Study of physico-chemical parameters of waste water generated from Aurangabad city of Maharashtra (India)

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Abstract- *Kham River is a seasonal river, which is passing through some part of Aurangabad city. The sewage generated in the city area is disposed in it at various points without any treatment. During the winter and summer season, river carrying the sewage and waste water only, whereas in rainy season it contaminates the running water. Present work is an effort to study the change of the water quality of Kham River due to the disposal of sewage and waste water in it. The water samples from the Kham River were collected from two selected locations, i.e. near the Makbara Road and Pachakki Road. The water quality was studied in terms of its physico-chemical parameters such as Temperature, pH, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Sodium ion (Na^+), Chloride (Cl^-) , Calcium ions (Ca^{++}), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Hardness (TH), Electrical Conductivity (EC), etc. The produced results were compared with the standard parameters for identification its suitability for specific water use such as domestic water uses and to decide the range of its pollution load. It was observed that the water quality is changed significantly due to contamination of sewage and waste water in it and not suitable for direct domestic use without treatment.*

I. INTRODUCTION

Aurangabad city has an area about 137.4 Sq.Km. with more than10 lakhs of the population as per of Indian census (2010). Aurangabad city represents a historic and industrial district of Maharashtra and it is located on the banks of Kham River in a latitude 19°53' north and a longitude 75°20' east (Boralkar, 2012). The samples were taken from two roads where the Kham River passes through them. The river is one of the most important surface resource water to provide people with water to use it in several purposes. Water can be used both home indoor and outdoor like water from bath, showers, washing of clothes and dishes, washing machine and toilets going down to the river water and mix with it (Mara, 1974). This water becomes polluted and then we can call it as waste water and these wastes contain some chemical ions, suspended solids and biological organisms, therefore, these ions, solids and harmful bacteria will cause various disease to human and harmful effects to water quality (Banejad and Abdosalehi, 2009).

The culture of society and governmental control may be affected on the degree of pollution of surface water like rivers, ponds, dams and seas (Pandey, Sandeep and Tiwari, 2009) and issuance of laws that prohibit any person or industrial activities to pollute the surface water and the governmental authorities must impose punishment against anyone makes pollution or discharge any pollutants to surface to protect the river water or any surface water to be clean and suitable for domestic purposes.

Most of the families observed are living on the two banks of Kham River especially in selected study area. These families are daily using water of the river daily for washing of dishes and clothes, showers, cleaning of houses and other uses and at the same time pollutants disposal into rivers in addition to industrial activities that discharge chemical and physical harmful contaminants to water of river (Hassan and Pande, 1993). We can see animals like oxen, cows, goats and dogs are swimming inside, drinking and disposal their waste to river water. Those cited reasons are increasing the risk of pollution of the river and the treatment and protection of this river and other rivers in India (Kelein, 1959).

1.1 Study area

Aurangabad is a city in the Maharashtra State of India (19°53'7" N and 75° 19' 11" E), Kham River flows 72km towards the south east and join to the Godavari river (Shinde et al., 2011). The Kham River receives so much amount of sewage from domestic and industrial waste which has the high value of pollutants and toxic materials (Ghorade et al., 2011). In this study, river is polluted because of the discharge of domestic sewage, animal disposal and industrial effluents of Aurangabad city.

In this study kham river water was the study area in Aurangabad, city of Maharashtra, and samples are taken from two locations

1- Makbara Road near Bibi ka Makbara referred as (L1)
2- Panchakki road near Panchakki Masjid referred as (L2)

The distance between Makbara Road and Panchakki Road is 3 km. The Kham River flows across these Road and others Roads with different quality, quantity and speed (Dilip, 2012). The two selected points (Roads) are good for study and give good information and clear picture about physico-chemical characteristics of River water and conclude water index of it (Sanman and Jain, 2014).

Fig. (a) Map of Maharashtra State (India) shows location of Aurangabad city.

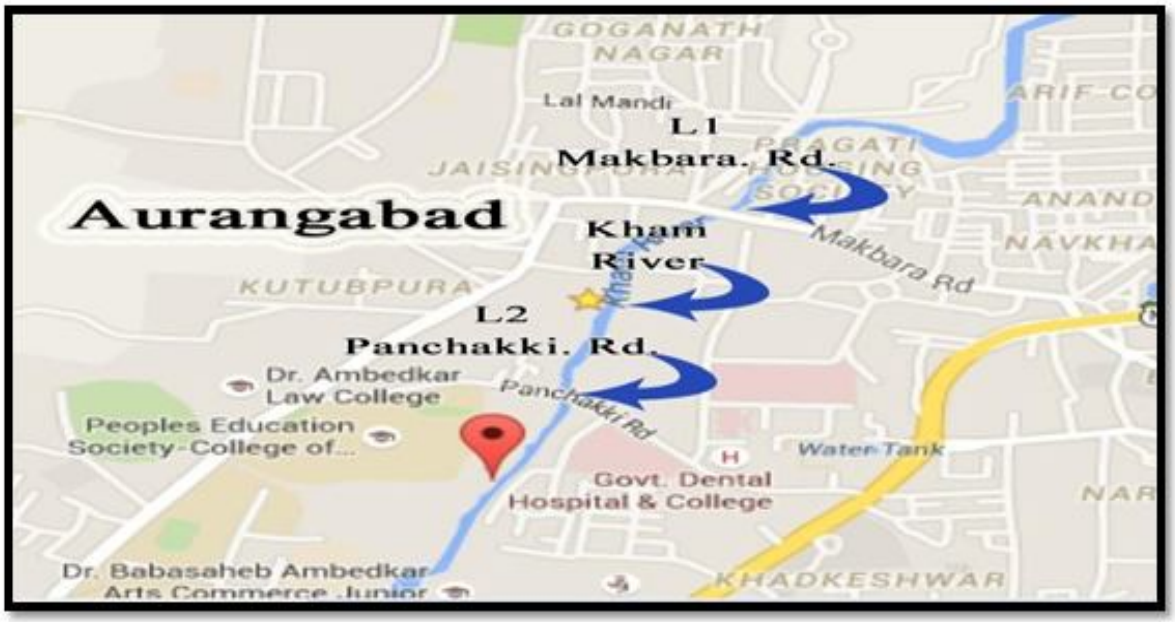

Fig. (b) Map of Aurangabad city shows locations of samples.

Fig. (c) Picture shows Kham River stream at Makbara Road near Bibi ka Maqbara in Aurangabad city.

Fig. (d) Picture shows Kham River stream at Panchakki road near Panchakki Masjid in Aurangabad city

1.2 Aim of study

1- Assessment of physico-chemical parameters of Kham river.
2- To decide that water river in selected locations polluted or not.
3- Making recommendations about how to protect rivers from pollution.

II. MATERIALS AND METHODS

Materials and methods for chemical and physical analysis of water samples accredited in this study work are according to A.P.H.A. (2000), (WHO Manual, 1996), (Operation Manual, 2001), NEERI, 2007), Saxena, 1987), (Purohit, 1986), (BIS, 1991), (ICMR,1975), Trivedi and Goel, 1984), (IWWA,1961) and (Kittrell, 1969).

In this study, four samples were collected regularly from two locations in Aurangabad city of the study area where Kham river water is flowing through, in early morning at 6 o'clock, and in the early evening at 6 o'clock. The two samples were taken from Makbara Road (L1) and other two samples were taken from Panchakki Road (L2), temperature and pH were measured for four samples at the two locations. Other parameters like Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Sodium (Na), Chloride (Cl), Calcium (Ca), Total Suspended Solids TDS, Total Hardness TH, Electrical Conductivity EC, Total Dissolved Solids TDS and Turbidity were analyzed in the laboratory for assessment quality of water of river from selected locations and make water quality index (WQI).

For recommendations of sampling and preservation of samples (NEERI, 2007) and (A. P. H. A., 2000) were accredited and for analysing that including chemical materials, methods, instruments and procedures, there are many references adopted in this study they are

For sampling, river water samples were taken by putting the hole of sampling plastic bottle opposite of water flow to fill the plastic bottle. The required volumes (one liter for each sample) of water were collected and transferred to the laboratory (Manivasakam, 1996).

The temperature was taken by the digital measurement operated by battery by immersion its two electrodes in the water and the temperature degree will appear in the digital display.

The value of the **pH** was measured as soon as the collection the samples at the locations by portable pH meter operated by battery and by using ready buffer solution of pH 4, pH7 and pH9 to calibrate pH meter. And other parameters were analyzed in the laboratory within 24 hours to 8 days.

Dissolved Oxygen (DO) was analyzed by The Winkler method with azide modification. **Biochemical oxygen demand (BOD)** was analyzed by using bottle incubation for 3-days at 27ºC)**.**

Chemical oxygen demand (COD) was analyzed by the open reflux method.

Sodium (Na^+) assessment of sodium was performed by Flame emission photometric method.

Chloride (Cl^-) content, in this study, was assessed by Argentometric titration, where silver nitrate reacts with chloride to form the very slightly soluble white precipitate of AgCl.

Calcium (Ca^{++}), like sodium, was analyzed by Flame Emission Photometric Method and the other method used is EDTA Titrimetric.

Total Dissolved Solid (TDS) content was determined as the residue left after evaporation of the filtered sample by heating; TDS was also calculated by summation of total suspended solid TSS with total solid TS.

Total Suspended solid TSS Residue left after the evaporation and subsequent drying in the oven at specific temperature 103-105^oC of a known volume of the sample are total and record final weight (W). Total solids include "Total suspended solids" (TSS) and "Total dissolved solids" (TDS)

Total Hardness TH is determined by the EDTA titration method in alkaline condition, its caused by the calcium and magnesium ions in water. The chemical materials were prepared with AR grade and Equivalent grade. Glassware and instruments that used for water quality parameters like flame photometer and spectrophotometer were calibrated at room temperature. Measuring flask, beakers graduated pipettes and burette were cleaned by distilled water (DW) and for preparation standard solutions we used double distilled (DD) water free from CO_2.

Electrical Conductivity EC is the capacity of water to carry an electrical current and varies both with number and types of ions in the solution, which in turn is related to the concentration of ionised substances in the water Electrical Conductivity can be measured by conductivity meter which is commercially available.

Turbidity is defined as suspended particles in water that don't allow the light to pass through the water, and can be analyzed by the Nephelometric method.

III. RESULT AND DISCUSSION

After sampling and analyzing the results recorded and written down in tables, table (2) is showing the results of Makbara road samples (L1) and table (4) is showing the results of Panchakki road samples (L2) and these two tables mentioned parameters, result of morning time, result of evening time, difference value of them and unites of parameters. The samples collected in September 2015 (monsoon season) from two locations as mentioned in study area part.

Note: All parameters below are given in (mg/l), excluding E.C. with (µmhos/cm), Temperature with (^oC), turbidity with (NTU) and pH without a unit.

Temperature

Temperature in this study of (L1) in the morning at 6 o'clock was 27.1^oC and in the evening at 6 o'clock was 26.8 ^oC the difference value was 0.3 ^oC for morning time and (L2) the temperature was 26.5 ^oC in the morning at 6 o'clock and 26.2 ^oC in at 6 o'clock evening the difference value Was 0.3 ^oC also , the observation here that there is the same difference value between (L1) and (L2), but the temperature in the morning higher than temperature in the evening, because of the sunlight and human and animal activities. Higher temperature of water affects on Dissolved Oxygen DO and other gasses solubility (Reza and Singh, 2009); therefore the metabolic activity of living organism in water increase this reactions happen in summer season (Jinwal, and Dixit, 2008), but in winter with low temperature the metabolic of organisms will be reduced and solubility of oxygen increases. BOD also will be affected with temperature (Kasthuri et al., 2005).

pH

In this study, pH of (L1) was 8.2 in the morning at 6 o'clock and was 8.7 in the evening at 6 o'clock the difference value was 0.5 for evening time and (L2) the pH was 8 in the morning at 6 o'clock and 8.3 in at 6 o'clock evening the difference value was 0.3 for evening time, this means that pH increasing in the evening time to be alkaline, but these values accepted as per ICMR, BIS and WHO standards and its not

harmful for using and it is low alkaline. The high value of pH in the evening is due to the using this water for human activities like several washing and shower after at 6 o'clock morning up to early evening approximately 9 o'clock evening and also industrial activities by discharge alkaline contents to water.

The obtained pH value of River water was in the range from 8 to 8.7, within the permissible limit 6.5 to 9 as per ICMR (ICMR, 1975), WHO (WHO, 1996) and BIS (BIS, 1991) and the chemical and biological reactions depend on the pH of water system in other word acidity or alkalinity of water system (Arora et al., 1985). The living organisms can survive in low water alkaline and low acidity and the presence of carbonate and bicarbonate in water this leads to most of the waters are slightly alkaline, in summary the pH is very important for plant and animal (Yaping and Zongrenl, 2011).

Dissolved Oxygen DO

This parameter just applied mainly for determination the DO for waste waters and Industrial effluents (Hassan and Pande, 1993), in this study Dissolved Oxygen of (L1) was 6.8n the morning at 6 o'clock and was 7.1 in the evening at 6 o'clock the difference value was 0.3 for evening time and (L2) the DO was 5.2 in the morning at 6 o'clock and 5.4 in at 6 o'clock evening the difference value Was 0.2 for evening time. The permissible limit is 5.0 mg/l as per ICMR (ICMR, 1975) and BIS (BIS,1991), this parameter is very important for unpolluted water to be indicator of water quality and it working as control of water where its concentration controls and arranges the distribution of animal and plant those living in water environment (Unni and Naik, 1997). Dissolved oxygen has high values in winter season because as mentioned in temperature point that low in temperature leads to increase of dissolved oxygen in water (Reza and Singh, 2009); therefore water organisms plant and animal will be increased, and vice versa in summer season where the temperature is high leads to decrease the DO value, therefore, the water organisms will be reduced and this effect to health of human being (Jinwal and Dixit, 2008).

Biochemical Oxygen Demand BOD

BOD is laboratory parameters which measures oxygen requirement for aerobic oxidation to decompose organic matter and inorganic materials in water (Ghorade and Jadhavar, 2011), polluted waters and wastewater under controlled conditions of temperature and incubation period (NEERI, 2007). Biochemical Oxygen Demand BOD In this study of (L1) was 18 in the morning at 6 o'clock and was 19.3 in the evening at 6 o'clock the difference value was 1.3 for evening time and (L2) the DO was 15 in the morning at 6 o'clock and 16 at 6 o'clock evening the difference value was 1 for evening time the permissible value of BOD is 5 mg/L as per ICMR (ICMR, 1975). In the (L1) BOD has higher level than (L2). This indicates that disposal of waste material from domestic and industrial and presence of the animal in (L1).

Chemical Oxygen Demand COD

Chemical oxygen demand COD is oxygen required for oxidation of organic and inorganic matter in the water. COD is a method the organic load of water. Chemical Oxygen Demand COD In this study of (L1) was 63 in the morning at 6 o'clock and was 17 in the evening at 6 o'clock the difference value was 8 for evening time and (L2) the COD was 54 in the morning at 6 o'clock and 56 at 6 o'clock evening the difference value was 2 for evening time the permissible value of COD is 5 mg/L as per ICMR (ICMR, 1975). The high values of COD are due to industrial and human activities where the waste water and waste material are pouring directly into River water and mix with it.

The low DO value and high BOD and COD value indicates there is a large- scale disposal of untreated waste water to the river (Hynes HBN., 1979). Lohar and Patel (1998) reported that concentration of DO is inversely proportional to the concentration of CO_2. High value of COD than BOD indicates the high degree of organic pollution (Adholia and Vyas, 1992). The low DO values and high BOD and COD values indicate large scale of untreated wastewater into the river (Mishra and Saksena, 1989), (Pandey et al., 1993),

Sodium Na^+

The permissible value of sodium in water must be 50 mg/l or less. In this study sodium content of (L1) was 95 in the morning at 6 o'clock and was 117 in the evening at 6 o'clock. The difference value was 22 for evening time, and (L2), sodium content was 83 in the morning at 6 o'clock and 91 in at 6 o'clock evening the difference value was 8 for evening time. Sodium contents in all samples in both locations above 50 mg/l this means water unsuitable for the portable purpose. And this water is saline (Tyagi et al, 2013), as per (BIS, 1991) and (WHO, 1996). In the evening, the content of sodium is high because of most of the houses near the banks of river discharge large quantity of remaining food to water this leads to make water saline the taste of water which has high-level content of Na undesirable (salty) and Na^+ react with Cl^- to form NaCl and change the taste of water.

Chloride Cl^-

In this study chloride Cl^- of (L1) was 151 in the morning at 6 o'clock and was 179 in the evening at 6 o'clock the difference value was 28 for evening time and (L2) the chloride Cl^- was 143 in the morning at 6 o'clock and 151 at 6 o'clock in the evening the difference value was 8 for evening time. High level of chloride observed in the morning period this means that chloride contents came from washing by detergents which including chloride in their ingredient and there is no washing activities in the evening. The permissible limit is 1000 mg/l as per BIS. Two selected locations below of permissible limit and they are not polluted with chloride Cl^-, high chloride content in drinking water result in high blood pressure in the human and salty taste of water (WHO, 1996). The high value of chloride means the water is not suitable for drinking and domestic purposes (Mark and Hammer, 2006).

Calcium Ca^+

Calcium value in water represents the hardness of water with other elements. In this study, Calcium Ca^+ value of (L1) was 63 in the morning at 6 o'clock and was 90 in the evening at 6 o'clock. The difference value was 27 for the evening time and (L2) the Calcium Ca value was 41 in the morning at 6 o'clock and 43 at 6 o'clock evening. The difference value was 2 for evening time. Calcium content of samples for two locations below of permissible value is 200 mg/l as per WHO (WHO, 1996) and Water has no hardness (Banejad and Salehi, 2009). Scientific Committee for Food, Nutrients and energy intake for the European Community (1993) reported that the recommended quantity of Ca daily taken for adults ranges from 700 to 1000 mg. The high level of Ca leads to kidney disease because of accumulation Ca molecules in kidney forms stones which are calcium carbonates and threat the urine system.

Total Dissolved Solids TDS

The values of Total dissolved solids TDS of two selected location samples of this study of (L1) were 223 in the morning at 6 o'clock and were 421 in the evening at 6 o'clock. The difference value was 198 for evening time, and (L2), the TDS was 581 in the morning at 6 o'clock and 211 in at 6 o'clock evening the difference value was 370 for morning time. The permissible value of TDS in water as per WHO (WHO, 1996) and (BIS, 1991) is 1500 mg/l, this leads to all the samples below of permissible limit. From the results, the observation is that value of TDS of (L2) in the morning more than the value in the evening time, due to some of diggings near the location in the early morning approximately start from 10 o'clock morning, so some of particulars of sands, mud and soil mix with water. The high content of TDS in some of in water generally is due to weathering of rock and soil (Kumar, 2003).

Total Suspended Solids TSS

In this study, the values of Total suspended solids TSS of two selected location samples of this study of (L1) was 5 in the morning at 6 o'clock and was 11 in the evening at 6 o'clock. The difference value was 6 for evening time, and (L2), the TDS was 9 in the morning at 6 o'clock and 7 in at 6 o'clock evening. The difference value was 2 for evening time. Permissible value of TSS is 500 mg/l as per WHO (WHO, 1996), the same observation that found in TDS where the value of TSS in the evening is more than its value in the morning due to some of the diggings near the location in the early morning approximately start from 10 o'clock morning, where TSS is summation of dissolved solids and suspended solids (Trivedi and Goel, 1986).

Total Hardness TH

In this work the values of Total Hardness TH of (L1) was 271 in the morning at 6 o'clock and was 368 in the evening at 6 o'clock the difference value was 97 for evening time and (L2) the TH was 221 in the morning at 6 o'clock and 229 in at 6 o'clock evening. The difference value was 8 for evening time. The permissible limit is 300 mg/l as per ICMR (ICMR, 1975), BIS (BIS, 1991) and WHO (WHO, 1996). This means this water no turbid and the value of magnesium and calcium compounds values in water must be low, and it explains that Ca in this study is low, therefore, this water is suitable for domestic purposes but not for drinking, water is not toxic and harmful for health.

Electrical Conductivity EC

In this work the values of Electrical Conductivity EC of (L1) was 641in the morning at 6 o'clock and was 1098 in the evening at 6 o'clock the difference value was 457 for evening time, and (L2) the Electrical Conductivity EC was 611 in the morning at 6 o'clock and 997 in at 6 o'clock evening. The difference value was 386 for evening time. All of the values are above the permissible limit 300 µmohs/cm as per of WHO (WHO, 1996) and BIS (BIS, 1991). Electrical conductivity is a measure of water capacity to transfer electrical current. It determines the amount of total dissolved salt. Alarge measure of EC means the presence of soluble ions which leads to the presence of metals and chlorides (Eldesouky and Ettony, 2002).

Turbidity

The values of Turbidity in this work of (L1) was 27 in the morning at 6 o'clock and was 36 in the evening at 6 o'clock the difference value was 9 for evening time, and (L2) the Turbidity was 24 in the morning at 6 o'clock and 27 at 6 o'clock evening. The difference value was 3 for evening time. The obtained results of turbidity above the permissible limit, 10 NTU as per BIS (BIS, 1991) and >5 NTU as per WHO (WHO, 1996), this means all the samples are turbid. This affects negatively to the aquatic organisms that are living in the water environment because of the sunlight doesn't reach to the water for photosynthesis process (Wilber, 1969)

Note: All parameters are given in mg/l, excluding E.C. with µmhos/cm, Temperature with ^{0}C, turbidity with NTU and pH without a unit.

Table (1): Water Quality Standard of ICMR, BIS, and WHO

Parameters	Water Quality Standard			Unit
	ICMR	BIS	WHO	
Temperature	--	--	--	C°
PH	6.5-8.5	6.5-9.0	6.5-8.5	--
DO	5	--	--	mg/l
BOD	5	--	--	mg/l
COD	--	--	10	mg/l
Na	50	50	50	mg/l
Cl	--	1000	--	mg/l
Ca	--	--	200	mg/l
TDS	<1500	1500	1500	mg/l
TSS	--	--	500	mg/l
TH	300	300	300	mg/l
EC	300	--	--	µmhos/cm
Turbidity	--	10	5	NTU

Table (2): Values of Parameters of Makbara Road Samples (L1) in Morning and Evening.

Parameters	Time		Unite	Average Value
	Morning 6 AM	Evening 6 pm		
Temperature	27.1	26.8	C°	26.95
PH	8.2	8.7	--	8.45
DO	6.8	7.1	mg/l	6.95
BOD	18	19.3	mg/l	18.65
COD	63	71	mg/l	67
Na	95	117	mg/l	106
Cl	151	179	mg/l	165
Ca	63	90	mg/l	76.5
TDS	223	421	mg/l	322
TSS	5	11	mg/l	8
TH	271	368	mg/l	319.5
EC	641	1098	µmhos/cm	869.5
Turbidity	27	36	NTU	31.5

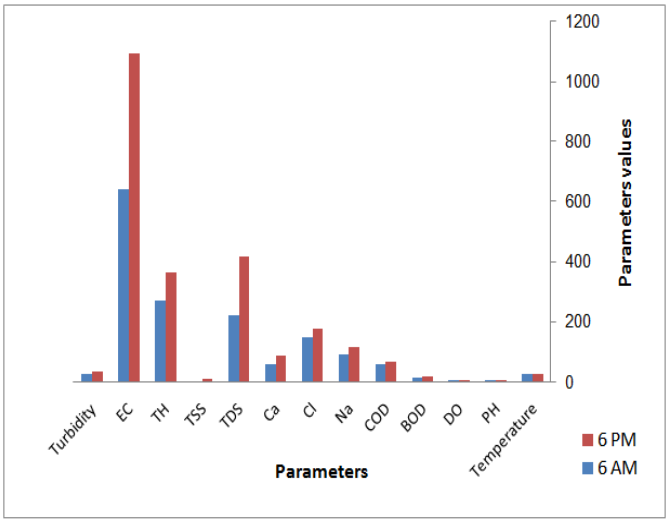

Fig. (e) A plot of Makbara Road samples Parameters values

Table (3): Statistical analysis of parameters of Makbara Road samples (L1).

Parameters	Max	Min	Avg.	S.D.
Temperature	26.8	27.1	26.95	0.212
PH	8.7	8.2	8.45	0.353
DO	7.1	6.8	6.95	0.212
BOD	19.3	18	18.65	0.919
COD	71	63	67	5.656
Na	117	95	106	15.556
Cl	179	151	165	19.798
Ca	90	63	76.5	19.091
TDS	421	223	322	140.007
TSS	11	5	8	4.242
TH	368	271	319.5	68.589
EC	1098	641	869.5	323.147
Turbidity	36	27	31.5	6.363

Table (4): Values of Parameters of Panchakki Road Samples (L2) in Morning and Evening

Parameters	Time		Unit	Average Value
	Morning 6 AM	Evening 6 pm		
Temperature	26.5	26.2	C°	26.35
PH	8	8.3	--	8.15
DO	5.2	5.4	mg/l	5.3
BOD	15	16	mg/l	15.5
COD	54	56	mg/l	55
Na	83	91	mg/l	87
Cl	143	151	mg/l	147
Ca	41	43	mg/l	42
TDS	581	211	mg/l	396
TSS	9	7	mg/l	7.5
TH	221	229	mg/l	225
EC	611	997	µmhos/cm	804
Turbidity	24	27	NTU	25.5

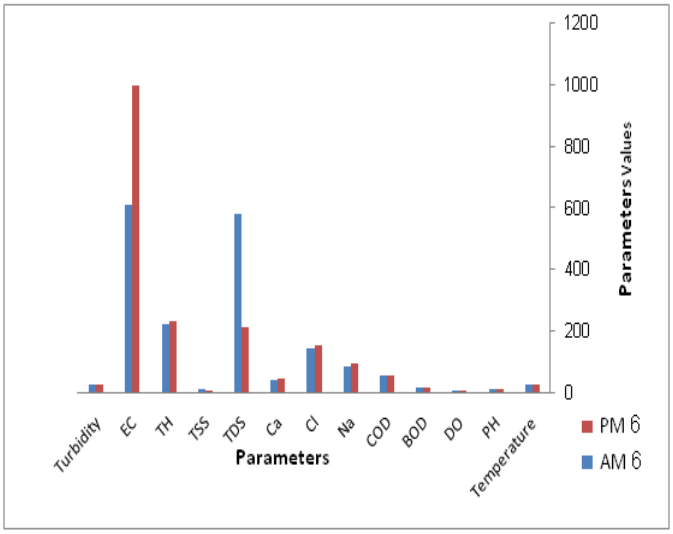

Fig. (f) A plot of Panchakki Road samples Parameters values

Table (5): Statistical analysis of Parameters of Makbara Road Samples (L2).

Parameters	Max	Min	Avg.	S.D.
Temperature	26.5	26.2	26.35	0.212
PH	8.3	8	8.15	0.212
DO	5.4	5.2	5.3	0.141
BOD	16	15	15.5	0.707
COD	56	54	55	1.414
Na	83	91	87	5.656
Cl	151	143	147	5.656
Ca	43	41	42	1.414
TDS	581	211	396	261.629
TSS	8.5	6.5	7.5	1.414
TH	229	221	225	5.656
EC	997	611	804	272.943
Turbidity	27	24	25.5	2.121

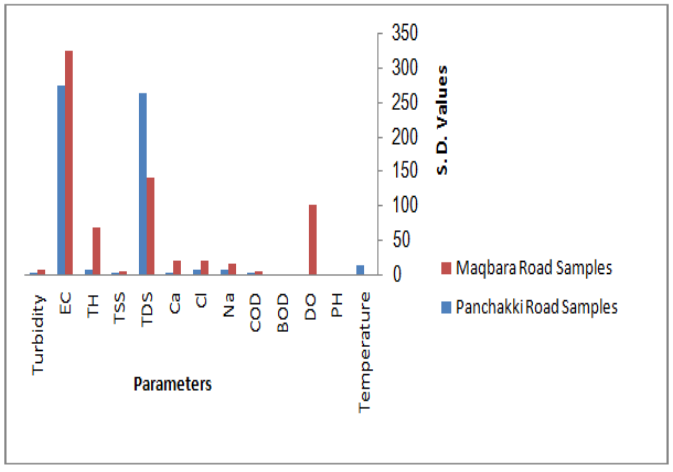

Fig. (g) A plot of Standard Deviation of Makbara Road Panchakki Road samples Parameters.

IV. CONCLUSIONS

Water is a very important element in our life. Without water, all living organisms can't live for one day, so from this point, we have to protect it from pollution and misuse of human and industrial activities. In this study, samples were collected from two locations where Kham river flow nearby them are polluted and bad, due to continuous disposal and discharge of untreated domestic sewage from poor residents who are that living on the two banks of river and observed that pipe of sewage water of houses open directly to the water of river. Also animals like dogs, cows and buffalos and other animals are roaming beside the River, drinking, washing their bodies by water of river and at same time disposal their waste directly to water, and industrial waste discharge daily to water. All of these wastes and pollutants mix with water and make it polluted and unsuitable for drinking and domestic purposes.

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