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Long Term Monitoring of Water Quality in the Gobind Ballabh Pant Sagar in the Region around a Thermal Power Plant

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Abstract:
Gobind Ballabh Pant Sagar created in 1962 on the river Rihand is located in the state of Uttar Pradesh (24°12'9"N 83°0'29"E 24.2025°N 83.00806°E). It was commissioned for the purposes like irrigation, flood control, fishery and wildlife conservation etc. along with electricity generation. Availability of coal mines in the vicinity of the reservoir resulted in rising of many thermal power plants of different capacity. These plants use the water from reservoir for various operations like cooling and discharging effluents which contaminates the hydro-environment. For monitoring the degree of hydro-pollution a long term detailed investigation program was initiated in the year 2002. The study indicates that monitoring process clearly arrested further deterioration of water quality in the reservoir. This paper presents the detailed observations carried out in the region around one of these thermal power plants in different seasons during the period October 2002 to August 2012.

Key words*: Effluents; pH; Conductivity; Suspended matter; Fly ash; Pollution; Chloride; Total dissolved salts; Hydro-environment; Ash slurry*

1. Introduction

Gobind Ballabh Pant Sagar (GBS), also known as Rihand reservoir was created in 1962 on the river Rihand, a tributary to Sone, which in turn joins the Ganga on its right flank. The river originates from the hills of Madhya Pradesh, draining a catchment of 13 344 km^2. Rihand Dam on it is located in the state of Uttar Pradesh (24°12′9″N 83°0′29″E 24.2025°N 83.00806°E). The reservoir has a capacity of 10 625 million m^3 at the FRL of 268 m above MSL and a surface area of 46538 ha, which shrinks to 13759 ha at the dead storage (mean 30149 ha). It has a maximum length of 48 km and the mean depth at FRL is 22.8 m. Annual rate of inflow is estimated at 6 301 million m^3.During Seventies, huge quantity of good quality coal was found at very shallow depths around and close to Rihand reservoir. Large quantities of readily available reservoir water and the abundant availability of coal from nearby open cast mines led to the installation of a number of thermal power plants (TPP). For the study the region around one of these coal-fired thermal power plants situated in the northern region of GBS (ATPP) (Fig 1) have been selected for carrying out observations. The ATPP use water from the reservoir for cooling and other purposes like discharging its run off in the reservoir. The fly ash discharged by ATPP ash pond (AP) increase the percentage of suspended solids in the reservoir waters[1]. The heated water discharged from it in the reservoir increase the temperature of the reservoir (Chandra, K., R. S. Panwar and D. N. Singh, 1985) from average reservoir water. The discharge adds pollutants which change the chemical composition of reservoir water (Davies, I., 1966). For the purpose of monitoring the degree of pollution caused by ATPP, a long term detailed investigation program was initiated. The study aims at long term monitoring and highlighting the degree of pollution of reservoir water so that measures to regulate it can be timely administered to arrest multifold impacts on both biotic as well as abiotic components.

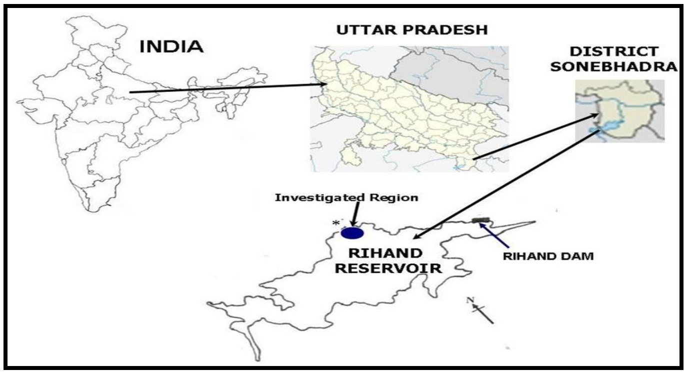

Figure 1: Location of the Investigated Region of GBS around ATPP

2. Salient Features of ATPP

The TPP is built aside Govind Ballabh Pant Sagar Lake. It has five units and all of these are coal-fired units. Three of these units have generating capacity of 210 MW each while the other two are of 500 MW each. The project would help in generation of electricity (Santosh Kumar Saini, 2011).

3. Anticipated Problems

Some of the anticipated problems associated likely to be encountered in the project, are

- Decrease in the water holding capacity of the reservoir.
- Increase in the average temperature of the reservoir water.
- Change in pH of reservoir water over a long period of time.
- Change in the total dissolved salts (TDS)
- Increase in aggressivity of water, which may affect the concrete structures.

4. Focus of Investigation

Continuous monitoring of the quality of water has been carried out for assessing the degree and rate of contamination. Following important aspects were taken into consideration during the investigation

- Quality of water in the immediate vicinity of the confluence of ash slurry from ATPP with the reservoir water.
- The quality of the ash slurry/chemical effluent water
- Identifying the number of Ash slurry samples from ATPP going into the reservoir and Reservoir water from various locations (RW) conforming/not conforming to the Central Pollution Control Board of India (CPCB) standard for Emission or Discharge of Environmental Pollutants, in a ash pond effluent - Pollution Control Acts, Rules and Notifications", (1996) and ISI standards for potable water (A.M. Shaikh, P.N. Mandre, 2009).

Suspended solid contents and pH value of the various ash slurry samples of ATPP for pollution studies was carried out apart from determining other chemical parameters.

5. Materials and Methods

Sampling location was selected for collection of ATPP AS and RW samples (Fig 1). During the period from October 2002 to August 2012 samples were collected during pre monsoon, monsoon and post monsoon periods. The samples were analyzed as per analytical procedure laid down in IS 3025-1986. Wherever necessary, reference was also made to the procedure laid down by the American Public Health Association and Water Pollution Control Federation, USA (1985).

6. Field Investigations

The in situ parameters viz. pH, Conductivity, Temperature, $CaCO_3$ Saturated pH, NH_4^+ and S^{2-} of water samples collected from various locations were determined immediately after collection of each sample.

7. Laboratory Investigations

Detailed laboratory chemical analysis was carried out on water samples collected from various locations. Chloride, Sulphate, Bicarbonate, Carbonate, Calcium, Magnesium, Sodium, Potassium, Copper, Zinc, Manganese, Lead, Chromium and Iron content is determined using state of the Art equipments like Atomic Absorption Spectrophotometer, microprocessor based flame photometer, UV Visible Spectrophotometer etc. In addition, the amount of suspended solids was also determined using gravimetric method.

8. Observations

The observed value of insitu Temperature, pH, Conductivity, Suspended solids, Bicarbonate (HCO_3^-), Chloride (Cl^-), Sulphate (SO_4^{2-}), Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Total dissolved salts for the ATPP AS and RW samples collected during different seasons is presented in Fig. 2 to Fig. 11. The ammonium content of water samples collected from various locations was found to be nil. The ammonia level of such water drastically reduces. Heavy metals like copper, manganese, iron, lead, chromium, zinc are found absent or in very low concentration.

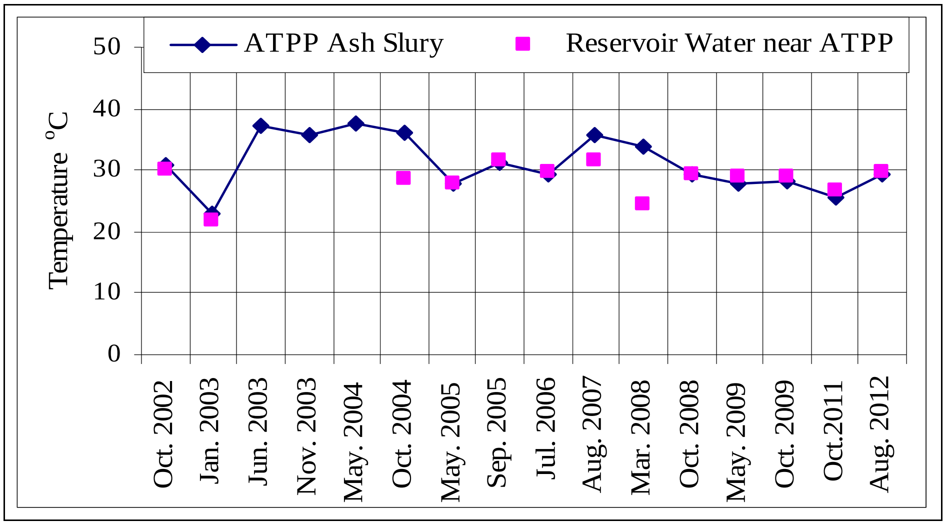

Figure 2: Insitu Temperature of Samples Collected in Different Seasons

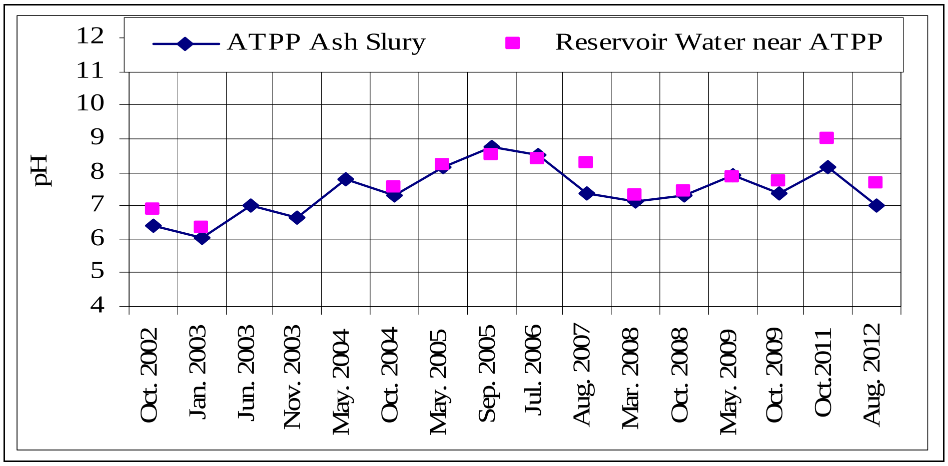

Figure 3: Ph of Samples Collected in Different Seasons

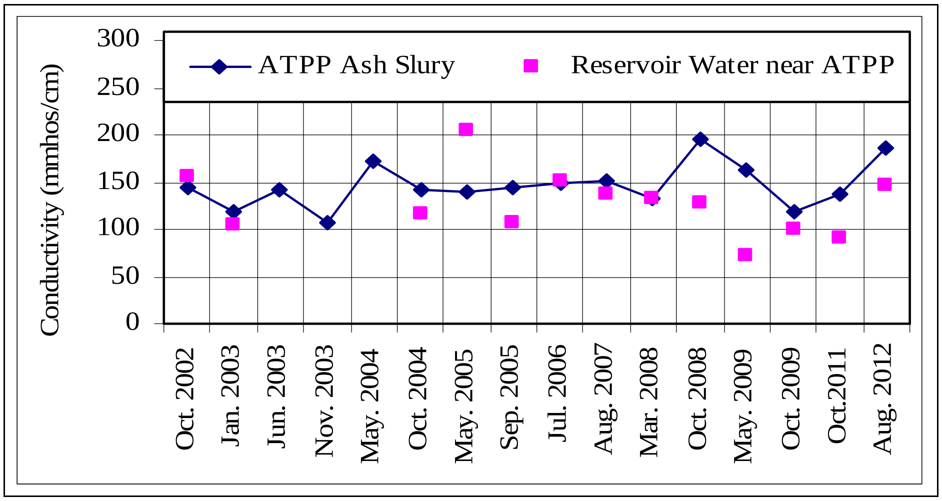

Figure 4: Conductivity of Samples Collected in Different Seasons

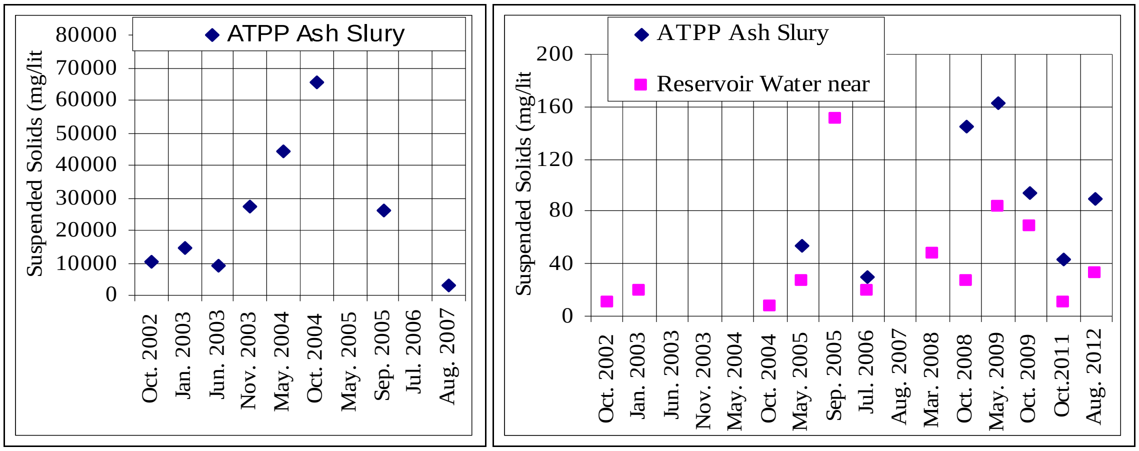

Figure 5: Results of Suspended Solids in the Samples Collected in Different Seasons

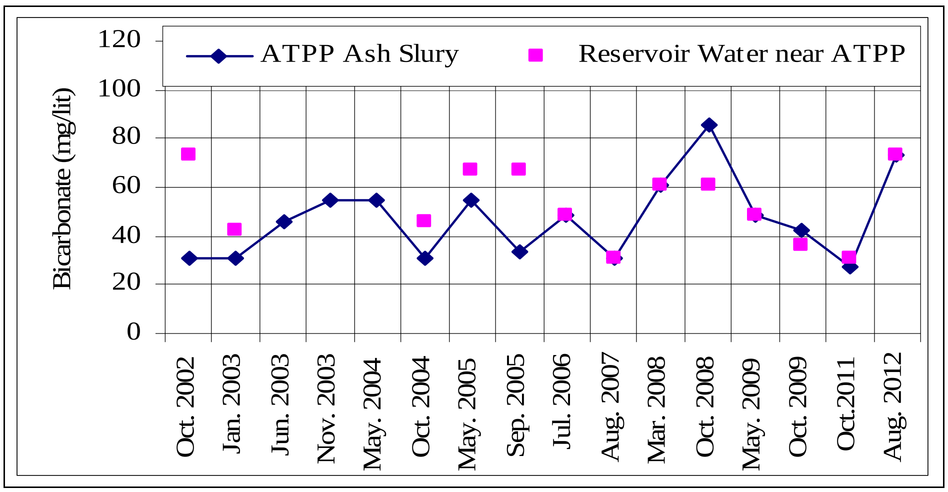

Figure 6: Results of Bicarbonate Content in the Samples Collected in Different Seasons

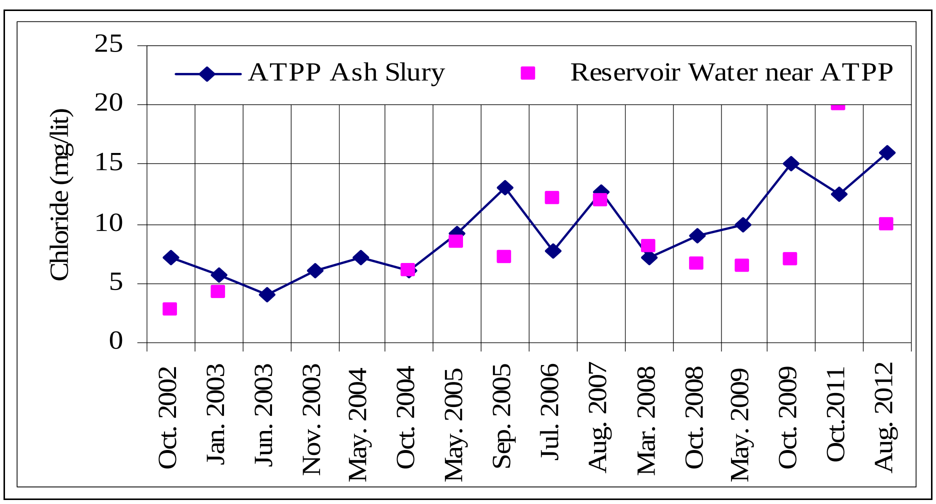

Figure 7: Results of Chloride Content in the Samples Collected in Different Seasons

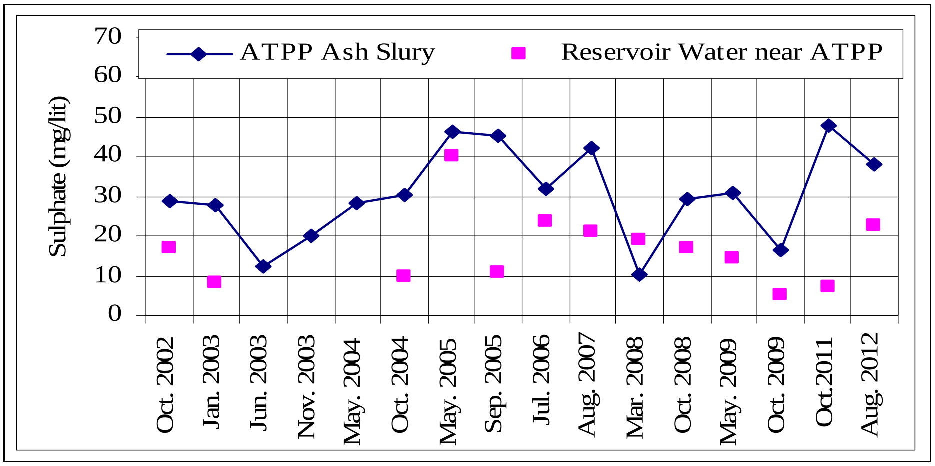

Figure 8: Results of Sulphate Content in the Samples Collected in Different Seasons

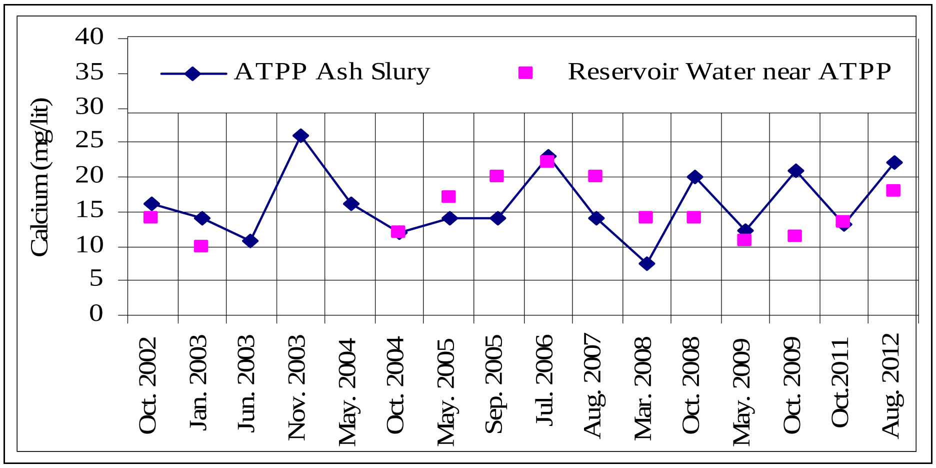

Figure 9: Results of Calcium Content in the Samples Collected in Different Seasons

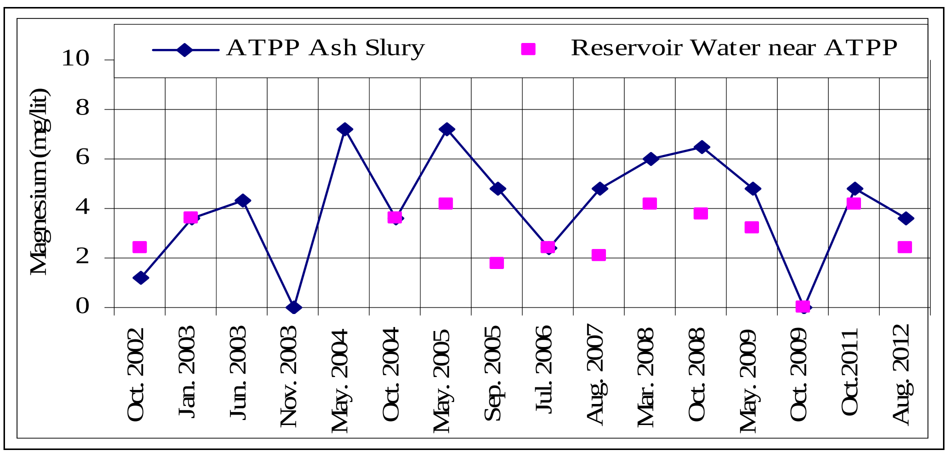

Figure 10: Results of Magnesium Content in the Samples Collected in Different Seasons

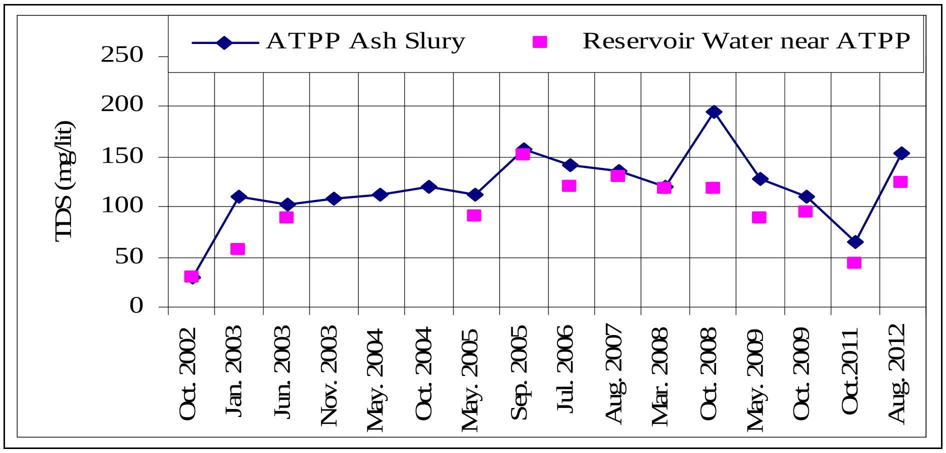

Figure 11: Results of Total Dissolved Solids in the Samples from Various Locations

9. Discussions of Results

9.1 Temperature

The main ecological consequence of heated water discharged by ATPP into the aquatic ecosystem is the increase in water temperature. Elevation of temperature of reservoir water by 8 to 10 °C has been reported by many observers. During the period of observations the average temperature of the TPP AS samples varied in the range 22.8 to 37.7°C and that of the RW samples between 21.7 to 31.7°C. Due to constant monitoring the average temperature of reservoir water has been maintained around 30°C.

9.2. Assessment of pH, suspended solids, conductivity, and total dissolved salts and chloride with respect to the standard parameters for discharge of environmental pollutants

Wastes emanating from ATPP may cause pollution hazards and ecological damage in the reservoirs. Further, it is high in total alkalinity, specific conductivity and chlorides. Results of pH, suspended solids, conductivity, total dissolved salts and chloride for the tests conducted on the TPP AS and RW samples (Investigation report on the effect of pollutants from the thermal power plants/chemical factory on the quality of water in the dam reservoir and its effects on the concrete durability for Rihand dam project, UP.", 2009, 2011, 2012a and 2012b, Central Soil and Materials Research Station, New Delh,. Sharma Pankaj et al (2012), Sharma SN, Sharma Pankaj, Pathak RP, (2012) are discussed w.r.t standard values (Table 1).

Sample	Parameter	Observed range for the collected samples	CPCB prescribed limits* and ISI prescribed limits**	Samples confirming to CPCB or ISI prescribed limits	Samples exceeding CPCB or ISI prescribed limits
TPP AS	pH	6.04 – 8.78	6.5 – 8.5*	13	3
	Suspended solids, mg/l	53.8 – 65661.0	100mg/l*	6	10
	Conductivity µmhos/cm	108 – 194.2	Less than 1500 µmhos/cm**	16	-
	Total dissolved solid, mg/l	29.6 – 195.0	500 mg/l. **	16	-
	Chloride, mg/l	4.0 – 13.10	200 mg/l**	16	-
RW	pH	6.33 – 8.99	6.5 – 8.5*	12*	1
	Conductivity µmhos/cm	71.3 – 205	Less than 1500 µmhos/cm**	3	10
	Total dissolved solid, mg/l	28.8 – 152	500 mg/l. **	13	-
	Chloride, mg/l	2.8 – 20.0	200 mg/l**	13	-
	Suspended solids, mg/l	6.8 – 83.5	100mg/l*	12*	1

Table 1: Assessment of TPP AS and RW Samples W. R. T. Recommended Standards

10. Conclusion

Sensing these concerns as raised by many authors a long term detailed investigation program was initiated for the purpose of monitoring the degree of pollution caused by ever growing industries. Constant monitoring of the hydro-environment in GBS in the region around ATPP has arrested further deterioration in the quality of the reservoir water.

11. Acknowledgement

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