WWF

REPORT

PK

2019

ILO 100 1919-2019

SOCIAL JUSTICE DECENT WORK

This project is funded by the European Union

SITUATIONAL ANALYSIS OF WATER RESOURCES OF KARACHI

Situational Analysis of Water Resources of Karachi

Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

Karachi, the city of lights, inhabits approximately 14.9 million people. Housing almost 60 per cent of the industries in the country, it is recognized as the industrial and financial center of Pakistan. Its significance in Pakistan's economy can be depicted through its 12-15 per cent contribution to the national Gross Domestic Product (GDP).

Due to the international buyers' demand, export-based industries need to comply with stringent environmental standards. Compliance with international and national standards not only promotes enterprise efficiency and supports competitiveness in international trade but also protects workers and consumers' health and safety. This in turn leads to more sustainable socio-economic development of the country. To achieve this, policy statements indicating specific regulations, rigorous implementation and stakeholders' participation is necessary. One of the main components of environmental compliance is water and its management, therefore data regarding it is crucial for effective policy making. This report regarding the water situation of Karachi is based on data compilation from different sources.

The water supply of Karachi is dependent on surface water and groundwater sources. Surface water sources include Lake Haleji, Lake Keenjhar and Hub Dam while groundwater source includes Dumlottee well-fields. However, the water supply from these wells is negligible, providing only 1.4 Million Gallon per day (MGD)of water after the rainy season while remaining dry for the rest of the year. Moreover, the quality of groundwater in most of the parts is saline due to over extraction and sea-water intrusion. Pakistan Council for Research in Water Resources (PCRWR) reports that 86 per cent of the water sources (surface water and groundwater) are contaminated with Coliform and are considered unsafe for drinking. The Water supply provided by Karachi Water and Sewerage Board (KWSB) is approximately 665 MGD against a demand of 820-1200 MGD resulting in a shortfall of 155-535 MGD. Unfortunately, an estimated 35 per cent (232 MGD) of the supplied water is lost during transmission thus decreasing the water availability to a mere 433 MGD. There is no metering for retail customers and only 25 percent of commercial and industrial customers have a metered supply.

Unsegregated industrial and municipal wastewater is gathered through pipes and uncovered channels and drained through rivers and *nullahs* (streams) into the Lyari and Malir rivers, and finally disposed off to the nearest coastal belt through the 232 km network of Main nullah and 1000 km network of town drains.

There are three sewer districts in Karachi city, namely TP-1, TP-2 and TP-3. A system of six large scale and 16 smaller scale pumping stations convey the generated sewage directly or indirectly to one of three sewage treatment plants. Out of the 151.5 MGD of installed capacity of wastewater treatment only 55 MGD of wastewater is treated and one of the treatment plants is not functional. There is one Combined Effluent Treatment

Plant (CETP) installed at Korangi Industrial Area, capable of treating wastewater generated from tanneries in Korangi Industrial Area and domestic sewage from KWSB Pumping Station-II (PS-II). However, it treats approximately 20,000 m^3, much lower than its designed capacity. The reason is that the CETP was designed for tanneries waste however, it is also a recipient of effluents from 280 other industries which compromises its performance. In essence, Karachi produces around 475 MGD of wastewater daily, out of which 420 MGD of wastewater remains untreated and severely contaminates the surface and groundwater sources.

Recent studies suggest that population will grow by 30 per cent from 2017 to 2030. This will translate in an increased water demand which will in turn put pressure on the already scarce water resources. Moreover, water supply pipelines and sewerage pipelines are corroded and often lie parallel to each other causing cross-contamination. Resultantly, majority of Karachi does not receive safe and clean water. Climate change also poses a threat to the water security of Karachi in the form of variable river flows due to change in rainfall pattern and rising of sea levels at the rate of 1.1 mm/year putting population residing by the water bodies at increased risk. Variation in rainfall patterns will also affect the Hub dam, which is rain-fed, thereby decreasing or increasing the supply to Karachi. Industrial and agriculture sector is also predicted to be severely affected by the reduced water availability in the future.

The situation of water in Karachi will continue to worsen if immediate steps are not taken to ameliorate the crisis. This report recommends mitigatory, preventive and compensatory measures that can be adopted to alleviate the water and wastewater predicament.

Chapter 1 Introduction

The city of Karachi is located on the coast of Arabian Sea in the extreme south of Pakistan and lies between 24° 56' 46.4'' north latitude and 67° 0' 20.2'' east latitude[1]. The total area of Karachi is approximately 3530 km.[2] It is among the most populous metropolitan cities of the world. According to the census conducted in 2017, Karachi inhabits 14.9 million people[2]. The population of Karachi is increasing rapidly, partly due to the migration of rural population to the urban areas for better livelihood opportunities resulting in urban sprawl and an increase in the number of housing schemes in the outskirts of the city. This additional increase in the population has put undue pressure on all available utilities and resources, including water resources, of the city. Resultantly, the abstraction of groundwater has increased.

The city is divided by two non-perennial river streams namely Rivers Lyari and Malir. The River Malir flows from the east towards the south and center, and the River Lyari flows from north to the southwest. The main tributaries of the River Lyari are Gujjar *nullah* and Orangi *nullah* while *Thaddo* and *Chakalo* are the main tributaries of the River Malir. The Karachi Harbour is a sheltered bay to the southwest of the city, protected from storms by the Sandspit Beach, the Manora Island and the Oyster. Rocks.

1.1 Climate

Located on the coastline, Karachi is classified as a region with temperate climate having warm summer, mild winter and high humidity ranging from 58 per cent in December (the driest month) to 85 per cent in August (the wettest month). From March to October, Karachi is marked by long, hot season. However, in July and August, temperature falls in moderate category due to the monsoon winds. For the dominant part of the year, including the monsoons, the winds blow from south-west to west and in winter to east and north-east. In winter, the wind blows at an average velocity of 6.5 miles per hour which can be classified as low wind[3]. Karachi has an average annual rainfall of 174.1 mm[4] and it is highly unpredictable. Most of the rainfall occurs at the end of monsoon season. August receives the highest rainfall with an average value of 59.2 mm per year. Karachi also experiences thunder storms in May and October. The rainfall pattern of Karachi from 1981-2014 is shown in **Figure 1**.

[1] Karachi, Pakistan Lat Long Coordinates Info, Retrieved from https://www.latlong.net/place/karachi-pakistan-2660.html
[2] Pakistan Bureau of Statistics. (2017) Census.
[3] Qureshi, S. (2010). The fast growing megacity Karachi as a frontier of environmental challenges: Urbanization and contemporary urbanism issues. Journal of Geography and Regional Planning, 3(11), 306-321.
[4] Based on Rainfall data from 1981-2014. Source: Pakistan Meteorological Department.

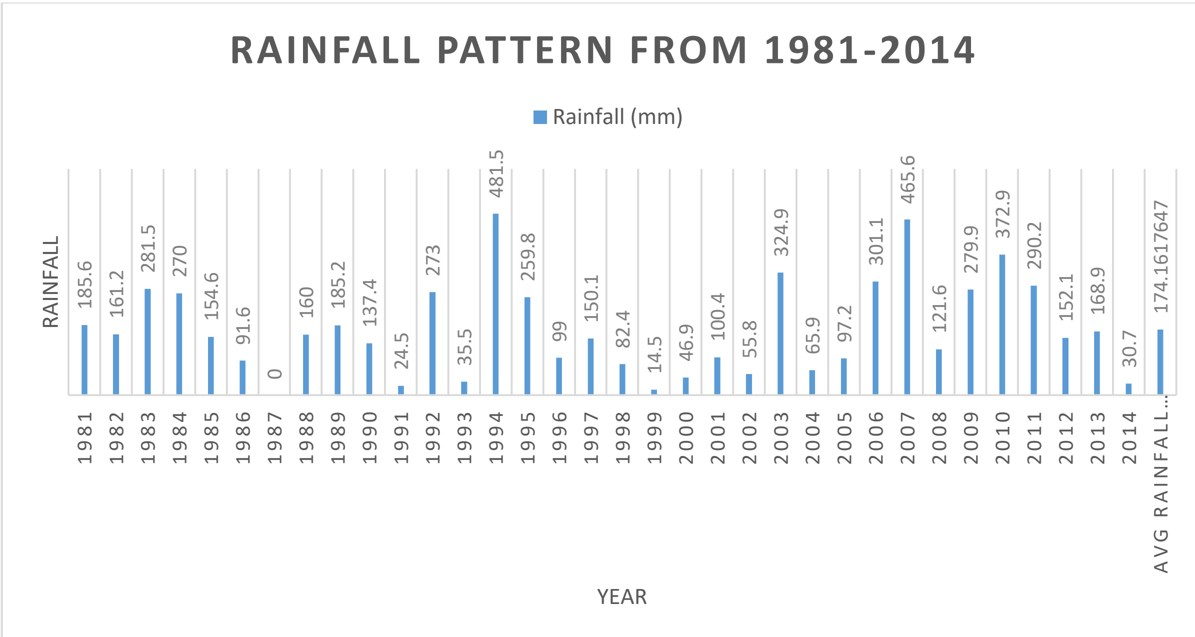

Figure 1: Rainfall pattern in Karachi from year 1981 to 2014

Along the banks of the rivers, crowded slum settlements and some industries exist. Because of rainstorms, the periodic threat of floods loom over Karachi particularly along the banks of these rivers. The confluence of Rivers Mol and Khadeji forms the River Malir which catchment lies in Karachi. Similarly, River Lyari is drained by Gujjar *nullah* and Orangi *nullah*. Both these rivers eventually fall into the Arabian Sea. In rainy seasons, River Malir experiences high flow which has the potential to be stored and utilized later.

1.2 Land use

Most of the land use in Karachi city is branching from Saddar Town which is located around the Port of Karachi. The largest portion of land-use in Karachi city constitutes of vacant land. The towns of Gadap, Bin Qasim and Keamari chiefly constitute of this vacant land. Residential, commercial and industrial buildings account for almost 15 per cent of the buildup, while 8 per cent is used for agriculture and 6 per cent for other infrastructures like transport network etc. The land use pattern of Karachi city is represented in **Table 1**[5].

Table 1: Land Use of Karachi by Categories[5]

Categories	**Area (ha)**	**Area (%)**
Building	55, 500	15%
Infrastructure	20, 400	6%

[5] JICA. (2012). The Study for Karachi Transportation Improvement Project in The Islamic Republic of Pakistan, Final Report, Volume-I.

Park	1, 800	0.5%
Agriculture	29, 100	8%
Restricted Area	1, 800	0.5%
National Park	73, 000	20%
Water Bodies	16, 400	4%
Vacant	166, 800	46%
Total	364,800	100%

Apart from national park, water bodies and vacant area use of land, most of the land use of Karachi city constitutes of residential areas, which covers about 30 per cent of urbanized area. Infrastructure like roads and airport occupies about 26 per cent of the area. Government offices and industrial land use is almost 11 per cent. Commercial use and mixed land use constitute almost 2 per cent of the area. Karachi's land use analysis excluding the land use of national park, water bodies and vacant area can be seen in **Table 2**.

Table 2: Land Use pattern of Karachi by Categories[5]

Land Use Categories	**Area (ha)**	**Area (%)**
Residential	32,600	41%
Commercial	1,100	1.4 %
Mixed Land Use	1,700	2.1%
Industrial	8,800	11%
Govt. offices	8,800	11%
Urban Facility	2,600	3.3%
Infrastructure	20,400	25.6%
Parks	1,800	2.3%
Restricted Area	1,800	2.3%
Total	79,600	100%

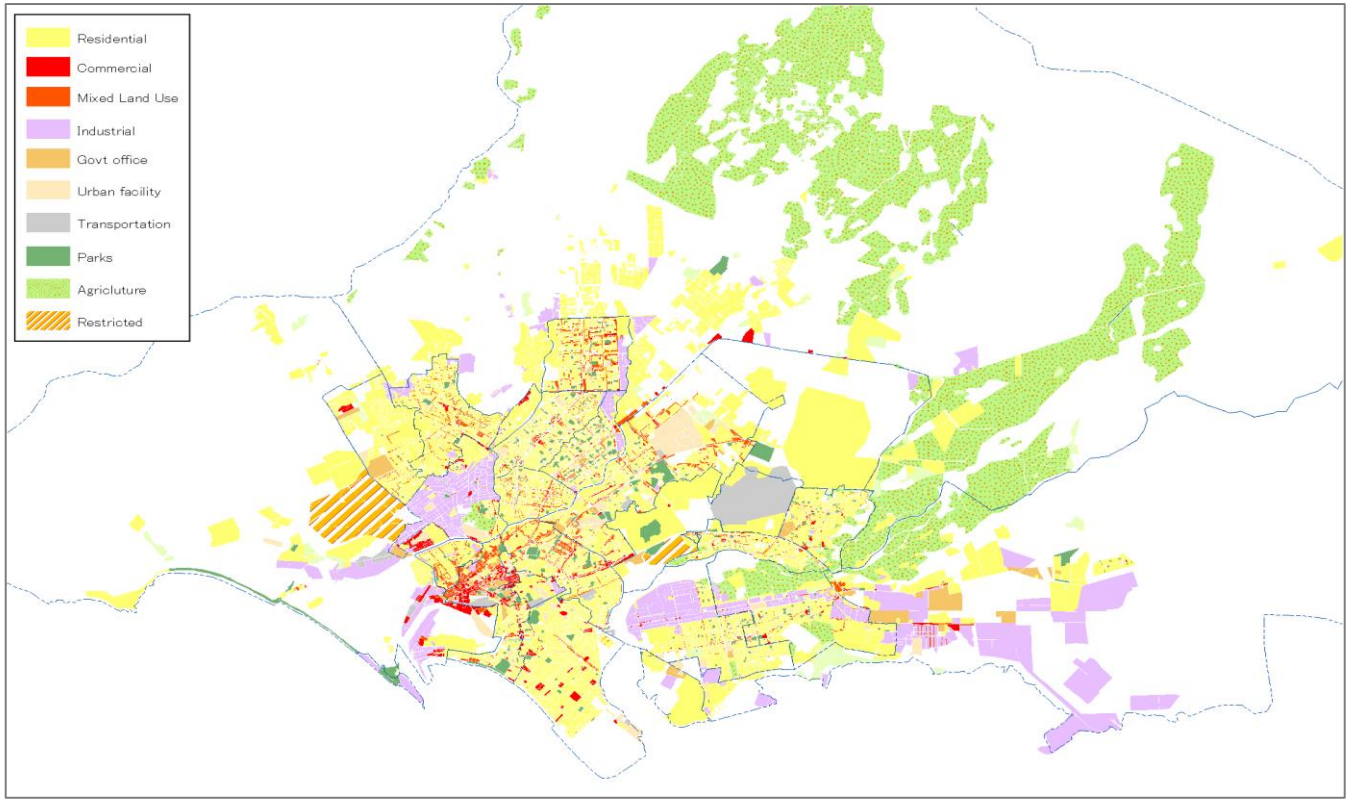

Figure 2: Land use map of Karachi[5]

1.3 Hydrogeology of Karachi

Taking surface runoff and streams flow as a criterion, Karachi's surface drainage can be divided into four parts including Malir River Basin, Lyari River Basin, Budnai Basin, and Coastal Basin. However, according to the hydrogeology of the city, Karachi lies in Malir River basin. In the west, it is surrounded by River Hub while in the east River Malir exists. River Malir, followed by Lyari channel drain the Malir basin. Both channels are transient, therefore, sewage and industrial effluent generally flow in it. River Hub is also transient but lacks wastewater contamination. Rivers Malir and Lyari are mainly responsible for recharging the coastal aquifers of Karachi. River Hub is recharging limited aquifers of Nari and Gaj formations[6]. Furthermore, Rivers Malir and Lyari basins are the two main basins which drain about 80 per cent of the surface runoff of the city. **Figure 3** represents the geographical locations of Rivers Malir and Lyari. Minor basins include Budnai and the coastal basins. Surface runoff is collected by hundreds of small and large channels in the basins, finally draining into the Arabian sea.

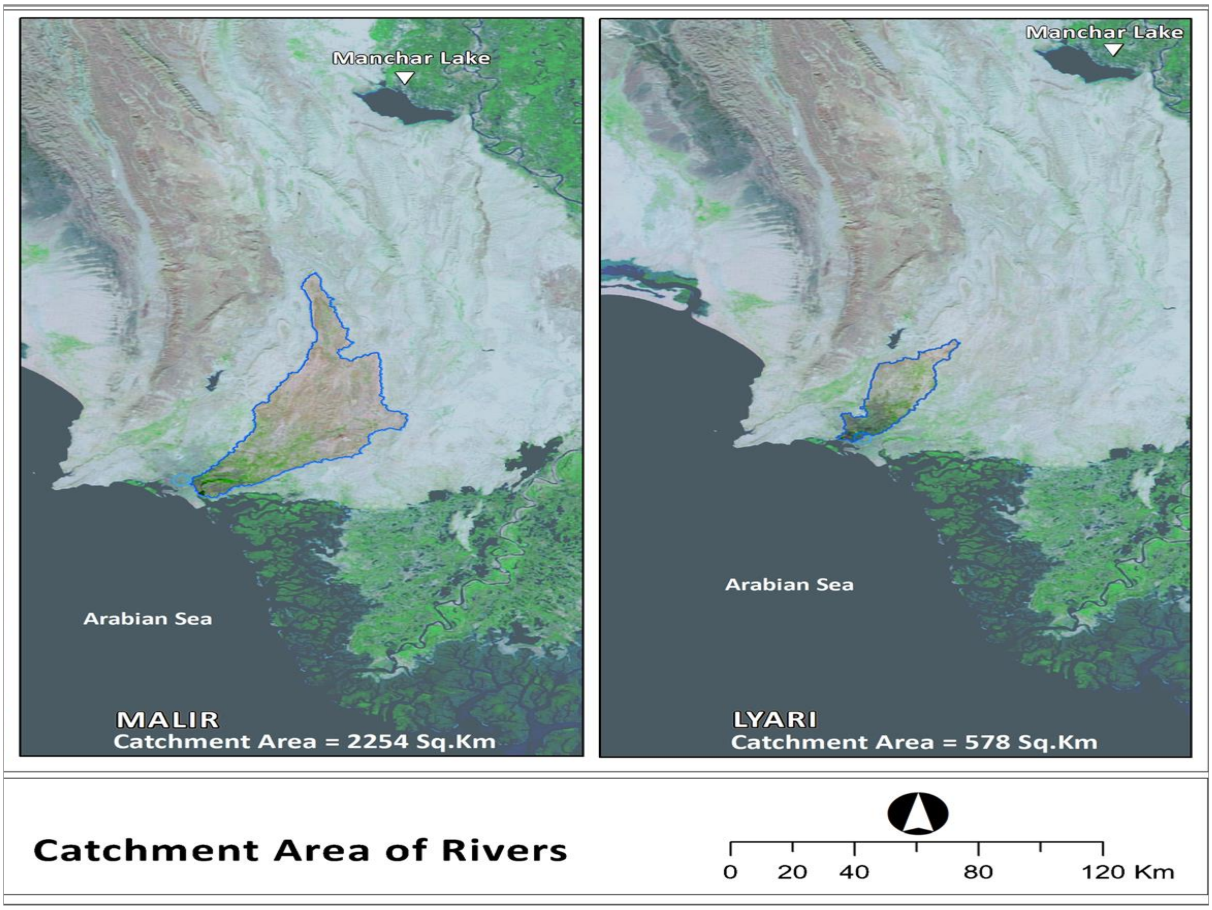

Figure 3: The catchment area of Rivers Malir and Lyari[7]

[6] Khan, A., & Bakhtiari, A. E. (2017). Groundwater assessment of coastal aquifers in Karachi: impact of seawater intrusion. Ground Sediment & Water, 248.
[7] I Irfan, M., Kazmi, S. J. H., & Arsalan, M. H. (2018). Sustainable harnessing of the surface water resources for Karachi: a geographic review. Arabian Journal of Geosciences, 11(2), 24.

1.4 The Malir River Basin

Table 3: Drainage characteristics of River Malir Basin[8,7]

Length of Stream	725 Km
Basin Area	2254 km^2
Drainage Pattern	Dendritic
Branching Ratio	3.4
Drainage Density	32.1 km/sq.km

The confluence of Rivers Khadeji And Mol form the River Malir whereas at the lower points, Konkar, Sukhan, Jarando, Langheji, Bazar, and Thaddo tributaries also join it. The catchment area of Malir River is about 2254 km^2. It is the largest basin in Karachi and passes through the densely populated areas of the city. After passing through Gizri creek estuary, it finally discharges into the Arabian Sea[9]. During the rainy season River Malir experiences flooding. **Table 3** represents drainage characteristics of Malir River Basin**Error! Bookmark not defined.**.

The past years have witnessed heavy floods in the River Malir floodplain. A great potential for rainwater harvesting exists in Malir River and its tributaries. For the past 300 years, indigenous bunds have been used for rainwater harvesting in the area. The agriculture in the area is rainfed and entirely dependent on seasonal rains. For a season, the indigenous bunds serve as a reservoir while simultaneously recharging the underground aquifers gradually. For the recharge of groundwater, the government of Sindh has constructed many small check dams during the last 25 years. Owing to the large size of sub-catchment areas, land sue, soil types and land cover, Rivers Mol and Khadeji contribute the maximum runoff to the Malir River. The Sub-basin contribution to Malir River watershed is presented in **Table 4**[7] . In the area around River Malir Basin, due to insufficient drainage capacity, the storm water tends to stay for longer period of time, damaging the property and infrastructure in the process. The water quality of River Malir is severely contaminated due to the unchecked discharge of untreated municipal and industrial wastewater.

Table 4: Sub-basins Contribution to Malir River watershed[7]

Sub-basin	**Area (km^2)**	**Avg. runoff (1000 m^3)**	**Contribution (%)**
Mol basin	608.1	95,038.6	32.8

[8] Akhter, S., & Dhanani, M. R. (2012). Surface Water Drainage And Flooding In Karachi City. Sindh University Research Journal (Science Series), 44(1), 59–70.

[9] The News. (2013, October 14). A hundred years down the line, Malir River may be flowing backwards. Retrieved 2019, from https://www.thenews.com.pk/archive/print/460785-a-hundred-years-down-the-linemalir-river-may-be-flowing-backwards

Khadeji basin	548.6	82,092.7	28.3
Thaddo basin	320.2	46,092.7	15.9
Sukkan basin	194.0	26,375.8	9.1
Langheji basin	131.4	17,861.3	6.2
Jarando basin	79.5	12,254.8	4.2
Malir sub-basin	85.8	9958.5	3.4

1.5 The Lyari River Basin

River Lyari stems from the foot-hills of Kirthar Range at the point of Manghopir. It has a catchment area of about 578 km^2. Its length is shorter i.e., 180 km, as compared to River Malir and a smaller number of tributaries constitute it. Mokhi nullah originating from Taiser hills, Orangi nulllah originating from Orangi hills and Gujro nullah originating from Manghopir hills are the main tributaries which discharge surface runoff to the Lyari River[8].

River Lyari, like other rivers of Karachi, is a non-perennial water channel flowing only when rain falls in its catchment. The river also passes through the urban areas of Karachi, carrying industrial effluents and domestic wastewater with it and finally falling into the Arabian Sea. Along the banks of River Lyari, almost 50 slum areas of approximately 0.8 million people reside. This makes them the most vulnerable to floods during seasons of heavy rainfall[7].

Table 5: Drainage characteristics of River Lyari Basin[8]

Length of Stream	180 km
Basin Area	578 km^2
Drainage Pattern	Dendritic
Branching Ratio	5.6
Drainage Density	10.1 km/sq.km

1.6 The Budnai Basin and Coastal Basin

Budnai Nadi and number of small torrential streams, originating from ridges of Orangi hills and Jhill hills in Mochko and around Sona pass, form Budnai basin. The Budnai stream is about 46 km long and has a catchment area of about 95 square kilometers. **Table 6** represents the Drainage characteristics of Budnai Basin.

Table 6: Drainage characteristics of Budnai Basin[8]

Length of Stream	46 km
Basin Area	95 km^2
Drainage Pattern	Dendritic
Branching Ratio	5.7
Drainage Density	5.3 km/sq.km

Chapter 2 Water Management and Policy Framework

2.1 Overview of Water Management & Policy Framework

Water governance refers to the political, social, economic and administrative systems therein; that influence usage of water and its management.[10].Furthermore, management strategies cover protection of sources from contamination, up-gradation of drinking water distribution lines and their proper maintenance, monitoring and awareness of the people. But during previous years in Karachi; water and sanitation sector is under continual crisis. To develop deeper understanding about the subject, it is important to understand basic dynamics of the city in terms of its demography and population. On the other hand, there are number of relevant policies regarding water supply and wastewater services in Karachi. The section below contains information on existing policies regarding water and wastewater management

2.2 Existing Policy Framework Relevant to Water & Waste Water Management

In the absence of a consolidated policy in Pakistan, water development has been taking place through guidelines prepared in various government policy programmes[11]. The detailed rules, regulations and guidelines required for the implementation of the policies and enforcement of legislation are still in various stages of formulation and discussion. **Table 8** presents a brief overview of the existing national policies, legislation and guidelines.

Table 7: Policies, Legislation and Guidelines

National Conservation Strategy (NCS)	The National Conservation Strategy (NCS) is the primary policy document of the Government of Pakistan on national environmental issues, approved by the Federal Cabinet in March 1992. The NCS identifies 14 core areas including conservation of biodiversity, pollution prevention and abatement, soil and water conservation and preservation of cultural heritage and recommends immediate attention to these core areas in order to preserve the country's environment.
National Environmental Policy 2005	The national environmental policy aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life. The objectives of the policy are: Conservation, restoration and efficient management of environmental resources. Integration of environmental considerations in

[10] Water Governance. (2019). Retrieved from http://www.watergovernance.org/water-governance/
[11] WaterInfo. (2014). Pakistan Water Situational Analysis. Retrieved 2019, from https://waterinfo.net.pk/sites/default/files/knowledge/Pakistan%20Water%20Situation%20Analysis.pdf

	policy making and planning process. Capacity building of government agencies and other stakeholders at all level for better environmental management. Meeting international obligations effectively in line with the national aspirations. Creation of a demand for environment through mass awareness and community mobilization[12].
Pakistan Penal Code (1860)	The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use[13].
The Factories Act, 1934	The clauses relevant to the Act are those that are concerned with health, safety and welfare of workers, disposal of solid waste and effluent and damage to private and public property. The Factories Act also provides regulation for handling and disposal of toxic and hazardous waste.
Indus Water Treaty 1960	After eight years of intense negotiation for the utilization of the waters of the Indus River System, agreement between Pakistan and India was singed in the form of "Indus Water Treaty" in 1960. According to this treaty control over the water flowing in three "eastern" rivers of India — the Beas, the Ravi and the Sutlej was given to India, while control over the water flowing in three "western" rivers of India — the Indus, the Chenab and the Jhelum was given to Pakistan.
National Water Policy – 2018	National water policy of Pakistan was approved on 24th April, 2018[14]. The policy empowers the provinces to develop their master plans within a national framework for sustainable development and management of water resources. It concedes that water resource is a national responsibility, but irrigation, agriculture, water supply, environment and other water-related sub-sectors are provincial subjects. National Water Policy (NWP) is based on the concept of integrated water resourcemanagement strategy that can optimize the economic, social and environmental returns on water resources, ensure equitable allocation among its competing demands as well as its judicious use

[12] GoP, & Environment, M. Of. National Environmental Policy (2005).
[13] GoP. Pakistan Penal Code (Act XLV Of 1860), 2004 & (2006).
[14] GoP, & Resources, M. Of W. Government Of Pakistan Ministry Of Water Resources National Water Policy (2018).

	by consumers and safe disposal of effluents.
National Drinking Water Policy – 2009	In September 2009, Pakistan approved its 1st National Drinking Water Policy which aims to provide adequate quantity of safe drinking water to the entire population in an equitable, efficient and sustainable manner. Highlights of the policy are: Access to safe drinking water is a basic human right of every citizen and it is the responsibility of the state to ensure its provision to all its citizens'. Provide a supportive policy framework that encourages alternate options through private provision, public-private partnerships, role of NGOs and community organizations. State must balance its function as service provider and regulator. Ensure participation of women in decision-making. Introduce financial viability through levying appropriate water charges and cost recovery.
Agriculture Perspective and Policy – 2004	Agricultural Perspective and Policy, 2004 prepared by the Ministry of Food, Agriculture and Livestock provides for the management of degraded lands and strategies for the control of desertification in Pakistan. It also contains updates on implementation of UNCCD and NAP in Pakistan, control of salinity, water-logging and control of erosion in the mountains, foothills and river plains. This policy document also lays down strategies for the control of wind erosion in Thar, Cholistan and Kharan deserts through measures such as control of grazing, sand dune stabilization, check dam construction, growing shelter hedges around cultivated fields and use of new technologies to control soil erosion[15]
The Indus River System Authority Act (IRSA), 1992	The IRSA Act, formulated in 1992, establishes the Indus River System Authority for regulating and monitoring the distribution of water sources of Indus River and implements the Water Accord which apportions the balance of river supplies, including flood surpluses and future storages among the provinces[16].
The Canal and Drainage Act, 1973	The Canal and Drainage Act of 1973 is the most comprehensive legislation aimed to control and regulate the entire irrigation and drainage system

[15] Hanif, D. M., Khan, D. S. A., & Nauman, F. A. (2004). Agricultural Perspective and Policy.
[16] GoP. Indus River System Authority Act, 1992 (1992).

	and to ensure the supply of irrigation water from the canal system to farmers. Under this law the divisional canal officers have been given the magisterial powers to control encroachments and to ensure equitable irrigation supplies[17].
The Pakistan Water and Power Development Authority (WAPDA) Act, 1958	The Water and Power Development Authority was created at the Federal level in 1958 through the WAPDA Act. Its mandate is to undertake construction of large irrigation and drainage projects and for construction and operation of large hydropower projects. The Authority is also responsible for generation, transmission and distribution of power in the country[18].
Sindh Drinking Water Policy, 2017	The policy's main focus is to facilitate the population of Sindh with safely managed drinking water for which supply is adequate, well maintained and sustainable. It also aims to enhance public awareness about health, nutrition and hygiene related to consumption of safe drinking water[19].
Sindh Sanitation Policy, 2017	The sanitation policy primarily focuses on increasing the coverage of sanitation services, safe disposal of liquid and solid waste; and promotion of health and hygiene practices in the entire province. It covers management of solid and liquid wastes generated from municipal, hospital and industrial sources[20].
Sindh Environmental Protection Act, 2014	The Sindh Environmental Protection Act, 2014 is the basic legislative tool empowering the provincial government to frame regulations for the protection of the environment. The act is applicable to a wide range of issues including air, water, soil, marine, and noise pollution, as well as the handling of hazardous wastes. This act extends to the whole Province of Sindh. Penalties have been prescribed for those contravening the provisions of the Act.
Sindh Environmental Quality Standards	The SEQS promulgated under the SEPA Act, 2014 specify standards for industrial and municipal effluents, gaseous emissions, vehicular emissions, drinking water and noise levels. Sindh EPA revised the Environmental Quality Standards (EQS) with

[17] GoP. The Canal and Drainage Act, 1873, 1873 (2011).
[18] GoP. The Pakistan Water and Power Development Act, 1 (1958).
[19] GoS. Sindh Drinking Water Policy (2017).
[20] GoS. Sindh Sanitation Policy (2017).

	full consultation of the private sector, industrialists, trade and business associations and NGOs. The SEPA Act 2014, empowers to impose pollution charges in case of non-compliance with the SEQS.
Self-Monitoring and Reporting by Industry (SMRI) Rules, 2014	According to SEQS, SMRI Rules, 2014 industrial units are responsible for monitoring their gaseous and liquid discharges and reporting them to the Sindh Environmental Protection Agency (SEPA). An environmental monitoring report shall comprise of liquid effluents monitoring report, gaseous emissions monitoring report and a cover sheet shall be submitted to SEPA as per frequency specified in SMRI Rules. Provided that such certified environmental laboratories shall not be part of, or an associated company or associated undertaking of, the said industrial unit.
Sindh Municipal Water Act 2012	Sindh Municipal Water Act, 2012 was enacted to recognize, regulate & manage municipal water in Sindh. It aims to provide an integrated and comprehensive regulatory framework for municipal water supply and sanitation services, to establish rights of access to basic water supply and basic sanitation, and to ensure conservation of water resources in the Province.
The Sindh Fisheries Ordinance, 1980	The Sindh Fisheries Ordinance, 1980 regulates fishing in the public waters, including the coastal areas, of Sindh. It empowers the government of Sindh to issue licenses for fishing in public waters, put restriction on the type of equipment that can be used for fishing, restrict fishing in certain areas or of certain species of fish, regulate the onshore trade of fish catch, and regulate the fish processing industry. Article 8 of the Ordinance prohibits the discharge of wastewater to public waters without the consent of the Director Fisheries.

The Karachi Water & Sewerage Board Act, 1996 (Amended in 2015)	The Karachi Water & Sewerage Board Act, 1996 was approved by the Provincial Assembly of Sindh for the establishment of a Board for supply of water and disposal of sewerage in the Karachi Division[21]. The Karachi Water & Sewerage Board Act, 1996 has been amended in 2015 to provide and maintain safe and secure water supply for drinking and domestic use to residents of Karachi. It is useful to assure smooth and uninterrupted flow from the source to destination and take stern action against water theft, illegal hydrants, outlet connections and damage to water trunks[22].

2.3 Sindh Environmental Protection Agency (SEPA)

Section 8 of the Pakistan Environmental Protection Act, 1997 establishes the provincial EPAs of which one is the Sindh Environmental Protection Agency. The provincial EPA is to exercise powers delegated under Section 26. Most of the federal agency's functions and powers under the Pakistan Environmental Protection Act, 1997 have already been delegated to the Provincial EPA's after the 18th amendment.

Sindh Environment Protection Agency is a regulatory body to implement the Sindh Environmental Protection Act, 2014 and ensure enforcement of the Sindh Environmental Quality Standards (SEQS) for the protection, conservation, rehabilitation and improvement of environment of the province. Proper enforcement of the Act will result in improved water quality in various water bodies, as the disposal of untreated municipal and industrial wastes will be controlled. However, enforcement of the Act is still weak.

Core functions of SEPA are to:

- Govern and implement the provisions of SEPA Act 2014 and the rules and regulations made therein
- Take all necessary measures for the implementation of the environmental policies
- Prepare and publish an annual Sindh Environment Report on the state of the environment in the province
- Update the Sindh Environmental Quality Standards with approval of the Sindh Environmental Protection Council and ensure its enforcement
- Establish different standards for discharge or emission of the ambient air, water and soil and for different areas and conditions by notification in the Official Gazette as may be necessary
- Establish systems and procedures for surveys, surveillance, monitoring, measurement, examination, investigation, research, inspection and audit to prevent and control pollution, and to estimate the costs of cleaning up pollution and rehabilitating the environment in various sectors

[21] GoS. The Karachi Water & Sewerage Board Act (1996).
[22] GoS. Karachi Water and Sewerage Board Act (2015).

- Take measures to promote research and the development of science and technology which may contribute to the prevention of pollution, protection of the environment, and sustainable development
- Issue licenses, approval for the consignment, handling, transport, treatment, disposal of, storage, handling or otherwise dealing with hazardous substances
- Certify laboratories as approved laboratories for conducting tests and analysis and one or more research institutes as environmental research institutes for conducting research and investigation for the purposes of this Act
- Assist Government agencies, local councils, local authorities and other persons to implement schemes for the proper disposal of wastes to ensure compliance with the Sindh Environmental Quality Standards
- Establish and maintain mechanisms, including its own website, to disseminate information, subject to the provisions of this Act, regarding policies, plans and decisions of the Government, the Council and the Agency, relating to the environment
- Specify safeguards for the prevention of accidents and disasters which may cause pollution, collaborate with the concerned persons in the preparation of contingency
- Plan for control of such accidents and disasters, and co-ordinate implementation of such plans
- Review and approve mitigation plan and give guidance and directions, where necessary, related to clean up operations ordered under this Act
- Encourage the formation and working of nongovernmental organizations, community organizations and village organizations to prevent and control pollution and promote sustainable development

2.4 Karachi Water and Sewerage Board (KWSB)

The KWSB is the main managerial and service-based consumer oriented governmental organization which was fully empowered with following functions after enactment of Karachi Water & Sewerage Board Act, 1996:

- Charge connection and water supply fees on new water and sewerage connections and on water supplies to tankers
- Production, transmission and distribution of potable water for domestic, commercial and industrial use, and charge monthly bill against the service provided
- Reduce, suspend or disconnect the water supply in the event of contravention of the provision of this Act or regulations and impose surcharge, not exceeding double the amount due, if rates, charges or fees for water supply or sewerage service or the arrears thereof are not paid within the time fixed by the KWSB

After Government's approval KWSB makes regulations and undertakes construction and improvement work by utilizing financial powers within the budget grant, this includes:

- Wells and recharge facilities for collecting, purifying, pumping, storing and distributing water to all types of consumers
- Assess the position of water supply time to time and regulate water supply
- Review the existing schemes or prepare new schemes relating to water works and sewerage work and undertake execution thereof with the approval of the Government
- Regulate, control or inspect water connection, sewer lines and service lines including internal fittings[23]

2.4.1 Revenue Collection Efficiency of KWSB

Among all the aforesaid functions, the most important function of KWSB is revenue collection, which enables the organization to continue its operations and launch new developmental schemes as part of their core function. Recent data on KWSB official website reveals that for the year 2017-2018 the revenue collection amounted to 86.65 per cent. The revenue collection efficiencies from the year 2013 to 2018 are presented in **Table 8**. KWSB revenue collection efficiency is likely to decrease if extra efforts are not made to strengthen the existing system. Poor billing, collection efficiency and the nature of the tariff structure also inhibit efforts to bridge the receipts expenditure gap.

Table 8: Revenue collection efficiency of KWSB from 2013 to 2018[24]

Bill demand generated	Revenue collection efficiency (%)
2013-14	76.80
2014-15	74.72
2015-16	48.19
2016-17	96.34
2017-18	86.65

2.4.2 Strength, Weakness, Opportunity, Threat (SWOT) Analysis for KWSB

SWOT analysis is an analytical method which is used to identify and categorize significant internal (Strengths and Weaknesses) and external (Opportunities and Threats) factors faced either in a particular area, such as an organization, or a territory, a region, nation, or city. It is one of the best known and commonly used tools developed to facilitate and encourage strategic thinking and planning. Strengths and weaknesses are mostly internal to the organization, while opportunities and threats are external and relate to the campaigning environment.

In order to identify strengths, weaknesses, opportunities and threats of KWSB related to water management and to increase its competitiveness, an analysis is carried out to design a SWOT matrix. **Table 5** represent the SWOT analysis for KWSB.

2.4.3 Methodology

Drawing up Opportunity and Threat matrices encourages an assessment of the likely probability and impact any factor may have on the organization. A scoring system

[23] GoS. The Karachi Water & Sewerage Board Act (1996).
[24] KWSB (2019). Collection and Payments. Retrieved on July, 2019 from *http://www.kwsb.gos.pk/View.aspx?Page=121*

can be used to assign importance to factors. A factor with a high score on both 'probability of occurrence' and 'likely impact on the organization or business', would have to be one worthy of close attention and play a significant part in the development of a strategic plan. Similarly, Strengths and Weaknesses can be assessed against a scoring system that allows the factors to be identified according to their significance (i.e. major, minor, and neutral) and level of importance (high, medium, low).

To be more specific, the set of questions that were considered were similar to the following:

- ✓ **Strengths**
  - What are KWSB's advantages?
  - What does KWSB do well?
  - What relevant resources does KWSB have access to?
  - What does public see as KWSB's strength?
- ✓ **Weaknesses**
  - What could KW&SB improve?
  - What are the poorly rendered services by KWSB?
  - What should KWSB avoid?
- ✓ **Opportunities**
  - Where are the good opportunities for KWSB?
  - What are the interesting trends?
- ✓ **Useful opportunities can come from such things as:**
  - Changes in technology and strategies on both a broad and narrow scale
  - Changes in policy related to use of resources
  - Changes in social patterns, population profiles, lifestyles, etc.
  - Local Events
- ✓ **Threats**
  - What obstacles does KWSB face?
  - What are KWSB's competitors doing?
  - Is changing technology threatening KWSB's position?
  - Does KWSB have bad debt or cash-flow problems?
  - Could any of KWSB's weaknesses seriously threaten their service?

2.4.4 Resources for SWOT

Resources can include funds, organizational staff and their skills, and the reputation of KWSB and its representatives. Many organizations become more resourced on the strength of their public support, their allies in various sectors, the knowledge and experience of their board members, or the latent capacity of their partners.

2.4.5 Advantages and Disadvantages of SWOT Analysis

The success of this method is mainly owed to its simplicity and its flexibility. Its implementation does not require technical knowledge and skills. SWOT analysis allows the synthesis and integration of various types of information which are generally known but still makes it possible to organize and synthesize recent information as well.

A correlation is made between the internal factors, strengths and weaknesses of the organization, and the external factors, opportunities and threats. An effort can be made to exploit opportunities and overcome weaknesses and at the same time for KWSB to protect itself from the threats of the external environment through the development of strategies and contingency plans.

The most common drawbacks of SWOT analysis are:

- The length of the lists of factors that have to be taken into account in the analysis
- Lack of prioritization of factors, there being no requirement for their classification and evaluation
- No suggestions for solving disagreements
- No obligation to verify statements or aspects based on the data or the analysis;
- Analysis only at a single level (not multi-level analysis)
- No rational correlation with the implementation phases of the exercise

Moreover, there are risks of:

- Inadequate definition of factors
- Over-subjectivity in the generation of factors (compiler bias)
- The use of ambiguous and vague words and phrases

Table 9: SWOT Analysis Matrix

	Helpful	Harmful
	Strengths	**Weakness**
Internal	- Availability of two major water resources i.e., Keenjhar Lake and Hub dam. - Monopoly of Service Provider (in terms of ownership/access/use of infrastructure/ facilities, and collection of revenue) - Workforce and management are technically competent and capable of delivering operational and service improvements. - KWSB has many dedicated professional and experienced staff and exhibit a degree of personal motivation. - Managers are generally enthusiastic about the organization and many have significant experience within the sector. - Financial support continues to be provided to KW&SB from the GoS despite unsatisfactory operational and commercial performance.	- A huge unmet demand for water (665 MGD supplied against a requirement for 820-1200 MGD) - Certain ambiguities in governance framework that opens the organization to multiple and at times uncoordinated controls. - KWSB suffers from overstaffing and operational inefficiencies. Along with electricity charges, salaries and benefits (establishment cost) represent about 92 percent of the total expenditures of KWSB. - Financial instability and very large financial losses (estimated at US$ 5 million per month). - KWSB relies directly on subsidies from the provincial and federal funds for debt servicing and infrastructure expansion. - There are skill gaps in the organization including human resource development, performance management, regulatory compliance, customer services, communications, risk management, systems development, community relations and health and safety. - Poor billing and collection efficiency and the nature of the tariff structure also inhibit efforts to bridge the receipts-expenditure gap. Only 30 percent, customers are being billed.

		- Domestic connections are not metered, and tariffs are thus based on property size and not on volumetric consumption. - Very large outstanding arrears (US $460 million). - An inability to pay for electricity (Outstanding debt to K-Electric is US $320 million). - Old and ineffectively managed water treatment and water supply infrastructure.
External	**Opportunities**	**Threats**
	- An internal commitment to institutional and governance reforms. - Strong donor support and technical assistance in implementing the reform process. - A number of urban planning exercises underway that could be integrated with the reform process. - New government that could provide the time and political space for finalizing and implementing politically feasible and sustainable reforms. - Environmental Legislation defining the procedure for detection of surface water bodies contamination and procedures for risk assessment.	- Lack of financial resources investments in infrastructure due to economic crisis (upgrading of treatment plants, rehabilitation of supply and discharge networks etc.) - A loss of donor support and interest in facilitating the reform process. - Internal incapacity to manage the modification process. - Resistance from civil society on the selected reform options. - Ineffective control of discharges in the Malir and Lyari River.

Chapter 3 Existing Water Situation for the City

3.1 Overview

This section of the report includes information regarding existing water situation of Karachi. Under this section, six aspects have been discussed:

1. Major water resources of Karachi
2. Greater Karachi Bulk Water Supply Scheme
3. Water distribution quota
4. Water supply network in the city
5. Current scenario of water distribution;
6. Past and present water supply and demand.

3.2 Water Resources of Karachi

Mainly there are four prominent, officially declared, and legal water resources for the city. Out of which three resources are categorized as surface water resources which include; Lake Haleji, Lake Keenjhar and Hub Dam. Fourth water resource is categorized as groundwater resource; the Dumlottee wells. Details about each water resource are presented below:

3.2.1 Surface Water Resources

The Indus River originates in the southwestern region of China and meanders through the disputed Kashmir region and then into Pakistan to drain into the Arabian Sea. The irrigation system of Pakistan is the largest integrated irrigation system of the world. It is fed by the River Indus and its tributaries. The system comprises of three major storage reservoirs, 19 barrages, 12 inter-river link canals, 43 independent irrigation canal commands, and over 107,000 watercourses[25].

Indus River, the main surface water source for Karachi, is severely constrained by water demand in the dry season but has abundant quantity of water in wet season. Apart from summer flood season, little water escapes to the sea.

As mentioned before Haleji Lake, Keenjhar Lake and River Hub are main surface water resources of Karachi on which the city relies. The resources are discussed in detail below.

3.2.1.1 Lake Haleji

Haleji Lake, situated at 24° 47 N, 067°46'E, is almost 70 kilometers from Karachi in District Thatta of Sindh. It is one of the major sources of freshwater for Karachi and is also considered as a wildlife sanctuary. The lake, formed in the 1930s, was converted from a lagoon into a water reservoir[26]. During the World War 2, the establishment of a cantonment in Karachi led to a surge in the population, thereby

[25] IUCN. (2004). Sindh State Of Environment And Development.
[26] Forever Indus. Retrieved in 2019 from https://foreverindus.org/ie_protectedareas_ramsar.php

increasing the city's water demand. To augment the city water supply by 20 MGD in two equal stages, the Hilaya Scheme was implemented. The phase-1, executed in 1943, was known as Haleji Scheme having a total capacity 10 MGD. The phase-2, commissioned in 1953, was known as Haleji water Scheme having a capacity of 10 MGD. Originally, this system channeled water from Haleji Lake having a surface area of 11 sq. miles and a storage capacity of 3000-acre feet. From the lake, water flows via a masonry conduit to two pump houses situated in Gharo. Each has a capacity of 10 MGD. Gharo has two water treatment plants of equal capacity where water is treated through sedimentation, rapid sand filtration and chlorination. A Roller-compacted concrete (RCC) pipeline brings the potable water to Karachi where it is again channeled to a 20 MG capacity reservoir before being distributed in the city. The water demand from this source has now increased and is currently providing about 30 MGD of water. The additional requirement is being met by the Greater Karachi raw-water conduit[27]. Features of Lake Haleji can be seen in **Table 12**.

Table 10: Lake Haleji Features

Location	24°48'18.25"N 67°46'27.28"E	
Surface Area	17.04 km²	
Maximum Depth	5 to 6 m	
Water Storage Capacity	3000 acre feet	
Current Water Supply to Karachi	30 MGD	Figure 4: Haleji Lake Credits: WWF-Pakistan

3.2.1.2 Lake Keenjhar

The union of Sonehri and Keenjhar lakes via the construction of an embankment on their eastern side formed Keenjhar Lake commonly known as Kalri Lake. The embankment was constructed to provide drinking water to the residents of Karachi in the 1950s. It is one of the largest freshwater lakes in Pakistan[28]. The water to Keenjhar lake is fed from Kotri Barrage canal upstream of Keenjhar lake via Kalri Baghar (KB) Feeder[29]. The runoff water from the area between the *Baran Nai* basin and the Malir River through Shohar *Nadi* and Kalu Rivers and many small water channels also enter the Keenjhar Lake**Error! Bookmark not defined.**. KB Feeder (Lower) takes water from the Keenjhar Lake which is used for irrigation and water supply to KG (Keenjhar Gujjo) canal and ultimately to Karachi Water Supply.

[27] KWSB. Bulk Water Supply Systems of Karachi Water & Sewerage Board. Retrieved in 2019 from http://www.kwsb.gos.pk/SitePdfFiles/BWSS.pdf
[28] WWF. (n.d.). Indus For All Program. Keenjhar Lake.
[29] SUPARCO (2012). Water Quality Assessment And Characterization Of Toxicity Of Keenjihar Lake. Retrieved from http://suparco.gov.pk/downloadables/Research%20Study%20Report%20on%20Keenkihar%20Lake-2012.pdf.

Due to the silt laden water of River Indus, Keejhar Lake is subjected to progressive siltation. The study also revealed that WAPDA performed hydrographic survey of the Lake bed in 2010, which revealed that the Lake has 44806 hectare-meter of useable storage capacity at full supply level of RL 54[30] . The catchment area of Keenjhar Lake extends north to the Karachi-Hyderabad National Highway. Due to the excessive seepage through the southern part of this embankment, the current top water level of the lake is held at about 51.6-ft reduced level (RL), providing a maximum usable storage (down to 41-ft RL) of 125.45 ha. Raising the top water level to its original design value of 54-ft RL increases the usable storage to 157.8 ha. Features of Keenjhar Lake can be seen in **Table 13**.

Table 11: Keenjhar Lake Features

Location	24°57'8.91"N 68° 2'8.98"E
Surface Area	9,842 Ha
Storage Capacity	0.508 ,million acre feet (MAF)
Usable Capacity	0.38 million acre feet (MAF)
Average Depth	6 m
Length of Embankments	31 Km
Maximum Height of Embankments	9 m
Main Water Supply Source	Kalari Baggar Feeder (Upper)
Outlets	Kalari Baggar Feeder (Lower) & KDA Canal
Current Water Supply to Karachi	587 MGD
Original life Expectancy	132 years
Reduced life after Silting	87 years

Figure 5: Keenjhar Lake
Credits: WWF-Pakistan

Furthermore, as discussed KWSB has recently updated its database with current information about water accounting and available resources for the city. Therefore, based on that information at present 95% of Karachi's water needs are fulfilled through Keenjhar, making it the largest source of water supply for Karachi. According to Karachi Water & Sewerage Board, each day, Lake Keenjhar supplies about 587 MGD of water to the city from June, 2019[31]. However, including

[30] Phul, A. M., Lashari, B. K., & Qasim, K. (2010). Remodeling of Kalri Baghar Feeder, 29(4), 689–696.
[31] Current water supply position. (2019, June 23). Retrieved fromhttp://www.kwsb.gos.pk/View.aspx?Page=212

3.2.1.3 Hub Dam

Hub Dam is Pakistan's third largest dam, constructed in 1981 on the Hub River. It is situated almost 50 km to the north-west of Karachi, in a region of arid plains and low stony hills[32]. The Hub Dam is an inter-provincial project, as two provinces in Pakistan *i.e.* Balochistan and Sindh utilizes Hub Dam as one of the major water resources. The reservoir supplies 27.4 per cent of the total allocated water for irrigation in the district of Lasbella of Balochistan and 62.2 per cent of total allocated water for domestic water supply to the Karachi metropolitan[33]. **Table 14** represents features of Hub Dam features.

Table 12: Hub Dam Features[34]

Location	25°16'49.23"N 67° 7'33.57"E
Total Catchment Area	3410 mile^2
Catchment Area in Sindh	990 mile^2
Catchment Area in Baluchistan	2420 mile^2
Length ofDam	15640 ft
Length of Saddle	5762 ft
Gross Storage Capacity	0.717 MAF
Live Storage Capacity	0.657 MAF
Dead Storage Capacity	0.060 MAF
Life of Dam	75 Years
Length of Karachi WS Canal	22.4 km
Capacity of Karachi WS Canal	210 cusecs

Figure 6: Hub Dam, Baluchistan

Credits: WWF

Source: Irrigation Department, (2014)

Hub Dam is rain fed and particularly impounds water during the monsoon season. The project's design supply to Karachi is 100 MGD however actual supply to the city averages on 49 MGD.

[32] JICA. (2008). The Study on Water Supply And Sewerage System In Karachi In The Islamic Republic Of Pakistan (Vol. 2).
[33] Ahmad, S. (2008). Water Apportionment Of Hub Dam, Water Conflict And Strategy For Resolution, Balochistan. Policy Briefings, 4(5), 11.
[34] GoB. (2014). Irrigation Department Government Of Balochistan Presentation / Brief On Water Resource Development.

3.2.2 Groundwater and rainwater resources

Dumlottee well-fields were constructed on the banks of River Malir in Dumlottee area, in the latter half of 19th century. In the alluvium of River Malir, a number of large shallow wells were built which provided about 8 MGD of water through gravity. However, over the time, supply from these wells have decreased considerably, and now these wells remain dry throughout the year except for some time after the rainy season. The discharge from these wells ranges from 0-1.4 MGD[32]. Now, a system has been devised to connect these wells to the water supply system originating from Keenjhar Lake[35]. The excessive excavation of sand from River Malir bed combined with the increased groundwater abstraction by farmers has resulted in the depletion of water levels in Dumlottee well-fields. The Dumlottee well system features are represented in **Table 14**.

The water supplied to Karachi fails to meet the water demand of the city. Therefore, the use of groundwater has increased for certain domestic and industrial purposes within the city. The available groundwater resources are mostly saline in nature as the city is located near coastal belt and excessive extraction of groundwater has resulted in seawater intrusion into the available water aquifers located in the areas near the sea[36] . It is important to note that in order to maintain the recharge potential of an aquifer, there needs to be a balance between ground water extraction and recharge. Naturally, recharge occurs due to precipitation/rainwater via infiltration into the saturated zone. Annual rainfall in Karachi is 174.16 mm[4]. Due to the poor infrastructure different parts of the city inundate with rainwater, as the city lacks prominent rainwater harvesting schemes. Outdated storm water drainage system within the city results in urban flooding and the wasted rainwater.

Table 13: Dumlottee-well system features

Location	24°58'2.27" N 67°19'6.62"E
Total Wells	12
Functional Wells	03
Current Water Supply (KWSB)	0-1.4 MGD

Sources: Irfan et al.,2018 and Dawn (2016) Retrieved from https://www.dawn.com/news/1033855

[35] Kaleem, M., & Ahmed, M. (2016). *Tapping into trouble*. Retrieved from Dawn: https://herald.dawn.com/news/1152875

[36] Khattak, M. I., & Khattak, M. I. (2013). *Ground water analysis of Karachi with reference to adverse effect on human health and its comparison with other cities of Pakistan*. Journal of Environmental Science and Water Resources, 2(11), 410-418.

3.3 Water Accounting

3.3.1 Greater Karachi Bulk Water Supply System

To supply the city of Karachi with 280 MGD of water supply, the Greater Karachi Bulk Water Supply Scheme was designed in 1953. The scheme was modeled and divided into four equal phases on the basis of population projection till the year 2000. Each scheme, with the design rate of 70 MGD, comprised of open canals, covered conduits, a tunnel, siphons, pumping stations and mains to supply water from the Keenjhar Lake. The details are discussed below in **Table 15** and **Figure 7**.

Table 14: Different Phases of Greater Karachi Bulk Water Supply Schemes[37]

Phases	Description
1st Phase	- Proposed raw-water pumping at Dhabeji to bring 70 MGD of water from Keenjhar Lake and water treatment plant of 70 MGD at COD Hills, Karachi. - Development of complete water conveyance system comprising of a 280 MGD lined canal, a conduit of equal capacity up to Pipri and of 140 MGD capacity up to Karachi. - Work on 10 MG reservoir at COD Hills along with the distribution net-work. - It started in 1954 and completed in 1961 at a total cost of PKR 185 million.
2nd Phase	- It included construction of a 70 MGD pump house at Dhabeji, laying of 84" dia pre-stressed pipe siphons, a 25 MGD pump house at pipri and two water treatment plants of 25 and 45 MGD along with 10 MG reservoirs at Pipri and COD Hills respectively. - Work for this phase was awarded in 1969 and completed in early 1971 at a total cost of PKR 200 million.
3rd Phase	- It included the construction of a 70 MGD pumping station at Dhabeji, two pumping stations along with water treatment plants of 25 MGD capacity each at North East Karachi and Pipri, 84" dia pipe siphons, three balancing reservoirs and the distribution mains. - A reservation for supply of 22 MGD of un-filtered water

[37] KWSB. *Bulk Water Supply Systems Of Karachi Water & Sewerage Board. Retrieved from:* http://www.kwsb.gos.pk/SitePdfFiles/BWSS.pdf

	to Karachi Steel has also been made under this phase. - Work for this phase started in 1975 and completed in 1978 with the total cost of PKR 750 million.
4th Phase	- Due to financial constraints, 4th Phase works were divided into two parts. - Under this phase improvement of lined canal, modifications of the present Dhabeji Pumping Stations, laying of 84" dia pipe syphons, construction of a 25 MGD pump house and clarification units at Pipri were commissioned. - Also, improvement of the secondary distribution network and installation of domestic meters in K.D.A. Scheme No.1 & 5 were taken up with the assistance of World Bank and all the works were completed in June, 1987 at a total cost of PKR 360 million. After this phase, the city's water supply increased by 50 MGD.
Hub Water Supply System	- The Hub dam was constructed by WAPDA on Hub River to from 1963-1981 - At Stage-I, 90 MGD pump house, two steel pressure mains one 20 MG reservoir, trunk mains and primary treatment of lake water by screening and chlorination were completed in August, 1982 at a total cost of PKR 260 million. - Stage-II included the improvement of secondary distribution network and construction of a 90 MGD water treatment plant.
5th Phase (Greater Karachi Bulk Water Supply Scheme)	- Karachi's water supply system has expanded considerably in this phase. As discussed in initial four phases, Karachi was getting 280 MGD of water. - Then 100 MGD water were added to the system through K-II supply project which were completed in 1998 with the assistance of World Bank. - Through a bulk water supply project, the city got another 40 MGD of water in 2000. - K-III 100 MGD Water Supply Project, further added into the existing supply which were completed in 2006 with

	the assistance of GoP. - Now, the K-IV water project has been planned to fill the gap between the city's demand and supply of water. - Approved on July 10, 2014 with the proposed design capacity of supplying an additional 650 MGD of water to Karachi. K-VI will be completed in three phases at a cost of PKR 25.6 billion rupees.

Source: KWSB (2019)

3.3.1.1 Proposed Bulk Water Supply Scheme

K-IV, is a municipal infrastructure project being jointly developed by the Provincial and Federal Governments in Karachi, Pakistan, to augment the city's daily water supply. This project is divided into three phases and each phase will increase water supply capacity. Details of K-IV are shown in **Table 16** and **Figure 8**.

Table 15: Details of K-IV Bulk Water Supply Scheme

K-IV Project; Part of Greater Karachi Water Supply Scheme, Indus Water from Keenjhar Lake to Karachi City		
Phase	**Capacity**	**Proposed Completion Year**
K-IV Phase-1	260 MGD	Year 2018
K-IV Phase-2	260 MGD	Year 2022
K-IV Phase-3	130 MGD	Year 2025
Total Cost	Rs. 25.6 billion	

Source: Frontier Work Organization (2019)

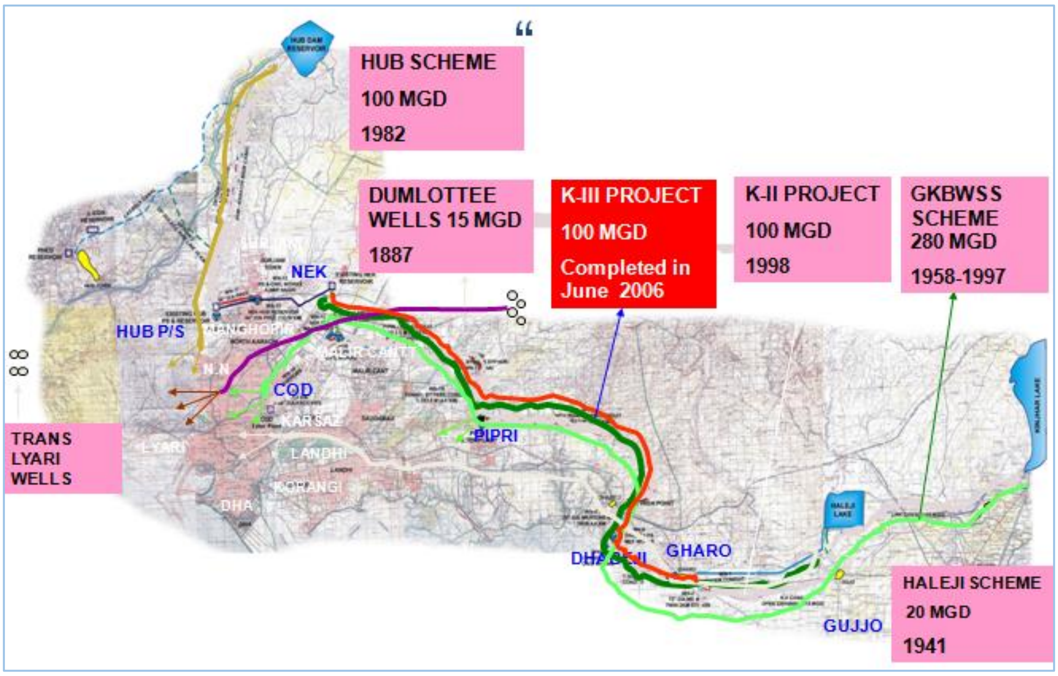

Figure 7: Water Supply System of Karachi (Glimpse From Past to Present)

Source: KW&SB (2019)

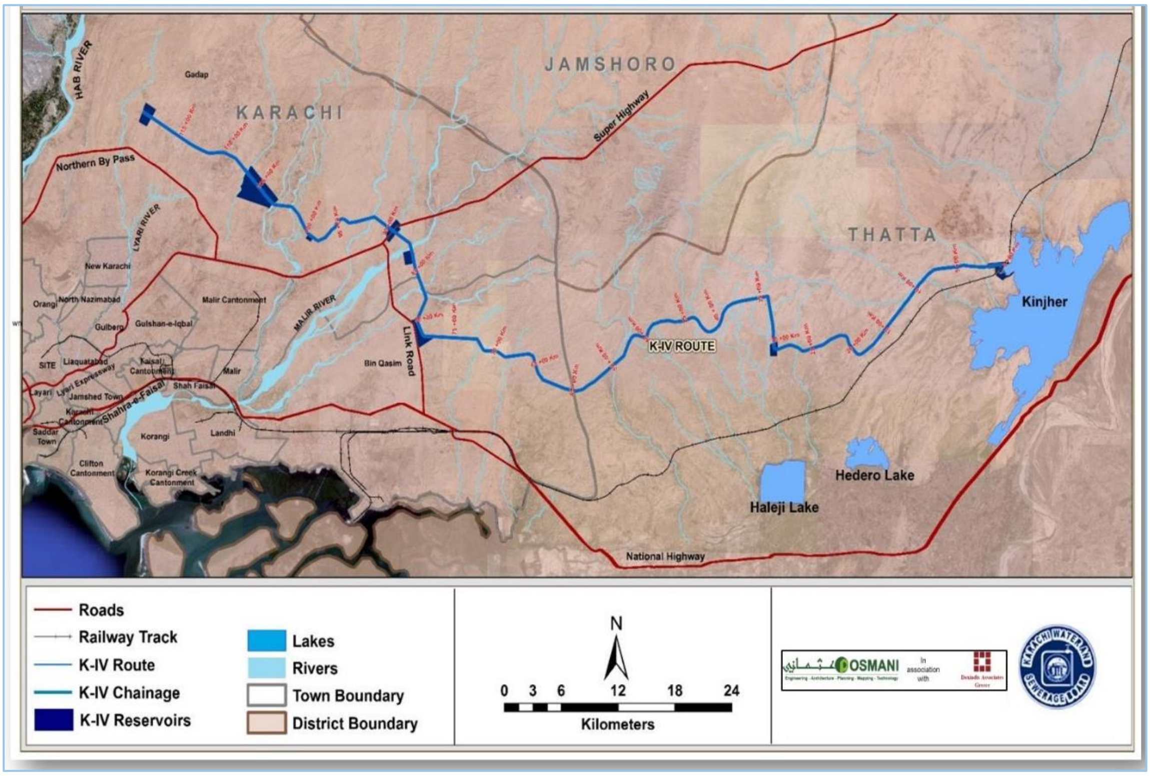

Figure 8: K-IV Bulk Water Supply Schemes Karachi

Source: Osmani & Co. (Pvt). Ltd. (2015)

3.3.2 Water Distribution Quota among all city districts

For domestic, industrial and commercial purposes, the water demand of Karachi is met by the Indus River and the Hub River Dam. For urban water supply to

Karachi, the Indus water quota was first established on May 11, 1957, according to which Karachi could take 242 MGD from 16 October to 15 April (Rabi) and 280 MGD from 16 April to 15 October (Kharif) from the tail of the system at Kotri, through storage in Keenjhar Lake. In 1988, this quota increased to 645 MGD through a presidential decree. Water is being pumped by Dhabeji pumping station to Karachi from which the Karachi water and Sewerage board has a quota of 417.65 MGD, of the available water for supply to the towns, the Cantonment and DHA areas. On 21st March 1991, after consultation of the four provinces, waters of the Indus River System were appointed as follows:

Table 16: Water Appointment Accord 1991

PROVINCE	KHARIF (MAF)	RABI (MAF)	TOTAL (MAF)
PUNJAB	37.07	18.87	55.94
SINDH*	33.94	14.82	48.76
N.W.F.P. (a) (b) CIVIL CANALS**	3.48 1.80	2.30 1.20	5.78 3.00
BALOCHISTAN	2.85	1.02	3.87
TOTAL	**77.34** **+ 1.80**	**37.01** **+1.20**	**114.35** **+3.00**

*Including already sanctioned Urban and Industrial uses for Metropolitan Karachi.
**Ungauged Civil Canals above the rim stations.
Source: Water Apportionment Accord, 1991

The detail of Karachi quota system along with percent deficiency rate can be seen in **Table 18.** The quota for the industrial estate of Karachi, comprised of Korangi, Landhi, North Karachi, SITE and FB area. are also included in the town supply. The average quota supply for the industrial sector is 46 MGD (**Table 19**). Due to the development of industrial sectors from the past 20 years the water requirement for the industrial Sectors has increased to 100-145 MGD[38].

Table 17: Town Wise Quota for Water Distribution[38]

Sr. No.	Town	Quota (MGD)	Actual Received	
			(MGD)	% Quota
1	Lyari	14	12	85
2	Saddar	32	30	93
3	Kaemari	10	8	80
4	Jamshed	30	14	46
5	Gulshan	35	20	57
6	Shah Faisal	12	9	75
7	Malir	20	12	60

[38] Rahman, P. (2008). *Water Supply In Karachi.*

8	Landhi	16	20	125
9	Korangi	24	21	87
10	Bin Qasim	14	14	100
11	Gulberg	22	17	77
12	North Nazimabad	20	14	70
13	Liaquat abad	18	18	100
14	North Karachi	35	20	57
15	Orangi	40	12	30
16	Baldia	20	8	40
17	Site	18	10	55
18	Gadap	8	3	37
19	Cantonment	22	22	100
20	DHA	6	9	133
	Total	**416**	**293**	

Table 18: Water Supply Demand of Industrial Sectors in Karachi[38]

S.No	Industrial Areas	Water Quota	Total Requirement of industries
1-	Landhi	13 MGD	100-145 MGD
2-	Korangi	14 MGD	
3-	SITE	10.76 MGD	
4-	North Karachi	5 MGD	
5-	F. B area	3 MGD	
	Total	**45.76**	

3.3.2.1 Current Water Distribution Scenario

As discussed above Karachi has quota of 650 MGD water from Keenjhar Lake and Hub dam against a demand of 820-1200 MGD. (refer to **Figure 9** to review the detailed water distribution in Karachi as of 30th June 2019 [39]). Water is collected and treated by the conventional water treatment plants and distributed by a system which is at least 40-45 years old with some new distribution facilities in the city. Approximately 210 MGD of water is supplied without treatment. **Table 19** represents the rated capacity of existing filtration plants. The outdated system along with improper operation and maintenance causes the issue of revenue loss. In addition, there is no metering for retail customers and only 25 percent of commercial and industrial customers have a metered supply. The water supply is irregular due to power failure at KW&SB pumping stations which further increases the problems in water distribution system. Moreover, almost 40 per cent of the city's

[39] KW&SB (2019, January 28th), *Current Water Supply Position*. Retrieved from http://www.kwsb.gos.pk/View.aspx?Page=212

population lives in slums with limited water supply and poor sanitary infrastructure[40].

Table 19: Existing Capacity of Filtration Plants

Sr. No	Location	Capacity (MGD)	Year of Construction
1	COD	70+45=115	1962
2	Pipri (old)	25+25=50	1971
3	Pipri (JBIC)	50	2006
4	NEK (OLD)	25	1971
	NEK (K-III)	--	--
5	NEK (k-II)	100	1998
6	Hub	80	2006
7	Gharo	10+10 =20	1943
Total		440	

Source: KW&SB (2018)

Table 20: Short Fall in Existing Water Treatment Facilities

S. No.	Filter Plant	Capacity
1	Gharo	20 MGD
2	Pipri	50 MGD
3	NEK Old	25 MGD
4	COD	115 MGD
Total		**210 MGD**

Source: KW&SB (2018)

[40] Anon, (2000). Karachi Development Plan, United Nation Centre for Human Settlements. UNDP Project Pak/80/019, Karachi Master Plan 1986-2000, p. 20

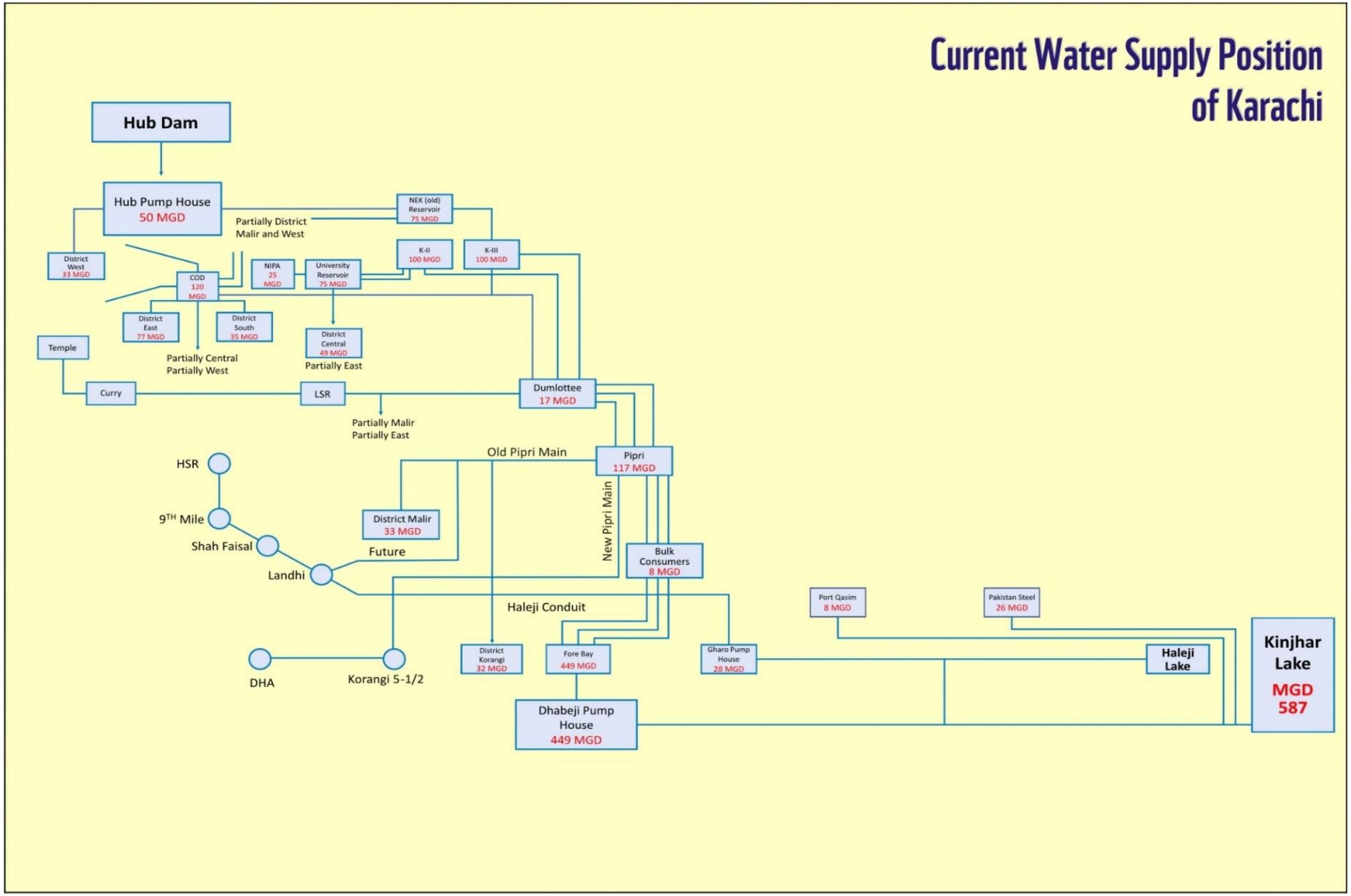

Figure 9: Current Water Distribution System in Karachi from Hub Reservoir and Keenjhar Lake

Source: KWSB (2019)

3.3.3 Water Supply Network

Karachi water and sewerage board (KWSB) is the organization responsible for water transmission and distribution across the city. Indus river system authority (IRSA) provides water to Sindh, therefore, this river indirectly becomes part of water supply system for the city. River Indus feeds water to the Lake Keenjhar. From Keenjhar, water through conduits goes to Haleji, Gharo, Port Qasim, Steel Mills and then to Dhabeji pumping station. From Dhabeji Pumping station, water is pumped to different pumping stations to supply water among all six districts of the city by using electrical pumping motors.

Water from Hub Dam is supplied to Hub Pump House through Hub Canal and then supplied to NEK, Old Reservoir and different areas of the city. Karachi's water supply infrastructure comprises of 25 bulk water reservoirs, 150 pumping stations, 8 water-filtration plants, 75 kilometers of canals, over 11,000 kilometers of pipeline, 20 sewage-pumping stations, 3 sewage treatment plants, and over 250,000 manholes. Almost 1.13 million domestic connections and 9,317 bulk customers in Karachi are provided water supply and sewerage services (**Figure 10**). In informal settlements and industries, the most of the water demand is met through non-piped systems, including private water tankers. Almost 24 hydrants have been licensed to the private parties by KWSB. Out of these 24 hydrants, only 10 are operational while the rest were closed as per a recent Supreme Court Order. unregulated hydrants are rampantly spread across the city. KWSB introduced amendments to discourage the illegal use of hydrants. Since 2009, it has dismantled over 948 illegal hydrants in an effort to confront the illegal use of water. Now six regulated and meter hydrants supply water to the city[41,42]. Despite that, the issue of unregulated hydrants needs attention. There are two distribution channels for Karachi, mainly Northern and Southern Channels. **Table 22** represents the Northern and Southern Channels for water supply within the city.

Table 21: Northern and Southern Water Supply Channels of Karachi[38]

Northern Channel	Southern Channel
Malir Cantonment Areas	Bin Qasim town
Gulshan COD reservoir	Landhi
Gulshan Town	Korangi
Gadap	Shah Faisal
North Karachi	Jamshed town
NEK	Saddar town
N.Nazimabad	Defence/Clifton
Gulberg	Lyari
Liquatabad	Kaemari
Lyari	

[41] World Bank Group (2018). *Pakistan; Getting More From Water.*
[42] World Bank (2017). *Karachi Water and Sewerage Services Improvement Project.*

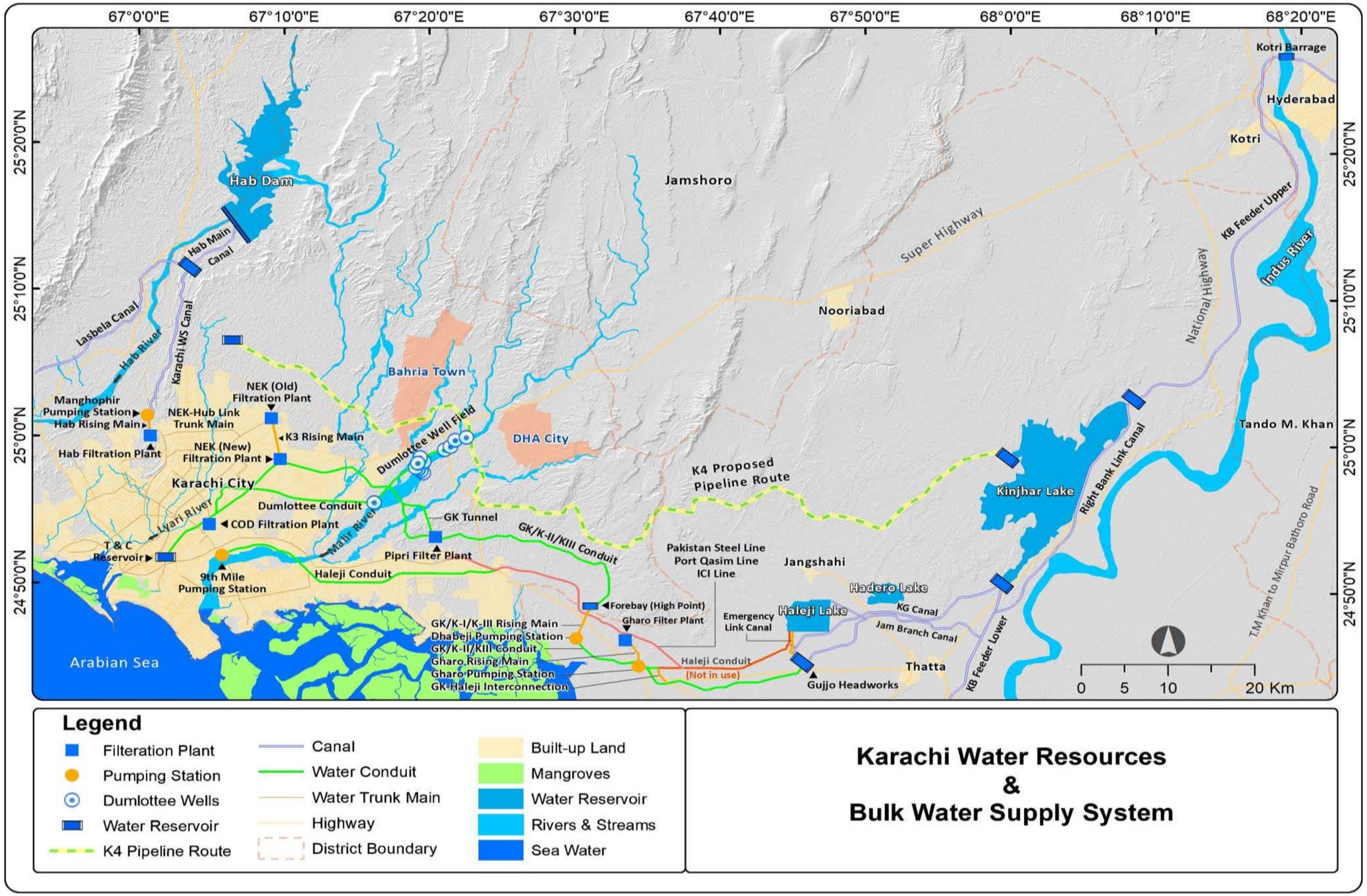

Figure 10: Karachi Water Resources and Bulk Water Supply System[7]

3.3.4 Water demand and supply with past trends and future trends

Karachi mainly relies on River Indus for water supply due to the decreased level of water from Hub dam. Karachi receives approximately 580 MGD of water from River Indus, but requirement of the city is around 820-1200 MGD according to World Health Organization (WHO) standards. That means Karachi gets almost 50 per cent of its present requirement. Recent studies suggest that population will grow by 30 per cent from 2017 to 2030[43]. This will translate in an increased water demand which will in turn put pressure on the already scarce water resources. **Table 24** shows water supply and demand gap till the year 2017.

Table 22: Water Supply and Demand Gap till the Year 2017

Year	Population (Million)	Demand (MGD)	Supply (MGD)	Gap (MGD)
1998	11.33	567	410	157
2017	14.9	820	650	170

3.4 Surface water and Groundwater Quality Assessment:

The shortage of water in Karachi city due to rapid increase in population and industrial activities, has forced people to meet their water requirements from alternative supplies such as privately-owned ground water sources which extract, process and sell groundwater at a very high commercial cost[41,44]. However, the quality of groundwater is very poor in Karachi mainly due to the excessive pumping of groundwater by farmers, seepage of domestic wastewater in groundwater, huge amounts of chemical constituents in industrial wastewater and sea water encroachment, rendering it medically unfit for human consumption if consumed without prior treatment. A study conducted by PCRWR in 2015-2016 to assess of the water quality of cities of Pakistan revealed that out of 28 samples collected from surface and groundwater of Karachi, 24 were found contaminated with E.coli. This constitutes almost 86 per cent of the total water sources of Karachi rendering it unfit for consumption[45]. The most probable source of bacterial contamination is the sewerage discharge, which is usually flowing in pipelines parallel to that of drinking and household water and poor maintenance and breakages in pipelines lead to the mixing of water supply with the sewerage water[46]. Also, no significant improvement in the water quality was observed from the year 2002-2015[45]. Another study analyzed the surface and groundwater samples of Karachi and found that almost 88 percent of

[43]EuroMonitor. (2018). *Global Overview of Megacities*.

[44] KWSB. (2010). Environmental Management Framework-Karachi Water Supply and Sewerage Improvement Project.

[45] PCRWR (2016). *Water Quality Status of Major Cities of Pakistan (2015-2016)*

[46] Muhammad, Syed & Nadeem, Syed & Saeed, Rehana. (2014). Determination of water quality parameters of water supply in different areas of Karachi city. European Academic Research. 12.

the samples/sources had lead higher than the WHO recommended guidelines47. According to a world bank study conducted in 18 towns of Karachi, blood lead levels greater than WHO guideline were found in 89 per cent of the samples. Increased lead levels have been related to learning disabilities in children resulting in reduced income in later life[48].

.

[47] N. Ul-Haq, M.A. Arain, N. Badar, M. Rasheed & Z. Haque. (2011). Drinking water: a major source of lead exposure in Karachi, Pakistan. Eastern Mediterranean Health Journal

[48] World Bank Group. (2018). Transforming Karachi into a Livable and competitive Megacity

3.5 Existing Wastewater Generation and Role of Sindh Environmental Protection Agency (SEPA)

3.5.1 Industrial and Municipal Sources & Wastewater Quality

The metropolis city of Karachi is a major contributor to industrial production in Pakistan as about 60 per cent of the total industries of the country are situated in this city[25]. These industries mainly consist of textiles, chemicals, pharmaceuticals, detergents and soaps, electronic goods, food, oil refineries, tanneries, iron and steel, and thermal power generation, etc. According to a SEPA survey, there are almost 10,000 small and big industries in Karachi, while only 4,500 of them are registered with the provincial environment authority[49]. There are two main sources of wastewater generation in the city: Industrial and domestic. KWSB estimates that approximately 472 MGD (70 per cent of water supplied) of sewage is generated in Karachi and adjacent areas from domestic and industrial sources. In this volume, industries contribute almost 60 per cent while domestic sources contribute 40 per cent of the pollution load. The two seasonal rivers, River Malir and Lyrari act as the wastewater carries of Karachi The Rivers Lyari and Malir are thus bearing about 59 per cent and 25 per cent of the total pollution load of Karachi City respectively. Apart from this, almost 15 per cent of the pollution load is directly discharged into the adjacent open seacoast or discharged via Gizri, Korangi and Gharo Creek[50]. The effluents mainly consist of large concentration of toxic metals and organic dyes which are partially treated or directly discharged into the Rivers Lyari and Malir. These rivers act as the wastewater carrier to the untreated industrial and domestic effluents due to which water pollution gets rampantly spread in the nearby areas and eventually in the sea water. PCRWR revealed that the discharge of untreated domestic and industrial effluents was seriously damaging the surface water and groundwater quality. Cyanide, lead and chromium have been detected in the groundwater near Karachi and in the Rivers Lyari and Malir[51].

3.5.2 Inadequacies in SEPA Regulations

The industrial wastewater accounts for about 283 MGD which discharges hazardous chemicals far exceeding the allowable Sindh Environmental Quality Standards (SEQS) into the water bodies of Karachi. Sindh EPA has categorized industries into A (High Pollution Load), B (Medium Pollution Load), and C (Low Pollution Load) categories as per the impacts of their discharge/pollution level. Number of different industrial estates is presented in **Table 25** while the operational industries in the city can be seen in **Table 26**.

Many industries situated in industrial areas of the city are generating huge amount of wastewater, while only few industries have installed the wastewater treatment facilities which treat the wastewater prior to its discharge into the water bodies. Major portion of industrial sector is discharging the wastewater directly into the sea without any treatment. Stricter actions are needed by the Sindh environmental protection agency to enforce the implementation of SEPA Act 2014 to the industrial zones of Karachi.

[49] Dawn. (2019). The Problems Caused by Mishandled Industrial Waste. Retrieved from: https://herald.dawn.com/news/1398877
[50] Amjad, S. (2010). Strategy For Industrial Waste Water And Pollution. Pakistan Business Review, 601–606.
[51] PCRWR (Pakistan Council of Research in Water Resources). 2002. Water Quality Status in Pakistan. Pakistan Council of Research in Water Resources, Ministry of Science & Technology, Government of Pakistan, Islamabad.

Mostly industrial wastewater contains toxic chemicals which are perilous for human and biodiversity both. Most of the industries in Karachi came into operation without proper planning and installation of wastewater treatment plants. They dispose off untreated toxic wastewater into nearby drains or rivers. As a result, major pollution load is introduced into the water bodies of Karachi city and this polluted water is then used for agricultural activities. An example is Landhi industrial area which is in close proximity with the fertile soil of Malir River. Farmers are receiving direct wastewater from the number of the factories and they are using the same heavy metal contaminated wastewater for irrigation purpose[52]. It is contributing in contaminating the food chain with heavy metals[53].

Table 23: Number of Industrial Estates in Karachi with covered area

Industrial Area	Start	Units	Area (acres)
Korangi	1970	4500	8500
Federal B. Area	1987	2000	--
North Karachi	1974	2500	725
Landhi	1987	100	11000
SITE	1947	2700	4460
Bin Qasim Industrial Zone	--	180	25000
Korangi Creek Industrial Park	2013		250

Table 24: Industries Operating in Karachi

S#	Sector	Category	Malir Industrial Area	Korangi Industrial Area	North Karachi Industrial Area	Federal B Area Industrial Area	West (S.I.T.E) Industrial Area	District South	Total in each sector
1	Textile	A	49	187	58	26	773	-	1093
2	Chemical	A	30	22	1	-	400	-	453
3	Paper	A	20	20	-	1	22	-	63
4	Steel	A	12	8	-	2	109	-	131
5	Leather	A	4	33	1	-	-	-	38
6	Textile Accessories	A	-	-	-	8	-	-	8

[52] Dawn (2016). How Sewage Waste Makes its way into our Kitchens. Retrieved from: https://herald.dawn.com/news/1153607

[53] Akhtar, M. S., Ahmed, M., & Qamarulhaq. (2013). Heavy Metals In Vegetables Grown In Korangi Area , Karachi , Pakistan. Fuuast Journal Of Biology, 3, 4.

S#	Sector	Category	Malir Industrial Area	Korangi Industrial Area	North Karachi Industrial Area	Federal B Area Industrial Area	West (S.I.T.E) Industrial Area	District South	Total in each sector
7	Rubber & Plastic	A	-	-	-	12	-	-	12
8	Power	A	1	2			2		5
9	Cement	A	2						2
10	Paint	A		1					1
Total in Category A			118	273	60	49	1306	0	1806
11	Food	B	60	53	1	17	40	-	171
12	Plastic	B	15	16	3	-	50	-	84
13	Wood	B	12	11	-	-	48	-	71
14	Woolen Units	B	-	-	-	-	57	-	57
Total in Category B			87	80	4	17	195	4	387
15	Pharmaceutical	C	6	33	3	3	45	-	90
16	Poultry	C	25	7	-	1	-	-	33
17	Lubricant	C	40	6	-	-	-	-	46
18	Light Engineering	C	60	37	-	-	92	-	189
19	Miscellaneous	C	291	117	-	-	-	-	408
20	Garments	C	-	-	28	17	155	-	200
21	Auto Parts	C	-	-	-	5	-	-	5
22	Printing & Packaging	C	-	-	-	19	-	-	19
23	Ware House	C	-	-	-	-	12	-	12
24	Marble Crushings	C	-	-	-	-	173	-	173
25	Stone Crushing	C	20	5	-	-	20	-	45
Total in Category C			442	205	31	45	497	0	1220
Total in Each District of Karachi			647	558	95	111	1998	4	3413

Source: Sindh EPA (2018)

The graph in **Figure 8** given below, shows the number of industries in all districts of Karachi along with the status of wastewater treatment facilities. In addition, there is one Combined Effluent Treatment Plant (CETP) installed at Korangi Industrial Area, capable of treating wastewater generated from tanneries in Korangi Industrial Area and domestic sewage from KWSB Pumping Station-II (PS-II). However, it treats approximately 20,000 m^3, much lower than its designed capacity. The reason is that the CETP was designed for tanneries waste however, it is also a recipient of effluents from 280 other industries which reduces its performance. **Table 22** shows details of CETP[54].

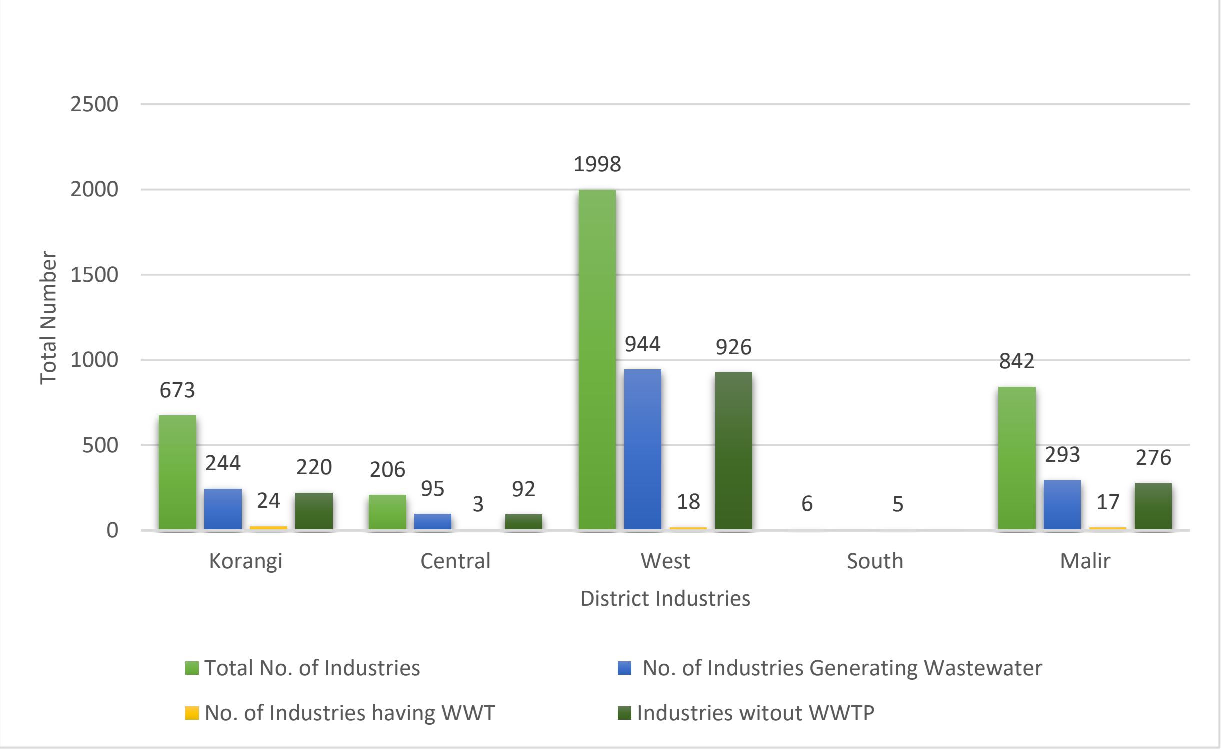

Figure 11: Wastewater Treatment Facilities Status (2019)

Table 25: Designed Capacity and Operational Status of Industrial Wastewater Treatment Plants for Karachi

Features	**CETP**
Drainage Area	150 tanneries of Korangi Tannery Cluster, domestic sewage from KWSB Pumping Station-II (PS-II).
Allocated Area	15 acres

54 SEPA. (n.d.) Industries in Karachi Having Wastewater Treatment Facility. Retrieved from http://epasindh.gov.pk/statement%20karachi.htm

Year of Construction	N/A
Treatment Process	Up-Flow Anaerobic Sludge Blanket (UASB) procedure.
Major Facilities	Influent pumps, pressure pipelines, etc.
Capacity	16,500 cubic meters per day tannery wastewater, 42,000 cubic meters per day of desecrate water and 26,000 cubic meters per day of domestic wastewater.
Current status	Not functioning up to its designed level. Treats 20,000 m^3 of wastewater.

Source: Pakistan Tanners Association; Dawn (2019). Retrieved from: https://herald.dawn.com/news/1398877

3.5.3 Existing Sewerage Facilities and Drainage System

Sewerage and drainage system is the basic utility in an area to cope up with effluents generated. There are three sewer districts in Karachi City, namely TP-1, TP-2 and TP-3 districts (**Figure 13**). On the right side of River Lyari lie North Karachi and Orangi Towns which will be included in sewer district of TP-3 after construction of new sub main sewers connecting to Lyari Interceptor. On the left bank side of River Malir lie Korangi and Landhi Towns which have been isolated from sewer district of TP-2 due to the destruction of the pressure main connected to TP-2. A new sewage treatment plant on the left bank side of River Malir is in the pipeline by KW&SB for these towns. KW&SB has planned to implement a new sewage treatment plant for these towns at the left bank side of Malir River.

Trunk Sewers include three to TP-1, two to TP-2 and one box culvert to TP-3. Total length of branch sewers is 3,290 km. A system of six large scale and 16 smaller scale pumping stations convey the generated sewage directly or indirectly to one of three sewage treatment plants[32], the details are discussed in **Table 27**. **Figure 9** represents the sewerage system in Karachi.

Table 26:Details of Sewerage Utilities of Karachi

Sewerage Facilities	Total Amount
Sewage Treatment Plants	3 Nos.
Major Sewage Pumping Stations	6 Nos.
Sewage Lift Pumping Stations	32 Nos.
Sewerage Cleaning Machines	23 Nos.
Lateral Sewers 8” – 15” dia.	1,844 miles
Sub-Trunk Sewers 15” – 24” dia.	500 miles
Trunk Sewers 30” – 66” dia.	200 miles

Total Length of Sewer 8" – 66"	3,544 miles
No. of Manholes	250,000

Source: City District Government Karachi Water and Sewerage Board, Planning Commission of Pakistan 2007

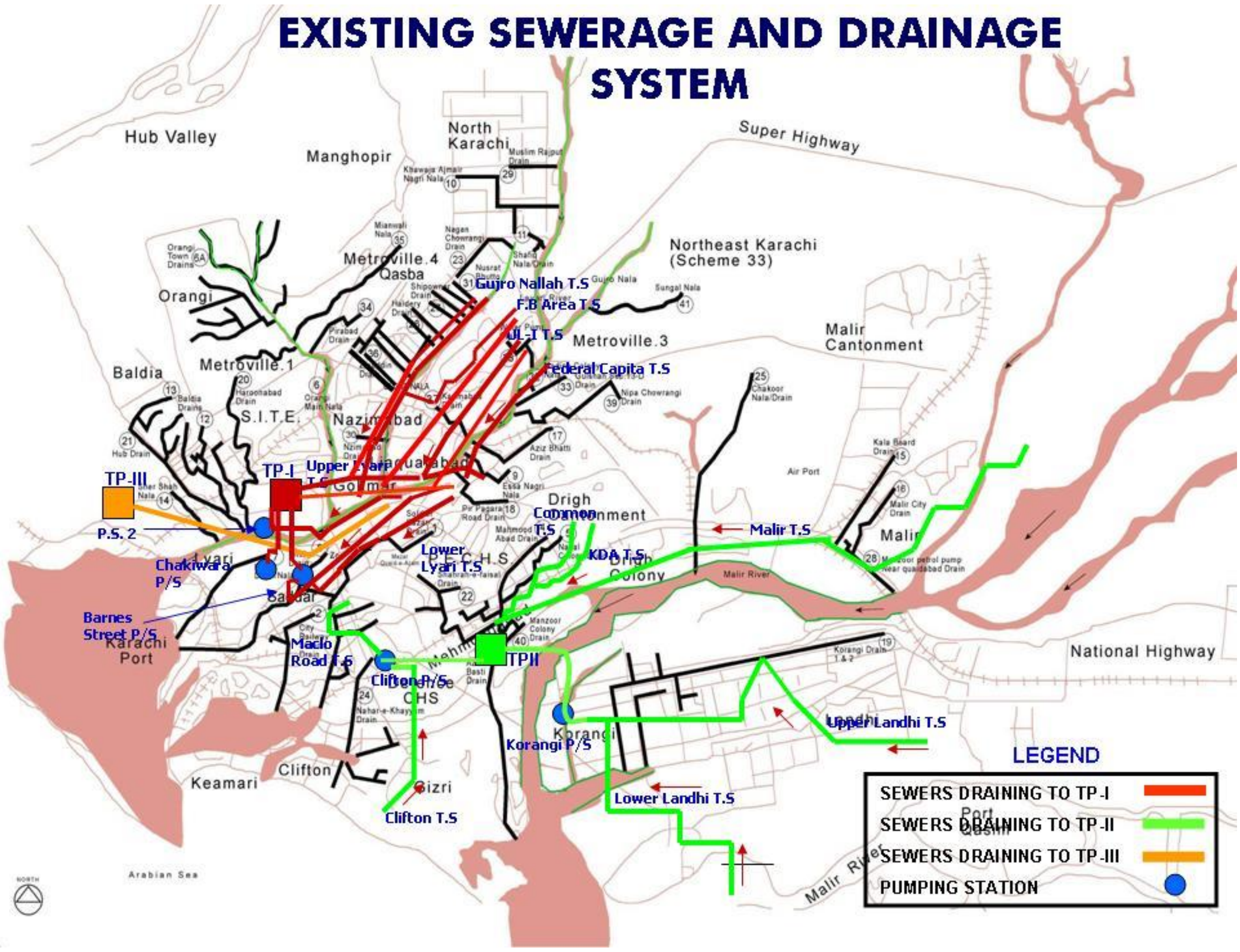

Figure 12: Sewerage and drainage system of Karachi showing Treatment plant's network

Source: KWSB, Sewage Disposal System, (2019)

3.5.4 Existing Scenario of Wastewater Treatment System

At present, in Karachi three sewage wastewater treatment plants are installed in order to treat the residential and commercial wastewater of the city namely TP-1, TP-2, TP-3. **Figure 23** shows location of aforesaid treatment plants in Karachi[55]. Another treatment plant is installed in DHA Phase VIII for the treatment of sewage water from the DHA phase VIII and Clifton Cantt. The plant was operational in 2014 with the rated capacity of 2.4 MGD while currently it receives 1.2 MGD of sewage of DHA Phase VIII[56].

Furthermore, it is important to note that at present the city is experiencing expansion in terms of land utilization and population, therefore, the existing sewerage facilities for sewage collection and its treatment are insufficient to treat huge quantity of wastewater generated within the city. It was observed that out of

[55]Retrieved from https://commons.wikimedia.org/wiki/File:Karachi_Transport_Network.png (Updated by GEMS)
[56] Retrieved from: https://www.dhakarachi.org/docs/DHANewsletter/DHA-Newsletter-2015.pdf

the 151.5 MGD of installed capacity of wastewater treatment only 55 MGD of wastewater is treated, and one of the treatment plants is not functional[57].

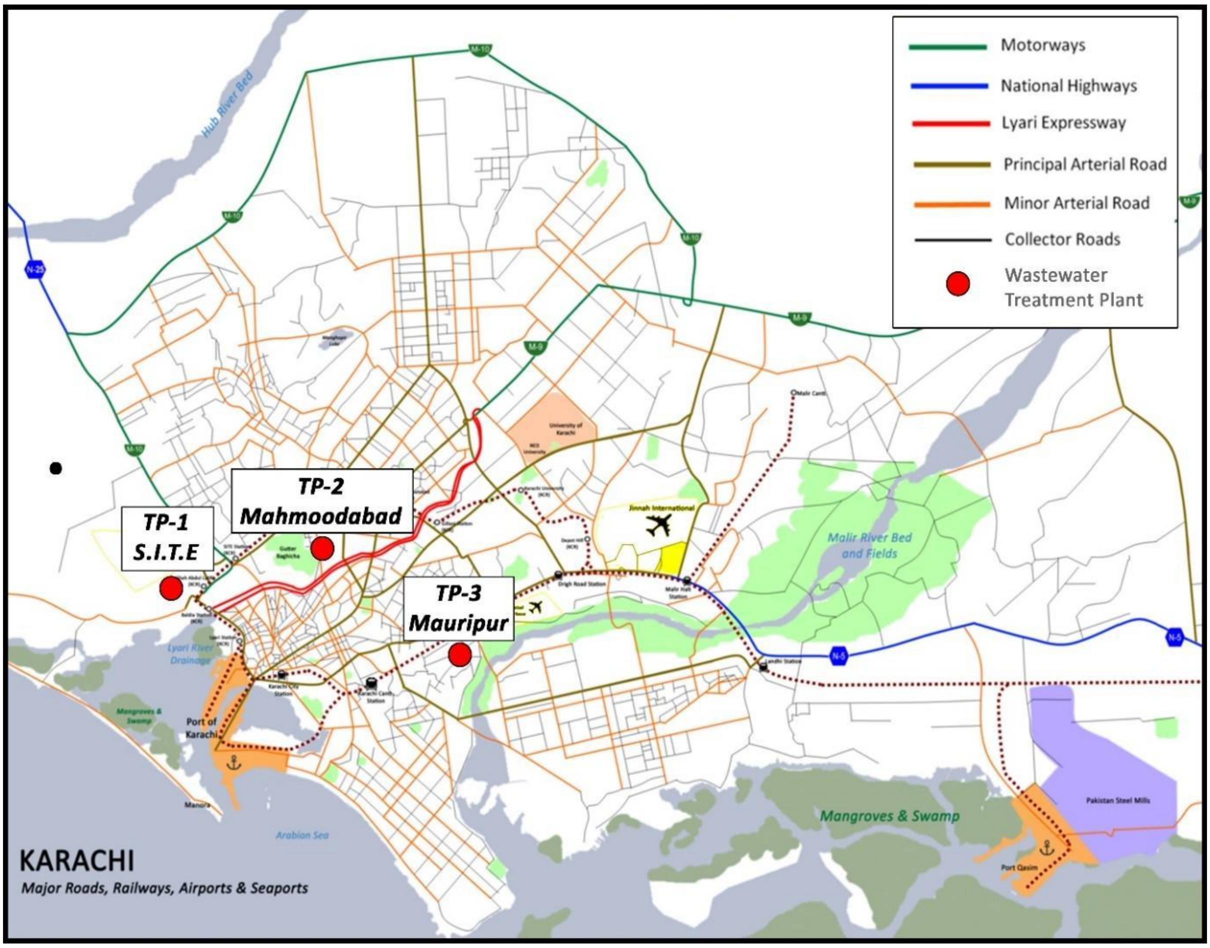

Figure 13: Wastewater Treatment Plant Locations in Karachi

Source: Adopted from Karachi Transport Network and Updated by GEMS

Table 27: Design Capacities and Current Operational Status of Wastewater Treatment Plants in Karachi

Features	TP-1 (SITE)	TP-2 (Mahmoodabad)	TP-3 (Mauripur)
Drainage Areas	F.B. Area, Liaquatabad, Nazimabad & North Nazimabad, Part of Orangi Town, Pak Colony etc.	Old city areas, Clifton Societies, Mahmoodabad, part of Azam Basti, Dada Bhai, Sadder, Malir	Old Lyari, Garden East and West, Gulshan-e-Iqbal, PIB colony, Soldier Bazar, Baldia, Nazimabad, North Karachi
Coverage Area	120 acres (48.6 ha)	120 acres (48.6 ha)	545 acres (221 ha)

[57]KWSB. (2019). Retrieved from http://www.kwsb.gos.pk/View.aspx?Page=32

Year of Construction	1960/1995 (rehabilitated)	1960/1996 (rehabilitated)	1998
Treatment Process	Trickling filter process	Trickling filter process	Anaerobic + Facultative pond
Major Facilities	Influent pumps, Primary Settling Tank, Trickling Filter, Final Settlement Tank, Anaerobic digesters, Sludge drying beds	Influent pumps, Primary Settling Tank, Trickling Filter, Final Settlement Tank, Anaerobic digesters, Sludge drying beds	Influent pumps, Anaerobic Pond, Filter Press Sludge drying beds
Capacity	51 MGD (232,000 m^3/d)	46 MGD (209,000 m^3/d)	54 MGD (245,000 m^3/d)
Current status	Treating 20 MGD	Non-Functional	Treating 35 MGD

Source: JICA (2008) and KWSB (2019)

3.5.5 Collection and Disposal Mechanism

Sewage is gathered through pipes and uncovered channels and drained in water bodies through rivers and *nullahs*. Karachi's untreated wastewater, including domestic sewage and industrial wastewater is discharged into the Lyari and Malir rivers, and finally disposed to the nearest coastal belt. Out of the 475 MGD of wastewater generated, around 420 MGD of wastewater remains untreated and a part of it is drained into the sea through the 232 km network of Main *nullah* and 1000 km network of town drains. These *nullahs* mainly discharge into the two main rivers namely; Malir River and Layari River[58], refer to **Table 29** to observe the main sewerage containing bodies.

Table 28: Final discharge Sources of the city

Major *nullahs (Streams) discharges directly into sea**	**Major Rivers discharges through streams into sea**
• Nehar – e – Khayam • Frere *nullah* • Manzoor Colony nullah	**Malir River System** *Sub-Streams:* • Chakora *nullah* • Thado *nullah*
• Pitcher *nullah* • Kalri *nullah*	**Lyari River System** *Sub Streams:*

[58] Hyder, I. (2007, March 16). A presentation on the reforms in Karachi Water & Sewerage Board (KW&SB). Retrieved from http://arifhasan.org/karachi/reforms-in-kwsb-an-overview-for-civil-society

• Railway *nullah*	• Gujjar *nullah* • Orangi *nullah*
• Kalong *nullah*	
• Soldier Bazaar	

Source: Cyclone Contingency Plan for Karachi City (2008); Government of Sindh. (2017).

* Natural storm water channels

3.5.6 Gaps in Wastewater Treatment Capacity

Currently, there is a huge gap between wastewater generation and treatment. The wastewater generated in Karachi city is beyond the capacity of the existing treatment plants. **Table 30** is representing the current scenario of Karachi city wastewater treatment with a shortfall of 322 MGD of treatment capacity. Approximately 417-425 MGD of wastewater is drained into sea water without any treatment.

Table 29: Gaps in Wastewater Treatment Capacity

Sewerage generated in City (70% of Water Supplied)	465-472 MGD
Optimum design capacity of Sewerage Treatment plants	150 MGD
Shortfall in Sewage Treatment capacity	approx. 322 MGD
Quantity of Sewage Treated	50 MGD
Untreated Sewage	417-425 MGD

Source: KW&SB (2019) & World Bank Group (2018)

3.5.7 Future of Wastewater treatment

3.5.7.1 Greater Karachi Sewerage Plan (S-III)

To improve the sewerage system of Karachi and reduce the pollution load on natural water bodies, KWSB is working on Greater Karachi Sewerage Plan (S-III). This project, through a well-integrated system of collection, treatment and sewage of wastewater from municipal and industrial sources, aims to improve the environmental conditions of Karachi. In this project, sewage will be transmitted to the River Lyari and Malir via a RCC before finally being disposed off in the sea. Following initiatives will be taken under this project[59]:

- Malir Trunk Sewer: 05 Contract Packages with overall length of 22.74 km
- Lyari Trunk Sewer: 08 Contract Packages with overall length of 33.32 km
- Upgradation and Capacity Enhancement of Sewage Treatment Plant from 51 to 100 MGD at Haroonabad SITE
- Upgradation and Capacity Enhancement of Sewage Treatment Plant from 54 to 180 MGD at Muaripur
- Construction of New Sewage Treatment Plant at Korangi of 180 MGD

[59] KWSB. (n.d.). Concept paper on Greater Karachi Sewerage Plan S-III Retrieved from: http://www.kwsb.gos.pk/SitePdfFiles/Flyer.pdf.

3.5.7.2 Current Status

According to the planning commission of Pakistan 862 Million Rupees have been allocated to the project for the fiscal year of 2018-2019[60]. The rehabilitation of the TP-III for 77 MGD has been done while five different packages of sewage transmission in the length of 20.151 km have substantially been completed[61].

[60] Retrieved from: https://www.pc.gov.pk/uploads/archives/Releases_Details_2018-19(11-01-19).pdf
[61] The News. (2019). Retrieved from: https://www.thenews.com.pk/print/480315-cm-to-fight-to-get-centre-to-pay-up-funds-pledged-for-s-iii-project

Chapter 4 Key Challenges and Way Forward

4.1 Prevailing Issues and Challenges:

Pinpointing the key challenges is an imperative part for resolving water related issues of any city. In this section key issues and challenges related to current water situation of the city have been identified which are directly or indirectly related to the water use and availability within the city.

4.1.1 Water Governance and Management

- Overstaffing at KWSB; which results in promoting the culture of ghost employees within the board, utilizing excessive funds for salary disbursement and causing an overall financial loss for the board. Obsolete and corroded water supply network results in water leakages and losses which accounts for more than 30 to 35 per cent of the total supplies. Lack of coordination among governmental departments and non-availability of designated water and sewerage corridor is another potential factor which results in supply line damages which at times is not repaired on immediate basis.
- Improvements in the system depends on public financing, for the existing tariffs only generate insufficient revenues to cover operational and maintenance costs. Efficiency of the delivery system is intricately tied up with the financial viability and related management issues.
- The underperformance of KWSB water pumping stations has been observed mainly due to the lack of maintenance works, electricity load shedding and non-availability of sufficient funds. Therefore, the citizens normally experience low water availability in their areas and suffer with water shortage issues. The situation is worsened during summer season, when electricity load shedding in Karachi is at its peak. Non-availability of water in certain areas of the city has significantly promoted unregulated hydrants across the city. Initially KWSB itself promoted regulated hydrants to supply water to suburbs and remote areas of Karachi These hydrant operators have now turned into mafia with strong networks.
- Unnecessary delays in K-IV water supply project which is a three phase project; (i) Phase-I which is expected to add additional 260 MGD into the existing supply network has not yet been completed, while on the other hand water demand and supply gap continues to stretch, (ii) Phase-2 which will add additional 260 MGD to the water supply network, (iii) Phase-3 which will add 130 MGD to the existing system are likely to be delayed. It is assumed that even after completion of K-IV the city is likely to experience water shortage, and the situation is likely to get worse if additional controls are not taken into consideration to address the current situation. K-IV project phase-I was supposed to be completed by 2018, however only 20 per cent of the work have been completed till date[62].

---

[62] Express Tribune. (2019). Fate of K-IV and S-III projects in doldrums. Retrieved from: https://tribune.com.pk/story/1993891/1-fate-k-iv-s-iii-projects-doldrums/

- Some of the key problems related to the governance affecting the water supply system in Karachi are discussed in below **Table 31**.

Table 30: Major problems with the water supply and sanitation system in Karachi

Major Problems	**Symptoms**	**Consequences**
Poor condition of water distribution system	An inflow of 665 MGD: resulting in a shortfall of 155-535 MGD[6]	Recent studies suggest that population will grow by 30 per cent from 2017 to 2030[43]. This will translate in an increased water demand which will in turn put pressure on the already scarce water resources.
Lack of autonomy	Intermittent water supply- available 2-4 hours per day High level of leakages Low system pressure Contamination: 30,000 people, mostly children, die each year in the city [63]. Inequitable distribution Less than 60 per cent people have access to sewerage facilities[48]	Customers' distrust in KW&SB and the services it provides Distribution System: 40-45 years Reluctance to pay for the services Insufficient revenues Access levels to water declined: 90 % (2006-07) to 89% (2014-15)[48] Less than 10% of sewage water treated.
Weak financial capacity	Unmetered water supply. There is no metering for retail customers and only 25 percent of commercial and industrial customers have a metered supply[3] Tanker supplies Illegal connections Low tariffs	Water consumption data for these sectors is not available Insufficient revenues Low morale of KW&SB staff
Absence of measured supplies and volumetric charging system	De-facto bankrupt utility Delay in capital replacement Delay in system	Yearly expenditure: US$ 106 million vs US$ 60 million revenue, yearly electricity bill only US$

[63] Engel, K., Jokiel, D., Kraljevic, A., Geiger, M., & Smith, K. (2011). Big Cities. Big Water. Big Challenges. Water in an Urbanizing World. WWF Germany, Berlin.

	expansion Poor current maintenance Poor working environments (offices & equipment) Reliance on Government funding (for capital and operational expenditure)	66m, Outstanding arrears estimated at $460M: $179M (retail); $281M (bulk), Non Water Revenue estimated to 60% (or USD240 million in 2015) [64] Deteriorating services Deteriorating assets Political interference

4.1.2 Wastewater Discharges in Agricultural Fields

Due to the lack of human, technical and financial resources, Sindh environmental protection agency cannot implement SEPA Act 2014 efficiently. Many industries situated in industrial areas of the city are generating huge amount of wastewater, while only few industries have installed the wastewater treatment facilities which treat the wastewater prior to its discharge into the water bodies. Major portion of industrial sector is discharging the wastewater directly into the sea without any treatment. Mostly industrial wastewater contains toxic chemicals. When this wastewater is discharged into natural water bodies, it causes degradation of the ecosystem. It is also a relatively common practice among farmers to use industrial wastewater for irrigation purposes. Due to the high price of chemical fertilizer, farmers sometime prefer wastewater because of its high nutrient contents despite the ill effects of wastewater irrigation on physical and chemical characteristics of the soil. It also causes contamination of human food chain and related health risks. An example is Landhi industrial area which is in close proximity with the fertile soil of Malir River, farmers are receiving direct wastewater from the number of the factories, and they are using the same heavy metal contaminated wastewater for irrigation purpose, which is contributing in producing heavy metal contaminated vegetables.

4.1.3 Water Quality

Most of the existing pipelines are made of asbestos cement. Financial constraints on CDGK and Sindh government programs have prevented them to replace these outdated pipes with High Density Polyethylene (HDPE) pipes. Although, measurement of asbestos fibers in drinking water is technically difficult, research has indicated that most water, whether or not distributed through asbestos cement pipes, contains asbestos fibers, which can significantly impact human health. Since the raw water supply lines are installed below the sewerage lines and these sewerage and raw water supply lines are obsolete and corroded, therefore leakages issues are commonly observed. This results in sewage water mixing with raw water and many areas in city are supplied with this contaminated water for their daily use. Most of the

[64] LEAD Pakistan. (2016). Retrieved from: http://www.lead.org.pk/lead/pages/img/presentations_cohort19/Masroor%20Ahmad,%20WB,%20Water%20and%20Sanitation.pptx

surface and drinking water sources (88 per cent) have lead higher than the WHO recommended value[65]. A study in 18 towns of Karachi revealed blood lead levels greater than WHO guidelines in 89 per cent of the samples[48]. Pakistan Council of Research in Water Resources (PCRWR) reports that 86 per cent of the water sources are contaminated with Coliform and are considered unsafe for drinking[45]. The groundwater of Karachi is brackish, and in parts saline due to sea water encroachment, rendering it unusable for people. Its quality improves only along the river beds of Rivers Lyari and Malir. Companies extract, process and bottle it and sell it at a high price.

4.1.4 Local and Regional Climate Change Scenarios

Water quality is expected to be altered due to climate change. This phenomenon drastically impacts surface water channels such as rivers, streams and lakes. Given the coastal and dryland ecology of Karachi, it will face unique challenges in the future in terms of sea level rise, heat waves, drought and floods. Reports suggest that in Karachi, sea levels are rising at the rate of 1.1 mm/year[41] putting population residing by the water bodies at increased risk. Variation in rainfall patterns will also affect the Hub dam, which is rain-fed, thereby decreasing or increasing the supply to Karachi. It will also cause increased frequency and severity of extreme events such as floods and droughts. Karachi's water supply is dependent on dams. Climate change will also increase sediment flow due to high intensity rains resulting in rapid loss of reservoir capacity. Due to increase in temperatures, water evaporation will increase thereby elevating the water demand for irrigation.

4.1.5 Economic and Land use Changes

Water crises in the city is likely to affect production capacities of industrial units, not only this but new development in industrial sector is also likely to face severe challenges due to prevailing water issues within the city. It has been reported recently that around 300 to 400 industrial units in SITE Super Highway Industrial Area are experiencing water crises, which has significantly affected their routine operations[66]. Incase if the current situation prevails industrial sector is likely to be affected which would be large scale economic loss not only for the city, but for Pakistan as well. The extreme weather conditions and economic disparity become exaggerating factors for rural to urban migration and an impulse migration trend is usually observed towards Karachi. Immigrants from rural areas usually prefer residing in slums known as "Katchi Abadis" in the outskirts of the city area. Rural to urban migration results in expansion of slum areas within the city. Not only this but the current migration trends have significantly contributed in unplanned expansion of the city area which includes construction of unplanned high-rise buildings, urban slums, illegal and informal settlements and encroachments on natural drains which have radically changed land use and water drainage patterns of the city.

[65] N. Ul-Haq, M.A. Arain, N. Badar, M. Rasheed & Z. Haque. (2011). Drinking water: a major source of lead exposure in Karachi, Pakistan. Eastern Mediterranean Health Journal

[66] Express Tribune. (2018). 400 Industrial units 'on verge of closure'. Retrieved from: https://nation.com.pk/18-Apr-2018/400-industrial-units-on-verge-of-closure

4.1.6 Groundwater abstraction

In Karachi, groundwater usage has increased considerably due to the acute shortage of surface water supply. Major industrial units and agriculture farmers in Karachi arrange their water sources on their own, e.g., Pakistan Steel Mill and ICI industries bring water from Keenjhar separately via their own water system, while many industrial units and agricultural farmers heavily depend on local groundwater sources. Some private water suppling companies extract, process, and sell groundwater at a very high commercial cost in bottles. Generally, the groundwater quality in Karachi varies, but in some areas, chemical parameters are significantly higher compared to the recommended limits of WHO.

Karachi receives a low amount of precipitation about 174.1 mm per year and sewage in downstream is the main source of groundwater recharge. Due to declined water level, scarcity of rain, quality of groundwater, and high cost of desalination, it was concluded that there is no feasible prospect to develop groundwater resources for combating increasing water demand of the city[32].

4.2 Recommendations and Way forwarding

WWF Pakistan recommends the following practices to be adopted to ameliorate the worsening water situation within the city

International Support

- Tap environmental grants by developing and submitting sustainable development project proposals to Financial Development Institutions such as International Finance Corporation (IFC), Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB) and Japan International Cooperation Agency (JICA).
- Expedite completion of K-IV project to ensure that the water demand and supply gap is decreased. Distribution network improvements to reduce line losses which constitutes for about 30 to 35 per cent of water losses out of total water supplied to the city. Also, it must be ensured to provide water to the houses on the tail end and to the areas where the water supply system is not available. New distribution lines of water supply may be laid before the start of K-IV (260 MGD) with the financial assistance of aforementioned organizations.
- **Institutional Coordination and Management Improvements**
- Restructure KWSB to enable effective implementation of the existing projects such as K-IV, and work on maintenance of existing infrastructure; for example, rehabilitation of existing water supply network and rehabilitation of sewerage treatment plants for Karachi.

- SEPA should develop an integrated system with SBCA in order to improve effluent discharge quality to meet with existing standards. Similarly, SBCA was continuously approving plans for multistoried and high-rise buildings without assessing the current water situation in the area. Also, unplanned mushroom growth of industries is increasing the pressure on water infrastructure, under this situation the coordinated efforts of departments are needed to overcome the situation.
- Unregulated water hydrants are being removed with the support of the administration in compliance of Supreme Court order, but it has been observed within the time the same are reestablished. A permanent computerized mechanism is required with the support of relevant governmental organization for an effective solution and patrolling against unregulated hydrants and water culprits. Moreover, a paradigm shift is needed from a conventional water metering system towards smart metering solutions to avoid water theft and improve revenue collection efficiencies.
- Maintain the water supply delivery with pressure to all the houses in the tail end or higher pocket areas.
- Collection and payments system needs reforms as currently, KWSB doesn't have the capacity to devise a suitable mechanism to get its dues from government departments or agencies and to generate its revenues or strengthen its billing system.
- Strong and effective Storm Water Management plan is needed for the city. Currently both major drain for the city namely Rivers Lyari and Malir as well as major nullahs including their outfall points in the city are badly affected due to dumping of solid waste and encroachments. It needs special attention in order to improve the sewerage flow and reduce the urban flooding situation in rainy season.
- Combined treatment plants, similar to the treatment plant in Korangi industrial area should be installed and the proposed S-III project should be executed on priority basis. Representative bodies should bridge the gap between industrialists and Government.
- KWSB Should establish Water Quality Labs at Towns level near water supply schemes for monitoring quality of drinking water before its supply to the people, and results must be uploaded on the websites on daily basis for public reference.
- Sindh Environment Protection Agency should ensure the monitoring of wastewater being discharged from the industries and that it meets Sindh Environment Quality Standards (SEQS) 2016 guidelines.
- KWSB should ensure timely leak detection, repair and maintenance of pipelines in order to stop contamination and water loss. Existing leaking

pipes should be replaced with High Density Polyethylene (HDPE) pipes in the water supply infrastructure. Moreover, pumping efficiency needs to be improved and backup pumps need to be installed at the pumping stations.

- Govt. departments may extend financial support to promote research and innovation for the development of low cost, improved, resilient, and environment friendly water and sanitation projects.

Recycling and Reuse of Wastewater

- The Rivers Lyari and Malir are open drains to untreated industrial effluents and raw municipal wastewater. Karachi needs strict implementation of sewerage recycling schemes and projects to recycle the bulk of wastewater, which constitutes to around 465-471 MGD.
- Industrial toxic wastewater contains heavy metals. It can be treated using financially viable and environment-friendly technologies. One such example is floating wetlands which is effective and sustainable technology for industrial wastewater treatment.
- Textile industries in Karachi should consider compliance of Zero Discharge for Hazardous Chemical (ZDHC) by 2020 as international buyers will actively start to pursue their suppliers for ZDHC.
- Industries should be encouraged to conduct their water audit in order to understand ways in which water consumption can be reduced.
- Not all industrial processes require potable water. Recycling grey water in industrial processes wherever potable water is not required can save freshwater. It can also be used to water gardens, flush toilets or for any other non-potable use.
- Industries should focus on reducing pollution at the source by using cleaner production techniques and reduce, reuse and recycle principles so that they produce less pollution load and save cost in terms of its treatment.
- A largescale reuse of treated effluent requires careful investigation whether the reuse is viable or not from technical, hygienic, financial and economic viewpoints, especially if additional and/or advanced level treatment is needed. Trial application of treated effluent is recommended prior to its full application.
- Most appropriate recommendations for treating domestic wastewater are: (a) Waste Stabilization Ponds (WSPs) and (b) Constructed wetlands (CWs) (phyto-technology). WSPs have already been successfully set up in many urban areas, while CWs are quite sustainable, aesthetically pleasing and cost-effective green wastewater treatment technology, particularly for developing countries including Pakistan. CWs innovatively optimize the wastewater treatment process with zero or very low energy consumption. Similarly, WSPs is an algal-based inexpensive and effective substitute for wastewater

treatment option which may also be adopted for wastewater treatment of Karachi.

Need for Research and Citizens Capacity Building

- Water Conservation Awareness and Education Plan should be developed by the collaboration of NGOs and policymakers, industrial associations, research institutes, media and water regulatory authorities to educate and masses about the importance of water and its responsible use.
- The citizens of Karachi should use home-based cost-effective water purification and storage systems i.e. boiling, solar disinfection, bio-sand filters, flocculation and chlorination techniques.
- An alliance of public and private stakeholders should be formed which should meet regularly to consult on issues pertaining to water and provide feedback, regularly.
- Water consumers and all stakeholders need to be educated regarding the efficient use of water so that water wastage can be minimized. In this regard, electronic, print and social media can play a vital role. Moreover, trainings on better water management practices should be conducted. In this case, NGOs and civil society can prove to be useful.
- Ensure that institutions at all levels (school, colleges and universities) teach about impeding water crisis and the need to manage water resources sustainably. It can be done via lectures, seminars, workshops etc.

Improve Power Supply

- It is imperative to ensure uninterrupted water supply to the Dhabeji, Gharo and other medium-size water pumping stations by installation of power generators at pumping stations by KWSB or K-Electric to provide separate electricity lines to KWSB pumping stations to ensure that power breakdown and load shedding do not impact water supply. It is also recommended to improve pumping efficiency by the installation of back up pumps and alternate source of electrical power at the existing pumping stations this may include alternate energy solutions.

Installation of Desalination Plants

The 1985 water supply master plan study revealed that desalination plants can be an alternate source of water for Karachi. However, the very high capital and operating costs of desalination plant was a drawback and could only become feasible if public and private sector would focus on developing indigenous cheap technology for energy consumption for desalination plants. Desalination of seawater has been in practice for nearly 50 years and is considered to be as one of the main sources of fresh water in many countries like Middle East and other regions of the world. However, one of the major hindrances other than the high cost are the records of poor maintenance and operations of water and wastewater treatment services in

Karachi. A desalination plant in DHA Karachi was established in 2008 which has since become non-operational. Nonetheless, it would continue to remain as an option for a limited number of organizations and industries located in the coastal region which can afford to pay the high cost of desalinated water in order to meet the water shortages persisting in their areas of jurisdiction such consumer would include the Karachi Port Trust (KPT), Port Qasim Authority (PQA) and Pakistan Steel Mill (PSM).

Small Reservoirs and check dams for water storage

- Construction of small reservoirs around Karachi can reduce the rate of rain water wastage and store water for use. Malir River and its tributaries discharge the highest amount of flood water from land area to the Arabian Sea. Check dams should be constructed on the streams like Jarando, Langheji, and Watanwari for flood control and groundwater recharge[7].
- The purpose of check dams is to stop the movement of sediment in streams, thus mitigating erosion while also replenishing aquifers. Check Dams have also been constructed in DHA City Karachi for accumulation/storage of rain water and for the constant recharging of aquifer to maintain the underground water level[67].
- The city government needs to build small reservoirs and check dams in Karachi on priority basis in order to store water, harvest rain water in light of water policy 2018, and to protect the agricultural and residential lands in Malir. It is also suggested to develop strategy to use local ponds, wetlands, lakes as natural expanded storages.

4.3 Implementation Mechanism and Need of PPP Unit

- Public Private Partnership (PPP) model is the suggested approach in order to ensure successful implementation of recommended measures for improving overall water situation of Karachi. In this PPP unit, professionals from relevant governmental department, NGOs, academic institutions, universities and other research institutes will be associated in order to devise, monitor and implement strategic action plan (SAP).
- A governance structure is the framework for resolving issues and managing problems that arise during the project life cycle, and for considering recommendations on planning project deliverables. Without a flexible project governance structure, most projects are likely to fail without achieving a successful outcome. The PPP Unit is an element of the structure.
- This unit is a decision-making body within the project governance structure that consists of top managers, decision and policy makers who provide, review and

[67] DCK Newsletter. (2016). Retrieved from: https://www.dhakarachi.org/dhacity/docs/DHA%20City%20Karachi%20Newsletter/DCK-Newsletter-Aug-2016.pdf

monitor strategic direction and policy guidance to the project team and other stakeholders. The unit also provides recommendations on project approaches and participates in discussing general strategies and opportunities for project planning and implementation.

4.3.1 Organization of PPP Unit

Following department are proposed as integral part of PPP unit.

- Chief Minister Sindh
- Irrigation Department
- Karachi water and supply Department (KWSB)
- Karachi Municipal Corporation (KMC)
- Sindh Environmental Protection Agency (SEPA)
- District Commissioner's office and union councils
- Industrial associations
- NGOs
- Universities, and other academic & research institutes

4.3.2 Functions of PPP Unit:

- Consider and draft policies to the government to mitigate water crisis within the city.
- Develop guidelines for identification of illegal water networks, prevention of illegal water supply pilferage, minimization of water losses and leakages during supply, improve revenue collection efficiency etc.
- Take measure to reduce illegal water supply and pilferages etc.
- Review adequacy of existing laws and recommend new ones if required.
- Review research reports and issue advice to relevant department or organization or concerned person to take specific measures to manage water crises and pollution issues.
- Establish systems and procedures for surveillance, monitoring and measurement of the point and nonpoint water pollution sources.
- Provide information and guidance to the public on water issues and conservation.