Comparison of Treatment Efficiencies of the Water Treatment Plants of Guwahati City of Assam, India

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***Abstract*— All foreign material added to a natural water body is considered contamination. Overloading a natural water body beyond its reserve or recuperative capacities with contaminants is a very serious matter that can cause health and environmental problems. The aim of a water treatment plant is to reduce the level of contaminants in raw water before use for various consumer needs. In this study, Panbazar water treatment plant (GMC), Satpukhuri water treatment plant (GMC), Kamakhya water treatment plant (GMC), Panbazar water treatment plant (PHED), Jalukbari water treatment plant (PHED and Zoo Road water treatment plant (AUWSSB) of Guwahati city of the state Assam, India have been selected to assess the water treatment efficiencies in terms of reduction of the water quality parameters that are present in higher levels in untreated raw river water. Brahmaputra river water is the source of raw water for these water treatment plants. For this study, untreated (raw) water samples and treated water samples were collected from the selected 6 water treatment plants. The samples were analyzed for fluoride, iron, manganese, nitrate, hydrogen-ion concentration, turbidity, total dissolved solids, alkalinity, chloride, total hardness, sulphate, arsenic, lead, residual chlorine and bacteriological parameter using appropriate analytical methods and sophisticated instruments and compared with the standards set by Bureau of Indian Standards. As these water treatment plants treat the raw river Brahmaputra water for drinking purpose (consumer needs), it is very important to assess the water quality parameters in treated water and thus to know their treatment efficiencies in terms of reduction in the levels of the parameters.**

Keywords—Arsenic; lead; water treatment plants; water quality parameters

I. INTRODUCTION

River water contains a number of contaminants including plant nutrients, pathogenic microorganisms, heavy metals, organic pollutants, biodegradable and micro-pollutants. All of these can cause health problems when river water is directly used for drinking without treatment. Water treatment and use of treated municipal water has been practiced since many decades. This has led to better understanding of the processes and treatment technologies and the eventual development of water quality standards. Water treatment involves physical, chemical or biological processes or combinations of these processes depending on the required outflow standards of the water treatment plant (WTP). Ill health conditions arising from inadequate or non-existing water treatment pose significant threats to human health, well being and economic activity. The efficiency of a WTP is very important if the treated water is used for consumer needs, such as for drinking purpose.

In this study, 6 WTPs of Guwahati city of Assam, India were selected for the analysis of the untreated (raw) river Brahmaputra water and treated water and thus, to find the treatment efficiencies of the selected 6 WTPs. The untreated raw water source of these WTPs is the Brahmaputra river. The Brahmaputra river is the downstream receptor of the Bharalu river, which carries a large portion of the city's municipal and other wastes and also serves as the natural drainage for storm water runoff. The wastewater entering into the river Brahmaputra poses a serious threat for health and environment. The selected WTPs release the treated water for consumer needs. As water is directly related to health, therefore water quality tests are of immense importance. The contents of the water quality parameters in the water samples were determined according to standard protocols by appropriate analytical techniques and sophisticated instruments. The results were compared with the standards given by Bureau of Indian Standards (BIS) (I.S. 10500-2012). The selected water quality parameters are fluoride (F), iron (Fe), manganese (Mn), nitrate (NO_3), hydrogen-ion concentration (pH), turbidity, total dissolved solids (TDS), alkalinity, chloride (Cl), total hardness (TH), sulphate (SO_4), arsenic (As), lead (Pb), residual chlorine (RCl) and bacteriological parameter.

Therefore, the purposes of this research work are (1) to assess the untreated and treated water quality of the selected 6 WTPs of Guwahati city of Assam, India, (2) to determine the concentrations/levels of the water quality parameters selected for this study, and (3) To compare the water treatment efficiencies of the 6 WTPs.

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II. MATERIALS AND METHODS

A. Study Area

Guwahati, the capital city of the state Assam of India, is situated on the south bank of the Brahmaputra river towards southeastern side of Kamrup district of the sate Assam, India. The geographical area lies between north latitudes 26°04'27"N and 26°13'51"N and east longitudes 91°34'0"E and 91°51'0"E and falls in the topographic sheet no. ng46 (Fig 1). The city is situated on an undulating topography with varying altitudes of 49.5 m to 55.5 m. The Greater Guwahati covers an area of

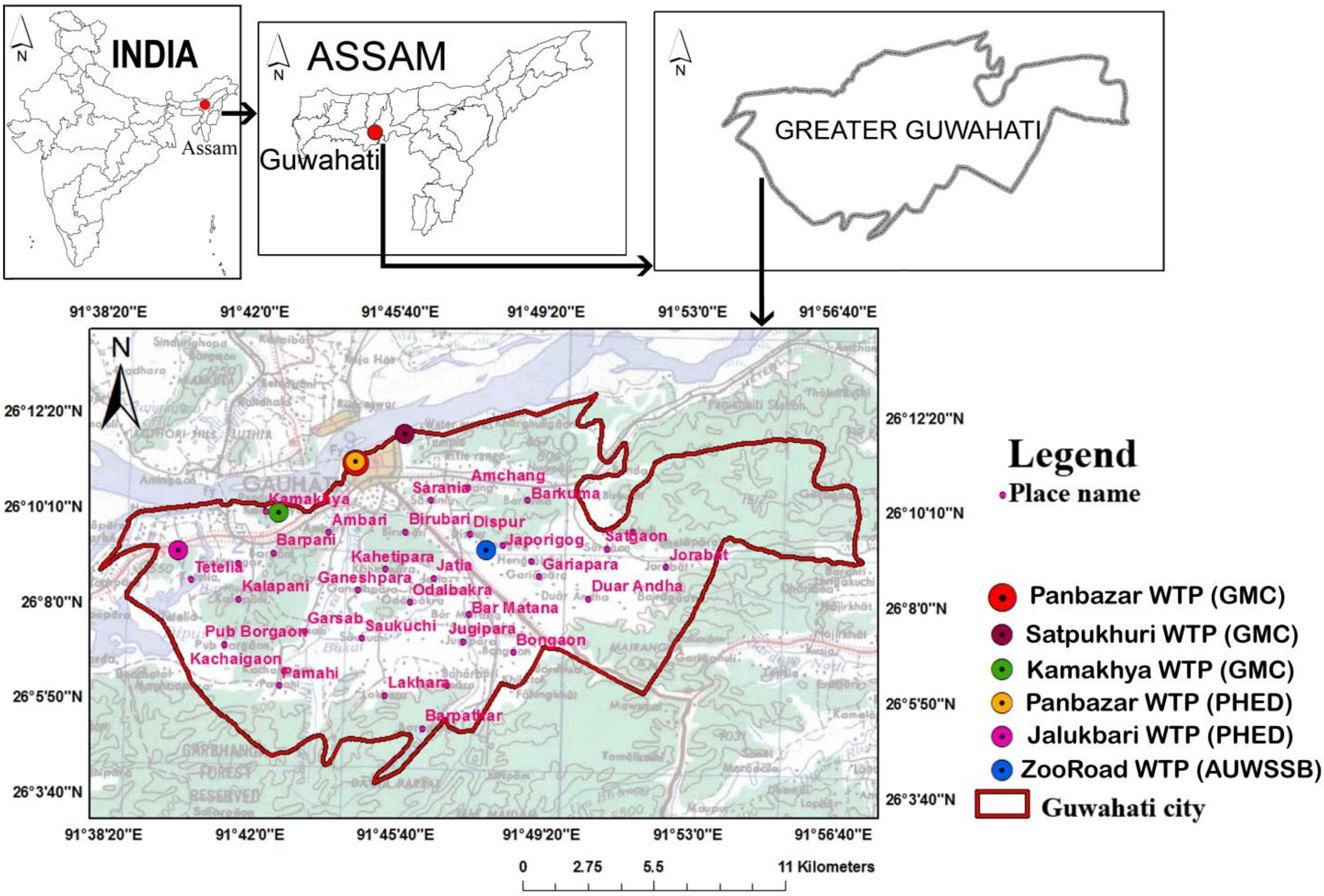

Fig. 1. Map of the study area showing the locations of the six water treatment plants

264 sq km, out of which Guwahati Municipal Corporation (GMC) area covers 216.19 sq km. The boundary of the GMC extends from the Brahmaputra river in the north, Basistha grant in the south, Khanyan river in the west and Khanapara hills in the east.

The city has warm summers and cold winters. Monsoon season commences from the month of June. The average annual rainfall at Guwahati is 1637.3 mm. About 90 percent of these rains occur between April to September. The major source of surface water available in the city is the Brahmaputra River and that of groundwater are deep tube wells.

There are three independent organizations namely Guwahati Municipal Corporation (GMC), Public Health Engineering Department (PHED) and Assam Urban Water Supply and Sewerage Board (AUWSSB) to provide water supply to the city through their water treatment plants and supply systems. There are 6 WTPs existing in the Guwahati out of which three are owned by GMC, two by PHED and one by AUWSSB. The geographic locations of these WTPs are shown in Fig 1. The untreated raw water source of these WTPs is the Brahmaputra river. All the plants follow conventional method of water treatment with RSF. The salient features of the WTPs are given in Table I.

B. Preparation of WTP location point feature map

The method that was followed to develop a WTP location point feature map from thematic maps is explained in this section. The ArcGIS software was utilized for creating the map. The locations of 6 WTPs (pinpoint locations) in the study area were obtained by using a handheld GPS instrument GARMIN GPS-60 receiver. GPS technology proved to be very useful for enhancing the spatial accuracy of the data integrated in the GIS. The WTP location data was imported to ArcGIS using WGS_1984_UTM_Zone_46N projection and attributes were assigned to each WTP. The digitized maps of India, Assam, Greater Guwahati and Survey of India (SOI) topographic sheet no. ng46 were used in ArcGIS to generate the final study area map. Based on the location data obtained, point feature was prepared showing the position of 6 WTPs

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(Fig 1) from where the untreated and treated water samples were collected. Also, the places of Guwahati city within the city boundary were digitized using the point feature of the editor toolbar in ArcGIS. The GPS data and the map thus obtained forms the spatial database.

C. Sampling and analysis

For the sampling of the untreated and treated water samples of the 6 WTPs of the study area, water samples from the 6 sites of WTPs (pinpoint locations) were collected. Since the water sources were known to vary with time, grab samples were collected with frequency of one. The samples were taken during March 2017 and were analyzed for physical, chemical and bacteriological parameters. The samples for analysis were collected in PET bottles of half litre size. Before filling, the bottles used for water sample collection were rinsed out two or three times with the water being collected. From each site, two samples were collected; one untreated and other treated wastewater. Thus, a total of 12 water samples were collected from 6 pinpoint locations of the study area (Table II).

TABLE I. SALIENT FEATURES OF THE WTPS OF GUWAHATI CITY OF THE STATE ASSAM, INDIA

WTP sl. no.	Name of WTP	WTP pinpoint location	Latitude (N) in degrees	Longitude (E) in degrees	Raw water source	Design capacity in MLD	Treatment method
1	Panbazar WTP (GMC)	Panbazar, Guwahati-1	26.186944	91.743055	River Brahmaputra	45	Aeration--> Alum Dosing--> Coagulation--> Sedimentation--> Filtration--> Disinfection
2	Satpukhuri WTP (GMC)	Satpukhuri, Guwahati	26.198055	91.763333	River Brahmaputra	22.5	Screening--> Aeration--> Alum Dosing--> Coagulation--> Sedimentation--> Filtration--> Disinfection
3	Kamakhya WTP (GMC)	Kamakhya, Guwahati-1	26.167777	91.711111	River Brahmaputra	4.7	Aeration--> Alum Dosing--> Sedimentation--> Filtration--> Disinfection
4	Panbazar WTP (PHED)	Panbazar, Guwahati-1	26.1875	91.742777	River Brahmaputra	11.35	Aeration--> Alum Dosing--> Coagulation--> Sedimentation--> Filtration--> Disinfection
5	Jalukbari WTP (PHED)	Jalukbari, Guwahati-13	26.153333	91.668888	River Brahmaputra	10	Aeration--> Alum Dosing--> Coagulation--> Sedimentation--> Filtration--> Disinfection
6	Zoo Road WTP (AUWSSB)	Hengrabari, Guwahati-36	26.154276	91.798263	River Brahmaputra	12.6	Aeration--> Alum Dosing--> Coagulation--> Sedimentation--> Filtration--> Disinfection

Sufficient information was recorded to provide positive sample identification at a later date, such as the name of the WTP, pinpoint location and untreated raw water source. After collection of the samples, the samples were shifted to the laboratory for analysis. The latitude and longitude data of the pinpoint locations were recorded using GPS instrument GARMIN GPS-60 receiver.

TABLE II. THE 12 WATER SAMPLES COLLECTED FROM 6 WTPS IN GUWAHTAI CITY, ASSAM, INDIA IN MARCH 2017

WTP Sl. no.	Name of WTP	Sample no.	Sample type
1	Panbazar WTP (GMC)	1	Untreated
		2	Treated
2	Satpukhuri WTP (GMC)	3	Untreated
		4	Treated
3	Kamakhya WTP (GMC)	5	Untreated
		6	Treated
4	Panbazar WTP (PHED)	7	Untreated
		8	Treated
5	Jalukbari WTP (PHED)	9	Untreated
		10	Treated
6	Zoo Road WTP (AUWSSB)	11	Untreated
		12	Treated

For the physical, chemical and bacteriological analysis of the samples, the selected water quality parameters are F, Fe, Mn, NO_3, pH, turbidity, TDS, alkalinity, Cl, TH, SO_4, As, Pb, RCl and bacteriological parameter. The analyses were carried out to determine the contents of the parameters and compared with the standard values recommended by BIS (Table III).

F, Fe, Mn, NO_3, SO_4, As and Pb contents of the water samples were analyzed by using Spectroquant Pharo 100 Spectrophotometer. pH of the water samples was analyzed by using pH meter. Turbidity of the water samples was analyzed by using Nephelometric turbidity meter. TDS of the water samples were analyzed by using Conductivity meter. Alkalinity, Cl and TH of the water samples were analyzed by using titration methods. RCl of the water samples were analyzed by using residual chlorine kit. The bacteriological parameter was analyzed using vials.

D. Treatment efficiency

Treatment means removing impurities from the water being treated. Treatment efficiency of a WTP can be attributed to the significant reduction in the levels of the water quality parameters with respect to the levels set in water quality standards such as BIS for a particular purpose (such as for drinking purpose). For knowing the efficiency of a WTP, the levels of the water quality parameters obtained for the untreated raw water sample are compared with those of the treated water sample of the same WTP after the analysis. The treatment efficiencies of all the 6 WTPs can be compared with each other to find out the most efficient WTP with respect to water treatment.

E. Criteria for acceptability and rejection in water quality

In this stage, the criteria for suitability and non-suitability (whether the treated water is potable or not) of the treated water samples of the WTPs were elucidated for analysis. This was performed based on the water quality standards stipulated by BIS (I.S. 10500-2012). The acceptable and maximum permissible limits for the water quality parameters are given in the Table III.

TABLE III. STANDARDS FOR WATER QUALITY PARAMETERS AS PER BIS (IS 10500-2012)

Sl. no	Water quality parameter	Acceptable (desirable) limit	Maximum permissible limit
1	Turbidity in NTU	1	5
2	Total dissolved solids (TDS) in mg/l	500	2000
3	Fluoride (F) in mg/l	1	1.5
4	Iron (Fe) in mg/l	0.3	1.0
5	Manganese (Mn) in mg/l	0.1	0.3
6	Nitrate (NO_3) in mg/l	<45	45
7	Hydrogen-ion concentration (pH)	6.5-8.5	6.5-8.5
8	Alkalinity in mg/l	200	600
9	Chloride (Cl) in mg/l	250	1000
10	Total hardness (TH) in mg/l	200	600
11	Arsenic (As) in mg/l	0.01	0.05
12	Residual chlorine (RCl) in mg/l	0.2	1.0
13	Lead (Pb) in mg/l	<0.01	0.01
14	Sulphate (SO_4) in mg/l	200	400
15	Bacteriological parameter	Absent	Absent

III. RESULTS AND DISCUSSIONS

The study has been conducted to see the overall treatment efficiencies of the 6 WTPs of Guwahati city of Assam, India. For this study, untreated raw water samples and treated water samples of the 6 WTPs were collected for analysis. The water quality parameters were analyzed and their levels in the water samples obtained are shown in Table IV and V. The water quality of untreated raw water and treated water is compared for each WTP to know the efficiency as regards treatment. The performance of 6 WTPs was assessed in this study to know the best one on the basis of efficiency in water treatment.

TABLE IV. THE RESULTS OF THE 12 WATER SAMPLES COLLECTED FROM 6 WTPS IN GUWAHTAI CITY, ASSAM, INDIA IN MARCH 2017

Name of WTP	Sample no.	Sample type	pH	Turbidity NTU	TDS mg/l	Alkalinity mg/l	TH mg/l	Cl mg/l	SO_4 mg/l	NO_3 mg/l
Panbazar WTP (GMC)	1	Untreated	7.86	9	90.37	16	120	12	177	7.3
	2	Treated	8.31	0	95.3	24	132	16	207	6.4
Satpukhuri WTP (GMC)	3	Untreated	8.21	18	91.26	18	104	10	186	6.1
	4	Treated	7.41	4	90.82	22	96	12	173	5.3
Kamakhya WTP (GMC)	5	Untreated	7.27	14	88.13	20	132	14	274	5.8
	6	Treated	7.88	3	86.14	18	128	22	361	5.8
Panbazar WTP (PHED)	7	Untreated	8.07	9	33.88	30	100	8	175	5.2
	8	Treated	7.61	3	0.68	10	128	14	196	2.2
Jalukbari WTP (PHED)	9	Untreated	8.06	15	87.49	16	108	10	188	4.9
	10	Treated	7.85	0	80.13	16	104	18	313	4.6
Zoo Road WTP (AUWSSB)	11	Untreated	7.71	24	80.58	20	96	6	226	8.2
	12	Treated	7.53	4	81.02	14	104	10	233	7.6

TABLE V. THE RESULTS OF THE 12 WATER SAMPLES COLLECTED FROM 6 WTPS IN GUWAHTAI CITY, ASSAM, INDIA IN MARCH 2017

Name of WTP	Sample no.	Sample type	F mg/l	As mg/l	Pb mg/l	Fe mg/l	Mn mg/l	RCl mg/l	Bacteriological parameter
Panbazar WTP (GMC)	1	Untreated	0.39	>0.100	0.97	0.33	0.7	0	Present
	2	Treated	0.19	>0.100	0.28	0.17	0.28	1	Absent
Satpukhuri WTP (GMC)	3	Untreated	0.22	>0.100	1.04	0.28	0.64	0	Present
	4	Treated	0	>0.100	0.24	0.12	0.31	0	Present
Kamakhya WTP (GMC)	5	Untreated	0.34	>0.100	0.31	0.29	0.41	0	Present
	6	Treated	0.21	>0.100	0.26	0.26	0.35	0.8	Absent
Panbazar WTP (PHED)	7	Untreated	0.28	>0.100	1.67	0.3	0.62	0	Present
	8	Treated	0.13	>0.100	0.18	0.2	0.33	0	Present
Jalukbari WTP (PHED)	9	Untreated	0.43	>0.100	0.47	0.23	0.57	0	Present
	10	Treated	0.33	>0.100	0.27	0.14	0.33	0	Present
Zoo Road WTP (AUWSSB)	11	Untreated	0.35	>0.100	0.68	0.42	0.75	0	Present
	12	Treated	0.24	>0.100	0.3	0.21	0.57	0	Present

The results of untreated raw water samples and treated water samples of the 6 WTPs for every water quality parameter are shown in graphs in this section.

Firstly, from the bacteriological test results, it can be seen that except for Panbazar WTP (GMC) and Kamakhya WTP (GMC), no other WTP became successful in removing the bacteriological parameter. Thus the above mentioned WTPs are efficient in bacteriological treatment. The treated water samples showed bacterial content even after treatment for all other WTPs except the above mentioned WTPs. This is very risky as water with bacterial content causes various water borne diseases, directly affecting health.

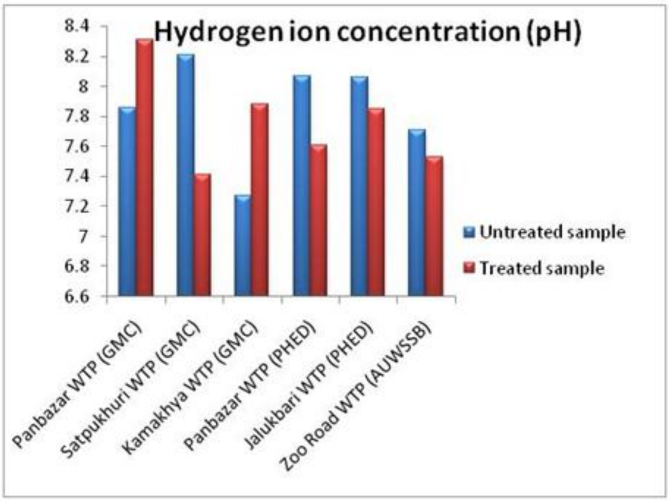

Fig. 2. Graph for hydrogen ion concentration (pH) of the water samples

From the graph, it can be seen that the pH values of the treated water samples are well within the BIS range of 6.5-8.5 for all the WTPs. So in this case, all the WTPs are efficient.

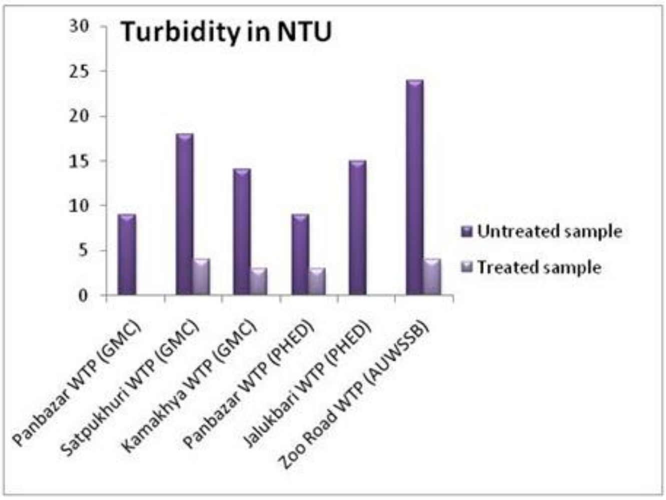

Fig. 3. Graph for turbidity of the water samples

From the above graph, it can be seen that for turbidity of the treated water samples, all the WTPs are found to be efficient to reduce turbidity well below the maximum permissible limit of 5 NTU. The highest amount of turbidity is reduced by the Zoo Road WTP (AUWSSB) and thus it is the most efficient in this case. Also, the Panbazar WTP (GMC) could totally reduce the turbidity level to 0. Thus is also efficient.

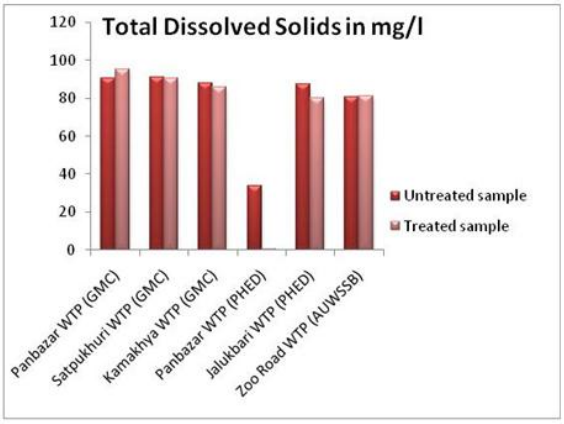

Fig. 4. Graph for total dissolved solids (TDS) of the water samples

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The above graph shows that except for Panbazar WTP (GMC) and Zoo Road WTP (AUWSSB), in all the other WTPs, TDS is found to get reduced in treated water; but overall, all the samples has TDS values below BIS standards. So, no WTP is inefficient in this case.

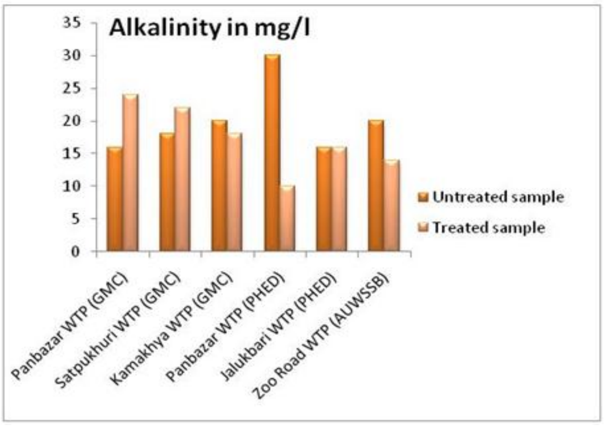

Fig. 5. Graph for alkalinity of the water samples

The values of alkalinity of treated samples of all WTPs are below the BIS standards prescribed. Here, Panbazar WTP (PHED) is found to the most efficient in reducing alkalinity.

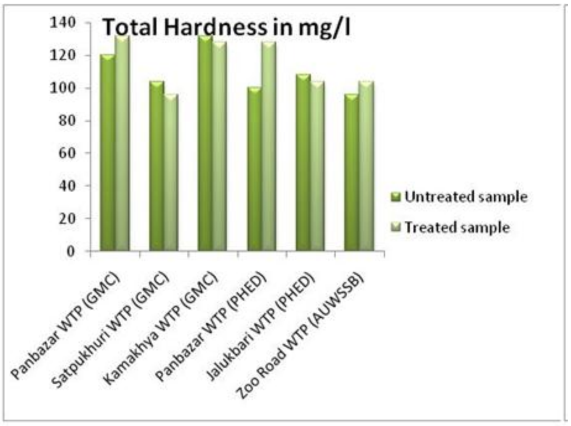

Fig. 6. Graph for total hardness (TH) of the water samples

From the graph, it can be seen that the TH values are within the limits set by BIS. For TH, the Satpukhuri WTP (GMC) proves to be the most efficient in reducing the TH content.

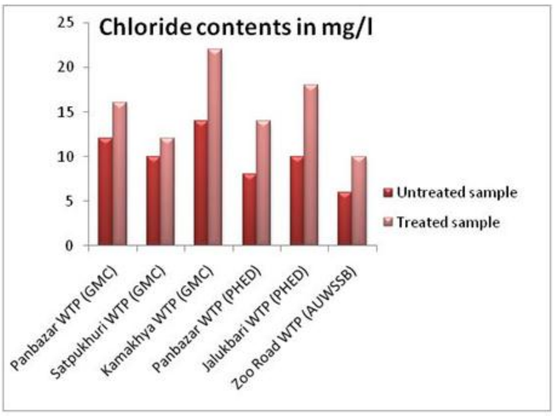

Fig. 7. Graph for chloride (Cl) contents of the water samples

For all the WTPs, no significant improvement in treatment is seen in terms of Cl content reduction. But overall, the Cl values are within the limits set by BIS.

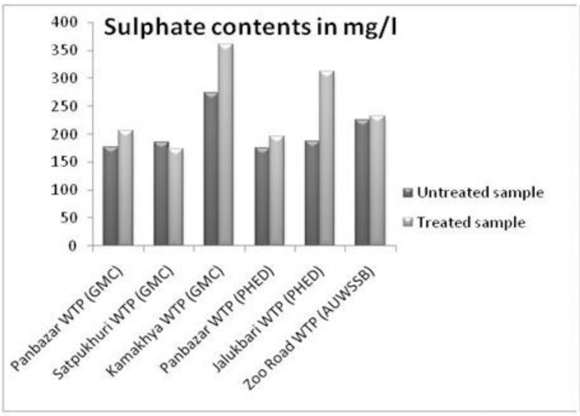

Fig. 8. Graph for sulphate (SO_4) contents of the water samples

Except Satpukhuri WTP (GMC), no WTP was efficient in treatment for reduction of SO_4 levels. Satpukhuri WTP (GMC) could reduce the SO_4 content, that too to a small extent. But overall, in all the treated water samples of the WTPs, SO_4 contents are found to be within the maximum permissible limit stated in BIS guidelines.

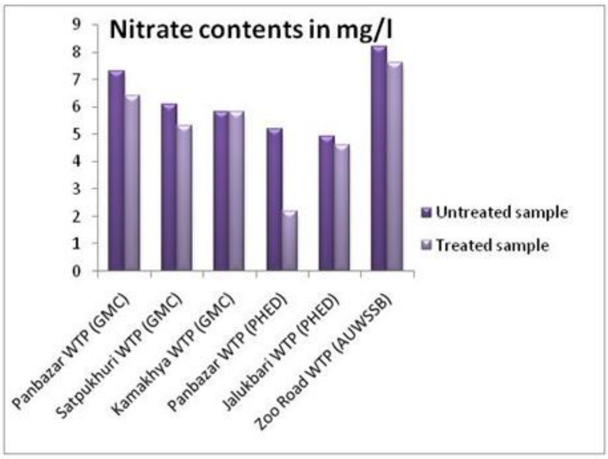

Fig. 9. Graph for nitrate (NO_3) contents of the water samples

From the graph, it can be seen that NO_3 contents are within the BIS limits. All the WTPs could reduce NO_3 levels; the most efficient being the Panbazar WTP (PHED).

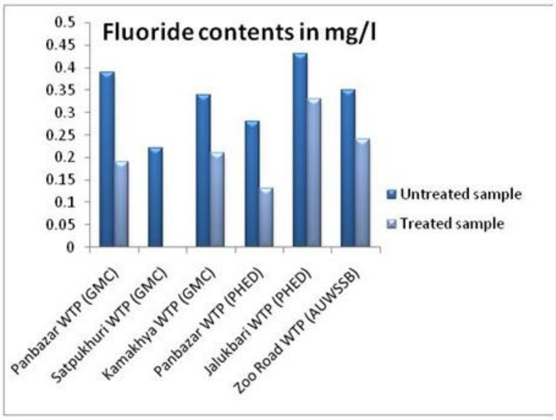

Fig. 10. Graph for fluoride (F) contents of the water samples

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For fluoride treatment, the Satpukhuri WTP (GMC) came out to be the most efficient. The Panbazar WTP (PHED and the Panbazar WTP (GMC) are also found to be efficient next to the Satpukhuri WTP. Moreover it can be seen that the fluoride levels are within the maximum permissible limit and all the WTPs were efficient in reducing fluoride contents.

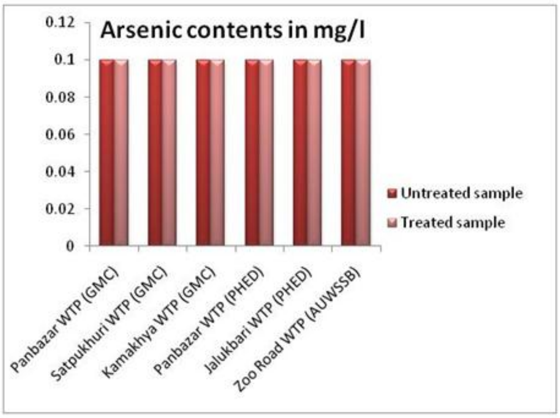

Fig. 11. Graph for arsenic (As) contents of the water samples

The results reveal that alarming high levels of arsenic, high above the maximum permissible limit, are present in all the treated water samples of the WTPs, creating a high risk for the consumers of the city of Guwahati. All the WTPs were found to be inefficient in reducing arsenic levels in treated water. This is a very serious matter and needs immediate action.

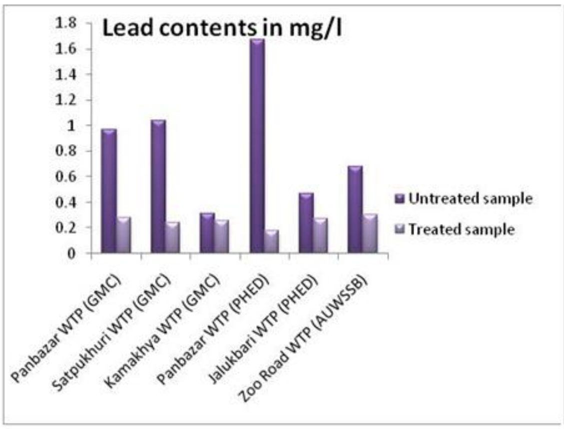

Fig. 12. Graph for lead (Pb) contents of the water samples

From the above graph, it can be seen that alarming high contents of lead is present in the treated water samples of all the WTPs, which poses great risk for the health of the consumers. Very high lead contents in raw water is reduced drastically at the Panbazar WTP (PHED), being the most efficient in reducing the toxic lead content but it could not reduce lead content level below the maximum permissible limit. All the other WTPs reduced lead contents to some amounts, but not below the maximum permissible limit.

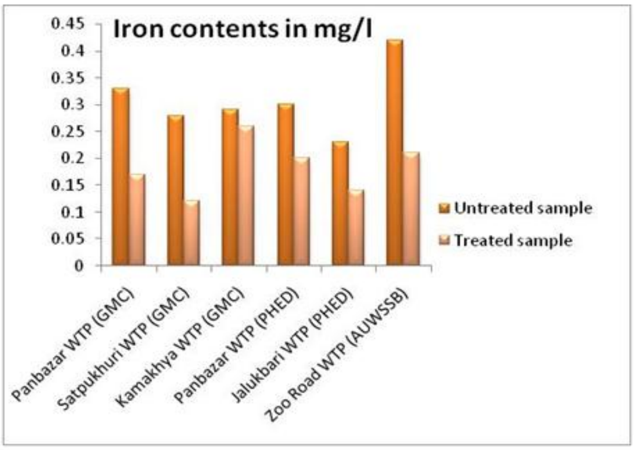

Fig. 13. Graph for iron (Fe) contents of the water samples

Iron contents were effectively reduced by all the WTPs below its maximum permissible limit; the Zoo Road WTP (AUWSSB) being the most efficient one in this regard.

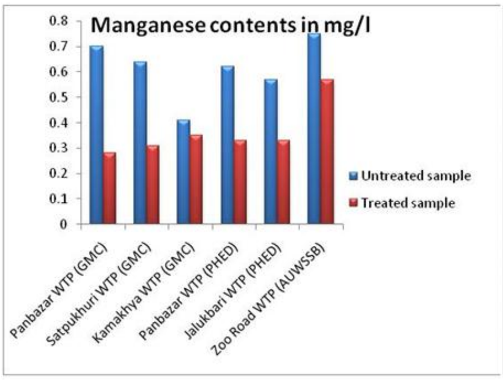

Fig. 14. Graph for manganese (Mn) contents of the water samples

High Mn content was reduced below its maximum permissible limit by the Panbazar WTP (GMC) only, being the most efficient. Rest, in all other WTPs, Mn could be reduced to some extent but not reduced below the permissible limit.

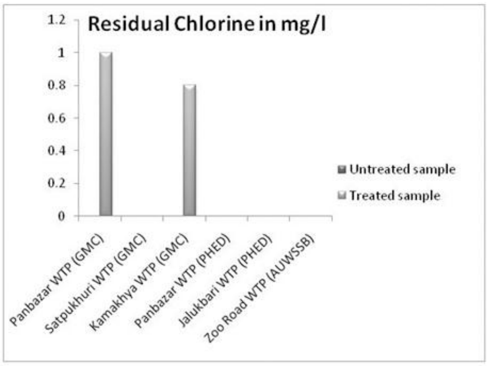

Fig. 15. Graph for residual chlorine (RCl) contents of the water samples

In the WTPs, disinfection of water is achieved using bleaching powder. Residual chlorine was found to be present in the treated water of the Panbazar WTP (GMC) and the Satpukhuri WTP (GMC) within its maximum permissible limit. This is somewhat good because it will disinfect incoming raw water in the WTPs.

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From the results, it can be observed that the treated water of all the 6 WTPs contained alarmingly high levels of arsenic and lead, far above their respective maximum permissible limits. This poses to be a very high risk factor because the treated water of these WTPs is led out for drinking purpose for the public. If such high levels of arsenic is consumed, it will lead to a dreadful disease called arsenicosis. At very high levels of lead, lead poisoning can be fatal. Manganese content levels in treated water were also found to be above its maximum permissible limit in 5 WTPs. This imparts blackish colour to water. However, when not considering these toxic parameters and the bacteriological parameter, the most efficient WTP is found to be the Panbazar WTP (PHED).

For comparing the results of analysis of the water samples (untreated and treated) collected from the 6 WTPs in the lean period of the river Brahmaputra (13th and 14th of March, 2017) when the discharge in the Brahmaputra river was lean, again the sampling was done on 2nd and 3rd of April, 2017 when the discharge in the Brahmaputra river increased substantially after heavy rainfall in the study area. The testing was done immediately and the results of analysis of the toxic water quality parameters, arsenic and lead are given in Table VI below.

TABLE VI. THE RESULTS OF THE 12 WATER SAMPLES COLLECTED FROM 6 WTPS IN GUWAHTAI CITY, ASSAM, INDIA IN APRIL 2017

Name of WTP	Sample no.	Sample type	Arsenic (mg/l)	Lead (mg/l)
Panbazar WTP (GMC)	1	Untreated	0.001	1.15
	2	Treated	0.001	0.41
Satpukhuri WTP (GMC)	3	Untreated	0	0.63
	4	Treated	0	0.40
Kamakhya WTP (GMC)	5	Untreated	0	0.66
	6	Treated	0	0.56
Panbazar WTP (PHED)	7	Untreated	0.001	1.18
	8	Treated	0.001	0.31
Jalukbari WTP (PHED)	9	Untreated	0	0.43
	10	Treated	0	0.26
Zoo Road WTP (AUWSSB)	11	Untreated	0	0.83
	12	Treated	0	0.31

Arsenic: from the analysis results, it can be seen that the arsenic levels is found to be nil for untreated and treated water samples of 4 WTPs. For Panbazar WTP (GMC) and Panbazar WTP (PHED) untreated and treated samples, the arsenic levels are found to be 0.001 mg/l, which is well below the maximum permissible limit of 0.05 mg/l.

The reduction in the levels of arsenic in the water samples of all the WTPs in the second phase of sampling and testing (2nd and 3rd of April, 2017) can attributed to the fact that due to the onset of monsoon period accompanied by heavy rainfall in the study area, the concentrations of arsenic in the river Brahmaputra water have gone down such that the levels of arsenic in the treated water pose no adverse health effects.

On the contrary, the high levels of arsenic found in the water samples of the WTPs (collected during the lean period on 13th and 14th of March, 2017) is because of the fact that the concentration of this parameter is high during the lean period of the river Brahmaputra. So testing of the treated samples of the WTPs should be done during the lean period/non-monsoon period and if high levels of this parameter are still found again, then appropriate treatment measures should be taken. Fig 16 shows the readings of the arsenic contents (in mg/l) of the treated water samples of some of the WTPs.

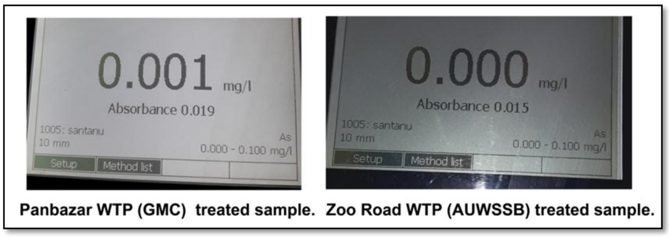

Fig. 16. Arsenic content readings (in mg/l) of the treaated water samples of some of the WTPs

Lead: from the analysis results, it can be seen that all the untreated and treated water samples of all the WTPs still have alarmingly high levels of lead. Even though the levels of lead in the treated water samples were found to be reduced but no WTP could reduce the levels of lead below the maximum permissible limit. Thus appropriate treatment measures should be taken to reduce the levels of lead below the maximum permissible limit such that it poses no adverse health effects.

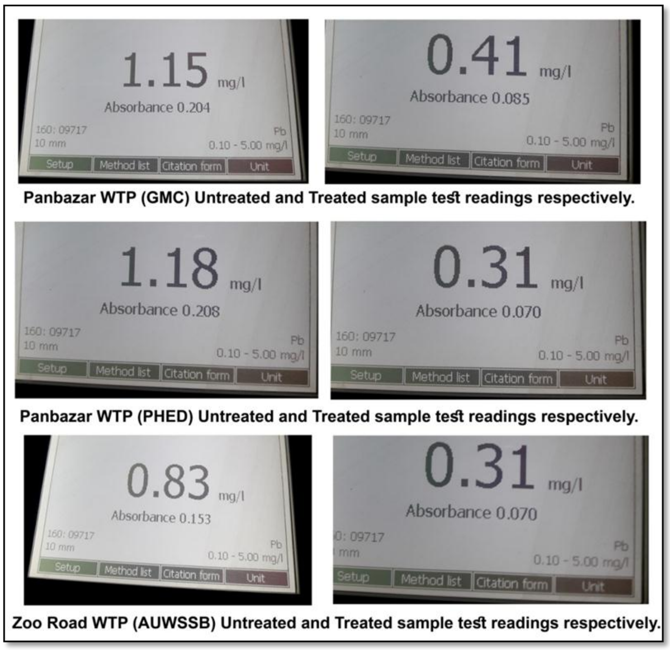

Fig. 17. Lead content readings (in mg/l) of the treaated water samples of some of the WTPs

The 6 WTPs follow the conventional methods of water treatment and so the lead levels could not be reduced below the maximum permissible limits, although could be reduced to a very small extent. Fig 17 shows the readings of the lead contents (in mg/l) of the untreated and treated water samples of some of the WTPs.

IV. CONCLUSION

As the demand for clean and potable water has grown, it has become more important to produce cleaner treated water for supply to the public. The demand for potable water has been met through better methods of removing contaminants at WTPs. Thus, water treatment is any process that makes water more acceptable for a specific end-use. The results of this study reveal that very high levels of arsenic and lead remain in the treated water samples of all the 6 WTPs, when analyzed during in the lean period of the river Brahmaputra in March 2017. Again, when again the water samples were analyzed in April 2017, arsenic levels in the treated water samples of all the WTPs were found to be within the maximum permissible limit but lead levels were alarmingly high in the treated water samples of all the 6 WTPs. This poses great risk because the end water is used for consumption needs. So, for use of the treated water of the WTPs, it should be further treated for making it potable so that the levels of these toxic parameters are reduced well below the maximum permissible limits.

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