

Chapter-1 Introduction

1.1 Preamble

Punjab is the most populous and industrialized province of Pakistan. Rapid urbanization, haphazard industrial development, and continuous population explosion have resulted in degradation of natural resources to an alarming stage. In Punjab municipal wastewater from almost all major towns in addition to industrial effluents are discharged into various streams without treatment which ultimately reach the rivers. This has given rise to serious water pollution and human health problems. Municipal wastes contaminate water bodies with pathogens whereas industrial wastes introduce a variety of chemicals of concern to environment and human health. In addition the biodegradable organic matter in municipal and industrial wastewaters results in the depletion of dissolved oxygen in water necessary for fish life. In agricultural areas of the country excessive use of fertilizers and pesticides also adds to surface and groundwater pollution. In particular, during rainfalls the surface overflows reach the rivers carrying large quantities of both pollutants. Discharge of excessive quantities of fertilizers may give rise to eutrophication in the receiving water bodies whereas fish may accumulate excess concentrations of heavy metals to affect consumers' health. Certain heavy metals may also badly harm the aquatic life.

Although during high flow season the effect of pollution of municipal and industrial discharges in rivers is not pronounced but during low flow conditions it becomes hazardous in certain reaches resulting in the depletion of dissolved oxygen.

Increasing trends of pollution of water bodies has become a matter of great concern, yet no systematic studies have been undertaken to assess the levels of prevailing pollution and to anticipate the future trends to this effect. Regular monitoring of river water quality is not being done in the country except for GEMS water

quality project (Aziz, 2001). Many reasons to this effect include lack of laboratory facilities, non-availability of laboratory staff and financial constraints.

The problem of pollution of surface water bodies due to anthropogenic activities is so severe that EPA, Punjab planned to evaluate the qualities of surface water sources in a systematic way with the objective of combat their respective pollution problem(s).

Environment Protection Department Government of Punjab decides to monitor the Quality of River Indus under its ADP Project “**Monitoring of Surface Water Bodies in Punjab**”. The river was decided to be monitored right from its entry point in Punjab district Attock to its point of exit in Punjab near Guddu Barrage to suggest the various options for improvement of environment of River Indus.

1.2 Objectives

The over all objectives of the study are as followings:

- 1.2.1 To study pollution status of River Indus from Entry Point into District Attock near Village Jabber to River Indus Exit Point Of District Rajan Pur. at Guddu Barrage.
- 1.2.2 To carry out the laboratory analysis regarding water quality of the river and various point sources adding pollution to the river Indus and comparison with NEQS.
- 1.2.3 To describe the threats posed to environment arid communities due to the present water quality situation in the Sindh River.
- 1.2.4 To present the statistical evidences of events causing hazards to environment and communities.
- 1.2.5 To assess various mitigation measures and provide different options available for controlling river water pollution

- 1.2.6 Analyze and provide recommendations for each option based on environmental considerations and its social acceptability by the communities.
- 1.2.7 Sharing reports with concerned agencies to prepare action plan for control of deterioration of water bodies.
- 1.2.8 Involve all stakeholders including provincial and district governments, community representatives, NGOs and activists in development of options through consultative workshops.
- 1.2.9 Suggest concerned District Government for preparation of detailed project (PC-I) to control pollution of River Indus / Surface water sources in their respective Districts.

1.3 Scope of Work

- 1.3.1 Conducting field visits to identify sampling points on various tributaries and in the river along with selection of groundwater and soil sampling locations.
- 1.3.2 Sampling of river water and its tributaries to determine the existing water quality.
- 1.3.3 Estimation of pollution loads entering the river through its tributaries and various sewage out falls, nullahs and drains.
- 1.3.4 Assessment of the prevailing environmental pollution based on the sample analyses.
- 1.3.5 Impact studies of River Indus pollution on the ambient environment including aquatic and human health and soil.
- 1.3.6 Propose strategic and technical measures to combat environmental pollution in the study area along with feasibility and economical analysis of different treatment options.

Chapter-2 Project Implementation Methodology

2.1 Introduction

This chapter presents the methodology followed for monitoring the quality of the all types of point sources of pollution of surface water as well as the water quality of the surface water body with object to ascertain the effect of pollution on the respective water source. This chapter also presents requirement for sampling program, guideline for sampling program including sampling site location, the list of pollution parameters.

2.2 Methodology

Methodology to achieve the aforementioned objectives comprised of but not limited to followings:

2.2.1 Stakeholder consultative workshop

Methodology for implementation of the scheme was shared with line departments in a consultative seminar. The objective involved was to make necessary improvements in the project implementation methodology, if necessary.

2.2.2 Lesion with Line Departments

EPA representative visited various Government Departments to hold meetings for collection of relevant data on matters of river pollution and its control. This Department/Organization included the followings

- ◆ Irrigation and Power Department, Government of Punjab
- ◆ Directorate of land Reclamation Irrigation & Power Department
- ◆ Office of Executive Engineer, Drainage Section, I&P Department.
- ◆ Town Municipal Administration,(TMAs).

- ◆ Institute of Environmental Engineering and Research, University of Engineering & Technology, Lahore.

Data collected from various research reports on Indus water quality and its assimilative capacity and stream pollution control was studied to be benefited for achievement of aforementioned objectives.

2.2.3 Identification of Pollution Sources

Task of identification of the sources of pollution that effect the river water quality was accomplished by literature review and a detailed field survey. EPA field officers were asked to identify the points of disposal of effluent of all types into the river passing in their respective districts. Later on detailed physical surveys were conducted to mark their location on the maps. Based on the field survey and literature review following sources of pollution were identified

a) **Sewage pumping station**

Sewage pumping stations from discharge untreated municipal sewage.

b) **Irrigation Canals & Lakes**

Following irrigation canal/Rivers of Irrigation and Power Department join river Indus to augment its flow at various locations along its length in punjab.

- I. Ghazi Brotha Canal
- II. River Siwan before Mixing Into River Indus
- III. River Chenab

c) **Wastewater Drains**

In addition to disposal points marked as pumping stations, various wastewater carrying drains dispose off effluent into the river Indus.

These mainly include the followings:

- i) Nallah Chail, before mixing Into River Indus, Near Jabber Village, District Attock.
- ii) Nallah Haro, Before Mixing into River Indus, At Brotha Village District Attock.

2.2.4 Sampling

EPA laboratory staff and concerned District Officers Environment conducted physical survey (areas of their jurisdiction) to undertake the sampling. Following sampling methodology was adopted

- a) Sampling of point sources
- b) River Indus sampling U/S of the point source
- c) River Indus Sampling D/S of the point source after mixing

Based on the physical survey and numbers of point sources disposing effluent into the River Indus, twenty nine (29) sampling points were identified for sampling. **Figure 2.1** indicates the location of the sampling points along the river Indus and point sources of pollution. **Table 2.1** indicates the locations of the various sampling pints fixed along the river length and on the point sources of the river Indus.

The
was
by qualified
EPA



sampling
conducted
staff of
Punjab

Laboratories. Measurements of Dissolved Oxygen (DO), temperature

and pH were made on the site during sampling. The samples were collected in polystyrene bottles ranging in capacity from 0.5 to 1.5 L. The bottles were thoroughly washed with water, before taking samples.

Sulfuric acid and Nitric acid were used as preservatives in sampling bottles for trace elements and nitrate determination respectively. All samples were brought to the lab and kept in refrigeration at a temperature of 4°C till analysis.

2.2.5 Analysis

Analysis of the wastewater samples was carried out in EPA Laboratory, Lahore. Samples were analyzed according to the standard procedure as described in **“Standard Methods for Examination of Water and Wastewater”** by WPCF, AWWF & APHA 18th edition was followed, to obtain base line information on industrial effluent along with pollution load study.

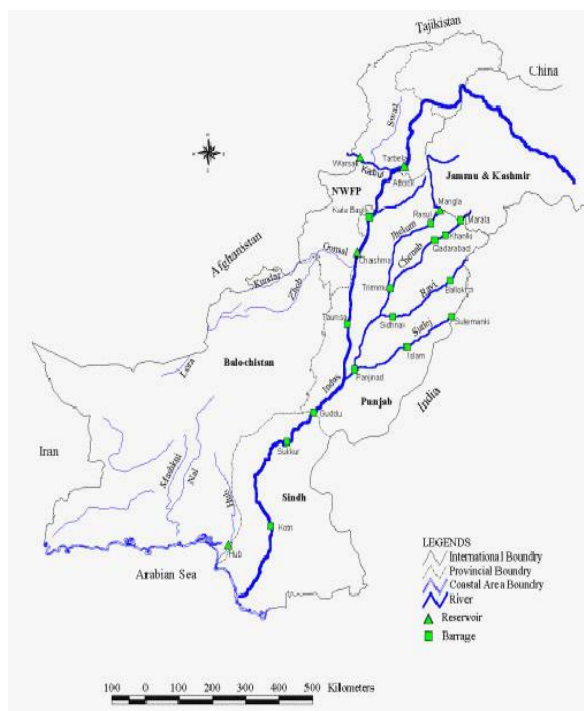
Table 2.1 Sampling Points along River Indus and Sources of Pollution

Sample No.	Location of Sampling Points
S-01	River Indus Entry Point Into District Attock Near Village Jabber.
S-02	Nallah Chail, Before mixing Into River Indus, Near Jabber Village, District Attock.
S-03	River Indus After Mixing With Nallah Chail, Near Attock Bridge, District Attock.
S-04	River Kabul Before Mixing Into River Indus Near Attock Bridge, District Attock.
S-05	River Indus, After Mixing With River Kabul And Before mixing With, Brotha Canal, District Attock.
S-06	Ghazi Brotha Canal before Mixing Into River Indus at Brotha Village District Attock.
S-07	Nallah Haro, Before Mixing Into River Indus, At Brotha Village District Attock.
S-08	River Indus After Mixing With Nallah Haro And Brotha Canal And Before Mixing With Siwan river At Village Makhand District Attock.
S-09	River Siwan Before Mixing Into River Indus at Village Tarap, District Attock.
S-10	River Indus Entry Point Into District Mianwali And Before Mixing Sewage Water Of Kala Bagh Village, At Village Kala Bagh, District Mianwali.
S-11	Sewage Water Of Village Kala bagh Before Mixing Into River Indus, District Mianwali.
S-12	River Indus After Mixing With Sewage Water Of Kala Bagh Village And Before Mixing With Sewage Water Drain Of Mianwali.
S-13	Mianwali Sewage Water Drain Before Mixing Into River Indus at Basti Qadirabad, District Mianwali.
S-14	River Indus After Mixing With Mianwali Sewage Water Drain Kundian Area, District Mianwali.

- S-15 River Indus Exit Point District Mianwali, At Chashma Barrage, District Mianwali.
- S-16 River Indus Entry Point Into District Bhakkar, near Kaloor Kot Tehsil And District Bhakkar.
- S-17 River Indus Exit Point District Bhakkar Near Wara Syrran Area, District Bhakkar.
- S-18 River Indus Entry Point District Layyah And before Mixing With Sewage Water Drain Of Layyah City. District Layyah.
- S-19 Sewage Water Drain, Before Mixing Into River Indus, Purani Mandi. District Layyah.
- S-20 River Indus Exit Point Of Layyah District And After Mixing With Sewage Water Drain Of Layyah City, At Dhole Wala. District Layyah.
- S-21 River Indus Before Mixing With Sangar Nullah. Near Dona Village, Tounsa Sharif, District Dera Ghazi Khan.
- S-22 Sangar Nullah, Before Mixing With River Indus, Tounsa Sharif, District Dera Ghazi Khan.
- S-23 River Indus After Mixing With Sangar Nullah Tounsa Sharif, District Dera Ghazi Khan.
- S-24 River Indus, Entry Point Into Teh. D. G. Khan And Before Mixing With Ghazi Ghat Drain, Near Khan Wah, Tounsa Sharif, District Dera Ghazi Khan.
- S-25 Ghazi Ghat Drain Before Mixing Into River Indus Muzaffar Garh.
- S-26 River Indus, Entry Point Into District Rajan Pur, And Before Mixing With Manka Drain And After Mixing With Ghazi Ghat Drain Near Jampur, District Rajan Pur.
- S-27 Manka Drain, Before Mixing Into River Indus, District Rajanpur.
- S-28 River Indus, After Mixing With Manka Drain, Near Mithan Kot, District Rajan Pur.
- S-29 River Indus Exit Point Of District Rajan Pur at Guddu Barrage.

2.3 Project Area Description

Indus River is a major river which flows through the Indian Subcontinent. Originating in the Tibetan plateau in the vicinity of Lake Mansarovar in Tibet Autonomous Region, the river runs a course through the Ladakh district of Jammu and Kashmir and then enters Northern Areas of Pakistan (Gilgit-Baltistan), flowing through the North in a



southerly direction along the entire length of the country, to merge into the Arabian Sea near port city of Karachi in Sindh. The total length of the river is 3,180 kilometers (1,976 miles) and is Pakistan's longest river. The river has a total drainage area exceeding 1,165,000 square kilometers (450,000 square miles).

The river's estimated annual flow stands at around 207 cubic kilometers, making it the twenty-first largest river in the world in terms of annual flow. Beginning at the heights of the world with glaciers, the river feeds the ecosystem of temperate forests, plains and arid countryside. Together with the rivers Chenab, Ravi, Sutlej, Jhelum, Beas and two tributaries from the North West Frontier and Afghanistan, the Indus forms the Sindhu Sapta delta of Pakistan. The Indus passes gigantic gorges 4,500-5,200 meters (15,000-17,000 feet) deep near the Nanga Parbat massif. It flows swiftly across Hazara, and is dammed at the Tarbela Reservoir.

Kabul River joins it near Attock. The remainder of its route to the sea is in plains of the Punjab and Sindh, and the river becomes

slow-flowing and highly braided. It is joined by Panjnad River at Mithankot.

Indus is one of the few rivers in the world that exhibit a tidal bore. Indus system is largely fed by the snows and glaciers of the Himalayas, Karakoram and the Hindu Kush ranges of Tibet, the state of Jammu and Kashmir and the Northern Areas of Pakistan respectively. The flow of the river is also determined by the seasons - it diminishes greatly in the winter, while flooding its banks in the monsoon months from July to September. There is also evidence of a steady shift in the course of the river since prehistoric times - it deviated westwards from flowing into the Rann of Kutch and adjoining Banni grasslands after the 1816 earthquake.



Indus River Delta forms where the Indus River flows into the Arabian Sea in Pakistan. The delta covers an area of about 16,000 square miles (41,440 km²), and is approximately 130 miles across where it meets the sea. Unlike many other deltas, the Indus River Delta consists of clay and other infertile soils, and is very swampy. The delta receives between 10 and 20 inches of rainfall in a normal year.

Pakistan's fifth largest cities, Hyderabad, lies about 130 miles north of the mouths of the Indus. Towns are found throughout the delta, but there are no large cities on the delta south of Hyderabad. Karachi, Pakistan's largest city lies west of the delta on the coast of the Arabian Sea.

Average temperatures for the delta region in July range from 70 - 85 ° F and 50 - 70 ° F in January. Indus River Delta is an important region for migrating water birds, and is an area rich in freshwater fauna. Fish found in the delta include the Hilsa, Indus baril, Indus

garua (a catfish), the giant snakehead, golden mahaseer and the Rita catfish.

The climate of the district is hot and dry. The summer season starts in April and continues until October. May, June, and July are the hottest months. The mean maximum and minimum temperatures for these months are about 47 and 28 degrees Celsius. Dry, hot, and dusty winds are common during summer. The winter season lasts from November to March. December, January and February are the coldest months. The mean maximum and minimum temperatures for this period are about 22 and 4 °C. Fog is very common during winter.

Indus provides the key water resources for the economy of Pakistan, especially the Breadbasket of Punjab province, which accounts for most of the nation's agricultural production, and Sindh. The river also supports many heavy industries and provides the main supply of potable water in Pakistan.

Chapter-3 Pollution of River Indus

This chapter describes the results of the analysis of the samples collected during August 2009 from the various sampling points along the river and its point sources of pollution. Details of the analysis of individual samples is given below whereas **Table 3.1** presents the summary of the results of analysis of sample collected along the river Indus and its sources of pollution.

3.1 Water Quality of the River Indus

Analysis reports of the individual samples indicates the following results:

3.1.1 River Indus Entry Point into District Attock near Village Jabber.

Dissolved Oxygen level at this sampling point was found as 10.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.1

**Table-3.1
Wastewater analysis report of River Indus Entry Point into District Attock near Village Jabber**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	15.0
2	Value of pH	6-9	7.5
3	Dissolved Oxygen	-	10.5
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	12.0
6	Total Dissolved Solids (TDS)	3500 mg/l	250
7	Total Suspended Solids	200 mg/l	260
8	Chloride (Cl ⁻¹)	1000 mg/l	75
9	Sulphate (SO ₄) ⁻²	600 mg/l	96
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.023
12	Cyanide (As CN ['])	1.0 mg/l	0.019
13	Manganese	1.5 mg/l	0.023
14	Copper	1.0 mg/l	0.051
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.005
18	Iron	8.0 mg/l	0.075
19	Nickel	1.0 mg/l	0.001
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	4

22	Calcium (Ca)	-	17
23	Potassium (K)	-	5.4

Remarks: The value of TSS exceeds the NEQS limits

3.1.2 Nallah Chail, Before mixing Into River Indus, Near Jabber Village, District Attock.

The Dissolved Oxygen level at this sampling point was found as 2.9 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 196 mg/l and 442 mg/l respectively. Nallah Chail is responsible for adding 4.795 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.2

**Table-3.2
Wastewater analysis report of the Nallah Chail, before
mixing into River Indus, near Jabber Village, District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	30.0
2	Value of pH	6-9	7.1
3	Dissolved Oxygen	-	2.9
4	Biochemical Oxygen	80 mg/l	196
5	Chemical Oxygen Demand	150 mg/l	442
6	Total Dissolved Solids (TDS)	3500 mg/l	700
7	Total Suspended Solids	200 mg/l	270
8	Chloride (Cl ⁻¹)	1000 mg/l	75
9	Sulphate (SO ₄) ⁻²	600 mg/l	112
10	Sulfide	1.0 mg/l	04
11	Fluoride (As F ¹)	10 mg/l	0.513
12	Cyanide (As CN ¹)	1.0 mg/l	0.02
13	Manganese	1.5 mg/l	0.028
14	Copper	1.0 mg/l	0.059
15	Cadmium	0.1 mg/l	0.005
16	Chromium	1.0 mg/l	0.002
17	Zinc	5.0 mg/l	0.012
18	Iron	8.0 mg/l	0.099
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0.9
21	Sodium (Na)	-	44

22	Calcium (Ca)	-	20
23	Potassium (K)	-	13.3

Remarks: The values of BOD, COD, TSS and Sulfide exceed the NEQS limits.

3.1.3 River Indus after Mixing With Nullah Chail, Near Attock Bridge, District Attock.

The Dissolved Oxygen level at this sampling point was found as 10.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.5 mg/l and 12.5 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.3

**Table-3.3
Wastewater analysis report of the River Indus after Mixing with Nullah Chail, near Attock Bridge, District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	15.0
2	Value of pH	6-9	7.5
3	Dissolved Oxygen	-	10.5
4	Biochemical Oxygen	80 mg/l	3.5
5	Chemical Oxygen Demand	150 mg/l	12.5
6	Total Dissolved Solids (TDS)	3500 mg/l	240
7	Total Suspended Solids	200 mg/l	260
8	Chloride (Cl ⁻¹)	1000 mg/l	30
9	Sulphate (SO ₄) ⁻²	600 mg/l	30
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.116
12	Cyanide (As CN ['])	1.0 mg/l	0.02
13	Manganese	1.5 mg/l	0.022
14	Copper	1.0 mg/l	0.052
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.005
18	Iron	8.0 mg/l	0.076
19	Nickel	1.0 mg/l	0.001
20	Oil & Grease	10 mg/l	0.0

21	Sodium (Na)	-	4
22	Calcium (Ca)	-	14
23	Potassium (K)	-	6.2

Remarks: The value of TSS exceeds the NEQS limits

3.1.4 River Kabul before Mixing into River Indus near Attock Bridge, District Attock.

The Dissolved Oxygen level at this sampling point was found as 10.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.4

**Table-3.4
Wastewater analysis report of the River Kabul before Mixing into River Indus near Attock Bridge, District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	14.5
2	Value of pH	6-9	7.4
3	Dissolved Oxygen	-	10.5
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	12.0
6	Total Dissolved Solids (TDS)	3500 mg/l	250
7	Total Suspended Solids	200 mg/l	200
8	Chloride (Cl ⁻¹)	1000 mg/l	10
9	Sulphate (SO ₄) ⁻²	600 mg/l	36
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.216
12	Cyanide (As CN ['])	1.0 mg/l	0.02
13	Manganese	1.5 mg/l	0.021
14	Copper	1.0 mg/l	0.052
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.004
18	Iron	8.0 mg/l	0.069
19	Nickel	1.0 mg/l	0.001

20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	4
22	Calcium (Ca)	-	17
23	Potassium (K)	-	6.1

Remarks: The parameters analyzed are within the NEQS limits.

3.1.5 River Indus, After Mixing with River Kabul And Before mixing With, Brotha Canal, District Attock.

The Dissolved Oxygen level at this sampling point was found as 10.2 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.5 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.5

**Table-3.5
Wastewater analysis report of River Indus, after Mixing with River Kabul and before mixing with, Brotha Canal, District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	19.0
2	Value of pH	6-9	7.6
3	Dissolved Oxygen	-	10.2
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	12.5
6	Total Dissolved Solids (TDS)	3500 mg/l	220
7	Total Suspended Solids	200 mg/l	240
8	Chloride (Cl ⁻¹)	1000 mg/l	25
9	Sulphate (SO ₄) ⁻²	600 mg/l	20
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.212
12	Cyanide (As CN ['])	1.0 mg/l	0.014
13	Manganese	1.5 mg/l	0.022
14	Copper	1.0 mg/l	0.050
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.005
18	Iron	8.0 mg/l	0.071
19	Nickel	1.0 mg/l	0.001

20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	5
22	Calcium (Ca)	-	26
23	Potassium (K)	-	6.0

Remarks: The value of TSS exceeds the NEQS limits.

3.1.6 Ghazi Brotha Canal, Before Mixing Into River Indus, At Brotha Village District Attock.

The Dissolved Oxygen level at this sampling point was found as 9.8 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0mg/l and 10.8 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.6

**Table-3.6
Wastewater analysis report of the Ghazi Brotha Canal,
before Mixing into River Indus, At Brotha Village District
Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	18.0
2	Value of pH	6-9	7.6
3	Dissolved Oxygen	-	9.8
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	10.8
6	Total Dissolved Solids (TDS)	3500 mg/l	280
7	Total Suspended Solids	200 mg/l	300
8	Chloride (Cl ⁻¹)	1000 mg/l	10
9	Sulphate (SO ₄) ⁻²	600 mg/l	18
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.44
12	Cyanide (As CN ['])	1.0 mg/l	0.02
13	Manganese	1.5 mg/l	0.020
14	Copper	1.0 mg/l	0.050
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.005
18	Iron	8.0 mg/l	0.073

19	Nickel	1.0 mg/l	0.001
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	4
22	Calcium (Ca)	-	14.
23	Potassium (K)	-	6.8

Remarks: The value of TSS exceeds the NEQS Limits.

3.1.7 Nallah Haro, Before Mixing Into River Indus, At Brotha Village District Attock.

The Dissolved Oxygen level at this sampling point was found as 3.8 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 12.8 mg/l and 46.8 mg/l respectively. Nallah Hars is responsible for adding 1.566 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.7

**Table-3.7
Wastewater analysis report of Nallah Haro, before Mixing into River Indus, At Brotha Village District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	25.0
2	Value of pH	6-9	7.3
3	Dissolved Oxygen	-	3.8.0
4	Biochemical Oxygen	80 mg/l	12.8
5	Chemical Oxygen Demand	150 mg/l	46.8
6	Total Dissolved Solids (TDS)	3500 mg/l	260
7	Total Suspended Solids	200 mg/l	40
8	Chloride (Cl ⁻¹)	1000 mg/l	25
9	Sulphate (SO ₄) ⁻²	600 mg/l	44
10	Sulfide	1.0 mg/l	4
11	Fluoride (As F ¹)	10 mg/l	0.432
12	Cyanide (As CN ¹)	1.0 mg/l	0.014
13	Manganese	1.5 mg/l	0.030
14	Copper	1.0 mg/l	0.060
15	Cadmium	0.1 mg/l	0.004
16	Chromium	1.0 mg/l	0.003
17	Zinc	5.0 mg/l	0.014

18	Iron	8.0 mg/l	0.093
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	1.1
21	Sodium (Na)	-	34
22	Calcium (Ca)	-	12
23	Potassium (K)	-	3.3

Remarks: The value of Sulfide exceeds the NEQS limits.

3.1.8 River Indus after Mixing With Nullah Haro and Brotha Canal and Before Mixing With Siwan River at Village Makhand District Attock.

The Dissolved Oxygen level at this sampling point was found as 9.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 4.2 mg/l and 12 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.8

**Table-3.8
Wastewater analysis report of River Indsus afterMixing With Nullah Haro and Brotha Canal and Before Mixing With Siwan River at Village Makhand District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	20.0
2	Value of pH	6-9	7.1
3	Dissolved Oxygen	-	9.5
4	Biochemical Oxygen	80 mg/l	4.2
5	Chemical Oxygen Demand	150 mg/l	12
6	Total Dissolved Solids (TDS)	3500 mg/l	320
7	Total Suspended Solids	200 mg/l	300
8	Chloride (Cl ⁻¹)	1000 mg/l	25
9	Sulphate (SO ₄) ⁻²	600 mg/l	120
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.423
12	Cyanide (As CN ['])	1.0 mg/l	0.015
13	Manganese	1.5 mg/l	0.024
14	Copper	1.0 mg/l	0.052
15	Cadmium	0.1 mg/l	0.003

16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.006
18	Iron	8.0 mg/l	0.077
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	6
22	Calcium (Ca)	-	18
23	Potassium (K)	-	5.1

Remarks: The value of TSS exceeds the NEQS limits.

3.1.9 River Siwan before Mixing Into River Indus, At Village, Tarap District Attock.

The Dissolved Oxygen level at this sampling point was found as 6.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 14.0 mg/l and 24.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.9

**Table-3.9
Wastewater analysis report of River Siwan Before Mixing into River Indus, At Village, Tarap District Attock**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	35.0
2	Value of pH	6-9	7.0
3	Dissolved Oxygen	-	6.5
4	Biochemical Oxygen	80 mg/l	14.0
5	Chemical Oxygen Demand	150 mg/l	24.0
6	Total Dissolved Solids (TDS)	3500 mg/l	420
7	Total Suspended Solids	200 mg/l	360
8	Chloride (Cl ⁻¹)	1000 mg/l	10
9	Sulphate (SO ₄) ⁻²	600 mg/l	96
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.216
12	Cyanide (As CN ⁻)	1.0 mg/l	0.02
13	Manganese	1.5 mg/l	0.032
14	Copper	1.0 mg/l	0.071
15	Cadmium	0.1 mg/l	0.005

16	Chromium	1.0 mg/l	0.002
17	Zinc	5.0 mg/l	0.011
18	Iron	8.0 mg/l	0.085
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	68
22	Calcium (Ca)	-	24
23	Potassium (K)	-	11.6

Remarks: The value of TSS exceeds the NEQS limits.

3.1.10 River Indus Entry Point into District Mianwali and Before Mixing Sewage Water of Kala Bagh Village, At Village Kala Bagh, District Mianwali.

The Dissolved Oxygen level at this sampling point was found as 8.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.10

**Table-3.10
Waste water Analysis Report of River Indus Entry Point Into District Mianwali And Before Mixing Sewage Water Of Kala Bagh Village, At Village Kala Bagh, District Mianwali.**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	22.4
2	Value of pH	6-9	7.8
3	Dissolved Oxygen	-	8.5
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	12.0
6	Total Dissolved Solids (TDS)	3500 mg/l	300
7	Total Suspended Solids	200 mg/l	270
8	Chloride (Cl ⁻¹)	1000 mg/l	15
9	Sulphate (SO ₄) ⁻²	600 mg/l	58
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ¹)	10 mg/l	0.314
12	Cyanide (As CN ¹)	1.0 mg/l	0.015
13	Manganese	1.5 mg/l	0.022
14	Copper	1.0 mg/l	0.048
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0

17	Zinc	5.0 mg/l	0.005
18	Iron	8.0 mg/l	0.072
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	2.7
21	Sodium (Na)	-	7
22	Calcium (Ca)	-	14
23	Potassium (K)	-	2.5

Remarks: The value of TSS exceeds the NEQS limits.

3.1.11 Sewage Water of Village Kala bagh Before Mixing Into River Indus, District Mianwali.

The Dissolved Oxygen level at this sampling point was found as 3.0 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 30.0 mg/l and 64.0 mg/l respectively. This drain is responsible for adding 0.011 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.11

**Table-3.11
Wastewater analysis report of Sewage Water of Village Kala bagh before Mixing into River Indus, District Mianwali**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	25.0
2	Value of pH	6-9	6.7
3	Dissolved Oxygen	-	3.0
4	Biochemical Oxygen	80 mg/l	30.0
5	Chemical Oxygen Demand	150 mg/l	64.0
6	Total Dissolved Solids (TDS)	3500 mg/l	920
7	Total Suspended Solids	200 mg/l	120
8	Chloride (Cl ⁻¹)	1000 mg/l	210
9	Sulphate (SO ₄) ⁻²	600 mg/l	216
10	Sulfide	1.0 mg/l	08
11	Fluoride (As F ['])	10 mg/l	0.316
12	Cyanide (As CN ['])	1.0 mg/l	0.97
13	Manganese	1.5 mg/l	0.035
14	Copper	1.0 mg/l	0.057

15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.002
17	Zinc	5.0 mg/l	0.008
18	Iron	8.0 mg/l	0.099
19	Nickel	1.0 mg/l	0.005
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	160
22	Calcium (Ca)	-	36
23	Potassium (K)	-	27.6

Remarks: The value of Sulfide exceed the NEQS limits.

3.1.12 River Indus after Mixing With Sewage Water of Kala Bagh Village and Before Mixing With Sewage Water Drain of Mianwali.

The Dissolved Oxygen level at this sampling point was found as 8.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.6 mg/l and 12 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.12

**Table-3.12
Wastewater analysis report of River Indus After Mixing With Sewage Water of Kala Bagh Village and Before Mixing With Sewage Water Drain of Mianwali**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	23.1
2	Value of pH	6-9	7.7
3	Dissolved Oxygen	-	8.5
4	Biochemical Oxygen	80 mg/l	3.6
5	Chemical Oxygen Demand	150 mg/l	12
6	Total Dissolved Solids (TDS)	3500 mg/l	200
7	Total Suspended Solids	200 mg/l	320
8	Chloride (Cl ⁻¹)	1000 mg/l	10
9	Sulphate (SO ₄) ⁻²	600 mg/l	36
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ¹)	10 mg/l	0.412
12	Cyanide (As CN ¹)	1.0 mg/l	0.101
13	Manganese	1.5 mg/l	0.022

14	Copper	1.0 mg/l	0.050
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.006
18	Iron	8.0 mg/l	0.071
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	7
22	Calcium (Ca)	-	16
23	Potassium (K)	-	2.9

Remarks: The value of TSS exceeds the NEQS limits.

3.1.13 Mianwali Sewage Water Drain Before Mixing Into River Indus, At Basti Qadirabad, District Mianwali.

The Dissolved Oxygen level at this sampling point was found as 2.0 mg/l. Biochemical Oxygen Demand (BOD)₅ and Chemical Oxygen Demand (COD) of the River were found to be 84 mg/l and 172 mg/l respectively. This drain is responsible for adding 1.42 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.13

**Table-3.13
Wastewater analysis report of the Mianwali Sewage Water Drain before Mixing Into River Indus, at Basti Qadirabad, District Mianwali**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	30.0
2	Value of pH	6-9	7.0
3	Dissolved Oxygen	-	2.0
4	Biochemical Oxygen	80 mg/l	84
5	Chemical Oxygen Demand	150 mg/l	172
6	Total Dissolved Solids (TDS)	3500 mg/l	1000
7	Total Suspended Solids	200 mg/l	300
8	Chloride (Cl ⁻¹)	1000 mg/l	400
9	Sulphate (SO ₄) ⁻²	600 mg/l	212
10	Sulfide	1.0 mg/l	12
11	Fluoride (As F ['])	10 mg/l	0.716

12	Cyanide (As CN')	1.0 mg/l	0.006
13	Manganese	1.5 mg/l	0.047
14	Copper	1.0 mg/l	0.065
15	Cadmium	0.1 mg/l	0.005
16	Chromium	1.0 mg/l	0.003
17	Zinc	5.0 mg/l	0.009
18	Iron	8.0 mg/l	0.198
19	Nickel	1.0 mg/l	0.006
20	Oil & Grease	10 mg/l	1.9
21	Sodium (Na)	-	200
22	Calcium (Ca)	-	36
23	Potassium (K)	-	36.8

Remarks: The values of BOD, COD, TSS and Sulfide exceed the NEQS limits

3.1.14 River Indus after Mixing With Mianwali Sewage Water Drain Kundian Area, District Mianwali.

The Dissolved Oxygen level at this sampling point was found as 8.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.5 mg/l and 12.8 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.14

**Table-3.14
Wastewater analysis report of the River Indus after Mixing with Mianwali Sewage Water Drain Kundian Area, District Mianwali**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	23.0
2	Value of pH	6-9	7.5
3	Dissolved Oxygen	-	8.5
4	Biochemical Oxygen	80 mg/l	3.5
5	Chemical Oxygen Demand	150 mg/l	12.8
6	Total Dissolved Solids (TDS)	3500 mg/l	260
7	Total Suspended Solids	200 mg/l	380
8	Chloride (Cl ⁻¹)	1000 mg/l	70
9	Sulphate (SO ₄) ⁻²	600 mg/l	48
10	Sulfide	1.0 mg/l	0.0

11	Fluoride (As F ⁻)	10 mg/l	0.02
12	Cyanide (As CN ⁻)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.023
14	Copper	1.0 mg/l	0.052
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.007
18	Iron	8.0 mg/l	0.056
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	09
22	Calcium (Ca)	-	18
23	Potassium (K)	-	3.4

Remarks: The value of TSS exceeds the NEQS limits.

3.1.15 River Indus Exit Point District Mianwali, At Chashma Barrage, District Mianwali.

The Dissolved Oxygen level at this sampling point was found as 8.2 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 4.5 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.15

**Table-3.15
Wastewater analysis report of River Indus Exit Point
District Mianwali, at Chashma Barrage, District Mianwali**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	25.0
2	Value of pH	6-9	7.8
3	Dissolved Oxygen	-	8.2
4	Biochemical Oxygen	80 mg/l	4.5
5	Chemical Oxygen Demand	150 mg/l	12.0
6	Total Dissolved Solids (TDS)	3500 mg/l	220
7	Total Suspended Solids	200 mg/l	260
8	Chloride (Cl ⁻¹)	1000 mg/l	45
9	Sulphate (SO ₄) ⁻²	600 mg/l	44
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.414

12	Cyanide (As CN ⁻)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.022
14	Copper	1.0 mg/l	0.048
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.006
18	Iron	8.0 mg/l	0.056
19	Nickel	1.0 mg/l	0.001
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	08
22	Calcium (Ca)	-	18
23	Potassium (K)	-	05

Remarks: The value of TSS exceeds the NEQS limits.

3.1.16 River Sindh Entry Point into District Bhakkar, near Kaloor Kot Tehsil and District Khushab.

The Dissolved Oxygen level at this sampling point was found as 9.8 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 4.0 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.16

**Table-3.16
Wastewater analysis report of River Sindh Entry Point into District Bhakkar, near Kaloor Kot Tehsil and District Bhakkar**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	20.0
2	Value of pH	6-9	7.0
3	Dissolved Oxygen	-	9.8
4	Biochemical Oxygen	80 mg/l	4.0
5	Chemical Oxygen	150 mg/l	12.0
6	Total Dissolved Solids	3500 mg/l	440
7	Total Suspended Solids	200 mg/l	120
8	Chloride (Cl ⁻¹)	1000 mg/l	50
9	Sulphate (SO ₄) ⁻²	600 mg/l	88
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	1.22

12	Cyanide (As CN ⁻)	1.0 mg/l	0.553
13	Manganese	1.5 mg/l	0.015
14	Copper	1.0 mg/l	0.040
15	Cadmium	0.1 mg/l	0.005
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.014
18	Iron	8.0 mg/l	0.176
19	Nickel	1.0 mg/l	0.009
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	48
22	Calcium (Ca)	-	22
23	Potassium (K)	-	7.6

Remarks: The parameters analyzed are within the NEQS limits.

3.1.17 River Indus Exit Point District Bhakkar near Wara Syrran Area, District Bhakkar.

The Dissolved Oxygen level at this sampling point was found as 8.2 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.6 mg/l and 12.5 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.17

**Table-3.17
Waste water Analysis Report of River Indus Exit Point
District Bhakkar near Wara Syrran Area, District Bhakkar**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	26.0
2	Value of pH	6-9	7.7
3	Dissolved Oxygen	-	8.2
4	Biochemical Oxygen	80 mg/l	3.6
5	Chemical Oxygen	150 mg/l	12.5
6	Total Dissolved Solids	3500 mg/l	380
7	Total Suspended Solids	200 mg/l	250
8	Chloride (Cl ⁻¹)	1000 mg/l	35
9	Sulphate (SO ₄) ⁻²	600 mg/l	56
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.420
12	Cyanide (As CN ⁻)	1.0 mg/l	0.001

13	Manganese	1.5 mg/l	0.02
14	Copper	1.0 mg/l	0.081
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.018
18	Iron	8.0 mg/l	0.156
19	Nickel	1.0 mg/l	0.009
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	09
22	Calcium (Ca)	-	16
23	Potassium (K)	-	2.8

Remarks: The value of TSS exceeds the NEQS limits.

3.1.18 River Indus Entry Point District Layyah And before Mixing With Sewage Water Drain Of Layyah City. District Layyah.

The Dissolved Oxygen level at this sampling point was found as 8.0 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.18

**Table-3.18
Wastewater analysis report of the River Indus Entry Point
District Layyah and before Mixing with Sewage Water
Drain of Layyah City, District Layyah**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	26.2
2	Value of pH	6-9	7.8
3	Dissolved Oxygen	-	8.0
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen	150 mg/l	12.0
6	Total Dissolved Solids	3500 mg/l	230
7	Total Suspended Solids	200 mg/l	330
8	Chloride (Cl ⁻¹)	1000 mg/l	35
9	Sulphate (SO ₄) ⁻²	600 mg/l	68
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.032

12	Cyanide (As CN ⁻)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.015
14	Copper	1.0 mg/l	0.04
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.015
18	Iron	8.0 mg/l	0.113
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	09
22	Calcium (Ca)	-	18
23	Potassium (K)	-	3.4

Remarks: The value of TSS exceeds the NEQS limits.

3.1.19 Sewage Water Drain, Before Mixing Into River Indus, Purani Mandi. District Layyah.

The Dissolved Oxygen level at this sampling point was found as 1.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 96 mg/l and 164 mg/l respectively. This drain is responsible for adding 0.62 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.19

**Table-3.19
Sewage Water Drain, before Mixing into River Indus,
Purani Mandi, District Layyah**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	33.0
2	Value of pH	6-9	6.8
3	Dissolved Oxygen	-	1.5
4	Biochemical Oxygen	80 mg/l	96
5	Chemical Oxygen	150 mg/l	164
6	Total Dissolved Solids	3500 mg/l	800
7	Total Suspended Solids	200 mg/l	200
8	Chloride (Cl ⁻¹)	1000 mg/l	160
9	Sulphate (SO ₄) ⁻²	600 mg/l	162
10	Sulfide	1.0 mg/l	16

11	Fluoride (As F')	10 mg/l	0.092
12	Cyanide (As CN')	1.0 mg/l	0.006
13	Manganese	1.5 mg/l	0.05
14	Copper	1.0 mg/l	0.085
15	Cadmium	0.1 mg/l	0.004
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.017
18	Iron	8.0 mg/l	0.09
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	2.2
21	Sodium (Na)	-	100
22	Calcium (Ca)	-	22
23	Potassium (K)	-	50

Remarks: The values of BOD,COD and Sulfide exceed the NEQS limits.

3.1.20 River Indus Exit Point of Layyah District and After Mixing With Sewage Water Drain of Layyah City, At Dhole Wala, District Layyah.

The Dissolved Oxygen level at this sampling point was found 7.8 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 4.0 mg/l and 14.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.20

**Table-3.20
Wastewater analysis report of the River Indus Exit Point Of Layyah District And After Mixing With Sewage Water Drain Of Layyah City, At Dhole Wala, District Layyah**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	27.0
2	Value of pH	6-9	7.7
3	Dissolved Oxygen	-	7.8
4	Biochemical Oxygen	80 mg/l	4.0
5	Chemical Oxygen	150 mg/l	14.0
6	Total Dissolved Solids	3500 mg/l	370
7	Total Suspended Solids	200 mg/l	270
8	Chloride (Cl ⁻¹)	1000 mg/l	10

9	Sulphate (SO ₄) ⁻²	600 mg/l	54
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.072
12	Cyanide (As CN ⁻)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.02
14	Copper	1.0 mg/l	0.052
15	Cadmium	0.1 mg/l	0.0013
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.019
18	Iron	8.0 mg/l	0.099
19	Nickel	1.0 mg/l	0.005
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	09
22	Calcium (Ca)	-	20
23	Potassium (K)	-	4.3

Remarks: The value of TSS exceeds the NEQS limits.

3.1.21 River Indus before Mixing With Sangar Nullah. Near Dona Village, Tounsa Sharif, District Dera Ghazi Khan.

The Dissolved Oxygen level at this sampling point was found as 8.3 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.2 mg/l and 10.8 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.21

**Table-3.21
Wastewater analysis report of the River Indus before
mixing with Sangar Nullah. Near Dona Village,
Tounsa Sharif, District Dera Ghazi Khan**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	30.0
2	Value of pH	6-9	7.5
3	Dissolved Oxygen	-	8.3
4	Biochemical Oxygen	80 mg/l	3.2
5	Chemical Oxygen	150 mg/l	10.8
6	Total Dissolved Solids	3500 mg/l	420
7	Total Suspended Solids	200 mg/l	260
8	Chloride (Cl ⁻¹)	1000 mg/l	50
9	Sulphate (SO ₄) ⁻²	600 mg/l	94

10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ⁻)	10 mg/l	0.059
12	Cyanide (As CN ⁻)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.021
14	Copper	1.0 mg/l	0.042
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.012
18	Iron	8.0 mg/l	0.085
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	15
22	Calcium (Ca)	-	31
23	Potassium (K)	-	4.7

Remarks: The value of TSS exceeds the NEQS limits.

3.1.22 Sangar Nullah, Before Mixing With River Indus, Tounsa Sharif, District Dera Ghazi Khan.

The Dissolved Oxygen level at this sampling point was found as 3.5 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 9.9 mg/l and 28.8 mg/l respectively. This Nullah is responsible for adding 36.3 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.22

**Table-3.22
Wastewater analysis report of Sangar Nullah before
Mixing with River Indus, Tounsa Sharif,
District Dera Ghazi Khan**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	34.0
2	Value of pH	6-9	7.1
3	Dissolved Oxygen	-	3.5

4	Biochemical Oxygen	80 mg/l	9.9
5	Chemical Oxygen	150 mg/l	28.8
6	Total Dissolved Solids	3500 mg/l	960
7	Total Suspended Solids	200 mg/l	1620
8	Chloride (Cl ⁻¹)	1000 mg/l	55
9	Sulphate (SO ₄) ⁻²	600 mg/l	256
10	Sulfide	1.0 mg/l	4.0
11	Fluoride (As F ¹)	10 mg/l	0.812
12	Cyanide (As CN ¹)	1.0 mg/l	0.007
13	Manganese	1.5 mg/l	0.029
14	Copper	1.0 mg/l	0.087
15	Cadmium	0.1 mg/l	0.004
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.112
18	Iron	8.0 mg/l	0.095
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	1.1
21	Sodium (Na)	-	88
22	Calcium (Ca)	-	80
23	Potassium (K)	-	5.4

Remarks: The values of TSS and Sulfide exceed the NEQS limits.

3.1.23 River Indus after Mixing With Sangar Nullah Tounsa Sharif, District Dera Ghazi Khan.

The Dissolved Oxygen level at this sampling point was found as 8.1 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.5 mg/l and 12.2 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.23.

**Table-3.23
Wastewater analysis report of River Indus after mixing
with Sangar Nullah Tounsa Sharif, District Dera Ghazi Khan**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	29.0
2	Value of pH	6-9	7.2
3	Dissolved Oxygen	-	8.1
4	Biochemical Oxygen	80 mg/l	3.5

5	Chemical Oxygen	150 mg/l	12.2
6	Total Dissolved Solids	3500 mg/l	340
7	Total Suspended Solids	200 mg/l	260
8	Chloride (Cl ⁻¹)	1000 mg/l	25
9	Sulphate (SO ₄) ⁻²	600 mg/l	80
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ¹)	10 mg/l	0.713
12	Cyanide (As CN ¹)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.025
14	Copper	1.0 mg/l	0.061
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.015
18	Iron	8.0 mg/l	0.087
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	09
22	Calcium (Ca)	-	29
23	Potassium (K)	-	4.9

Remarks: The value of TSS exceeds the NEQS limits.

3.1.24 River Indus, Entry Point Into Teh. D.G.Khan And Before Mixing With Ghazi Ghat Drain, Near Khan Wah, Tounsa Sharif, District Dera Ghazi Khan.

The Dissolved Oxygen level at this sampling point was found as 8.0 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.0 mg/l and 12.5 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.24

**Table-3.24
Wastewater analysis report of River Indus, Entry Point into District D.G.Khan and Before Mixing With Ghazi Ghat Drain, Near Khan Wah, Tounsa Sharif, District Dera Ghazi Khan**

S#	PARAMETERS	N.E.Q.S.	RESULTS
1	Temperature	=<3° C	30
2	Value of pH	6-9	7.6

3	Dissolved Oxygen	-	8.0
4	Biochemical Oxygen	80 mg/l	3.0
5	Chemical Oxygen Demand	150 mg/l	12.5
6	Total Dissolved Solids (TDS)	3500 mg/l	300
7	Total Suspended Solids	200 mg/l	380
8	Chloride (Cl ⁻¹)	1000 mg/l	20
9	Sulphate (SO ₄) ⁻²	600 mg/l	68
10	Sulfide	1.0 mg/l	0
11	Fluoride (As F ['])	10 mg/l	0.25
12	Cyanide (As CN ['])	1.0 mg/l	0.0015
13	Manganese	1.5 mg/l	0.022
14	Copper	1.0 mg/l	0.037
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.013
18	Iron	8.0 mg/l	0.079
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	0
21	Sodium (Na)	-	08
22	Calcium (Ca)	-	33
23	Potassium (K)	-	4.3

Remarks: The value of TSS exceeds the NEQS limits.

3.1.25 Ghazi Ghat Drain Before Mixing Into River Indus Muzaffar Garh.

The Dissolved Oxygen level at this sampling point was found as 3.5mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 84 mg/l and 210 mg/l respectively. This drain is responsible for adding 1.23 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.25

**Table-3.25
Wastewater analysis report of the Ghazi Ghat Drain
before Mixing into River Indus Muzaffar Garh**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	33.0
2	Value of pH	6-9	7.7
3	Dissolved Oxygen	-	3.5

4	Biochemical Oxygen	80 mg/l	84
5	Chemical Oxygen	150 mg/l	210
6	Total Dissolved Solids	3500 mg/l	620
7	Total Suspended Solids	200 mg/l	40
8	Chloride (Cl ⁻¹)	1000 mg/l	50
9	Sulphate (SO ₄) ⁻²	600 mg/l	142
10	Sulfide	1.0 mg/l	04
11	Fluoride (As F ¹)	10 mg/l	0.215
12	Cyanide (As CN ¹)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.34
14	Copper	1.0 mg/l	0.075
15	Cadmium	0.1 mg/l	0.013
16	Chromium	1.0 mg/l	0.017
17	Zinc	5.0 mg/l	0.077
18	Iron	8.0 mg/l	1.12
19	Nickel	1.0 mg/l	0.004
20	Oil & Grease	10 mg/l	4.7
21	Sodium (Na)	-	100
22	Calcium (Ca)	-	26
23	Potassium (K)	-	9.8

Remarks: The values of BOD, COD and Sulfide exceed the NEQS limits.

3.1.26 River Indus, Entry Point into District Rajan Pur, And Before Mixing With Manka Drain and After Mixing With Ghazi Ghat Drain Near Mouza Jampur District Rajan Pur.

The Dissolved Oxygen level at this sampling point was found as 8.1 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.5 mg/l and 12.8 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.26

**Table-3.26
Wastewater analysis report of River Indus, Entry Point into District Rajan Pur, And Before Mixing With Manka Drain and After Mixing With Ghazi Ghat Drain Near Mouza Jampur District Rajanpur**

S#	PARAMETERS	NEQS	RESULTS
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1	Temperature	=<3° C	30.0
2	Value of pH	6-9	7.7
3	Dissolved Oxygen	-	8.1
4	Biochemical Oxygen	80 mg/l	3.5
5	Chemical Oxygen	150 mg/l	12.8
6	Total Dissolved Solids	3500 mg/l	340
7	Total Suspended Solids	200 mg/l	440
8	Chloride (Cl ⁻¹)	1000 mg/l	25
9	Sulphate (SO ₄) ⁻²	600 mg/l	96
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.623
12	Cyanide (As CN ['])	1.0 mg/l	0.002
13	Manganese	1.5 mg/l	0.11
14	Copper	1.0 mg/l	0.035
15	Cadmium	0.1 mg/l	0.002
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.017
18	Iron	8.0 mg/l	0.092
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0
21	Sodium (Na)	-	10
22	Calcium (Ca)	-	32
23	Potassium (K)	-	4.8

Remarks: The value of TSS exceeds the NEQS limits.

3.1.27 Manka Drain, Before Mixing Into River Indus, District Rajanpur.

The Dissolved Oxygen level at this sampling point was found as 4.2 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 48 mg/l and 124 mg/l respectively. This drain is responsible for adding 6.4 ton/day of organic load to the river. The detailed analysis report of the sample collected from this point is given in Table-3.27

**Table-3.27
Wastewater analysis report of the Manka Drain, before
Mixing into River Indus, District Rajanpur**

S#	PARAMETERS	NEQS	RESULTS
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1	Temperature	=<3° C	33.0
2	Value of pH	6-9	7.6
3	Dissolved Oxygen	-	4.2
4	Biochemical Oxygen	80 mg/l	48
5	Chemical Oxygen	150 mg/l	124
6	Total Dissolved Solids	3500 mg/l	660
7	Total Suspended Solids	200 mg/l	160
8	Chloride (Cl ⁻¹)	1000 mg/l	45
9	Sulphate (SO ₄) ⁻²	600 mg/l	112
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ¹)	10 mg/l	0.023
12	Cyanide (As CN ¹)	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.21
14	Copper	1.0 mg/l	0.035
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.008
18	Iron	8.0 mg/l	0.058s
19	Nickel	1.0 mg/l	0.003
20	Oil & Grease	10 mg/l	3.4
21	Sodium (Na)	-	72
22	Calcium (Ca)	-	52
23	Potassium (K)	-	5.1

Remarks: The parameters analyzed are within the NEQS limits.

3.1.28 River Indus, After Mixing With Manka Drain, Near Mithan Kot, District Rajan Pur.

The Dissolved Oxygen level at this sampling point was found as 7.8 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 3.5 mg/l and 14.5 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.28

**Table-3.28
Wastewater analysis report of the River Indus, after Mixing with Manka Drain, near Mithan Kot, District Rajan Pur.**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	33.0

2	Value of pH	6-9	7.8
3	Dissolved Oxygen	-	7.8
4	Biochemical Oxygen	80 mg/l	3.5
5	Chemical Oxygen	150 mg/l	14.5
6	Total Dissolved Solids	3500 mg/l	320
7	Total Suspended	200 mg/l	400
8	Chloride (Cl ⁻¹)	1000 mg/l	10
9	Sulphate (SO ₄) ⁻²	600 mg/l	88
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.0
12	Cyanide (As CN ['])	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.119
14	Copper	1.0 mg/l	0.047
15	Cadmium	0.1 mg/l	0.003
16	Chromium	1.0 mg/l	0.0
17	Zinc	5.0 mg/l	0.017
18	Iron	8.0 mg/l	0.71
19	Nickel	1.0 mg/l	0.002
20	Oil & Grease	10 mg/l	0
21	Sodium (Na)	-	12
22	Calcium (Ca)	-	30
23	Potassium (K)	-	4.1

Remarks: The value of TSS exceeds the NEQS limits.

3.1.29 River Indus Exit Point of District Rajan Pur.At Guddu Barrage.

The Dissolved Oxygen level at this sampling point was found as 7.7 mg/l. Biochemical Oxygen Demand (BOD₅) and Chemical Oxygen Demand (COD) of the River were found to be 4.5 mg/l and 14.0 mg/l respectively. The detailed analysis report of the sample collected from this point is given in Table-3.29.

**Table-3.29
Wastewater analysis report of the River Indus Exit Point of
District Rajan Pur, at Guddu Barrage**

S#	PARAMETERS	NEQS	RESULTS
1	Temperature	=<3° C	33.5
2	Value of pH	6-9	7.6

3	Dissolved Oxygen	-	7.7
4	Biochemical Oxygen	80 mg/l	4.5
5	Chemical Oxygen	150 mg/l	14.0
6	Total Dissolved Solids	3500 mg/l	320
7	Total Suspended Solids	200 mg/l	420
8	Chloride (Cl ⁻¹)	1000 mg/l	35
9	Sulphate (SO ₄) ⁻²	600 mg/l	90
10	Sulfide	1.0 mg/l	0.0
11	Fluoride (As F ['])	10 mg/l	0.051
12	Cyanide (As CN ['])	1.0 mg/l	0.001
13	Manganese	1.5 mg/l	0.13
14	Copper	1.0 mg/l	0.051
15	Cadmium	0.1 mg/l	0.005
16	Chromium	1.0 mg/l	0.005
17	Zinc	5.0 mg/l	0.0
18	Iron	8.0 mg/l	0.005
19	Nickel	1.0 mg/l	0.08
20	Oil & Grease	10 mg/l	0.0
21	Sodium (Na)	-	12
22	Calcium (Ca)	-	29
23	Potassium (K)	-	4.4

Remarks: The value of TSS exceeds the NEQS limits

3.2 Quality of the wastewater Carrying Drains

Individual results of the analysis of the waste water samples collected from the waste carrying drains have been given in the section 3.1.

The summary of the analysis is given as below.

3.2.1 Near Jabber village, during low season, amongst wastewater carrying drains, Nallah Chail being is responsible for adding 4.795 tons per day of organic load. Then comes Nallah Hars which contributing 1.566 Tons per day of organic load into the river Indus. Sewage Water

of Village Kala bagh is conveying wastewater having organic load of 0 .011 tons per day.

3.2.2 Near Mianwali, Mianwali Sewage Water Drain is disposing 1.42 tons per day of organic load whereas Sewage Water Drain near District Layyah, adding 0.62 tons per day of organic load into river Indus. Sangar Nullah is responsible for adding 36.3 tons per day of organic load. Ghazi Ghat Drain and Manka Drain are adding 1.23 & 6.4 tons of organic waste respectively into the River Indus.

3.3 Sources of Pollution of River Indus

The pollution of the River Indus and the groundwater in the project comprise mostly of municipal sewage and industrial effluents, sources related to agricultural activities and solid waste disposal

3.3.1 Municipal Sewage

The disposal of untreated municipal wastewaters into the river is main cause of deterioration of river water quality. Swage water impregnated with heavy organic load add greater fraction to deoxygenating of water. It carries with huge organic loads to heavily tax the oxygen resources of the river. In addition municipal wastewaters contain pathogenic organisms and their disposal results in contamination of the river which is used as a source of drinking water supplies downstream.

3.3.2 Wastewater Carrying Drains

There are many drains which collects the sewage and industrial wastewater in the urban areas and make their ways into Indus river. Numbers of drain join each other and carry all the collected sewage and industrial wastewater generated within the urban areas and dispose of in the river Sindh through various

pumping stations. Discharge in the drains is subjected to seasonal variation and mostly depends upon the weather conditions. In winter discharge is minimum and impregnated with heavy load due to less use of water.

Catchments areas and average flow of these drains is given as below:

i) Nallah Chail

Nallah Chail joins the river Indus near Jabbar village District Attock. It carries the domestic waste water of cities Hazro and Kamra district Attock. It has an average discharge of 10 cusecs and carries domestic waste.

ii) Nallah Haro

Nallah Haro comes from Haripur District and enters into River Indus near Brotha village District Attock. It is a storm water drain carrying domestic water of Attock city and other towns. It has an average discharge of 50 cusecs.

ii) Sewage Water of Village Kala bhag

The small channels carrying waste water of Kala bhag city enters into Indus River at different points. Almost each having average discharge of 0.5 cusecs.

iv) Mianwali Sewage Water Drain

This Drain comes from Mianwali city. It has an average discharge of 10.0 cusecs and it carries the sewerage water of Mianwali city and other settlements and joining the river Indus near Basti Qadirabad.

v) Sewage Water Drain

It carries the sewerage water of Layyah city and pumped into the Indus River at Purani Mandi area. It has an average discharge of 7.0 cusecs and it carries domestic waste of district Layyah.

vi) Sangar Nullah

Sangar Nullah is a very big storm water drain having large catchment areas in Koh Sulaman mountain range Tounsa Sharif District D.G Khan. Generally it flows in rainy season and has an average discharge of more than 2000 cusecs.

vii) Ghazi Ghat Drain

Ghazi Ghat drain has an average discharge of 54 cusecs. It is the most polluted drain and mainly carries industrial waste that join the river Indus in Muzafargarh District.

viii) Manka Drain

This drain has an average discharge of 6.0 cusecs. It originates from district D.G Khan and carries the sewerage water of D.G Khan city and Jampur city, district Rajanpur. Its water is being pumped out for irrigation purpose and the remaining portion is going into river Indus.

All drains after joining to some major drains /trunk sewers ultimately dispose of the collected sewage/wastewater into the river Indus.

3.3.3 Industrial Effluents

The industrial effluents contain pollutants including dissolved and suspended organic matter, heavy metals, and other toxic chemicals. With the exception of few, industrial units discharge their untreated wastewaters on land, in rivers, or nullahs and drains to ultimately reach the river or groundwater.

The discharge of industrial effluents in the river results in depletion of oxygen resources. Harmful industrial chemicals disposed of in the river through its have potential to pose serious health problems. In addition, such discharges may result in adverse effects on downstream agriculture.



Industrial wastewater contains toxic chemicals. It is alarming that most industries have been started without proper planning and waste treatment plants. They just dispose of untreated toxic waste into nearby drains, canals or rivers. Automobile service stations are another major contributor to surface water pollution. Untreated oil, grease and dirt find its way into nearby canals and drains ultimately falling into Indus, where it critically damages the ecosystem.

3.3.4 Agricultural Runoff

Agriculture runoff is another source of pollution of Indus. Extensive and indiscriminate use of pesticides and fertilizers to support agricultural activities in surrounding areas, results in leaching of such chemical during heavy rainfall. No specific data are available on the

quantities of pesticides and fertilizers being used in the surrounding areas of River Indus.

Since agriculture sector in Punjab is largest contributor to its GDP, there has been observed significant increase in use of fertilizers during the past few years. The excessive and indiscriminate use of



pesticides results in its leaching to the ground water as well as to surface water through run off during rainy season.

3.3.5 Solid Wastes Disposal

Very small part of solid waste generated in urban areas finds its way into the sewer system and a part of it appears in the outfall drains to ultimately reach the River Indus resulting in its unaesthetic appearance and degraded water quality.

Chapter-4 Conclusions and Recommendations

This chapter describes the conclusions of the monitoring of river Indus during low flow season. Conclusions and recommendations of the monitoring exercise are given as below:

4.1 Conclusions

- 4.1.1 Indus river is the largest and less polluted river in the Punjab.
- 4.1.2 In Punjab, the Indus water quality is not much more affected by the domestic waste water discharge because the volume of the wastewater joining the river is very minute as compared to the river water.
- 4.1.3 The river water quality is acceptable for irrigation purpose and for aquatic life.
- 4.1.4 The average amount of dissolved oxygen is almost found to be 10 ppm at 15 °C and varies with the temperature.
- 4.1.5 The Industrial effluents contamination is very less in Indus River as compared to other rivers because there is hardly one or two drains that carries the industrial effluent.

4.2 Recommendations

- 4.2.1 The population of concerned Districts (Attock, Mianwali, Layyah, D.G Khan, Bakhar, Muzafargarh, Rahim yar kahn Rajanpur) is increasing day by day due to which water consumption is also increasing resulting in causing more sewage production. So installation of sewage treatment plants must be planed to properly dispose off swage water and to avoid agricultural soil contamination.

4.2.2 Government of concerned Districts of River Indus must take measures to control /reduce upstream pollution control measures for Nallah Chail, Nallah Hars, sewage water of village Kala bagh, Mianwali sewage water drain, Sangar Nullah, Ghazi Ghat Drain, Manka Drain by installation of sewage treatment plants.

4.2.3 Irrigation Department of concerned districts may be requested to direct the industries to dispose off their effluents after proper treatment.

4.2.4 Industries should also be restricted to conduct third part audits occasionally and submit their report to EPA Punjab for examination.

Table 4.1 Summary of Issues of River Indus, proposed Measures and Roles and Responsibilities

Issue	Measures	Responsible Organizations
Pollution of River Indus due to industrial effluent carrying drains	<p align="center">Industrial Pollution Control</p> <ul style="list-style-type: none"> • Wastewater Reduction through cleaner production practices • Conservative use of industrial water • Installation of in-house wastewater treatment • Installation of common industrial effluent treatment plant • Shifting of most polluted industrial 	<ul style="list-style-type: none"> • Industrial establishments in catchments areas of drains • Chamber of Commerce and Industries • Industrial establishment • I&P Department • Individual industrial establishments • EPD, Punjab • EPD, Punjab • Industrial organization • Industries Department GOP • Chamber of Commerce and Industries • Industrial organization

	sector to designated areas equipped with common effluent treatment plants	<ul style="list-style-type: none"> • Industries Department GOP • Chamber of Commerce and Industries • EPD, Punjab
Pollution of River Indus due to Domestic sewage of Attock, Mianwali, Layyah, D.G Khan, Muzafargarh, Rajanpur	Pollution Control caused by untreated sewage <ul style="list-style-type: none"> • Public awareness for conservative use of domestic water • In house preliminary treatment • Installation of common sewage treatment plants 	<ul style="list-style-type: none"> • TMAs (Town Municipal Administration) • Mandatory provision of three compartment septic tanks in new housing schemes and where possible in existing scheme. • Concerned Development Authority (ies) • Private Housing Schemes • Development Authorities
Pollution of River Indus due to Improper Management of Domestic Solid Waste	Control of Pollution caused by Solid wastes	
	<ul style="list-style-type: none"> • Public Awareness for Waste Minimization at sources • Introduce the benefits of Recycling, Reuse, Recover, Refuse and Repaired • Public Awareness for Waste Minimization at sources • Introduce the benefits of Recycling, Reuse, Recover, Refuse 	<ul style="list-style-type: none"> • TMAs • EPD • TMAs • EPD • TMAs • EPD, TMAs • CDG (City District Government) Jhelum and Jhang

	<p>and Repaired</p> <ul style="list-style-type: none"> • Conversion of domestic solid waste into compost • Installation of Waste Disposal facilities i.e. Landfill facilities and RDF facilities etc. 	
Pollution of River Indus due to Agriculture Run Off	Control of Agriculture Run Off	
	<ul style="list-style-type: none"> • Environment Friendly use of pesticides and fertilizers 	<ul style="list-style-type: none"> • Agriculture Department • EPD, Punjab