Buletin Poltanesa Vol. 26 No. 2 (December 2025) 679-687 p-ISSN 1412-0097 e-ISSN 2614-8374
https://doi.org/10.51967/tanesa.v26i2.3514 © 2025 Politeknik Pertanian Negeri Samarinda

Analysis of Water Quality in the Winto River, Buton, Southeast Sulawesi

Arini Rajab
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
arinirajab@politanisamarinda.ac.id

Fachruddin Azwari *
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
fahriazwari@politanisamarinda.ac.id
**Corresponding author*

Kemala Hadidjah
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
kemala.hadidjah@politanisamarinda.ac.id

Martha E. Siahaya
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
marthasiahaya@gmail.com

Adi Supriadi
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
adisupriadi.politani@gmail.com

Christine Elia Benedicta
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
eliabenedicta25@gmail.com

Christopaul Palalangan Toding Layuk
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
christopaul@politanisamarinda.ac.id

Andi Gita Tenri Sumpala
Environmental Pollution Control Engineering Technology, Samarinda State Agriculture Polytechnic, 75131, Indonesia
gitatenris@politanisamarinda.ac.id

Submitted: 2025-10-03; Accepted: 2025-11-01; Published: 2025-12-20

Abstract**—** This study assessed the water quality of the Winto River in Buton Regency, Southeast Sulawesi, at upstream and downstream points adjacent to asphalt mining activities. Sampling was carried out in accordance with SNI 8995:2021, and the results were evaluated by comparing the physical, chemical, heavy metal, and biological parameters against river water quality standards for classes 1 to 4 as stipulated in Government Regulation No. 22 of 2021. Findings revealed that physical, chemical, and biological parameters generally remained within safe limits. The measurement results show that the water temperature is maintained at a constant 28 °C and is still within the permissible deviation. TDS and TSS values were low, pH was neutral, and both BOD and COD indicated minimal organic loads. Nutrients and heavy metals were well below permissible thresholds, while total coliform counts complied with Class 1 standards. These results suggest that the Winto River has not yet experienced significant water quality degradation despite its proximity to asphalt mining. The novelty of this research lies in providing empirical evidence from a rarely studied context in Indonesia, serving as an essential baseline for long-term monitoring. Practically, the findings highlight the need for continuous monitoring and for evidence-based policies by local authorities to ensure sustainable water resource management in mining-affected regions.

Keywords**—**Water Quality, Winto River, Physical Parameter, Chemical Parameter, Biological Parameter

I. Introduction

Water is one of the most important natural resources for the survival of humans, animals, and plants (Lestari et al., 2021). The availability of adequate clean water is a primary need to support various activities, including consumption, agriculture, fisheries, and industry. Water quality assesses the physical, chemical, and biological conditions of waterbodies to identify and address concerns related to their intended use. Water quality parameters differ depending on its intended purpose, such as public water supply, fish and wildlife habitat, recreation, agriculture, or industrial. Drinking water quality standards must be greater than those for agriculture and industry (Giri, 2021). Environmental contamination, particularly water quality, is a worldwide concern. The degradation in water quality has a wide range of significant and diverse implications on human health (Zubaidah et al., 2024).

Rivers, as a source of surface water, play an important role in people's lives (Ikhsan et al., 2021). Rivers can become polluted when there are changes in environmental use, so that the components within them can no longer be used for their intended purposes (Kamila et al., 2024). Rivers are vital to life because they support various human activities, but their quality can decline due to pollution from industrial and household waste (Pramaningsih et al., 2023).

These days, several rivers have seen decline in their water quality and even pollution (Tanjung et al., 2022). Declining water quality can have a direct impact on public health and aquatic ecosystems (Harefa et al., 2024). Therefore, regular water quality management and monitoring are essential. The persistent perception that rivers are a convenient place to dump waste remains a persistent challenge. Addressing this issue requires efforts to raise individual awareness of the critical role rivers play in supporting ecosystem and environmental sustainability

The challenges of maintaining river water quality in Indonesia are compounded by rapid population growth, land use change, and limited waste treatment infrastructure. Rivers receive untreated household sewage, livestock waste, and agricultural runoff containing fertilizers and pesticides. In addition, industries discharge chemical waste, including heavy metals, into river systems (Majumdar & Avishek, 2024). As a result, river pollution has become a widespread problem, with many water bodies showing signs of declining quality despite existing regulations. Continuous monitoring and localized studies are therefore essential to provide updated data that can inform effective management strategies.

There are several previous studies that investigate the quality of different rivers. The alteration of pH and TSS parameters suggests that coal mining activities have caused the Kintap River to become lightly polluted (Adyatma, et. al, 2024). In Yogyakarta, heavy metal indices applied to the Winongo and Gajahwong Rivers confirmed water quality decline under anthropogenic pressures (Widyastuti et al., 2023). The Way Umpu River (Lampung) recorded higher COD (Risgiyanto et al., 2023), the Babon River (Central Java) showed Cd and Pb accumulation (Haeruddin et al., 2024), and the Citarum River (West Java) suffered severe contamination (Marselina et al., 2025). Coal mining pit lakes in East Kalimantan exhibited water quality variation but remained manageable (Tuheteru et al., 2021), while tin mining in Bangka elevated Cu, Zn, and sedimentation (Hambali et al., 2024).

In Indonesia, the government has established a classification system for rivers to ensure that their uses correspond with acceptable water quality standards. Rivers are categorized into four classes, ranging from Class 1 (intended for drinking water and requiring the highest quality) to Class 4 (for cultivation and other purposes requiring water of equivalent quality). To assess compliance with these standards, systematic monitoring of river water quality is necessary.

River water quality monitoring is carried out by measuring physical, chemical, and biological parameters in accordance with quality standards set by the government. These parameters include temperature, pH, TDS, TSS, organic matter, nutrients, and heavy metal. Heavy metals are classified into two types: essential metals and non-essential metals. Essential metals are metals that are needed by living organisms in certain concentrations while non-essential heavy metals are heavy metals whose presence in the body is not yet known but are harmful to the body (Ishak et al., 2023). It is widely recognized that heavy metals are toxic, have a long atmospheric lifespan, and can accumulate in the human body through bioaccumulation (Niampradit et al., 2024). Heavy metals are a major environmental problem because of their harmful effects, which are amplified by their bioaccumulation and biomagnification (Khan et al., 2023). Biological indicators such as microbial counts and aquatic bioindicators.

The Winto River, located in Buton Regency, is one of the water resources in the region. There are multiple asphalt mining companies operating around the river, whose activities may potentially influence the river's ecological condition. However, to date, no comprehensive reports have been published regarding the water quality of the Winto River. Research on water quality in mining areas in Indonesia has been conducted extensively, but studies highlighting the impact of asphalt mining on water quality are still limited. This analysis of water quality is important to determine the level of pollution so that negative impacts on aquatic ecosystems and human health can be minimized, and to ensure that water quality continues to meet quality standards. In addition, it is necessary to identify affected physical and chemical parameters of water, such as pH, temperature, suspended solids, and degraded organic matter, so that pollution mitigation efforts can be carried out effectively and sustainably. Therefore, analyzing the water quality of rivers around asphalt mines is an important step in protecting the aquatic environment and ensuring the sustainability of water resources for the surrounding communities and ecosystems.

This research on river water quality is expected to provide an overview of the actual condition of the Winto River. The analysis results can also be used as consideration for local governments and communities in formulating water resource management policies, so that environmental sustainability is maintained and the community's need for clean water is met.

II. Methods

This study was carried out at two distinct sampling points that were deliberately chosen to represent upstream and downstream conditions of the river system as shown in Figure 1. Point 1, located at the upstream section, was intended to capture the baseline quality of the river water before being influenced by significant human activity or land use along its flow. Point 2, on the other hand, was situated downstream to reflect the cumulative effects of various natural and anthropogenic inputs, such as agricultural runoff, domestic waste, and potential industrial discharges. These locations were selected to obtain an overview of the differences in water quality based on the position of the river flow.

Figure 1. Sampling points

Water sampling was carried out in accordance with the Indonesian National Standard (SNI) 8995:2021 procedure on Surface Water Sampling which provides comprehensive guidelines for collecting samples that represent the actual conditions of the river. During sampling, sterile containers are used to avoid cross-contamination, and sampling techniques are tailored to the specific parameters to be analyzed, such as physical, chemical, and biological indicators. At this stage, samples were taken directly using sterile containers according to the test parameters to be analyzed. The samples were then labeled. Samples were then transported immediately to the laboratory under controlled conditions to prevent any alteration in their physical, chemical, and biological characteristics.

Water quality analysis refers to the parameters set in the Indonesian National Standard (SNI) related to water quality, including physical, chemical, and biological parameters. These standards used as a reference in determining the water quality of the Winto River, as summarized in Table 1.

The results of the water quality analysis of the Winto River were then compared with the River Water Quality Standards listed in Government Regulation of the Republic of Indonesia Number 22 of 2021. This comparison aimed to determine the water quality status and the level of suitability of the Winto River's quality for its intended use, so that the potential for pollution and its impact on the environment and surrounding communities could be identified.

III. Results and Discussion

The Winto River is located in Pasar Wajo district, Buton Regency, Southeast Sulawesi. The condition of the river at the sampling time is shown in Figure 2. The results of water quality parameter measurements for the Winto river include data on physical, chemical, and biological conditions at both sampling points (upstream and downstream) as tabulated in Table 2. Each parameter is compared with the river water quality standards as stipulated in Government Regulation of the Republic of Indonesia Number 22 of 2021.

Table 1. Water Quality Parameter Testing Methods

Parameters	Method
Temperature	SNI 06-6989.23-2005
Total Dissolved Solids (TDS)	SNI 6989.27:2019
Total Suspended Solids (TSS)	SNI 6989.3:2019
pH	SNI 6989.11:2019
Biological Oxygen Demand (BOD)	SNI 6989.72:2019
Chemical Oxygen Demand (COD)	SNI 6989.2:2019
Sulfate (SO_4^{2-})	SNI 6989.20:2019
Chloride (Cl)	SNI 6989.19:2009
Nitrate (as N)	SNI 6989.79:2011
Nitrite (as N)	SNI 06-6989.9-2004
Ammonia (as N)	SNI 06-6989.30-2005
Total Phosphate (as P)	SNI 6989-31:2021
Fluoride (F)	SNI 06-6989.29-2005
Cyanide (CN)	SNI 6989.77:2011
Barium (Ba)	SNI 6989-82:2018
Boron (B)	SNI 6989-82:2018
Arsenic (As)	SNI 6989-82:2018
Selenium (Se)	SNI 6989-83:2018
Iron (Fe)	SNI 6989-82:2018
Cadmium (Cd)	SNI 6989-82:2018
Cobalt (Co)	SNI 6989-82:2018
Manganese (Mn)	SNI 6989-82:2018
Zinc (Zn)	SNI 6989-82:2018
Copper (Cu)	SNI 6989-82:2018
Lead (Pb)	SNI 6989-84:2018
Total Detergent	SNI 06-6989.51-2005
Total Coliform	APHA 23rd 9221, A,C, and E-2017

Measurements of water quality parameters in the Winto River, Buton Regency, show that the condition of the water in the upstream and downstream is generally still within the quality standards set for class 1 to class 4. Based on the data obtained, the measured water temperature was at 28 °C in both the upstream and downstream areas, which is still within the maximum permissible deviation. The ambient temperature at the time of water collection reached 30°C in the upstream section and 29°C in the downstream. A previous study conducted by (Alfatihah et al., 2022) on the Patrean River in Sumenep Regency showed a similar temperature range of 28.73 to 27.73°C. This range is still considered acceptable under the water quality standards, as it remains below the maximum threshold stipulated in Government Regulation No. 22 of 2021.

Rivers with water temperatures below the permissible limit support the survival of aquatic organisms (Tyassari et al., 2024). Water temperature serves as a key physical indicator in river systems, as it influences a wide range of physical and biogeochemical processes while regulating the metabolic activities of aquatic organisms. Therefore, understanding river thermal dynamics is essential for assessing and managing river ecosystems (Sun et al., 2024). An increase in temperature can accelerate the rate of chemical reactions in water, including acid-base reactions, so that an increase in temperature is usually followed by an upward trend in the pH value of the water (Yolanda, 2023). A 10 °C rise in water temperature causes the oxygen consumption of aquatic organisms to increase about 2–3 times, thereby raising their oxygen demand (Ramadani et al., 2021).

Figure 2. Winto river

The total dissolved solids (TDS) and total suspended solids (TSS) parameters also showed very low values, 98–103 mg/L for TDS and 24–27 mg/L for TSS, respectively, which are well below the threshold. These conditions indicate that the river water is relatively free of excessive suspended particles. Prior research on the Previous studies on the Bone River showed a similar finding, with TDS concentrations tend to rise from upstream to downstream. This trend was attributed to contaminants transported along the river flow (Badu et al., 2023).

TDS includes the amount of material in water, which can be in the form of carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions (Rino et al., 2022). Changes in TDS concentration can be harmful because they cause changes in salinity, changes in ion composition, and toxicity of each ion. Changes in salinity can disrupt the balance of aquatic biota, biodiversity, cause less tolerant species to emerge, and cause high toxicity at certain stages of an organism's life (Alfatihah et al., 2022)

TSS is usually found in domestic, industrial, and agricultural wastewater, and can also be detected in rivers, lakes, and marine waters due to soil erosion and rainwater runoff (Ering., et al., 2024). Excessive suspended solids can increase turbidity, thereby reducing light penetration into the water and ultimately disrupting photosynthesis (Rusdiyanto et al., 2021). Lower TSS correlates with higher dissolved oxygen concentrations and better water clarity (Adnina et al., 2023; Nurbaya et al., 2024).

Table 2. Winto River Water Test Results

No	Parameters	Unit	Quality Standards				Results	
			Class 1	Class 2	Class 3	Class 4	Up-stream	Down-stream
1	Temperature	°	Dev 3	Dev 3	Dev 3	Dev 3	28	28
2	Total Dissolved Solids (TDS)	mg/L	1000	1000	1000	2000	98,0	103.0
3	Total Suspended Solids (TSS)	mg/L	40	50	100	400	24.0	27.0
4	pH	-	6 – 9	6 – 9	6 – 9	6 – 9	6.87	6.71
5	Biological Oxygen Demand (BOD)	mg/L	2	3	6	12	1.71	2.25
6	Chemical Oxygen Demand (COD)	mg/L	10	25	40	80	6.97	9.44
7	Sulphate (SO_4^{2-})	mg/L	300	300	300	400	12.63	14.25
8	Chloride (Cl)	mg/L	300	300	300	600	4.45	5.48
9	Nitrate (as N)	mg/L	10	10	20	20	1.96	2.07
10	Nitrite (as N)	mg/L	0.06	0.06	0.06	-	<0.003	<0.003
11	Ammonia (as N)	mg/L	0.1	0.2	1.0	-	<0.015	<0.015
12	Total Phosphate (as P)	mg/L	0.2	0.2	1.0	-	0.042	0.047
13	Fluoride (F^-)	mg/L	1	1.5	1.5	-	<0.040	<0.040
14	Cyanide (CN^-)	mg/L	0.02	0.02	0.02	-	<0.0005	<0.0005
15	Barium (Ba)	mg/L	1.0	-	-	-	<0.002	<0.002
16	Boron (B)	mg/L	1.0	1.0	1.0	1.0	<0.002	<0.002
17	Arsenic (As)	mg/L	0.05	0.05	0.05	0.10	<0.05	<0.05
18	Selenium (Se)	mg/L	0.01	0.05	0.05	0.05	<0.001	<0.001
19	Iron (Fe)	mg/L	0.3	-	-	-	0.043	0.052
20	Cadmium (Cd)	mg/L	0.01	0.01	0.01	0.01	<0.004	<0.004
21	Cobalt (Co)	mg/L	0.2	0.2	0.2	0.2	<0.007	<0.007
22	Manganese (Mn)	mg/L	0.1	-	-	-	0.011	0.014
23	Zinc (Zn)	mg/L	0.05	0.05	0.05	2	<0.002	<0.002

No	Parameters	Unit	Quality Standards				Results	
			Class 1	Class 2	Class 3	Class 4	Up-stream	Down-stream
24	Copper (Cu)	mg/L	0.02	0.02	0.02	0.2	<0.006	<0.006
25	Lead (Pb)	mg/L	0.03	0.03	0.03	0.5	<0.001	<0.001
26	Total Detergent	mg/L	0.2	0.2	0.2	-	<0.006	<0.006
27	Total Coliform	MPN/100 mL	1000	5000	10000	10000	350	420

When compared with other rivers in Indonesia, the Winto River shows a favorable condition. For instance, TDS values exceeding 5,000 mg/L in the Bengawan Solo river, influenced by domestic and industrial waste (Sholiha, 2022) and studies in the Sebuku River, Nunukan Regency, North Kalimantan, reported TSS concentrations above 200 mg/L in several locations due to mining activities, erosion, and human activites along the banks of the river (Mujiono et al., 2025). In contrast, the much lower TDS and TSS values in the Winto River suggest that it is less affected by such anthropogenic pressures.

pH, BOD, and COD also indicate good conditions. pH indicates the degree of acidity and is used to determine whether a solution is acidic or alkaline (Dzulkiflih et al., 2022). The ideal acidity level for the life of freshwater biota is pH 6.8–8.5. Very low pH values increase the solubility of metals in water, which are toxic to aquatic organisms (Kulla et al., 2020). An increase in pH in river water can be influenced by the entry of organic and inorganic waste into the river system (Mazaya et al., 2023). The pH values obtained ranged from 6.71 to 6.87, which remain within the quality standard range of 6–9. The pH level of the river water indicates that the water is suitable for a wide range of uses, including human consumption and agricultural activities (Ayu et al., 2024).

BOD is the biological oxygen requirement needed by microorganisms, especially bacteria, to break down organic matter aerobically through the decomposition process, in which microorganisms obtain energy from the oxidation process while utilizing and consuming organic matter found in water (Atmaja et al., 2024). The BOD of water is significantly influenced by its temperature. If there is an increase in temperature in water, oxygen solubility will also decrease (Daroini & Arisandi, 2020).

According to Government Regulation of the Republic of Indonesia Number 22 of 2021, the maximum allowable BOD concentration for class 2 which are intended for water recreation, freshwater aquaculture, livestock, agriculture, and other equivalent activities is set at 3 mg/L. The BOD values measured in the Winto River ranged from 1.71 to 2.25 mg/L, which are still below this established threshold. This condition indicates that the Winto River maintains relatively good water quality, characterized by low levels of organic pollution, thereby supporting the sustainability of aquatic ecosystems, and remaining suitable for various uses by the surrounding community.

These results differ from the research conducted by (Istomi et al., 2025) on the Mesuji River in Lampung, which reported that BOD values were above the established quality standards. These findings indicate that the level of organic pollution in the Winto River is lower than that in the Mesuji River. Thus, the Mesuji River has the potential to have a greater negative impact on the sustainability of the aquatic ecosystem and water use for the surrounding community

The COD is the quantity of dissolved oxygen required to oxidize organic materials in water chemically (Harahap et al., 2022). Higher COD values indicate that many organic substances can be oxidized through chemical processes but cannot be oxidized biologically (Royani et al., 2021). A high COD value indicates an accumulation of organic substances in the water, which usually comes from domestic waste, industrial activities, and agricultural activities (Ro'in & Dahalan, 2024). The survival of aquatic life is significantly impacted by COD levels, which show the degree of toxicity in the water (Setyaningrum et al., 2022). COD tests usually produce higher oxygen demand values than BOD because many substances that are stable to biological reactions can be oxidized (Naillah et al., 2022). The COD value in the Winto River, which ranges from 6.97 to 9.44 mg/L, is relatively low and below the quality standards for class I (10 mg/L) according to Government Regulation No. 22 of 2021. When compared to studies on other rivers, such as the rivers in Semarang which have COD levels of 36,14 and 31,85 mg/L (Naufal & Salmahaminati, 2024). The condition of the Winto River is much better. This low COD value indicates that the organic pollutant load in the Winto River is still minimal. This confirms that the water quality of the Winto River is relatively well-preserved and has not experienced significant organic pollution pressure.

Inorganic content such as sulfate, chloride, nitrate, nitrite, ammonia, and phosphate in the Winto River are recorded well below the established threshold, indicating relatively good conditions. The low concentration of these nutrients indicates that the Winto River is not in a condition that could trigger eutrophication (Surya et al., 2024). In contrast, in the Cangkring River, Tuban Regency, East Java, the concentrations of nitrite, ammonia, and phosphate exceed the maximum limits for class 3, meaning that the water quality is classified as moderately polluted. The high levels of nitrite and ammonia are thought to be related to increased nitrogen. Nitrites and ammonia are not always associated with the oil and gas industry but also with agricultural activities (Patimah et al., 2023).

Human health could possibly be at risk from fluoride in surface water that enters groundwater through hydrological cycles (Mu et al., 2024). In this study, the results of fluoride analysis showed that its concentration was consistently below the detection limit (<0.040 mg/L). These findings indicate that the measured values were not only well below the detection limit, but also within the safe limits set by applicable regulations. (Rompas et al., 2024) examined the fluoride content of the Panasen river in Minahasa Regency, discovered similar findings. In addition, study that conducted by (Hidayatullah et al., 2022) reported that the river in Mataram city had the highest fluoride level of 1.046 mg/L, while the lowest fluoride level was 0.213 mg/L. These findings are also below the threshold, posing no significant risk of chemical pollution.

The results of the cyanide analysis conducted on water samples collected from the Winto River revealed that the concentration of cyanide was consistently below the established detection limit (<0.0005 mg/L). This outcome indicates that cyanide was either absent or present only in trace amounts too low to be quantified by the analytical method used. The low values further suggest that cyanide contamination in the Winto River is negligible and does not pose any measurable risk to water quality during the period of assessment. When used excessively and irresponsibly, cyanide can harm people and other animals through skin contact, inhalation into the lungs, and ingestion through the digestive tract. Cyanide can cause damage if it is present in quantities that exceed environmental quality standards (Maksum & Kadir, 2024).

Human activities including wastewater discharge from factories, farms, and settlement can cause heavy metals to enter the aquatic environment (Anh et al., 2023). Water quality test results show that heavy metal parameters are well below the quality standards set in Government Regulation No. 22 of 2021. The concentrations of arsenic, selenium, cadmium, lead, copper, and zinc are very low to undetectable, thus meeting Class 1 quality standards for drinking water. Heavy metal testing results show excellent conditions. Essential metals such as iron (0.043–0.052 mg/L) and manganese (0.011–0.014 mg/L) were detected, but their levels were very low and did not pose a risk of contamination. Thus, it can be concluded that there are no indications of heavy metal contamination in either the upstream or downstream sections of the Winto River. The finding that concentrations of the heavy metals were below the detection limit provides valuable baseline data for future monitoring activities. This data is important as a reference for assessing changes in environmental quality in the event of anthropogenic activities such as mining, agriculture, or development in watershed areas. Although water conditions indicate excellent quality, environmental monitoring needs to be expanded not only to water quality but also to river sediments, as heavy metals tend to accumulate in sediments (Nurjanah et al., 2025) and can serve as long-term indicators of water quality conditions.

Several studies in Indonesia have found that Fe and Mn levels in river water often exceed quality standards due to anthropogenic activities. For instance, the water quality of the Negara River is influenced by various factors, including environmental conditions, industrial waste disposal, household activities, and other anthropogenic activities. These influences have caused the concentration of Fe in the river to exceed the threshold limit of 0.3 mg/L (Mangalik et al., 2023).

Meanwhile, the total detergent parameter also showed safe results. Total detergent was very low (<0.006 mg/L), indicating minimal contamination from domestic and industrial activities. However, these findings contrast with the condition of the Badung River, which is contaminated by detergents, primarily as a result of poorly managed domestic and industrial waste discharges (Mendes et al., 2024). Surfactants in detergents in certain amounts can cause foam that disturbs the view and covers the surface of the water, slowing down the diffusion of oxygen from the air, thereby reducing the level of dissolved oxygen in the water and disrupting aquatic life. Additionally, phosphate in detergents in water can cause eutrophication, as they can cause aquatic plants to become fertile and algae growth to increase, which, if it exceeds the limit, can cause blooming (Larasati et al., 2021).

From a microbiological perspective, the presence of coliform bacteria in water can be used to determine whether the water is safe for drinking, fishing, farming, and other daily activities. The use of water contaminated with coliform bacteria can cause various environmental health problems such as diarrhea and skin infections (Sabila & Setyaningrum, 2023). The results of the biological parameter analysis showed that the water sample had a total coliform content of 350–420 MPN/100 mL. When compared with the quality standard of 1,000 MPN/100 mL, this value is still below the threshold and can be categorized as not exceeding the standard and still meets the class 1 criteria. This condition indicates that the Winto River is relatively clean from excessive pathogenic bacterial contamination. As a comparison, a prior investigation on the Unus River found a total coliform level of ≥16,000 MPN/100 mL, which is far higher than the recommended range and suggests a very high level of contamination (Anisafitri et al., 2020). Meanwhile, research conducted on the Banjir Kanal Barat and Silandak Rivers showed total coliform level at several points also have exceeded the quality standard (Asih et al., 2020). From a public health perspective, these conditions indicate that the water quality of the Winto River is still safe for recreational activities, agriculture. However, regular monitoring is still necessary to prevent an increase in microbiological contamination due to human activities around the river.

Based on the analysis results, the water quality of the Winto River still meets the standards set by the government. This indicates that asphalt mining activities around the river have not had a significant impact on river water quality. The data obtained in this study can be used as a basis for assessing the current water quality of the Winto River and as a reference for future environmental management. However, continuous monitoring of water quality is necessary to ensure that environmental conditions are well maintained. In addition, further analysis of other parameters related to human activities, both mining and other sectors, is very important to gain an understanding of the future water quality of the Winto River.

III. Conclusion

The water quality of the Winto River, both upstream and downstream, was found to comply with the safe thresholds under Government Regulation No. 22/2021. Physical, chemical, and biological parameters indicate that the river remains suitable for domestic, agricultural, and fisheries uses, with potential for drinking water after further treatment. This study provides one of the first documented assessments of a river adjacent to asphalt mining activities in Indonesia. The findings serve as an essential baseline for long-term monitoring and evidence-based policymaking in mining regions. Although current conditions remain favorable, continuous monitoring is recommended to anticipate long-term risks from mining operations. Future research should focus on sediment quality, aquatic bioindicators, and possible hydrocarbon release associated with asphalt mining. In addition, socio-economic studies of surrounding communities are crucial to support more comprehensive and sustainable water resource management strategies.

Reference

Adnina, G. S. N., Rastina & Sulistiono. (2023). Water pollution index based on physical-chemical parameters in Bojonegara Coastal Waters of Banten Bay, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *1251*(1). https://doi.org/10.1088/1755-1315/1251/1/012023

Alfatihah, A., Latuconsina, H. & Prasetyo, H. D. (2022). Analisis Kualitas Air Berdasarkan Paremeter Fisika dan Kimia di Perairan Sungai Patrean Kabupaten Sumenep. *AQUACOASTMARINE: Journal of Aquatic and Fisheries Sciences*, *1*(2). https://doi.org/10.32734/jafs.v1i2.9174

Anh, N. T., Can, L. D., Nhan, N. T., Schmalz, B. & Luu, T. Le. (2023). Influences of key factors on river water quality in urban and rural areas: A review. *Case Studies in Chemical and Environmental Engineering*, *8*. https://doi.org/10.1016/j.cscee.2023.100424

Anisafitri, J., Khairuddin, K. & Rasmi, D. A. C. (2020). Analisis Total Bakteri Coliform Sebagai Indikator Pencemaran Air Pada Sungai Unus Lombok. *Jurnal Pijar Mipa*, *15*(3), 266–272. https://doi.org/10.29303/jpm.v15i3.1622

Asih, D. P., Ain, C. & Widyorini, N. (2020). Analisis Total Bakteri Coliform Di Sungai Banjir Kanal Barat dan Silandak, Semarang Analysis of Total Coliform Bacteria in Banjir Kanal Barat and Silandak Rivers, Semarang. *Management of Aquatic Resources Journal (MAQUARES)*, *8*(4). https://doi.org/10.14710/marj.v8i4.26549

Atmaja, A. G. W., Wahyuni, S. & Salimi, S. (2024). Analisis Biological Oxygen Demand (BOD) Mata Air Cikareo Di Perumda Tirtawening Kota Bandung. *Jurnal Biosains Medika*, *2*(2), 63–67.

Ayu, D., Mirino, T. & Alfius, B. (2024). Analisis Parameter Kualitas Air Sungai Kampung Salak Kota Sorong Papua Barat Daya. *Casuarina: Environmental Engineering Journal*, *1*(2), 13–16.

Badu, M. M., Badu, R. R., Paramata, M. Z., Gonibal, F., Ladua, S. M., Widya, T., Ningsih, R., Hamzah, N., Biga, K. P., Suci, S., Usman, C., Pambi, M. & Lahuding, M. R. (2023). Analisis Kandungan TDS dan pH untuk Mengetahui Kualitas Air Sungai Bone. *Journal of Environmental Engineering Research*, *1*(1), 3030–9875.

Daroini, T. A. & Arisandi, A. (2020). Analisis BOD (Biological Oxygen Demand) Di Perairan Desa Prancak Kecamatan Sepulu, Bangkalan. *Juvenil*, *Vol 1(4)*.

Dzulkiflih, D., Sya'roni, I., Dewi, M. Y., Firdaus, R. A. & Khoiro, M. (2022). Analisa Kelayakan Air Di Kabupaten Sidoarjo Menggunakan Alat Ukur TDS dan pH Meter Berbasis Mikrokontroller. *Jurnal Pena Sains*, *9*(2), 1–7. https://doi.org/10.21107/jps.v9i2.16931

Ering, D. M. B., Mangangka, I. R. & Legrans, R. R. I. (2024). Analisis Kadar Total Suspeded Solid (TSS) dan Ferrum (Fe) Di Bendungan Kuwil. *TEKNO*, 22(89), 1691-1697.

Giri, S. (2021). Water quality prospective in Twenty First Century: Status of water quality in major river basins, contemporary strategies and impediments: A review. *Environmental Pollution*, 271. https://doi.org/10.1016/j.envpol.2020.116332

Haeruddin, H., Soegianto, A., Purwanti, F., Rahman, A., Payus, C. M. & Effendi, H. (2024). Spatial Distribution and Pollution Assessment of Metals in Sediments of the Babon River, Central Java, Indonesia. *Scientifica*, *2024*. https://doi.org/10.1155/2024/2065513

Hambali, R., Tae, L. S., Bachtiar, H., Denansyah, F. I. & Pamungkas, A. (2024). River Sedimentation Due to Tin Mining Activities in Bangka Island. *Journal of the Civil Engineering Forum*, *10*(3), 315–326. https://doi.org/10.22146/jcef.14749

Harahap, M. R., Amanda, L. D. & Matondang, A. H. (2022). Analisis Kadar COD (Chemical Oxygen Demand) Dan TSS (Total Suspended Solid) Pada Limbah Cair Dengan Menggunakan Spektrofotometer UV-Vis. *AMINA*, *2*(2). https://doi.org/10.22373/amina.v2i2.772

Harefa, M. S., Hidayat, S., Simamora, A. S., Sabela, S. & Marpaung, V. (2024). Pemantauan Kualitas Air Danau Toba, Sitongging dan Dampak Limbah Domestik Dan Industri Terhadap Ekosistem. *Jurnal Ilmu Sosial*, *5*.

Hidayatullah, K., Alaa', S., Hasmiyatni, H. & Kurniawidi, D. W. (2022). Analisis Tingkat Pencemaran Air Sungai Berdasarkan Kadar Fluorida Di Kota Mataram Menggunakan Metode Spektrofotometri UV-Vis. *BIOSAINTROPIS (BIOSCIENCE-TROPIC)*, *7*(2). https://doi.org/10.33474/e-jbst.v7i2.482

Ikhsan, J., Kurniati, R. & Rozainy, M. R. (2021). Analysis of river water quality in the upstream of the Code River, Indonesia. *IOP Conference Series: Earth and*

Environmental Science, *794*(1). https://doi.org/10.1088/1755-1315/794/1/012044

Ishak, N. I., Mahmudah, Kasman, Ishak, E., Effendy, I. J. & Fekri, L. (2023). Analisis Kandungan Logam Berat Pada Air Sungai Martapura, Provinsi Kalimantan Selatan Tahun 2022. *JURNAL SAINS DAN INOVASI PERIKANAN*, *7*(1), 35-41. https://doi.org/ 10.33772/jsipi.v7i1.210

Istomi, A. R., Suharso, Buhani, Tugiyono, Satria, H., Artika, E. & Zulaicha, A. S. (2025). Study of water pollution parameters in the dry and rainy seasons on the pollution index of the Mesuji River, Lampung, Indonesia. *Results in Chemistry*, *13*. https://doi.org/10.1016/j.rechem.2024.101906

Kamila, A., Sadidan, I. & Fauzie, A. K. (2024). Penilaian Status Mutu Air Sungai Citarum Menggunakan Metode Indeks Pencemaran. *Ruwa Jurai: Jurnal Kesehatan Lingkungan*, *18*(2), 84–91. https://doi.org/10.26630/rj.v18i2.4562

Khan, M., Omer, T., Ellahi, A., Ur Rahman, Z., Niaz, R. & Ahmad Lone, S. (2023). Monitoring and assessment of heavy metal contamination in surface water of selected rivers. *Geocarto International*, *38*(1). https://doi.org/10.1080/10106049.2023.2256313

Kulla, O. L. S., Yuliana, E. & Supriyono, E. (2020). Analisis Kualitas Air dan Kualitas Lingkungan untuk Budidaya Ikan di Danau Laimadat, Nusa Tenggara Timur. *PELAGICUS*, *1*(3). https://doi.org/10.15578/plgc.v1i3.9290

Larasati, N. N., Wulandari, S. Y., Maslukah, L., Zainuri, M. & Kunarso, K. (2021). Kandungan Pencemar Detejen Dan Kualitas Air Di Perairan Muara Sungai Tapak, Semarang. *Indonesian Journal of Oceanography*, *3*(1). https://doi.org/10.14710/ijoce.v3i1.9470

Lestari, R. I., Ramadhani, R., Sherawali, S. & Yudha, A. T. R. C. (2021). Air dan Dampak Kelangkaannya bagi Perekonomian Masyarakat Urban: Studi Pustaka Pulau Jawa. *OECONOMICUS Journal of Economics*, *6*(1). https://doi.org/10.15642/oje.2021.6.1.38-48

Majumdar, A. & Avishek, K. (2024). Assessing heavy metal and physiochemical pollution load of Danro River and its management using floating bed remediation. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-60511-x

Maksum, T. S. & Kadir, R. O. (2024). Penilaian Risiko Kesehatan Akibat Pajanan Sianida (CN) Secara Real-Time pada Sumber Air PAMSIMAS di Area Pertambangan Emas. *Jurnal Kolaboratif Sains*, *7*(e), 1636–1643.

Mangalik, G. C. A., Asmawi, S. & Sofarini, D. (2023). Analisis Logam Berat Besi (Fe), Mangan (Mn), Tembaga (Cu) Pada Perairan Sungai Negara, Kabupaten Hulu Sungai Selatan, Provinsi Kalimantan Selatan. *AQUATIC Jurnal Manajemen Sumberdaya Perairan*, *6*(1), 24–45. https://doi.org/10.20527/aquatic.v6i1.2077

Marselina, M., Rahmi, N. A. & Nurhayati, S. A. (2025). The water quality of the Upper Citarum: Applying the overall index of pollution, Said-WQI, and pollution index methods. *Heliyon*, *11*(2). https://doi.org/10.1016/j.heliyon.2025.e41690

Mazaya, G. I., Mahyudin, R. P., Abdi, C. & Khair, R. M. (2023). Kajian Status Mutu Air Dan Identifikasi Sumber Pencemar Sungai Cantung Menggunakan Metode Indeks Pencemaran (IP). *Jukung (Jurnal Teknik Lingkungan)*, *9*(2). https://doi.org/10.20527/jukung.v9i2.17563

Mendes, B. A. R., Suarna, I. W. & Wijana, I. M. S. (2024). Studi Kualitas Air, Status Mutu Air dan Beban Pencemaran Sungai Badung. *Jurnal Wilayah, Kota Dan Lingkungan Berkelanjutan*, *3*(2), 117–132. https://doi.org/10.58169/jwikal.v3i2.529

Mu, R., Cui, K., Chen, Y., Tang, Y., Wang, K. & Sun, S. (2024). Distribution characteristics and risk assessment of fluoride in surface water of urban typical rivers. *Science of the Total Environment*, *951*. https://doi.org/10.1016/j.scitotenv.2024.175548

Mujiono, M., Sastranegara, Moh. H. & Effendi, M. (2025). Study of Sebuku River Water Quality and Public Perception of PT ABC's Mining Activities. *Journal La Lifesci*, *6*(3), 297–310. https://doi.org/10.37899/journallalifesci.v6i3.2528

Naillah, A., Yulia Budiarti, L. & Heriyani, F. (2022). Literature Review: Analisis Kualitas Air Sungai Dengan Tinjauan Parameter pH, Suhu, BOD, COD, DO Terhadap Coliform. *Journal of Aquatic Fisheries Sciences*, *1*(2).

Naufal, M. A. & Salmahaminati. (2024). Analysis of COD (Chemical Oxygen Demand) and TSS (Total Suspended Solid) Levels in River Water in Semarang City. *Indonesian Journal of Chemical*, *9*(1), 40–48.

Niampradit, S., Kiangkoo, N., Mingkhwan, R., Kliengchuay, W., Worakhunpiset, S., Limpananont, Y., Hongsibsong, S., Inthorn, D. & Tantrakarnapa, K. (2024). Occurrence, distribution, and ecological risk assessment of heavy metals in Chao Phraya River, Thailand. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-59133-0

Nurbaya, F., Oktavia, Y. F. & Johar, S. A. (2024). Quality of River Water in the District Area of Middle of Java. *Media Karya Kesehatan*, *7*(2), 268–287. https://doi.org/10.24198/mkk.v7i2.53067

Nurjanah, S., Nazwasyawinka, K., Abrar, C. B., Nasution, I. A., Dida, E. N., Sasongko, A. S., Widiyanto, K. & Cahyarini, S. Y. (2025). Kandungan Logam Berat Besi (Fe) pada Sedimen Ekosistem Terumbu Karang di Perairan Pulau Kalih Selatan Banten. *Buletin Oseanografi Marina*, *14*(2), 231–240. https://doi.org/10.14710/buloma.v14i2.69313

Patimah, A. S., Prasetya, A. & Santosa, S. H. M. B. (2023). Environmental assessment of river water quality near oil and gas fields. *Global Journal of Environmental Science and Management*, *9*(2). https://doi.org/10.22034/gjesm.2023.02.07

Pramaningsih, V., Yuliawati, R., Sukisman, S., Hansen, H., Suhelmi, R. & Daramusseng, A. (2023). Indek Kualitas Air dan Dampak terhadap Kesehatan Masyarakat Sekitar Sungai Karang Mumus, Samarinda. *Jurnal Kesehatan Lingkungan Indonesia*, *22*(3), 313–319. https://doi.org/10.14710/jkli.22.3.313-319

Ramadani, R., Samsunar, S. & Utami, M. (2021). Analysis of Temperature, Power of Hydrogen (pH), Chemical Oxygen Demand (COD), and Biologycal Oxygen Demand (BOD) in Domestic Wastewater in Sukoharjo Environmental Office. *Indonesian Journal of Chemical Research*, 6(2), 12-22. https://doi.org/ 0.20885/ijcr.vol6.iss1.art2

Rino, Ulfa Sulaeman, Sumiaty, Alfina Baharuddin & Ayu Puspitasari. (2022). Analisis Spasial Kualitas Air Logam Berat Timbal (Pb) di Kanal Hertasning Kota Makassar Tahun 2022. *Window of Public Health Journal*, *3*(3). https://doi.org/10.33096/woph.v3i3.81

Risgiyanto, A., Suharso, Buhani, Tugiyono, Kiswandono, A. A., Rahmawati, A., Prasetyo, S. I. & Wardani, D. W. S. R. (2023). Study of Water Quality of Way Umpu River, Way Kanan Regency, Lampung Province, Indonesia, Based on Differences of TSS, DO, BOD, COD, and Phosphate Levels in Mining Locations. *AIP Conference Proceedings*, *2540*. https://doi.org/10.1063/5.0105993

Ro'in, F. N. & Dahalan, F. A. (2024). *Characterization of domestic wastewater based on BOD, COD and TSS parameters*. *2*, 16–23. https://doi.org/10.33086/etm.v4i2.6989

Rompas, R. G., Hendratta, L. A. & Legrans, R. R. I. (2024). Analisis Kandungan Besi (Fe), Fluorida (F) Dan Fecal Coliform Di Sungai Panasen,Desa Panasen, Kabupaten Minahasa. *Tekno*, *22*(89), 1671–1682.

Royani, S., Fitriana, A. S., Enarga, A. B. P. & Bagaskara, H. Z. (2021). Kajian COD dan BOD Dalam Air Di Lingkungan Tempat Pemrosesan Akhir (TPA) Sampah Kaliori Kabupaten Banyumas. *Jurnal Sains &Teknologi Lingkungan*, *13*(1). https://doi.org/10.20885/jstl.vol13.iss1.art4

Rusdiyanto, E., Sitorus, S. R. P., Noorachmat, B. P. & Sobandi, R. (2021). Assessment of the Actual Status of the Cikapundung River Waters in the Densely-Inhabited Slum Area, Bandung City. *Journal of Ecological Engineering*, *22*(11). https://doi.org/10.12911/22998993/142916

Sabila, N. & Setyaningrum, D. (2023). Analisis Coliform dan Colifecal pada Air dari Berbagai Sumber Menggunakan Metode MPN (Most Probable Numbers). *Jurnal Kimia Dan Rekayasa*, *3*(2).

Setyaningrum, D., Anisa, Z. & Rasydta, H. (2022). Pengujian Kadar Chemical Oxygen Demand (COD) pada Air Limbah Tinggi Kalsium Klorida Menggunakan Metode Refluks Terbuka. *Formosa Journal of Science and Technology*, *1*(4). https://doi.org/10.55927/fjst.v1i4.1050

Sholiha, D. L. (2022). Measurement of Cod, Tds, and Hexavalent Chromic Metals As a Quality Monitoring of Bengawan Solo River Bodies in the Laboratory Upt of the Environmental Service Gresik. *Indonesian Journal of Chemical Research*, *6*(2).

Sun, J., Di Nunno, F., Sojka, M., Ptak, M., Luo, Y., Xu, R., Xu, J., Luo, Y., Zhu, S. & Granata, F. (2024). Prediction of daily river water temperatures using an optimized model based on NARX networks. *Ecological Indicators*, *161*. https://doi.org/10.1016/j.ecolind.2024.111978

Surya, A. T. J., Sasongko, A. S. & Cahyadi, F. D. (2024). Kandungan Amonia, Fosfat, Nitrat dan Nitrit Air Laut Di Perairan Pesisir Desa Lontar. *Juvenil: Jurnal Ilmiah Kelautan Dan Perikanan*, *5*(3), 238–245. https://doi.org/10.21107/juvenil.v5i3.23089

Tanjung, R. H. R., Yonas, M. N., Suwito, Maury, H. K., Sarungu, Y. & Hamuna, B. (2022). Analysis of Surface Water Quality of Four Rivers in Jayapura Regency, Indonesia: CCME-WQI Approach. *Journal of Ecological Engineering*, *23*(1). https://doi.org/10.12911/22998993/143998

Tuheteru, E. J., Kusuma, G. J., Pranoto, K., Palingi, Y. & Gautama, R. S. (2021). Studi Kualitas Air dan Potensi Pemanfaatan Danau Bekas Tambang JVoid PT Kaltim Prima Coal, Kalimantan Timur. *Indonesian Mining and Energy Journal*, *4*(1), 52-59.

Tyassari, D. V., Soenarno, S. M. & Kristiyanto, K. (2024). Analisis Kualitas Air Sungai Ciliwung di Wilayah Jakarta Timur. *EduBiologia: Biological Science and Education Journal*, *4*(1). https://doi.org/10.30998/edubiologia.v4i1.21107

Widyastuti, M., Jayanto, G. D., Irshabdillah, M. R. & Fadlillah, L. N. (2023). Water Quality Indices for Assessing Heavy Metal Pollution in Winongo River and Gajahwong River Yogyakarta-Indonesia. *Jurnal Ilmu Lingkungan*, *22*(1). https://doi.org/10.14710/jil.22.1.100-108

Yolanda, Y. (2023). Analisa Pengaruh Suhu, Salinitas dan pH Terhadap Kualitas Air di Muara Perairan Belawan. *Jurnal Teknologi Lingkungan Lahan Basah*, *11*(2). https://doi.org/10.26418/jtllb.v11i2.64874

Zubaidah, T., Hamzani, S. & Arifin, A. (2024). Analyzing The Impact of Dissolved Organic Components On River Water Quality And Its Implications For Human Health: A Case Study From Banjar District. *Jurnal Kesehatan Lingkungan*, *16*(2), 181–189. https://doi.org/10.20473/jkl.v16i2.2024.181-189