ANALYSIS OF PHYSICOCHEMICAL AND BACTERIOLOGICAL QUALITY (COLIFORM AND FECAL COLI) IN SEAWATER USING MOST PROBABLE NUMBER (MPN) METHOD AT PETITENGET BEACH AND BATU BOLONG BEACH FROM 2022 - 2023

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www.westerlakenfoundation.org
info@westerlakenfoundation.org

Author:
- Pande Ketut Cahya Krisnanta Arioka, S.Si.
  Coordinator of Marine Environment Program
- Ni Putu Gita Saraswati Palgunadi, S.KM
  Program Manager
- drh. Steven Yohanes Bogia
  Marine Vet
- Dr. Rodney Westerlaken, M.A., M.Si., M.Ed.
  Patron

Yayasan Westerlaken Alliance Indonesia

Deed of notary	:	Nyoman Oka SH., M.Kn, nomor 60 - 30 November 2015
Secretariat	:	Jalan Umalas I No. 3, Badung, Bali, Indonesia
Website	:	www.westerlakenfoundation.org
Email	:	info@westerlakenfoundation.org
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Foreword

It is within an urgent sense of responsibility that we present this conducting research. This study aims to analyze the physicochemical and bacteriological quality of seawater using the parameters Coliform and Fecal Coli, employing the Most Probable Number (MPN) method at two distinct locations, namely Petitenget Beach and Batu Bolong Beach from 2022 - 2023. We would like to express our heartfelt gratitude to all those who have provided support, assistance, and their valuable time during the course of this research endeavor.

Our sincere thanks go to Petitenget and Batu Bolong village government and local people for granting the opportunity and permission to conduct the research at the designated locations. We also extend our gratitude to our supervising faculty members, colleagues, and all those who have offered valuable insights and encouragement at every stage of this research.

We would also like to convey our genuine appreciation to our families and friends who have consistently provided moral support, encouragement, and opportunities for us to learn and grow in the field of research.

All the efforts we have put forth are intended to contribute positively to the advancement of knowledge and understanding regarding seawater quality. Perfection belongs only to God, and therefore, any limitations or shortcomings in this research are entirely our responsibility.

In conclusion, we hope that the findings of this research will provide new insights and a constructive contribution to both the scientific community and the wider society. We offer our heartfelt thanks for all the support and participation.

Denpasar, February 2024
Co-author,

YAYASAN WESTERLAKEN ALLIANCE INDONESIA

Pande Ketut Cahya Krisnanta Arioka, S.Si.
Coordinator of Marine Environment Program

Abstract

Petitenget and Batu Bolong beach are popular destinations for tourists. The types of waste that pose a threat to the river estuaries and sea waters originate from both tourism activities and households, indicated by waste from restaurants, bathrooms, laundry, and cleaning. This certainly leads to pollution in the sea waters. At the research location points, sea water samples of 250 ml each were collected using cleaned and sterilized containers. The collection of water samples was performed using the grab sample technique. Sampling was conducted at the same point once every week, starting from January 2022 until December 2023. Analysis of the physical quality of sea water was carried out by measuring Salinity, pH, Temperature, and Electrical Conductivity using a Multifunction Water Quality Tester. Microorganisms within the water samples were analyzed using the MPN (Most Probable Number) method. Bacteria were cultured in both Lactose Broth (LB) and Brilliant Green Lactose Broth (BGLB) media with three different concentrations. Microorganism growth was observed by the gas captured in Durham tubes. The microorganism concentration was then estimated using the MPN table. The results of this research indicated poor seawater quality of Petitenget and Batu Bolong Beach.

Keywords: Sea Water Quality, Physical, Coliform, Fecal Coli, MPN

Table of Contents

I. Introduction

1.1 Background

The Kerobokan region has rapidly developed into a tourist destination, particularly for beach tourism. Petitenget and Batu Bolong Beach is one of the beaches frequently visited by tourists. This area also serves as the estuary for several rivers in the Kerobokan area. Poor waste management by businesses and the community at large has resulted in the river estuary becoming a dumping ground for wastewater. The types of waste threatening the river estuary and the surrounding sea waters at Petitenget and Batu Bolong Beach stem from both tourism activities and households, including waste from restaurants, bathrooms/toilets, and laundry (Suyasa *et al.*, 2018). This situation undoubtedly leads to pollution in the sea waters at those beach. Pollution in a water body is closely related to the types and quantities of microorganisms present. One group of microorganisms often used as indicators of water pollution is the Coliform bacteria group (Nurdiana *et al.,* 2019).

In the months of April to June 2018, Suyasa *et al*. (2018) conducted research on the water quality at the river estuaries along Petitenget beach. This study revealed extremely poor water quality at the river estuaries surrounding Petitenget beach, particularly in terms of biological indicators. It was found that the Total Coliform Bacteria and Fecal Coliform in the river estuaries in the vicinity of Petitenget beach exceeded the standards for Class III water quality (water intended for freshwater fish cultivation, livestock, irrigation, and other uses requiring water of similar quality). Additionally, the pH value of the examined river estuary water had an average pH of 3.6. This value is highly acidic compared to the standard minimum pH requirement of 6 for river water quality. Consequently, the river estuaries around Petitenget beach can be categorized as severely polluted (Suyasa *et al*., 2018). With the high concentration of coliform and fecal coli bacteria in the river estuaries and the acidic pH value, the quality of sea water in the vicinity of Petitenget Beach is undoubtedly at risk. Polluted sea water will have negative ecological and health impacts, indirectly affecting the economy. Considering the significant impact of sea water quality on the ecological, health, economic, and tourism sectors in the Petitenget beach area, the researchers are motivated to conduct a study with the title, "Physical and Bacteriological Quality (Coliform and Fecal Coli) of Sea Water Using the Most Probable Number (MPN) Method at Petitenget Beach and Batu Bolong Beach."

1.2 Research Objectives

The objectives of this research are as follows:

1. To determine the physical quality of sea water at Petitenget and Batu Bolong Beach from 2022 - 2023.
2. To assess the bacteriological quality (Coliform and Fecal coli) of sea water at Petitenget and Batu Bolong Beach from 2022 - 2023.
3. To evaluate the suitability level of the physical and bacteriological sea water quality at Petitenget and Batu Bolong Beach from 2022 - 2023 based on the Sea Water Quality Standards.

II. LITERATURE REVIEW

2.1 Physical Properties of Water

2.1.1 pH

pH, the measure of acidity or alkalinity, reflects the concentration or activity of hydrogen ions in water. Generally, pH values indicate the degree of acidity or alkalinity of a water body. A pH value of 7 indicates neutrality, pH < 7 indicates acidic conditions, and pH > 7 indicates alkaline conditions (Effendi, 2003). The presence of carbonate, bicarbonate, and hydroxide ions increases water alkalinity. On the other hand, the presence of acids in free minerals and carbonic acid increases water acidity. Consistent with this notion, Mahida (1986) stated that industrial and household waste can influence water pH levels. pH values can affect the chemical speciation and toxicity of trace elements in water, such as toxic hydrogen sulfide (H2S), commonly found in polluted water and waters with low pH values (Mahida, 1986). In this study, pH measurement instruments used a pH meter. pH measurement is highly influenced by the temperature of the solution. Therefore, a temperature sensor (thermoprobe) is needed in the pH meter setup. The temperature reading is an input for pH calculation performed by the microprocessor (Day and Underwood, 2002).

2.1.2 Salinity

Salinity is often referred to as the salt content of seawater, although this is not entirely accurate as there is a distinction between the two. Salinity is defined as the weight in grams of all dissolved solids in one kilogram of seawater when all bromine and iodine are replaced by an equivalent amount of chlorine; all carbonate is converted to oxide, and all organic matter is oxidized. The salinity value is expressed in g/kg, commonly denoted as ‰ or ppt, which stands for parts per thousand. The salinity of seawater is approximately 0.14 ‰ less than the actual salt content present in seawater (Arief, 1984).

2.1.3 Water temperature

Temperature significantly influences processes occurring within water bodies. Wastewater temperature is usually higher than that of pure water. This is due to the biodegradation process that occurs in waste water, which involves microorganisms like bacteria and fungi and can cause temperature increases. Water temperature affects the rate of chemical reactions both in the environment and within aquatic organisms. Higher temperatures accelerate chemical reactions while causing gas concentrations, including oxygen levels in the water, to decrease. The temperature of an aquatic ecosystem is influenced by factors such as sunlight intensity, heat exchange between water and surrounding air, and geographic elevation (Letterman, 1999). Additionally, human activities such as warm wast,e water discharge from industrial cooling processes can influence water temperature. Factors affecting temperature distribution include heat flux, precipitation, river flow, and water circulation patterns (Hadi, 2007).

Water temperature observations are utilized to understand water conditions and the interactions between temperature and the health aspects of habitats and other aquatic organisms. Elevated water temperature can have several consequences: (1) reduced dissolved oxygen levels, (2) increased chemical reaction rates, (3) disruption of aquatic life, and (4) mortality if lethal temperature thresholds are surpassed (Fardiaz, 1992). In the realm of physics, temperature is a crucial factor regulating life processes and absorption in organisms, functioning within a relatively narrow temperature range. This range typically spans from 0°C to 4°C (Arthana, 2007). Normal water temperature refers to the range that allows living organisms to conduct metabolism and reproduce (Day and Underwood, 2002). Consequently, temperature is a crucial physical factor in aquatic environments.

2.2 Coliform bacteria and Fecal Coli

2.2.1 Coliform Bacteria

Coliform bacteria are aerobic and facultative anaerobic microorganisms that are gram-negative and rod-shaped. They do not form spores and can ferment lactose. Coliform bacteria can produce acid at temperatures between 35-37°C over 48 hours (Chandra, 2007). The presence of Coliform bacteria in water bodies can indicate organic waste contamination. The presence of Coliform bacteria can lead to an increase in pathogenic bacteria such as Vibrio cholerae, Salmonella, and Shigella (Askar et al., 2018). Coliform bacteria serve as indicators of fecal pollution and poor sanitation conditions in the environment or water. The presence of Coliform bacteria suggests the possible presence of enteropathogenic or toxigenic microorganisms that can be harmful if ingested (Irianto, 2013).

Coliform bacteria naturally inhabit warm-blooded animal digestive tracts as well as non-digestive environments like soil and water. Natural inhabitants of the digestive tract include Escherichia coli and species of Citrobacter, Enterobacter, Klebsiella, and Serratia. Bacteria other than E. coli can survive in soil or water longer than E. coli. Thus, the presence of Coliform bacteria in food or the environment does not always indicate contamination from feces; instead, it suggests inadequate processing or sanitation practices. Contamination levels vary greatly by region, often influenced by seasonal changes. Water is prone to microbial contamination during rainy seasons when water sources are high. Therefore, testing during rainy seasons is recommended, and the presence of Coliform bacteria indicates the contamination of tested water with organic material. Poor sewage systems or animal waste can act as sources of water contamination (Agrippina, 2019).

2.2.2 Fecal Coli Bacteria

Fecal Coli bacteria are a subset of total Coliform bacteria capable of fermenting lactose at 44.5°C. About 97% of Fecal Coli bacteria content consists of Escherichia coli and some Klebsiella species. Fecal Coli bacteria are frequently found in animal feces, making them suitable indicators of animal fecal contamination (Chandra, 2007). Excessive E. coli bacteria can cause diarrhea, and if these bacteria migrate to other body systems/organs, they can lead to infections. E. coli type O157:H7 is particularly dangerous, surviving at very low temperatures and in acidic conditions. An example of this is the E. coli outbreak in Germany in 2013-2014; while the exact strain remains unidentified, it is suspected to be O157:H7 (Sutiknowati, 2016).

2.3 Seawater Physicochemical and Bacteriology Quality Standards

Sea water quality standards are regulated by Bali Provincial Regulation No. 16 of 2016, as depicted in the figure below (Pemerintah Provinsi Bali, 2016).

BAKU MUTU AIR LAUT UNTUK PARIWISATA DAN REKREASI

(MANDI, RENANG DAN SELAM)

NO.	PARAMETER	SATUAN	KADAR MAKSIMUM
1	2	3	4
	FISIKA		
1	Warna	TCu	≤ 30
2	Kebauan		Alami[3]
3	Kecerahan[a]	m	≥ 30
4	Kekeruhan[a]	NTU	≤ 10
5	Padatan tersuspensi Total[b]	mg/L	≤ 20
6	Benda Terapung		Nihil[1(4)]
7	Lapisan minyak[5]		Nihil[1(5)]
8	Temperatur[c]	°C	26-30
	KIMIA		
9	pH[d]		6,5-8,5[(d)]
10	Salinitas[e]	$^0/_{00}$	alami[3(e)]
11	Oksigen terlarut (DO)	mg/L	≥ 5
12	BOD_5	mg/L	≤ 10
13	COD	mg/L	≤ 20
14	Amonia bebas (NH_3-N)	mg/L	Nihil[1]
15	Nitrat (NO_3-N)	mg/L	0,008
16	Sianida (CN)	mg/L	≤ 0,05
17	Sulfida (H_2S)	mg/L	Nihil[1]
18	Minyak Bumi	mg/L	Nihil[1]
19	Senyawa Fenol	mg/L	Nihil[1]
20	Pestisida organoklorin (DDT)	mg/L	Nihil[1]
21	Polikhorina ted bifenil (PCB)	mg/L	Nihil[1]
22	Surfaktan (detergen)	mg/L MBAS	Nihil[1]
23	Logam semi logam		
	- Raksa (Hg)	mg/L	≤ 0,0001
	- Krom heksavalen (Cr(VI))	mg/L	0,00004
	- Arsen (As)	mg/L	0,0026
	- Selenium (Se)	mg/L	0,00045
	- Cadmium (Cd)	mg/L	0,00002
	- Tembaga (Cu)	mg/L	0,008
	- Timbal (Pb)	mg/L	0,00002
	- Seng (Zn)	mg/L	0,002
	- Nikel (Ni)	mg/L	0,007
	- Perak (Ag)	mg/L	0,0004
	BIOLOGI		
24	Koli tinja	Sel/100 ml	Nihil[1]
25	Patogen	Sel/100 ml	Nihil[1]
26	Plankton	Individu	Tidak blooming[6]

Figure 1. Sea Water Quality Standards

2.4 *Most Probability Number* (MPN)

Microorganism counts can be performed using the Most Probable Number (MPN) method. The MPN method is a quantitative analysis technique used to determine the MPN of a target microorganism in a sample. This method involves inoculating samples into tubes containing culture media (da Silva et al., 2018). The MPN method calculates the lowest count of living microorganisms. This is done by inoculating samples into tubes containing liquid media with three different sample sizes or through dilution. The media used should support bacterial growth and yield positive results in each sample size or dilution after tube incubation (Adams et al., 2008). The principle of the MPN method is based on the quantity factor with microorganisms and the quantity factor without microorganisms. Estimates are made by calculating the probability of the original microorganism density in the sample, assuming that microorganisms are randomly distributed throughout the sample. Samples can be divided into liquid and solid types. Liquid samples do not require dilution, whereas solid samples require dilution. The first dilution of a solid sample immediately yields a quantity factor. The MPN method offers several advantages over the standard plate count method. The MPN technique is more sensitive than the plate count method, increasing detection flexibility. It is versatile and can identify several microorganism species using different culture media and incubation conditions. This technique is useful for detecting harmful microorganisms in food and assessing food safety standards based on microorganism counts (da Silva et al., 2018).

Cell counting is performed using the MPN technique, which consists of three tests: presumptive, confirmed, and completed tests. Various media are employed, including single and double Lactose Broth for the presumptive test, Brilliant Green Lactose Broth for the confirmed test, and EMB agar for the completed test (Krisnamurti, 2017).

III. RESEARCH METHODOLOGY

3.1 Research Design

This study employs an experimental approach using the Most Probable Number (MPN) method to calculate the quantities of Coliform and Fecal Coli bacteria in seawater at Petitenget Beach, Kerobokan Kelod and Batu Bolong Beach, Canggu, North Kuta, Badung Regency.

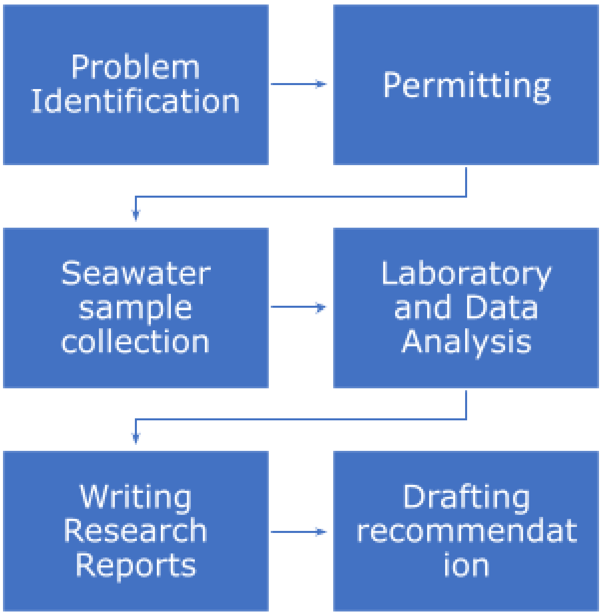

Figure 2. Research Design

3.2 Overview of Study Location and Research Schedule

The study's location is Petitenget beach at Jalan Petitenget, Kelurahan Kerobokan Kelod, Kecamatan Kuta Utara, Badung Regency, Bali. Another location is Batu Bolong beach on Jalan Pantai Batu Bolong, Kelurahan Canggu, Kecamatan Kuta Utara, Badung Regency, Bali. The points for water sampling are determined using the grab sampling technique.

The research activities will be conducted at:

1. Data collection will be carried out at Petitenget beach, Kerobokan Kelod, North Kuta, Badung Regency, and Batu Bolong beach at Kelurahan Canggu, Kecamatan Kuta Utara, Badung Regency.
2. Data analysis will take place at Yayasan Westerlaken Alliance Indonesia office located at Jalan Umalas I No. 3, Kerobokan Kelod, Badung Regency, 80361 and Jalan Pulau Moyo gang Telkom II no 8, Kecamatan Denpasar Selatan Bali.

The research activities can be see in this table below:

Table 1. Research Schedule

No	**Activities**	**Month**		
		1	**2-24**	**24**
1	Obtaining permits			
2	Preparation of tools and materials			
3	Sampling in the environment and laboratory analysis			
4	Data analysis			
5	Report writing			

3.3 Data Collection Technique

At each research location, a 250 ml sample of seawater is collected using pre-cleaned and sterilized containers. Water sampling is performed using the grab sample technique. Sampling will be conducted at the same point once every week, from January 2022 to December 2023. The total number of samples is detailed in the following table.

Table 2. Locations and Number of Samples

Location	**Water Samples**	**Total Samples**
Petitenget Beach	1 sample per week	89 samples
Batu Bolong Beach	1 sample per week	28 samples

3.4 Laboratory Analysis Method and Data Analysis

3.4.1 Analysis of Seawater Physical Quality

The analysis of seawater physical quality involves measuring Salinity, pH, Temperature, and Electro Conductivity. These four indicators are measured using a Multifunction Water Quality Tester. Results are recorded and subsequently summarized for data analysis purposes.

3.4.2 Coliform Microorganism Analysis (Most Probable Number - MPN)

Microorganisms in the water samples are cultivated in Lactose Broth (LB) and Brilliant Green Lactose Broth (BGLB) media with varying concentrations. Microorganism growth is assessed based on gas captured in Durham tubes. Microorganism concentrations are then estimated using the MPN table.

Equipment and Materials

a. 9 reaction tubes
b. 9 Durham tubes
c. Incubator
d. Sterile 10 and 1 ml pipettes
e. Ose needle
f. Spirit lamp
g. Water samples
h. Lactose Broth (LB)
i. Brilliant Green Lactose Broth (BGLB)
j. Cotton wool

Procedure

1. Presumptive Test

a. Place a Durham tube upside down in each tube.
b. Add double LB (26 g of LB dissolved in 1 liter of distilled water) to tubes 1-3, 5 ml each. Add single LB (13 g of LB dissolved in 1 liter of distilled water) to tubes 4-9, 10 ml each. Ensure no gas is trapped in the Durham tubes.
c. Seal with cotton wool and sterilize in an autoclave at 121°C for ± 15 minutes.
d. Heat the pipette with a spirit lamp, then transfer 10 ml of the water sample into tube no. 1. Work near the spirit lamp to prevent contamination. Repeat for tubes 2 and 3.
e. Add 1 ml of the water sample to tubes 4-6 and 0.1 ml to tubes 7-9.
f. Incubate all sample-containing tubes at 37°C for 2 x 24 hours.
g. Positive results are indicated by gas captured in the Durham tubes.
h. Coliform bacteria concentration is then determined by matching against the MPN table series 3.

nomor tabung yang positif			indeks MPN per 100 ml	95% batas kepercayaan	
10 ml	1 ml	0,1 ml		terendah	tertinggi
0	0	1	3	<0.5	9
0	1	0	3	<0.5	13
1	0	0	4	<0.5	20
1	0	1	7	1	21
1	1	0	7	1	23
1	1	1	11	3	36
1	2	0	11	3	36
2	0	0	9	1	36
2	0	1	14	3	37
2	1	0	15	3	44
2	1	1	20	7	89
2	2	0	21	4	47
2	2	1	28	10	150
3	0	0	23	4	120
3	0	1	39	7	130
3	0	2	64	15	380
3	1	0	43	7	210
3	1	1	75	14	230
3	1	2	120	30	380
3	2	0	93	15	380
3	2	1	150	30	440
3	2	2	210	35	470
3	3	0	240	36	1300
3	3	1	460	71	2400
3	3	2	1100	150	4800

Figure 3. MPN Table Series 3

2. Confirmative Test

a. Prepare 2 reaction tubes containing BGLB (40 g in 1 liter) and Durham tubes for each positive tube from the presumptive test. Label them 44°C and 37°C, respectively.
b. Heat the Ose needle with a spirit lamp, then transfer colonies from one positive tube to the two BGLB-containing tubes. Shake for homogeneity. Repeat for other positive tubes.
c. Incubate according to the labeled temperature for 2 x 24 hours.
d. Positive results in tubes incubated at 37°C indicate the presence of coliform, while positive results in tubes incubated at 44°C indicate the presence of fecal coli.

3.4.3 Research Data Analysis

After data collection and laboratory analysis, the data processing phase follows, consisting of the following stages.

1. Editing Data

Editing data is conducted to ensure that all data collected from each instrument is complete.

2. Data Analysis

Complete data is input into analysis software (Microsoft Excel and STATA) for further data analysis.

IV. RESULTS AND DISCUSSION

4.1 Physicochemical seawater properties of Petitenget and Batu Bolong Beach

Petitenget Beach is one of the beaches that serve as a recreational area for both domestic and international tourists. This beach has black sand with a flat coastline. The waves at Petitenget Beach are slightly big. According to Suyasa *et al*. (2018), the North Kuta and Kerobokan areas are the headwaters of four small rivers that flow into Petitenget Beach. The identified sources of pollution include hotels, restaurants, service activities/businesses, commerce, and settlements, so improper waste management efforts by the community can harm the river estuary and beach area.

Batu Bolong Beach is a picturesque and popular destination located on the island of Bali, Indonesia. Situated in the vibrant coastal town of Canggu, it is renowned for its stunning scenery, excellent surf breaks, and cultural significance. In January 2022, the beach faced some challenges regarding pollution, although the extent and severity might have varied over time. Some common types of pollution that could affect Batu Bolong Beach such as plastic pollution, marine debris, sewage and waste water, run off pollution, oil or chemical pollution. Addressing pollution requires coordinated efforts from government agencies, local communities and visitors.

Location	Parameter			
	Salinity (ppm)	Salinity (%)	pH	Temp (°C)
Petitenget Beach	1.300 – 3.120	1,3 – 3,12	6,53 – 7,08	25 – 33,5
Batu Bolong Beach	2.700 – 3.090	2,7 – 3,09	6,11 – 7,06	25,5 – 33

Table 3 Physicochemical properties of water samples collected from Petitenget and Mertasari Beach during January 2022 – December 2023

The physical and chemical properties of maximum allowable seawater levels are regulated within the Sea Water Quality Standards for Tourism and Recreation (Bathing, Swimming, and Diving) stipulated in the Bali Governor's Regulation No. 16 of 2016. Several parameters that are established in the mentioned regulation include salinity, pH, temperature, color, odor, and fecal coliform.

Table 3 indicates that salinity and pH values of the seawater at Petitenget Beach and Batu Bolong Beach are still within the normal range. However, the seawater temperature at Petitenget Beach and Batu Bolong Beach falls outside the normal temperature threshold of 26-30°C. Furthermore, the color and odor observed in the annexes on January 26, March 9, and April 6 revealed turbid conditions.

4.2 Coliform Bacterial Count in Seawater Samples of Petitenget and Batu Bolong Beach

Table 4 Coliform bacterial load in water samples collected from Petitenget and Batu Bolong Beach during January 2022 – April 2023

Location	Result (MPN/100 ml)	Standard*
Petitenget Beach	460 → 1100	0 (Pariwisata dan Rekreasi) 1000 (Biota Laut)
Batu Bolong Beach	> 1100	0 (Pariwisata dan Rekreasi) 1000 (Biota Laut)

**Pergub Bali No 16 tahun 2016 tentang Baku Mutu Lingkungan Hidup dan Kriteria Baku Kerusakan Lingkungan Hidup di Baku Mutu Air Laut untuk Biota Laut, Pariwisata, dan Rekreasi* (Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Criteria for Environmental Damage)

The presumptive results for coliform bacteria count in seawater samples taken from Petitenget Beach and Batu Bolong Beach ranged from 460 to >1100 MPN/100 ml. These results have exceeded the established standards for tourism and recreation, as outlined in Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Criteria for Environmental Damage.

The abundance of coliform bacteria is influenced by the high level of human activity and tourism in the vicinity of both the beaches and the rivers that flow into Petitenget and Batu Bolong Beaches (Askar *et al*. 2018; Suyasa *et al*. 2018). Improper disposal of domestic waste, including feces, urine, and other wastewater (from bathrooms, laundry, and kitchens), can lead to pollution and an elevation in pathogenic microorganisms in the water (Askar *et al*. 2018; Kusnoputranto 2000). Water pollution from organic waste can create a breeding ground for pathogenic microorganisms (Trisna 2018).

A high concentration of pathogenic microorganisms in the seawater of tourist beaches or swimming areas can pose a potential risk of waterborne disease transmission (Setyati *et al*. 2022). Exposure to seawater in areas contaminated with pathogenic microorganisms can increase the risk of gastrointestinal diseases, skin infections, and acute respiratory infections (Fleisher *et al*. 2010). Individuals in coastal tourism areas should take preventive measures such as practicing good personal hygiene and refraining from consuming seawater. (Setyati *et al*. 2022; Lee *et al*. 2017).

V. CONCLUSION

5.1 Conclusion

The conclusions drawn from this research are as follows:

1. It is evident that the physical quality of seawater at Petitenget Beach and Batu Bolong Beach did not comply with the established seawater quality standards outlined in Bali Provincial Regulation No. 16 of 2016.
1. The abundance of coliform bacteria in collected seawater samples from Petitenget Beach and Batu Bolong Beach indicated both beaches were contaminated with the potential pathogenic bacteria.
2. The assessment of physicochemical and bacteriological quality of seawater at Petitenget Beach and Batu Bolong Beach indicated poor water quality at both locations.

5.2 Suggestion

Seawater samples should be collected at distances of 0, 50, and 100 meters, respectively, in order to observe the differences in seawater quality at these distances. Furthermore, sample collection can be conducted along the entire coastline of Bali, employing the 'citizen science' principle, which involves assistance from the locals to gather samples and compensate them for their efforts.

REFERENCES

Adams, Martin R. & Moss, M.O., 2008. *Adams and Moss - Food Microbiology - 2007.pdf, Third. ed.* University of Surrey, Guildford.

Agrippina, F.D., 2019. Identifikasi Coliform dan Escherichia Coli Pada Air Minum Dalam Kemasan (AMDK) di Bandar Lampung. *J. Maj. Teknol. Agro Ind.* 11, 54–57.

Arief, D., 1984. Pengukuran Salinitas Air Laut Dan Peranannya Dalam Ilmu Kelautan. *Oseana IX*, 3–10.

Arthana, I.W., 2007. Studi Kualitas Air Beberapa Mata Air di Sekitar Bedugul, Bali (The Study of Water Quality of Springs Surrounding Bedugul, Bali). J*. Lingkung. Hidup Bumi Lestari* 7.

Askar, A.T., Agung, M.U.K., Andriani, Y., Yuliadi, L.P., 2018. The Abundance of Coliform Bacteria in Sea Water, Sediment and Foraminifera Type Calcarina In Coral Reef Ecosystem of Pramuka Island, Kepulauan Seribu, DKI Jakarta. *J. Akuatika Indones.* 3, 36–41.

Chandra, B., 2007. *Pengantar Kesehatan Lingkungan*. Jakarta: Penerbit Buku Kedokteran EGC

da Silva, N., Taniwaki, M.H., Junqueira, V.C.A., de Arruda Silveira, N.F., Okazaki, M.M., Gomes, R.A.R., 2018. *Microbiological Examination Methods of Food and Water.* Microbiol. Exam. Methods Food Water.

Day, R.A., Underwood, R.A., 2002. *Analisis Kimia Kuantitatif Edisi Keenam, Analisis Kimia Kuantitatif.* Jakarta: Erlangga.

Effendi, H., 2003. *Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan*. Jakarta: Penerbit Kanisius.

Fardiaz, S., 1992. *Polusi Air dan Udara.* Penerbit Kanisius, Yogyakarta.

Fleisher, J.M., Fleming, L.E., Solo-Gabriele, H.M., Kish, J.K., Sinigalliano. C.D., Plano, L., Elmir, S.M., Wang, J.D., Withum, K., Shibata, T., *et al.* 2010. The BEACHES study: health effects and exposures from non-point source microbial contaminants in subtropical recreational marine waters. *International Journal of Epidemiology*. 39(5), 1291-1298.

Hadi, A., 2007. *Prinsip Pengelolaan Pengambilan Sampel Lingkungan*. Jakarta: PT Gramedia Pustaka.

Irianto, K., 2013. *Mikrobiologi Medis Pencegahan Pangan Lingkungan.* Bandung: Alfabeta.

Krisnamurti, G.C., 2017. Penghitungan Jumlah Sel Bakteri dengan Metode Most Probable Number (MPN). *Pros. Semin. Nas. SIMBIOSIS II*, 329–341.

Kusnoputranto, H. 2000. *Air Limbah dan Ekskreta Manusia*. Jakarta: Direktorat Jenderal Pendidikan Tinggi.

Lee, J.L., Kim, I.H., Yeon, Y.J., Lee, J. 2017. Monitoring and analysis of bacterial communities during a summer season on Gyeongpo Beach. *Journal of Coastal Research*. 79(1), 249-253.

Letterman, R.D., 1999. *Water Quality and Treatment : A Handbook of Community Water Supplies, 5th ed. ed.* McGraw-Hill, New York.

Mahida, U.N., 1986. *Pencemaran Air dan Pemanfaatan Limbah Industri*. Jakarta: Rajawali Press.

Nurdiana, F., Julyantoro, P.G.S., Suryaningtyas, E.W., 2019. Kelimpahan Bakteri Coliform Pada Musim Kemarau di Perairan Laut Celukan Bawang , Provinsi Bali. *J. Trends Aquat. Sci*. II 1, 101–107.

Setyati, W.A., Pringgenies, D., Pamungkas, D.B.P., Suryono, C.A. 2022. Coliform Bacteria monitoring in the beach sand and sea water at the tourist site of Marina Beach and Baruna Beach. *Jurnal Kelautan Tropis.* 25(1), 113-120.

Sukawati, N.K.A., Restu, I.W., Saraswati, S.A. 2018. Sebaran dan struktur komunitas moluska di Pantai Mertasari, Kota Denpasar, Provinsi Bali. *Journal of Marine and Aquatic Sciences.* 4(1): 78-85.

Sutiknowati, L.I., 2016. Bioindikator Pencemar, Bakteri Escherichia coli. *J. Oseana* 41, 63–71.

Suyasa, W.B., Pancadewi G. A, S.K., Suprihatin, I.E., Adi Suastuti G. A., D., 2018. Kualitas Air Sungai Di Kawasan Wisata Pantai Petitenget, Kerobokan Kabupaten Badung Bali. *ECOTROPHIC J. Ilmu Lingkung. (Journal Environ. Sci*. 12, 226.

Trisna Y. 2018. Water quality and public health complaints around the Watoetoelis Sugar Mill. *Journal of Environmental Health.* 10(2): 220-230.

APPENDIX

Appendix 1. Activity Documentation

Figure 4. Seawater Sampling

Figure 5. Preparation of LB and BGLB Solutions with Distilled Water and Seawater

Figure 6. Laboratory Analysis Ready for Placement in the Incubator

Figure 7. Laboratory Analysis Results Showing Bubbles in Durham Tubes Indicating Coliform and Fecal Coli Bacteria

Appendix 2. Physicochemical seawater properties of Petitenget Beach

Table 5 Physicochemical properties of seawater samples collected from Petitenget Beach during January 2022 – December 2023

Date	**Parameter**					
	Salinity (ppm)	**Salinity (%)**	**pH**	**Temp (°C)**	**Color**	**Smell**
26 Jan 2022	2960	2,96	7,00	32,3	Turbid	Natural
2 Feb 2022	2850	2,85	6,91	33,5	Clear	Natural
9 Feb 2022	3040	3,04	7,02	30,9	Clear	Natural
16 Feb 2022	2890	2,89	6,99	30,9	Clear	Natural
23 Feb 2022	2960	2,96	7,04	28,3	Clear	Natural
2 Mar 2022	3120	3,12	6,99	30,1	Clear	Natural
9 Mar 2022	3090	3,09	6,98	30,4	Clear	Natural
16 Mar 2022	3000	3,00	6,98	33,0	Clear	Natural
23 Mar 2022	2980	2,98	7,02	30,6	Clear	Natural
30 Mar 2022	2940	2,94	7,06	32,1	Clear	Natural
6 Apr 2022	3000	3,00	7,04	30,2	Clear	Natural
13 Apr 2022	2990	2,99	7,00	32,8	Clear	Natural
20 Apr 2022	2780	2,78	7,08	29,8	Clear	Natural
27 Apr 2022	1300	1,30	6,61	26,3	Clear	Natural
4 May 2022	2690	2,69	6,62	27,7	Clear	Natural
11 May 2022	2940	2,94	6,53	28,7	Clear	Natural
18 May 2022	2790	2,79	6,92	29,5	Clear	Natural
25 May 2022	2786	2,78	6,92	29,6	Clear	Natural
1 Jun 2022	2880	2,88	6,98	30,1	Clear	Natural
31 Aug 2022	2890	2,89	6,90	30,2	Clear	Natural
7 Sep 2022	2860	2,86	6,95	28,5	Clear	Natural
14 Sep 2022	2990	2,99	6,90	25,0	Clear	Natural
21 Sep 2022	2870	2,87	6,95	26,1	Clear	Natural
28 Sep 2022	2940	2,94	6,95	26,9	Clear	Natural
5 Oct 2022	2940	2,94	6,99	25,6	Clear	Natural
12 Oct 2022	3030	3,03	7,01	26,8	Clear	Natural
19 Oct 2022	2860	2,86	6,94	27,0	Clear	Natural
26 Oct 2022	2850	2,85	6,89	25,5	Clear	Natural
2 Nov 2022	2990	2,99	6,99	27,7	Clear	Natural
9 Nov 2022	2870	2,87	6,80	26,6	Clear	Natural
16 Nov 2022	3010	3,01	7,01	25,6	Clear	Natural
23 Nov 2022	2980	2,98	6,98	28,5	Clear	Natural
30 Nov 2022	2880	2,88	6,95	27,3	Clear	Natural
7 Dec 2022	3020	3,02	7,02	27,3	Clear	Natural
14 Dec 2022	2950	2,95	7,04	25,3	Clear	Natural
21 Dec 2022	3040	3,04	6,71	25,7	Clear	Natural
28 Dec 2022	2980	2,98	7,01	26,4	Clear	Natural
4 Jan 2023	2770	2,70	6,69	28,3	Clear	Natural
11 Jan 2023	2910	2,91	7,00	28,1	Clear	Natural

18 Jan 2023	2880	2,88	6,95	27,3	Clear	Natural
25 Jan 2023	2890	2,89	6,92	27,8	Clear	Natural
1 Feb 2023	3020	3,02	6,98	28,2	Clear	Natural
8 Feb 2023	3000	3,00	7,03	28,1	Turbid	Natural
15 Feb 2023	2680	2,68	6,94	26,1	Clear	Natural
22 Feb 2023	2800	2,80	6,83	26,3	Clear	Natural
1 Mar 2023	2740	2,74	6,65	28,2	Clear	Natural
8 Mar 2023	2980	2,98	6,87	28,9	Clear	Natural
15 Mar 2023	3030	3,03	7,03	26,8	Clear	Natural
22 Mar 2023	2800	2,80	6,95	27,0	Clear	Natural
29 Mar 2023	2940	2,94	6,90	25,5	Clear	Natural
5 Apr 2023	2820	2,82	6,91	27,7	Clear	Natural
12 Apr 2023	2940	2,94	7,01	27,1	Clear	Natural
19 Apr 2023	3050	3,05	6,90	27,3	Clear	Natural
26 Apr 2023	2940	2,94	7,04	25,6	Clear	Natural
3 May 2023	2940	2,94	6,90	27,6	Clear	Natural
10 May 2023	3000	3,00	6,98	27,7	Clear	Natural
17 May 2023	3010	3,01	7,01	27,8	Clear	Natural
24 May 2023	2840	2,84	6,79	27,1	Clear	Natural
31 May 2023	3020	3,02	6,90	27,3	Clear	Natural
7 Jun 2023	3030	3,03	6,78	25,6	Clear	Natural
14 Jun 2023	3000	3,00	6,81	25,8	Clear	Natural
21 Jun 2023	2950	2,95	6,86	26,4	Clear	Natural
28 Jun 2023	2930	2,93	6,91	32,8	Clear	Natural
5 Jul 2023	2800	2,80	6,96	29,9	Clear	Natural
12 Jul 2023	2820	2,82	6,99	31,1	Clear	Natural
19 Jul 2023	2990	2,99	6,99	27,7	Clear	Natural
26 Jul 2023	2870	2,87	6,80	26,6	Clear	Natural
2 Aug 2023	3010	3,01	7,01	25,6	Clear	Natural
9 Aug 2023	2870	2,87	6,95	26,1	Clear	Natural
16 Aug 2023	3000	3,00	7,04	30,2	Clear	Natural
23 Aug 2023	3010	3,01	7,01	27,8	Clear	Natural
30 Aug 2023	3070	3,07	6,57	27,3	Clear	Natural
6 Sep 2023	2690	2,26	6,62	27,7	Clear	Natural
13 Sep 2023	2940	0,31	6,53	28,7	Clear	Natural
20 Sep 2023	3000	0,77	6,62	29,7	Clear	Natural
27 Sep 2023	2800	2,80	6,88	27,1	Clear	Natural
4 Oct 2023	3090	3,09	6,98	30,4	Clear	Natural
11 Oct 2023	3000	3,00	6,98	33,0	Clear	Natural
18 Oct 2023	2870	2,87	7,00	27,8	Clear	Natural
25 Oct 2023	2950	2,95	6,84	26,4	Clear	Natural
1 Nov 2023	2700	2,7	6,69	28,3	Clear	Natural
8 Nov 2023	2760	2,76	7,01	30,2	Clear	Natural

15 Nov 2023	2950	2,95	6,54	32,8	Clear	Natural
22 Nov 2023	2810	2,81	6,64	27,4	Clear	Natural
29 Nov 2023	2760	2,76	6,70	28,2	Clear	Natural
6 Dec 2023	3100	3,10	6,98	30,4	Clear	Natural
13 Dec 2023	2880	2,88	6,66	32,2	Clear	Natural
20 Dec 2023	2890	2,89	7,03	28,6	Clear	Natural
27 Dec 2023	2990	2,99	6,84	27,6	Clear	Natural

Appendix 3. Physicochemical seawater properties of Batu Bolong Beach

Table 6 Physicochemical properties of seawater samples collected from Batu Bolong Beach during June 2023 – December 2023

Date	Parameter					
	Salinity (ppm)	Salinity (%)	pH	Temp (°C)	Color	Smell
21 Jun 2023	2950	2,95	6,84	26,4	Clear	Natural
28 Jun 2023	2990	2,99	6,90	25	Clear	Natural
5 Jul 2022	2870	2,87	6,95	26,1	Clear	Natural
12 Jul 2022	2990	2,99	6,99	27,7	Clear	Natural
19 Jul 2022	2940	2,94	6,99	25,6	Clear	Natural
26 Jul 2022	3030	3,03	7,01	26,8	Clear	Natural
2 Aug 2022	3030	3,03	7,03	26,8	Clear	Natural
9 Aug 2022	3090	3,09	6,98	30,4	Clear	Natural
16 Aug 2022	3000	3,00	6,98	33	Clear	Natural
23 Aug 2022	2940	2,94	7,06	32,1	Clear	Natural
30 Aug 2022	2940	2,94	6,11	27,9	Clear	Natural
6 Sep 2022	2850	2,85	6,89	25,5	Clear	Natural
13 Sep 2022	2990	2,99	6,99	27,7	Clear	Natural
20 Sep 2022	2870	2,87	6,80	26,6	Clear	Natural
27 Sep 2022	3010	3,01	7,01	25,6	Clear	Natural
4 Oct 2023	2980	2,98	6,98	28,5	Clear	Natural
11 Oct 2023	2880	2,88	6,95	27,3	Clear	Natural
18 Oct 2023	3020	3,02	7,02	27,3	Clear	Natural
25 Oct 2023	2900	3,00	7,00	26,4	Clear	Natural
1 Nov 2023	2700	2,70	6,69	28,3	Clear	Natural
8 Nov 2023	2690	2,69	6,62	27,7	Clear	Natural
15 Nov 2023	2940	2,94	6,53	28,7	Clear	Natural
22 Nov 2023	2790	2,79	6,92	29,5	Clear	Natural
29 Nov 2023	2786	2,78	6,92	29,6	Clear	Natural
6 Dec 2023	3050	3,05	7,02	25,6	Clear	Natural
13 Dec 2023	2960	2,96	6,14	25,8	Clear	Natural
20 Dec 2023	2780	2,78	6,96	26,4	Clear	Natural
27 Dec 2023	3070	3,07	7,00	32,8	Clear	Natural

Appendix 4. Presumptive coliform count from seawater of Petitenget Beach

Table 7 Presumptive coliform count in seawater collected from Petitenget Beach during Jan 2022 – December 2023

Date	Result			Result (MPN/100 ml)	Standard*
	10^1	10^0	10^{-1}		
26 Jan 2022	3/3	3/3	3/3	>1100	1000
2 Feb 2022	2/3	3/3	3/3	1100	1000
9 Feb 2022	3/3	3/3	3/3	>1100	1000
16 Feb 2022	3/3	3/3	3/3	>1100	1000
23 Feb 2022	3/3	3/3	3/3	>1100	1000
2 Mar 2022	3/3	3/3	3/3	>1100	1000
9 Mar 2022	1/3	3/3	3/3	460	1000
16 Mar 2022	3/3	3/3	3/3	>1100	1000
23 Mar 2022	3/3	3/3	3/3	>1100	1000
30 Mar 2022	3/3	3/3	3/3	>1100	1000
6 Apr 2022	3/3	3/3	3/3	>1100	1000
13 Apr 2022	3/3	3/3	3/3	>1100	1000
23 Apr 2022	3/3	3/3	3/3	>1100	1000
20 Apr 2022	3/3	3/3	3/3	>1100	1000
27 Apr 2022	3/3	3/3	3/3	>1100	1000
4 May 2022	3/3	3/3	3/3	>1100	1000
11 May 2022	3/3	3/3	3/3	>1100	1000
18 May 2022	3/3	3/3	3/3	>1100	1000
25 May 2022	3/3	3/3	3/3	>1100	1000
1 Jun 2022	3/3	3/3	3/3	>1100	1000
31 Aug 2022	3/3	3/3	3/3	>1100	1000
7 Sep 2022	3/3	3/3	3/3	>1100	1000
14 Sep 2022	3/3	3/3	3/3	>1100	1000
21 Sep 2022	3/3	3/3	3/3	>1100	1000
28 Sep 2022	3/3	3/3	3/3	>1100	1000
5 Oct 2022	3/3	3/3	3/3	>1100	1000
12 Oct 2022	3/3	3/3	3/3	>1100	1000
19 Oct 2022	3/3	3/3	3/3	>1100	1000
26 Oct 2022	3/3	3/3	3/3	>1100	1000
2 Nov 2022	3/3	3/3	3/3	>1100	1000
9 Nov 2022	3/3	3/3	3/3	>1100	1000
16 Nov 2022	3/3	3/3	3/3	>1100	1000
23 Nov 2022	3/3	3/3	3/3	>1100	1000
30 Nov 2022	3/3	3/3	3/3	>1100	1000
7 Dec 2022	3/3	3/3	3/3	>1100	1000
14 Dec 2022	3/3	3/3	3/3	>1100	1000

21 Dec 2022	3/3	3/3	3/3	>1100	1000
28 Dec 2022	3/3	3/3	3/3	>1100	1000
4 Jan 2023	3/3	3/3	3/3	>1100	1000
11 Jan 2023	3/3	3/3	3/3	>1100	1000
18 Jan 2023	3/3	3/3	3/3	>1100	1000
25 Jan 2023	3/3	3/3	3/3	>1100	1000
1 Feb 2023	3/3	3/3	3/3	>1100	1000
8 Feb 2023	3/3	3/3	3/3	>1100	1000
15 Feb 2023	3/3	3/3	3/3	>1100	1000
22 Feb 2022	3/3	3/3	3/3	>1100	1000
1 Mar 2023	3/3	3/3	3/3	>1100	1000
8 Mar 2023	3/3	3/3	3/3	>1100	1000
15 Mar 2023	3/3	3/3	3/3	>1100	1000
22 Mar 2023	3/3	3/3	3/3	>1100	1000
29 Mar 2023	3/3	3/3	3/3	>1100	1000
5 Apr 2023	3/3	3/3	3/3	>1100	1000
12 Apr 2023	3/3	3/3	3/3	>1100	1000
19 Apr 2023	3/3	3/3	3/3	>1100	1000
26 Apr 2023	3/3	3/3	3/3	>1100	1000
3 May 2023	3/3	3/3	3/3	>1100	1000
10 May 2023	3/3	3/3	3/3	>1100	1000
17 May 2023	3/3	3/3	3/3	>1100	1000
24 May 2023	3/3	3/3	3/3	>1100	1000
31 May 2023	3/3	3/3	3/3	>1100	1000
7 Jun 2023	3/3	3/3	3/3	>1100	1000
14 Jun 2023	3/3	3/3	3/3	>1100	1000
21 Jun 2023	3/3	3/3	3/3	>1100	1000
28 Jun 2023	3/3	3/3	3/3	>1100	1000
5 Jul 2023	3/3	3/3	3/3	>1100	1000
12 Jul 2023	3/3	3/3	3/3	>1100	1000
19 Jul 2023	3/3	3/3	3/3	>1100	1000
26 Jul 2023	3/3	3/3	3/3	>1100	1000
2 Aug 2023	3/3	3/3	3/3	>1100	1000
9 Aug 2023	3/3	3/3	3/3	>1100	1000
16 Aug 2023	3/3	3/3	3/3	>1100	1000
23 Aug 2023	3/3	3/3	3/3	>1100	1000
30 Aug 2023	3/3	3/3	3/3	>1100	1000
6 Sep 2023	3/3	3/3	3/3	>1100	1000
13 Sep 2023	3/3	3/3	3/3	>1100	1000

20 Sep 2023	3/3	3/3	3/3	>1100	1000
27 Sep 2023	3/3	3/3	3/3	>1100	1000
4 Oct 2023	3/3	3/3	3/3	>1100	1000
11 Oct 2023	3/3	3/3	3/3	>1100	1000
18 Oct 2023	3/3	3/3	3/3	>1100	1000
25 Oct 2023	3/3	3/3	3/3	>1100	1000
1 Nov 2023	3/3	3/3	3/3	>1100	1000
8 Nov 2023	3/3	3/3	3/3	>1100	1000
15 Nov 2023	3/3	3/3	3/3	>1100	1000
22 Nov 2023	3/3	3/3	3/3	>1100	1000
29 Nov 2023	3/3	3/3	3/3	>1100	1000
6 Dec 2023	3/3	3/3	3/3	>1100	1000
15 Dec 2023	3/3	3/3	3/3	>1100	1000
22 Dec 2023	3/3	3/3	3/3	>1100	1000
27 Dec 2023	3/3	3/3	3/3	>1100	1000

*_Pergub Bali No 16 tahun 2016 tentang Baku Mutu Lingkungan Hidup dan Kriteria Baku Kerusakan Lingkungan Hidup di Baku Mutu Air Laut untuk Biota Laut, Pariwisata, dan Rekreasi_ (Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Criteria for Environmental Damage)

Appendix 5. Presumptive coliform count from seawater of Batu Bolong Beach

Table 8 Presumptive coliform count in seawater collected from Batu Bolong Beach during June 2023 – December 2023

Date	Result			Result (MPN/100 ml)	Standard*
	10^1	10^0	10^{-1}		
21 Jun 2023	3/3	3/3	3/3	>1100	1000
28 Jun 2023	3/3	3/3	3/3	>1100	1000
5 Jul 2022	3/3	3/3	3/3	>1100	1000
12 Jul 2022	3/3	3/3	3/3	>1100	1000
19 Jul 2022	3/3	3/3	3/3	>1100	1000
26 Jul 2022	3/3	3/3	3/3	>1100	1000
2 Aug 2022	3/3	3/3	3/3	>1100	1000
9 Aug 2022	3/3	3/3	3/3	>1100	1000
16 Aug 2022	3/3	3/3	3/3	>1100	1000
23 Aug 2022	3/3	3/3	3/3	>1100	1000
30 Aug 2022	3/3	3/3	3/3	>1100	1000
6 Sep 2022	3/3	3/3	3/3	>1100	1000
13 Sep 2022	3/3	3/3	3/3	>1100	1000
20 Sep 2022	3/3	3/3	3/3	>1100	1000
27 Sep 2022	3/3	3/3	3/3	>1100	1000
4 Oct 2023	3/3	3/3	3/3	>1100	1000
11 Oct 2023	3/3	3/3	3/3	>1100	1000
18 Oct 2023	3/3	3/3	3/3	>1100	1000
25 Oct 2023	3/3	3/3	3/3	>1100	1000
1 Nov 2023	3/3	3/3	3/3	>1100	1000
8 Nov 2023	3/3	3/3	3/3	>1100	1000
15 Nov 2023	3/3	3/3	3/3	>1100	1000
22 Nov 2023	3/3	3/3	3/3	>1100	1000
29 Nov 2023	3/3	3/3	3/3	>1100	1000
6 Dec 2023	3/3	3/3	3/3	>1100	1000
13 Dec 2023	3/3	3/3	3/3	>1100	1000
20 Dec 2023	3/3	3/3	3/3	>1100	1000
27 Dec 2023	3/3	3/3	3/3	>1100	1000

**Pergub Bali No 16 tahun 2016 tentang Baku Mutu Lingkungan Hidup dan Kriteria Baku Kerusakan Lingkungan Hidup di Baku Mutu Air Laut untuk Biota Laut, Pariwisata, dan Rekreasi* (Governor Regulation No. 16 of 2016 concerning Environmental Quality Standards and Criteria for Environmental Damage)