533	253	843	683
6	Iron	7.83	6.03	6.33	8.53
7	Nitrates	578	266	593	671

Table. 2: Characteristics of groundwater samples by AMC officials.

Sr. No.	Parameters	Desirable limits as per BIS
1	pH	6.5 to 8.5
2	TDS	503
3	Total Hardness	303
4	Sulphates	153
5	Chlorides	253
6	Calcium	78
7	Magnesium	303
8	Iron	0.6
9	Nitrates	48

Table 3: Desirable limits of different parameters for drinking water as per BIS.

Results And Discussion:

The contamination capability of leachate relies upon its synthesis and it more often than not contains high centralizations of a wide scope of contaminants. Uncontrolled and untreated leachate of a landfill site dirties the encompassing soil, surface water and groundwater and consequently a potential danger to human and condition. The trial results and the information gathered from AMC indicates high groupings of practically every one of the parameters when contrasted with the BIS gauges for drinking water. The exploratory outcomes and the information gathered from AMC demonstrates high centralizations of practically every one of the parameters when contrasted with the BIS gauges for drinking water. The general population living close-by the landfill site utilizes this contaminated groundwater which is destructive to their wellbeing. So the groundwater close-by the pirana landfill site is prescribed for drinking and cooking yet simply after the best possible treatment which evacuates every one of the contaminants present in the water.

The TDS is a profitable pointer of the all out broke up salt substance of water. The high TDS saw in the groundwater recommend a descending exchange of leachate into groundwater. High groupings of TDS decline the satisfactoriness of water and may likewise cause gastrointestinal bothering in people.

The presence of high concentration of Fe in the leachate indicates that Fe scraps are likely dumped in the landfill. Concentration of Fe above the permissible limit in water results in aesthetic problems relating to taste, odour and colour.

Conclusion:

1. The result shows very high amount of almost all parameters and so it is harmful for drinking and cooking. The reverse osmosis (RO) system should be used because it removes all the dissolved solids upto 90% and makes the water safe for drinking. The only limitation of this system is that the membrane should be replaced during regular time intervals and frequent service should be given to the RO system. It is better to spend some money on this system and it is profitable also because it saves money which would otherwise be wasted for curing of diseases caused due to drinking of contaminated water.

2. Heavy metals in all samples do indicate an empirical relation between MSW, leachate and groundwater sample. The results of factor analysis indicate that pollution source is dominated over natural process in the vicinity of this landfill site. Moreover, positive loading of most of the factor for heavy metal clearly shows landfill impact on ground water quality especially in the direction of groundwater movement which is further supported by cluster analysis finding of two major groups of samples comprises samples with and without under the influence of landfill and contaminated leachates. These techniques can be used as a handy monitoring and assessment tool for immediate preliminary determination of landfill impacts extent. This study emphasized regular but cost effect monitoring of such hazardous sites by using multivariate statistical techniques and hydro- chemical relationships. A particular attention should be paid to the wells situated down gradient of the landfill and in the direction of groundwater flow.

REFERENCES:

Aderemi Adeolu O, O. A. (2011). Assessment of groundwater contamination by leachate near a muicipal solid waste landfill. African Journal of Environment Science and Technology, Vol. 5(11), pp. 933-940.

APHA (1995). Standard methods for the examination of water and wastewater (19th ed.). Washington, DC: American Public Health Association

Baedecker, M. J., & Apgar, M. A. (1984). Hydrochemical Studies at a Landfill in Delaware. In J. Bredehoeft (Ed.), Groundwater Contamination (pp.127–138). Washington, DC: National Academy.

Barker, J. F., Barbash, J. E., & Labonte, M. (1988). Ground- water contamination at a landfill sited on fractured carbonate and shale. Contaminant Hydrology, 3,127–138. Berner-Kay, E., & Berner, R. A. (1987). The global water cycle, Geochemistry and Environment. Englewood Cliffs:

Central Pollution Control Board (CPCB), (2004). Management of Municipal Solid Waste. New Delhi, India: Ministry of Environment and Forest.

Corporation, A. M. (2011). Ahmedabad.

CPCB (2000). Status of Solid Waste Generation, Collection, Treatment and Disposal in Metrocities, Series: CUPS/46/ 1999–2000

Danielsson, A., Cato, I., Carman, R., & Rahm, L. (1999). Spatial clustering of metals in the sediments of the Skagerrak/kattegat. Applied Geochemistry, 14, 689–706.

Davis, J. C. (1986). Statistics, data analysis in geology. New York: Wiley.

Edmond, J. M., Palwer, M. R., Measures, C. F., Grant, B., & Stallard, R. F. (1995). The fluvial geochemistry and denudation rate of the Guayana Shield in Venezuela. Geochimica et cosmochimica acta, 59, 3301–3323.

EPTRI (1995). Status of solid waste disposal in Metropolis Hyderabad. Hyderabad, India: Environmental Protection Training and Research Institute (46 pp).

Flyhammar, P. (1995). Leachate quality and environmental effects of active Swedish municipal landfill. In R. Cossu, H. T. Christensen, & R. Stogmann (Eds.), Proceeding Sardinia 95. Fifth Int. Landfill symposium (pp. 551–557), Vol. II.

Fovell, R., & Fovell, M. Y. (1993). Climate zones of the conterminous United States defined using cluster analysis. Journal of Climate, 6, 2103–2135.

Futta, D., Yoscos, C., Haralambous, K. J., & Loizidou, M. (1997). An assessment of the effect of landfill leachate on groundwater quality. Proceeding Sardinia 97. Sixth Int. landfill symposium S. Margherita di Pule, Gagliari Italy, 13–17 October, pp. 181–187.

Gaily, R. M., & Gorelick, S. M. (1993). Design of optimal, reliable plume capture schemes: application to the Glou- cester landfill groundwater contamination problem. Groundwater, 31, 107–114.

Gharaibeh, S. H., & Masad, A. (1989). Die Problomatite der Ahallbeseitingung in Jordan. Fallstudie Fur Enstasicklungs lander. Wasser und Boden, 10, 620–622.

Guler, C., & Thyne, D. G. (2004). Hydrological and geological factors controlling surface and groundwater chemistry in Indian Wells-Owens valley area, southeastern California, USA. Journal of Hydrology, 285, 177–198.

Gupta, S., Mohan, K., Prasad, R., Gupta, S., & Kansal, (1998). A solid waste management in India: Options and opportuni- ties. Resources, Conservation and Recycling, 24, 137–154. Handa, B. K. (1988). Content of potassium in groundwater in

Hem, J. D. (1991). Study and interpretation of the chemical characteristics of natural groundwater. U.S Geological Survey Water Supply, 1473 pp.

Huh, Y., Tsoi, M. Y., Zaitiser, A., & Edward, J. N. (1998). The fluvial geochemistry of the river of eastern Siberia. I. Tributaries of Lena River draining the sedimentation platform of the Siberia Craton. Geochimica et cosmochimica acta, 62, 1657–1676.

Kjeldsen, P., Bjarg, P., Rugger, K., Pedsersen, J. K., Skov, B., Forverskov, A., et al. (1993). Assessing the variability in leachate from an old municipal landfill. In R. Gosso, H.T. Christensen, & R. R., Stegman (Eds.), Presidents Sardinia 93, Fourth Int. Landfill Symposium (pp. 1514–1531).

Kumar, M., Kumari, K., Ramanathan, A. L., & Saxena, R. (2007). A comparative evaluation of groundwater suitability for irrigation and drinking purposes in two agriculture dominated districts of Punjab, India. Environmental Geology, doi: 10.1007/s00254-007-0672-3.

Kumar, M., Ramanathan, A. L., Rao, M. S., & Kumar, B. (2006). Identification and evaluation of hydrogeochemical processes in the groundwater environment of Delhi, India. Environmental Geology 50, 1025–1039.

Kurumbein,W. C., & Graybill, F. A. (1965). An introduction to statistical models in geology. New York: McGraw-Hill

Laaksoharju, M., Skarman, C., & Skarman, E., (1999). Multivariate mixing and mass balance (M3) calculation, a new tool for decoding hydrogeochemical information. Applied Geochemistry, 14, 861–871.

Laine, D. L., Parra, J. O., & Owen, T. E. (1982). Application of an automatic Earth resistivity system for detecting ground- water migration under a municipal landfill. In: Proceedings of NWWAConference on Surface and Borehole Geophys- ical Methods in Groundwater Investigations (pp. 34–51). 12–14 February 1982

Loizidon, M., & Kapetanios, E. (1993). Effect of leachate from landfills in under groundwater quality. The Science of the Total Environment, 128, 69–81.

Malek, B. R. (2013). Environmental Engineering Ahmedabad: Mahajan Publication.

Md. Azim, m. M. (2011). Characteristics of leachate generated at landfill sites and probable risks of surface and groundwater pollution in the surrounding areas : a case study of matuail landfill site, dhaka . Journal of Bangladesh Academy of Sciences, Vol. 35, No. 2, 153- 160.*

Meju, M. A. (1993). Geophysical mapping of polluted groundwater in a closed landfill site. In:Proceedings of the Third International Congress of Brazilian Geophysical Society (Expanded).

Nath, K. J. (1984) Metropolitan solid waste management in India. In J. R. Holmes (Ed.), Managing Solid Wastes in Developing Countries. New York: Wiley, 304.

NEERI Report (1994). Investigation into contamination of French wells at Ahmadabad. National Environmental Engineering Research Institute (NEERI), Nagpur, India.

Nema, P., Ojha, C. S. P., Kumar, A., & Khanna, P. (2001). Techno-economic evaluation of soil-aquifer treatment using primary effluent at Ahmadabad, India. Water Research, 35(9), 2179–2190.

Newell, G. J., Hopkins, L. P., & Bedient, P. B. (1990). A hydrogeologic data for groundwater modeling. Journal of Groundwater, 28, 703–714.

Rajesh, R., Sreedhara Murthy, T. R., & Raghavan, B. R. (2002). The utility of multivariate statistical techniques in hydro- geochemical studies: an example from Karnataka, India. Water Research, 36, 2437–2442.

Robinson, H. C., Barber, C., & Maris, P. J. (1982). Generation and treatment of leachate from domestic wastes in landfills. Water & Pollution Control, 54, 465–478.

Rown, C. H. (1998). Applied Multivariate statistics in Geohydrology and Related Sciences. Berlin: Springer.

Tejero, M. I., Fantelli, L. M., Diaz, I. R., & Azanto, N. M. (1993). Characteristics and treatment of leachate in the Meruleo landfill (Spain). In R. Cossu, H. I. Christensen.

Usunoff, E. J., & Guzman-Guzman, A. (1989). Multivariate analysis in hydrogeochemistry: an example of the use factor and correspondence analyses. Groundwater, 27, 27–34.

Vendrame, I., & Pinho, M. F. (1997). Groundwater quality in Taubate Landfill, Brazil. In: J. Chilton, A. A. Balkema (Ed.), Ground- water in the Urban Environment (pp. 559–564) Rotterdam.

WHO (2004) Guidelines for drinking water quality-II (p. 333).

Yedla, S., & Parikh, J. (2001). Solid Waste Management- Current Status and Strategies for the Future 12–14 December 2002. India: Bangalore.