CSE Study on Textile Pollution in Pali

CONTENTS

1. POLLUTION MONITORING LABORATORY OF CSE

The Centre for Science and Environment (CSE), a non-governmental organization based in New Delhi, has set up the Pollution Monitoring Laboratory (PML) to monitor environmental pollution. PML is an ISO 9001:2008 accredited laboratory certified by SWISSCERT Pvt. Ltd. for conducting Pollution Monitoring and Scientific Studies on Environmental Samples. The Laboratory has highly qualified and experienced staff that exercise Analytical Quality Control (AQC) and meticulously follow what is called Good Laboratory Practices (GLP). It is equipped with most sophisticated state-of-the-art equipments for monitoring and analysis of air, water and food contamination, including Gas Chromatograph with Mass Detector (GC-MS), Gas Chromatograph (GC) with ECD, NPD, FID and other detectors, High Performance Liquid Chromatograph (HPLC), Atomic Absorption Spectrometer (AAS), UV-VIS Spectrophotometer, Mercury Analyzer, Respirable Dust Sampler etc. Its main aim is to undertake scientific studies to generate public awareness about food, water and air contamination. It provides scientific services at nominal cost to communities that cannot obtain scientific evidence against polluters in their area. This is an effort to use science to achieve ecological security.

2. INTRODUCTION

The degradation of surface and groundwater quality due to industrial and urban waste has been recognized for a long time (Olayinka 2004). The rivers and stream are the common recepients of industrial effluent all over the world. The deterioration in water quality has an adverse effect on human beings as well as aquatic ecosystem directly or indirectly (Chinda *et al*. 2004; Ugochukwo 2004; Emongor *et al*. 2005). The current practice of any industrial unit is to discharge wastewater into local environment without any treatment. The untreated or partially treated effluent on entering a water body either gets dissolved or lie suspended on river bed, thereby causing the pollution of water body (Panda *et al*. 2006). Industries are tempted to assume that they cannot avoid large volumes of wastewater produced during major industrial operations and therefore, they become lax in pollution prevention. One essential step in water pollution is precise assessment of pollution status of every individual unit and its potential for improvement. Thus the first step in a pollution prevention strategy for water resource is a thorough audit and characterization of wastewater from industrial operations (Wood 1992). The textile industry is classified into three main categories

1) Cellulose fibres (cotton, rayon, linen, ramie, hemp and lyocell),
2) Protein fibres (wool, angora, mohair, cashmere and silk)
3) Synthetic fibres (polyester, nylon, spandex, acetate, acrylic, ingeo and polypropylene).

In this context, Pali city is known for its textile, dyeing and printing work. It is the administrative headquarter of Pali district of Rajasthan state. Situated on the banks of river Bandi, This city lies between 24° 42’ 43” to 25° 55’ N latitude and 72° 50’ 45” to 73° 28’ 30” E longitude. The textile dyeing and printing units situated at Pali have been discharging effluents in the river Bandi. Water quality of river Bandi is severely polluted (Rathore 2011). At present more than 800 industrial units are carrying out dyeing and printing of cotton and synthetic clothes on large scale (Rathore, 2012).

3. REVIEW OF LITERATURE

Textile and Clothing (T&C) is one of the largest and oldest industries present globally (Gereffi, 2002). However, the textile industry is considered to be one of the biggest threats to the environment. The various processes carried out in the textile industries produce large amounts of gas, liquid and solid wastes. The textile industry uses a variety of chemicals and a large amount of water for all of its manufacturing steps. About 200 L of water are used to produce 1 kg of textile.

In the year 2012, Paul et al. selected six textile industries in East region of Solapur city for analyzing the major pollution indicator parameters namely BOD, COD, TDS, sulphide, sulphate, chloride, hardness, alkalinity, calcium and magnesium. They reported upto 1548 ppm COD, 7072 ppm TDS, 79 ppm sulfide, 2750 ppm chloride and 912 ppm sulphate for different textile units of Solapur.

As per the report by Rathore (2012), around 49 MLD (Million Litres/Day) of combined effluent from more than 800 texile dyeing and printing industries with domestic sewage is being discharged in Bandi river at Pali. The physicochemical parameters Cl^-, SO_4^{2-}, NO_3^-, suspended solids, chemical oxygen demand and biological oxygen demand assessed in the combine effluent were higher than the recommended standards for discharge of industrial effluent by BIS. The overall pollution load in Bandi river in terms of chemical oxygen demand, biological oxygen demand, suspended solids and total alkalinity is 57,520 kg/ day 38,160 kg/day, 61,950 kg/day and 74570 kg/day respectively. Therefore, the pollution load estimated clearly illustrates the environmental degradation in the study area to a great extent.

In addition to this, Pali city is one of the critically polluted areas identified by CPCB in 1998. These textiles and dying industries discharge their treated and untreated residual wastes directly into the Bandi river that flows from east to west. Due to this discharge, the river water acquired an organic, pungent smell, dark color, high alkaline pH, very low dissolved oxygen, high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and high amounts of total suspended / dissolved and volatile solids (TDS) (Bhadra, 2013).

The study by Dutta and Singh (2014) revealed that the groundwater samples of Pali, industrial area has shown alkaline nature and chemical parameters – COD, BOD, total dissolve solids electrical conductivity, chloride and Cr have exceeded the maximum discharge limits laid down by Bureau of Indian Standards , rendering wells in the area unfit for drinking and even for irrigation. The soil in this area has also become hard and infertile.

3.1 Treatment of textile effluents

Several primary, secondary and tertiary treatment processes have been used to treat these effluents. These included flocculation, chemical coagulation, simple sedimentation, aerated lagoons, aerobic activated sludge, trickling filters, reverse osmosis and electrodialysis. However, these treatments are not found effective against the removal of all dyes and chemicals used in the industry (Al-Kdasi *et al*., 2004; Eswaramoorthi *et al*., 2008). These effluents do not only contain high concentration of dyes, but also contain the chemicals used in the various processing stages. Some trace metals such as Cr, As, Cu and Zn are present in these effluent and are capable of causing several health problems including haemorrhage, ulceration of skin, nausea, severe irritation of skin and dermatitis (Nese *et al*., 2007). Textile effluents are also found to contain other organic and microbial impurities (Laxman, 2009).

4. Environmental Impacts of Textile Effluent

The characteristics of textile effluents vary and depend on the type of textile manufactured and the chemicals used. The textile wastewater effluent contains high amounts of agents causing damage to the environment and human health including suspended and dissolved solids, biological oxygen demand (BOD), chemical oxygen demand (COD), chemicals, odour and colour. Most of the BOD/COD ratios are found to be around 1:4, indicating the presence of non-biodegradable substances (Arya and Kohli, 2009).

The textile effluents contain trace metals like Cr, As, Cu and Zn, which are capable of harming the environment (Eswaramoorthi *et al*., 2008). Dyes in water give out a bad colour and can cause diseases like haemorrhage, ulceration of skin, nausea, severe irritation of skin and dermatitis (Nese *et al*., 2007). The suspended solid concentrations in the effluents play an important role in affecting the environment as they combine with oily scum and interfere with oxygen transfer mechanism in the air-water interface (Laxman, 2009).

Human exposure to textile dyes has resulted in lung and skin irritations, headaches, congenital malformations and nausea (Mathur *et al.*, 2005). Textile dyestuffs are found to contain a large amount of organic substances which are difficult to degrade and are resistant to aerobic degradation (Nese *et al*., 2007). They are also found to be reduced into carcinogenic agents under anaerobic conditions (Jain *et al*., 2003).

Inorganic substances in the textile effluents make the water unsuitable for use due to the presence of excess concentration of soluble salts. These substances even in a lower quantity are found to be toxic to aquatic life (Tholoana, 2007). Some of the inorganic chemicals like hydrochloric acid, sodium hypochlorite, sodium hydroxide, sodium sulphide and reactive dyes are poisonous to marine life (Blomqvist, 1996; Tholoana, 2007). The organic components are found to undergo chemical and biological changes that result in the removal of oxygen from water (Tholoana, 2007).

5. OBJECTIVE OF THE STUDY

The main objective of the present study was to evaluate the status of pollution in Pali caused by textile industries, as Pali is an important industrial area of Rajasthan where a number of textile industries are active.

6. MATERIALS AND METHODS

6.1 Sampling

A total of fifteen water samples were collected from different places in Pali. Appropriate preservatives were added during the sampling and brought to the laboratory for analysis. Details of the samples are given in Table 3 (ANNEXURE I).

6.2 Equipments

- Atomic Absorption Spectrometer (Thermo) Solar M-6 Series (AAS)
- UV-Visible Spectrophotometer (Agilent Carry 100 Model)

- Microwave Assisted Digestion System, Milestone, Start D
- Water bath

6.3 Chemicals

All the acids and reagents – nitric acid, hydrochloric acid, sodium hydroxide etc. used for the analysis were of analytical grade and purchased from Merck. Ultrapure water was used from Elga USF Maxima Ultra Pure Analytical Grade DI Water System.

6.4 Glassware

Different glasswares used *viz.* beakers, volumetric flasks, conical flasks, funnels, pipettes, watch glasses and glass rods were obtained from Borosil. The volumetric flasks and pipettes used, were calibrated. All the glasswares were cleaned with detergent followed by 10 % nitric acid and rinsed thoroughly with distilled water before use. All the glasswares used in the estimation of phenols were cleaned with detergent and rinsed thoroughly with tap water followed by distilled water. Thereafter, glasswares were washed with chloroform and dried before use.

6.5 Standards

Standards for zinc, nickel and chromium were purchased from Merck.

6.6 Determination of Physico-chemical Properties of Water

Total dissolved solids, chloride, sulphate were determined by using the standard methods published jointly by American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF) 99. The chemical oxygen demand (COD) of all the samples was determined by using the reagents procured from Merck and the methodology followed corresponds to the ISO 15705 and is analogous to EPA 410.4 and APHA 5220 D.

6.6.1. Analysis of phenolic compound in Water samples

To determine phenolic compounds the samples were distilled. A total of 500 mL sample was taken and its pH was adjusted to 4.0 with H_3PO_4 solution. After collecting 450 mL distillate the process of distillation was stopped till boiling ceased. Further, 50 mL of warm water was added to distilling flask and distillation was continued until a total of 500 mL was collected. The distillate volume must ultimately be equal to that of the original sample.

Thereafter, 100 mL of distillate was taken as sample and 100 mL of double distilled water as blank into 250 mL conical flask. In both the flasks (containing the sample and the blank), 2.5 mL of 0.5 N NH_4OH solution was added and the pH was adjusted to 7.9 ± 0.1 with phosphate buffer (pH 6.8). Subsequently, 1.0 mL of 4-aminoantipyrine solution (2 %) was added and mixed well. Later, 1 mL of 8 % $K_3Fe(CN)_6$, was added & mixed properly. This solution was kept for 15 min for color development finally the absorbance of samples were measured at 500 nm against reagent blank.

6.6.2. Analysis of sulphides in Water samples

Sulfides were analyzed by iodometric method. In this method all the samples containing zinc acetate as the preservative were firstly subjected to filtration using filter paper. The precipitate recovered after filtration was then dissolved in 200 mL of the sample followed by the addition of 2 mL of hydrochloric acid (6N). Further, iodine solution was added to the mixture till the color retains. This mixture was then back titrated with sodium thiosulfate solution by adding a few drops of starch indicator. The point at which the blue colour disappears was considered as the end point and was noted.

6.7 Digestion and Analysis of Heavy Metals in Water by AAS

6.7.1 Zinc, Nickel and Chromium in Water: Samples were digested in a microwave assisted digestion system following the EPA method 3051A and analyzed in flame AAS.

7. RESULTS AND DISCUSSION

In view of the presence of a large number of textile industries in Pali region, the physicochemical (*viz.* estimation of pH, DO, TDS, EC, COD, chlorides, sulfides, sulphates and phenolic compounds) and heavy metal analysis (Zn, Ni and Cr) of water samples was carried out.

7.1. Surface water

A total of five surface water samples were collected and analyzed for various physicochemical properties as well as for heavy metal analysis. Results of these analysis were compared with the Indian standards for surface water (ISI-IS: 2296-1982). As per to this standard, there are five classes of surface water. Different classes of surface water are presented in Table 4.

Table 4: Different classes of surface water

Classification	Type of use
Class A	Drinking water source without conventional treatment but after disinfection
Class B	Outdoor bathing
Class C	Drinking water source with conventional treatment followed by disinfection.
Class D	Fish culture and wild life propagation
Class E	Irrigation, industrial cooling or controlled waste disposal

7.1.a Physicochemical analysis of surface water samples

7.1.a.i) pH & DO: Observations presented in Table 5 clearly reveal that out of 5 surface water samples, 80 % of the samples *i.e.* 4 (sample code – X, XI, XIII, XIV) have pH and DO above the limit of Indian Standards for surface water (ISI-IS: 2296-1982). As per to this standard, these samples do not fall under any class of surface water (*i.e*. A, B, C, D and E). However, sample code I (Bandi U/S river) falls under the limit of this standard therefore can be used for any sort of work related to surface water.

7.1.a.ii) TDS & Electric conductivity: As far as the total dissolved solids (TDS) and electric conductivity (EC) values in surface water samples are concerned, none of the five samples showed their TDS and EC value within the standard limit. This indicates that all these five samples cannot be used under any category of surface water.

7.1.a.iii) COD: Analysis of chemical oxygen demand (COD) in all the five samples showed COD in the range of 219 – 1330 ppm. Wherein, maximum COD was observed in sample XI (D/S river 30 Km Jaitpur) and minimum COD was observed in sample code I (Bandi U/S river). The results of COD analysis showed that these values are either closer or even higher than the permissible limit of **effluent standards**. Thus, cannot be considered as good enough to be used as surface water.

7.1.a.iv) Chloride: On analyzing chloride content in all the five surface water samples, it was observed that, none of the sample had the chloride content within the limit of the Indian standards, showing that these samples can neither be used for drinking and bathing nor for irrigation.

7.1.a.v) Sulfide: Sulfide content analysis of all the five surface water sample shows a varied degree of response in the range of 0.7 – 30.2 ppm. Here, sample code I, XIII showed the sulfide content of 0.7 & 1.3 ppm. In addition to this sample code XV, XI showed the total sulfide content of 9.1 and 16.1 ppm. On the other hand, a much higher sulfide content of 30.2 ppm was observed in sample code X (D/S river 15 Km Raopawas/Karel road). However, these data cannot be compared with the standards as there are no standards for sulfide content in surface water.

7.1.a.v) Sulphate: Analysis of sulphate content in the surface water samples revealed that all the samples can be use for Irrigation, industrial cooling or controlled waste disposal (Class E) but not for the other surface water uses. However, sample code X (D/S river 15 Km Raopawas/Karel road) can be used as Drinking water source under class A and C of Indian Standards for surface water (ISI-IS: 2296-1982). On the other hand, sample codes I, XI, XIII and XIV cannot be used under any of these surface water categories (ISI-IS: 2296-1982).

7.1.a.vi) Phenolic compounds: On evaluating the presence of phenolic compounds, it was observed that the phenolic compounds are not detected in all the five surface water samples. Indicating that on the basis of phenolic compounds these samples (surface water) can be used under all classes (A, B, C, D, E).

7.1.b Heavy metal analysis of surface water samples

All the five surface water samples were also evaluated for heavy metals (Zn, Ni & Cr) using Atomic Absorption Spectrophotometer (AAS). However, results show that, none of the heavy metals (Zn, Ni & Cr) were detected in all the five samples. As per to the results of heavy metal analysis, all these five samples can be used for different surface water usage as suggested by Indian standards for surface water.

7.2 Drinking water

The physicochemical analysis and evaluation of heavy metals was carried out for the total of three drinking water samples. These samples were collected from drinking g/w near CETP 4 (sample code IX), open well 30 Km, Jaitpur (sample code XII), open well Nehra village (sample code XV). Observations recorded were further compared with the Indian standards [IS-10500:1991 (Ammended)]. Results obtained are presented in Table 5.

7.2.a. Physicochemical analysis of drinking water samples

7.2.a.i) pH: On checking the pH of the three drinking water samples, it was found that all the samples are well within the range of Indian standards *i.e.* 6.5 – 8.5. Suggesting that on the basis of pH the water is fit for drinking.

7.2.a.ii) DO: Further, the dissolved oxygen in these samples were also evaluated and were found to be in the range of 0.24 – 3.3. Wherein, maximum DO was observed in samples code IX (Drinking g/w near CETP 4) and minimum level was observed in sample code XV (Open well Nehra village). However, data cannot be compared due to the lack of standards.

7.2.a.iii) TDS: Analysis of total dissolved solids (TDS) revealed that, the dissolved solids in all the three samples are more than the limits suggested by Indian standards [IS-10500:1991 (Ammended)]. Therefore, as per the TDS results these samples are not fit for drinking.

7.2.a.iv) Electric conductivity: The electric conductivity in all these drinking water samples have been observed to be in the range of 1.6 – 10.2. Wherein, higher conductivity of 10.2 and 10.0 mS was observed in sample code XII (Open well 300 Km Jaitpur) and XV (Open well Nehra village). However, lesser conductivity of 1.6 mS was observed in sample code IX (Drinking g/w near CETP 4).

7.2.a.v) COD: On analyzing the chemical oxygen demand (COD) of all the drinking water samples it was found, that the COD of sample code XII (Open well 30 Km Jaitpur) is quite higher (938 ppm). On the other hand the COD of sample code IX and XV is observed to be 230 and 358 ppm, respectively.

7.2.a.vi) Chloride: Chloride content analysis of all these drinking water samples revealed that sample code IX (drinking g/w near CETP 4) is fit for drinking as the chloride content in this sample (230 ppm) is well within the standards limit (250 ppm). However, the chloride content of sample code XII and XV is quite higher *i.e.* 1857 and 2898 ppm, respectively. Therefore, cannot be considered as fit for drinking.

7.2.a.vii) Sulfide: Analysis of sulfide content in drinking water samples reveal that sulfide is not present in sample code IX (Drinking g/w near CETP 4). However, a higher sulfide content of 24.1 ppm was observed in sample code XV (Open well Nehra village). On the other hand very low sulfide content of 0.3 ppm was observed in sample code XII (Open well 30 Km Jaitpur). All the value obtained for sulfides are much higher than the limit of the standard (0.05 ppm).

7.2.a.viii) Sulphate: Thereafter, sulfate analysis of these samples was carried out and it was observed that the sulfate content in sample code IX (45.2 ppm) is well within the limits of standard (200 ppm). However, in sample XII and XV this level is 480 and 627 ppm, respectively which is much higher than the limit, showing these samples are not fit for drinking.

7.2.a.ix) Phenolic compounds: Analysis of phenolic compounds in these drinking water samples revealed that the phenolic compounds in these samples are not detected.

7.2.b. Heavy metal analysis of drinking water samples

On analyzing the heavy metals (Zn, Ni and Cr) in these drinking water samples through AAS, it was observed that none of the above mentioned heavy metals were detected in all the three drinking water samples.

7.3 Textile effluent

A total of seven textile effluent samples were collected from the inlets and outlets of common effluent treatment plant (CETP) 1, 2, 3 and 4. All these seven samples were subjected to different physicochemical as well as heavy metal analysis. Results of all these analysis are presented in detail in Table 5.

7.3.a. Physicochemical analysis of textile effluents

7.3.a.i) pH: With respect to the pH analysis of all the textile effluents, it was found that the pH of these samples is in the range of 7.5 to 12.2. Out of total 7 textile effluent samples analyzed, 71 % *i.e.* five samples (sample code II, V, VI, VII and VIII) showed pH 9.1 – 12.2, which is higher than the CPCB standards for the pH of textile effluents. On the other hand, 29 % samples (sample code III, IV) showed their pH as 7.5 and 8.1, respectively which is well within the limits of CPCB standards for textile effluents.

7.3.a.ii) DO: Dissolved Oxygen profile for all the textile effluents, showed that the dissolved oxygen level in all these samples is very low (>1 ppm) indicating that these samples are highly polluted.

7.3.a.iii) TSS: While analyzing the total suspended solids in all the textile effluents, it was observed that, all these samples showed higher TSS values in the range of 1220 – 7840 ppm which far more than the limit set by CPCB for textile effluents. As per the CPCB standards of TSS, these samples are highly polluted.

7.3.a.iv) Electric conductivity: Furthermore, the electric conductivity analysis showed conductivity to be in the range of 10.8 to 13.3 mS.

7.3.a.v) COD: The COD analysis showed that all these effluent samples have very high COD level (in the range of 684-2826 ppm), which is far more than the CPCB standards. These results indicate that the samples are highly polluted.

7.3.a.vi) Chloride: Analysis of chloride content in different samples showed higher levels of chloride in different samples ranging from 464 – 2415 ppm. Wherein, maximum level was observed in sample no. III (CETP 1 outlet) and minimum in sample code (CETP 4 outlet).

7.3.a.vii) Sulfide: On analyzing sulfides in the samples, it was observed that the level of sulfide was found to be above the permissible limit in approximately, 71 % of textile effluent samples. However, in sample code II (CETP ½ inlet) and III (CETP 1 outlet), sulfide content was not detected. These results show that as per to the sulfide analysis, except sample code II and III, all the other textile effluents were found to be polluted.

7.3.a.viii) Sulphate: Out of the total seven effluent samples analysed, 3 samples (II, III and IV) showed the sulphate content to be more than 1000 ppm. However, in sample V, VI and VII, the amount of sulphate was found to be 802, 855 and 857 ppm, respectively. On the other hand, in sample code VIII (CETP 4 outlet), the sulphate content is observed to be 397 ppm. However, the data cannot be compared with the standards due to the lack of standard limits for textile effluents.

7.3.a.ix) Phenolic compounds: Phenolic compounds were also estimated in all the effluent samples and it was observed that in sample code VIII (CETP 4 outlet) the phenol content (1.7 ppm) was found, which is much higher than the standard limit of CPCB (1.0 ppm). However, the phenol content found in sample code III, V, VI and VII, is well within the standard limit of CPCB. On the other hand, it was also observed that in sample code II (CETP ½ inlet) and IV (CETP 2 outlet), phenolic compounds were not detected.

7.3.b. Heavy metal analysis of textile effluents

Along with the physicochemical analysis, all the textile effluent samples were also subjected to heavy metal analysis, wherein Zn, Ni and Cr were analyzed. As per the results, it was observed that Ni was not detected in any of the textile effluent. Similarly, in sample code II, III and IV, Zn and Cr was not detected. However, in sample code V, VI, VII and VIII Zn and Cr was detected, wherein the amount was well within the limit of CPCB standards.

8. CONCLUSIONS

- Out of the total five surface water samples, 80 % (four) are not fit to be used under any class of surface water (ISI-IS: 2296-1982) on the basis of the higher values obtained for their pH, DO, TDS, electric conductivity, COD, chloride, sulfide and sulphate analysis.
- Sample code IX (drinking g/w near CETP 4) is inferred to be fit for drinking on the basis of the results obtained for its pH, TDS, EC, chloride, sulfide, sulphate, phenolic compounds and heavy metal analysis. However, sample code XII (Open well 30 Km, Jaitpur) and XV (Open well Nehra village) were not found to be fit for drinking.
- Among all the textile effluent samples analyzed, approximately, 80 % of the samples were found to be highly polluted as per the results obtained for their pH, DO, TDS, COD, chloride, sulfide and sulphate analysis. These results were compared with the standards of CPCB for textile effluents.
- Phenolic compounds were detected in sample code III (CETP 1 outlet), V (CETP 3 inlet), VI (CETP 3 outlet) and VII (CETP 4 inlet), and their values were within the range of the standard limit.
- However, the content of phenolic compounds detected in sample code VIII (CETP 4 outlet) were higher than the permissible limit (1.0 ppm) *i.e.* 1.7 ppm.

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10. ANNEXURES

Annexure I : Details of water samples collected from Pali, Rajasthan (Table 3)

Annexure II : Results of physicochemical parameters and heavy metal analysis of water samples from Pali, Rajasthan (Table 5)

ANNEXURE – I

Table 3: Details of water samples collected from Pali, Rajasthan

S. No.	Sample Code	Location	Date of collection
1.	I	Bandi U/s river	01.06.2014
2.	II	CETP ½ inlet	02.06.2014
3.	III	CETP 1 outlet	02.06.2014
4.	IV	CETP 2 outlet	02.06.2014
5.	V	CETP 3 inlet	02.06.2014
6.	VI	CETP 3 outlet	02.06.2014
7.	VII	CETP 4 inlet	02.06.2014
8.	VIII	CETP 4 outlet	02.06.2014
9.	IX	Drinking g/w near CETP 4	02.06.2014
10.	X	D/S river 15 Km Raopawas/ Karel road	04.06.2014
11.	XI	D/S river 30 Km (Jaitpur)	03.06.2014
12.	XII	Open well 30 Km (Jaitpur)	03.06.2014
13.	XIII	Bandi Nehra Dam (U/S) 40 Km	03.06.2014
14.	XIV	Bandi Nehra Dam D/S (43 Km)	03.06.2014
15.	XV	Open well Nehra village	03.06.2014

ANNEXURE – II

Table 5: Results of physicochemical parameters and heavy metal analysis of water samples from Pali, Rajasthan

S. No.	Sample Code	Sample Name	pH	DO (ppm)	TS (ppm)	TDS (ppm)	TSS (ppm)	Electric conductivity (mS)	COD (ppm)	Chloride as Cl (ppm)	Sulfide as H_2S (ppm)	Sulphate as SO_4 (ppm)	Phenolic compds as C_6H_5OH (ppm)	Zn (ppm)	Ni (ppm)	*Total Cr (ppm)
Surface water		**ISI-IS: 2296-1982**	**6.0-8.5**	**4.0-6.0**	**---**	**500, 2100**	**---**	**1.0**	**---**	**250**	**----**	**400, 1000**	**0.002, 0.005**	**15**	**---**	**0.05-1.0**
1.	I	Bandi U/s river	6.9	6.82	4580	4560	20	6.9	219	1969	0.7	417	ND	ND	ND	ND
2.	X	D/S river 15 Km Raopawas/ Karel road	9.1	0.04	7016	6190	826	9.2	1313	1904	30.2	295	ND	ND	ND	ND
3.	XI	D/S river 30 Km (Jaitpur)	8.9	0.15	7586	6650	936	10.0	1330	2090	16.1	440	ND	ND	ND	ND
4.	XIII	Bandi Nehra Dam (U/S) 40 Km	8.8	0.19	9674	8600	1074	12.8	718	2182	1.3	605	ND	ND	ND	ND
5.	XIV	Bandi Nehra Dam D/S (43 Km)	9.2	0.25	9794	8740	1054	13.0	648	2322	9.1	650	ND	ND	ND	ND
Drinking water		**IS – 10500: 2004 (Amended)**	**6.5-8.5**	**---**	**---**	**500**	**---**	**---**	**---**	**250**	**0.05**	**200**	**0.001**	**5.0**	**---**	**0.05**
6.	IX	Drinking g/w near CETP 4	7.2	3.3	1050	1040	10	1.6	230	227	ND	45.2	ND	ND	ND	ND
7.	XII	Open well 30 Km (Jaitpur)	8.3	1.21	7736	6880	856	10.2	938	1857	0.3	480	ND	ND	ND	ND
8.	XV	Open well Nehra village	6.8	0.24	7382	6540	842	10.0	358	2898	24.1	627	ND	ND	ND	ND
Textile effluents		**CPCB Standards**	**5.5-9.0**	**---**	**---**	**---**	**100**	**---**	**250**	**---**	**2**	**---**	**1**	**---**	**---**	**2.0**
9.	II	CETP 1/2 inlet	10.6	0.58	9674	7200	2474	10.8	2604	1625	ND	1185	ND	ND	ND	ND
10.	III	CETP 1 outlet	7.5	0.3	9090	7870	1220	11.8	684	2415	ND	1395	0.2	ND	ND	ND
11.	IV	CETP 2 outlet	8.1	0.15	8584	7360	1224	10.8	979	1950	3.8	1012	ND	ND	ND	ND
12.	V	CETP 3 inlet	11.3	0.05	11136	7850	3286	11.8	2153	789	48.7	802	0.5	0.68	ND	0.32
13.	VI	CETP 3 outlet	9.1	0.04	10722	8810	1912	13.1	673	2275	45.3	855	0.8	0.34	ND	0.21
14.	VII	CETP 4 inlet	12.2	0.95	16620	8780	7840	13.2	2826	1904	8.5	857	0.2	0.20	ND	ND
15.	VIII	CETP 4 outlet	9.9	0.5	11478	8820	2658	13.2	2273	464	46.7	397	1.7	0.27	ND	0.14

ND = Not Detected   *** = Standards are for Hexavalent Cr**