



## Analysis of River Water Quality Using The Pollution Index Method on the Batang Jujuhan River in Jambi Province

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#### Abstract

Rivers flowing through industrial areas are exposed to anthropogenic pressures that may degrade water quality and limit their capacity to receive additional pollutant inputs. The Batang Jujuhan River in Jambi Province flows through an industrial zone and is intensively used by local communities, making a quantitative assessment of its water quality status essential for effective river management. This study aims to evaluate the water quality status of the Batang Jujuhan River using the Pollution Index (PI) method and to estimate mixed pollutant concentrations at an industrial wastewater discharge point using a mass balance approach. Water samples were collected at upstream and downstream sections of the river and analyzed for physical, chemical, and biological parameters by an accredited laboratory, with results compared to Class II water quality standards based on Government Regulation No. 82 of 2001. The results show that Pollution Index values range from 0.7 to 0.9, indicating good water quality conditions at both locations. Mass balance analysis indicates that combined concentrations of key parameters, including COD, TSS, and oil and grease, remain below the applicable quality standards under observed river discharge conditions. These findings suggest that current pollutant inputs do not exceed regulatory thresholds and provide a quantitative baseline for water quality management in industrial river systems.

**Keywords:** Water, Quality Standards, Pollution, Rivers

#### INTRODUCTION

Increased anthropogenic activities, particularly from industrial and residential sectors, have placed significant pressure on surface water quality. Wastewater generated from these activities often contains organic matter, nutrients, and hazardous substances that can reduce water quality and disrupt aquatic ecosystems (Moiseenko, 2022). Rivers function as receiving bodies for wastewater discharge, making them

highly vulnerable to pollution accumulation, especially in areas experiencing intensive human activity (Rani et al., 2022).

The Batang Jujuhan River is one of the rivers in Jambi Province that is intensively utilized by local communities for daily activities while simultaneously receiving wastewater from surrounding industrial areas. The river flows throughout the year, with discharge characteristics influenced by seasonal

variations, which directly affect its natural dilution and self-purification capacity (Patri et al., 2024). Under such conditions, the balance between pollutant loads entering the river and its assimilation capacity becomes a critical factor in maintaining water quality.

Assessment of river water quality is a fundamental component of water resource management. This assessment is commonly conducted through measurements of physical, chemical, and biological parameters, which are subsequently compared with water quality standards according to designated water use classifications (Setiyowati, 2024). Based on Government Regulation of the Republic of Indonesia Number 82 of 2001, the Batang Jujuhan River is classified as Class II water. In addition, the Pollution Index method, as regulated by Minister of Environment Regulation Number 115 of 2003, provides a quantitative framework for determining overall water quality status.

Beyond water quality status, evaluation of a river's pollution load capacity is essential to determine its ability to receive pollutant inputs without exceeding established standards. Pollution load capacity analysis serves as an important basis for water pollution control and sustainable environmental management (Nugraha et al., 2022). However, quantitative studies that integrate Pollution Index analysis with pollutant mixing estimation using a mass balance approach remain limited for rivers in industrial areas of Jambi Province.

Therefore, this study aims to determine the water quality status of the Batang Jujuhan River using the Pollution Index method and to estimate mixed pollutant concentrations at the wastewater discharge point using a mass balance approach. The results of this study are expected to provide a scientific reference for river water quality management and pollution control

strategies in industrial river systems (Awfaa et al., 2024).

## **MATERIALS AND METHODS**

### **Tools and Materials**

Laboratory analysis of physical, chemical, and biological parameters, including TDS, TSS, BOD<sub>5</sub>, COD, DO, oil and grease, surfactants (MBAS), and coliform bacteria, was conducted at an environmental laboratory accredited by the National Accreditation Committee (KAN). All analyses followed applicable Indonesian National Standards (SNI) and APHA standard methods.

### **Sample Preparation**

River water sampling was conducted using a purposive sampling approach based on hydrological and environmental considerations. Sampling locations were selected to represent river conditions before and after receiving industrial wastewater input. Three sampling points were established: the industrial wastewater outlet (PT. X), the Batang Jujuhan River upstream of the discharge point, and the Batang Jujuhan River downstream of the discharge point. The selection of these points considered river discharge, current velocity, wet cross-sectional width, and estimated complete mixing distance between wastewater and river water.

Sampling was carried out using the grab sampling method in accordance with SNI 6989.57:2008 concerning surface water sampling. Water samples at upstream and downstream locations were collected at two lateral points (1/3 and 2/3 of river width) at a depth of 0.5 times the total water depth. This study represents a snapshot assessment conducted at a single sampling period; therefore, temporal variations in water quality due to seasonal changes were not evaluated and constitute a limitation of this study.

### **Determination of Pollution Index**

Based on Minister of Environment Regulation No. 115 of 2003 concerning Guidelines for Determining Water Quality Status, water quality status can be determined using the Storet method or the Pollution Index method. In determining the water quality status of the Batang Jujuhan River as a water source receiving wastewater from PT.X, the Pollution Index (PI) method was used.

**RESULTS AND DISCUSSION**

**River water sampling**

The river water samples collected in this study represent the water quality conditions at the time of sampling. The sampling was conducted using an instantaneous approach, so the results reflect the conditions at a specific

moment under certain hydrological and environmental circumstances. The measured water quality parameters only reflect short-term conditions and may not account for changes in river discharge, seasonal rainfall, or variations in pollutant inputs over time.

Despite this limitation, the sampling locations were chosen to represent both upstream and downstream conditions in relation to the industrial wastewater discharge point. The hydrological conditions observed during sampling, such as river discharge and flow conditions, validate the data's representativeness for assessing water quality and pollutant mixing under typical flow conditions. The results offer a solid foundation for evaluating the spatial impact of wastewater discharge on river water quality at the study site.

Table 1. *Flow Velocity of the Jujuhan River*

Location	Wet Cross-Section Width (m)	Depth (m)	Flow Velocity (m/s)	Debit (m <sup>3</sup> /s)
Upstream	200	4	0,05	39,9
Downstream	300	5	0,06	41,5

Based on the river flow velocity data, the discharge at the upstream section of the Batang Jujuhan River is 39.9 m<sup>3</sup>/s, and it increases to 41.5 m<sup>3</sup>/s downstream. The relatively high discharge indicates a strong dilution potential, which contributes to the river's ability to reduce pollutant concentrations after receiving wastewater inputs. The increase in discharge from upstream to downstream indicates the addition of flow from industrial effluent and other lateral inflows, affecting the mixing process and pollutant assimilation capacity. Under these hydrological conditions, pollutants entering the river

are likely to be diluted effectively, supporting the observed water quality results that remain within Class II standards. To ensure accurate measurements across the river cross-section under these flow conditions, water samples were collected at both upstream and downstream locations at two lateral points (1/3 and 2/3 of the river width) at a depth of 0.5 times the total water depth, following the guidelines of SNI 6989.57:2008. This sampling approach enhances the reliability of the reported water quality data related to discharge.



**River Water Quality**

To assess the water quality of the Jujuhan River, samples were collected both upstream and downstream of the wastewater discharge point. The tests

were conducted by an accredited environmental laboratory, and the data on the water quality of the Batang Jujuhan River is presented in Table 2.

Table 2. *Water Quality of the Batang Jujuhan River*

No	Parameter		Unit	Result		Class II Water Quality Standards (PPRI 82/2001)
				Upstream	Downstream	
1	Total Dissolved (TDS)	Solid	mg/L	46	45	1000
2	Total Suspended (TSS)	Solid	mg/L	26	24	50
3	pH		-	7,00	7,00	6-9
4	Biological Oxygen Demand (BOD <sub>5</sub> )		mg/L	2,83	2,42	3
5	Chemical Oxygen Demand (COD)		mg/L	11	9	25
6	Dissolve Oxygen (DO)		mg/L	4,89	4,35	Min 4
7	Oil and Grease		mg/L	< 2	< 2	1000
8	Surfactants (MBAS)		mg/L	< 0,03	< 0,03	0,2
9	Total Coliform		MPN/100 mL	230	170	5000
10	Fecal Coliform		MPN/100 mL	490	490	1000

Source: Laboratory Measurement Data, 2024

Table 2 shows variations in water quality parameters between the upstream and downstream sections of the Batang Jujuhan River, highlighting the impact of wastewater discharge. Although all measured parameters are within Class II water quality standards, variations in key indicators provide important information about anthropogenic pressure. The BOD<sub>5</sub> concentration at the upstream site is 2.83 mg/L, close to the regulatory limit of 3 mg/L, indicating the presence of organic matter before wastewater mixing. Following mixing, the BOD<sub>5</sub> value decreases to 2.42 mg/L, showing the impact of dilution during periods of high river discharge. A similar pattern is observed for COD and TSS, which show slight reductions downstream. In contrast, dissolved oxygen (DO) decreases from 4.89 mg/L upstream to 4.35 mg/L downstream, likely due to oxygen

consumption during the degradation of organic substances introduced by wastewater inputs. However, the DO concentration remains above the minimum standard, suggesting that the river’s reaeration capacity is sufficient under the observed flow conditions. These results show that although regulatory standards are not exceeded, there are subtle changes in parameter values indicating the impact of human activities. This influence may become more significant under lower discharge conditions.

**Analysis of water quality measurements in the Batang Jujuhan River**

Based on water quality measurement data for the Batang Jujuhan River and analyzed using the Pollution



Index method, the water quality status of the Batang Jujuhan River is as shown in Table 3 below.

Table 3. *Water Quality Status of the Batang Jujuhan River*

Pij Upstream	Pij Downstream	Evaluation of PI Value (Ministerial Decree No. 115 of 2003)	Water Quality Status
0,9	0,7	$0 \leq PI_j \leq 1,0$ : Good Condition	Good Condition
0,9	0,8	$1,0 < PI_j \leq 5,0$ : Light Polluted	
		$5,0 < PI_j \leq 10$ : Moderate Polluted	
		$PI_j > 10$ : Heavy Polluted	

Based on the Pollution Index results, the Batang Jujuhan River shows PI values of 0.9 at the upstream section and 0.8–0.7 at the downstream section of the wastewater discharge point from PT. X. These values indicate that the overall water quality condition of the river remains within the “good” category according to the Pollution Index classification. The slight decrease in PI values at the downstream section suggests that wastewater inputs do not result in a deterioration of overall water quality under the observed conditions. This outcome is closely related to the high river discharge, which reduces the relative contribution of pollutants through dilution. However, it should be noted that the Pollution Index method integrates multiple parameters into a single value, which may limit its

sensitivity in detecting small changes in individual water quality parameters.

Water pollution load capacity refers to the ability of a water body to receive pollutant inputs without causing a decline in water quality, while pollution load represents the quantity of pollutants contained in water or wastewater, as defined by KEPMENLH Number 110 of 2003. In this study, the mass balance method was applied to estimate the contribution of pollutants from PT. X’s wastewater to the Batang Jujuhan River. This approach considers the concentration and flow rate of both river water and wastewater effluent to estimate mixed concentrations after discharge. The method was used to evaluate whether pollutant inputs remain within acceptable limits under the observed hydrological conditions.

Table 4. *Results of Pollution Load Capacity Analysis Using the Mass Balance Method*

Parameter	Wastewater (Outlet)		River Water (Upstream)		Average Concentration	Class II Water Quality Standard (mg/L)	Note
	Result (mg/L)	Debit (m <sup>3</sup> /s)	Result (mg/L)	Debit (m <sup>3</sup> /s)			
COD	25		11		11,007	25	
TSS	16		26		26,004	50	
Oils and Fats	2,4	0,00029	0	39,9	0,001	1	Allowed
NH <sub>3</sub> N	2,32		0		0,001	(-)	

Note: The meaning of (-) indicates that for the class in question, the parameter is not required.



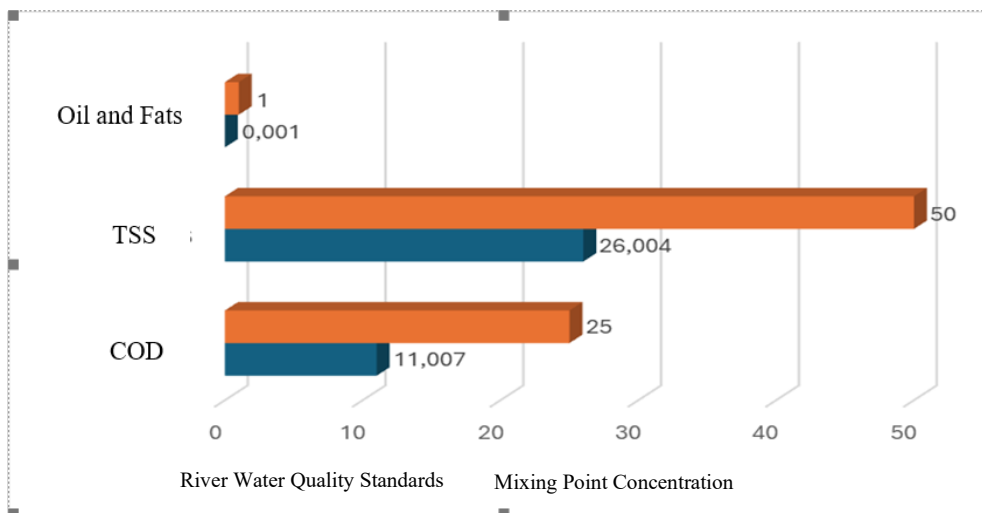


Figure 1. Batang Jujuhan River Water Quality Chart

Based on the mass balance results and graphical analysis, the concentrations of oil and grease, TSS, and COD at the mixing point between wastewater and river water do not exceed the Class II water quality standards. This condition is primarily influenced by the large difference between river discharge and wastewater flow, which results in a strong dilution effect. In addition, the rocky and uneven riverbed of the Batang Jujuhan River enhances water turbulence and reaeration, facilitating oxygen transfer from the atmosphere into the water column. This process supports the breakdown of organic substances and helps maintain dissolved oxygen levels, thereby contributing to the river's capacity to assimilate pollutant inputs under the observed flow conditions.

## CONCLUSION

Based on the study results, the water quality of the Batang Jujuhan River, assessed using the Pollution Index method, is classified as good. The Pollution Index values range from 0.9 in the upstream section to 0.7–0.8 in the downstream section. The slight decrease in Pollution Index values downstream indicates that industrial wastewater inputs from PT. X do not cause a

significant deterioration in overall water quality under the observed hydrological conditions, primarily due to the high river discharge that promotes effective dilution.

The mass balance approach applied in this study was used to estimate mixed pollutant concentrations after the wastewater discharge rather than to calculate pollution loads in units of mass per time. The results indicate that the total concentrations of COD, TSS, and oil and grease at the mixing point are within the Class II water quality standards set by Government Regulation No. 82 of 2001. This suggests that, at the time of sampling, the river can handle the current pollutant levels without surpassing the regulatory limits.

These findings suggest that water quality in the Batang Jujuhan River is significantly affected by river discharge and physical features that promote dilution and reaeration. Therefore, it is crucial to prioritize ongoing monitoring of river water quality, especially during periods of low flow, to maintain pollutant levels within acceptable limits and prevent potential degradation of water quality in the future.

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