# Impact of Releasing Wastewater of Sugar Industries into Drainage System of LBOD, Sindh, Pakistan

Abdul Latif Qureshi, Ali Asghar Mahessar, Muhammad Ehsan-Ul-Haq Leghari, Bakhshal Khan Lashari, and Fateh Muhammad Mari

***Abstract*—Sugar factories are supporting national economy as these are playing key role for development of socio-economic sectors of a country. The main product of Sugar industries is white sugar and by products are alcohol, ethanol, liquid carbon dioxide and household textiles. However, industries are generating effluents during cane crushing and distillery operation; which is hazardous, damaging and degrading the environmental eco-system. Sugar industries were established in the catchment area of Left bank outfall drain (LBOD) system. The untreated effluent generated from these Sugar mills is released into drainage system through network of LBOD system in lower part of Sindh province of Pakistan. The effluent generated is mostly organic having small quantum of in-organic material. Estimated wastes are Sulphur dioxide, hydrochloric acid, lead, fly-ash and dust, plant and workforce sewage, process waste which comprised of bagass, molasses, filter mud and grease oil from various sources of plant. The pollution level of effluents was evaluated against the National Environmental quality standard (NEQS) recommended level as well as with World Health Organization (WHO) level.**

***Index Terms*—LBOD catchment area, sugar industries, untreated effluent and wastewater disposal.**

## I. Introduction

Water is important natural resource which covers 70% of earth that exists on planet of earth and without it, life cannot survive. The major human activities have been used for polluting fresh water bodies. About 1.5 billion people have no safe drinking water globally and about 5 million deaths per year are attributed due to waterborne diseases [1]. It is estimated that 70% of industrial wastes in developing countries are disposed of untreated into waters where they contaminate existing water supplies [2]. The UN also estimates that the amount of wastewater produced annually is about 1,500 $km^3$, i.e. six times more water than exists in all the rivers of the world [3].

The effluents from sugar mills are discharging without treatment into fresh water bodies which makes poor water quality. This polluted water is utilized by human for drinking, domestic, agriculture and industrial purposes.

Sugar factories are based on agriculture which are playing major role for strengthening national economy and social development of a country [4], [5]. The activities of sugar mills require huge quantum of fresh water for milling processes and subsequently releasing of bulk effluent into the environment. Factories are consumers of huge volume of freshwater; wastewater contains high level of contaminants such as, suspended solids, organic and inorganic matter and chemicals. Most chemicals used in sugar processing are toxic; if not well treated might ultimately find their course into the streams which make poor quality of fresh water bodies [6].

The sugar mills generate effluent which makes environmental problems related to water and land pollution. The wastewater generated from sugar mills infiltrate into subsoil and leaches into ground water forming contaminated pool which disturb the groundwater quality by changing its chemical composition property [7]. The untreated wastewater discharging from these industries contaminates surface and ground water. It also damages eco-system of water bodies such as left bank outfall drainage (LBOD) system.

## II. Research Area

The left bank outfall drain (LBOD) system covers areas of districts Shaheed Banazirabad, Sanghar, Mirpurkhas and Badin. The LBOD system serves to drain out agricultural effluent from the area of about 1.27 million acres and storm water from its catchment. In this catchment area and its surrounding districts, there are seventeen (17) sugar industries which are shown in Fig. 1. These industries are in functional but without in-house treatment plants for their effluents.

The untreated water of these Sugar mills has been released into surface drains of the LBOD system [8]. However, disposing points for some industries are still not identified. These are discharging their effluent in open surface of LBOD catchment area. Sugar industries' names and disposal points of their effluents are described in Table I.

Samples were collected from these sugar industries before discharging into their disposing locations; These samples were collected in clean polyethylene bottles and transported to Soil and Water Testing Laboratory of Pakistan Council of Research in Water Resources (PCRWR), which is located at Drainage and Reclamation Institute of Pakistan (DRIP), Tando Jam, for analysis. However, pH and Dissolved oxygen (DO) values were observed and recorded at the site.

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Abdul Latif Qureshi is with the Institute of Water Resources Engineering and Management (IWREM), Mehran University Engineering & Technology, Jamshoro, Sindh, Pakistan (e-mail: latif.qureshi@faculty.muet.edu.pk).

Ali Asghar Mahessar is with the Environmental Management Unit, Sindh Irrigation and Drainage Authority, Hyderabad, Sindh, Pakistan.

Muhammad Ehsan-Ul-Haq Leghari is with Sindh Irrigation & Drainage Authority, Hyderabad, Sindh, Pakistan.

Bakhshal Khan Lashari is with IWREM, Mehran University of Engg. & Tech., Jamshoro, Sindh, Pakistan, (e-mail: bakhshall@yahoo.com).

Fateh Muhammad Mari is with Sindh Water Sector Improvement Project, Karachi, Sindh, Pakistan (e-mail: fateh.marri@wsip.gos.pk).

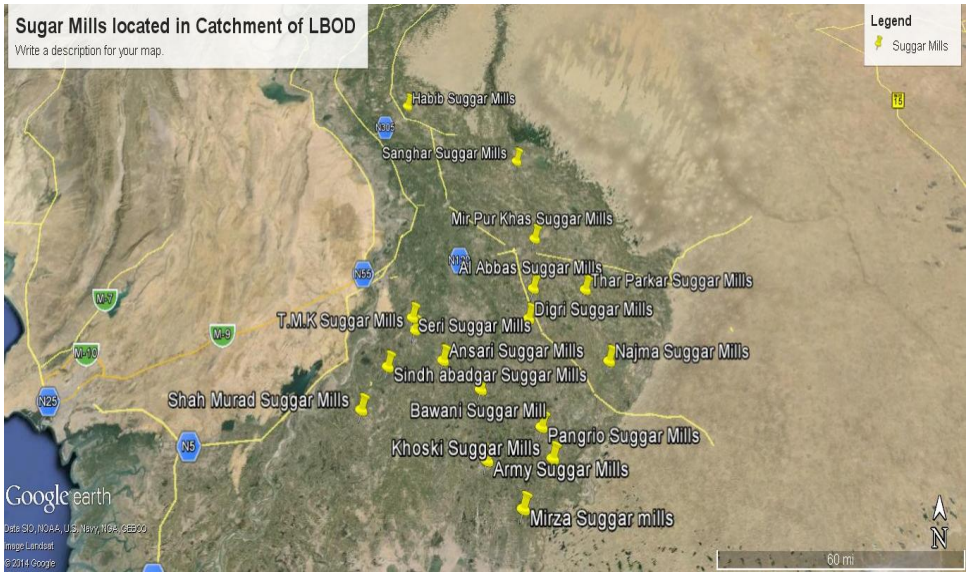


Fig. 1. Sugar mills located in the catchment of LBOD project area.

TABLE I: SUGAR MILLS AND DISPOSAL POINTS THEIR EFFLUENTS

| S. No. | Name of Sugar mill: | Disposing points |
|---|---|---|
| 1 | Habib | Ganjra branch drain at RD 72 |
| 2 | Sanghar | Sanghar Main drain at RD 43+ 645 |
| 3 | MirpurKhas | M3R at RD 41+700 |
| 4 | Tharparkar | SP2L at RD 04 + 900 |
| 5 | Al-Abbas | M1L at RD 04 + 200 |
| 6 | Najima | Not identified/required yet |
| 7 | Digri | Not identified/required yet |
| 8 | Army Welfare | Sirani branch drain RD 60 |
| 9 | Mirza | 3R KPOD at RD 15l |
| 10 | Ansari | Jagsi sub drain RD 16 |
| 11 | Khoski | Khos ki Link RD10 |
| 12 | Sindh Abadgar | Abad Sub Drain |
| 13 | Pangrio | 6 R Tando Bago sub-Drain |
| 14 | T. M. Khan | 5 R T M Khan branch drain at RD 5 |
| 15 | Seri | Not identified |
| 16 | Shah Murad | Not identified |
| 17 | Bhawany | Not identified |

## III. RESULTS AND DISCUSSIONS

### A. Analysis of Collected Sugar Mills' Effluents

The wastewater samples of the Sugar Industries were collected and analyzed. The results of analyzed parameter are as follows:

#### 1) pH value

The pH measure of acidic or basic (alkaline) nature of a solution normal range varying from 6.2 to 8.5 provides protection for life of freshwater fish and bottom dwelling invertebrates. Fig. 2 shows that pH values of analyzed of samples of Sugar Mills along with lower and upper NEQS limit. Some sugar mills viz. Ansari, T M Khan, Dewan and Pangrio show pH value below the lower limit. The lower pH values of these Mills may cause of degrading water quality. Extreme changes in pH (acidity and alkalinity) can exert stress conditions or destroy aquatic life.

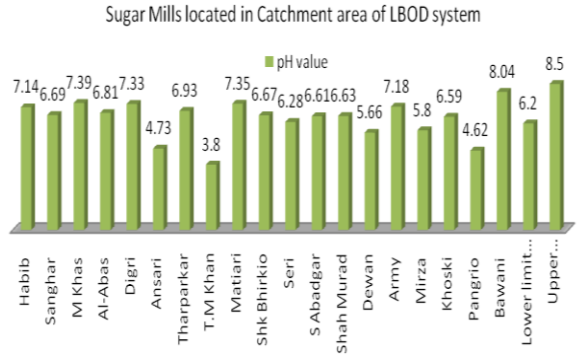


Fig. 2. pH values of sugar mills located in LBOD system.

#### 2) Electrical conductivity (EC)

The electrical conductivity (EC) of analyzed samples are ranging from 1131 to 26,100 µS/m, (Fig. 3) shows that there is no any single industry whose value is within permissible level as the permissible is 680 µS/m NEQS.

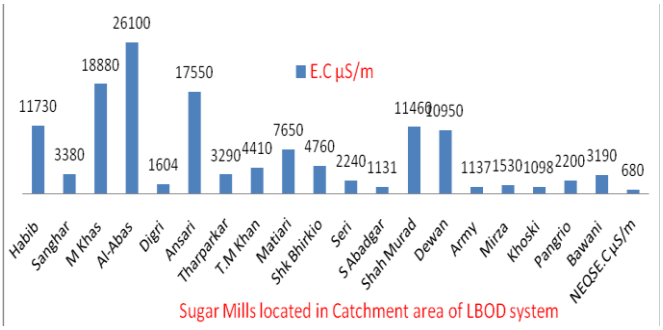


Fig. 3. Electrical conductivity (EC) values of sugar mills.

#### 3) Total dissolved solids (TDS)

The analyzed TDS values of samples of Sugar Industries are ranging from 703 to 16,704 mg/L which shows a big variation of sugar industries effluent LBOD project area (Fig. 4). The values of TDS of most of the samples are higher values than permissible NEQS limit. TDS are correlated fairly well to the total mineral content of the water (deposits left after evaporation of a water sample), primarily salts,

carbonates and metals. A high concentration of TDS is an indicator of possibly high value of contamination. However, some industries have relatively less TDS value (1000 gm/L), which area Sindh Abadgar, Army, Mirza and Khoski.

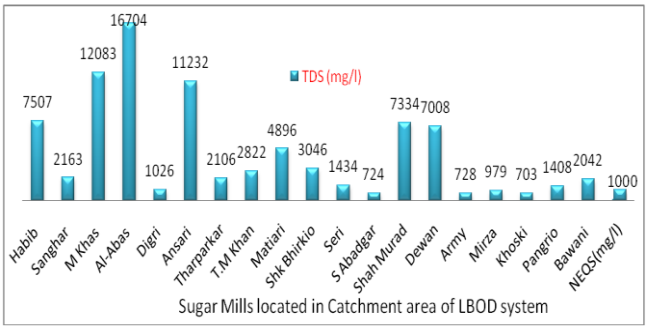


Fig. 4. TDS values of Sugar Mills, in catchment area of LBOD system.

### 4) *Total suspended solids (TSS)*

Total suspended solids (TSS) are aesthetically displeasing, the settle to form sludge deposits in water body, these cover the bottom with a blanket of material that can destroy fish food fauna and flora. Results show that TSS of Seri and Digri mills are only within permissible NEQS limits. Sample collected from T M Khan Sugar mill shows highest values of 32,720 mg/l, follows by that of Al-Abas the second highest, than those of Ansari, Matiari and Shah Murad sugar mills having TSS values of more than 3000 mg/l. TSS value samples from Tharparkar and Mirza sugar industries are at the borderline (see Fig. 5). Deposits containing organic materials may deplete bottom oxygen supplies and may produce noxious gases such as hydrogen sulphide, carbon dioxide and methane.

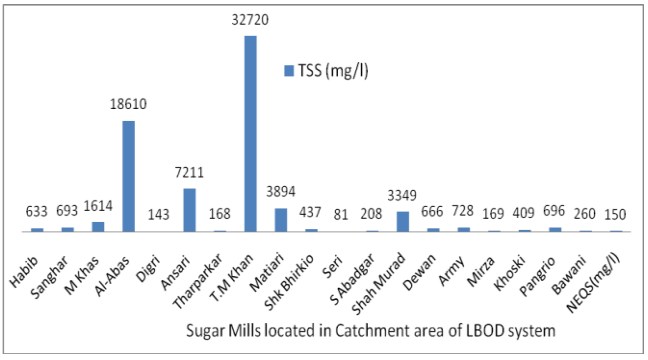


Fig. 5. TSS values of Sugar Mills, located in catchment area of LBOD system.

### 5) *Dissolved oxygen (DO)*

It is one of very important parameter in water quality assessment i.e. index of physical and biological process going in water. The DO level in natural as well as waste water depends on physical, chemical and biological activities of water bodies. Aquatic ecosystem is totally depends on dissolved oxygen various biochemical changes.

The recommended value of dissolved oxygen in normal drinking water is 8 mg/l and high dissolved oxygen was found its normal value [9]. Dissolved oxygen (DO) is an indicative of oxygen depletion.

Samples collected from Habib and Bawani sugar mills are normal as per permissible NEQS limits; however samples analyzed values of all other sugar mills are abnormal (see Fig. 6). These results indicate that there is very low oxygen for aquatic life in water bodies which may cause death of ecological habitat and aquatic life.

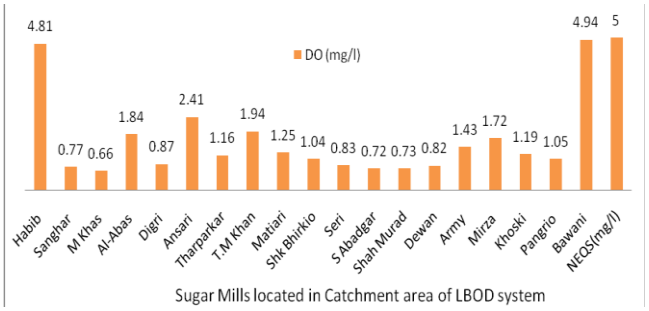


Fig. 6. DO values of Sugar Mills located in LBOD catchment area.

It was observed that number of fish was found dead due to depletion of oxygen content in the LBOD system where effluent of sugarcane was discharged without treatment (see Plate 1)

Plate 1. Dead fish found in the LBOD system.

### 6) *Biological oxygen demand ($BOD_5$)*

Measure of oxygen consuming capabilities of organic matter, $BOD_5$, of collected samples effluents from Sugar industries is varying from 24 to 2,236 mg/L (see Fig. 7). The $BOD_5$ values are higher for all Sugar Mills except Army and Bawani sugar mills. If proper treatment be done these values can be reduced to the NEQ permissible limit.

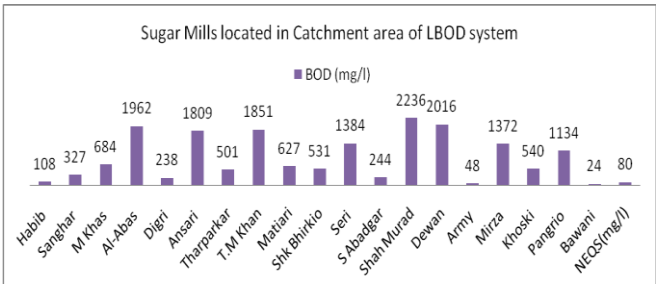


Fig. 7. BOD values of Sugar mills located in LBOD catchment area.

### 7) *Chemical oxygen demand (COD)*

The COD test is used to measure the oxygen equivalent of the organic material in wastewater that can be oxidized chemically using dichromate. The COD test that can be completed in only 2.5 hours, $BOD_5$ test takes 5 or more days, Sugar Mills effluent is varying from 59 to 26,760 mg/l. The analysis shows higher values except Seri, Army and Bawani Sugar Mills. Hence, it is concluded that quality of effluent of

Seri, Army and Bawani sugar mills is good and fit for ecological habitats and other aquatic life.

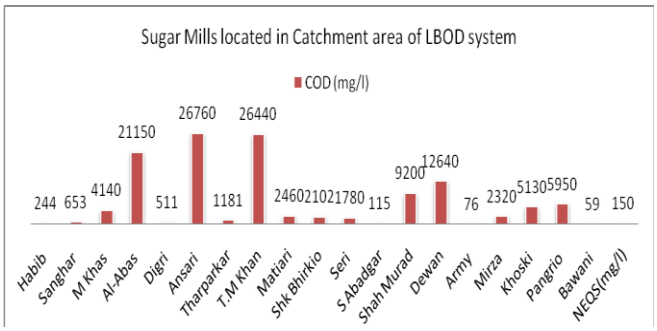


Fig. 8. COD values of sugar mills, located in catchment area of LBOD system.

It has been observed that the water consumption/utilization from these drains is also used for various purposes viz., agriculture, fish ponds and used for drinking purpose of animals. These contaminated water bodies became more harmful for aquatic life and increase soil salinity when used for irrigated agriculture. Hence, untreated effluents of sugar mills may not be discharged into water bodies without any treatment, which will contaminate the water bodies.

The main options for dealing with the wastewater production of sugar mills consist of in-plant practices to reduce the production of wastewater, regulated land disposal and end-of-pipe treatment suggested by [10].

## IV. Impacts of Effluent on Health of Community

The chemical and poisonous industrial waste discharged by sugar mills in Badin district is becoming serious health hazards who are suffering from various skin and other diseases such as asthma, eye infection etc.

Reference [11] demonstrates rashes on the body of newborn baby (Plate 2), showing terrible aspect of the skin diseases caused by chemical waste transforming through her mother.

Plate 2. Horrific aspect of skin disease on body of new born baby [11].

## V. Soil Degradation and Groundwater Contamination

Sugar factories effluents seeping through soil from unlined ponds, drains, lagoons or dumps and spills contaminate the groundwater. It was observed that local people inhabiting in surrounding of sugar mills using groundwater for their drinking purpose, which is severely polluted.

Plate 3. Untreated sugar industry effluent seeping through the soils.

Plate 3 is an evidence for degradation of soils in the vicinity of sugar mills, which is due to the effects of sugar mills effluents and other waste materials.

According to a recent study conducted by Indus Institute for Research and Education (IIRE) regarding groundwater quality of twelve districts of Sindh province on the left bank of Indus river [12]. The study portrayed that those districts where these sugar industries are disposing their effluents having more deteriorated quality of groundwater. The groundwater quality in terms of percentage of samples having higher TDS values is shown in Table II.

TABLE II: Total Dissolved Solids (%age) of Groundwater collected from Various Districts on Left Bank of Indus River [12]

| S. No | District | No. of Samples analyzed | Samples with TDS <1000 mg/l | Samples with TDS >1000 mg/l | %age Samples with High TDS |
|---|---|---|---|---|---|
| 1 | Ghotki | 8 | 8 | 0 | 0 |
| 2 | Sukkur | 15 | 13 | 2 | 13 |
| 3 | Khaipur | 15 | 12 | 3 | 20 |
| 4 | Noshero feroz | 15 | 13 | 2 | 13 |
| 5 | Hyderabad | 20 | 17 | 3 | 15 |
| 6 | Shaheed Benazirabad | 14 | 11 | 3 | 21 |
| 7 | Sanghar | 17 | 11 | 6 | 35 |
| 8 | MirpurKhas | 11 | 7 | 4 | 36 |
| 9 | Thatta | 16 | 10 | 6 | 38 |
| 10 | Umerkot | 19 | 6 | 13 | 40 |
| 11 | Badin | 19 | 9 | 10 | 52 |
| 12 | Tharparkar | 18 | 3 | 15 | 83 |

Above Table II shows that only Ghotki district had good quality water at all locations. This table has also confirmed that districts of southern Sindh (where LBOD system is available) i.e. from S. No. 6 (Shaheed Benazirabad) to S. 12 (Tharparkar), %age of samples having higher TDS values of groundwater is increasing.

It is obvious that the adjoining areas/districts nearby river Indus have good quality groundwater, which is due to seepage of fresh water from the river. The districts Badin and Tharparkar are far away from the Indus River, consequently groundwater of both districts is highly saline and hence these are highly affected areas in terms of sugarcane industries' effluent.

The groundwater samples were collected from the vicinity of these sugar industries, their analysis is described in Table

III as follows.

TABLE III: QUALITY OF GROUNDWATER IN THE VICINITY OF SUGAR MILLS

| Sr. No | Location | EC µS/cm | TDS mg/1 | DO mg/1 |
|---|---|---|---|---|
| 1 | Shaheed Benazirabad Road | 1194 | 764 | 0.87 |
| 2 | Bandhi | 1334 | 854 | 0.83 |
| 3 | Parvez Ahmad Dahri | 2720 | 1741 | 0.88 |
| 4 | Alamdar chock | 785 | 502 | 0.78 |
| 5 | Khair Muhammad Kalhoro | 1830 | 1171 | 0.78 |
| 6 | Dahri Ghot | 6070 | 3885 | 0.84 |
| 7 | RD 814 LBOD | 1526 | 977 | 0.88 |
| 8 | RD 780 LBOD | 675 | 432 | 0.83 |
| 9 | Haji Haroon Shaugo | 3550 | 2272 | 0.54 |
| 10 | Haji Mubarak Majidano | 1594 | 1020 | 0.82 |
| 11 | Baloch abad | 2480 | 1587 | 0.79 |
| 12 | Ten mile | 1038 | 664 | 0.8 |
| 13 | Silver Mori ( canal water being used for drinking) | 381 | 244 | 0.8 |
| 14 | RD 305 70 Mori | 477 | 305 | 0.79 |
| 15 | Near RD 277 LBOD | 1780 | 1139 | 0.88 |
| 16 | LBOD RD 204 | 1089 | 697 | 1.00 |
| 17 | Near LBOD RD 159 | 2850 | 1824 | 0.89 |
| | NEQS | < 680 | < 1000 | > 4.0 |

## VI. ENVIRONMENTAL IMPACT ON ECOSYSTEM

### A. Deterioration of Fresh Water Bodies and Ecosystem

There are 19 wetlands declared as Ramsar Sites in Pakistan, nine are located in Sindh province. Six are situated on the left bank of Indus viz., Deh Akro, Nurruri lagoon, Jubbo lagoon, Runn of Kutch, Indus delta, and The Indus Dolphin Reserve. They have gained importance due to their unique biodiversity and habitat which shelters large number of species.

Plate 4. Fresh water bodies polluted due to untreated sugar industry effluent.

The sugar mills of three districts-Badin, Tando Mohammad Khan and Mirpurkhas-are discharging their untreated effluent into the Nurreuri Lake, destroying not only the freshwater body, but it is also causing outbreak of diseases among the people in the area (see Plate 4).

The poisonous waste is also 'killing' the ecosystem of the freshwater lakes. Amir Shah Drain, which carry the industrial waste of the sugar mills to fresh water Nurruri Lake, the residents complained that drinking water of wells had been turned brackish and poisonous due to chemical waste of the sugar mills. Offensive and suffocating chemical smell of the waste has forced hundreds of people to leave the area on healthier grounds.

Deh Akro-II is wildlife protected area and declared as Ramsar site under UN Convention on Wetlands. It consists of four major habitats; desert, wetland, marsh and agricultural. This desert wetland complex, 330km northeast of Karachi, representing an example of a natural inland wetland ecosystem comprising 36 lakes and unique desert habitat, which supports variety of rare and endangered wildlife species. The sugar mills effluent-laden water from Karo Ghungro and Guni Phuleli drains killed fish in Wetland complex (see Plate 1).

### B. Livestock and Wild Life

During field visits, it was found that the livestock including buffalos, cows and goats suffered due to various diseases. Even some of them were died due to consumption of sugar mills effluents discharged into drains, which in the vicinity of villages.

The fish catching birds and aquatic fauna are dependent on the drain system. All wetlands attract local and migratory wildlife, particularly in winter. The contaminated water always threat for wildlife. It was found that the dead birds in the drains due to local sugar industry effluents.

## VII. CONCLUSION

The untreated effluents of Sugar Mills from LBOD catchment area highly contains pH, EC, TDS, TSS, BOD5, COD and lower limits of DO, which are causes of degrading of water bodies. Hence, these are unfit and must not be discharged into irrigation and drainage systems. Analyzed values of collected samples of these Sugar Industries demonstrate clearly that no any single in house treatment plant is installed in the Sugar Mills for treating effluents released from Sugar Mills processing.

Untreated effluents discharging from Sugar Mills not only degrade surface water body, fertile soil but also pollute groundwater. Hence, it is suggested that without treatment of wastewater may be not released into irrigation and drainage network, which will toxic water quality for aquatic life and ecological habitat. The treated wastewater of Sugar factories will dilute with fresh water which may be suitable for irrigation and utilizing again for industrial processing. The diluted wastewater of mills may satisfy with National Environmental Quality Standards (NEQS) level to be used for some unusual conditions/areas where irrigation water is in shortage.

It is recommended that legal action must be enforced as per land of law i.e. the Pakistan Environmental Protection Act 1997 (Act No. XXXIV OF 1997) [13], Sindh Fisheries Ordinance 1980, Factories Act 1934 including the Provincial Factory Rules, Sindh Irrigation Act 1879 and Sindh Water Management Ordinance 2002 [14]. Also it mandatory for the Sugar Factories to install in-house treatment plants to treat the out coming effluent before discharging into the water bodies.

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**Abdul Latif Qureshi** was born in a small village Channa Lal Esson of District Jamshoro, Sindh Pakistan in December 1964. He received the bachelor degree in civil engineering from Mehran University of Engineering and Technology (MUET), Jamshoro, Pakistan in 1988. He was awarded the master degree in 1992 and PhD degree in 2004 in hydraulics and irrigation engineering from the Institute of Water Resources Engineering and Management, MUET, Jamshoro, Pakistan.

He joined as a lecturer in the Department of Civil Engineering, MUET, Jamshoro in 1992 and then promoted as an assistant professor in May 1993. He became a full Professor in 2006 in the Institute of Water Resources Engineering and Management (IWREM), Jamshoro, Pakistan. He has teaching and research experience of more than 24 years in water resources engineering and management. He has written more than 40 research papers in International and National Journals and presented in various conferences. He has worked with Food and Agricultural Organization of United Nations as a resource person for the project planning of Water Sector Improvement Project (WSIP) of Sindh.

**Ali Asghar Mahessar** was born in 1970 in small village Kaman Mahessar which is located in Riverine area of Left Bank of Indus River and got primary education in his native place. He got the secondary and higher secondary from Kandiaro, the bachelor degree in agriculture engineering from SAU, Tando Jam and master degree of engineering in hydraulics and irrigation engineering from the Institute of Water Resources Engineering and Management, Mehran University of Engineering and Technology (MUET), Jamshoro. He is a Ph.D Scholar in IWREM, MUET, Jamshoro.

He got job as an assistant irrigation specialist and later on appointed as the deputy director of water resources in Sindh Irrigation and Drainage Authority (SIDA), Hyderabad, Pakistan. Recently, he is working as the deputy director in Environmental Management Unit (EMU) in same Organization.

Mr. Mahessar has research experience of more than 12 years. He wrote more than 20 research papers published in national and international journals and presented in various conferences.

**Mohammad Ehsan-Ul-Haq Leghari** was born in Ghotki, Sindh Pakistan in January 1965. He received the B.Sc degree in civil engineering from Mehran University of Engineering and Technology (MUET), Jamshoro, Pakistan in 1988 and master degree in 2012 in the field of environmental engineering and management from the Institute of Environment Engineering & Management, MUET, Jamshoro, Pakistan.

He joined as a lecturer in the Department of Civil Engineering, MUET, Jamshoro, in April 1989. He worked as a junior engineer in WAPDA in May 1991. He also worked as a programme coordinator Sindh in Oxfam GB, Pakistan program from Jan. 2000 to July 2005. Recently he is working as a managing director of Water Sector Improvement Project (WSIP), Sindh Irrigation & Drainage Authority (SIDA), Hyderabad, Pakistan.

Mr. Leghari has teaching and research experience of more than 25 years in the field of water resources engineering and management. He has presented research papers in international and national conferences. He is member of various national and international organizations.

**Bakhshal Khan Lashari** was born in a small village Nari Lashari, District Larkana, Sindh, Pakistan in 1955. He passed the bachelor degree from Sindh Agricultural University, Tandojam and master degree of engineering from IWREM, Mehran University, Jamshoro. He received the Ph.D degree from Poland and Post Docs from Colorado State University, USA in 2005 under Fulbright post doc scholarship and Charles Strut University, Australia in 2008 under Australian Endeavour Award.

He joined as a research assistant in the Mehran University of Engineering & Technology, Jamshoro in 1980 and he promoted as a lecturer, assistant professor, associate professor and professor in 1982, 1985, 1990 and 1996 respectively. At present he is working as a meritorious professor and the director in Institute of Water Resources Engineering & Management, MUET, Jamshoro, Sindh, Pakistan. Dr. Lashari has worked as a consultant and specialist with International organizations and national organizations. He has been engaged in collaboration activities with international and national institutions and organizations.

Dr. Lashari has written more than 60 research papers and presented in national/international journals/conferences. He has written more than 30 technical reports.

**Fateh Muhammad Mari** was born in Sanghar, Sindh Faheh Pakistan in June 1971. He received the B.Sc degree in agricultural engineering from Sindh Agricultural University (SAU) Tandojam, Pakistan in 1995 and master degree in 1997 and Ph.D degree in 2009 in agricultural economics from SAU, Tandojam, Sindh Pakistan. He participated in training courses on spate irrigation from Netherlands, Environmental Economics from Srilanka and Decentralization and Intergovernmental Fiscal Relations from USA.

He joined as a social organizer in International Water Management Institute (IWMI) in 1997. He was appointed as a agricultural economics in Sindh Agriculture University, Tandojam, Pakistan in 1998 and then promoted as an assistant professor in April 2006. He has worked with Action-Aid Iinternational Pakistan as a program manager from may 206 to September 2008. Later on he was selected as the director Monitoring and Evaluation, Water Sector Improvement Project (WSIP), Sindh in 2009. Presently he is working as a project coordinator, WSIP, Govennment of Sindh.

Dr. Mari has teaching and research experience of about 20 years in agricultural engineering and economics. He has written more than 30 research papers published/presented in international/national journals and conferences.