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ASSESSMENT OF RIVER AND WELL WATER QUALITY AND HEALTH IMPACTS OF DOMESTIC WASTE IN THE RACI RIVER DOWNSTREAM

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ABSTRACT

Assessment of River and Well Water Quality and Health Impacts of Domestic Waste in the Raci River Downstream. *Data from the 2023 Performance Report of the Directorate of Water Pollution Control indicate that water pollution in Indonesia is predominantly caused by household activities or domestic waste. Pasuruan Regency is one of the regions in East Java that recorded 133 water pollution reports during 2014–2018, ranking second after Sidoarjo City as the area with the highest pollution level in the province. The Raci River, located in Pasuruan Regency, is also affected by pollutant inputs originating from agricultural, industrial, and domestic activities. The high discharge of domestic waste into the Raci River has the potential to degrade environmental quality in the surrounding area. This study aimed to describe the quality of Raci River water and community well water based on Total Dissolved Solids (TDS), odor, color, phosphate, and nitrite parameters, which are indicated to originate from domestic waste activities. This study employed a quantitative descriptive research design and was conducted from December 2023 to August 2024. The samples consisted of six river water samples, thirteen well water samples, and thirteen respondents representing the local community. The results showed that the quality of Raci River water and nearby community well water exceeded the established water quality standards. Health impacts associated with the use of well water were also identified. Community members who used well water for cooking and drinking reported health complaints within the last three months, including diarrhea and itching or skin irritation. In addition, well depth, well floor condition, well floor structure, and the distance between wells and wastewater disposal channels were identified as factors influencing well water quality.*

INTRODUCTION

Water is an essential component that serves as a fundamental source of human life. The increasing demand for clean water has led to intensified human activities, which in turn contribute to the growing generation of domestic waste. Domestic waste refers to waste produced from household activities originating from residential areas, offices, and other similar environments [(1)]. Data from the Indonesian Environmental Statistics Report indicate that more than 50% of the Indonesian population disposes of household waste directly into drainage channels and river waters. In addition, domestic wastewater sources represent the highest contributors to water pollution, as domestic wastewater management coverage has not yet reached 50% of the total population in Indonesia.

According to the 2019 Environmental Pollution Statistics Report, Pasuruan Regency ranked second among regencies in East Java with the highest level of environmental pollution [2]. The Raci River is one of the rivers in Pasuruan Regency that is exposed to potential pollution risks due to the high pollutant load entering the river system. The presence of residential settlements in the downstream area of the Raci River, along with business activities generating domestic waste around the river, makes the Raci River highly vulnerable to domestic waste pollution. Preliminary studies indicate that most of the pollutant load entering the Raci River originates from household wastewater discharge and solid waste disposal by the community. In terms of sanitation indicators, Pasuruan Regency has achieved 97.2% of villages implementing the Community-Based Total Sanitation (STBM) STOP Open Defecation program, while Open Defecation Free (ODF) coverage in Raci Village reached 67.5%. Therefore, the potential source of domestic waste pollution primarily originates from human activities producing household waste and solid waste that are directly discharged into the Raci River.

Preliminary observations revealed that the physical characteristics of the Raci River water include a blackish color, the presence of both organic and inorganic solid waste accumulation, and unpleasant odors. Water quality monitoring conducted in 2024 by the Environmental Agency of Pasuruan Regency showed that several parameters exceeded the water quality standards in the downstream section of the Raci River, particularly phosphate levels of 0.809 mg/L (quality standard: 0.2 mg/L). Furthermore, laboratory monitoring and testing reports by PT SIER in 2023 indicated that several parameters in the Raci River exceeded environmental quality standards, including phosphate at 0.86 mg/L (quality standard: 0.2 mg/L), Total Dissolved Solids (TDS) at 975 mg/L (quality standard: 1000 mg/L), and nitrite at 0.78 mg/L (quality standard: 0.06 mg/L). Observations conducted on one of the community wells near the Raci River revealed physical conditions such as odor, unpleasant taste, and turbidity. Elevated concentrations of phosphate, TDS, and nitrite in river water may originate from domestic waste, particularly due to high detergent usage [3]. The presence of phosphate, TDS, and nitrite in community well water exceeding quality standards may cause adverse health effects, including Blue Baby Syndrome or methemoglobinemia, decreased blood pressure, and other health impacts such as nausea, vomiting, and diarrhea when consumed over prolonged exposure periods [4]. Therefore, this study is necessary to assess and describe the quality of Raci River water and community well water, as well as their impacts on public health. The water quality parameters examined in this study include TDS, odor, color, phosphate, and nitrite, referring to Government Regulation No. 22 of 2021 and the Regulation of the Minister of Health No. 2 of 2023 concerning the Implementation of Government Regulation No. 66 of 2014 on Environmental Health.

MATERIALS AND RESEARCH METHODS

This study employed a quantitative descriptive research design. The study population consisted of river water, well water, and community populations. The river water population was represented by the Raci River, which is classified as a Class II water body. River water samples were collected at three sampling points in the downstream section of the Raci River, referring to Indonesian National Standard (SNI) 8995:2021 concerning Water Sampling Methods for Physical and Chemical Testing [5]. River water sampling was conducted in the morning at 09:00 AM and 12:00 PM local time.

The population of community wells consisted of 101 households using well water. Well water sampling was determined using a total sampling method, in which all households meeting the distance criterion of less than 95 meters were included as samples. A total of 13 wells met the sampling criteria. River water samples were collected at the midpoint of the river at each of the three sampling locations, as the river discharge was less than 5 m^3/second, and sampling was conducted at a depth of 0.5 times the total water depth from the surface, in accordance with SNI 8995:2021 on Water Sampling Methods for Physical and Chemical Testing.

The data used in this study consisted of primary and secondary data. Data analysis and processing techniques included editing, coding, data entry, data cleaning, and tabulation. Observations of river water quality and well water quality were conducted through laboratory examinations, with assessments based on established Environmental Quality Standards. Data analysis related to well construction aspects was performed using univariate analysis. Furthermore, the results of water quality examinations, observations, and interviews were presented descriptively.

RESEARCH RESULTS AND DISCUSSION

The study area in this research consisted of the Raci River and community wells. The river water sampling location was situated in the downstream section of the Raci River. The downstream area of the Raci River is part of a watershed located near densely populated residential areas and is characterized by intensive activities from Islamic boarding schools, hotels, and household activities that generate substantial amounts of domestic waste.

Sampling Point 1 was located in a section of the Raci River approximately 200 meters upstream from areas influenced by household waste discharge and residential settlements. Sampling Point 2 was located approximately 100 meters downstream from Sampling Point 1. At Sampling Point 2, major sources of domestic pollution were identified, originating from large-scale activities of Islamic boarding schools and hotels without wastewater treatment plants (WWTP), resulting in the direct discharge of domestic wastewater into the river. Based on literature data, Islamic boarding school activities involve approximately 7,450 students, and hotel activities include facilities with a capacity of 65 rooms, both of which potentially contribute significant domestic waste loads to the Raci River.

Sampling Point 3 was located approximately 100 meters downstream from Sampling Point 2 and was identified as being closer to residential areas. At Sampling Point 3, a higher number of domestic wastewater disposal channels (SPAL) and household waste activities discharging into the river were observed.

The community well locations included wells situated within a distance of less than 95 meters from the Raci River. The wells observed in this study consisted of drilled wells and dug wells.

Table 1. Raci River Water Quality Based on TDS, Odor, Color, Phosphate, and Nitrite Parameters

Parameter	Sampling Location 1		Sampling Location 2		Sampling Location 3		Quality Standard & Unit
	09.00	12.00	09.00	12.00	09.00	12.00	
TDS	604	608	630	612	618	627	1000 mg/L
Odor	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
Color	16	24	24	22	33	38	50 TCU
Phosphate	0,46	1,84	4,2	3,6	5,0	5,3	0,2 mg/L
Nitrite	0,08	0,20	3,40	3,60	0,20	4,70	0,06 mg/L

Laboratory analysis of the Raci River water quality showed that phosphate and nitrite concentrations exceeded the Environmental Quality Standards (EQS) at all three sampling points, both during morning and midday observations. The highest phosphate concentration was detected at Sampling Point 3, reaching 5.3 mg/L, which exceeded the permissible limit (EQS = 0.2 mg/L). Similarly, the highest nitrite concentration was also recorded at Sampling Point 3, with a value of 4.70 mg/L. These results indicate that Raci River water tended to contain higher pollutant concentrations at Sampling Point 3, particularly during midday observation periods.

The elevated concentrations of pollutants, especially phosphate and nitrite at Sampling Point 3, can be attributed to the characteristics of the area, which is more densely populated and experiences more intensive domestic waste activities. The presence of phosphate and nitrite pollutants in the downstream section of the Raci River may originate from the extensive use of soaps and detergents by the local community.

In addition, the results showed a general trend of increasing concentrations for each parameter across the three sampling points. These findings are supported by a study conducted by Pandiangan (2023), which reported that high Total Dissolved Solids (TDS) concentrations in the Ciliwung River were primarily caused by domestic waste activities, particularly in densely populated areas with limited access to wastewater treatment systems [6].

Table 2. Community Well Water Quality Based on TDS, Odor, Color, and Nitrite Parameters

Well Location	Well Type	Distance from Well to River (m)	TDS (Quality Standard = 300 mg/L)	Odor (Quality Standard: Odorless)	Color (Quality Standard = 10 TCU)	Nitrite (Quality Standard = 3.0 mg/L)
Well 1	Dug well	18	518*	Odorless	4	0,04
Well 2	Dug well	10	674*	Odorless	11*	3,1*
Well 3	Dug well	35	207	Odorless	6	0,04
Well 4	Dug well	15	605*	Odorless	13*	0,05
Well 5	Dug well	26	443*	Odorless	2	0,03
Well 6	Drilled well	53	280	Odorless	2	0,11
Well 7	Drilled well	55	100	Odorless	4	0,03
Well 8	Dug well	9	729*	Odorless	18*	3,4*
Well 9	Dug well	14	468*	Odorless	13*	0,02
Well 10	Dug well	16	660*	Odorless	11*	0,06
Well 11	Drilled well	18	646*	Odorless	2	0,03
Well 12	Drilled well	70	107	Odorless	<1	0,02
Well 13	Drilled well	87	100	Odorless	<1	0,03

Laboratory examination of 13 community wells showed that 8 wells (61.5%) exceeded the Environmental Quality Standards (EQS) for the Total Dissolved Solids (TDS) parameter, 5 wells (38.46%) exceeded the EQS for color, and 2 wells (15.29%) exceeded the EQS for the nitrite parameter. For the odor parameter, organoleptic laboratory examination did not indicate the presence of odor in any of the wells. However, based on field observations, Well 8 exhibited physical characteristics of colored water, unpleasant odor, and a bitter taste when consumed. In this study, Well 8 was identified as exceeding the EQS for phosphate, color, and nitrite parameters. This condition may be attributed to the location of Well 8, which was the closest well to the river and domestic wastewater disposal channels (SPAL).

Well water with high TDS concentrations may exhibit physical characteristics such as salty or bitter taste and unpleasant odor, as reported by Krisno et al. (2021) [7]. A study conducted by Aneta Risaldy and Sondakh Ricky C. (2021) also demonstrated that household activities generating domestic waste and directly discharged into rivers can lead to increased TDS concentrations [8]. Furthermore, research by Sailaukhanuly et al. (2024) found that wells located near polluted rivers tend to have higher nitrite concentrations due to contamination from river water [10]. Well water may contain nitrite as a result of contamination from river water and household waste. Elevated nitrite levels in well water can cause serious health problems, particularly in infants and children [10].

Table 3. Assessment of Well Construction Aspects and Distance to Potential Sources of Contamination

Construction Aspects & Distance from Pollution Sources	**Meets Requirements**		**Does Not Meet Requirements**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**
Well Construction						
Well depth	4	30,8	9	69,2	13	100
Well wall depth	2	15,4	6	46,2	8	61,6
Well wall condition	5	38,5	3	23,1	8	61,6
Well floor condition	3	23,1	5	38,5	8	61,6
Well floor shape	2	15,4	6	46,2	8	61,6
Well floor width	6	46,2	2	15,4	8	61,6
Well floor height	4	30,8	4	30,8	8	61,6
Well floor slope	7	53,8	1	7,7	8	61,6
Distance from Pollution Sources						
Distance between well and septic tank	9	69,2	4	30,8	13	100
Distance between well and wastewater disposal system (SPAL)	3	23,1	10	76,9	13	100
Distance between well and other pollution sources	8	61,5	5	38,5	13	100

The results of the study on well construction aspects showed that well depth was the most frequently non-compliant parameter among community wells surrounding the Raci River, with 9 out of 13 wells (69.2%) failing to meet the required standards. In terms of the distance between wells and sources of pollution, domestic wastewater disposal channels (SPAL) represented the construction aspect most commonly found to be non-compliant with the minimum distance requirement of 11 meters, with 10 out of 13 wells (76.9%) failing to meet this criterion.

Furthermore, the relationship between well construction aspects and well water quality can be identified through the results of the following tabulation:

Table 4. Cross-tabulation of Well Construction Aspects and Distance to Sources of Contamination in Relation to Well Water Quality

Well Construction Aspects & Distance from Pollution Sources		Parameter															
		TDS				Odor				Color				Nitrite			
		<BML		>BML		<BML		>BML		<BML		>BML		<BML		>BML	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Well Construction																	
Well Depth	MS	1	7,7	3	23,1	4	30,8	0	0	3	23,1	1	7,7	2	15	2	15,4
	TMS	4	30,8	5	***38,5**	9	69,2	0	0	5	38,5	4	30,8	4	31	5	***38,5**
	Total	5	38,5	8	61,5	13	100,0	0	0	8	61,5	5	38,5	6	46	7	53,8
Well Wall Depth	MS	1	7,7	1	7,7	2	15,4	0	0	1	7,7	1	7,7	2	15	0	0,0
	TMS	0	0,0	6	***46,2**	6	46,2	0	0	2	15,4	4	***30,8**	4	31	2	15,4
	Total	1	7,7	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46	2	15,4
Well Wall Condition	MS	1	7,7	4	30,8	5	38,5	0	0	2	15,4	3	23,1	4	31	1	7,7
	TMS	0	0,0	3	23,1	3	23,1	0	0	1	7,7	2	15,4	2	15	1	7,7
	Total	1	7,7	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46	2	15,4
Well Floor Condition	MS	1	7,7	2	15,4	3	23,1	0	0	2	15,4	1	7,7	2	15,4	1	7,7
	TMS	0	0,0	5	***38,5**	5	38,5	0	0	1	7,7	4	***30,8**	4	30,8	1	7,7
	Total	1	100,0	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46,2	2	15,4
Well Floor Shape	MS	1	7,7	1	7,7	2	15,4	0	0	1	7,7	1	7,7	1	7,7	1	7,7
	TMS	0	0,0	6	***46,2**	6	46,2	0	0	2	15,4	4	***30,8**	5	38,5	1	7,7
	Total	1	7,69	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46,2	2	15,4
Well Floor Width	MS	1	7,69	5	38,5	6	46,2	0	0	2	15,4	4	30,8	4	30,8	2	15,4
	TMS	0	0,00	2	15,4	2	15,4	0	0	1	7,7	1	7,7	2	15,4	0	0,0
	Total	1	7,69	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	100,0	2	15,4
Well Floor Height	MS	0	0,00	4	30,8	4	30,8	0	0	1	7,7	3	23,1	3	23,1	1	7,7
	TMS	1	7,69	3	23,1	4	30,8	0	0	2	15,4	2	15,4	3	23,1	1	7,7
	Total	1	7,69	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46,2	2	15,4
Well Floor Slope	MS	1	7,69	6	46,2	7	53,8	0	0	2	15,4	5	38,5	5	38,5	2	15,4
	TMS	0	0,00	1	7,7	1	7,7	0	0	1	7,7	0	0,0	1	7,7	0	0,0
	Total	1	7,69	7	53,8	8	61,5	0	0	3	23,1	5	38,5	6	46,2	2	15,4
Distance from Pollution Sources																	
Distance Between Well and Septic Tank	MS	2	15,4	7	53,8	9	69,2	0	0	4	30,8	5	38,5	7	53,8	2	15,4
	TMS	3	23,1	1	7,7	4	30,8	0	0	4	30,8	0	0,0	4	30,8	0	0,0
	Total	5	38,5	8	61,5	13	100	0	0	8	61,5	5	38,5	11	84,6	2	15,4
Dista nce Between Well and Wastewater Disposal System (SPAL)	MS	1	7,7	2	15,4	3	23,1	0	0	1	7,7	2	15,4	2	15,4	6	46,2
	TMS	4	30,8	6	***46,2**	10	76,9	0	0	7	53,8	3	23,1	3	23,1	2	15,4
	Total	5	38,5	8	61,5	13	100	0	0	8	61,5	5	38,5	5	38,5	8	61,5
Distance Between Well and Other Pollution Sources	MS	2	15,4	6	46,2	8	61,5	0	0	5	38,5	3	23,1	6	46,2	2	15,4
	TMS	3	23,1	2	15,4	5	38,5	0	0	3	23,1	2	15,4	5	38,5	0	0,0
	Total	5	38,5	8	61,5	13	100	0	0	8	61,5	5	38,5	11	84,6	2	15,4

Well construction aspects and distances from pollution sources were assessed to identify factors influencing well water quality other than the distance between wells and the river. The results of the assessment of well construction aspects and pollution source distances are described as follows.

Well Depth

The well depth aspect was considered compliant when the well depth exceeded 7 meters. Based on cross-tabulation results, 5 wells (38.4%) did not meet the depth requirement (<7 meters) and exceeded the Environmental Quality Standards (EQS) for TDS and nitrite parameters. Thus, well depth may be one of the contributing factors affecting well water quality in this study. Well depth can influence water quality through turbidity, pH, and temperature factors. Deeper wells may reduce the impact of surface contamination, such as surface water infiltration that can degrade water quality [11]. This finding is supported by a study conducted by Nadhila and Nuzlia (2021), which reported that well depth may influence nitrite presence, as shallow wells are more susceptible to surface contamination, including nitrite from agricultural activities or domestic waste [12].

Well Wall (Casing)
The well wall construction aspect in this study refers to the condition and depth of the well wall (casing) relative to the well opening. The well wall depth was considered compliant if the casing extended at least 3 meters below the floor surface and was cemented and watertight. The results showed that 6 wells (46.1%) did not meet the well wall depth requirement and exceeded the EQS for the TDS parameter, while 4 wells (30.8%) did not meet the requirement and exceeded the EQS for the color parameter. These findings indicate that well wall depth may be one of the factors influencing well water quality in this study. In contrast, most wells met the requirements for well wall condition, despite some exceeding EQS values, suggesting that wall condition alone was not sufficient to influence well water quality. These findings are supported by Raokhil et al. (2021), who reported that inadequate well wall depth can contribute to well water contamination (13). Proper wall depth and watertight cemented walls can prevent the intrusion of surface water contaminated by waste, pesticides, or other chemical substances.

Well Floor
The well floor aspect in this study refers to floor condition, shape, width, height, and slope. The results showed that floor width, height, and slope did not significantly influence well water quality, as most wells met the requirements and none exceeded EQS values for the four water quality parameters. However, regarding floor condition and shape, 5 wells (38.4%) did not meet the requirements and exceeded the EQS for TDS, while 4 wells (30.8%) did not meet the requirements and exceeded the EQS for color. Therefore, well floor condition and shape may contribute to well water quality in this study. These findings are supported by research conducted by M. Sari and Huljana (2019), which reported that non-watertight well floors may allow contamination of well water by groundwater containing dissolved solids (TDS) (14). Additionally, watertight well floors with a minimum width of 1 meter from the well edge can prevent the infiltration of contaminated groundwater into the well (15).

Distance Between Wells and Septic Tanks
The distance between wells and septic tanks was assessed based on a radius of less than 11 meters. This aspect was considered compliant when septic tanks were located more than 11 meters from wells. The results indicated that the distance between wells and septic tanks was not a significant factor affecting well water quality in this study, as most wells met the safe distance requirement despite some exceeding EQS values for several parameters.

Distance Between Wells and Domestic Wastewater Disposal Channels (SPAL)
The distance between wells and SPAL was considered compliant when the distance exceeded 11 meters. The results showed that 6 wells (46.15%) did not meet the requirement and exceeded the EQS for the TDS parameter. These findings indicate that the distance between wells and SPAL may be a factor influencing well water quality. This result is consistent with a study conducted by Amnan and Naelasari (2023), which reported that while 69% of dug wells in Telagawaru Village met construction requirements, 100% of SPAL conditions did not meet the standards (16). Physical water quality parameters such as odor, taste, and color indicated that 29% of wells had odor, 30.4% had taste issues, and 53.6% had color issues. Poor water quality was attributed to inadequate SPAL facilities.

Distance Between Wells and Other Pollution Sources
Other pollution sources assessed included livestock pens, landfills (TPA), and temporary waste disposal sites (TPS). Based on observations and interviews, 5 wells (38.4%) did not meet the minimum distance requirement from other pollution sources. Cross-tabulation analysis indicated that distances between wells and other pollution sources such as TPA/TPS and livestock pens were not significant factors affecting well water quality in this study. This may be due to the absence of such pollution sources near residential areas. Therefore, the

distance between wells and TPA/TPS or livestock pens did not influence well water quality in this study.

Table 5. Utilization of Well Water by the Community

Well Water Utilization	Yes		No		Total	
	n	%	n	%	n	%
Bathing, Washing, and Sanitation (MCK)	11	84,6	2	15,4	13	100
Cooking	8	61,5	5	38,5	13	100
Drinking Water	4	30,8	9	69,2	13	100

Based on the results presented in Table 5, the majority of residents in Raci Village, totaling 11 out of 13 respondents (84.6%), utilized well water for bathing, washing, and sanitation (MCK) purposes. In addition, community members also used well water for cooking and drinking (raw water), accompanied by the use of other clean water sources. Based on interview results, the alternative water source used by the community in addition to well water was the local piped water supply (PDAM). Several respondents reported not using well water for cooking and drinking due to complaints that the well water appeared colored, turbid, and occasionally emitted unpleasant odors when consumed.

According to the Regulation of the Minister of Health No. 2 of 2023, well water used as a source of clean water should be odorless, colorless, and tasteless to meet environmental health quality standards. Water that does not meet these criteria may indicate contamination or the presence of hazardous substances, which can negatively affect human health, including gastrointestinal diseases, skin infections, and internal organ disorders (17).

Table 6. Community Health Complaints

Health Complaints	n	%
Type of Health Disorder		
Diarrhea	2	15,4
Itching or Skin Irritation	1	7,7
Digestive Disorders	0	0
Nausea	0	0
Vomiting	0	0
No Health Complaints	10	84,6
Total	13	100

Based on the results presented in Table 6, diarrhea (15.4%) and itching/skin irritation (7.7%) were the health complaints experienced by community members that were indicated to be associated with the use and consumption of well water. Respondents reported that these health complaints occurred spontaneously, often within less than three hours after using or consuming well water. In addition, it was found that all respondents had been using well water for more than 10 years. Long-term use of wells without adequate protection may allow surface contaminants to infiltrate the well structure and contaminate the water. Studies conducted by Sartika et al. (2021) and Sunarsih et al. (2023) reported that well use for more than 10 years or over extended periods may increase the risk of contamination (18) (19).

The findings of this study are also supported by research conducted by Sumantri (2017), which indicated that communities consuming well water with high TDS and nitrite concentrations may experience health complaints such as diarrhea, nausea, vomiting, and itching or skin irritation. TDS in consumed well water may cause digestive disorders, including gastrointestinal problems, as well as skin conditions such as irritation and allergic reactions (21). This may occur because TDS contains excessive amounts of dissolved ions, such as sodium, potassium, calcium, and magnesium. Health effects associated with elevated nitrite levels in well water include methemoglobinemia in infants and young children (22). Nitrite can convert hemoglobin into methemoglobin, leading to impaired oxygen transport and respiratory disorders. In addition, high nitrite concentrations may cause diarrhea, nausea, and vomiting among vulnerable age groups that are sensitive to the type of food or beverages consumed.

CONCLUSIONS AND RECOMMENDATIONS

The quality of Raci River water based on Total Dissolved Solids (TDS), odor, and color parameters met the established environmental quality standards. However, based on phosphate and nitrite parameters, Raci River water exceeded the environmental quality standards at all three sampling points, both during morning and midday observations. Regarding community well water quality, eight wells exceeded the environmental quality standards for the TDS parameter, five wells exceeded the standards for color, two wells exceeded the standards for nitrite, and one well exhibited physical characteristics of odor. Well depth, well floor condition, well floor shape, and the distance between wells and domestic wastewater disposal channels (SPAL) were identified as factors influencing well water quality in this study.

Most residents of Raci Village utilized well water for bathing, washing, and sanitation purposes, while others used it for cooking and raw drinking water in combination with alternative clean water sources. The community also utilized piped water (PDAM) as an alternative clean water source in addition to well water. Diarrhea and itching or skin irritation were the health complaints experienced by the community as a result of using and consuming well water that exceeded environmental quality standards.

Based on these findings, it is recommended that local government authorities and the Environmental Agency enhance community education through socialization programs, environmental clean-up activities, and river care programs, as well as provide education on simple domestic wastewater filtration and management. Future research is recommended to employ analytical study designs, expand the spatial coverage of study locations, and include key microbiological parameters such as total coliform or other relevant indicators.

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