In the present study it was observed that pH value of surface water of greater Guwahati at all sampling stations (S₁ to S₇) were found to be within the permissible limit. The temperature of surface water sample of Brahmaputra River at S₆ was recorded 2 to 3°C less than the temperature recorded at other sampling station at a particular date and time. The decrease in temperature could be due to either the glacier origin of the river or mixing the bottom water with surface water. The alkalinity values were also within the permissible limit prescribed by BIS and ICMR. The EC values of surface water samples under study are quite safe for irrigation. In the present study BOD values in all sampling stations were found to be beyond the accepted standards of surface water. The COD values of surface water at some sampling stations were found to be higher than the highest desirable limit of BIS for surface water. The hardness values of all sampling stations were observed to be within the desirable limit prescribed by WHO and ISI. According to the degree of hardness the surface water of all sampling stations excepting S₁ may be classified as soft water. In the present investigation, the calcium concentration at different sampling stations was found to be within the permissible limit prescribed by WHO and ISI for surface water. The magnesium concentration in the all sampling stations during the study period was found to be within the permissible limit for survival of aquatic organism remains in fresh
water. Oil and grease was found only in three sampling stations (S₁, S₂, and S₆), the values of which were below the standard limit as prescribed by BIS for surface water. The phenolic compound was found only in three stations (S₁, S₂ and S₇) these concentrations were above the limit prescribed by US Public Health Service. (0.001mg/l) In the present investigation the maximum chloride concentration was found 75 mg/l at the sampling station S₁, S₂ and S₅. The value was much below the tolerance limit of surface water used for irrigation.(600mg/l).The sulphate concentration in the study was found to be within the desirable limit for survival of aquatic organism.

The bulk density values of bed sediment at S₁ showed the accumulation of organic matter on the bed sediment. The average pH value of bed sediment at S₁ showed that soil become alkaline due to the deposition of materials from effluent. The electrical conductivity of bed sediment samples showed that the samples were contaminated to certain extent with respect to inorganic salts. The average value of organic carbon content of the bed sediment samples indicates the higher organic pollution load in some sampling stations.

The concentration of Pb in surface water samples during phase I were well below the one–hour average concentration limit, 0.034 µg/ml at hardness 50 mg/l for USEPA water quality criteria for protection of fresh water aquatic life, except S₁ where upper range of concentration exceed the limit. But concentration of Pb in surface water sample during phase II in higher range at all sampling
stations was above the one-hour average concentration limit, 34.0 $\mu$g/l (0.034 $\mu$g/ml) at hardness 50 mg/l for protection of fresh water aquatic life. Pb, mostly comes to the environment from Pb compound used in gasoline as additives, paint and pigment, and Pb storage batteries. The use of lead is increased day to day in different activities. Therefore, surface water sample contains higher concentration of Pb in later part of the study. (Phase II)

The values of Mn in surface water sample during phase I were well below the recommended value of USEPA of 0.1-1 $\mu$g/ml provided for protection of fresh water aquatic life. In the phase II study period the concentration of Mn in water sample was also within the recommended value of USEPA of 0.1-1 $\mu$g/ml provided for fresh water aquatic life. Since the values were within the limit therefore, the toxicity to aquatic life was not expected to occur.

The values of Ni in surface water sample during phase I study period were below the twenty-four-hour average concentration limit 0.056 $\mu$g/ml at hardness of 50 mg/l recommended value of USEPA for freshwater aquatic life. The result of the study reveals that in the phase II the higher concentration range of Ni in surface water of $S_3$ (0.108 $\mu$g/ml), $S_4$ (0.064 $\mu$g/ml), and $S_5$ (0.07 $\mu$g/ml) crossed the recommended value (0.056 $\mu$g/ml) of USEPA at hardness of 50 mg/l for protection of fresh water aquatic life. The sampling station $S_3$ and $S_4$ were in Deepar beel, which was recognize as Ramsar site. The aquatic life of Deepar beel (large stagnant water body) may be effected by the higher concentration of Ni.
Ni used as additive in gasoline and can be transported to the environment by the urban run-off after having been emitted by vehicles. Deepar beel received large amount of storm water from main city of Guwahati, which may contributed in heavy metal concentration. The sampling station $S_5$ was on the River Brahmaputra, one of the famous perennial rivers of Asia. The heavy metal concentration of River Brahmaputra alarmingly increased day to day due to pollution.

The value of Zn in surface water sample during phase I study period was below the limit not exceeded at any time $0.18 \mu g/ml$ at hardness of $50 \, mg/l$, excepting the higher range of concentration of Zn at sampling station $S_2$ ($0.54 \mu g/ml$) and at $S_3$ ($0.251 \mu g/ml$) which were crossed the hardness dependent limit recommended by USEPA for protection of fresh water aquatic life. In the phase II study period concentration of Zn in $S_4$ and $S_6$ were below the limit set by USEPA, and at $S_5$ the higher range of concentration slightly crossed the limit for protection of aquatic life. The higher range of Zn concentration in water sample at $S_1$ ($0.275 \mu g/ml$), $S_2$ ($1.15 \mu g/ml$) and $S_3$ ($0.38 \mu g/ml$) crossed the hardness dependent limit of Zn recommended by USEPA for fresh water aquatic life. ($0.18 \mu g/ml$)

Cd concentration in surface water at all sampling station was below detection limit (bdl) during the study period.
The concentration of Pb in sediment was below the limit of USEPA fresh water sediment quality criteria for typical contaminated sediment, which is 36 µg/g (TEC) and 130 µg/g (PEC) for Pb [TEC: The concentration of contaminants below which the incidence of toxicity to sediment dwelling organism was not expected to occur. PEC: Probable effect concentration of contaminants, above which the incidence of toxicity to sediment dwelling organisms was expected to occur.] Since the values are below than both limits therefore, the toxicity to sediment dwelling organisms was not expected to occur.

The concentration of Mn in sediment was well below the USEPA fresh water sediment quality criteria for typical contaminated sediment, which are 460 µg/g, (dry wt.) for TEC level (for assessing and managing sensitivity) and 1,100 µg/g, (dry wt.) for PEC level. Therefore, immediate toxicity to sediment dwelling organisms was not expected to occur. Basically, the distribution of Mn is strongly controlled by oxygen distribution and is related by inverse special distribution of DO. The exchangeable fractions will be in dominant phase in suspended sediments and residual fractions will be in dominant phase in bed sediments.

The concentrations of Zn in sediment were below the limit set by USEPA for contaminated sediment, which was 120 µg/g (TEC limit) and 460 µg/g .(PEC limit) Therefore, no toxicity was expected for observed Zn concentration to sediment dwelling organisms.
All Ni concentrations in sediment were below the limit considered by USEPA in sediment quality criteria, which was 23 µg/g, for TEC limit and 49 µg/g for PEC limit. Therefore, no toxicity expected for Zn concentration to sediment dwelling organism.

USEPA recommended sediment quality guideline values for Cd was 0.99 µg/g (TEC limit) and 5.0 µg/g (PEC limit). This value of Cd in sediment was below the recommended value (as above) of USEPA for protection of sediment dwelling organism. Therefore, toxicity to sediment dwelling organism may not occur at this concentration level of Cd in sediment.

From the determination of heavy metal content in surface water and sediment it was clear that concentration of heavy metals in sediment samples were much higher than that of surface water. The concentration of heavy metals in bed sediment samples was found in the following order Mn > Zn > Pb > Ni.

It is evident from statistical analysis of surface water data that distribution of BOD, hardness, calcium, EC, and magnesium were significantly correlated (r > 0.5) with temperature. It indicates that temperature has direct influence on BOD and hardness which is depends on salts of calcium and magnesium. No significant correlation was obtained between temperature and alkalinity, COD, chlorine, and sulphate.
A high positive correlation was obtained between alkalinity and BOD, (0.89), COD (0.833), hardness (0.693), calcium (0.69), and magnesium (0.57). A poor negative correlation was obtained between alkalinity and chloride (-0.277). BOD showed a good positive correlation with COD, hardness, calcium and magnesium. Similarly COD have a good positive correlation with hardness, calcium and magnesium. A good positive correlation of hardness with calcium, magnesium indicates hardness of water mainly due to dissolved calcium and magnesium salts. Similarly, positive correlation of hardness with electrical conductivity showed that hardness also contributes to electrical conductivity.

A total of 203 ground water samples collected from different drinking water source of greater Guwahati, were analyzed for fluoride, calcium, total alkalinity and pH. Out of the total ground water samples analyzed, 36 samples contain fluoride concentration within 1 to 8.03 mg/l. These samples mostly belong to the north-eastern part of the greater Guwahati. Out of these 36 samples, 28 samples contain fluoride concentration within 1-2 mg/l, 3 samples contain fluoride concentration within 2-3 mg/l, 2 samples contain fluoride concentration within 4-5 mg/l, one each sample contain fluoride concentration within 6-7 mg/l, 7-8 mg/l, and 8-9 mg/l respectively. Remaining part of the samples contain fluoride concentration below 1 mg/l. The analysis of ground water samples for fluoride showed that a wide variation of dissolved fluoride concentration, ranging from 0.056 to 8.03 mg/l in different parts of greater Guwahati. Higher dissolved fluoride has been found in eastern part of the city.
Highest dissolved fluoride (8.03 mg/l) has been found in Birkuchi area. This higher level of fluoride in drinking water affected the people of this area. The distribution pattern of fluoride ion concentration was obtained from GIS data base mapping. This also indicates that towards north-eastern part of the city’s ground water contain higher fluoride concentration. The contamination of ground water of Birkuchi and Narengi area with excess fluoride has caused irreversible damage to the human health result in physiological disorder such as skeletal and dental fluorosis.

Physico-chemical properties of ground water samples which were collected from seven selected sampling stations were indicated that most of the properties except few lies within the permissible limit of WHO. Fluoride concentration in $S_1$ and $S_2$ exceed the WHO permissible limit. In the present study concentration of lead was within permissible limit in four sampling stations, while in three sampling stations concentration of lead was slightly higher than the permissible limit (0.1mg/l) of ISI (1983) and WHO. The Cd concentration of four sampling stations ($S_2$, $S_3$, $S_4$ and $S_5$), slightly crossed the ISI Standard but none crossed the WHO European Standard for Cd.

In order to find out a cost effective, eco friendly and easily available material (or method) to remove the excess dissolved fluoride from drinking water a series of experiments has been conducted. For these purpose three materials namely activated charcoal, silica gel and rice husk have been chose. It
was observed that removal efficiency of activated charcoal, silica gel and rice husk were found to be in the following order activated charcoal > silica gel > rice husk in one hour of contact time with fluoridated water. Similar trends were observed for higher contact time with three materials. It was observed that rice husk lagging behind compared with other two materials at the first few hours. But it was reached at higher level after six hours of contact time. After studying the adsorption pattern of rice husk it can be concluded that the adsorption processes of rice husk probably due to the formation of single layer of adsorbed molecules which is known as chemisorptions. The adsorption processes is mainly depend on initial fluoride concentration, duration of contact time and particle size of the adsorbent molecule.

The adsorption of fluoride on different adsorbent did not involve ion-exchange mechanism; it was simply an irreversible adsorption to non-polar interaction. It is evident from the studies that the use of rice husk for the removal of fluoride from water is technically feasible. As rice husk is a better adsorbent it can be used for defluoridation before subjecting it for reverse osmosis or in ion-exchange process; thereby it increases the efficiency and life expectancy of valuable resins.

The absorption of Mn and Zn by Eichhornia Crassipes has been studied in the Laboratory at 6.5 pH. The results of absorption of metals by water hyacinth were found to be very significant. Highest % removal of Zn after 10 days was
found to be 79.2% at initial solution concentration 3.445 mg/l. The result also reveals that there is a uniform increase in the total removal of Zn from the solutions by the plant water hyacinth (Eichhornia Crassipes) with increase in initial concentration of the solution. The removal of Zinc from the solution appeared to be more efficient at lower concentration.

The highest % removal of Mn by water hyacinth for the initial concentration 3.10 mg/l was found to be 98.7%. The results reveal that the uptake of Mn by water hyacinth was found to be rapid during the first phase and in the second phase the process was slow and extended for all initial concentration of Mn.

The results of experiment of bio absorption of heavy metal from solution under controlled laboratory conditions shows that the water hyacinth is capable of being absorbing a substantial quantity of Zn and Mn in different parts of the plant. Therefore, the water hyacinth may be viable alternative for removing heavy metal from polluted water, which appears to be cost effective and eco friendly as compared to some modern methods.

From the study of bioaccumulation of selected heavy metals in field condition following conclusions has been drawn. It was observed that there was no uniformity trend in bio-accumulation of heavy metal by water hyacinth from surface water.
The average concentration (1.58 - 23.4 μg/g) and (10.7- 43.4 μg/g) of lead during the whole study period in water hyacinth samples at all sampling stations lies within the sensitive range of critical concentration for lead. (25 to 85 μg/g.) The absorption pattern of lead by water hyacinth was found to be quite complex unlike controlled laboratory experiment of bio-absorption of Pb by water hyacinth. There exist a linear correlation between the concentration of Pb in water and concentration of Pb in water hyacinth in controlled laboratory condition. However, no such linear correlation, between concentration of Pb in water hyacinth have been found in field studies as such absorption depends on several factors viz, plants species, age, temperature, light, season, pH, salinity, concentration, duration of exposure, presence of chelating agents etc.

The concentration Mn in water hyacinth samples was found to be higher during the study period than the reference sample. This result reveals that the average accumulation of Mn in water hyacinth were much higher during Aug’04 to Aug’05 as compared to Oct’02 to Aug’03 in all sampling stations. In case of enrichment ratio, an irregular trend was observed among all the sampling stations, the station S₆ has the lowest average concentration of Mn in surface water but proportionally a very high accumulation value which leads to height AF value. It was clear from the results that AF value not only depends on concentration of metal in water, but also depends on other factors. Irregular trends of AF value may be due to the fact that interacting effects, which can occur in a water medium, containing more than one metal ions as the ions compete for uptake.
FROM THE ABOVE DISCUSSION THE FOLLOWING CONCLUSION CAN BE DRAWN:

1. From the result of the analysis of surface water at seven sampling stations of greater Guwahati it can be concluded that the different values for the following parameters viz pH, EC, hardness, Ca, Mg, SO$_4^{2-}$, Cl$^-$ and Oil-grease was found to be lower than the limit prescribed by ISI / EPA for water quality standard for various class of surface water and for the protection of aquatic organism.

2. However, BOD and phenolic compounds were higher than the limit prescribed by ISI for surface water.

3. During the study period the values of Pb in all sampling stations (phase II), Zn in S$_2$, S$_3$ (phase I) and S$_1$, S$_2$, S$_3$, S$_5$ (phase II), Ni in sampling stations S$_3$, S$_4$, S$_5$(phase II) in surface water sample were found to be higher than the recommended value of USEPA provided for protection of fresh water aquatic life.

4. The values of Pb in all sampling stations (phase I), Mn in all sampling stations throughout the period, Zn in S$_1$, S$_4$, S$_5$, S$_6$, S$_7$ (phase I) and S$_4$, S$_6$, and S$_7$ (phase II) and Ni in all sampling stations (phase I) and in S$_1$, S$_2$, S$_6$ and S$_7$ (phase II) surface water sample were well below the recommended value of USEPA provided for protection of fresh water aquatic life.
5. Cd concentration in surface water at all sampling stations was below detection limit (bdl) during the study period, but the organic load and other heavy metals like Pb and Zn of the surface water concentration were more, which probably entering the water from the effluent coming from the carbon industry.

6. The higher organic load in surface water was evident from the lower value of bulk density and higher % of organic carbon and organic matter of sediment. This shows a higher organic pollution load entering into the water system from wastewater of carbon industry.

7. The value of Pb, Zn, Ni and Cd in sediment was below the recommended value of USEPA for protection of sediment dwelling organism. Therefore, toxicity to sediment dwelling organism may not occur at this concentration level of in sediment.

8. The analysis of ground water samples for fluoride showed that a wide variation of dissolved fluoride concentration, ranging from 0.056 to 8.03 mg/l in different parts of greater Guwahati. Higher dissolved fluoride has been found in eastern part of the city. Highest dissolved fluoride (8.03 mg/l) has been found in Birkuchi area. This higher level of fluoride in drinking water affected the people of this area. The distribution pattern of fluoride ion concentration was obtained from GIS data base mapping. This also indicates that towards north-eastern part of the city’s ground water contain higher fluoride concentration. The contamination of ground water of
Birkuchi and Narengi area with excess fluoride has caused irreversible damage to the human health result in physiological disorder such as skeletal and dental fluorosis.

9. Physico-chemical properties of ground water samples which were collected from seven selected sampling stations were indicated that most of the properties except few lies within the permissible limit of WHO. Concentration of lead was within permissible limit in four sampling stations, while in three sampling stations concentration of lead was slightly higher than the permissible limit (0.1mg/l) of ISI (1983) and WHO. The Cd concentration of four sampling stations (S2, S3, S4 and S5), slightly crossed the ISI Standard but none crossed the WHO European Standard for Cd.

10. To remove the excess dissolved fluoride from drinking water a series of experiments has been conducted. For these purpose three materials namely activated charcoal, silica gel and rice husk have been chosen. It was observed that removal efficiency of activated charcoal, silica gel and rice husk are found to be affective for drinking water. This indicated that the adsorption processes are rapid at higher contact time and low initial fluoride concentration. (5.8 ppm) Rice husk can be regarded as better adsorbent than silica gel (at 12 hours contact time).

The data reveals that rice husk is a good adsorbent at higher contact time. From the above discussion it is clear that the fluoride removal efficiency of three bulk materials decrease with increasing initial fluoride concentration
11. The results reveal that the uptake of Mn by water hyacinth was found to be rapid during the first phase and in the second phase the process was slow and extended for all initial concentration of Mn. The highest % removal of Mn by water hyacinth for the initial concentration 3.10 mg/l was found to be 98.7 %.

12. The results of experiment of bio absorption of heavy metal from solution under controlled laboratory conditions shows that the water hyacinth is capable of being absorbing a substantial quantity of Zn and Mn in different parts of the plant.

13. From the study of bioaccumulation of selected heavy metals in field condition following conclusions has been drawn. It was observed that there was no uniformity trend in bio-accumulation of heavy metal by water hyacinth from surface water.

The results of experiment of bio absorption of heavy metal from solution under controlled laboratory conditions shows that the water hyacinth is capable of being absorbing a substantial quantity of Zn and Mn in different parts of the plant. Therefore, the water hyacinth may be viable alternative for removing heavy metal from polluted water, which appears to be cost effective and eco friendly as compared to some modern methods.
14. The results of the surface water and sediments quality of greater Guwahati it is observed that the surface water of Deepar beel, which an internationally recognized wetland (Ramsar site), Dighalipukhuri is also historically famous pond of Guwahati is deteriorated with respect to some heavy metals like Pb, Ni and Zn were found to be higher than the recommended value of USEPA provided for protection of fresh water aquatic life. Therefore, this concentration level of heavy metals in water may be toxic to aquatic organism. The surface water of river Brahamaputra (a famous river of the world) is polluted with respect to some heavy metals.