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# WATER QUALITY IN RURAL AREAS

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***Abstract***

*Water is one of the most fundamental needs to support people's livelihood. Access to water and sanitation is even recognized by the United Nations as human rights, which reflects the crucial role of water in human lives. But we need to keep our water as clean as possible.*
*In many rural areas, the sewerage system is completely missing. People use the water from the well, and the water used returns either to uninsulated septic tanks or directly to the soil. This can endanger public health and soil quality. The purpose of this work is to determine the physico-chemical indices of water in the Butimanu village, Dambovita county, rural area, to integrate into quality classes and to find a suitable solution that would put an end to this circuit.*

***Key words**: health, quality, rural, water.*

## INTRODUCTION

Romania has an area of 238 000 km², of which 87% is represented by the rural area. (European Commission, 2021). The rural population is currently about 9.24 million people (46% of the population) (Otiman, 2012). Most of these rural areas have something in common: the lack of a sewerage system and a water network.


Figure 1. Position of the village on map

In this study, we chose Butimanu, Dambovita county, Muntenia geographical coordinates: 44°41′34"N 25°53′47"E. According to the census conducted in 2011, the population of Butimanu village amounts to 2,435 inhabitants, up from the previous census in 2002, when 2,359 inhabitants were registered. In this locality, the sewerage system is missing, and in its absence, all the wastewater is ejected into septic tanks, which are not waterproofed, and when they are emptied by a septage, the wastewater is not taken to a purification station, instead it is dumped in the immediate outskirts of the village, in agricultural areas, directly on the ground.
The main activities in this area are, fishing, agriculture and animal husbandry. But agriculture is based on pesticides and insecticides, and animal waste is stored directly on the soil and not on a waterproof platform.
Following these observations, we analyzed samples of water from the shallow depth and surface water, in order to observe the effects of the discharge of waste water in undeveloped places.

## MATERIAL AND METHODS

Name of samples and geographical position

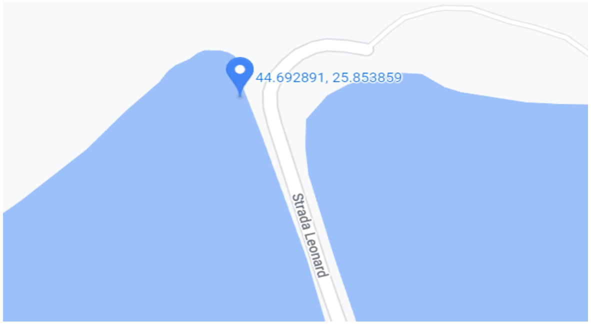



Figure 2. P01- Left side lake test (Surce: Google Earth)

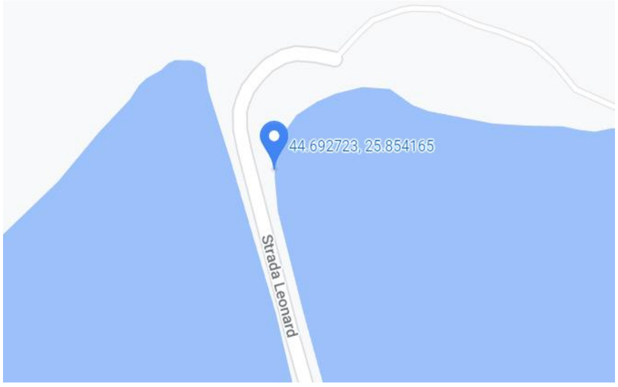



Figure 3. P02- Right side lake test (Surce: Google Earth)

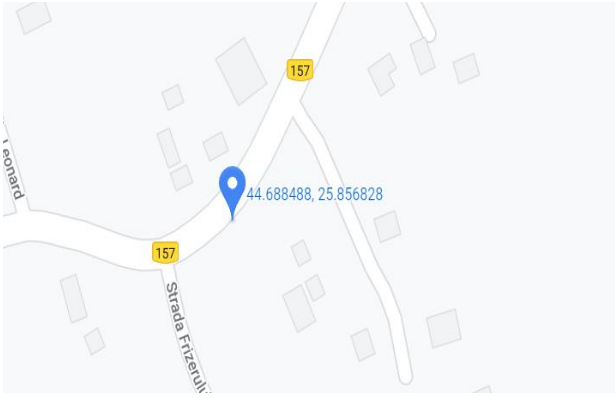



Figure 4. P03- Household test (Surce: Google Earth)

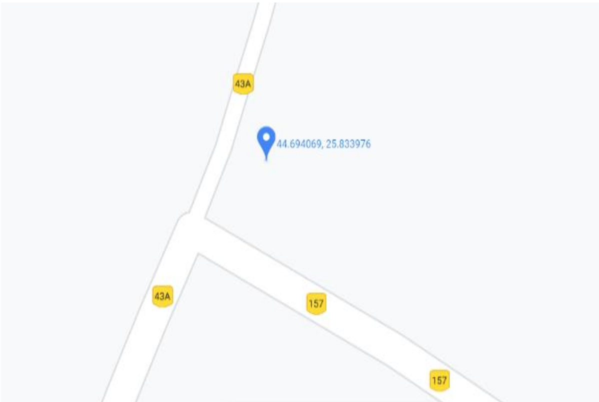



Figure 5. P04- Public well test (Surce: Google Earth)

The collection of water samples was carried out according to the norms for collecting surface and shallow water. Water samples were collected in wrinkle bottles so that the Sun's rays did not change the properties of the sample.

In order to measure the environmental impact and risk we used the colorimetric method for pH, NH4+, NO3, NO2, potentiometric method for E.C and DO. The method of determining TDS in water supplies most commonly used is the measurement of specific conductivity with a probe that detects the presence of ions in water. Conductivity measurements are converted into TDS values by means of a factor that varies with the type of water (12,13).

BOD5 was determined with the tritimetric method, the principle of the method being the determination of the biochemical oxygen consumption within a period of 5 days by the microorganisms in the water, by the difference between the amount of oxygen found in the water sample on the day of harvesting and 5 days after.

This method allows the measurements of impact and risk using specific indicators, which are characterizing the water quality. The specific indicators that characterize the water quality in this study were: pH, E.C, NH4+, NO3, TDS. The time interval for sampling and analysis of the samples started in December 2021 and ended in February 2021. This provided a 3 months window for impact and risk monitoring.

**Description of parameters**

*Dissolved oxygen* (DO) is one of the most important indicators of water quality. It is essential for the survival of fish and other aquatic organisms. Oxygen dissolves in surface water due to the aerating action of winds. Oxygen is also introduced into the water as a byproduct of aquatic plant photosynthesis. When dissolved oxygen becomes too low, fish and other aquatic organisms cannot survive. Oxygen levels also may be reduced when there are too many bacteria or algae in water (see Biochemical Oxygen Demand). After the algae complete their life cycle and die, they are consumed by bacteria. During this decay process the bacteria also consume the oxygen dissolved in the water. This can lead to decreased levels of biologically available oxygen, in some cases leading to fish and to other aquatic organisms to die. (Sarasota County, USF Water Institute).

*PH* Measures the activity of hydrogen ions in water. PH is an indicator of whether the water is acidic, neutral, or basic.

*Electrical conductivity* measures how well can an electrical current travel through the soil water. Electrical conductivity is an indicator of how much salt is present in the soil

*Total dissolved solids* (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. (WHO, 2016).

*Nitrites NO2, nitrates NO3*, these compounds are present in waters as ions, compounds that are involved in the nitrogen cycle. The main source of nitrite and nitrate in water is the wastewater untreated properly, agriculture (inorganic nitrogenous fertilizers), and oxidation of nitrogenous waste in human and animal excreta (World Health Organization, 2011).

Nitrate (NO3) and nitrite (NO2) are forms of nitrogen in the environment, both natural and human-made. Large amounts of nitrate in drinking water can be harmful to a person's health because nitrate can change into nitrite in the human body.

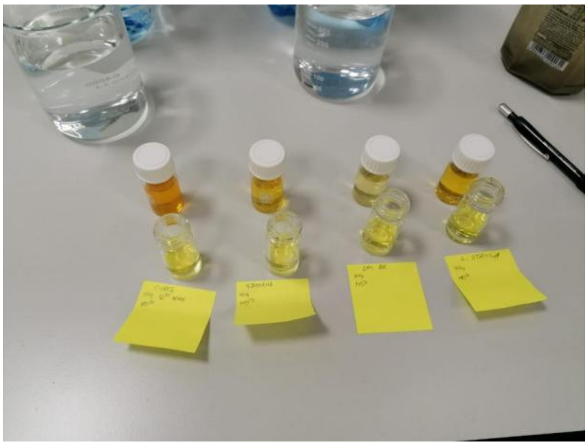
Swallowing high amounts of nitrate and/or nitrite can cause a condition called methemoglobinemia (met·he·mo·glo·bi·ne·mia). This condition affects the blood's ability to carry oxygen. Infants younger than six months of age and pregnant women are more at risk of developing this condition. Others can develop this condition too, such as those with genetic conditions or reduced stomach acidity (MDHHS, 2020).

The presence of NH4+ at high concentrations in a stream or a lake can contribute to eutrophication, that is, massive algae blooming resulting in the depletion of dissolved oxygen in water and the subsequent devastation of aquatic life. Therefore, many countries regulate NH4+ concentration of surface water and wastewater.

*Biochemical oxygen demand* (BOD) refers to the amount of dissolved oxygen needed by microbes to break down organic material present in a given water sample at certain temperature over a specific time period. BOD is measured in a water sample during 5 days of incubation at 20°C, known as BOD5. BOD represents the amount of organic matter which can be decomposed by aquatic organisms. It also indirectly represents the degree of organic pollution of the water. (Environmental Protection Administration Taiwan, 2020).

**Protocol of analysis:**

The physico-chemical indices were determined by colorimetric method using the Pro JBL test kit, a quick and easy way to perform for the summary control of NO2, NO3, NH4, and pH inside the surface water as well as the shallow water.



## RESULTS AND DISCUSSIONS

Table 1. Date: 01.12.2021

| | pH | E.C µS/L | NH4+ Mg/l | NO3 Mg/l | NO2 Mg/l | DO Mg/l | TDS | T°C |
|---|---|---|---|---|---|---|---|---|
| P01 | 7.5 | 550 | 0.05 | 1 | 0.05 | 4.5 | 275 | 20 °C |
| P02 | 7.8 | 420 | 0.05 | 0.5 | 0.05 | 5.9 | 210 | 20 °C |
| P03 | 7.2 | 1970 | 0.05 | 80 | 0.05 | 5.1 | 985 | 20 °C |
| P04 | 7.2 | 610 | 0.05 | 10 | 0.01 | 5.0 | 305 | 20 °C |

Table 2. Date:27.12.2021 SEMPLES

| | pH | E.C µS/L | NH4+ Mg/l | NO3 Mg/l | NO2 Mg/l | DO Mg/l | T°C |
|---|---|---|---|---|---|---|---|
| P01 | 8.2 | 420 | 0.05 | 5 | 0.1 | 1.1 | 20°C |
| P02 | 8.1 | 430 | 0.1 | 30 | 0.2 | 2.2 | 20°C |
| P03 | 7.1 | 1370 | 0.05 | 120 | 0.05 | 2.2 | 20°C |
| P04 | 7.5 | 590 | 0.05 | 30 | 0.025 | 1.6 | 20°C |

Table 3. Date: 10.02.2022 SEMPLES

| | pH | E.C Mg/l | NH4+ Mg/l | NO3 Mg/l | NO2 Mg/l | DO Mg/l | TDS | $BOD_5$ Mg/l | T°C |
|---|---|---|---|---|---|---|---|---|---|
| P01 | 7.7 | 180 | 0.1 | 0.5 | 0.5 | 7.88 | 90 | 2.19 | 20°C |
| P02 | 8.1 | 220 | 0.05 | 0.5 | 0.1 | 19.10 | 110 | 13.74 | 20°C |
| P03 | 7.2 | 730 | 0.05 | 20 | 0.01 | 8.94 | 365 | 4.47 | 20°C |
| P04 | 7.3 | 310 | 0.05 | 1 | 0.01 | 2.72 | 155 | 0.55 | 20°C |

Table 4. Low no 458/2002 CMA for drinking water

| pH | C.E µS/L | NH4+ Mg/l | NO3 Mg/l | NO2 Mg/l | DO Mg/l | $BOD_5$ Mg/l |
|---|---|---|---|---|---|---|
| 6,5-9,5 | 2500 | 0.5 | 50 | 0.5 | Winter time: 4,0<br>Summer time: 6,0 | 3 |

Table 5. Normative of 16 February 2006 on the classification of the quality of surface water in order to establish the Ecological Status of Water Bodies

| pH | C.E µS/L | NH4+ Mg/l | NO3 Mg/l | NO2 Mg/l | DO Mg/l | $BOD_5$ Mg/l |
|---|---|---|---|---|---|---|
| 6.5-9 | 2500 | 0.5 | 1-11,2 | 1.5 | 6.2 | 6 |

The presence of dissolved solids in water may affect its taste (Bruvold and Ongerth, 1969). The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows:

Table 6. TDS water taste

| | |
|---|---|
| <300 mg/l | Excellent |
| 300-600 mg/l | Good |
| 600-900 mg/l | Fair |
| 900-1200 mg/l | Poor |

**Interpretation of data for samples P01 and P02 for surface water**

The pH value during the three months of observations is between 7.2 - 8.2, these values do not exceed the quality standard of surface water indicating a neutral pH.

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalines, chlorides, sulfides and carbonate compounds. (Langland and Cronin, 2003)

After measuring the electrical conductivity parameters for samples P01 and P02, values between 180 and 550 µS/L were recorded, it can be seen that the concentration of salts dissolved in water is decreasing towards the beginning of spring.

According to the standard of 16 February 2006 on the classification of surface water quality in order to establish the ecological status of water bodies, the electrical conductivity does not exceed the maximum permissible concentration of 2500 µS/L.

After measuring the electrical conductivity parameters for samples P01 and P02, values between 180 and 550 µS/L were recorded, it can be seen that the concentration of salts dissolved in water is also decreasing towards the beginning of spring.

According to the standard of 16 February 2006 on the classification of surface water quality in order to establish the ecological status of water bodies, the electrical conductivity does not exceed the maximum permissible concentration of 2500 µS/L.

Nitrates vary from 0.5-30 mg N/l. There is an increase in the NO3 level at the end of December, unlike the NO3 level at the beginning of the month where the value was 0.5 respective 1 mg N/l.

As can be seen in tables 1, 2 and 3, the level of the N02-N concentration does not exceed the value of the maximum permissible concentration.

The reduction of dissolved oxygen at values of 2 mg of O2/l and less than that leads to the mass perishing of the aquatic fauna. For the winter period, the dissolved oxygen level should not be less than 4 mg / l. In December, for the P01 sample, the dissolved oxygen value is 4.4 mg/l, and for P02 the value is 5.9 mg/l, these values falling within the standards denoted by Law 458/2002. At the end of December, the values dropped to 1.1 mg/l for the P01 sample and 2.2 mg/l for the P02 sample, these values being very low. In the last month of observations, the dissolved oxygen level for P01 is 2.73 mg/l being again a much too low value, but for the P02 sample the determined value is 7.88 mg/l.

According to the Norm of 16 February 2006 ON the classification of surface water quality in order to establish the ecological status of water bodies. Biochemical oxygen consumption for surface waters of 6.0 mg/l. Following the determinations, the values for P01 is 2.19 mg/l and for the P02 sample the value is 13.74 mg/l.

**Interpretation of data for samples P03 and P04- drinking water**

P03 and P04 are samples of water intended for food consumption.

After determining the Ph value, values between 7.1-7.5 were recorded, these values indicating a neutral pH.

The electrical conductivity indicates values between 310-1970 μS/L. For the water sample that was harvested from the household, the highest values were recorded, between 730-1970 μS/L, these values demonstrating a high concentration of salts dissolved in the water, but still these values do not exceed the maximum concentrations approved by Law no. 458/2002 for drinking water.

P03 and P04 are samples of water intended for food consumption.

After determining the Ph value, values between 7.1-7.5 were recorded, these values indicating a neutral pH.

The electrical conductivity indicates values between 310-1970 μS/L. For the water sample that was harvested from the household, the highest values were recorded, between 730-1970 μS/L, these values demonstrating a high concentration of salts dissolved in the water, but still these values do not exceed the maximum concentrations approved by Law no. 458/2002 for drinking water.

Following further the determined values for NH4+, are 0.05 mg/l throughout the observation range for both water samples, not exceeding the maximum permissible value.

Instead, for NO3 the maximum allowable value is 50 mg/l, and for P03 this value is exceeded. At the beginning of the analysis interval, the water sample had a NO3 concentration of 80 mg/l, increasing to 120 mg/l in the next 30 days, so that in February it would drop to 20 mg/l, this final concentration not exceeding the maximum allowable value.

The NO2 concentration for the P03 and P04 samples is maximum 0.2 mg/l which means that the maximum permissible concentration for the water intended for food consumption is not exceeded.

For drinking water the concentration of dissolved oxygen should not be less than 4.0 mg / l, and in the open summer should not be less than 6.0 mg/l.

The first determination of the P03 and P04 water sample was 5.1 mg/l respectively 5.0 mg/l, being a value that fits into the standard, but at two determinations of dissolved oxygen the values decreased to 2.2 mg/l in the P03 sample, and for the P04 sample 1.6 mg/l.

For February, the concentration of dissolved oxygen began to increase. For the sample P03 OD is 8,94 mg/l and for P04 the value is 19,10 mg/l.

After determining the biochemical oxygen consumption, for P03 the consumption value is 4.47 mg/l being a value that is not adequate for food consumption, and for P04 the value indicates 0.55 mg/l, the maximum concentration allowed according to Law no. 458/2002 is 3 mg/l.

According to the World Health Organization, for water to taste good, TDS values must be lower than 300 mg / l.

For the P03 and P04 water samples, in the first month of measurements, values of 985 mg/l and 305 mg/l were recorded for the P04 sample. The taste of the water in the household, that is, the P03 sample is not satisfactory, and for the water sample from the public fountain is within the parameters that indicate a good quality of the water taste. In the second month of the analysis period for the P03 sample, the value of 685 mg/l was recorded, although the level is lower, compared to the first month, the quality of the water taste still does not fall within the level of excellence. In contrast, for the P04 sample, the recorded value is 295 mg/l, the quality of the taste of the water falling within the excellence class. In the last month of the monitoring interval, the value for the sample P03, being 365 mg/l indicating a good quality of taste quality, and for P04 the value is 155 mg/l remaining at the level of excellent taste quality.

## RESULTS AND DISCUSSIONS

Evaluation of quality chemical and physico-chemical elements for rivers and lakes.

Table 7. (Source: Norm 161/2006 on the classification of surface waters)

| Nr.crt | Quality indicator | UM | Quality class | | | | |
|---|---|---|---|---|---|---|---|
| | | | I | II | III | IV | V |
| 1 | Temperature | °C | It is not standardized | | | | |
| 2 | Dissolved oxygen | mg $O_2$/l | 9 | 7 | 5 | 4 | <4 |
| 3 | pH | mg/l | It is not standardized | | | | |
| 4 | Nitrates ($N\text{-}NO_3^-$) | mg N/l | 1 | 3 | 5,6 | 11,2 | >11,2 |
| 5 | Nitrites ($N\text{-}NO_2^-$) | mg N/l | 0,01 | 0,03 | 0,06 | 0,3 | >0,3 |
| 6 | Ammonium ($N\text{-}NH_4^+$) | mg N/l | 0,4 | 0,8 | 1,2 | 3,2 | >3,2 |

Following the results obtained in the three months of determinations, regarding the variation of the dissolved oxygen quantity, it was found that the values are different depending on the time and season of sampling as it can be seen in Figure 6.

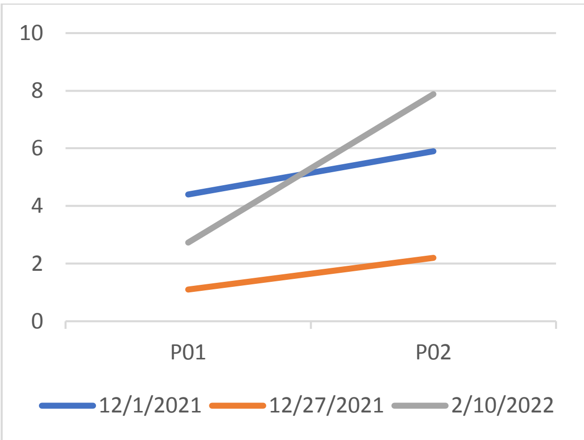



Figure 6. Variation of dissolved oxygen mg/l

The values recorded after the determinations of the NO3 concentration for the P01 sample, the variations were not high, indicating the integration of the water in the I and II quality clamps but for the P02 sample, the values were between 0.5 and 30 mg/l. This result is classifying water in quality class V.

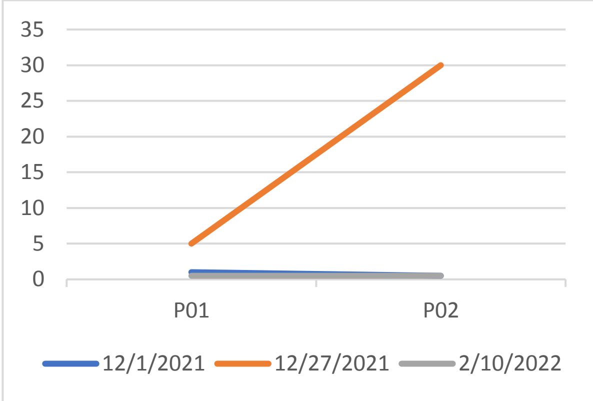



Figure 7. Nitrate variation mg/l

As can be seen in the chart below the NO2 level varies between close values but in no period of testing in this interval of three months, the water does not fall into class I of quality, but varies between class III and class V.

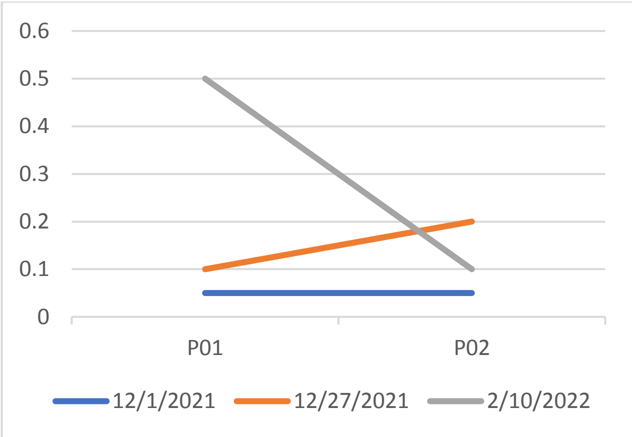



Figure 8. Variation NO2-N mg/l

After determining the NH4-N concentration, the recorded values are between 0.05-0.1 mg/l, this time the values fall into the quality class I.

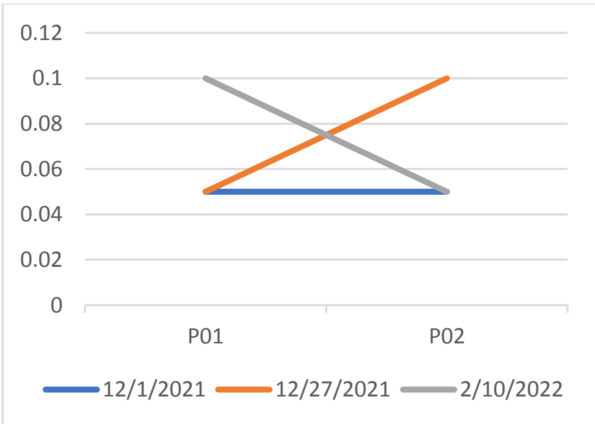



Figure 9. Variation NH4-N mg/l

## CONCLUSIONS

During the three months of monitoring of the physico-chemical indices of the surface waters and of the shallow water destined for household consumption, taken from the village Butimanu Dambovita County does not present a danger for the public health but we can not say that the quality of the water is a satisfactory one. However, to avoid high concentrations of NO3 as it was in the case of the P03 sample. The locality needs a sewerage system and a water network. As a solution proposed by us taking into account the activities that people carry out in that locality such as agriculture, animal husbandry and fishing, we propose the installation of a sewerage network system where purified water to return back to lakes or be used for irrigation in agriculture, as can be seen in the examples below.

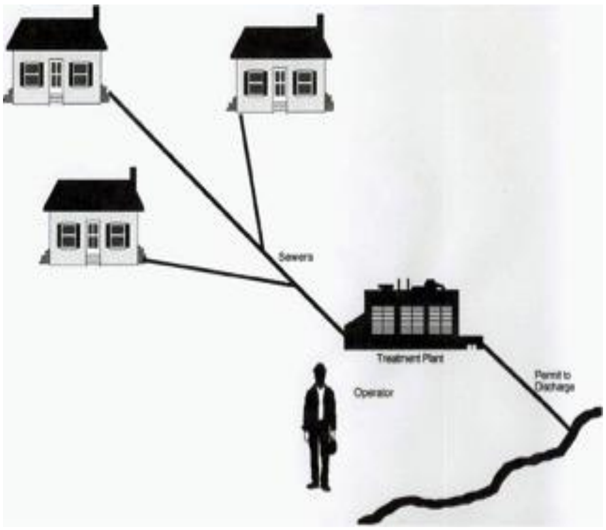



Figure 10. Option 1

Collect wastewater and treat to remove all pollutants before discharge to a stream.
When considering the stream discharge option, the following components are necessary:

- a sewer system to collect all of the wastewater from individual homes
- a body of water to discharge the treated wastewater
- a high-technology treatment plant that can remove all water pollutants
- attentive and highly trained people to operate and manage the collection and treatment system

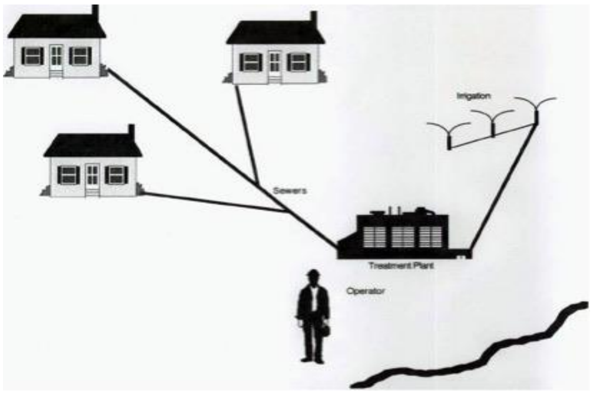



Figure 11. Option 2

Collect wastewater and treat before reuse through irrigation.
When considering the irrigation option, the following components are necessary:

- a sewer system to collect all the
- wastewater from individual homes
- land and an irrigation system
- a medium-technology treatment plant that can reduce odors and pathogens
- attentive and trained people to manage the collection, treatment and irrigation system (Karen Mancl, 2016)

In order to reduce the level of pollution of the soil and water and to improve their quality, I propose to implement one of the options listed above.
Water is a necessary resource for survival but if its quality is not favorable, the whole ecosystem can suffer material losses and even loss of life.
The water in the groundwater as it is also called "the water of our grandchildren" is a limited source of water.
Continuing at this rate of wastewater discharge directly onto the ground, the groundwater can be infected and the entire community suffers.

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# SECTION 03
# DISASTER MANAGEMENT