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Utilizing Qual2Kw software to calculate the pollution load capacity of Ciliwung River Segment IV (Depok City)

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ABSTRACT

Situated in the administrative boundaries of West Java Province and DKI Jakarta Province, the Ciliwung River is a national river. Its river length is about 120 km, and its watershed area is about 425 km^3 (DAS). The population of Depok City is growing at a pace of 1.79% annually, which leads to a rise in the demand for food, clothing, and housing, among other necessities. As a result of the growth of various industrial and community residential buildings to accommodate human needs, wastewater discharge into rivers will increase and the amount of pollution entering the Ciliwung River may surpass its carrying capacity if efforts are not made to control water pollution. As a result, research must be done to ascertain Segment IV Depok City's Ciliwung River Pollutant Load Capacity utilizing a simulation model and Qual2Kw software. Primary data samples of the Ciliwung River's water and pollution sources that enter it were collected for this study, in addition to firsthand field observations. Data calibration is carried out after entering hydraulic and quality data into worksheets. In order to ensure that river flow data still satisfies class II river water quality standards, modeling is done utilizing the following sources: (1) existing data; (2) upstream data of class II river water quality standards; and (3) current conditions of river flow and trial & error pollutant source data. The findings indicated that the Ciliwung River section IV, Depok City, has a somewhat contaminated water quality. Pollutant loads for TSS and COD criteria can still be accommodated in Ciliwung River section IV, Depok City. In the meantime, the BOD criteria for carrying pollutant loads has been surpassed; therefore, to meet class II water quality regulations, the BOD pollutant load needs to be reduced by 22.58% to 37.50%.

ABSTRAK

Terletak di batas administratif Provinsi Jawa Barat dan Provinsi DKI Jakarta, Sungai Ciliwung merupakan sungai nasional. Panjang sungainya sekitar 120 km, dan luas daerah aliran sungainya sekitar 425 km^3 (DAS). Pertumbuhan penduduk Kota Depok sebesar 1,79% setiap tahunnya menyebabkan peningkatan permintaan terhadap pangan, sandang, papan, dan kebutuhan lainnya. Akibat tumbuhnya berbagai bangunan industri dan pemukiman masyarakat untuk menampung kebutuhan manusia, pembuangan air limbah ke sungai akan semakin meningkat dan jumlah pencemaran yang masuk ke Sungai Ciliwung dapat melampaui daya dukungnya apabila tidak dilakukan upaya pengendalian pencemaran air. Oleh karena itu, perlu dilakukan penelitian untuk memastikan Kapasitas Beban Pencemar Sungai Ciliwung Segmen IV Kota Depok dengan menggunakan model simulasi dan software Qual2Kw. Sampel data primer air Sungai Ciliwung dan sumber pencemaran yang masuk ke dalamnya dikumpulkan untuk penelitian ini, selain observasi lapangan secara langsung. Kalibrasi data dilakukan setelah memasukkan data hidrolik dan kualitas ke dalam lembar kerja. Untuk memastikan data debit sungai masih memenuhi baku mutu air sungai kelas II, pemodelan dilakukan dengan menggunakan sumber-sumber sebagai berikut: (1) data eksisting; (2) data hulu baku mutu air sungai kelas II; dan (3) kondisi aliran sungai terkini dan data sumber pencemar trial & error. Temuan menunjukkan bahwa Sungai Ciliwung seksi IV Kota Depok memiliki kualitas air yang agak tercemar. Beban pencemar kriteria TSS dan COD masih dapat tertampung di Sungai Ciliwung seksi IV Kota Depok. Sementara itu, kriteria BOD untuk memikul beban polutan telah terlampaui; Oleh karena itu, untuk memenuhi ketentuan mutu air kelas II maka beban pencemar BOD perlu diturunkan sebesar 22,58% menjadi 37,50%.

Keywords: *Ciliwung River, pollutant load, Qual2Kw, water quality*

INTRODUCTION

The river is a natural element that has an important role in various cultural features of a nation since ancient times. The potential availability of water, the fertility of the valley and other potentials become a magnet for humans to live around rivers. Their daily life cannot be separated from the use of the river in various ways including the engineering needed to utilize more of the potential that can be extracted from the river. (Mulyanto, 2018). Rivers have a very important role as natural resources that provide many benefits, but rivers can also pose a threat to the sustainability of human life. Various efforts made by humans make use of rivers and surrounding land such as agriculture, fisheries, irrigation, hydroelectric power, transportation and so on. Various efforts to safeguard against river hazards continue to be carried out for the welfare of mankind such as efforts to control floods, efforts to protect, prevent and deal with damage to facilities and infrastructure in river basins (Kumala, 2021).

Watershed (DAS) with a river length of ± 120 Km, the head of the Ciliwung River originates from Mandalawangi Lake on Mount Pangrango which is the peak area of Bogor Regency. The Ciliwung River flows from Puncak, Bogor Regency, crosses Bogor City, Bogor Regency, Depok City, South Jakarta, Central Jakarta and North Jakarta, empties into the Jakarta Bay. The Ministry of Environment and Forestry divides the Ciliwung watershed into 6 segments, namely segment 1 is upstream in Puncak Bogor Regency, segment 2 is in Bogor City, segment 3 is in Bogor Regency after passing through Bogor City, segment 4 is in Depok city, segment 5 located in South Jakarta City, and finally Segment 6 which is in Central Jakarta City and North Jakarta City. The increase in the population of Depok City with a growth rate of 1.79% per year based on data from Depok City in Figures 2023 from the Central Statistics Agency, this increase in population encouraging an increase in various needs for food, clothing, and boards so that various kinds of industries and residential houses emerge. The increasing number of industries and community houses around the Ciliwung watershed is expected to cause a pollution load on the Ciliwung River. The condition of the forest around the Ciliwung watershed which has decreased has also caused a lack of water absorption so that the river water discharge and its quality fluctuate.

Based on the background above, the problems in the research that the authors conducted identified the problems as follows:

1. The increase in population every year and the increase in development, human and industrial activities, the waste water discharged into water bodies / rivers is also increasing.
2. From data on the water quality status of the Ciliwung River Segment IV (Depok City) at the Onlimo Station of the Ministry of Environment and Forestry located in Depok Village, Pancoran Mas District, Depok City, it is known that the results of monitoring the water quality of the Ciliwung River have good fluctuations - slightly polluted.
3. Data on Pollution Load Capacity of Ciliwung River Segment 4 Depok City is not yet available using quality standards in accordance with Appendix VI Class II River Water Government Regulation Number 22 of 2021.

This study aims to determine the status of water quality, determine the pollutant load carrying capacity of the TSS, BOD, and COD parameters, and determine the allocation of pollutant load for the parameters TSS, BOD, and COD of the Ciliwung River Segment IV.

METHODS

Time and Location

Field observations and surface water sampling were carried out on March 7, 2023, located in the Ciliwung River segment IV, Depok City.

Tools and Materials

This study used sampling equipment and water sample testing directly or in an environmental laboratory. Data processing uses Qual2Kw Software version 5.1 and Google Earth Pro.

Sampling Methods

Primary data collection was carried out by direct observation and sampling in the Ciliwung River segment IV, Depok City, consisting of 5 points on the Ciliwung River and 2 points on tributaries as a source of pollutants entering the Ciliwung River.

Measurement Methods

The measurement method is carried out directly in the field and samples are also taken to be tested in an environmental laboratory. River distance measurement using Google Earth Pro software.

Experimental Design

This study uses descriptive quantitative research methods by collecting primary data, processing data and analyzing.

Stage of Research Activity

are then entered into the QUAL2Kw software *worksheet* with the following conditions:

1) Discharge data and quality of Ciliwung River segment IV Depok City are used as a reference for model simulation results.
2) Data on wastewater discharge entering the Ciliwung River segment IV, Depok City at point *sources* as input in *the point sources worksheet*.
3) Climatological data (air temperature, etc.) are used to determine climatic conditions along the Ciliwung River segment IV, Depok City.

The flow regarding the use of the QUAL2Kw software can be seen in Figure 1 and Figure 2 as follows:

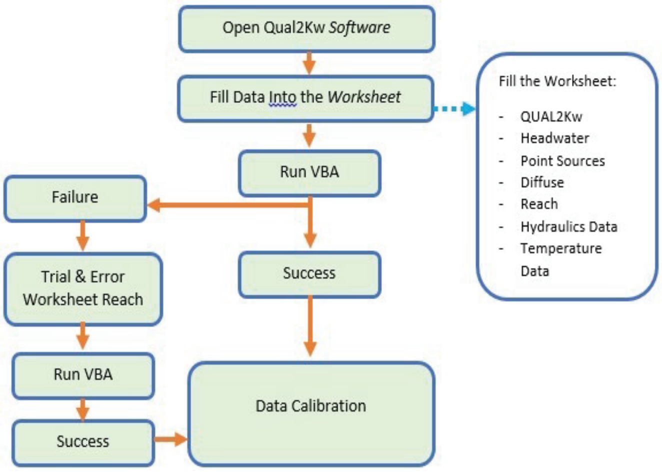

Figure 1. Use of QUAL2Kw in hydraulic data calibration.

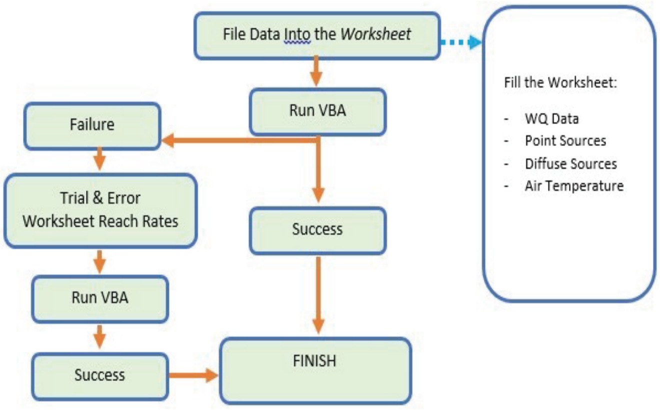

Figure 2. Use of QUAL2Kw in hydraulic data calibration.

Data Calculation and Analysis

The simulations in this study are divided into 3 simulations which will be used to obtain quality results and capacity according to the Ciliwung River Table 1. Based on Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management, that if the Government has not set water quality surface water bodies, class 2 quality standard attachment VI is used in Government Regulation Number 22 of 2021 concerning Implementation of Environmental Protection and Management. Based on this, the Ciliwung River quality simulation technique is adjusted to class 2 water quality standards.

Table 1. Data simulation techniques.

No	Condition	Source of Pollutants	River Water Conditions
1	Existing	Existing	Model
2	Grade 2 quality standard	No burden	Model
3	Existing	Model	Grade 2 quality standards

The simulation used in this study is as follows:

1. Simulation 1
   In simulation 1, data on upstream water conditions and uncertain pollutant sources such as domestic waste loads are categorized as non-point sources whose discharge amount is based on the number of residents as well as point sources of pollutant sources from drainage channels and streams coming out of the Ciliwung River whose waste is directly to water bodies using existing data.
2. Simulation 2
   In simulation 2, the upstream data is adjusted to class 2 water body quality standards, while no pollutant load is considered to enter the water body. This serves to determine the self-purification process and the capacity of the river because there is no pollutant load that reduces quality.
3. Simulation 3
   In simulation 3, data on the existing Ciliwung River was carried out by conducting trial and error on pollutant sources (point sources) with the aim that along the flow of the Ciliwung River quality must meet class II water quality standards. The result of this simulation is to obtain a model for the quality of the Ciliwung River maximum pollution load with class II water quality standards.

The data is analyzed by comparing the value of the maximum pollution load with the initial (existing) pollution load, the value of the difference is the allocation of the available pollution load or which must be reduced if the existing conditions have exceeded the pollutant load capacity.

RESULT AND DISCUSSION

Ciliwung River Flow Data Segment IV

Table 2. Name tag of sampling locations.

No	Sampling Point	Coordinate	Name/Tag
1	Bridge of Pondok Rajeg - Bojong Pondok Terong	S: 6 ^{O} 26' 44.90” E:106 ^{O} 48' 46,22”	Reach A
2	GDC Bridge	S: 6 O 24' 41.40” E:106 O 49' 07,40”	Reach b
3	Cikumpa Downstream (Point Source)	S: 6 O 24' 07.66” E:106 O 49' 51,20”	Point Source 1
4	Panus Bridge	S: 6 O 23' 02.80” E:106 O 49' 54,59”	Reach C
5	Juanda Bridge	S: 6 O 23' 43.06” E:106 O 50' 20.76”	Reach D
6	Sugutamu Downstream (Point Source)	S: 6 O 22' 34.95” E:106 O 50' 32,53”	Point Source 2
7	UI Access PAL Bridge	S: 6 O 21' 16.23” E:106 O 50' 09,11”	Reach E

This study will analyze data on the Ciliwung River segment 4 along 20.89 kilometers in Depok City, starting from the border of Depok City - Bogor Regency as the upstream segment 4 of the Ciliwung River to the border of Depok City - South Jakarta City as the downstream segment 4 of the Ciliwung River. To facilitate the naming in this study, the dot naming was carried out which can be seen in Table 2. While the division of the river flow can be seen in Table 3.

Table 3. Distribution of river flows.

No	Streams	Distance from Downstream (Km)	Water Level	
			Upstream	Downstream
1	Stream 1 (Reach A - Reach B)	20.89 - 13.62	105.00	85.00
2	Stream 2 (Reach B - Reach C)	13.62 - 11.07	85.00	77.50
3	Stream 3 (Reach C - Reach D)	11.07 - 6.27	77.50	65.00
4	Stream 4 (Reach D - Reach E)	6.27 - 0.00	65.00	55.00

The distribution of river flow as in table 3 can be seen visually in Figure 3.

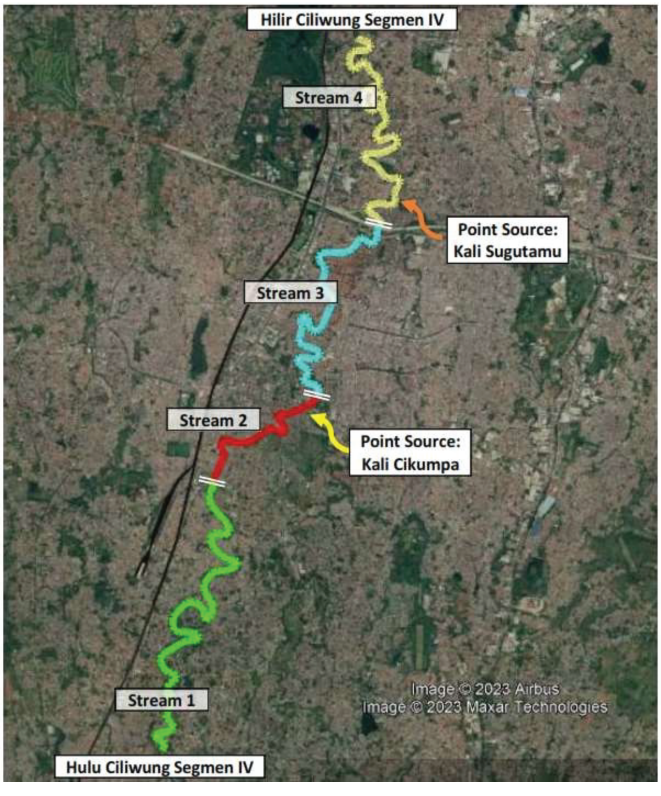

Figure 3. Distribution of the Ciliwung River Segment IV.

Description of Environmental Baseline for Research Locations

The environmental baseline provides an overview of the surrounding conditions and the condition of the river at the sampling points according to Table 3 on the Ciliwung River.

Reach point A, which is the upper reaches of the Ciliwung River segment IV, which is located between Pondok Rajeg Village and Bojong Pondok Terong Village, contains various types of plants. The riverbank area or commonly called the riverbank, around 50 to 150 meters, is filled with various kinds of plants which constitute a river buffer ecosystem to protect the river from landslides and other damage. The function of the riverbank ecosystem is to maintain the availability of groundwater, prevent flooding, windbreak, sediment catcher and as a partial cover of sunlight entering the river. The combination of humidity and atmospheric conditions makes it a comfortable place for various types of animals to breed. Plants found on the banks of the Ciliwung River include: bamboo trees, coconut trees, banana trees, melinjo trees, mango trees, breadfruit trees, kapok trees, as well as garden plants such as cassava and taro.

Reach point B is under the Grand Depok City (GDC) bridge, in this stream there are rocks in the middle of the river so that a natural aeration process occurs.

The banks of the river about 10 to 30 meters are covered with various types of trees, dominated by banbu trees on the banks of the river, besides that there are also kapok trees, coconut trees, banana trees and cassava. At this point there are still many long bamboo trees on the banks of the river which cover the banks of the river from the sunlight. The river water flow is quite clean, there is no garbage and the water looks quite clear. The GDC Bridge is a gathering place for the Ciliwung community and as a pier for rafting activities or river cruising using rubber boats which are usually carried out by the Ciliwung community together with the government or environmentalists.

Reach point C is under the Panus Bridge on the Iskandar Toll Road, at the sampling location on the bridge piers there is a water level gauge as an indicator of Jakarta's flood preparedness, which also has a monitoring post near the Panus Bridge. On the banks of the river near the Panus Bridge about 20 to 50 meters there are plants such as bamboo trees, kapok trees, coconut trees, banana trees, and jackfruit trees. At this point there are still many long bamboo trees on the banks of the river which cover the banks of the river from the sunlight. The water condition at this point looks still quite clear, but there is visible garbage stuck in the Panus bridge pillars.

Reach point D is under the Jalan Juanda toll bridge, with a riverbank of about 10 to 30 meters where various types of trees, especially bamboo, are grown, besides that there are also kapok trees, coconut trees, banana trees and various other gardens, as well as wild animals such as monitor lizards. At this point there are still many long bamboo trees on the banks of the river which cover the banks of the river from the sunlight. In this stream, the water is still quite clear. Under this bridge there is also a

Ciliwung community post and a wharf for rafting activities or river cruising.

Reach point E is under the PAL Access UI bridge, with a riverbank of about 10 to 20 meters where there are many residential areas on the riverbank. On the banks of the river are still dominated by bamboo trees, besides that there are also banana trees, kapok trees, and so on. On the bank of the river you can also see the life of yuyu (small crabs) and snakehead fish. At this point there are still long bamboo trees on the banks of the river which cover the banks of the stream from the sun.

Sampling Data and Test Results

Data from the sampling results can be seen in the Table 4.

Table 4. Field test results.

No	Sampling Point	Water Discharge (m^3/sec)	DO (mg/L)	Electrical Conductivity (µS/cm)	Air Temperature (°C)	Humidity (%)
1	Reach A	34,36	9,1	138.4	30,3	74
2	Reach b	48,20	8,4	151.0	30.5	71
3	Point Source 1	7,47	5,8	205.5	31,6	64
4	Reach C	57.85	9.0	156.8	31,2	66
5	Reach D	23.55	7,5	147,6	32,8	72
6	Point Source 2	2,26	6,6	348.9	32,1	69
7	Reach E	27,74	7,4	160.2	31,2	67

Table 5. Test results in the laboratory.

No	Sample	Temperature (°C)	TSS (mg/L)	pH	COD (mg/L)	BOD (mg/L)
1	Reach A	25.5	26,8	8.00	7,9	4,8
2	Reach b	25.0	18,4	7,73	14,7	9,2
3	Point Source 1	28.0	11,4	7,25	20,2	12.0
4	Reach C	26.0	24,7	7,42	7,2	4,2
5	Reach D	26.5	28,9	7,39	13,4	8,2
6	Point Source 2	30.0	18,4	7,44	18,7	11,2
7	Reach E	27.0	28,8	7,21	6,8	4.0

Table 6. Class II water quality standards based on Appendix IV PP RI No. 22/2021.

Name	Temperature (°C)	TSS (mg/L)	pH	DO (mg/L)	COD (mg/L)	BOD (mg/L)
Quality Standards Class II of River Water	-	50	6-9	4	25	3

Based on calculations using the Storet Method, the results show that the water quality status of segment IV Ciliwung River is lightly polluted.

Modeling using Qual2Kw software, the river water discharge model is obtained as follows.

Based on the Figure 4 from point 3 to point 4 there is a decrease in discharge, this happens because at that location there is surface water taking from the Ciliwung River as PDAM raw water.

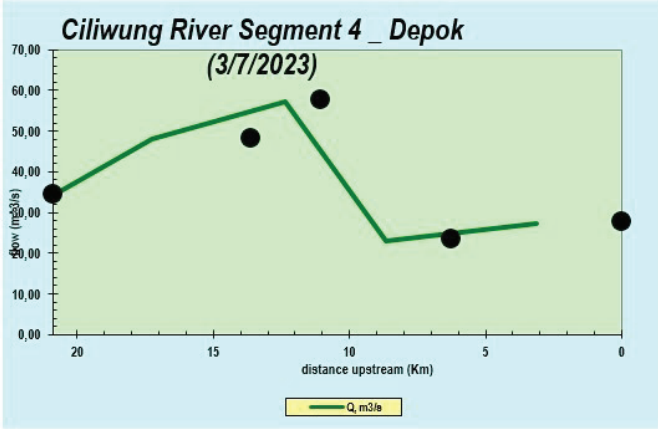

Figure 4. Results of river discharge model calibration.

Simulation 1

Based on the results of simulation 1, the graphs in Figure 5 to Figure 9 are obtained as follows:

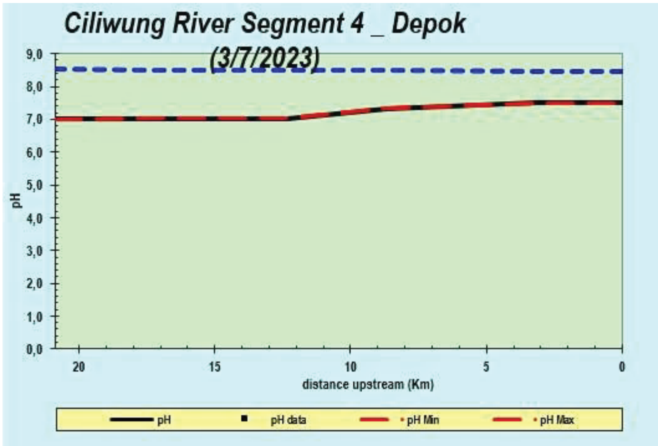

Figure 5. Graph of pH value (simulation1).

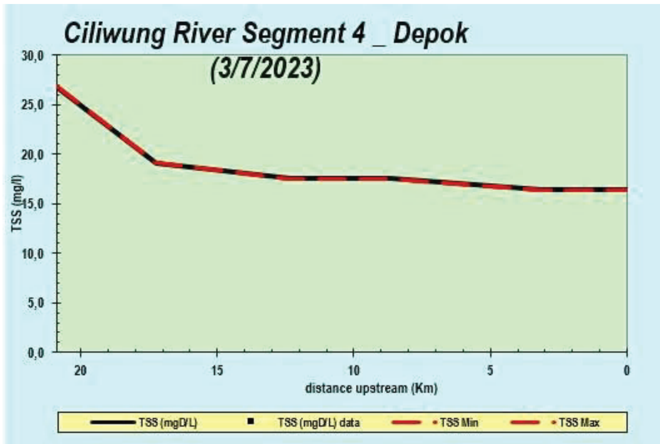

Figure 6. Graph of TSS values (simulation1).

In Figure 5 and Figure 6 it can be seen that the pH and TSS parameters meet the quality standards.

In Figure 7 it can be seen that the DO value meets the quality standard (DO value above 4 mg/l), but there is a DO value that exceeds the DO Saturated value. This can occur due to turbulence in the water during sampling.

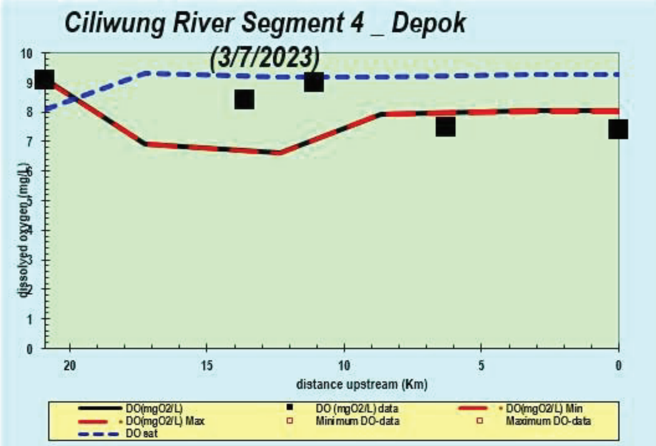

Figure 7. Graph of DO values (simulation 1).

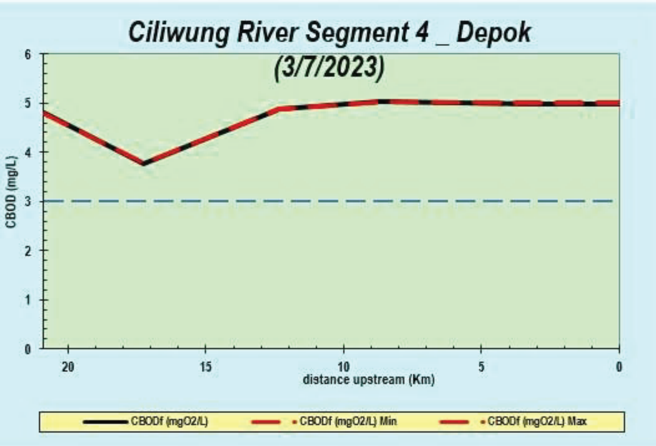

Figure 8. Graph BOD of values (simulation1).

The Figure 8 shows that the BOD value exceeds the quality standard, which is more than 3 mg/l. fluctuations occur due to pollutant loads that enter the river flow.

As for the COD value, based on Figure 9, it can be seen that the COD value fluctuates due to pollutant loads that enter the river flow, but the COD value still meets the quality standard, which is 30 mg/l.

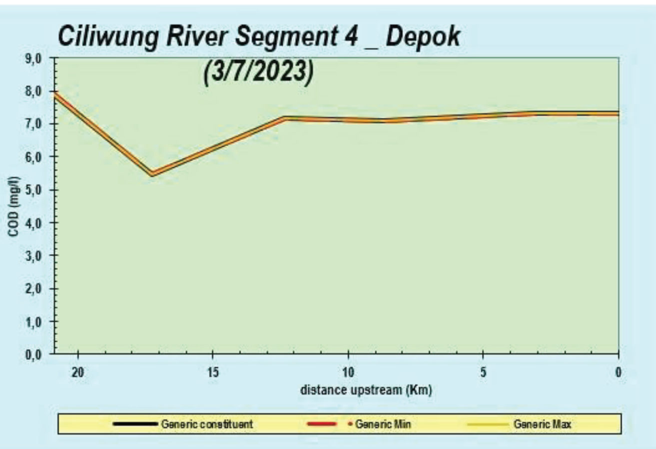

Figure 9. Graph of COD values (simulation1).

The results of simulation 1 obtained Water Quality Output data on the WQ Output sheet with the following Table 7.

Table 7. WQ output of simulation results 1.

STREAM	TSS (mgD/L)	DO (mgO2/L)	CBODf (mgO2/L)	COD (mgO2/L)
STREAMS 1	26.80	8.00	4.80	7.90
STREAMS 2	19.10	6.91	3.05	5.47
STREAMS 3	17.54	6.62	3.97	7.16
STREAMS 4	17.54	7.94	3.82	7.09
Terminus	16.37	8.03	3.13	7.30

Simulation 2

Based on the results of simulation 2, we get a graph like Figure 10 to Figure 12.

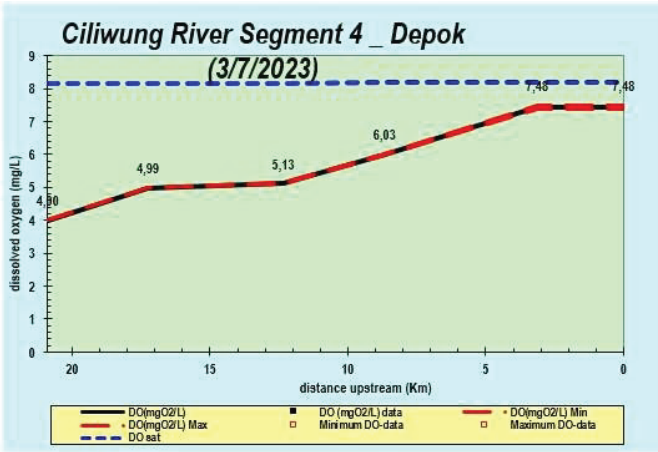

Figure 10. Graph of DO value (simulation 2).

Based on the Figure 10, it can be seen that in the absence of incoming pollutant loads, the DO value continues to increase close to the DO Saturated condition.

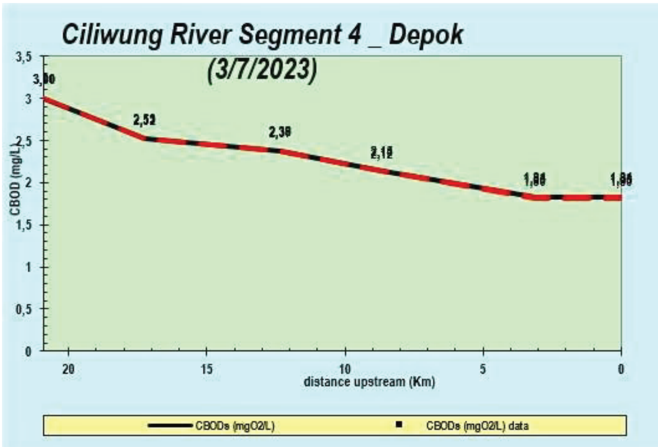

Figure 11. Graph of the BOD value (simulation 2).

Based on the Figure 11, it can be seen that in the absence of incoming pollutant loads, the BOD value will continue to decrease, this occurs due to the ability of water to *self-purify*. It can be calculated that the decrease in BOD levels along the Ciliwung River segment IV in Depok City is 38.67%.

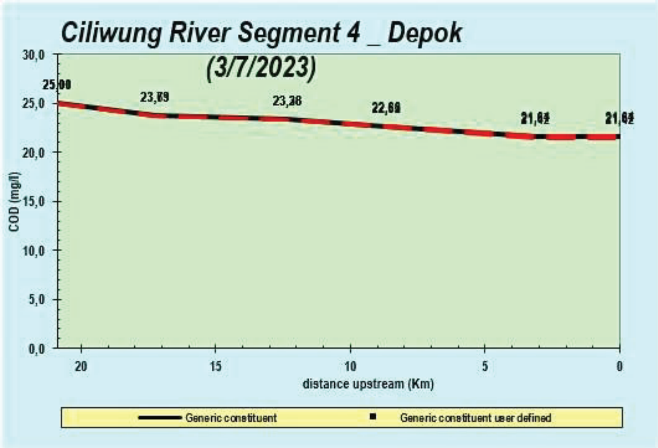

Figure 12. Graph of COD values (simulation 2).

As for the COD parameter, based on Figure 12, it can be seen that in the absence of incoming pollutant loads, the COD value will decrease and it can be calculated that the reduction in COD levels is 13.44%.

Simulation 3

Based on the results of simulation 3, the results are as follows:

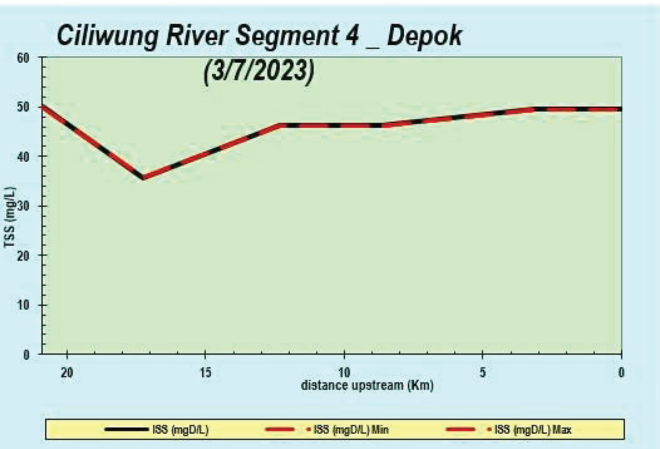

Figure 13. Graph of TSS values (simulation 3).

The Figure 13 is obtained based on *trial and error* of pollutant sources (*point sources*) where optimum conditions with the target of meeting class II water quality standards are obtained from the set point at point source 1 with a TSS concentration of 11.40 mg/l and point source 2 with a TSS concentration of 18. 40 mg/l.

Figure 14 is obtained based on *trial and error* of pollutant sources (*point sources*) where optimum conditions with the target of meeting class II water quality standards are obtained from the set point at point source 1 with a BOD concentration of 12 mg/l and point source 2 with a BOD concentration of 4 mg/l l.

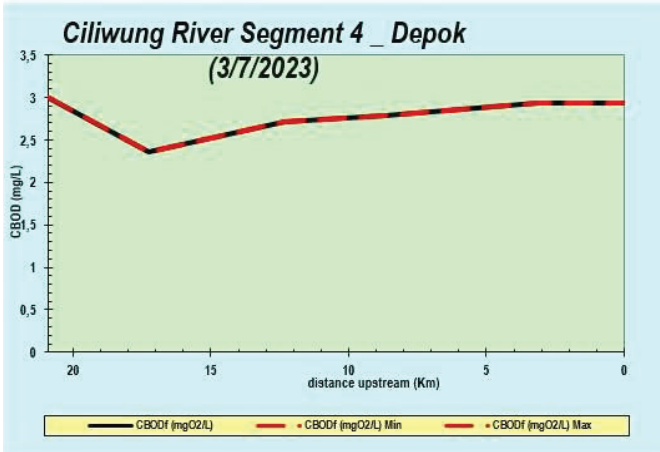

Figure 14. Graph of BOD value (simulation 3).

The simulation results for the COD parameter can be seen in the figure above obtained based on *trial and error* of pollutant sources (*point sources*) where the optimum conditions with the target of meeting class II water quality standards are obtained from the set point at point source 1, the COD concentration is 20.20 mg/l and point source 2 COD concentration of 18.70 mg/l.

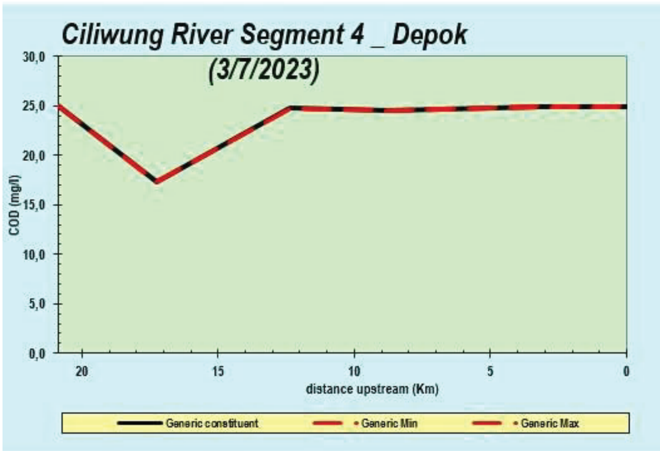

Figure 15. Graph of COD values (simulation 3).

Table 8. WQ output of simulation results 3.

STREAM	TSS (mgD/L)	DO (mgO2/L)	CBODf (mgO2/L)	COD (mgO2/L)
STREAMS 1	50.00	4.00	3.00	25.00
STREAMS 2	35.64	4.01	2.36	17.32
STREAMS 3	46.24	4.01	2.71	24.74
STREAMS 4	46.24	6.74	2.79	24.51
Terminus	49.50	7.56	2.93	24.88

Pollutant Load Capacity

Calculation of pollutant load carrying capacity using WQ Output simulation data 3 in Table 8, these results are the maximum concentrations that can be accommodated in river water flow with the target of meeting class II water quality standards, from these results to calculate the pollutant load capacity is calculated by the following formula:

Capacity Pollutant Load = Concentration x Discharge

Discharge data can be seen in Table 4, and for unit conversion in this calculation it is known that:
1 mg/second = 86.40 KG/day, so the calculation results for Pollutant Load Capacity are obtained in Table 9 as follows:

Table 9. Pollutant load capacity.

STREAM	debit (m^3/sec)	Distance (km)	TSS (kg/day)	BOD (kg/day)	COD (kg/day)
STREAMS 1	34,36	20.89 - 13.62	148435.20	8906.11	74217.60
STREAMS 2	48,20	13.62 - 11.07	148422.07	9828.17	72128.79
STREAMS 3	57.85	11.07 - 6.27	231118.62	13545.23	123656.46
STREAMS 4	23.55	6.27 - 0	94085.45	5676.87	49870.99

Pollutant Load Allocation

Calculation of pollutant load allocation using the results of simulation 1 and simulation 3, from these results it can be calculated the difference between the maximum pollutant load (simulation 3) and the pollution load of the existing initial conditions (simulation 1) in each Ciliwung River water flow with the following formula:

Pollutant Load Allocation = Maximum Pollutant Load - Existing Pollutant Load

Based on the results of Simulation 1 and Simulation 3 it can be seen that the Existing Pollutant Load can be seen in Table 9 and the Maximum Pollutant Load can be seen in Table 9, so that the concentration of pollutant load allocation can be calculated with the results shown in Table 10.

Table 10. Difference of WQ output of simulation 1 and simulation 3.

STREAM	Distance (km)	TSS (mgD/L)	CBODf (mgO2/L)	COD (mgO2/L)
STREAMS 1	20.89 - 13.62	23.20	-1.80	17.10
STREAMS 2	13.62 - 11.07	16.54	-0.69	11.85
STREAMS 3	11.07 - 6.27	28.70	-1.26	17.58
STREAMS 4	6.27 - 0	28.70	-1.03	17.42

The results above are concentrations that can still be accommodated in river water flow, from these results to calculate the allocation of pollutant loads is calculated using the following formula:

Allocatio of Pollutant Load = Concentration x Discharge

Discharge data can be seen in Table 4, and for unit conversion in this calculation it is known that:
1 mg/second = 86.40 KG/day, so the calculation results for Pollutant Load Capacity are obtained in Table 11.

Table 11. Allocation of pollutant loads.

STREAM	debit (m^3/sec)	Distance (km)	TSS (kg/day)	BOD (kg/day)	COD (kg/day)
STREAMS 1	34,36	20.89 - 13.62	68873.93	-5343.67	50764.84
STREAMS 2	38,2	13.62 - 11.07	68860.85	2865.65	49357.32
STREAMS 3	57.85	11.07 - 6.27	143441.96	6310.12	87876.04
STREAMS 4	23.55	6.27 - 0	58393.41	2103.94	35444.24

Based on the Table 10, it can be seen that the BOD parameter is negative (-) this indicates that the pollutant load capacity of the BOD parameter has been exceeded.

Water Pollution Control Strategy

Based on the calculation results of the pollutant load carrying capacity and load allocation, it can be seen that the pollutant load capacity of the Ciliwung River segment IV Depok City for the BOD parameter has been exceeded, so efforts are needed to reduce the pollutant load entering the Ciliwung River, especially the BOD parameter.

Strategies that can be carried out by the Government include:

1) Build a communal domestic wastewater treatment plant to treat domestic wastewater in the Ciliwung watershed area at various points where the flow empties into the Ciliwung River.
2) Relocating businesses and/or activities on the banks of the Ciliwung river into 1 location provided by the Government along with its wastewater treatment plant.
3) Returning the width of the river bank to its normal condition, which is 50 meters, and carrying out land acquisition that is in line with the river.
4) Make an inspection road on the bank of the river.
5) Conduct patrols and educate the public not to throw garbage into the river.
6) Installing CCTV cameras at several points on the Ciliwung River.
7) Doing greenery around the Ciliwung River.
8) Legal education and socialization related to water pollution control for business actors and the community.

CONCLUSION

Based on the results of the study it can be concluded that:

1. The water quality status of the Ciliwung River segment IV in Depok City is Lightly Contaminated.
2. Ciliwung River Pollution Load Capacity IV segment Depok City based on TSS, BOD and COD parameters with reference to class II river water quality, the following results are obtained:
   a) In Stream 1 (20.89 – 13.62 Km), with a discharge of 34.36 m3 / second, the pollutant load carrying capacity for the TSS parameter is 148,435.20 kg/day, the BOD parameter is 8,906.11 kg/day and the COD parameter is 74,217.60 kg/day.
   b) In Stream 2 (13.62 – 11.07 Km), with a discharge of 48.20 m3 / second, the pollutant load carrying capacity for the TSS parameter is 148,422.07 kg/day, the BOD parameter is 9828.17 kg/day and the COD parameter is 72,128.79 kg/day.
   c) At Stream 3 (11.07 – 6.27 Km), with a discharge of 57.85 m3 / sec, the pollutant load carrying capacity for the TSS parameter is 231,118.62 kg/day, the BOD parameter is 13,545.23 kg/day and the COD parameter is 123,656.46 kg/day.
   d) In Stream 4 (6.27 – 0 Km), with a discharge of 23.55 m3 / second, the pollutant load capacity for the TSS parameter is 94,085.45 kg/day, the BOD parameter is 5,676.87 kg/day and the COD parameter is 49,870.99 kg/day.
3. Allocation of Pollutant Load in Ciliwung River segment IV in Depok City based on TSS and COD parameters with reference to class II river water quality, the following results are obtained:
   a) In Stream 1 (20.89 – 13.62 Km), with a discharge of 34.36 m3 / second, the pollutant load allocation for the TSS parameter is 68,873.93 kg/day and the COD parameter is 50,764.84 kg/day.
   b) In Stream 2 (13.62 – 11.07 Km), with a discharge of 48.20 m3 / second, the pollutant load allocation for the TSS parameter is 68,860.85 kg/day and the COD parameter is 49,357.32 kg/day.
   c) In Stream 3 (11.07 – 6.27 Km), with a discharge of 57.85 m3 / second, the pollutant load allocation for the TSS parameter is 143,441.96 kg/day and the COD parameter is 87,876.04 kg/day.
   d) At Stream 4 (6.27 – 0 Km), with a discharge of 23.55 m3 / sec, the pollutant load carrying capacity for the TSS parameter is 58,393.41 kg/day and the COD parameter is 35,444.24 kg/day.

As for the BOD parameter, the pollutant load carrying capacity has been exceeded so that there is no longer any allocation of pollutant load, and efforts must be made to reduce the pollutant load for the BOD parameter as follows:

a) In Stream 1 (20.89 – 13.62 Km), with a discharge of 34.36 m3 / second, the excess pollutant load for the BOD parameter is 5,342.67 kg/day.
b) In Stream 2 (13.62 – 11.07 Km), with a discharge of 48.20 m3 / second, the excess pollutant load for the BOD parameter is 2,865.65 kg/day.
c) In Stream 3 (11.07 – 6.27 Km), with a discharge of 57.85 m3 / second, the excess pollutant load for the BOD parameter is 6,310.12 kg/day.
d) In Stream 4 (6.27 – 0 Km), with a discharge of 23.55 m3 / second, the excess pollutant load for the BOD parameter is 2,103.94 kg/day.

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