Indonesian Journal of Engineering, Science and Technology
IJENSET
Volume 02 - Issue 02, June 2025
e-ISSN: 3089-2392
Journal Link: https://jurnal.umla.ac.id/index.php/ijenset/index

ANALISIS OF SOIL QUALITY POLLUTIONS AT LANDFILLS IN BLITAR CITY BASED ON pH, HUMIDITY, AND TEMPERATURE PARAMETER

Ananda Siti Ardila[1]*, Ulfa Niswatul Khasanah[1], Kartika Wulandari[2]

[1]Physics Department; Faculty of Exact Science; Universitas Nahdlatul Ulama Blitar; Blitar 66171, Indonesia
[2]School of Civil Engineering and Technology, Sirindhorn International Institute of Technology, Thammasat University, Bangkok 12121, Thailand

*Corresponding Author Email: ardila10969@gmail.com

Article Information

Submitted	:	November 02, 2025
Revised	:	December 05, 2025
Accepted	:	December 15, 2025
Paper page	:	97-103
DOI	:	10.38040/ijenset.v2i2.1451

ABSTRACT

Based on data from the Dinas Lingkungan Hidup 2024, waste accumulation in Blitar City reached 60,49 tons per day in 2023. This high volume poses a significant risk of soil degradation due to leachate seepage. While most studies focus on heavily polluted metropolitan landfills, this research provides a critical assessment of soil health in a medium-sized city landfill under modern waste loads, offering a contemporary baseline for ecological resilience. This study aims to analyze soil quality at the Blitar City Landfill using pH, humidity, and temperature as key indicators of soil health. Data were collected at four strategic locations using a Digital Soil Analyzer. To ensure data validity and reliability, the instrument was pre-calibrated with standard buffer solutions, and all measurements were performed in triplicate. The analysis shows an average pH of 5.87 (slightly acidic), Optimum humidity of 29.8%, and a normal tropical temperature of 29.6°C. According to the Peraturan Pemerintah Republik Indonesia 2000, the soil remains within healthy environmental standards, supporting microbial activity and plant growth. However, the trend toward acidity necessitates the implementation of more effective leachate drainage systems and routine monitoring to prevent long-term soil quality decline and ensure sustainable environmental management.

Keywords**—***Humidity; Landfill; pH; Soil pollution; Temperature.*

I. INTRODUCTION

Environmental pollution remains a critical urban challenge in Indonesia, as waste generation continues to escalate alongside urban growth. The latest data from the Environment and Forestry Service reveals that the daily waste accumulation in Blitar City reached an average of 60,49 tons in 2023 (Dinas Lingkungan Hidup Kota Blitar, 2024) (Hayuningrat & Rahmadyanti, 2021). This substantial volume poses a direct threat to soil integrity due to potential leachate seepage. While heavy metal contamination is a common focus in landfill studies, there is a significant research gap regarding the fundamental physical-thermal response of the soil under these conditions.

Parameters such as pH, humidity, and temperature were strategically selected as primary indicators because they constitute the essential regulatory matrix of the soil ecosystem. These parameters dictate the soil's buffering capacity, nutrient availability, and the metabolic rates of microorganisms responsible for natural detoxification. Unlike complex chemical markers, these physical-thermal indicators provide a real-time diagnostic of soil vital signs. Previous studies have demonstrated that improperly lined landfills allow leachate to alter soil cation exchange capacity and pH, leading to fertility loss (Khoiron et al., 2020). Previous studies have shown that improperly lined landfill can cause leachate to flow freely into the underlying soil layers, resulting in significant degradation of soil quality within a certain radius of the landfills (Ibrahim et al., 2021). However, specific data characterizing the physical resilience of the soil at the Blitar City Landfill remains scarce.

Therefore, this study is conducted to address this void by providing a systematic assessment of these core indicators. This research characterization of the soil's physical-thermal stability, offering a fundamental physics-based framework for predicting early-stage degradation in landfill-adjacent ecosystems before irreversible chemical toxicity occurs.

II. METHOD

This field measurement has been held on July 1 – August 10, 2025 at the Blitar City Environmental Service Office located at Jl. Pemuda Sumpono No. 75, Gedog, Sanan Wetan District, Blitar City.

Data collection for this articles took place at the Blitar City Landfill, which is divided into four locations, as shown in figure 1 below.

Figure 1. Location Point to take data (Source: Google Map)

The data collection process at the Blitar City of Department of Environment (DLH) to ensure data representative and minimize environmental bias, measurements at each location were performed in triplicate (three replications). The Digital Soil Analyzer was pre-calibrated using standard buffer solutions (pH 4.01, 6.86, and 9.18) and specific ranges for humidity and temperature; this process is fundamental to guarantee the validity and reliability of the field instrument readings. The final data were then cross-referenced with standards from (Peraturan Pemerintah Republik Indonesia, 2000) and (Kementrian Pertanian, 2002)

Table 1. Dataset pH, Humidity, and Temperature

Parameters	Unit	Criteria
pH Soil	Unit	Very Acid <4,5 Acid 4,5 – 5,5 Most Acid 5,6 – 6,5 Neutral 6,6 – 7,5 Most alkalis 7,6 – 8,5 Alkalis > 8,5
Hummidity	%	Very Dry < 10% Dry 10–20% Optimum Humidity 20–40%

		Wet 40–60% Water Saturation > 60%
Temperature	℃	Extreme Cold < 15 Cold 15–20 Normal/Optimum 20–35 Hot 35–40 Extreme Heat > 40

Source: KLHK and Kementrian Pertanian

III. RESULTS AND DISCUSSION

This study discusses soil quality pollution around the landfills. The data collection locations are around the new wastewater treatment plant (WWTP), the new landfill, the old wastewater treatment plant (WWTP), the old landfill, and the monitoring wells of both WWTPs. Before taking measurements at the four locations, a digital soil analyzer was calibrated.

Table 2. Calibration Digital Soil Analyzer

pH Buffer	Measurement 1	Measurement 2	Measurement 3	Average	Erors (%)
4.01	4.5	4.5	4.5	4.5	12
6.86	6.0	6.0	6.0	6.0	12
9.18	6.0	6.0	6.0	6.0	34

Based on the data in the table, a relatively large error value was obtained, reaching 12% in solutions with pH 4.01 and 6.86, and an error of 34% in solutions with pH 9.18. This indicates that the pH value of the buffer solution was not fully detected. According to previous research, errors in the Digital Soil Analyzer were caused by the calibrator not being compatible with the instrument, the calibrator not being fully dissolved, and the instrument's accuracy level (Saputra et al., 2025). Instead, this limitation do not significally affect the main conclusion.

The first point of measurement data collection is the land at T1 or the new wastewater treatment plant (WWTP) of the new landfill with coordinates -8.093340, 112.198002. Measurements were carried out using a Digital Soil Analyzer and repeated three times by taking three parameters, namely pH, humidity, and temperature and compared with the quality standards stipulated by the Minister of Environment and Forestry Regulation No. 150 of 2000. The subsequent measurement data are presented in the following table:

Table 3. Measurement at Location point T1

Parameters	Average	Quality Standards	Details
pH	6.0	6.0-8.0	Neutral – Optimum
Humidity	22%	20-40%	Moist – Optimum
Temperature (°C)	27.53°	20-35°	Normal – Optimum

The humidity content reached 22%, indicating the soil falls within the Optimum moisture category. The Optimum moisture category indicates the soil around the wastewater treatment plant (WWTP) is still ideal for plant growth and microbial activity (Yuwan Marthyn Ziliwu & Natalia Kristiani Lase, 2025). The humidity at the first point meets the quality standards set by the Minister of Agriculture, where 22% represents moist but not saturated soil, allowing air pores to function for gas exchange and oxygen diffusion (Nanda et al., 2024). Meanwhile, the temperature falls within the neutral range, supporting the metabolic rate of soil microbes without causing thermal stress or excessive heating (Muning Harjanti et al., 2020).

The second measurement location point is T2 or the new wastewater treatment plant (WWTP) monitoring well of the new landfill which has coordinates of -8.093138, 112.198054.

Table 4. Measurement at Location Point T2

Parameters	Average	Quality Standards	Details
pH	6.0	6.0	Neutral - Optimum
Humidity	32.3%	20-40%	Moist - Optimum
Temperature (°C)	26.53°	20-35°	Normal - Optimum

Where the soil has a pH value of 6.0 (Neutral - Optimum) the presence of a neutral pH is very important because it is able to maintain the chemical balance of the soil, so that the availability of nutrients is not hampered by acidic or alkaline conditions (Hassan & Umer, 2022). Humidity at 32.3% also indicates that the soil is in an ideal condition for plant physiological processes, because water is available for the photosynthesis process, but still allows for soil aeration (Ideal Humidity) which means the soil is in an ideal condition for planting plants. The temperature at this location is also relatively normal for human use. The soil temperature of 26.53°C supports enzymatic activity and microorganism metabolism, which in turn facilitates the mineralization process and maintains soil fertility (Krisna Sari Dohare et al., 2025).

The third land location point measured was T3 or the old wastewater treatment plant (WWTP) old lanfill which had coordinates of -8.094105, 112.197021.

Table 5. Measurement at Location Point T3

Parameters	Average	Quality Standards	Details
pH	5.0	6.0-8.0	Neutral - Optimum
Humidity	36.6%	20-40%	Moist - Optimum
Temperature (°C)	33.1°	20-35°	Normal - Optimum

An average pH of 5.0 indicates acidic soil conditions. This acidity can reduce the availability of certain essential nutrients, such as phosphorus, and increase the solubility of heavy metals that are potentially toxic to plants (Della Lusiana Fitri et al., 2025). The humidity level of 36.6% remains within the relatively Optimum humidity range, supporting water availability for plants and microbial activity. The temperature was 33.1°C, which is considered high due to limited vegetation and the data collection time of 9:40 a.m. WIB, when more sunlight is absorbed. However, it is still within the normal-Optimum range, allowing for proper soil biota activity. Despite the acidic and humid soil conditions, plants can still be grown in this area (Purba et al., 2021).

Table 6. Measurement at Location Point T4

Parameters	Average	Quality Standards	Details
pH	6.0	6.0-8.0	Neutral - Optimum
Humidity	28.3%	20-40%	Moist - Optimum
Temperature (°C)	31.26°	20-35°	Normal - Optimum

pH of 6.0 is within the neutral range, supporting the availability of macro and micro nutrients for plants and maintaining the stability of microbial activity in the soil. A humidity of 28.3% (ideal humidity) remains within the ideal humidity range for vegetation and maintains water balance in the soil. Meanwhile, a soil temperature of 31.26°C is considered normal-Optimum, supporting the decomposition of organic matter by microbes without causing excessive heat stress (Krisna Sari Dohare et al., 2025).

From all the data above, it can be presented in graphic form to make it easier to understand as follows:

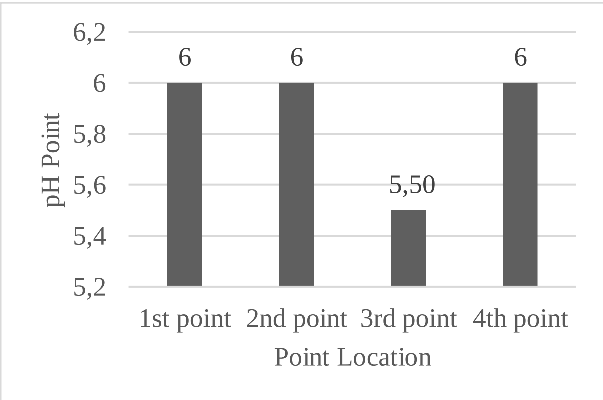

Figure 2. pH Parameters

At the new wastewater treatment plant of the new landfill, the monitoring well of the new wastewater treatment plant (WWTP) of the new landfill, and the monitoring well of the old wastewater treatment plant (WWTP) of the old landfill, soil pH values were consistently recorded at 6.0. This value indicates soil conditions that tend to be neutral to slightly acidic, a pH range that generally supports the activity of soil microorganisms and the availability of essential nutrients for vegetation (Muning Harjanti et al., 2020). In contrast, the old wastewater treatment plant (WWTP) of the old landfill showed a lower pH value, namely 5.0, indicating acidic soil conditions. This acidity can be attributed to the intensive decomposition process of organic matter in the waste pile (Laili, 2021).

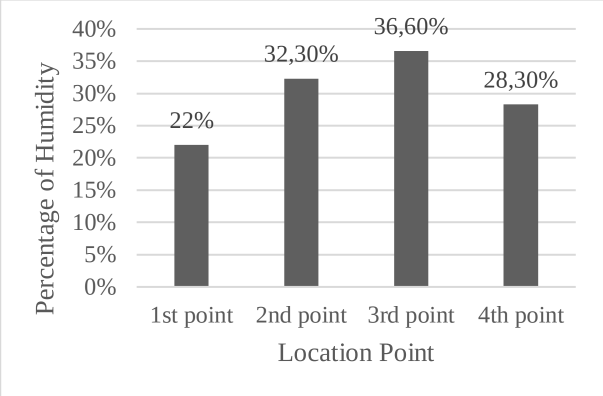

Figure 3. Humidity Parameters

The humidity parameters in Figure 3 show varying fluctuations between sampling points. The high humidity in the old wastewater treatment plant and the old landfill area (36.6%) can be interpreted as a consequence of the accumulation of leachate, a liquid produced from water percolation through decomposing waste piles.

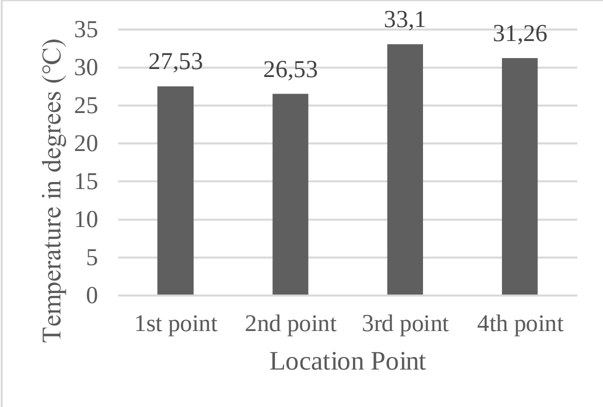

Figure 4. Temperature Parameters

Soil temperature measurement in figure 4 shows relatively close ranges of values across the four locations. The significant increase in soil temperature in the Old Wastewater Treatment Plant area (33.1°C) can be explained by the exothermic nature of the organic waste decomposition process. The metabolic activity of microorganisms in decomposing organic materials releases energy in the form of heat, which directly increases the temperature of the environment around the waste pile (Yuwan Marthyn Ziliwu & Natalia Kristiani Lase, 2025). Based on the results obtained from the measurements above, they can be presented in the following table 7:

Table 7. Analisys from all location point

Parameters	T1	T2	T3	T4	$\overline{T}$	Training Time (s)
pH	6	6	5.5	6	5,875	Sour
Humidity	22%	32.30%	36.60%	28.30%	29.8%	Optimum Humidity
Temerature (℃)	27.53°C	26.53°C	33.1°C	31.26°C	29,605°C	Normal Optimum

Table 7 shows the average pH value obtained is 5.875 or is classified as Acidic, where in the quality standards set by the Peraturan Pemerintah Republik Indonesia, 2000 the pH value is close to Optimum Neutral. Meanwhile, for humidity, the average value is 29.8% with the Optimum Humidity category and for temperature, the average value is 29.605°C or falls into the Optimum Normal category. Based on these results, it can be said that the Blitar City Environmental Service can control soil quality pollution at the landfill very well.

The relatively stable physical parameters observed at the Blitar City Landfill present a notable contrast to studies conducted at larger, more saturated landfill sites. For instance, research at the Piyungan Landfill in Yogyakarta or Terjun Landfill in Medan often reports significantly lower pH levels (acidic) and higher soil temperatures, which are directly correlated with intensive anaerobic decomposition and heavy leachate infiltration over longer operational periods. In contrast, the Optimum humidity (29.8%) and near-neutral pH (5.87) at the Blitar City Landfill suggest that the soil's natural buffering capacity is still functioning effectively despite the 100-ton daily waste load. This comparison indicates that the Blitar City Landfill is currently in an equilibrium phase, where the physical-thermal environment still supports microbial life. However, looking at the degradation patterns of larger landfills, this equilibrium is fragile; without a more robust leachate management system, the Blitar City Landfill is at risk of following the same trajectory toward severe acidification and thermal stress as seen in metropolitan landfills.

IV. CONCLUSION

Based on the results of measurements of pH, humidity, and temperature parameters at four locations of the Blitar City Landfill, soil quality showed a pH with some locations are in the acidic category and others are neutral-Optimum. The humidity was generally considered Optimum humidity, while the soil temperature was still within normal limits for tropical regions. These conditions indicate that soil pollution at the Blitar City Landfill meets quality standards or has not reached an extreme level, but there are indications of quality decline, especially at locations with low pH and high humidity.

Therefore, regular monitoring of these vulnerable points is required as well as the implementation of a more effective leachate drainage system to prevent further soil acidification and maintain the stability of the environmental ecosystem around the landfill. Further research can be carried out on comprehensive soil quality monitoring at the landfill to determine the changes that occur and can use more than one Parameters so that there is no data loss.

ACKNOWLEDGEMENT

Sincere gratitude to the Department of Environment (Dinas Lingkungan Hidup) of Blitar City for their invaluable guidance and assistance during the data collection process. Extend our appreciation to our supervising lecturers for their insightful mentorship throughout the reporting phase. Finally, we thank Universitas Nahdlatul Ulama Blitar for providing the academic support and research facilities essential to the completion of this study.

REFERENCES

Della Lusiana Fitri, Firra Rosariawari, & Aprilia Permata Sari. (2025). Analisis Deskriptif Performa Instalasi Pengolahan Air Limbah (IPAL) Berdasarkan Parameter BOD, COD dan TSS pada Industri Pengalengan Bekicot. *Manufaktur: Publikasi Sub Rumpun Ilmu Keteknikan Industri*, *3*(2), 01–11. https://doi.org/10.61132/manufaktur.v3i2.831

Dinas Lingkungan Hidup Kota Blitar. (2024). *Jumlah Pengelolaan Sampah Kota Blitar Tahun 2023*. https://opendata.blitarkota.go.id/dataset/lingkungan-hidup---jumlah-pengelolaan-sampah-kota-blitar-tahun-2023

Hassan, N. E., & Umer, M. I. (2022). Primary Treatment of Landfill Leachate Effects on Heavy Metal and Soil Chemical Properties in Kwashe Industrial Area in Duhok Province, Kurdistan Region of Iraq. *Journal of Medicinal and Chemical Sciences*, *5*(1), 1–9. https://doi.org/10.26655/JMCHEMSCI.2022.1.1

Hayuningrat, M. A., & Rahmadyanti, E. (2021). Analisis Kebutuhan Lahan Dan Sarana Prasarana Pengelolaan Sampah (Studi Kasus : TPA Ngegong Kota Blitar). *Jurnal Teknik Sipil*, *2*(1), 217–227.

Ibrahim, M., Saufan, L. O., Ode, L., & Bende, S. (2021). Analisis Persebaran Lindi Tempat Pemerosesan Akhir (Tpa) Puuwatu Analysis Of Leachate Distribution In Puuwatu Landfill. *Jurnal Perencanaan Wilayah PPS UHO*. https://journal.uho.ac.id/index.php/jpw/index

Khoiron, K., Probandari, A. N., Setyaningsih, W., Kasjono, H. S., Setyobudi, R. H., & Anne, O. (2020). A review of environmental health impact from municipal solid waste (MSW) landfill. *Annals of Tropical Medicine and Public Health*, *23*(3), 60–67. https://doi.org/10.36295/ASRO.2020.23316

Krisna Sari Dohare, Mesrana Putri Lahagu, & Putri Novi Kristiani Waruwu. (2025). Peran Mikroorganisme Tanah dalam Meningkatkan Kesehatan Tanah dan Hasil Pertanian Organik. *Hidroponik : Jurnal Ilmu Pertanian Dan Teknologi Dalam Ilmu Tanaman*, *2*(1), 166–178. https://doi.org/10.62951/hidroponik.v2i1.253

Laili, F. (2021). *Analisa Kualitas Air Lindi Dan Potensi Penyebarannya Ke Lingkungan Sekitar TPA Gunung Tugel Kabupaten Banyumas*.

Muning Harjanti, I., Anggraini, P., & Studi Diploma Perencanaan Tata Ruang Wilayah dan Kota, P. (2020). Pengelolaan Sampah Di Tempat Pembuangan Akhir (TPA) Jatibarang, Kota Semarang. *Jurnal Planologi*, *17*(2), 1829–9172. http://jurnal.unissula.ac.id/index.php/psa

Nanda, M. F., Maulanah, S., & Hidayah, T. N. (2024). *Analisis Pentingnya Pengelolaan Limbah TerhadapKehidupan Sosial Bermasyarakat*. *2*(2).

Peraturan Pemerintah Republik Indonesia, Pub. L. No. 150 (2000).

Purba, T., Ningsih, H., Junaedi, S. A., Arsi, Firgiyanto, Junairiah, & Gunawan, B. (2021). *Buku Tanah Dan Nutrisi Tanaman* (Abdul Karim). Yayasan Kita Menulis.

Saputra, Z., Silalahi, P., Verentinus, S., & Safitri, W. (2025). *Monitoring Kualitas Air Kolam Ikan Lele Berbasis IoT*. *03*(1).

Yuwan Marthyn Ziliwu, & Natalia Kristiani Lase. (2025). Peran Mikroorganisme dalam Proses Degradasi Bahan Organik. *Hidroponik : Jurnal Ilmu Pertanian Dan Teknologi Dalam Ilmu Tanaman*, *2*(1), 132–141. https://doi.org/10.62951/hidroponik.v2i1.235

Kementrian Pertanian. (2002). *Nilai pH ambang Batas untuk Tanah.* Kementrian pertanian.