Distribution patterns study of *Escherichia coli* as an Indicator for ground water quality at Matraman District, East Jakarta

U Anisah, B Iswanto, A Rinanti*

Environmental Engineering Department, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta

*Corresponding Author: astririnanti@trisakti.ac.id

**Abstract.** The purpose of this study was to determine the distribution pattern *E. coli* as indicators of ground water contamination by *fecal coliforms* at Matraman District, East Jakarta, Indonesia (106°49'35"E 06°10'37"LS) consisting of six sub-districts (Utan Kayu Selatan, Utan Kayu Utara, Kayu Manis, Pal Meriam, Kebon Manggis and Pisangan Baru). The presence of *E. coli* examined by the method of Most Probable Number (MPN) according to SNI 01-2332.1-2006 about the determination of *coliforms* and *E. coli* in fishery products which consists of three stages of tests in a row, the estimation, determination or confirmation and complementary or morphology test. Matraman District is a densely populated area and the distance between septic tank and well is inadequate, both with their own’s septic tank or with neighbors’s septic tank. The result of sample analysis shows that *E. coli* counts exceeds water quality standards in accordance with regulation Health Ministry No.492/2010 concerning the drinking water quality requirements. The lowest MPN number is 3 MPN/100 ml and the highest number of *E. coli* is more than 1100 MPN/100 ml. The temperature, pH and DO (O) on average are 27.5°C, 5.59 and 2.24 mg/L. This study is expected to be a reference in the use of ground water for daily activities in the district Matraman.

**Keywords**: e.coli, fecal coliform, ground water

1. **Introduction**

Clean water is very much needed by living things but not so easy to obtained. Based on [1] and [2], Indonesia is one of the 10 countries that nearly two-thirds of the population have no access to obtain a source of clean drinking water and that diarrhea is still the main cause of death of children aged under five years old, while 946 million people still defecating outside, like in urban drainage or open channel [1], [2]. The use of drinking water refers to the criteria of quality standards according to [3] on the requirements of the drinking water quality. Drinking water that contaminated by fecal bacteria coli, namely *Escherichia coli* (*E. coli*) could inflict disorder against human health.

*E. coli* is one of indicator of ground water pollution and in general may found living in the ground or soil. The existence of fecal coliform in well water or ground water indicates the contamination of ground water caused by waste water from toilet [4]. There are some of the total and fecal coliform in ground water covering agricultural runoff, out of septic tank or drainage, and absorption of human waste and animal which also containing fecal [5].

*E. coli* is usually found in waste water that when directly or indirectly consumed would cause diarrhea, a disease characterized by increasing the frequency of excreting more than 3 times each day, accompanied by changes of form and the consistency of fecal matter. Because one of the factors greatest in water pollution of the land was the construction septic tank itself so the construction should fulfill the SNI (Indonesian National Standard) 03-2398-2002 [6] regarding the procedures of the...
designing the septic tank with a system of absorption. In the regulation, it is explained that distance septic tank absorption to the plane to buildings must be 1.5 m, to clean water wells must be located up to 10 m and 5 m with absorption wells rain water. Technical requirements it gets into a building the septic tank covering material buildings must be strong, resistant to an acid and is impermeable to water, building material can be selected for the base of the building. The lid and channeling pipe waste water are the times, red bricks, adobe, reinforced concrete, concrete without a bone, pvc, ceramic, plate metals and plastics.

Referring to this problem, a research has done to know the quality of ground water in Matraman district, East Jakarta (106°49′35″ E 06°10′37″ LS) who would be emphasized to the examination of the presence of *Escherichia coli*. For supporting this analysis, examination parameter physical chemistry such as temperature, pH, Dissolved Oxygen (DO). Pattern to scatter bacteria *Escherichia coli* needed to provide recommendations whether the ground water at Matraman district, East Jakarta worthy used as the source of drinking water or not.

### 2. Research Method

Measurement of the pH using pH indicators, with the Winkler methods modified by Alsterberg for remove the effect of ions nitrates in the water by means titration, while water temperature measured by thermometer. The amount of bacteria *Escherichia coli* calculated by a method of Most Probable Number (MPN) based on SNI 01-2332.1-2006 [7] about how to test microbiology section 1 namely the determination of coliform and *Escherichia coli* on fisheries products. A method of MPN it was split into three (3) stages examination or the determination of the presumptive test, confirmation test and complete test. The results obtained will be compared with the Decree of Health Ministry No.492 year 2010 about the requirements the quality of drinking water that bacteria *E. coli* is must be 0 MPN/100 ml.

The sampling point of ground water determined by stratified random sampling methods on the six sub-district at Matraman district, based on the wide of the area and the possibility of a great height of *Escherichia coli* like near the market, close to river and slums area (Table 1).

| Sampling Point | Location (Subdistrict) and Coordinate | Sampling Point | Location (Subdistrict) and Coordinate |
|----------------|--------------------------------------|----------------|--------------------------------------|
| 1              | Sub-District Utan Kayu Utara 106°51′47″ E ; 6°11′36″ S | 10             | Sub-District Kebon Manggis 106°51′21″ E ; 6°12′15″ S |
| 2              | Sub-District Utan Kayu Utara 106°52′13″ E ; 6°11′36″ S | 11             | Sub-District Kebon Manggis 106°51′8″ E ; 6°12′28″ S |
| 3              | Sub-District Utan Kayu Utara 106°52′26″ E ; 6°11′49″ S | 12             | Sub-District Palmeriem 106°51′34″ E ; 6°12′28″ S |
| 4              | Sub-District Kayu Manis 106°51′34″ E ; 6°11′49″ S | 13             | Sub-District Kayu Manis 106°51′47″ E ; 6°12′28″ S |
| 5              | Sub-District Palmeriem 106°51′21″ E ; 6°12′2″ S | 14             | Sub-District Utan Kayu Selatan 106°52′13″ E ; 6°12′28″ S |
| 6              | Sub-District Palmeriem 106°51′34″ E ; 6°12′2″ S | 15             | Sub-District Pisangan Baru 106°52′0″ E ; 6°12′41″ S |
| 7              | Sub-District Utan Kayu Selatan 106°52′0″ E ; 6°12′2″ S | 16             | Sub-District Palmeriem 106°51′47″ E ; 6°12′41″ S |
| 8              | Sub-District Utan Kayu Selatan 106°52′13″ E ; 6°12′2″ S | 17             | Sub-District Kebon Manggis 106°51′21″ E ; 6°12′41″ S |
| 9              | Sub-District Utan Kayu Selatan 106°52′0″ E ; 6°12′15″ S | 18             | Sub-District Pisangan Baru 106°52′26″ E ; 6°12′54″ S |
3. Results and Discussion

3.1. The Measurement Result

The measurement result of groundwater in all points of sampling indicate the average DO values is 2.24 mg/L, the average temperature is 27.52°C and the average of pH is 5.59. The existence of DO in ground water could assure bacteria to survive, while for pH is below the requirement and for temperature must be ± 3°C air temperature. Escherichia coli is growing on temperature between 10-45°C with the optimum temperature is 37°C and optimum pH of 7-7.5 but able to survive at pH 4 (minimum) and 9 (maximum) [8] to the steady state for E.coli to grow well and be expand. So it can be concluded that E.coli can still growing based on the results of research finding and the quality of water did not fulfill the criteria for drinking water.

3.2. The Measurement Result of E. Coli at Matraman District

The amount of E.coli in all sampling points show in Table 2. In Table 2 appears that the presence of bacteria E. coli on groundwater in Matraman District within range <3 MPN/100 ml up to >1100/100 ml. The distribution patterns of E. coli is shown in Figure 1a for 1st period, Figure 1b for 2nd period and Figure 1c for 3rd period. The number of E. coli in this research it would probably influenced by several factors such as distance between septic tank and well, the depth of well, climate, human activities, and sanitation.

The distance between septic tank and well must be more than 10 m and the depth of the well should be 7 m based on the Regulation of Ministry for Public Works and Public Housing No.27 year 2016. Climate, heavy rainfall and flood will cause the impact, especially severe for sanitation system that still bad in slum areas. E.coli cause diarrhea that can be contagious or through the intermediary water. Based on Jakarta Environmental Management Board Report Year 2004-2005 that 75 ground water well in Jakarta have high pollutants organic and inorganic. It means that groundwater in Jakarta has not fulfill water quality standard, especially for drinking water. In East Jakarta, 45% ground water have been contaminated by fecal coliform and 80% by E. Coli [9]. The other research in Ciracas District, East Jakarta report that coliform and E.coli in ground water within range of 18-26000 MPN/100 mL samples and 1.8-6790 MPN/100 mL, respectively [10].

**Table 2.** Sampling point and number of E. coli.

| Sample point | Depth of well (m) | Distance between well and septic tank (m) | 1st Period MPN/100 ml | 2nd Period MPN/100 ml | 3rd Period MPN/100 ml | Regulation Standard [3] |
|--------------|------------------|------------------------------------------|-----------------------|-----------------------|-----------------------|------------------------|
| 1            | 25               | 5                                        | 1100 ± 0              | 220 ± 9.8             | >1100 ± 0             |                        |
| 2            | 12               | 3                                        | 7.4 ± 0               | 195 ± 6.3             | >1100 ± 0             |                        |
| 3            | 25               | 2                                        | 43 ± 0                | 43 ± 0                | 1100 ± 0              |                        |
| 4            | 10               | 13                                       | <3 ± <3               | 43 ± 0                | 695 ± 5.70            |                        |
| 5            | 15               | 3                                        | >1100 ± 0             | >1100 ± 0             | >1100 ± 0             |                        |
| 6            | 15               | 10                                       | 21.5 ± 2.12           | 1100 ± 0              | >1100 ± 0             |                        |
| 7            | 14               | 1.5                                      | 93 ± 0                | 210 ± 0               | >1100 ± 0             |                        |
| 8            | 15               | 10                                       | 10.1 ± 1.27           | 23 ± 0                | 350 ± 5.50            |                        |
| 9            | 22               | 9                                        | 1100 ± 0              | 240 ± 0               | 780 ± 15.00           | 0                      |
| 10           | 14               | 20                                       | 3 ± 0                 | <3 ± <3               | <3 ± <3               |                        |
| 11           | 20               | 5                                        | <3 ± <3               | 23 ± 0                | <3 ± <3               |                        |
| 12           | 14               | 8                                        | >1100 ± 0             | >1100 ± 0             | >1100 ± 0             |                        |
| 13           | 12               | 1.2                                      | >1100 ± 0             | 1100 ± 0              | <3 ± <3               |                        |
| 14           | 14               | 2                                        | 23 ± 0                | 6.4 ± 3.96            | 1100 ± 0              |                        |
| 15           | 15               | 10                                       | 3.6 ± 0               | 58 ± 4.9              | >1100 ± 0             |                        |
| 16           | 15               | 15                                       | 18 ± 4.24             | <3 ± 1.4              | 251.5 ± 4.90          |                        |
| 17           | 10               | 5                                        | 39 ± 5.66             | 3.3 ± 0.42            | <3 ± 0.39             |                        |
| 18           | 30               | 11.4                                     | 460 ± 0               | 126.5 ± 4.70          | >1100 ± 0             |                        |
In this research, the depth of well and the distance of the septic tank to the well also be a concern. The correlation between the number of bacterial cells of *E. coli* and the depth of well presented in Figure 2. Based on the Figure 2 it can be concluded that there is a relation between number of *E. coli* against the depth of well as much as 6.5% for 1st period, 3.2% for 2nd period and 9.9 for 3rd period. The correlation between the number of bacterial cells of *E. coli* and the distance between septic tank and well is presented in Figure 2. Based on the Figure 2 it can be concluded that there is a relation between number of *E. coli* against the distance between septic tank and well as much as 6.3% for period I, 6.3% for period II and 8.7% for period III. The graph shows that although the distance septic tank and well far enough (>10m) and the depth of well is 7 m, the number of *E. coli* was high.

**Figure 1.** The distribution patterns of *E. coli* a) 1st Period, b) 2nd Period, c) 3rd Period.

**Figure 2.** Number of *E. coli* (MPN/100 ml) vs the depth of well.
Allegedly building construction of septic tank that not met the standard that causes the leak of septic tank. Considering Matraman District is very dense residential population so the distance between the septic tank and the well is near. Although wells and septic tank which is private property have met standard but the condition of wells and septic tank belonging to neighbors could be not qualified then there is still found high numbers of E.coli. This is in accordance with the research of [11] states that there is relationship between the depth of the wells and septic tank distance. On the contrary, although the distance septic tank close enough (<10m) but found very little E.coli. Allegedly building septic tank around the sample has met standard construction so there is no leakage in the septic tank to well.

4. Conclusion
The depth of well and distance septic tank to well affecting the amount of E.coli in ground water. Deeper well contained a few bacteria E.coli. The same case with the distance septic tank and well, the far the distance the amount of bacteria E.coli will decrease. With the result that have obtained, ground water at Matraman District not meet the quality standard of drinking water that had been determined.

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