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DEGRADATION OF UNDERGROUND DRINKING WATER QUALITY AND ASSESSMENT OF WATER QUALITY INDEX NEARBY GHAZIPUR SOLID WASTE LANDFILL SITE, DELHI

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ABSTRACT

The aim of our research study is to calculate water quality index at Ghazipur solid waste land fill site, Delhi. Water quality index shows water quality at a certain point and time. The pH, TDS, Turbidity Hardness, Cl, Ca, SO_4, Nitrate, Flouride, Zn, Fe, Pb, Cu, Cr, Ni, & Cd (different radial parameter were tested) along with pH, TDS,EC, Alkanity, Chloride, Sulphate, Nitrate, BOD, COD, Iron, Hardness, Temperature (Leachate parameter were tested) and pH, TDS, Hardness, Chlorine, Calcium, Sulphate, Nitrate, Zinc& Iron(Water Quality Index parameter calculated). Sampling of water was done twice in a year i.e. pre monsoon season and post monsoon season. The water quality was found to be very poor for drinking purposes.

Keywords: Groundwater contamination, Landfill, leaching, seasonal variations, water quality parameters, WQI (Water Quality Index).

1. Introduction

Groundwater, the major source of freshwater in the world, are being over utilized for different uses like drinking, bathing, washing, cleansing, industry, irrigation, domestic, commercial etc. causing depletion of this precious resource. Besides, it is being polluted due to uncontrolled dumping of untreated domestic, industrial, and chemical wastes and percolation of pollutants into the subsurface. The quality of groundwater, consequently, in many parts of the country, particularly shallow subsurface water, is changing rapidly because of human activities. Although, groundwater is less polluted than the surface water because the soil and rocks through which water percolate filters various bacteria and other pollutants, but still some bacterial and chemical pollutants reach groundwater. The presence of dissolved minerals, organic matters and heavy metals in the groundwater is the result of surface pollutants reaching subsurface soil. Most of them are harmful for human consumption and a few may even be highly toxic in concentration. Also, water dissolves minerals from the soil and rocks and over ground dumped material with which the percolating water comes in contact. Groundwater, therefore, may contain various dissolved minerals and gases that give bad odour and are not good in taste as well. The most common dissolved mineral substances found in groundwater are sodium, iron, calcium, magnesium, potassium, chloride, bicarbonate, and sulfate.

Contamination of groundwater with excessive amounts of heavy metals such as cadmium, lead, mercury, zinc, and chromium pose serious threat to every ecosystem, humans, and the all living organism. Excessive dissolved matters present in water causes corrosion of the materials that comes in contact. Solid waste landfill leachate that infiltrates in the subsurface and surrounding soil also percolates into groundwater which is highly poisonous and causes adverse impact on living being and environment. Leachate, a brownish colour solution, having high chemical oxygen demand (COD) and lower biochemical oxygen demand (BOD) (Calabro et al., 2010) adversely affect the quality of water and the soil. Assessing the composition of leachate therefore is very crucial for understanding the impact of landfill sites on the surrounding soils and subsurface water. The decomposition of the refuses continues even after waste materials are not dumped into a landfill site. (Kjeldsen et al., 2002). Therefore, it is crucial to have a detailed study of the area where a landfill site is planned, which should be in accordance with the environmental guidelines.

1.1. Need of Study

The rapid growth in population together with indiscriminate industrialization and urbanization leading to significant increase in the generation municipal waste has been recorded in many parts of the world. It has been found that the generation of municipal waste can directly be correlated with the economic development of the country world over. Though, economic development is essential for any country, it is crucial to properly handle municipal waste for the sustainable development. Municipal waste generation over a period has drastically increased in proportion to the phenomenal upsurge in population and urbanization. Economic growth along with improved life style and social status of the populations resulted in tremendous increase in per capita generation of municipal waste (Sharholy, M.etal 2007).Handling and disposing this huge quantity of municipal waste is challenging (Idris, A. et al, 2004) that requires more landfill sites in an urban center otherwise over dumping of the wastes will lead environmental pollution.

2. Literature Review

Literature Survey: In the present waste management system, the development of landfill site is a common practice and whatever wastes come from the city is dumped at landfills. But landfills badly affect environment hence landfill sites should be constructed as per standard guidelines. Besides, proper policies of waste handling and overall waste management need to be developed and implemented to decrease the number of landfill sites. Alternate measures in the management of municipal waste such as recycling, composting, incineration, waste segregation etc should be adopted to effectively control the environmental pollution.

Municipal solid waste MSW), in India, is disposed-off in low-lying areas without following proper waste handling guidelines. Hence, municipal solid waste management (MSWM) is one of the major environmental concerns of Indian cities. Solid waste management system involves activities such as waste generation, collection, storage, transport, treatment, and its disposal. But the MSWM system, in India, mostly comprises waste generation, collection, storage, transportation, and disposal. Treatment of waste before its disposal is generally not followed and therefore the disposed-off untreated solid waste is an environmental hazard. Improper waste collection and transportation is also a major concern which results in accumulation of waste everywhere in the city. Besides, unavailability of suitable facilities for the treatment of municipal solid waste, which is going through a critical phase due to unscientific disposal of MSW, adversely impact all components of the environment and human health (Gupta S. et al 2007, Jha M.K. et al 2003, Rathi S. 2006, Ray M.R. et al 2005, Sharholy M. et al 2005). The magnitude of the problem in handling MSW is bound to increase significantly as India strives to become an industrialized nation in future(Sharma S. et al 2005, CPCB 2004, Shekdar A.V. 1999).Municipal solid waste management system should include proper collection (prohibiting littering or burning of the waste), segregation, storage (establishing storage facility in accordance with the waste generated), transportation (wastes should be transported in a covered containers to prevent scattering), processing (adoption of technologies to recycle waste to minimize burden on landfills),and disposal of waste (biodegradable waste should be stabilized by composting and other techniques and non-biodegradable waste should only be dumped at the landfill sites to avoid environmental pollution).The efficient management of MSW requires appropriate infrastructure, maintenance, and regular upgrade of all activities as the continuous and unplanned growth of urban centres put tremendous pressure on the existing facilities. But providing desired level of public service is difficult in the urban centres because of the poor financial status of the municipal corporations (Ahsan N. 1999, Mor S. et al 2006, Raje D.V. 2001). In the present study, an attempt has been made to provide a comprehensive assessment of the groundwater condition around a landfill site due to infiltration and percolation of waste and leachate into the subsurface and forecasting projected future status of the problems of MSW landfill sites in major Indian cities.

According to world health organization solid waste includes domestic refuse, construction debris and street sweepings, non-hazardous institutional and commercial wastes (WHO 2013).The disposal of solid waste is major concern of humanity since ancient time and it is found that the methods like composting and decomposing of the biodegradable waste have been practiced since a long time. The use of non-biodegradable materials, and manifolds increase in the amount of waste generated and the constant rise in population has amplified the problem. The National Capital of India is inhabited by about 16.75 million people (Census of India 2011), which are collectively producing about 8000 tons of solid waste per day. The solid waste generated is disposed of in three major sanitary landfills in and around Delhi every day namely, Bhalswa Landfill site, Ghazipur and Okhla which were commissioned in 1994, 1984 and 1996, respectively (Vishal D et al 2020, Hafsa N et al 2019). These landfill sites are still being used even after being completely saturated that adversely affects environment and hence the concept of sustainable landfill should be implemented (Magdalena 2019).

3. Aim of Study

The aim of this study is to assess the groundwater quality with the help of water quality index (WQI) and its suitability for human consumption in the residential neighborhood adjacent to landfill site. For the purpose of this study, twenty-four ground water samples were collected up to 2 km from the periphery of landfill site during pre-monsoon (April 2023) and post-monsoon season (October 2023). Each of the samples were analyzed and compared with Bureau of Indian Standards (BIS) for drinking water. The higher WQI value has been found due to increased concentration of different parameters in the groundwater. The results indicate that there are significant seasonal variations during Pre and Post Monsoon season and contamination level was very high in most of the ground water samples. The results of the present study clearly indicate that the groundwater near landfill site requires adequate treatment before its utilization for human consumption.

4. Area of Study

The study area i.e. Ghazipur landfill site lies between 28°37'30.8784"N latitude and 77°19'40.764"E longitude which spreads over an area of around 70 acres. This landfill site, started in the year 1984, is one of the major waste dumping sites of Delhi where approximately 14 million tons of municipal waste is dumped. The municipal waste is collected from individual houses of the city and transported to the Ghazipur dumping site.


Photo: Ghazipur Solid Waste Landfill Site

5. Research Methodology

The methodology of the study comprises collection and analysis of environmental indicators that gives information regarding potential environmental problems associated with the solid waste landfills sites and its impact on all environmental elements. Besides, it suggests the proper location of landfill sites from city population, its designing aspects as per environmental guidelines, and its maximum capacity to accept the solid waste to be disposed.

Various **Instruments Used:** Experimental setups were used as per BIS:3025 and APHA standards for analyzing groundwater quality to ensure best results. Prepared reagents for experimental work and used pH meter, EC meter, Turbidity meter etc.

5.1. Sample Collection

Water sample were collected at different points and directions and also leachate samples were collected near drain. Collection and transportation of the sample to the laboratory was done following the procedure of the BIS:3025 (Part I) and APHA. Representative samples of leachate were taken from the Drain. The analysis of the collected samples was done at the Environmental Engineering laboratory of the Civil Engineering department of the Rama University, Kanpur, (UP) India and Environmental Engineering laboratory of the Civil Engineering department of the Al-Falah University, Faridabad, (Haryana) India.

6. Experimental Design With Result and Calculation

Different parameters and their dimension for experimental analysis of groundwater were conducted at different interval of time like pre monsoon and post monsoon season and water sample were collected at one and two kilometers from the periphery of the land fill site.

6.1. Material and Accessories to Be Used

All apparatus and salts (reagent) were used for conducting water tests as per BIS:3025 and APHAi.e. TDS meter, pH meter, Turbidity meter, Electrical conductivity meter, Chemical analysis by titrimetric methods and Atomic Absorption Spectrometer for heavy metals etc.

6.2. Pre- Monsoon Season Analysis, Calculation And Result

Site: Ghazipur landfill site at Delhi April, 2023: Analysis and monitoring report (Table-1) of underground water close to solid waste landfill site at different radial distances. Experimental value of the leachate concentration is given in Table-2.Pie-chart(Figure-1) of the water quality parameters andGraph (Figure-2) of the leachate concentration represent the percentile of each parameter.

S.No	Parameters	Less than 1.0 km SL	At 2.0 km SL(sample location)	Desirable limit (IS)
1	pH	7.54	6.15	6.5-8.5
2	TDS(mg/l)	873	715	500
3	Turbidity(NTU)	Nil	Nil	5
4	Hardness(mg/l)	530	880	300
5	Cl(mg/l)	315	180	250
6	Ca(mg/l)	190	232	75
7	SO_4(mg/l)	840	820	200
8	Nitrate(mg/l)	45	20	45
9	Fluoride(mg/l)	NF	NF	1
10	Zn(mg/l)	0.58	0.76	5
11	Fe(mg/l)	0.25	0.24	0.3
12	Pb(mg/l)	NF	NF	0.05
13	Cu(mg/l)	NF	NF	0.05
14	Cr(mg/l)	NF	NF	0.05
15	Ni(mg/l)	NF	NF	0.1
16	Cd(mg/l)	NF	NF	0.01

Table: 1

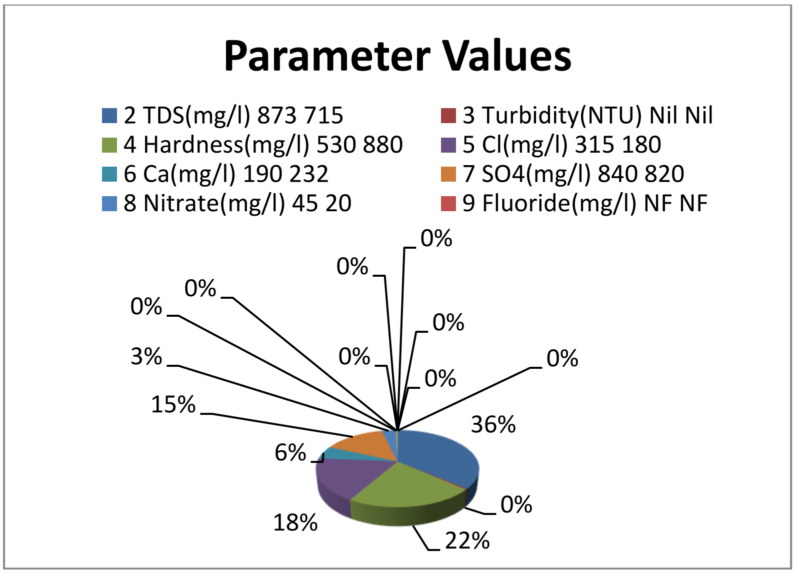

Figure 1.0: Water Quality Parameters

Table: Leachate concentration at Ghazipur landfill site, waste water collected from nearby pond (drain)

S.No.	Parameter	Experimental Value	Typical value (IS)	Remarks
1.	TDS (mg/l)	27300	250-850	Above typical value
2.	pH	7.36	6.5-8.5	Above typical value
3.	EC (MHO/cm)	1492	2250	Above typical value
4.	Alkalinity (mg/l)	2385	50-200	Above typical value
5.	Chloride (mg/l)	1888	30-100	Above typical value
6.	Sulphate(mg/l)	336	200	Above typical value
7.	Nitrate (mg/l)	172	20-40	Above typical value
8.	BOD5 (mg/l)	1192	50-100	Above typical value
9.	COD (mg/l)	7514	250-1000	Above typical value
10.	Iron (mg/l)	61.5	0.05-0.1	Above typical value
11.	Hardness (mg/l)	6742	50-100	Above typical value
12.	Temp (Celsius)	$23^{o}{}_{C}$	------------	------------------------

Table: 2

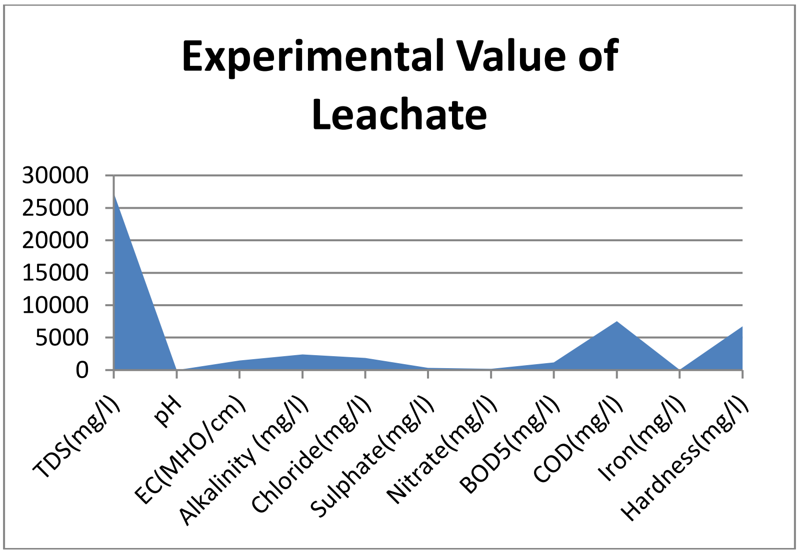

Figure 2.0: Leachate concentration

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Water Quality Index (WQI) of Ghazipur landfill site at radial distances of 1 Km (Table: 3, 4, 5 &6) and 2 Km (Table: 7, 8, 9&10) around the site were calculated using the most widely used formula i.e. National Sanitation Foundation Water Quality Index (NSFWQI). Result of the WQI indicates that the quality of water is very poor therefore it is not suitable for drinking purpose.

Table: 3 Calculation for Water Quality Index of Ghazipur landfill site (Eastern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.6	8.5	89.4118	0.0318	2.8401
2	TDS (mg/l)	880	500	176	0.00054	0.09504
3	Hardness(mg/l)	540	300	180	0.0009	0.162
4	Chlorine(mg/l)	320	250	128	0.00108	0.13824
5	Calcium(mg/l)	192	75	256	0.0036	0.9216
6	SO_4(mg/l)	839	200	419.5	0.00135	0.566325
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.58	5	11.6	0.054	0.6264
9	Iron(mg/l)	0.27	0.3	90	0.9	81
					Total = 0.9992	Total = 86.9497
						WQI = 87.0163

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$
$$\therefore K = 0.27$$

Result: 87.01 Very Poor Water Quality

Table: 4 Calculation for Water Quality Index of Ghazipur landfill site (Western side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.45	8.5	87.6471	0.0318	2.7841
2	TDS (mg/l)	875	500	175	0.00054	0.0945
3	Hardness(mg/l)	536	300	178.6667	0.0009	0.1608
4	Chlorine(mg/l)	321	250	128.4	0.00108	0.138672
5	Calcium(mg/l)	194	75	258.6667	0.0036	0.9312
6	SO_4(mg/l)	844	200	422	0.00135	0.5697
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.58	5	11.6	0.054	0.6264
9	Iron(mg/l)	0.26	0.3	86.6667	0.9	78
					Total = 0.9992	Total = 83.9054
						WQI = 83.9696

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$
$$\therefore K = 0.27$$

Result: 83.96 Very Poor Water Quality

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Table: 5 Calculation for Water Quality Index of Ghazipur landfill site (Northern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.55	8.5	88.8235	0.0318	2.8215
2	TDS (mg/l)	875	500	175	0.00054	0.0945
3	Hardness(mg/l)	550	300	183.3333	0.0009	0.165
4	Chlorine(mg/l)	312	250	124.8	0.00108	0.134784
5	Calcium(mg/l)	189	75	252	0.0036	0.9072
6	SO_4(mg/l)	840	200	420	0.00135	0.567
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.56	5	11.2	0.054	0.6048
9	Iron(mg/l)	0.29	0.3	96.6667	0.9	87
					Total = 0.9992	Total = 92.8947
						WQI = 92.9658

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 92.96 Very Poor Water Quality

Table: 6 Calculation for Water Quality Index of Ghazipur landfill site (Southern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.55	8.5	88.8235	0.0318	2.8245
2	TDS (mg/l)	872	500	174.4	0.00054	0.094176
3	Hardness(mg/l)	527	300	175.6667	0.0009	0.1581
4	Chlorine(mg/l)	310	250	124	0.00108	0.13392
5	Calcium(mg/l)	189	75	252	0.0036	0.9072
6	SO_4(mg/l)	838	200	419	0.00135	0.56565
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.58	5	11.6	0.054	0.6264
9	Iron(mg/l)	0.27	0.3	90	0.9	81
					Total = 0.9992	Total = 86.9069
						WQI = 86.9735

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 86.97 Very Poor Water Quality

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Table: 7 Calculation for Water Quality Index of Ghazipur landfill site (Eastern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P[H]	7	8.5	82.3529	0.03176	2.6159
2	TDS (mg/l)	722	500	144.4	0.00054	0.0780
3	Hardness(mg/l)	889	300	296.3333	0.0009	0.2667
4	Chlorine(mg/l)	176	250	70.4	0.00108	0.076032
5	Calcium(mg/l)	227	75	302.6667	0.0036	1.0896
6	SO_4(mg/l)	825	200	412.5	0.00135	0.556875
7	Nitrate(mg/l)	20	45	44.4444	0.006	0.26667
8	Zinc(mg/l)	0.76	5	15.2	0.054	0.8208
9	Iron(mg/l)	0.24	0.3	80	0.9	72
					Total = 0.9992	Total = 77.7706
						WQI = 77.8301

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 77.83 Very Poor Water Quality

Table: 8 Calculation for Water Quality Index of Ghazipur landfill site (Western side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P[H]	6.3	8.5	74.1176	0.0318	2.3543
2	TDS (mg/l)	735	500	147	0.00054	0.07938
3	Hardness(mg/l)	875	300	291.6667	0.0009	0.2625
4	Chlorine(mg/l)	180	250	72	0.00108	0.07776
5	Calcium(mg/l)	235	75	313.3333	0.0036	1.128
6	SO_4(mg/l)	820	200	410	0.00135	0.5535
7	Nitrate(mg/l)	20	45	44.4444	0.006	0.2667
8	Zinc(mg/l)	0.75	5	15	0.054	0.81
9	Iron(mg/l)	0.27	0.3	90	0.9	81
					Total = 0.999	Total = 86.5323
						WQI = 86.59848

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 86.59 Very Poor Water Quality

Table: 9 Calculation for Water Quality Index of Ghazipur landfill site (Northern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	6.35	8.5	74.7059	0.03176	2.3730
2	TDS (mg/l)	722	500	144.4	0.00054	0.077976
3	Hardness(mg/l)	875	300	291.6667	0.0009	0.2625
4	Chlorine(mg/l)	189	250	75.6	0.00108	0.081648
5	Calcium(mg/l)	240	75	320	0.0036	1.152
6	SO_4(mg/l)	819	200	409.5	0.00135	0.552825
7	Nitrate(mg/l)	20	45	44.4444	0.006	0.26667
8	Zinc(mg/l)	0.75	5	15	0.054	0.81
9	Iron(mg/l)	0.24	0.3	80	0.9	72
					Total = 0.9992	Total = 77.5766
						WQI = 77.6360

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 77.63 Very Poor Water Quality

Table: 10 Calculation for Water Quality Index of Ghazipur landfill site (Southern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	6.25	8.5	73.5294	0.03176	2.3356
2	TDS (mg/l)	722	500	144.4	0.00054	0.077976
3	Hardness(mg/l)	890	300	296.6666	0.0009	0.267
4	Chlorine(mg/l)	175	250	70	0.00108	0.0756
5	Calcium(mg/l)	232	75	309.3333	0.0036	1.1136
6	SO_4(mg/l)	817	200	408.5	0.00135	0.551475
7	Nitrate(mg/l)	22	45	48.8889	0.006	0.2933
8	Zinc(mg/l)	0.75	5	15	0.054	0.81
9	Iron(mg/l)	0.26	0.3	86.6667	0.9	78
					Total = 0.9992	Total = 83.5246
						WQI = 83.5886

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 83.58 Very Poor Water Quality

4.3 POST- MONSOON SEASON ANALYSYS, CALCULATION AND RESULT

Site: Ghazipur landfill site at Delhi,October 2023: Analysis and monitoring report (Table-11) of underground water closing to solid waste landfill site at different radial distances. Experimental value of the leachate concentration is given in Table-12.Pie-chart (Figure-3) of the water quality parameters and Graph (Figure-4) of the leachate concentration shows the percentile of each parameter.

S.No	Parameters	Less than 1.0 km SL	At 2.0 km SL (sample location)	Desirable limit (IS)
1	pH	7.0	6.10	6.5-8.5
2	TDS (mg/l)	865	710	500
3	Turbidity (NTU)	Nil	Nil	5
4	Hardness (mg/l)	520	870	300
5	Cl (mg/l)	310	170	250
6	Ca (mg/l)	180	230	75
7	SO_4 (mg/l)	830	815	200
8	Nitrate (mg/l)	45	20	45
9	Fluoride (mg/l)	NF	NF	1
10	Zn (mg/l)	0.58	0.76	5
11	Fe (mg/l)	0.25	0.24	0.3
12	Pb (mg/l)	NF	NF	0.05
13	Cu (mg/l)	NF	NF	0.05
14	Cr (mg/l)	NF	NF	0.05
15	Ni (mg/l)	NF	NF	0.1
16	Cd (mg/l)	NF	NF	0.01

Table: 11

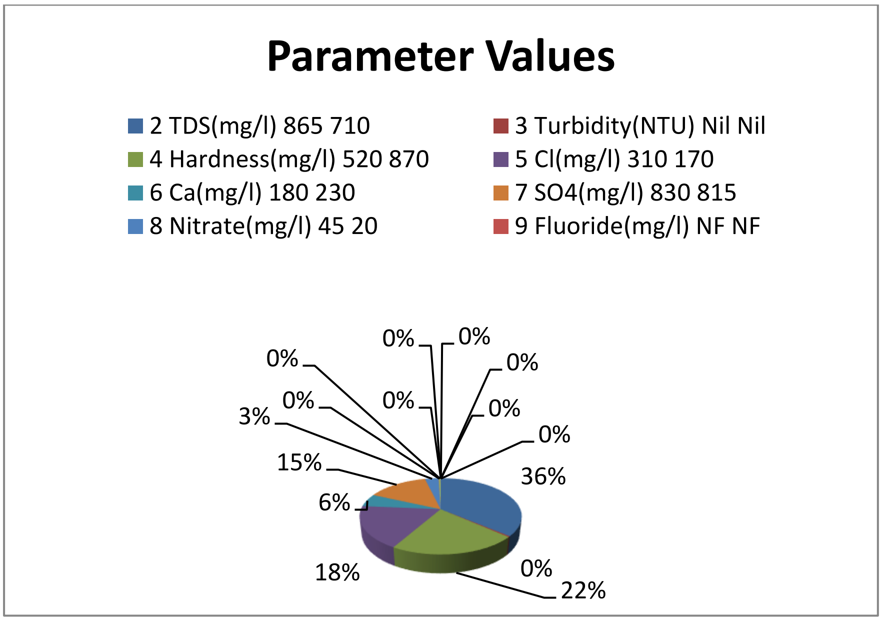

Figure 3.0: Water Quality Parameters

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Table: Leachate concentration at Ghazipur landfill site, waste water collected from nearby pond (drain)

S.No.	Parameter	Experimental Value	Typical value (IS)	Remarks
1.	TDS (mg/l)	27300	250-850	Above typical value
2.	pH	7.1	6.5-8.5	Above typical value
3.	EC (MHO/cm)	1382	2250	Above typical value
4.	Alkalinity (mg/l)	2275	50-200	Above typical value
5.	Chloride (mg/l)	1982	30-100	Above typical value
6.	Sulphate(mg/l)	342	200	Above typical value
7.	Nitrate (mg/l)	112	20-40	Above typical value
8.	BOD5 (mg/l)	1792	50-100	Above typical value
9.	COD (mg/l)	7914	250-1000	Above typical value
10.	Iron (mg/l)	66.5	0.05-0.1	Above typical value
11.	Hardness (mg/l)	6142	50-100	Above typical value
12.	Temp (Celsius)	$27^{o}C$	------------	------------------------

Table: 12

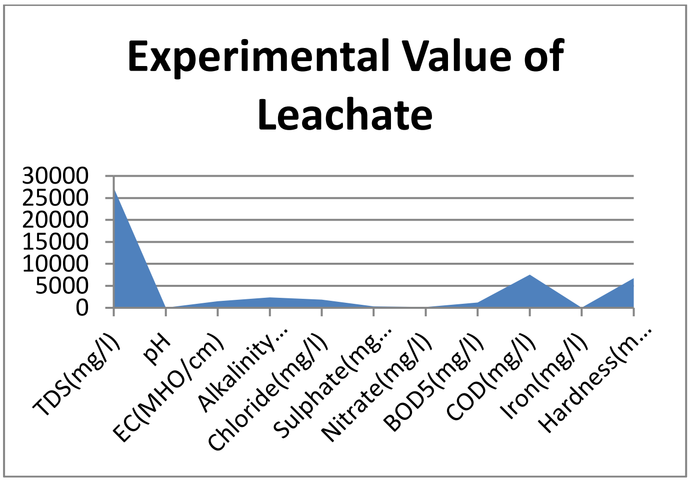

Figure 4.0: Leachate Concentration

Water Quality Index (WQI) of Ghazipur landfill site at radial distances of 1 Km (Table: 13, 14, 15 &16) and 2 Km (Table: 17, 18, 19 &20) around the site were calculated using the most widely used formula i.e. National Sanitation Foundation Water Quality Index (NSFWQI). Result of the WQI indicates that the quality of water is very poor therefore it is not suitable for drinking purpose.

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Table: 13 Calculation for Water Quality Index of Ghazipur landfill site (Eastern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.54	8.5	88.70	0.032	2.83
2	TDS (mg/l)	873	500	174.6	0.00054	0.094
3	Hardness(mg/l)	530	300	176.6	0.0009	0.159
4	Chlorine(mg/l)	315	250	126	0.0011	0.138
5	Calcium(mg/l)	190	75	253.3	0.0036	0.911
6	SO_4(mg/l)	840	200	420	0.0013	0.55
7	Nitrate(mg/l)	45	45	100	0.006	0.60
8	Zinc(mg/l)	0.58	5	11.6	0.054	0.62
9	Iron(mg/l)	0.25	0.3	83.33	0.9	74.99
					Total = 0.999	Total = 80.89
						WQI = 81.71

$$K = \frac{1}{\frac{1}{8.5}+\frac{1}{500}+\frac{1}{300}+\frac{1}{250}+\frac{1}{75}+\frac{1}{200}+\frac{1}{45}+\frac{1}{5}+\frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 81.71 Very Poor Water Quality

Table: 14 Calculation for Water Quality Index of Ghazipur landfill site (Western side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.50	8.5	88.23	0.032	2.82
2	TDS (mg/l)	870	500	174	0.00054	0.094
3	Hardness(mg/l)	530	300	176.6	0.0009	0.159
4	Chlorine(mg/l)	317	250	126.8	0.0011	0.14
5	Calcium(mg/l)	190	75	253.3	0.0036	0.911
6	SO_4(mg/l)	845	200	422.5	0.0013	0.55
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.58	5	11.6	0.054	0.62
9	Iron(mg/l)	0.25	0.3	83.33	0.9	74.99
					Total = 0.999	Total = 80.884
						WQI = 81.64

$$K = \frac{1}{\frac{1}{8.5}+\frac{1}{500}+\frac{1}{300}+\frac{1}{250}+\frac{1}{75}+\frac{1}{200}+\frac{1}{45}+\frac{1}{5}+\frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 81.64 Very Poor Water Quality

Table: 15 Calculation for Water Quality Index of Ghazipur landfill site (Northern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	P^H	7.53	8.5	88.6	0.032	2.83
2	TDS (mg/l)	872	500	174.4	0.00054	0.094
3	Hardness(mg/l)	530	300	176.6	0.0009	0.159
4	Chlorine(mg/l)	315	250	126	0.0011	0.138
5	Calcium(mg/l)	192	75	256	0.0036	0.921
6	SO_4(mg/l)	845	200	422.5	0.0013	0.55
7	Nitrate(mg/l)	45	45	100	0.006	0.6
8	Zinc(mg/l)	0.56	5	11.2	0.054	0.60
9	Iron(mg/l)	0.26	0.3	83.33	0.9	74.99
					Total = 0.999	Total = 80.882
						WQI = 81.96

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 81.96 Very Poor Water Quality

Table: 16 Calculation for Water Quality Index of Ghazipur landfill site (Southern side) less than 1.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	pH	7.50	8.5	88.23	0.032	2.82
2	TDS (mg/l)	870	500	174	0.00054	0.094
3	Hardness(mg/l)	530	300	176.6	0.0009	0.159
4	Chlorine (mg/l)	315	250	126	0.0011	0.138
5	Calcium (mg/l)	192	75	256	0.0036	0.921
6	SO4 (mg/l)	840	200	420	0.0013	0.55
7	Nitrate (mg/l)	45	45	100	0.006	0.6
8	Zinc (mg/l)	0.58	5	11.6	0.054	0..62
9	Iron (mg/l)	0.25	0.3	83.33	0.9	74.99
					Total = 0.999	Total = 80.89
						WQI = 81.97

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 81.97 Very Poor Water Quality

Table: 17 Calculation for Water Quality Index of Ghazipur landfill site (Eastern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	pH	6.15	8.5	72.35	0.032	2.31
2	TDS (mg/l)	715	500	143	0.00054	0.0772
3	Hardness(mg/l)	880	300	293.33	0.0009	0.264
4	Chlorine (mg/l)	180	250	72	0.0011	0.0792
5	Calcium (mg/l)	232	75	309.33	0.0036	1.11
6	SO4 (mg/l)	820	200	410	0.0013	0.533
7	Nitrate (mg/l)	20	45	44.44	0.006	0.26
8	Zinc (mg/l)	0.76	5	15.2	0.054	0.82
9	Iron (mg/l)	0.24	0.3	80	0.9	72
					Total = 0.999	Total = 77.45
						WQI = 78.177

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 78.177 Very Poor Water Quality

Table: 18 Calculation for Water Quality Index of Ghazipur landfill site (Western side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	pH	6.15	8.5	72.35	0.032	2.31
2	TDS (mg/l)	720	500	144	0.00054	0.077
3	Hardness(mg/l)	875	300	291.66	0.0009	0.26
4	Chlorine (mg/l)	180	250	72	0.0011	0.0792
5	Calcium (mg/l)	230	75	306.66	0.0036	1.1
6	SO4 (mg/l)	822	200	411	0.0013	0.53
7	Nitrate (mg/l)	20	45	44.44	0.006	0.26
8	Zinc (mg/l)	0.75	5	15	0.054	0.81
9	Iron (mg/l)	0.24	0.3	80	0.9	72
					Total = 0.999	Total = 77.42
						WQI = 77.49

$$K = \frac{1}{\frac{1}{8.5} + \frac{1}{500} + \frac{1}{300} + \frac{1}{250} + \frac{1}{75} + \frac{1}{200} + \frac{1}{45} + \frac{1}{5} + \frac{1}{0.3}} = \frac{1}{3.68}$$

$$\therefore K = 0.27$$

Result: 77.49 Very Poor Water Quality

Table: 19 Calculation for Water Quality Index of Ghazipur landfill site (Northern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	pH	6.15	8.5	72.35	0.032	2.31
2	TDS (mg/l)	715	500	143	0.00054	0.0772
3	Hardness(mg/l)	880	300	293.33	0.0009	0.266
4	Chlorine (mg/l)	180	250	72	0.0011	0.0792
5	Calcium (mg/l)	230	75	306.66	0.0036	1.1
6	SO4 (mg/l)	820	200	410	0.0013	0.533
7	Nitrate (mg/l)	20	45	44.44	0.006	0.26
8	Zinc (mg/l)	0.75	5	15	0.054	0.81
9	Iron (mg/l)	0.24	0.3	80	0.9	72
					Total = 0.999	Total = 77.43
						WQI = 78.16

$$K = \frac{1}{\frac{1}{8.5}+\frac{1}{500}+\frac{1}{300}+\frac{1}{250}+\frac{1}{75}+\frac{1}{200}+\frac{1}{45}+\frac{1}{5}+\frac{1}{0.3}} = \frac{1}{3.68}$$
$$\therefore K = 0.27$$

Result: 78.16 Very Poor Water Quality

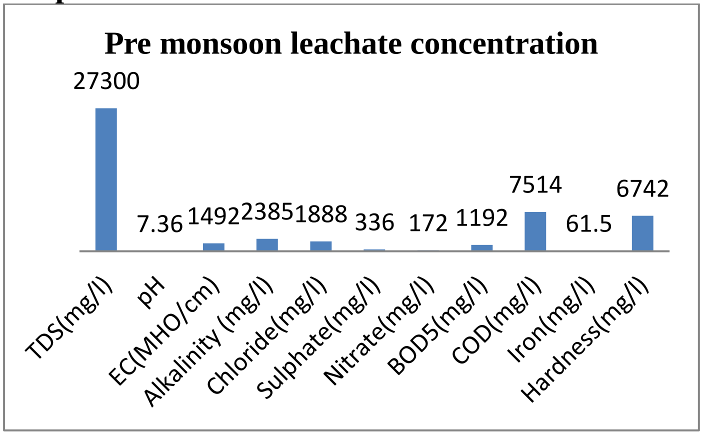
Table: 20 Calculation for Water Quality Index of Ghazipur landfill site (Southern side) less than 2.0 Km

S.No	Parameter	Observed Value (V_n)	Standard Value (S_n)	Quality Rating $Q_n = \frac{V_n}{S_n} \times 100$	Unit Weight $W_n = \frac{K}{S_n}$	Water Quality Index $WQI = Q_n \times W_n$
1	pH	6.15	8.5	72.35	0.032	2.31
2	TDS (mg/l)	720	500	144	0.00054	0.077
3	Hardness(mg/l)	880	300	293.33	0.0009	0.264
4	Chlorine (mg/l)	180	250	72	0.0011	0.0792
5	Calcium (mg/l)	230	75	306.66	0.0036	1.1
6	SO4 (mg/l)	815	200	407.5	0.0013	0.53
7	Nitrate (mg/l)	22	45	48.88	0.006	0.29
8	Zinc (mg/l)	0.75	5	15	0.054	0.81
9	Iron (mg/l)	0.24	0.3	80	0.9	72
					Total = 0.999	Total = 77.46
						WQI = 77.53

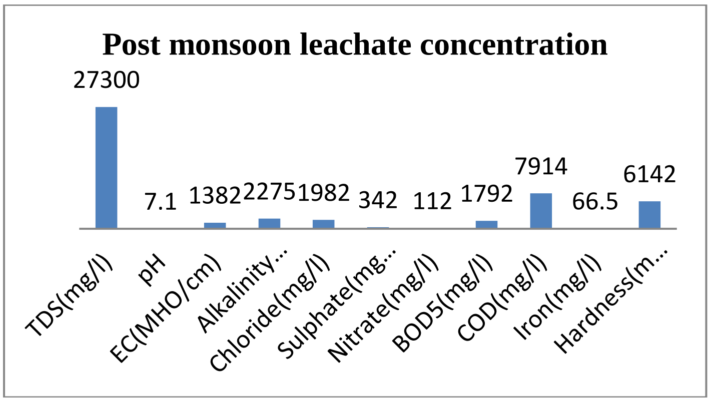
$$K = \frac{1}{\frac{1}{8.5}+\frac{1}{500}+\frac{1}{300}+\frac{1}{250}+\frac{1}{75}+\frac{1}{200}+\frac{1}{45}+\frac{1}{5}+\frac{1}{0.3}} = \frac{1}{3.68}$$
$$\therefore K = 0.27$$

Result: 77.53 Very Poor Water Quality

Graph 1.0 to 2.0 leachate concentration at different seasons

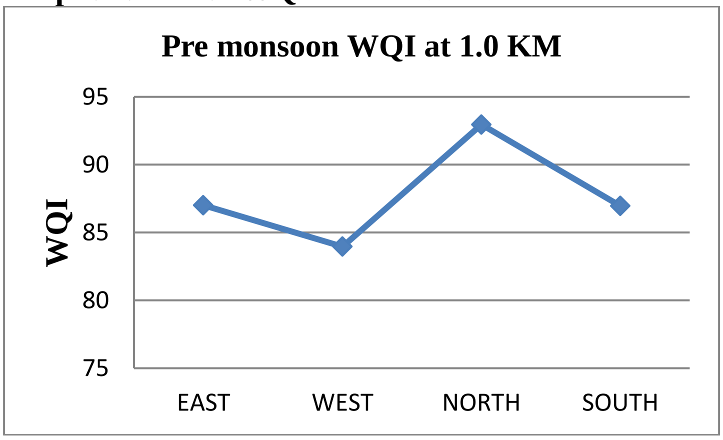


Graph: 1.0 Graphical representation of Leachate (X- Axis Parameters and Y – Axis Observed value)



Graph: 2.0 Graphical representation of Leachate (X- Axis Parameters and Y – Axis Observed value)

Graph: 3.0 to 6.0 WQI at various distances/directions



Graph: 3.0 Graphical representation of WQI (X- Axis Direction and Y – Axis WQI value)

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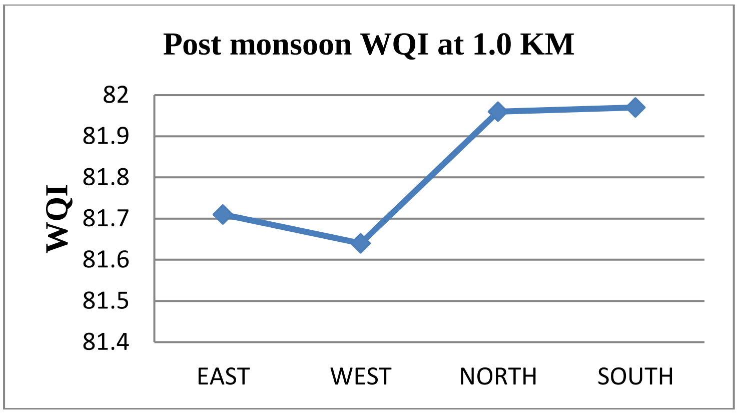
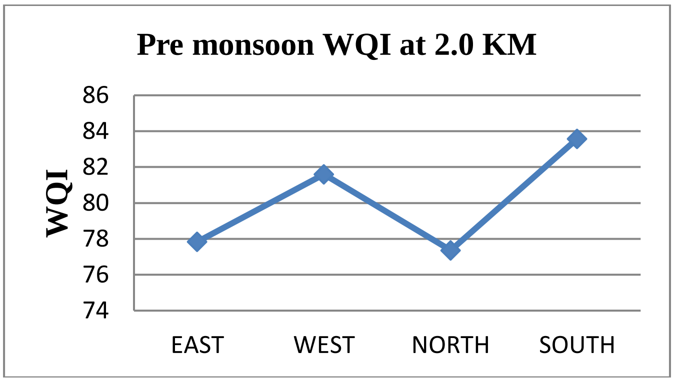
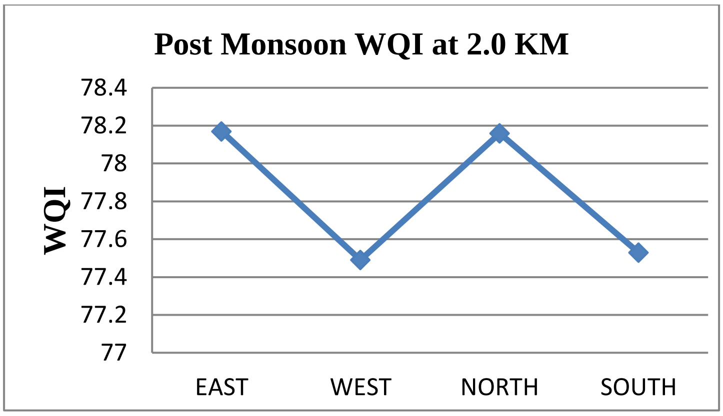


Graph: 4.0 **Graphical representation of WQI (X- Axis Direction and Y – Axis WQI value)**



Graph: 5.0 **Graphical representation of WQI (X- Axis Direction and Y – Axis WQI value)**



Graph: 6.0 **Graphical representation of WQI (X- Axis Direction and Y – Axis WQI value)**

Effects of Ghazipur solid waste landfill site

1. Contamination of ground water with leachate.
2. Pollution of the surrounding environment.
3. Bad smell and breading of insects that spreadsin larger areas.
4. Probability of fire eruption in the area.
5. Health issues causing problems among peoples.
6. Unhealthy environment.

Environmental impact of Ghazipur solid waste landfill site.

1. Air pollution.
2. Fire burning.
3. Breathing problems.
4. Greenhouse gases.
5. Contaminate of groundwater by the Leachate.
6. Very high level of TDS causes adverse health impact on humans.
7. Leachate plumes may degrade subsoil and the groundwater within and around landfill dumping sites.
8. Consumption of water contaminated with leachate is a major health hazard that may cause blood disorders, bleeding in the stomach, congenital disabilities, cancer ,and many other serious ailments.

7. CONCLUSION

The results indicated poor underground water quality in both seasons due to leachate penetration in to the subsoil and the groundwater. Surface water (drain) and groundwater samples close to the dumping site showed that the water is most polluted. Samples of groundwater were collected during pre & post monsoon seasons and physico- chemical parameters were analyzed. The study exhibits that groundwater in the surrounding area of Landfill site has been contaminated by percolation of leachate. Most of the results have shown higher values of WQI in pre monsoon season i.e. 87.01, 83.96, 92.96, 86.97 and post monsoon season values of WQI i.e. 81.71, 81.64, 81.96, and 81.97(up to 1.0 KM).The results of the samples collected at 2.0 KM are found to contain higher concentration values.

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