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# Physiochemical Properties of Madhyapara Granite Mine Water

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***Abstract:*** *Mine activity plays dynamic role in the overall development and progress of any country. The developments of mining practices, significant increase the environmental risks. In Bangladesh, the only hard Rock Mine is situated at Maddhapara, Parbatipur, Dinajpur which produce granite and most of the hard rock production in Bangladesh comes from the underground hard rock mines. During the FY 2018-19, a total 10,67,646.63 MT of granite was extracted from the mine with huge amount of water (~ 58,940 L /hour) which discharge to the nearby environment. The aim of the research is to find the water quality that discharge to the environment. For this point of view, eight samples are collected from the different location and tested at Public Health Engineering Rangpur Zonal Lab, Radha Ballob, Rangpur and compare the result with standard discharge parameters defined by Ministry of Environment and Forest, Bangladesh. Tested result showing that the quality of the water is good only some of the parameters are slightly greater than the permissible value. Therefore, there is huge scope to use mine water for irrigation and other domestic purposes to fulfill the local needs after some treatment.*

***Key Word****: Hardrock, Mine water, Discharge, Environment, Bangladesh.*

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## I. Introduction

Mining operations disturb the underground water level and surface topography. Mining operations includes the excavation of large quantities of waste rock (material not containing the target mineral) in order to extract the wanted mineable hard rock. The waste rock and the exposed bed rock walls from which it is excavated are the source of most of the metal contamination caused by mining [1, 2] . The developments of mining practices, significant increase the environmental risks. Mine operation plays dynamic role in the overall development and progress of any region. Along with the development, on the same time, it has the bad impact on environment such as air pollution, water pollution and many others. The large amounts of impurities as well as heavy metals from mine operation are of special concern because they produce water or chronic poisoning in aquatic animals [3, 4]. Mining process changes in land use/land cover due to exploration of hard rock and consequently the bad impact on environment. Besides, significant amount of solid waste piled in the water level and discharge of effluents from mines into nearby water-bodies are some of the other connected problems that have adverse environmental impact [4, 5]. Water is one of the most significant compounds to the ecosystem. It is avital component of the environment and it sustains life on the earth. Better quality of water defined by its physical, chemical and biological characteristics. Human beings depend upon water for their survival in the earth. Thus, approximation of quality of water is extremely important for proper assessment of the associated hazards. Due to lack of proper planning and negligence of regulations, an appreciable amount of environmental degradation and ecological harm to water, air and soil occurs [4, 6] . Acid drainage is considered to be one of the most important and long-lasting environmental concerns at hard rock and coal mines. Mining can reduce surface and groundwater supplies [7]. The influence on surface and ground water varies depending on the nature and chemical composition of the mine water.

Granite Maddhapara Granite Mining Company Limited (MGMCL) at Dinajpur, the only underground mining company of this kind in the world, has been extracting granite which is used mostly as construction material. During the FY 2018-19, a total 10,67,646.63 metric tons of granite was extracted from the mine and 7,31,493.56 metric tons was sold [8].

## II. Mine water production in Madhyapara Granite Mine (MGM)

Madhyapara Granite Mine (MGM) is the only hard rock mine company in Bangladesh which produced granite rock. The hard rocks are one of the key factors for Bangladesh development because those rocks are used different development project like Padma bridge, Padma rail project, Asian highway project, Ruppur nuclear power plant etc. Madhyapara Granite Mine (MGM) company produced 1,097,232.94 MT granite rock yearly and discharge 58,940L water per hour which was approximately 516,314,400 L in a year 2017 [9].

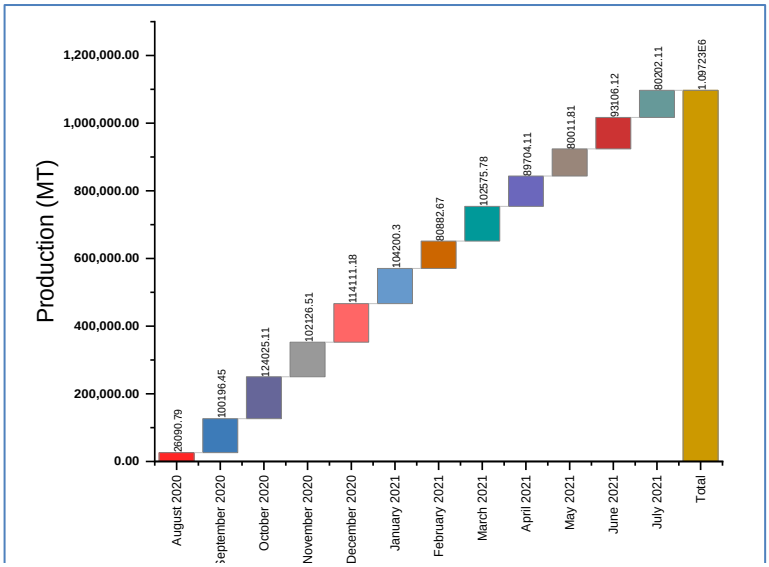


**Figure 1**: Granite production from Maddhapara Hard rock mine (Source GTC)

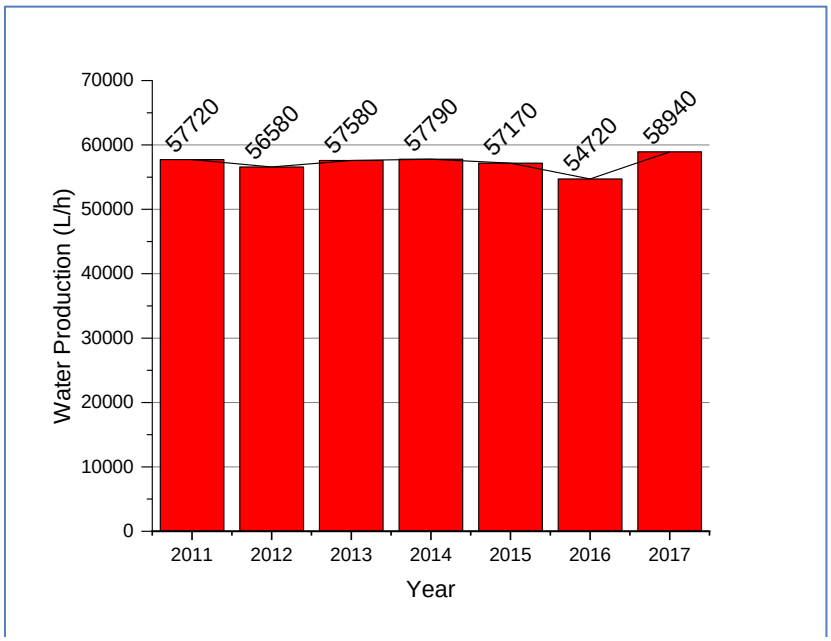


**Figure 2**: Mine water discharge from Madhyapara Granite Mine (MGM) [9].

## III. Methodology

Madhyapara Granite Mine (MGM) is the single underground hard rock mine in Bangladesh under the Petrobangla and the Ministry of Power, Energy and Mineral Resources of Bangladesh. Maddhapara hard rock mine consequently is situated in Madhyapara, Dinajpur district, northwest Bangladesh, with an area of about 1.44 km², between latitude 25º23´22´´ N and 25º34´43´´ N and longitude 89º03´34´´ E and 89º05´04´´ E. In 1974, Geological Survey of Bangladesh (GSB) ran an exploration survey in Madhyapara. In the Madhyapara area, basement rock is encountered at a depth of 130 m. An expected reserve of 174 million tons of hard rock in Maddhapara hard rock mine consisting of granodiorite, diorite, quartz diorite and gneiss of the Pre-Cambrian age has been discovered [10].

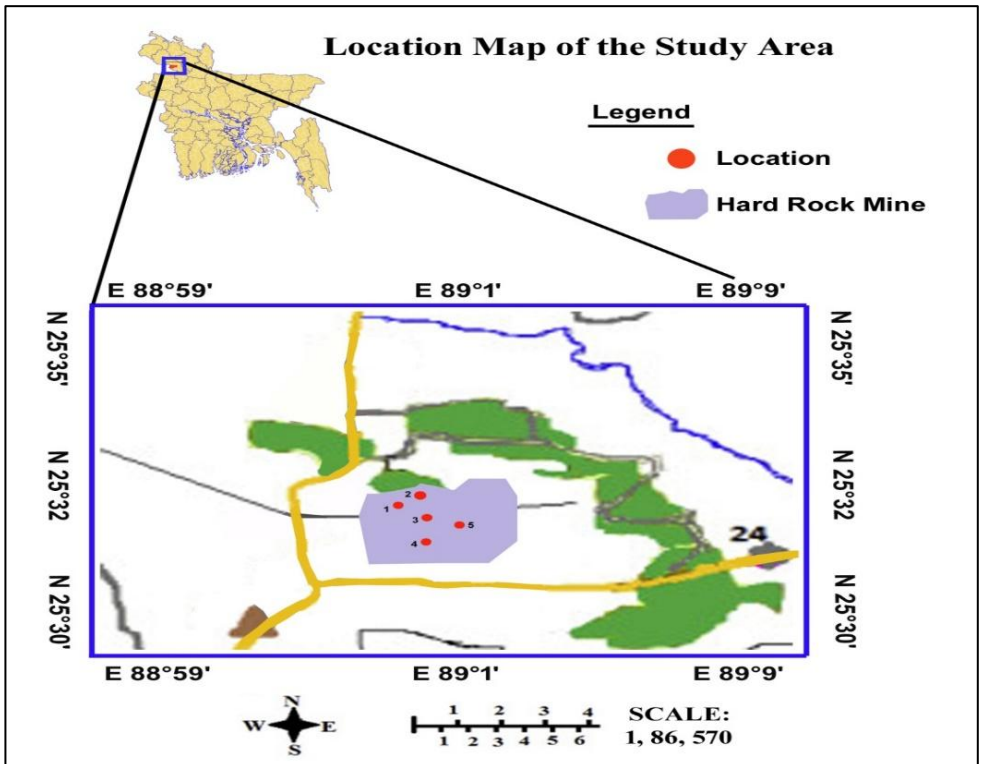


**Figure-3**: Location map of the study area.

Sample of water were collected from different location of the hard rock mining water discharge area. The common parameters such as Alkalinity, Arsenic (As), Chloride, Coliform (Faecal), Colour, EC, Hardness, Iron (Fe), Manganese (Mn), Odour, pH, Salinity, Total Dissolved Solid (TDS), Turbidity of samples water were estimated from lab test at Public Health Engineering Rangpur Zonal Lab, RadhaBallob, Rangpur and the water parameters compared with waste water discharge standard by Department of Environment, Ministry of Environment and Forest, Bangladesh. Satandard methods were applied to measure the water parameters and the result compared with Bangladesh drinking water stadard. The testing methods showing in table 1.

**Table 1:** Mine water parameters testing methods

| Elements/ Parameters | Methods/Device |
|---|---|
| Alkalinity | Titrimetic |
| Arsenic (As) | AAS |
| Chloride | Titrimetic |
| Coliform (Faecal) | MFM |
| Colour | UVS |
| EC | Multimeter |
| Hardness | Titrimetic |
| Iron (Fe) | AAS |
| Manganese (Mn) | AAS |
| Odour | Threshold Method |
| pH | pH Meter |
| Salinity | Multimeter |
| Total Dissolved Solid (TDS) | Millimeter |
| Turbidity | Turbidity Meter |

## IV. Physico-Chemical Properties of Mine Water

The rainfall events precipitation and surface runoff results in seasonal fluctuations in volume of the mine water. The water available in mine pit is selected for their Physico-Chemical analysis. Water may contain different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities. Total 8 numbers of water samples were collected from hard rock mines area. The bottles were kept air tight and labeled properly for identification. Samples were brought to the laboratory for the analysis of different physicochemical characteristics like Alkalinity, Arsenic (As), Chloride, Coliform (Faecal), Colour, EC, Hardness, Iron (Fe), Manganese (Mn), Odour, pH, Salinity, Total Dissolved Solid (TDS) and Turbidity**.**

**pH**

pH is an important parameter which indicates the suitability of water for numerous purposes. In the present investigation, the pH value was 7.2-8 where most pH value was at sample 6 and lower value at sample 2,3,4 and 5. This result indicated all the samples are in the desired limit. The higher pH values observed recommends that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physico-chemical condition [11]. The pH value of the samples water shown in figure 4.

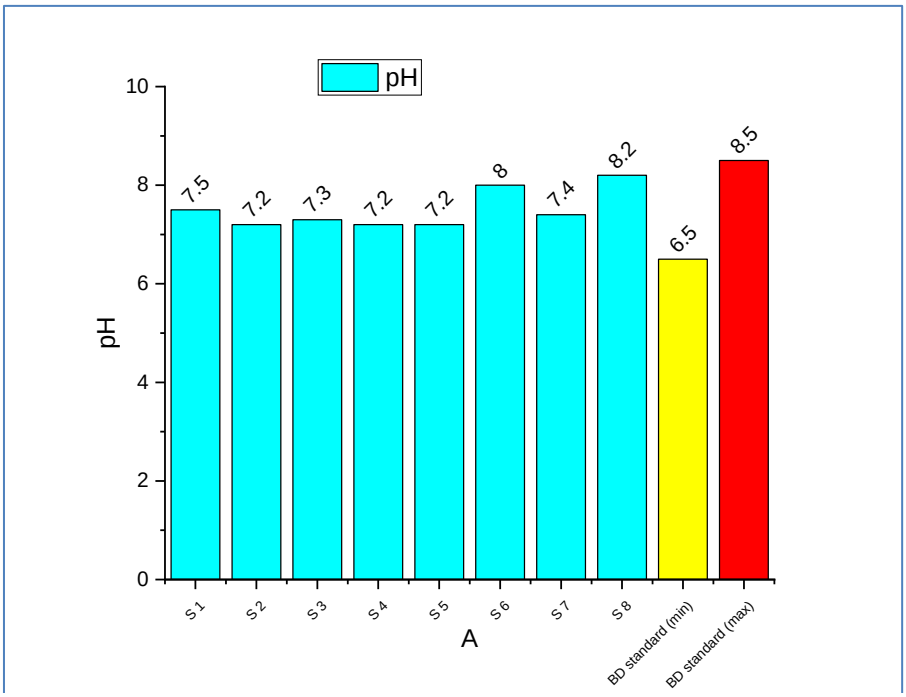


**Figure 4**: pH value of water collected from location of Madhyapara hard rock mine area.

**Alkalinity (CaCO3)**

Alkalinity of the water source is more important than its pH because it takes into account the principal constituents that influence the water's ability to regulate the pH of the medium. Alkalinity rises as the number of dissolved carbonates and bicarbonates increase [11] . The value of alkalinity of water samples was found 16-98 mg/L. The alkalinity was maximum value due to rise in bicarbonates in the water. Alkalinity values of all the water samples were showing high than desirable limit [11, 12]. The alkalinity of the samples water shown in figure 5.

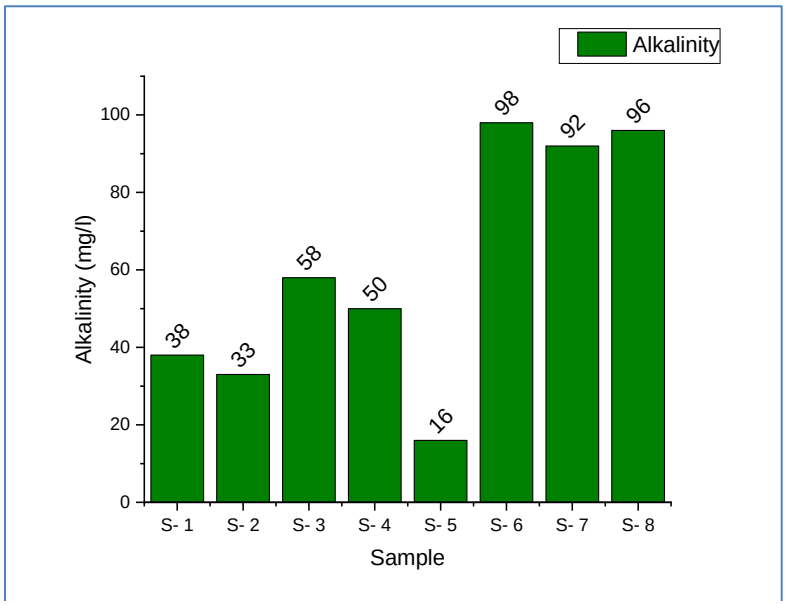


**Figure 5:** Alkalinity of the samples water collected from Madhyapara hard rock mine area.

**Arsenic (As)**

Arsenic in groundwater is now a common feature in Bangladesh. The excess amount of arsenic in drinking water has been informed from Bangladesh. WHO informed that at least 140 million people of 50 countries are visible to arsenic through arsenic polluted groundwater at levels above 10 µg/L and a majority of them live in India and Bangladesh [13]. The permission able limit of Arsenic in drinking water in Bangladesh is 0.05. The tested water sample are not exceeding desirable limit and less than the waste water disposal limit both in irrigated land or surface area [12]

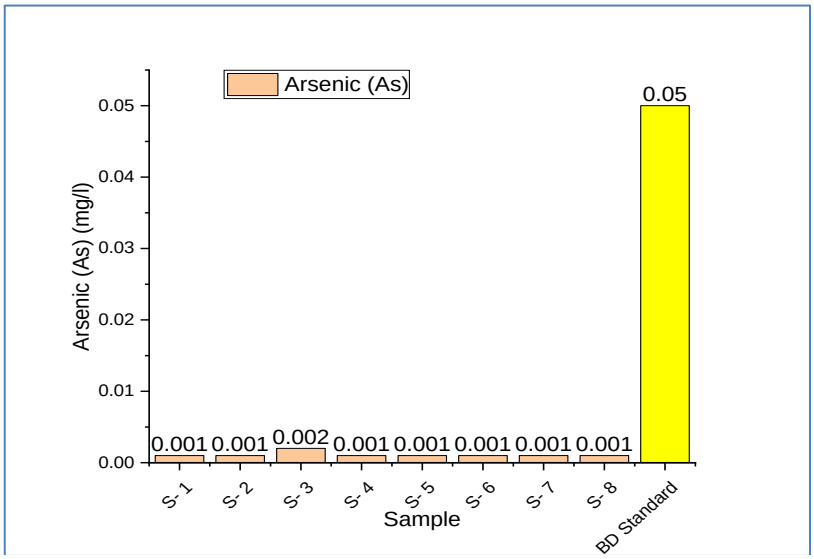


**Figure 6**: Arsenic (As) concentration of the discharge water.

**Chloride**

Chloride is frequently associated with sodium since sodium chloride is a common constituent if some water sources, the levels above 140 mg/L are considered to be toxic for plants [14]. The chloride contents indicate domestic as well as industrial contamination [15]. Chloride is one of the most important parameters in measuring the quality of water. The Chloride content of all the water samples were within the desirable limit for drinking purpose as well as discharge to the environment [12, 16].

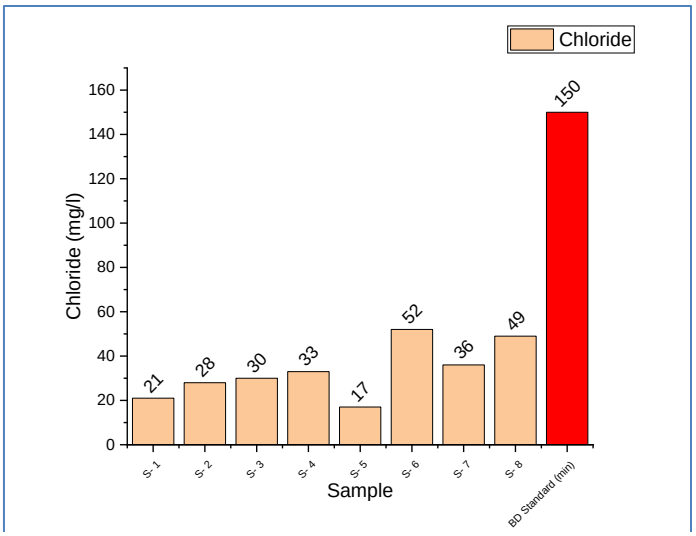


**Figure 7:** Chloride concentration of the sample water discharge from Madhyapara hard rock mine area.

**Coliform (Faecal)**

The existence of fecal coliform in marine environments may designate that the water has been polluted with the fecal material of humans or other animals. Fecal coliform bacteria can enter rivers through direct release of waste from mammals and birds, from agricultural and storm runoff, and from human sewage. The

Coliform (Faecal), of the sample water higher than acceptable limit in samples 3, 6, 7 & 8 other samples remaining at acceptable limit.

**Colour**

The colour of the water sample was found 0 Hazen. No colour value was found in the water sample. Usually, the colour of the water samples was within the desirable limit [12].

**Electric Conductivity (EC)**

Conductivity indicates the presence of ions within the water. The EC of the sample water 6, 7 & 8 are much higher than samples 1, 2 but the range within the standard value for drinking water in Bangladesh shown in figure 8.

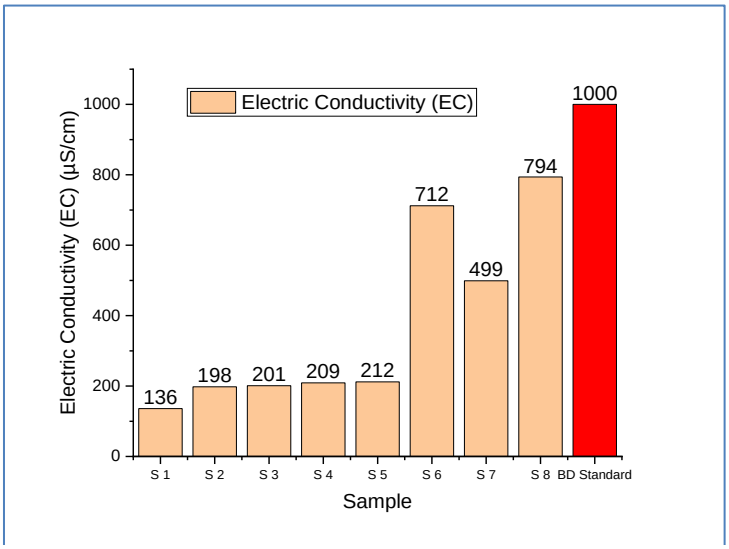


**Figure 8**: EC of the samples water.

**Total hardness**

Total hardness is the property of water which presents the leather formation with soap and it moreover increased the boiling points of water. Hardness of water generally depends upon the amount of magnesium and calcium salts dissolved [11]. The value of total hardness of water samples in the present study varied from 10 mg/L to 96 mg/ L. The maximum and minimum value was recorded of the water samples were showing under the desirable limit[12] .

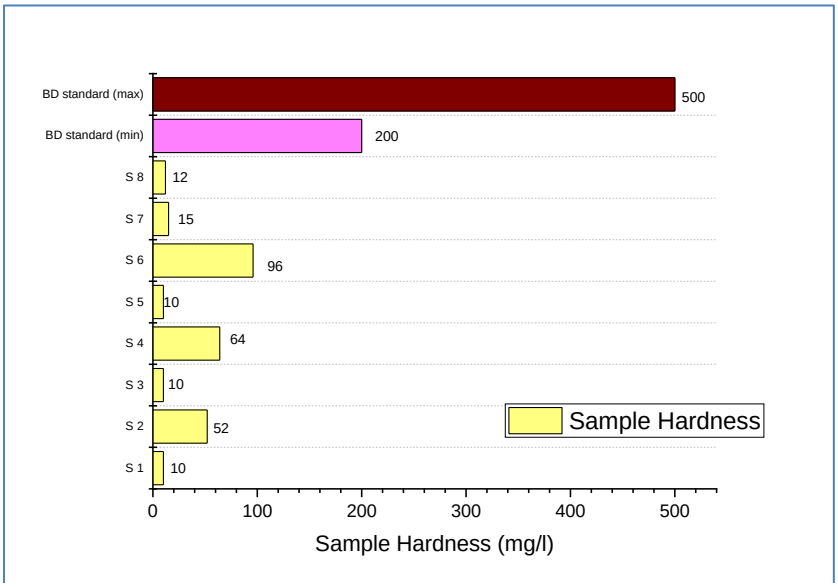


**Figure 9**: Total Hardness of the sample water along with Bangladesh drinking water standard.

**Irons (Fe)**

Iron is the essential metal for life of vegetable and animal organisms. It is unwanted for household and for industry. Iron concentration in all the samples were 0.01 to 3.16 mg/L. Normally, the concentration of iron of all the samples was within the desirable limit except sample 6 and 8 shown in figure 10 [12, 16].

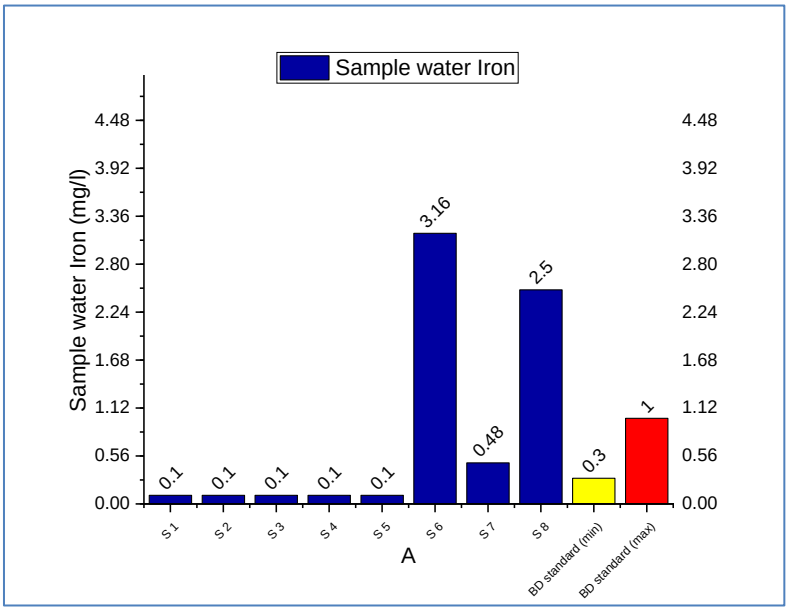


**Figure 10**: Iron concentration of the water samples.

**Manganese (Mn)**

Manganese in the environment is found in form of oxides, silicates, carbonates etc. Magnesium is often related with calcium in all kinds of water, but its concentration remains usually lower than the calcium. In the present investigation, the results of manganese of water samples in all the water samples were 0.01 to 0.28 mg/L. Normally, the concentration of Manganese was within the required limit.

**Total Dissolved Solids (TDS)**

In natural waters, dissolved solids consist generally of inorganic salts such as carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium (Mn), sodium, potassium, iron (Ae) etc. and small amount of organic matter and dissolved gases. The values of dissolved solids of the water samples ranged between 88 mg/L and 508 mg/L. In the investigation the dissolved solids in water sample were found within the desirable limits to discharge in the environment shown in figure 11.

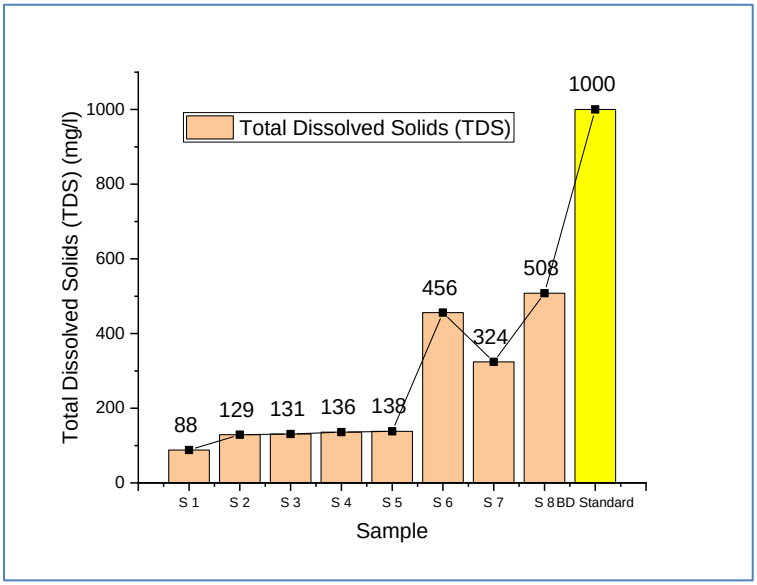


**Figure 11**: Total Dissolved Solids (TDS) of the sample water.

**Turbidity**

Turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material in water. Because absorption and scattering are influenced by both size and surface characteristics of the suspended material, turbidity is not a direct quantitative measurement of suspended solids. Most turbidity in surface water results from the erosion of colloidal materials such as clay, silt, rock fragments and metal oxides from the soil. Vegetable's fibers and microorganism may also contribute to turbidity. The disinfection of turbid water is difficult because of the adsorptive characteristic of some colloids and because of the solids that partially shield organism from the disinfection [17, 18].

If turbidity is largely due to organic particles, dissolved oxygen depletion may occur in the water body. The excess nutrients available will encourage microbial breakdown, a process that requires dissolved oxygen. In addition, excess nutrients may result in algal growth. Although photosynthetic by day, algae respire at night, using valuable dissolved oxygen. Fish kills often result from extensive oxygen depletion.
Turbidity of the samples water were 1 to 536 where accaptbel limit for drinking water is 10 NTU.
The average value of physiochemical properties of the sample water shown in table 2.

**Table 2:** Physiochemical properties of the mine water produced from Madhyapara hard rock mine[12, 13].

| Parameters | Unit | Average Value | Bangladesh Drinking Standard | **Location of Final Disposal** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Inland Surface Water** | **Public Sewer** | **Irrigated Land** | Remarks |
| Alkalinity | mg/L | 60.13 | - | | | | |
| Arsenic (As) | mg/L | 0.001 | 0.05 | 0.2 | 0.5 | 0.2 | Within limit |
| Chloride | mg/L | 33.25 | 150-600 | 600 | 600 | 600 | Within limit |
| Coliform (Faecal) | cfu/100ml | 2.13 | 0 | - | - | - | |
| Colour | Hazen | 0.00 | 15 | - | - | - | |
| EC | µS/cm | 370.13 | 150-1000 | 1200 | 1200 | 1200 | Within limit |
| Hardness | mg/L | 33.63 | 200-500 | 2100 | 2100 | 2100 | Within limit |
| Iron (Fe) | mg/L | 0.83 | 0.3-1 | 2 | 2 | 2 | Within limit |
| Manganese (Mn) | mg/L | 0.06 | 0.1 | 5 | 5 | 5 | Within limit |
| Odour | Odourless | 0.00 | Odorless | - | - | - | Within limit |
| pH | - | 7.50 | 6.5-8.5 | 6-9 | 6-9 | 6-9 | Within limit |
| Salinity | % | 0.01 | - | | | | Within limit |
| Total Dissolved Solid (TDS) | mg/L | 238.75 | 1000 | 2100 | 2100 | 2100 | Within limit |
| Turbidity | NTU | 120.75 | 10 | | | | Higher than limit |

## V. Conclusion

All the water samples were analyzed and found that the quality of the water is good only some of the parameters are slightly greater than the permissible value. Therefore, there is huge scope to use mine water for irrigation and other domestic purposes to fulfill the local needs after some treatment. It is necessary to provide good quality water to mine area for the better health condition of the workers and others personal, because mining is one of the major economic activities in many developing countries. Maddhapara hard rock mine assists the country by providing with hard rocks which is used in numerous purposes. Extraction of hard rock in MGM helps us to save significant number of foreign currencies. So, to progress socio economic infrastructure of our country this mine can play a vital role in improving gross national economy of Bangladesh. For this several measures have to be taken which will control the pollution from different sources. These take in proper management of mining waste; proper way of mining technique and above all, the public consciousness is must for the conservation of these precious ground water resources.

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