PUNJAB CITIES PROGRAM
PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY
Government of the Punjab

TRAINING PROGRESS REPORT

ENVIRONMENTAL & SOCIAL CONSIDERATIONS IN WASTEWATER REUSE AND TREATMENT TECHNOLOGIES/OPTIONS

17&18 JULY 2023






BY ESM WING PCP-PMDFC

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Acronyms

E & S	Environment and Social
ESMF	Environmental & Social Management Framework
ESMMP	Environmental and Social Management and Monitoring Plan
MCs	Municipal Committees
MD	Managing Director
O & M	Operation and Maintenance
PCP	Punjab Cities Program
PEQs	Punjab Environmental Quality Standards
PMDFC	Punjab Municipal Development Fund Company
PO- ESM	Program Officer – Environment and Social Safeguard
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

Section 1: Introduction to Workshop

1.1. Background

Government of the Punjab, with the technical and financial assistance from the World Bank, is implementing **Punjab Cities Program (PCP).** This project is being implemented by the Municipal Committees/Corporations of 16 MCs that includes Daska, Hafizabad, Jhelum, Kamoke, Muridke, Wazirabad, Gojra, Jaranwala, Jhang, Kamalia, Okara, Bahawalnagar, Burewala, Khanewal, Kot Addu, and Vehari. Under PCP, **Environmental and Social Management Framework (ESMF)** is prepared by the PMDFC to ensure the development subprojects implemented by the MCs are environmentally sound and socially acceptable in order to minimize the potential environmental and social impacts that may emerge during development projects/sub projects of MCs. The ESMF also aims to ensure that MCs adopt and pursue sound environmental and social policies and procedures during their routine practices.

1.2. Introduction

ESMF implementation will require comprehensive trainings and demonstrations for long-term sustainability. The environmental & social aspects identifications and mitigations integrated with the PCP trainings will equip the program facilitators for a keen sight of program component related environmental issues and their solutions.

To ensure the successful implementation of ESMF and compliance of the environmental and social mitigation measures, strengthening of relevant technical staff and MCs' competencies is essential. These training/capacity enhancement programs will lay the foundation of a self-sustainable program.

The PMDFC being responsible for capacity building activities under the project has designed various training workshops for implementation of ESMF.

Present two days training workshop on "**Environmental and Social Consideration in Wastewater Reuse and Treatment"** was designed to provide the information on wastewater treatment and reuse processes. This training aimed to equip participants with the knowledge and skills necessary to address the growing challenges of wastewater management and its impact on the environment and society. The agenda of the workshop is attached as ***Annexure A.***

1.3. Objectives of Workshop

The major objectives of Two Days Training on Environmental & Social Considerations in Wastewater Reuse and Treatment Options/Technologies were:

- Awareness about upcoming water scarcity issues, promoting sustainable practices, and
- Developing the necessary expertise to address the challenges and opportunities associated with wastewater reuse and treatment.

Followings were the participants of the 02 days training workshop:

Participants of Training (July 17-18th, 2023)
1. Consultants (MMP, ASIAN, NESPAK)[1]
• Environmental specialist
• Social Safeguards Specialist/Resettlement Specialist
• WWTP Design Engineers
2. 16 Municipals Committees
• Chief Officers
• Municipal Officer (I&S)
• Municipal Officer (Planning)
3. PMDFC
• ESM Team (Head Office & Regional offices)
• Regional Program Coordinators
• Program Officers-Infrastructure Development

Detailed list of participants who attended the workshop is attached as **Annexure B.**

[1]. PMDFC being the technical lead of Local Government & Community Development Department, is building the capacity of consultancy firms and municipal committees in compliance of environment and social safeguards

SECTION 2: Proceedings of the 1st Day of Workshop (July 17,2023)

Training workshop for implementation of ESMF under the theme "**Environmental and Social Considerations in wastewater treatment and its reuse**" was held at PCOM, Lahore on July 17, 2023. Training workshop proceeded according to the agenda of the workshop. Agenda of workshop is attached as **Annexure A.**

Day 1: Forty-Four (44) Participants attended the workshop on January 17, 2023

2.1. Introductory Session

1st day of training session was a technical and theoretical session at PCOM, Lahore on 17th July 2023, and introductory session was comprised of recitation of Holy Quran, round of introduction, opening remarks and welcome address.

2.1.1. Recitation of Holy Quran & Round of Introduction

Ms. Tehmina Kiran (PO ESM) performed as stage secretary of training. She on the behalf of PMDFC invited Mr. Hafiz Shuaib MOP Jehlum for recitation from the Holy Quran and the participants introduced themselves.

Figure 2: Tehmina Kiran PO ESM (Stage Secretary)

Figure 1: MOP Jhelum during recitation of Holy Quran

Figure 3: Participants during round of Introduction

2.1.2. Welcome Remarks

Mr. Pervaiz Iqbal Chairman PMDFC gave opening remarks. He welcomed the participants and described the significance of the training session on Environmental and Social Considerations in Wastewater Reuse and Treatment Options/Technologies. He encouraged the participants to participate in open dialogue and ensure their active participation in sharing their ideas and experiences during the training session.

Figure 4: Charmain PMDFC during Opening Remarks

Mr. Syed Zahid MD, PMDFC gave welcome remarks and thanked to participants to attend the training. He emphasized the importance of environment & social safeguards of PCP. He added that these training will be useful to cope up the challenges face during execution of projects.

Figure 5: MD- PMDFC during Welcome Address

2.1.3. Introduction to Workshop

Ms. Rizwana Anjum SPO ESM- PCP briefly described the workshop agenda.

2.1.4. Pre-Training Evaluation Form

Pre-training evaluation form was developed by ESM team to evaluate the knowledge of participants before training session and it was shared online to all the participants and they submitted their response before the initiation of technical session of training. **Online analysis of pre-training evaluation is given in Section 04.**

2.2. Technical Session

Technical session of training workshop was consisted upon 04 lectures based upon Power Point presentations, interactive discussions and question answer sessions and 01 Group Activity for active learning of the participants.

2.2.1. 1st Presentation on "Options for Urban Drainage & Flooding"

1st presentation was on Options for "Urban Drainage & Flooding" presented by MD PMDFC Syed Zahid Aziz. In his presentation he described the conventional methods for rainwater management. Further he described the concept of infiltration Vs Storage. He presented global practices and worldwide examples of Underground Rain Water Storage. He also presented real time example of Lahore underwater tank Storage at Lawrence Garden, managed by WASA Lahore. At the end, way forward was given with reference to PCP cities. He further added that in PCP participating 16 MCs, PMDFC is going to adopt rainwater storage tanks and in this regard, MCs should actively participate to accomplish the subproject successfully.

BOX 1-Contents of Presentation

Conventional Methods of Rain Water Storage
Infiltration VS Storage
Under Ground Reservoir for Rain Water Storage Facility
Use of Stored Water for Horticulture
Construction of rain water storage tanks (in progress)

Detail presentation is attached as **Annexure C**.

Figure 7: MD PMDFC during his 1st presentation

Figure 6: Participants during training

2.2.2. 2nd Presentation on "Water Supply in Punjab (Challenges and Way Forward)"

2nd lectures were on a briefed presentations on "Water Supply in Punjab (Challenges and Way Forward)" by MD PMDFC Syed Zahid Aziz. (Topics discussed in his presentation are mentioned in Box 2). The session was very interactive. All participants enjoyed the session and chairman PMDFC put some queries.

Detail Presentation is attached as *Annexure D.*

BOX 2-Contents of Presentation

Overall Water Scenario
Ground Water Situation in Punjab
Water Supply in Lahore and Rawalpindi (best and worst cases)
Water Quality Data of Punjab
Interventions and Constraints in Water Supply Sector in Punjab

Figure 8: MD PMDFC during his 2nd presentation

Questions & Answers Session

During presentation following questions were asked from participants and answered accordingly:

Question: Chairman PMDFC asked a question that what is main cause of water scarcity in different cities of Punjab?

Answer by MD PMDFC: Main Reason of Water scarcity is increase in population as increase in population is in direct proportion to the per capita consumption.

Question: How can we monitor ground water level, and how it will be helpful to determine the water availability in coming years?

Answer: Complete procedure of monitoring of ground water was discussed by MD PMDFC and he suggested to all MCs that they should install this system in their cities.

2.2.3. 3rd Presentation on "E &S Considerations in WWTP at Design, Construction & Operation Phase

3rd presentation was on "E&S Considerations in WWTP design, construction & Operation Phase presented by Ms. Rizwana Anjum SPO ESM. The presentation on "Environmental & Social Considerations in WWTP (Wastewater Treatment Plant) Design, Construction & Operation Phase" discussed the crucial factors that need to be taken into account during the entire lifecycle of a wastewater treatment plant. It emphasizes the importance of considering both environmental and social aspects to ensure sustainable and responsible management of wastewater This was a detailed and interactive session. Overall, it was an interactive part of session. Topics covered in this presentation are given in BOX 3 and **presentation is attached as Annexure E.**

Figure 9: SPO ESM during her presentation

BOX 3

Environmental Considerations in Wastewater Treatment Plants-At Planning & Design Phase
Social Considerations in Wastewater Treatment Plants-At Planning & Design Phase
Design Parameters of WWTP
World Bank Guidelines for Construction of WWTP under PCP
E&S Considerations at Construction Phase and compliance of ESMMP
E&S Considerations at Operation Phase

Questions and Answers Session

During presentation following questions were asked from participants and answered accordingly:

Question: What social factors are considered while planning and designing WWTP?

Answer: Accessibility to local community and population, public acceptance, land acquisition and displacement related social concerns, impacts on livelihoods, damage to properties and land worth are important. All other social factors are discussed in detail and importance of their consideration is also discussed. All that factors are part of presentation attached as annexure E.

Question: What should be minimum distance of WWTP from community?

Answer: WWTP should be at least 500 meters away from the local population. It should be at least 15 meters from any building. It should be at least 100 meters from a water supply (e.g., well or borehole). No access roads, driveways or paved areas should be located within the area.

Question: What are the major factors for site selection of WWTP?

Answer: All problems related site selections were discussed. Some factors that are most important during site selection was briefed like settlements, land acquisition, impacts on livelihoods, land use (agriculture, forest, orchids, commercial etc.), biodiversity of the area, local community's concerns and acceptance etc.

Question: How composite sampling is different from grab sampling and why composite sampling is more suitable for analysis of wastewater in WWTP project?

Answer: Grab samples are usually taken when we want to take information specific to a particular sampling location, time or distinct areas within a sampling location i.e. from a lake while Composite samples are usually taken when we want an average representation of a sampling location or time. Composite sampling of wastewater is ensured to determine the overall characteristics of wastewater particularly BOD in case of municipal sewage treatment plants design.

Question: How water pollution is associated with climate change?

Answer: climate change causes more floods and droughts which we are experiencing globally. Water quality is also affected by climate change, as higher water temperatures and more frequent floods and droughts are projected to exacerbate many forms of water pollution.

Question: How we can reuse treated effluent?

Answer: All wastewater reuse options were discussed in accordance with the PEQs, WHO and US EPA Guidelines.

Figure 10: Pictorial evidences during 4th Presentation

2.2.4. 4th Presentation on "Wastewater Treatment & Its Reuse"

4th lecture was "Wastewater Treatment & Its Reuse" presented by Muhammad Hafeez (Individual Consultant). All WWT Technologies & its reuse were discussed by the reference of different developing and developed countries. All participants enjoyed a lot because of new and informative content. Over all this session was very informative. Main points discussed in this session is given in BOX 04 and presentation is attached as Annexure F.

BOX 04

Wastewater Characteristics
Wastewater Treatment Process
Conventional and Advance Technologies of Wastewater Treatment
Largest and Successful WSPs in overall the World (advantages & disadvantages)
Wastewater Reuse (Conditions & Guidelines)

During presentation following questions were asked from participants and answered accordingly:

Question: What is meant by 1:10 dilution factor?

Answer: Dilution factor is relationship between wastewater and surface water body in which wastewater is to be discharged. 1:10 is ratio is ration between wastewater and surface water body respectively. By this action wastewater become diluted and become less harmful for environment and ecosystem.

Figure 11:Pictorial evidences during 5th Presentation

2.3. Group Activity

To assess the knowledge of Environmental & Social Considerations of participants, a group activity was carried out among the participants.

2.3.1. Group Activity

A case study of WWTP site of Jaranwala was presented to participants. They were asked to determine the following components:

- **Category of Project**
- **E&S Instruments to be developed**
- **ESMMP- Outline**

All participants actively responded in the group activity and presented their outcomes. At the end of activity representative from each group presented the findings of activity.

Figure 12:Pictorial evidences during group activity

2.3.2. Post Training Evaluation Form

3. An online post-training evaluation form was shared with the participants and they submitted their response. Analysis of post-training evaluation is given in section 04.

SECTION 3: PROCEEDINGS OF THE SECOND DAY OF WORKSHOP (July 18th, 2023)

On 2nd day of Training workshop **"Study Visit of Wastewater and Surface Water Treatment Plant in Faisalabad"** was arranged by PMDFC on 18th July 2023. Agenda of field study is attached as **Annexure A.**

Day 02: Thirty-Four (34) Participants attended the workshop on 18th July, 2023

3.1. Site # 1 Domestic Sewage Treatment Plant Chokera, Faisalabad

Mr. Hammad Fazal Deputy Director DC-II/O&M WASA briefed about the Wastewater Treatment Plant. The sewage treatment plant was established at 1998. The main objective of sewage treatment plant is:

- To avoid contamination of surface and sub soil water;
- To improve environmental conditions in downstream areas of Maduana Drain

Half of the Faisalabad City is being disposed off into Ravi River through Madhuana Drain without treatment. It is causing severe environmental pollution from Faisalabad to River Ravi (above 100 km). Seepage from the drain is causing contamination of sub soil water and pollutes fresh water of River Ravi.

The design of sewage treatment plant is comprised of:

Sludge Drying ponds /lagoons 04NOs	5 Hectares
Anerobic Ponds (2.5m deep) 06 Nos.	25 Hectares
Facultative Ponds (1.5m deep) 06 Nos.	125 Hectares
Influent Pump Station	180 Cfs

Design parameters

Capacity	20 MGD
Influent BOD	380 mg/l
Effluent BOD	40 mg/l
Retention Time	19 days

There are 4 sludge drying ponds of 5 hectares area. 06 anerobic ponds on 25 hectares area. The depth of anerobic pond is 2.5 m deep. 06 facultative ponds 1.5 meter deep on 125 hectares. As an experiment WASA-F introduced of floating wetlands in anerobic sections with the help of NIBGE.

Figure 13: Field Visit of Chokers Site

3.2. Site # 2 Jhal Surface Wastewater Treatment Plant

Mr. Rohaan Javaid Director Water Resources, WASA Briefed about the Surface Water Treatment Plant.

The project comprises the Operation and Management of the new Jhal 10 MGD Water Treatment Plants constructed under a French Government Loan located near Novelty Bridge as plan:-

10 MGD is run into a Raw Water tank under gravity from the Rakh Branch Canal through an automatic screen to prevent debris from entering the tank. 3 No 1000 Cum/Hr pumps then force the incoming canal water into the Distribution Chamber of the plant which is elevated approximately 5m above canal water level. Then the water splits into two parallel treatment lines. Solutions of Aluminium Sulphate, Sodium Hydroxide (Lime) and Anionic Polymer is added to the raw water in the Coagulation Tanks and mixed in the Flocculation Tanks from where it passes to the Lamella filter tanks. Here suspended solids settle to the bottom of the tank. The water partially cleaned passes to two banks of rapid sand filters each bank comprises four tanks. After passing through the rapid sand filters the water passes through a chlorine contact tank for disinfection before passing to a water storage tank and then to the outlet pumping station. In the outlet pumping station 3No 1000 cum/hr pumps send the water into WASA's existing Arterial Main on Sammundri Road. The whole process in managed by a SCADA system which is automatic. A 1000Kva Standby Generator is included. The chemicals are stored dry in a Reagent Building and introduced into 4 mixing tanks with mechanical stirrers and potable water then pumped to the Coagulation Section under control of dosing pumps managed by the SCADA system. Chlorine Gas cylinders are located in the Chlorine Building and the gas is mixed with potable water as supervised by the SCADA system and pumped to the Contact Tank located directly under the Rapid Sand Filters. There is an automatic chlorine recovery system in case of any leaks in the Chlorine Building where the escaped gas is drawn through a Neutralisation Tower filled with Sodium Hydroxide (Caustic Soda) to render it harmless. The rapid sand filters are automatically washed with high pressure air and water as they become progressively blocked with suspended particles managed by the SCADA system. The sludge from the base of the lamella filters and the rapid sand filters released during washing is collected in a recovery tank where it is pumped into a settlement tank whereby the thickened sludge is pumped to one of eight sludge drying beds and the water released is pumped by to the distribution chamber to mix with the incoming canal water. There is a Collection Pit where all overflow water is collected and pumped back into to the Canal. Water quality of the incoming water, temperature, pH, turbidity is automatically monitored

at various points in the treatment process as is the potable water leaving the plant. There is an Administration Block which also houses the outlet pumping station in a basement, the main electrical switch rooms, transformer on the public supply and the generator. Additionally it houses the plant laboratory where manual tests may be performed in addition to the automated water quality sensors.

Water Lagoon There are water lagoons (capacity 32 MGD) for the storage of Raw water during the scheduled / unscheduled canal closure. Its proper functioning / operation will also be the prime responsibility of the operator.

Non-Revenue Water (NRW) The city has been zoned hydraulically into 16 District Meter Zones (DMZ) and further sub-divided into a total of 90 District Meter Areas (DMA) by fitting valves for zoning so that each zone can be hydraulically isolated as required. The 6 zones are completely connected & monitored through SCADA whereas the rest are partially monitored. The water flow into each zone is measured with bulk meters and pressures controlled by Pressure Regulating Valves (PRV). Pressure is also monitored. The data for pressure and discharge is then transmitted to a central SCADA system located in the new Jhal Water Treatment Plant. The operator is responsible for operation & maintenance of all the installed equipment's under the NRW component of the project, in the water network of the city.

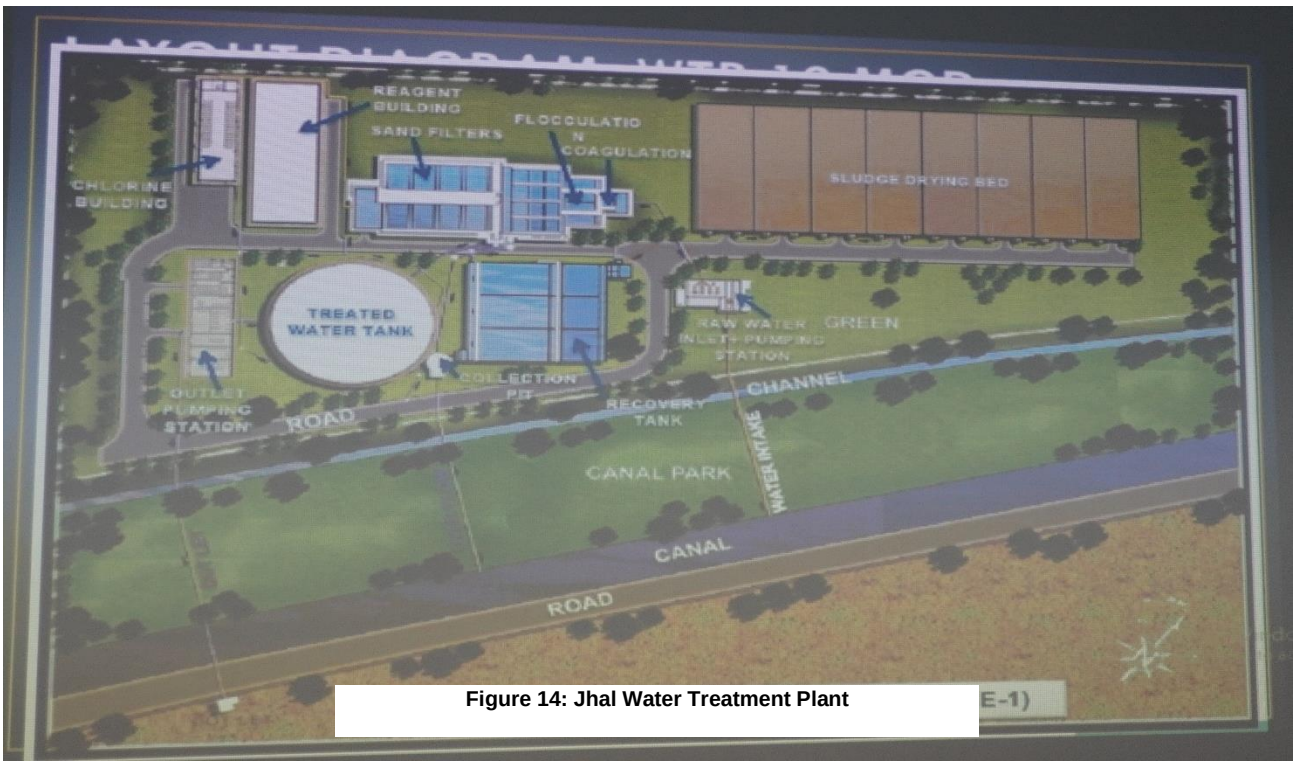


Figure 14: Jhal Water Treatment Plant






Figure 15:Field Visit of Surface Water Treatment Site

3.3. Site # 3 Floating Wetlands NIBGE

Dr Afzal Dr. M. Afzal, Deputy Chief Scientist, Soil and Environmental Biotechnology Division, NIBGE, Jang Road Faisalabad briefed about the floating wetlands. He explained that Floating Treatment Wetlands are Only practical approach in Pakistan due to following aspects:

- Indigenous
- Sustainable
- Feasible
- Low cost
- No operational cost
- No maintenance cost
- No Chemical use
- No electricity use

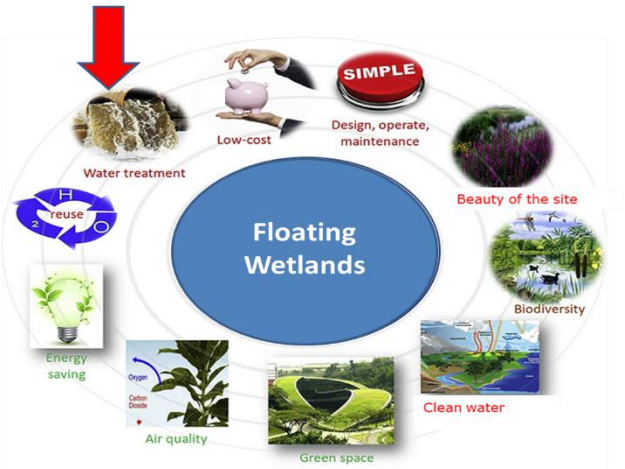


Figure 16: Field Visit of Surface water Treatment Site

3.4. CLOSING REMARKS

During closing session, Ms. Rizwana Anjum (SPO ESM) acknowledged the value of the training workshop. He admired the efforts of all resource persons who briefed the project details during visit. She expressed her heartfelt gratitude for active participation and engagement throughout the sessions.

Figure 17: Closing remarks by SPO ESM on 2nd Day of training

further she described that over the 02 days, we have investigated into various aspects of wastewater management, exploring the challenges, opportunities, and best practices in treating and reusing liquid waste responsibly. We believe that the knowledge and insights gained during this workshop will contribute significantly to the collective efforts in promoting sustainable and environmentally friendly wastewater solutions.

Throughout this journey, we have emphasized the importance of environmental protection, water conservation, and public health in wastewater management. We have discussed the significance of compliance with regulations, stakeholder engagement, and the incorporation of innovative technologies to address the complexities of this critical field.

3.5. Certificate Distribution

Certificated were distributed among the participants and Group photo was taken after closing remarks

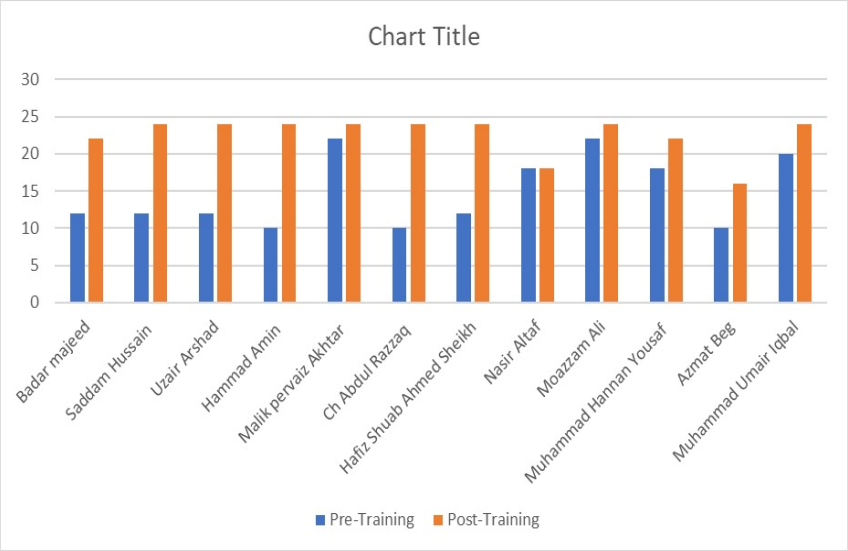
Figure 18: Certificate Distribution

Figure 20: Group Photo at NIBGE

Figure 19: Surface Water treatment Plan

SECTION 4: PRE-TRAINING & POST TRAINING AND FEEDBACK EVALUATION

1. **Knowledge increased upto level**



For precise feedback evaluation of this training workshop, two assessments were carried out. One was pre-training assessment to gain insight of participant's knowledge about the subject, other was post-training assessment which give apprehension of participants after training workshop. According to response Average score of Pre-training is 16.11 out of 24. Average score of post-training is 21.53.

Figure 22: Pre-Training Assessment

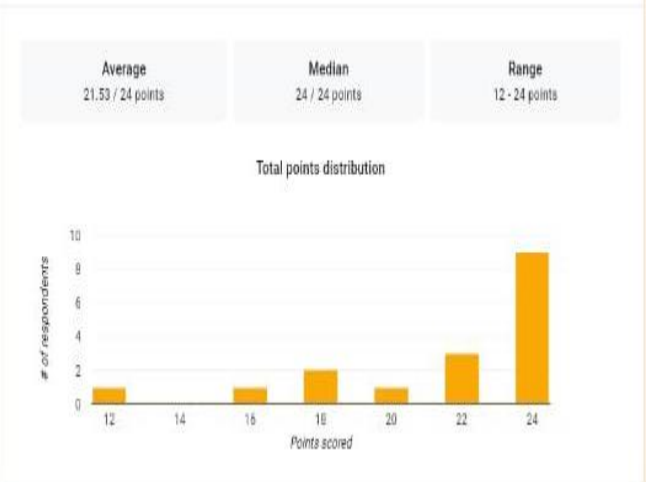


Figure 21: Post Training Assessment

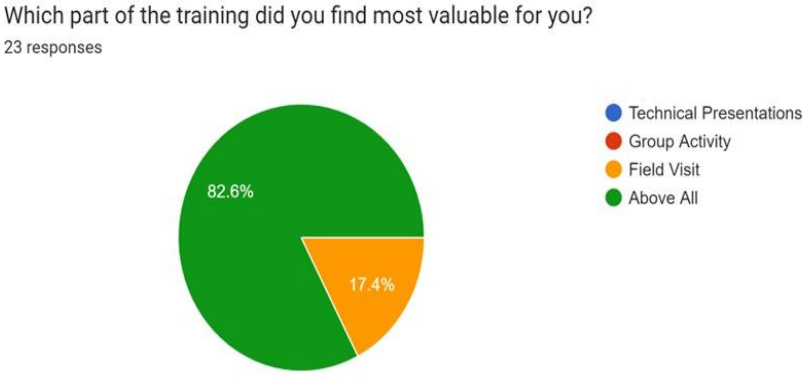
At the end of the training session various questions were asked in order to evaluate the success of training workshop. Region wise feedback evaluation is given below:

3.1. Training Evaluation

2. **Knowledge regarding environmental and social considerations in wastewater reuse and treatment technologies is improved by this training workshop**

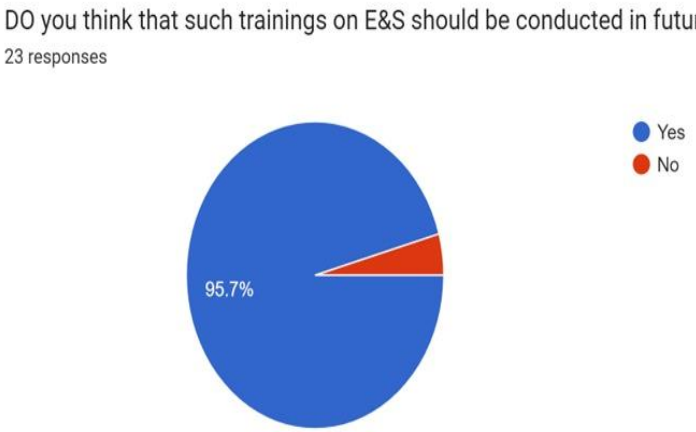
On the response of this question **73.9% participants** respond that this training workshop was useful for their professional knowledge regarding environmental and social considerations in wastewater reuse and treatment technologies.

3. **What part of the training workshop did you find most valuable?**



Over all participants mentioned that all training activities including technical presentations, Group activity and field visit as most valuable part of the training. While 17.4% participants emphasized that field visit was the most valuable part of the training as they observed the technical procedure and discussion with the technical staff in the field enhanced their understanding.

4. **Do you think that such trainings on E & S should be conducted in future as well?**



On the response of this question **95.7% participants** of three regions respond **yes**, that training workshop on E & S should be conducted in future because it was informative.

5. **What do you think the training material provided to you was?**

According to response 47.8% of participants said training material was excellent, while 30.4% participants considered that this was very good. 21.7% participants mentioned that it was good.

6. **Overall, how would you rate the training?**

According to 69.6% participants rated the training Excellent. 30.4% participants rated training Good.

3.2. General Remarks

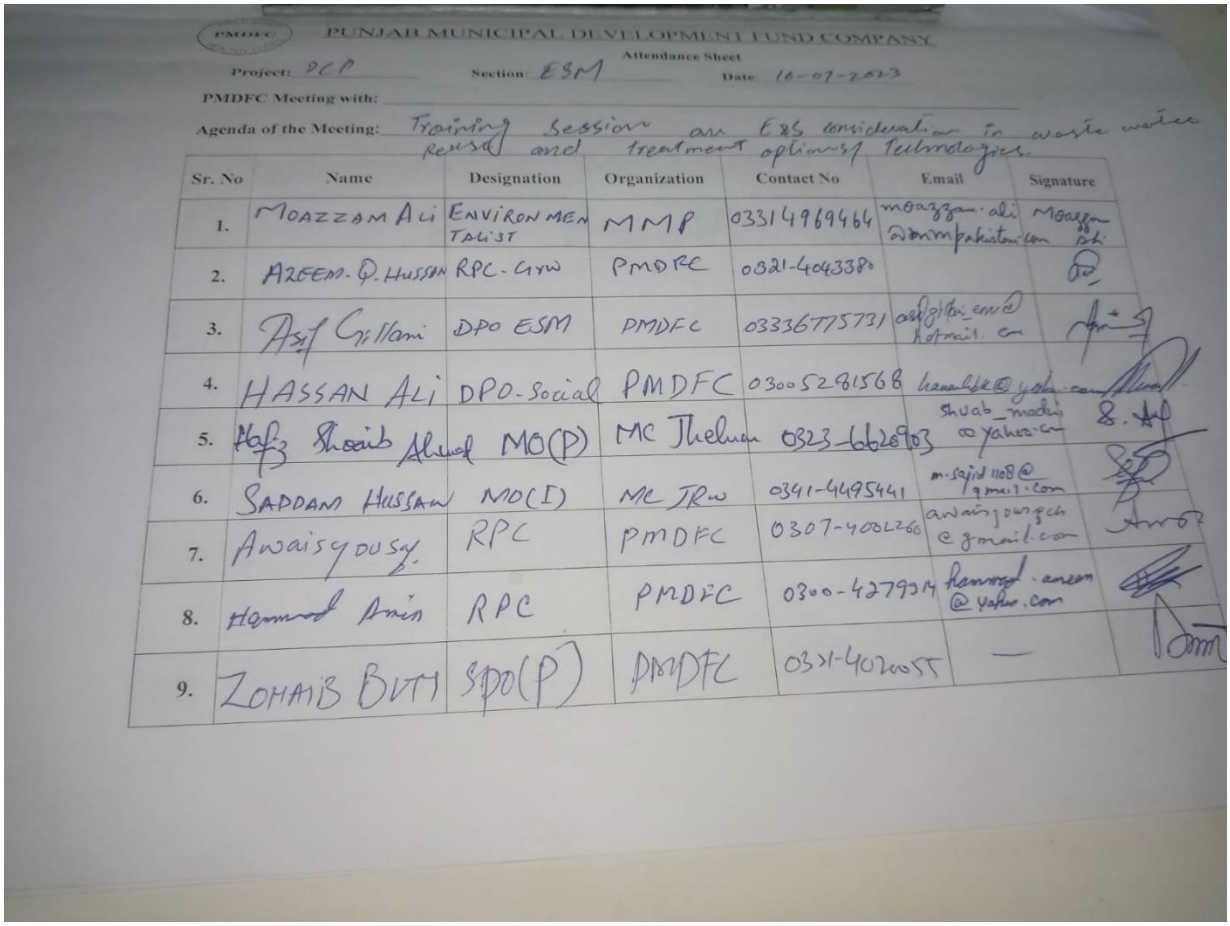
At the end of feedback form participants gave their general remark about training and these are presented below:

- Training was very informative.
- Staff was very cooperative and memorable training
- Trainer was excellent learnt a lot regarding Environmental & social considerations in wastewater reuse and training.
- Such trainings should be arranged regularly.

SECTION 5: ANNEXURES

Annexure A Attendance Sheet

17th July 2023 Day 01



PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

Project: PCP Section: ESM Date: 16-07-2023

PMDFC Meeting with:

Agenda of the Meeting: Training Session on E&S consideration in waste water reuse and treatment options/ Technologies.

Sr. No	Name	Designation	Organization	Contact No	Email	Signature
1.	Moazzam Ali	Environmentalist	MMP	03314969464	moazzam.ali@mmpakistan.com	
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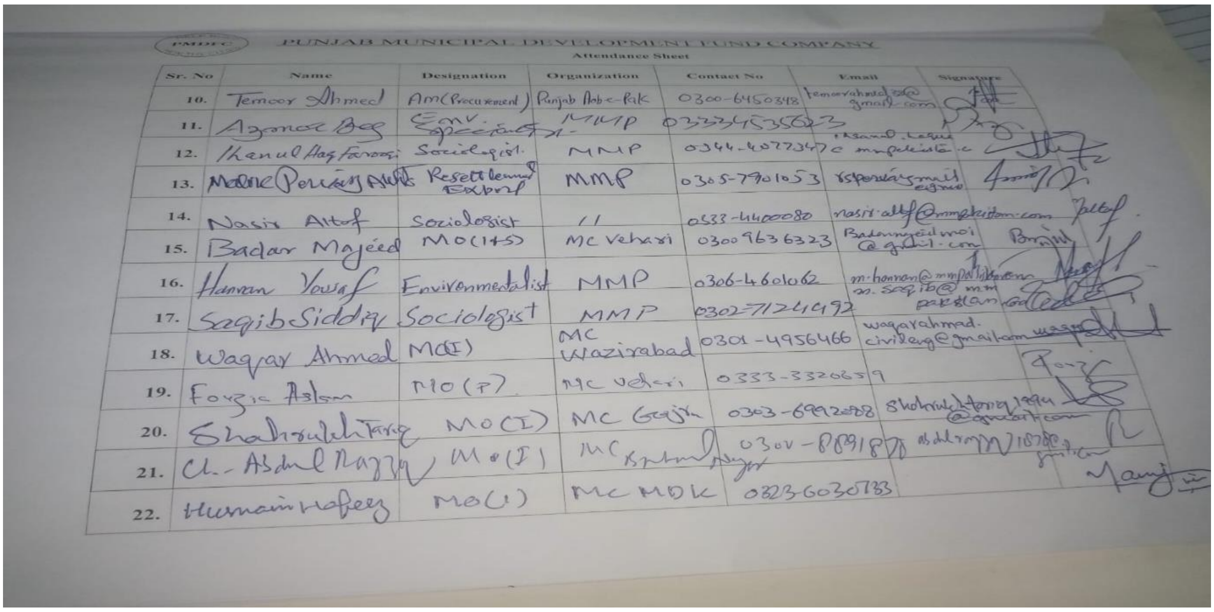
7.	Awais Yousaf	RPC	PMDFC	0307-4002260	awaisyousafch@gmail.com	
8.	Hammad Amin	RPC	PMDFC	0300-4279314	hammad.ameen@yahoo.com	
9.	Zohaib Butt	SPO(P)	PMDFC	0321-4020055	—	



PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

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10.	Temoor Ahmed	AM(Procurement)	Punjab Aab-e-Pak	0300-6450348	temoorahmed@gmail.com	
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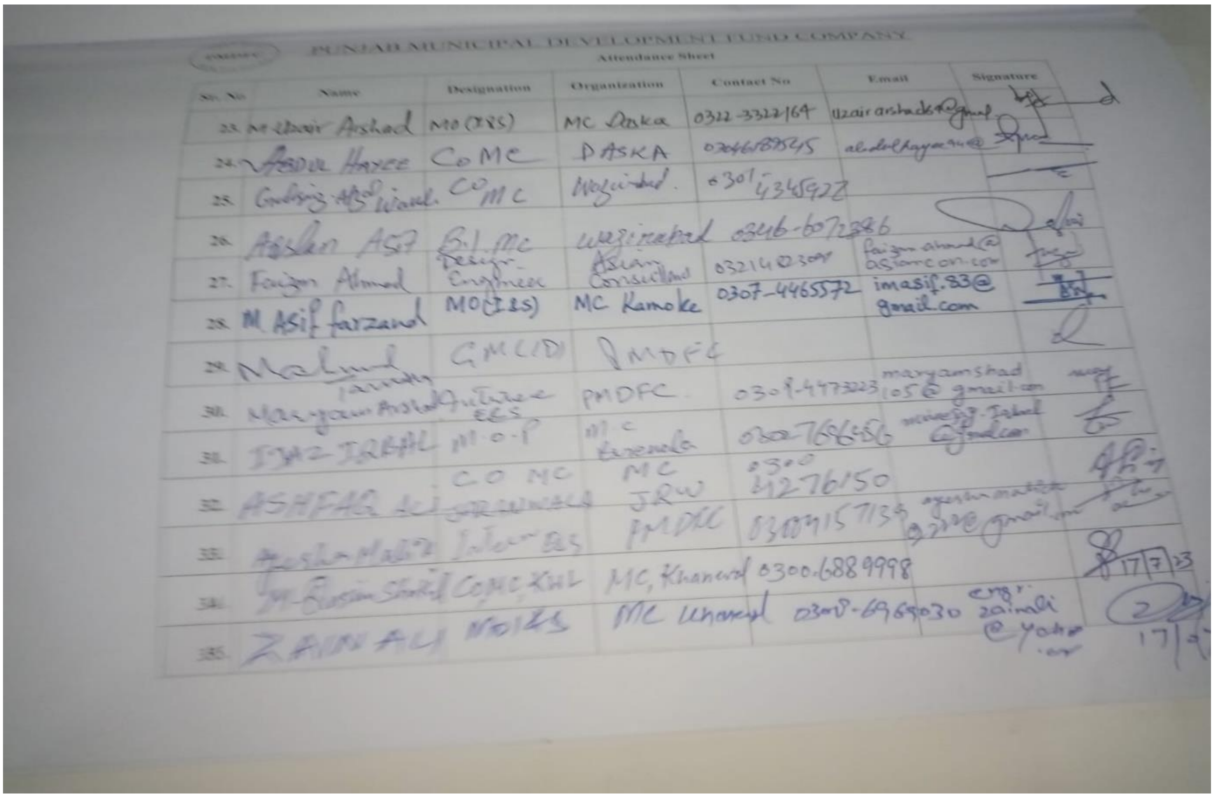
22.	Humair Hafeez	MO(I)	MC MDK	0323-6030733		



PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

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25.	[illegible]	CO MC	Wazirabad	0301-4345922		
26.	Arslan Asif	B.I. MC	Wazirabad	0346-6072386		
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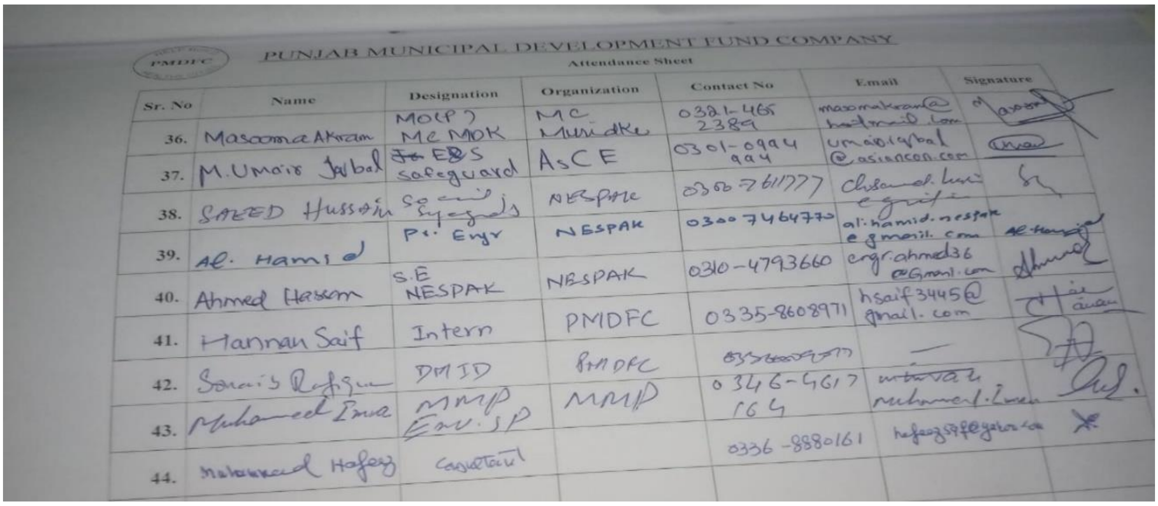
31.	IJAZ IQBAL	M.O.P	MC [illegible]	0302-7696456	[illegible]@gmail.com	
32.	ASHFAQ ALI [illegible]	CO MC	MC JRW	0300-4276150		
33.	Ayesha Malik	Intern E&S	PMDFC	03104157134	ayeshamalik[illegible]@gmail.com	
34.	M. Basim Shahid	CO MC KHL	MC, Khanewal	0300-6889998		
35.	ZAIN ALI	MO I&S	MC Khanewal	0308-6969030	engr.zainali@yahoo.com	

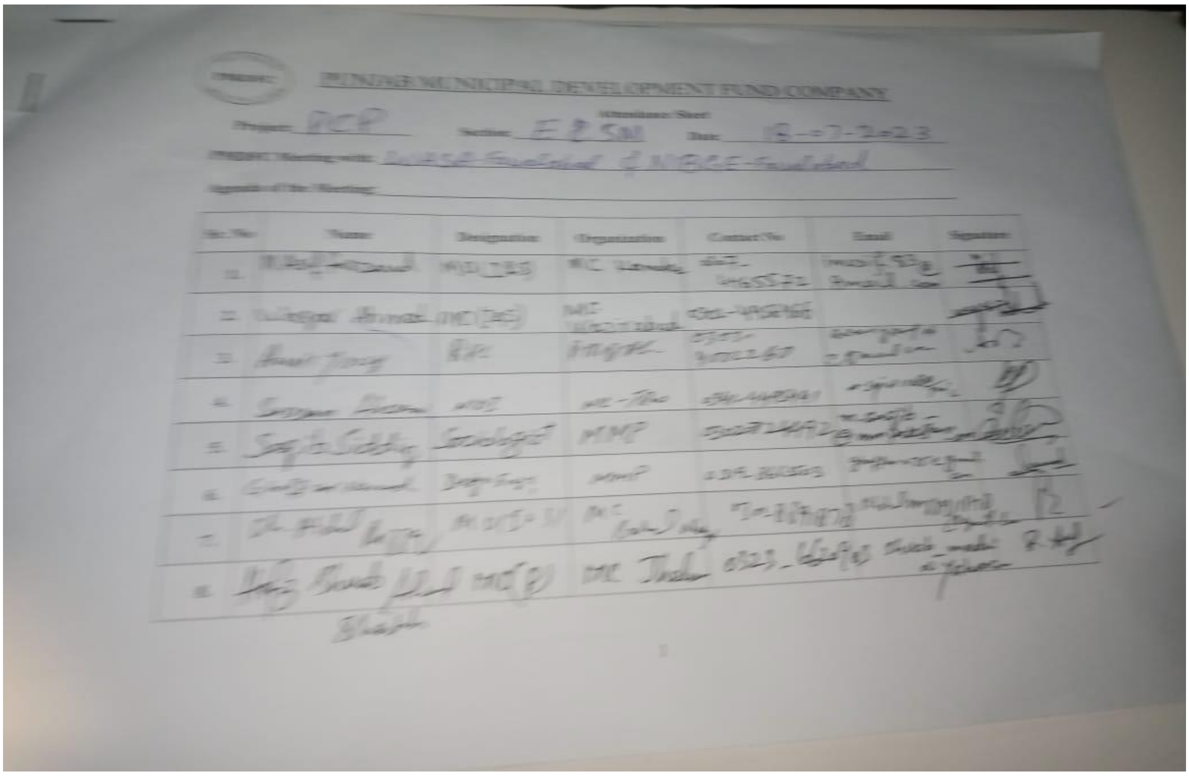


PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

Sr. No	Name	Designation	Organization	Contact No	Email	Signature
36.	Masooma Akram	MO(P?) MC MOK	MC Muridke	0321-4652389	masoomakram@hotmail.com	
37.	M. Umair Iqbal	E&S safeguard	AsCE	0301-0994994	umairiqbal@asiancon.com	
38.	SAEED Hussain	Social safeguards	NESPAK	0300 7611777	[illegible]	
39.	Al. Hamid	Pr. Engr	NESPAK	0300 7464770	al.hamid.nespak@gmail.com	
40.	Ahmed Hassan	S.E NESPAK	NESPAK	0310-4793660	engr.ahmed36@Gmail.com	
41.	Hannan Saif	Intern	PMDFC	0335-8608971	hsaif3445@gmail.com	
42.	Sonai's Rafique	DMSD	PMDFC	[illegible]	[illegible]	
43.	Muhammad Imran	MMP Env. SP	MMP	0346-4617164	muhammad.imran[illegible]	
44.	Muhammad Hafeez	Consultant		0336-8880161	hafeez[illegible]@yahoo.com	

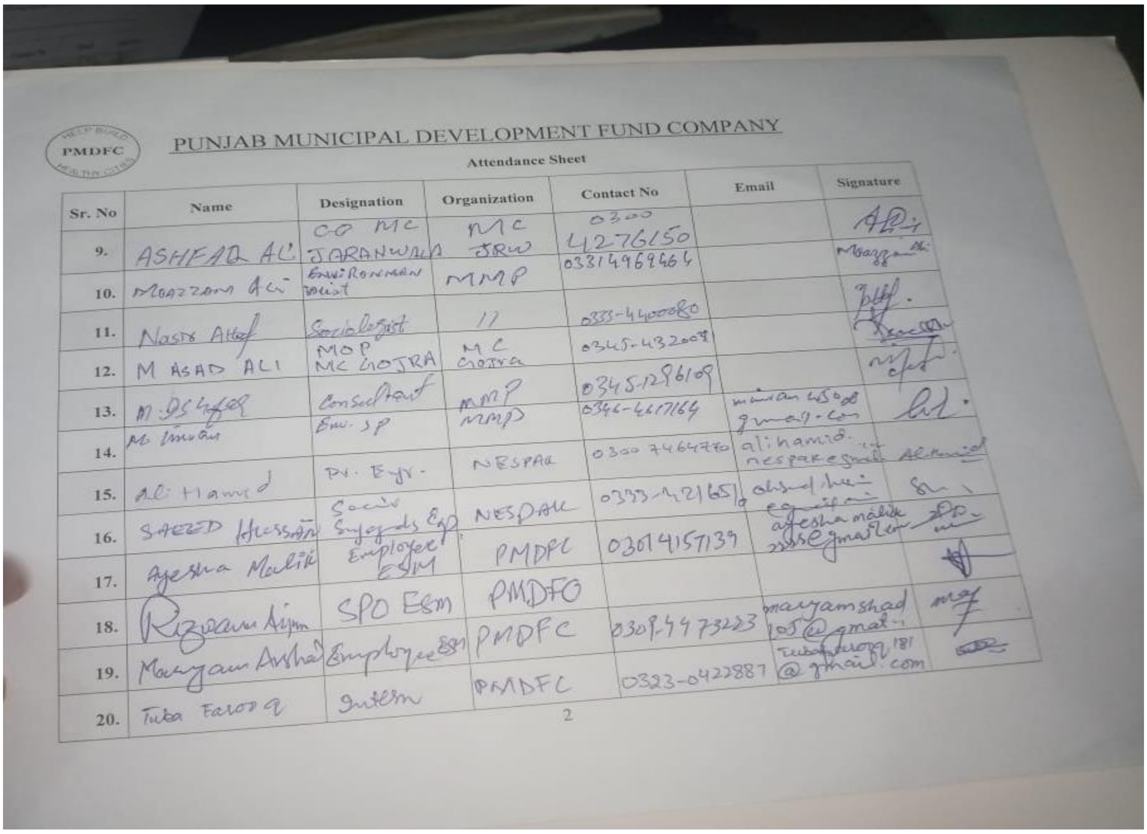
18th July 2023



PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

Project: PCP Section: E&SM Date: 18-07-2023



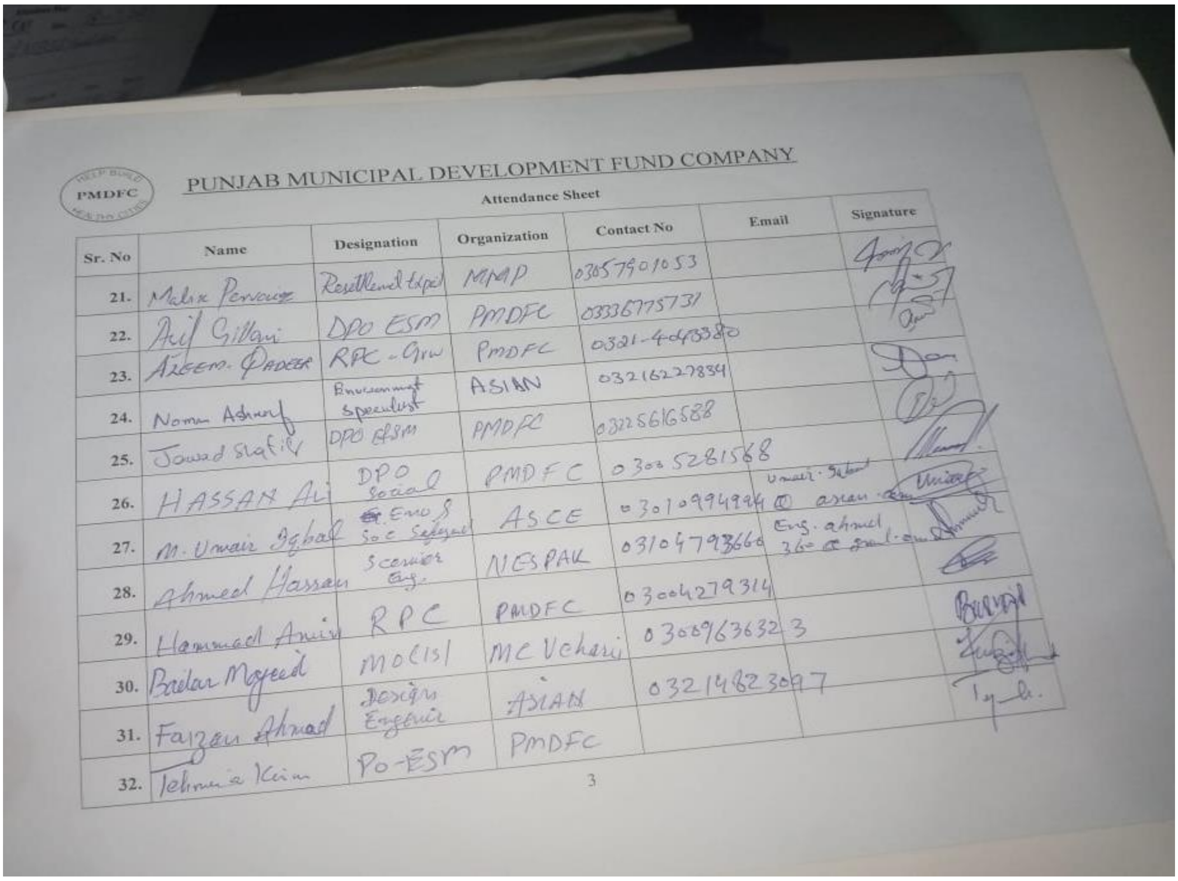
PMDFC

PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

Sr. No	Name	Designation	Organization	Contact No	Email	Signature
9.	ASHFAQ ALI	CO MC JARANWALA	MC JRW	0300 4276150		
10.	Moazzam Ali	Environmentalist	MMP	03314969464		
11.	Nasir Altaf	Sociologist	//	0333-4400080		
12.	M ASAD ALI	MOP MC GOJRA	MC Gojra	0345-4320081		
13.	M. Ishfaq	Consultant	MMP	0345-1296109	[illegible] @gmail.com	
14.	M. Imran	Env. SP	MMP	0346-4617164		
15.	Ali Hamid	Pr. Engr.	NESPAK	0300 7464770	alihamid. nespak@gmail	
16.	SAEED Hussain	Socio Safeguards Exp	NESPAK	0333-4216510	[illegible]	
17.	Ayesha Malik	Employee ESM	PMDFC	03014157139	ayesha malik [illegible]@gmail.com	
18.	Rizwan Aijaz	SPO ESM	PMDFC			
19.	Maryam Arshad	Employee ESM	PMDFC	0309-4473223	maryamshad 105@gmail	
20.	Tuba Farooq	Intern	PMDFC	0323-0422887	tubafarooq181 @gmail.com	

2



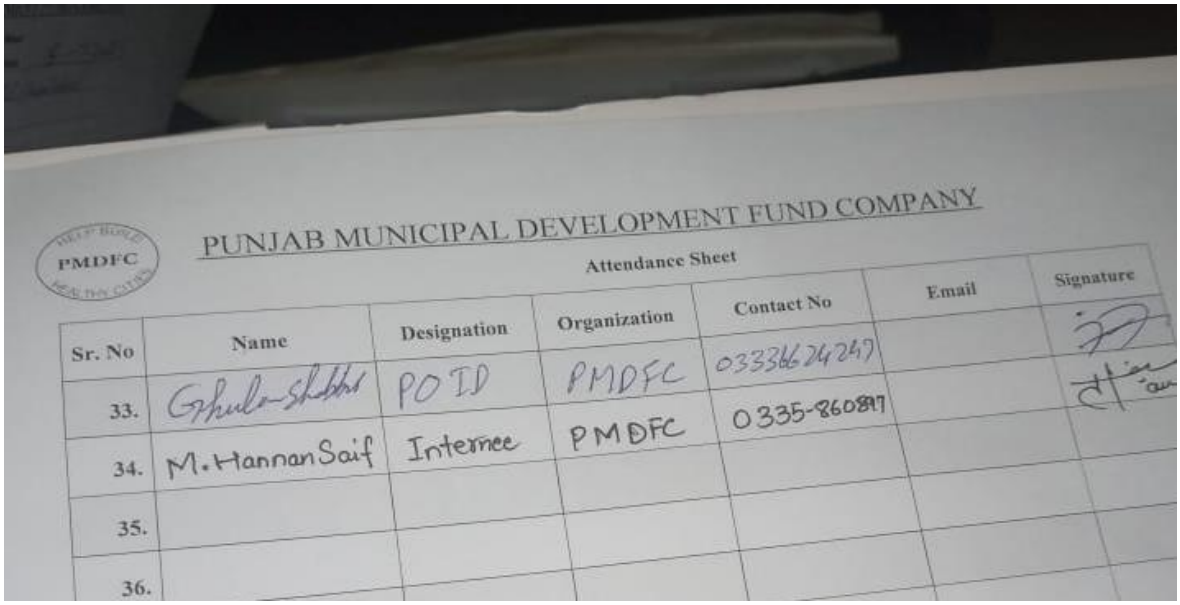
PMDFC

PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

Attendance Sheet

Sr. No	Name	Designation	Organization	Contact No	Email	Signature
21.	Malik Pervaiz	Resettlement Expert	MMP	03057901053		
22.	Arif Gillani	DPO ESM	PMDFC	03336775731		
23.	Azeem Qadeer	RPC - Grw	PMDFC	0321-4043380		
24.	Noman Ashraf	Environment Specialist	ASIAN	03216227834		
25.	Jawad Shafiq	DPO ESM	PMDFC	03225616588		
26.	HASSAN Ali	DPO Social	PMDFC	0303 5281568		
27.	M. Umair Iqbal	Env & Soc Safeguard	ASCE	03010994994	umair.[illegible]@asian.com	
28.	Ahmed Hassan	Senior Eng.	NESPAK	03104793660	Eng.ahmed 360@gmail.com	
29.	Hammad Amin	RPC	PMDFC	03004279314		
30.	Badar Majeed	MOI(S)	MC Vehari	03089636323		
31.	Faizan Ahmad	Design Engineer	ASIAN	03214823097		
32.	Tehmina Karim	PO-ESM	PMDFC			

3



PUNJAB MUNICIPAL DEVELOPMENT FUND COMPANY

PMDFC

Attendance Sheet

Sr. No	Name	Designation	Organization	Contact No	Email	Signature
33.	Ghulam Shabbir	POID	PMDFC	03336241247		
34.	M. Hannan Saif	Intern	PMDFC	0335-8605817		
35.						
36.						

Annexure B: Agenda of Workshop

Agenda

Two Days Training Session on E&S Considerations in Wastewater Reuse and Treatment Options/Technologies

Schedule

Date: 17th July,2023 (Monday)

Time: 10:00 hrs to 05:00 hrs

Venue: PCOM, Lahore

Agenda:

#	Activity	Time	Moderator/Speaker
Day 01 (17th July 2023)			
1.	Registration of Participants and Filling of pre-training Evaluation Form	010:00hrs	ESM Team of PCP
2.	Recitation from Holy Quran	10:00hrs to 10:05 hrs	ESM Team of PCP
3.	Introduction of Participants	10:05hrs to 10:10hrs	Participants
4.	Guest Remarks	10:10hrs to 10:15hrs	Chairman PMDFC
5.	Welcome Address	10:15hrs to 10:20hrs	MD-PMDFC
6.	Introduction to workshop	10:20hrs to 10:25hrs	SPO ESM
7.	Options for Urban Drainage & Flooding	10:25hrs to 10:55hrs	MD-PMDFC
8.	**Group Photo & Tea (10:55 hrs to 11:10 hrs)**		
9.	Water Supply in Punjab (Challenges & Way forward)	11:10 hrs to 11:50 hrs	MD PMDFC
10.	E&S Considerations in WWTP	11:50hrs to 01:15hrs	SPO ESM
11.	**Namaz Break & Lunch (01:15 hrs to 02:00 hrs)**		
12.	WWTP Technologies	02:00hrs to 03:30hrs	M. Hafeez -Consultant
13.	Group Activity	03:30hrs to 04:00hrs	SPO-ESM (PCP)
14.	Case study of WWTP-Gojra	04:00hrs to 04:30hrs	Ghulam Shabbir PO ID Ghaffar Naveed-Consultant
15.	Closing Remarks	04:30hrs to 04:45hrs	MD -PMDFC

16.	Certificate Distribution	04:45hrs to 05:00hrs	Chairman PMDFC ESM Team of PCP

Agenda

Visit of Wastewater and Surface Water Treatment Plant in Faisalabad

Schedule

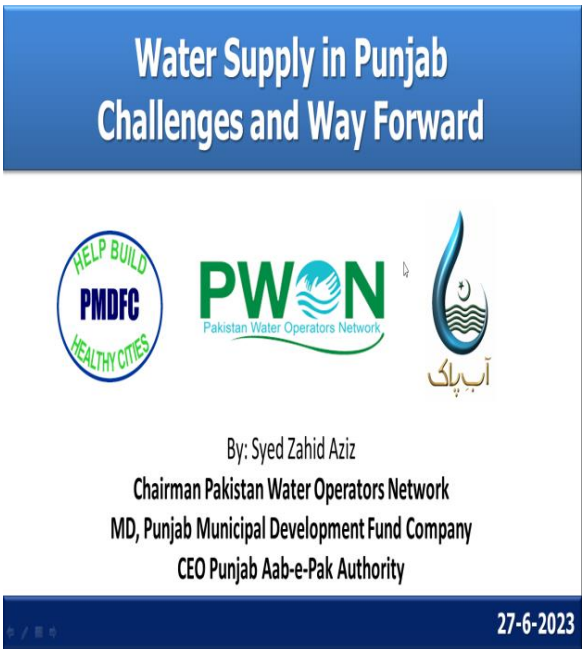
Date: 18th July,2023 (Tuesday)

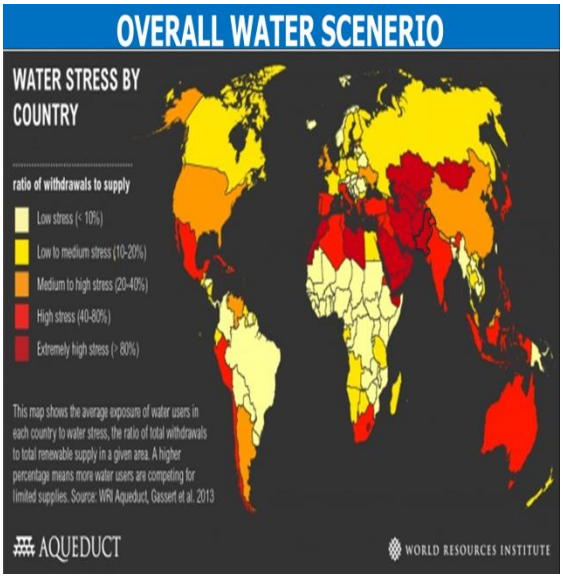
Time: 08:00 hrs to 02:00 hrs

No. of Participants: (Chief Officers & Municipal Officers of Municipal Committees, representatives of PMDFC and E&S and design Consultants of PMDFC)

#	Activity	Time
1.	Departure from PMDFC	08:00 am
2.	Arrival at Chokera WWTP Faisalabad	11:00 am
3.	Briefing by WASA Faisalabad	11:00 am- 11:30 am
4.	Visit of Surface Water Treatment Plant Faisalabad and Briefing by WASA Faisalabad	11:30 am-12:30 pm
5.	Arrival at NIBGE	01:00 pm
6.	Briefing and Visit by NIBGE	01:00 pm- 02:00 pm
7.	Lunch	02:00 pm
8.	Back to Lahore	

Annexure C:Presentation 1 Water Supply in Punjab Challenges and Way Forward





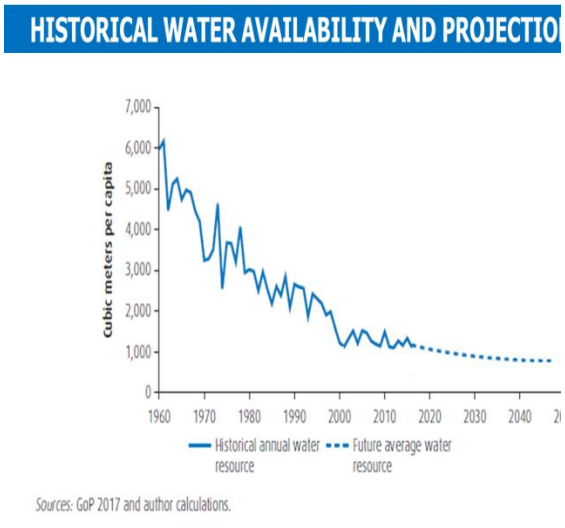
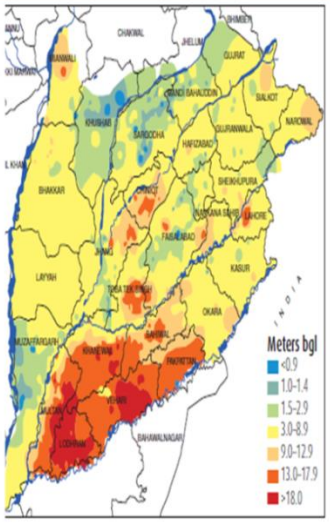


Table 1.3 Average Annual Water Withdrawal and Consumption Volumes, Pakistan
billion cubic meters

Average Annual Water Withdrawal and Consumption volumes, Pakistan			
Canals	122	Irrigation	80
Groundwater	62	Livestock	1
Total	184	Municipal	1
Double counting	48	Industrial	<1
Net withdrawal	136	Total	82

Sources: Amir and Habib 2015; FAO 2011; IFPRI CGE-W baseline model; Laghari, Vanhamm, and Rauch 2012.

Groundwater Depths in Punjab

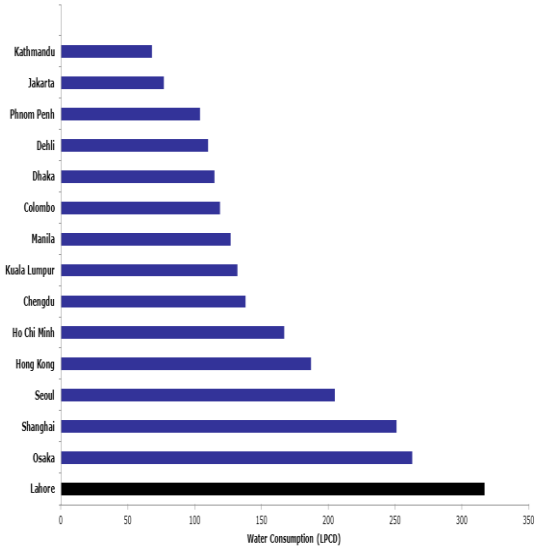


WATER SUPPY IN LAHORE

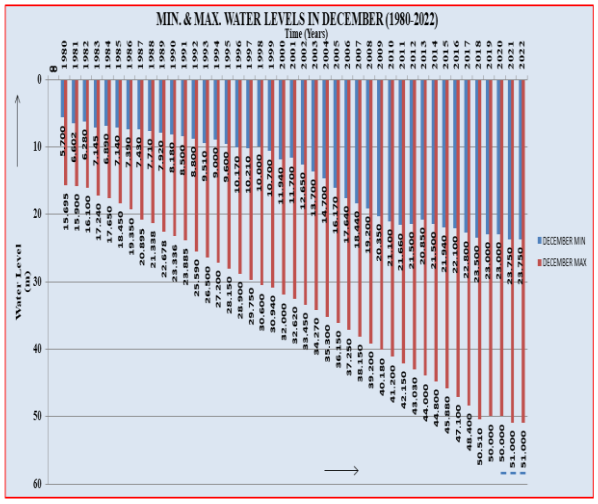
- Water supply of Lahore is based on ground water extraction.
- Water supply network of WASA, Lahore is fed by 596 tubewells
- Length of water distribution system is 5826 KM
- Water quality at all tubewells is within National Standards for Drinking Water Quality (NSDWQ)
- Total water yield of tubewells is above 1000 cusec
- Water supply to citizens is 70 GPCD (315 LPCD) which is highest in the region (Now changed to 50 GPCD)

  (Singapore 143 LPCD, Paris150 LPCD, New Delhi 130 LPCD)
- Average static water level of Lahore is 160ft
- Water level decline / year is above 01 meter
- Water supply hours are 12/day

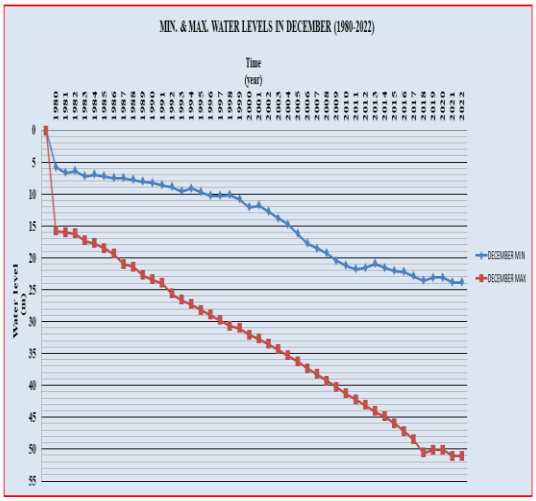
WATER CONSUMPTION IN LAHORE

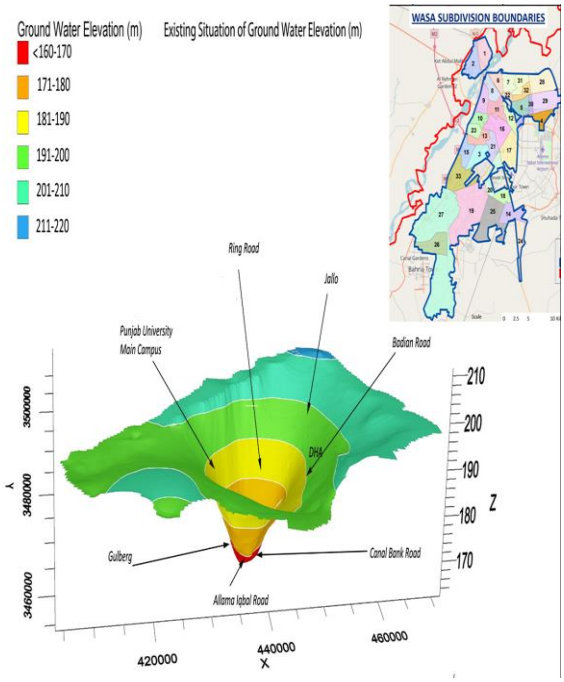


Ground Water Level in Lahore



Ground Water Level in Lahore

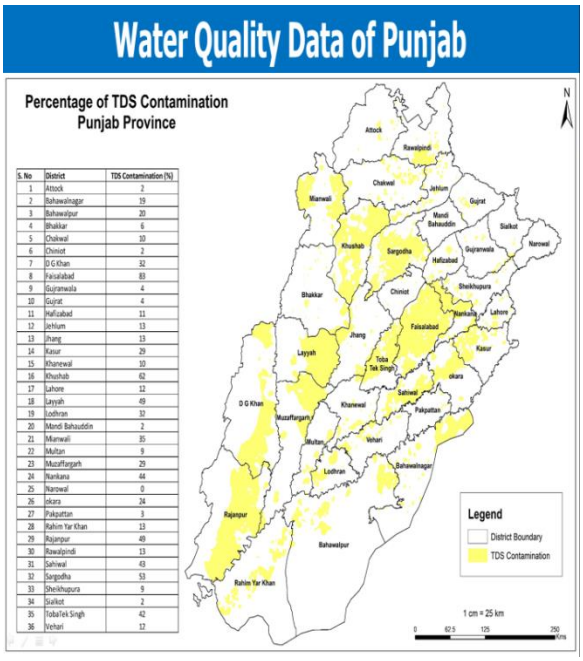


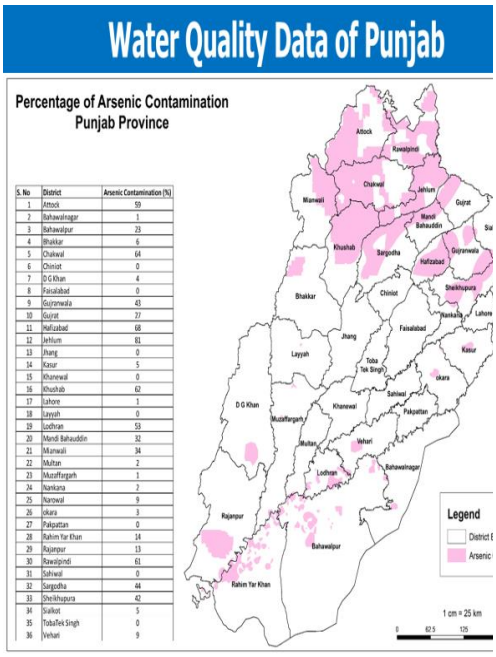


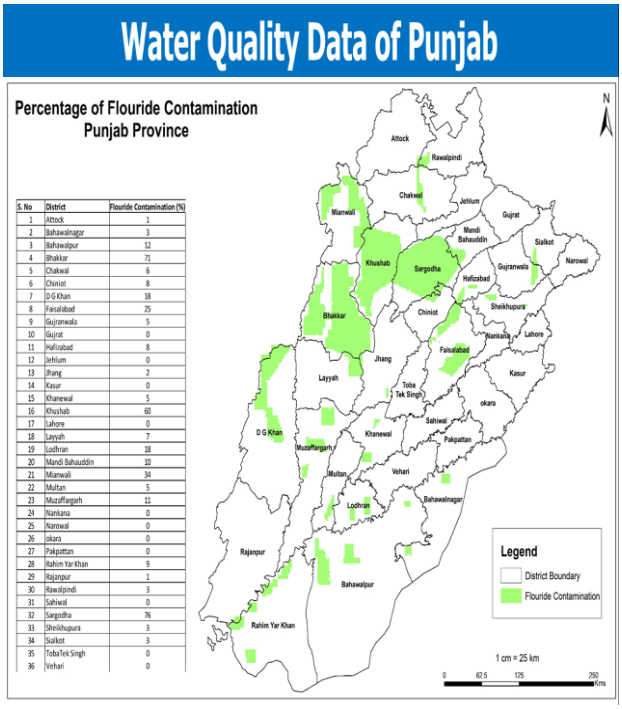
WATER SUPPY IN RAWALPINDI

- Water supply of Rawalpindi is based on ground water extraction (Tubewell) & Surface Water Treatment (Rawal Dam + Khanpur Dam)
- Water supply network of WASA, Rawalpindi is fed by 480 tubewells
- Length of water distribution system is 1000 KM
- Water quality at all tubewells is within National Standards for Drinking Water Quality (NSDWQ)
- Total water yield of tubewells and Dam is about (35 + 16 = 51 MGD)
- Water supply to citizens is 40 GPCD (152 LPCD)

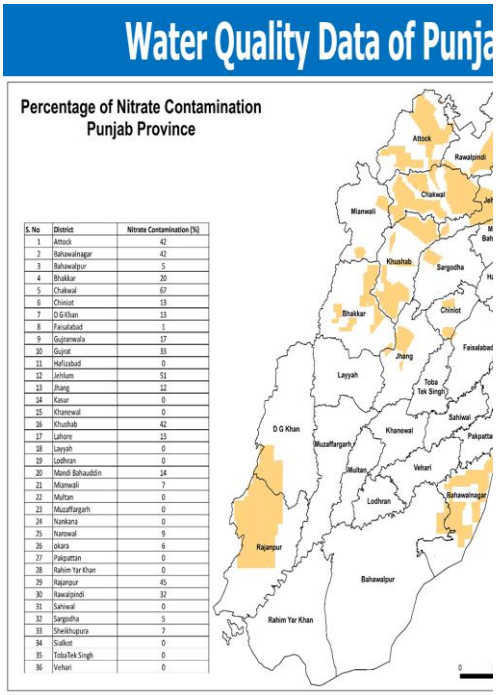
  (Singapore 143 LPCD, Paris 150 LPCD, New Delhi 130 LPCD)
- Average static water level of Rawalpindi is 250ft
- Water level decline / year is above 04 meter
- Water supply hours are just 2/day


Water Quality Data of Punjab
Percentage of TDS Contamination
Punjab Province
S. No | District | TDS Contamination (%)
1 Attock 2
2 Bahawalnagar 19
3 Bahawalpur 20
4 Bhakkar 6
5 Chakwal 10
6 Chiniot 2
7 D G Khan 32
8 Faisalabad 83
9 Gujranwala 4
10 Gujrat 4
11 Hafizabad 11
12 Jehlum 13
13 Jhang 13
14 Kasur 29
15 Khanewal 10
16 Khushab 62
17 Lahore 12
18 Layyah 49
19 Lodhran 32
20 Mandi Bahauddin 2
21 Mianwali 35
22 Multan 9
23 Muzaffargarh 29
24 Nankana 44
25 Narowal 0
26 okara 24
27 Pakpattan 3
28 Rahim Yar Khan 13
29 Rajanpur 49
30 Rawalpindi 13
31 Sahiwal 43
32 Sargodha 53
33 Sheikhupura 9
34 Sialkot 2
35 TobaTek Singh 42
36 Vehari 12
N
Legend
District Boundary
TDS Contamination
1 cm = 25 km

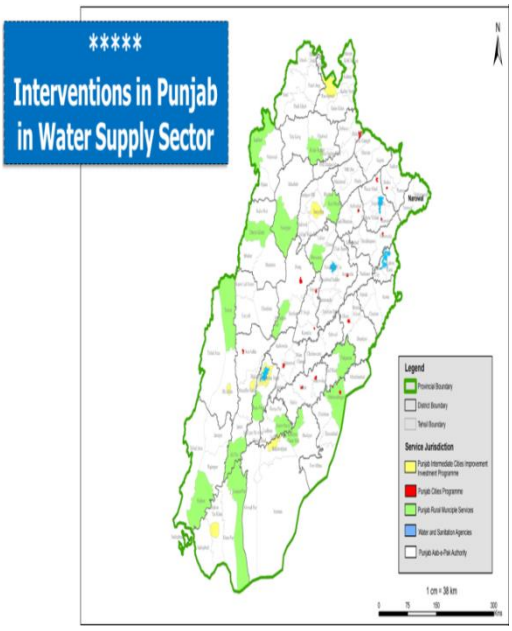

Water Quality Data of Punjab
Percentage of Arsenic Contamination
Punjab Province
S. No | District | Arsenic Contamination (%)
1 Attock 59
2 Bahawalnagar 1
3 Bahawalpur 23
4 Bhakkar 6
5 Chakwal 64
6 Chiniot 0
7 D G Khan 4
8 Faisalabad 0
9 Gujranwala 43
10 Gujrat 27
11 Hafizabad 68
12 Jehlum 81
13 Jhang 0
14 Kasur 5
15 Khanewal 0
16 Khushab 62
17 Lahore 1
18 Layyah 0
19 Lodhran 53
20 Mandi Bahauddin 32
21 Mianwali 34
22 Multan 2
23 Muzaffargarh 1
24 Nankana 2
25 Narowal 9
26 okara 3
27 Pakpattan 0
28 Rahim Yar Khan 14
29 Rajanpur 13
30 Rawalpindi 61
31 Sahiwal 0
32 Sargodha 44
33 Sheikhupura 42
34 Sialkot 5
35 TobaTek Singh 0
36 Vehari 9
Legend
1 cm = 25 km

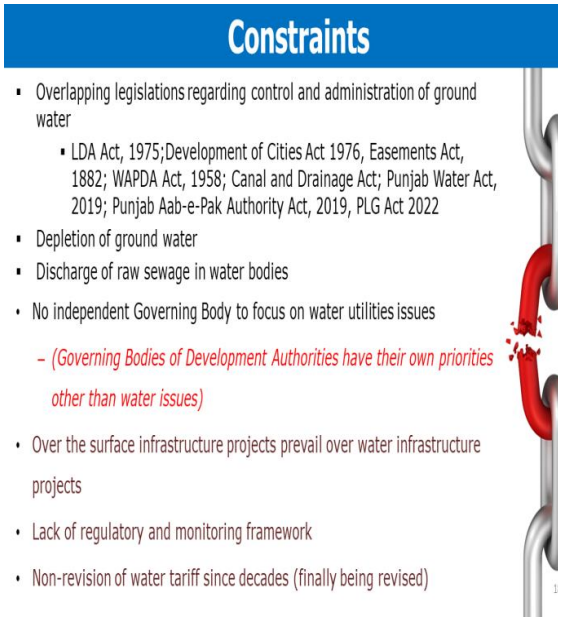


S. No	District	Flouride Contamination (%)
1	Attock	1
2	Bahawalnagar	3
3	Bahawalpur	12
4	Bhakkar	71
5	Chakwal	6
6	Chiniot	8
7	D G Khan	18
8	Faisalabad	25
9	Gujranwala	5
10	Gujrat	0
11	Hafizabad	8
12	Jehlum	0
13	Jhang	2
14	Kasur	0
15	Khanewal	5
16	Khushab	60
17	Lahore	0
18	Layyah	7
19	Lodhran	18
20	Mandi Bahauddin	10
21	Mianwali	34
22	Multan	5
23	Muzaffargarh	11
24	Nankana	0
25	Narowal	0
26	okara	0
27	Pakpattan	0
28	Rahim Yar Khan	9
29	Rajanpur	1
30	Rawalpindi	3
31	Sahiwal	0
32	Sargodha	76
33	Sheikhupura	3
34	Sialkot	3
35	TobaTek Singh	0
36	Vehari	0



S. No	District	Nitrate Contamination (%)
1	Attock	42
2	Bahawalnagar	42
3	Bahawalpur	5
4	Bhakkar	20
5	Chakwal	67
6	Chiniot	13
7	D G Khan	13
8	Faisalabad	1
9	Gujranwala	17
10	Gujrat	33
11	Hafizabad	0
12	Jehlum	51
13	Jhang	12
14	Kasur	0
15	Khanewal	0
16	Khushab	42
17	Lahore	13
18	Layyah	0
19	Lodhran	0
20	Mandi Bahauddin	14
21	Mianwali	7
22	Multan	0
23	Muzaffargarh	0
24	Nankana	0
25	Narowal	9
26	okara	6
27	Pakpattan	0
28	Rahim Yar Khan	0
29	Rajanpur	45
30	Rawalpindi	32
31	Sahiwal	0
32	Sargodha	5
33	Sheikhupura	7
34	Sialkot	0
35	TobaTek Singh	0
36	Vehari	0





Let us Work to Change the Scenario

- Pakistan well endowed with water
  - Only 16 countries have more water than Pakistan
  - But Pakistan is world's 6th most populous country
- Water availability per capita is low
  - Fewer than 10% of global population has lesser water per capita than Pakistan
  - 32 countries have less water per capita than Pakistan
  - Only 6(all African) out of 32 are poorer than Pakistan

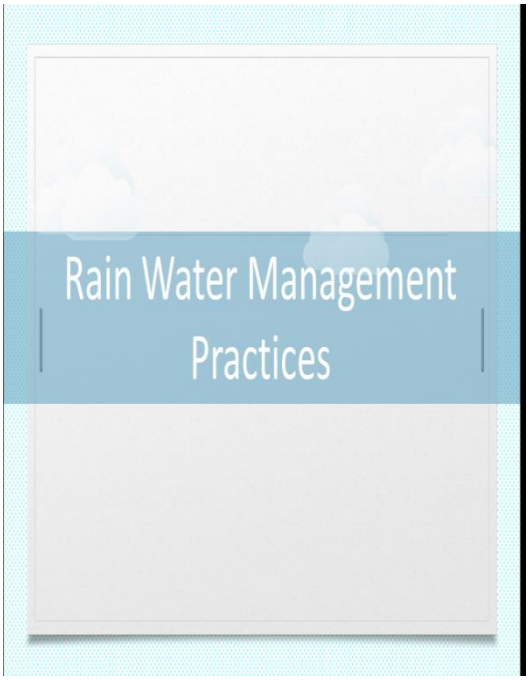
Way Forward

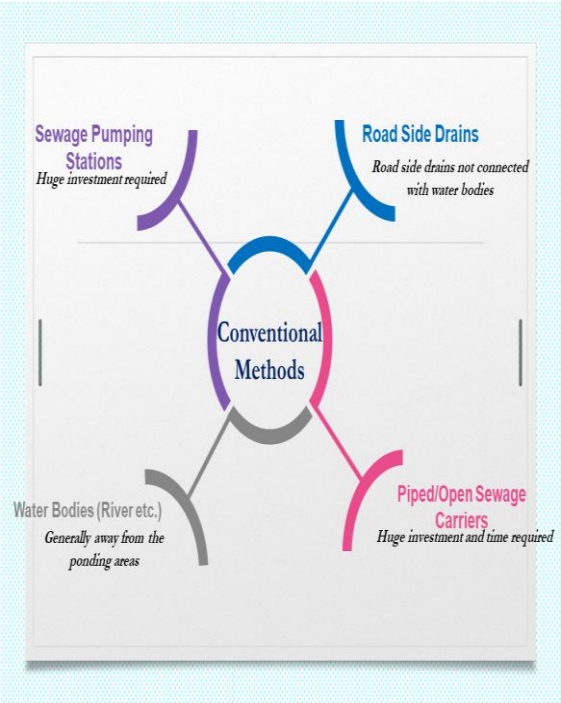
Let us Work to Change the Scenario

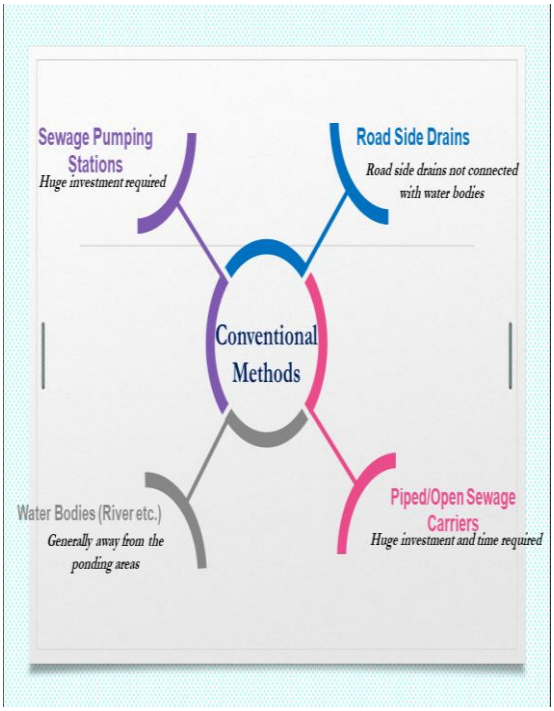
- Therefore, water security can be achieved by:
  - Population control
  - Rapid development and management of water resources
  - Efficient use of water
    - Efficient irrigation with value crops
    - Distribution network improvement
    - Strategic planning
  - Clarity of legal / regulatory framework
  - Public Awareness

THANKS

Annexure D:Presentation 2 Rain Water Management




Sewage Pumping Stations
Huge investment required
Road Side Drains
Road side drains not connected with water bodies
Conventional Methods
Water Bodies (River etc.)
Generally away from the ponding areas
Piped/Open Sewage Carriers
Huge investment and time required


Sewage Pumping Stations
Huge investment required
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Road side drains not connected with water bodies
Conventional Methods
Water Bodies (River etc.)
Generally away from the ponding areas
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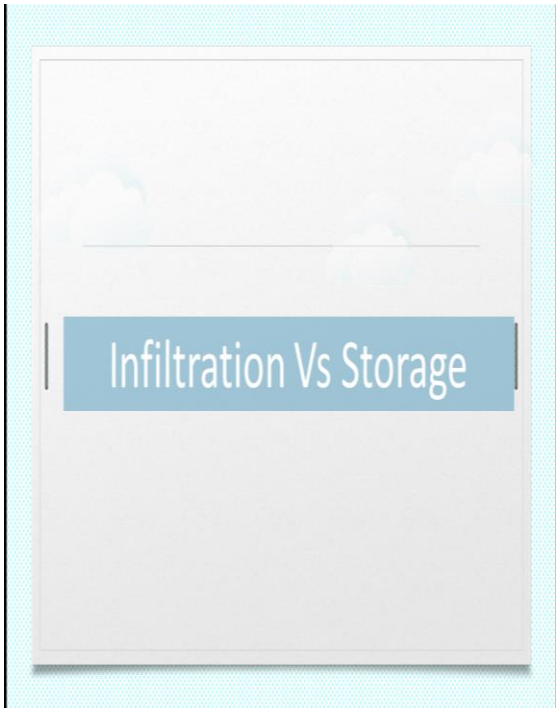
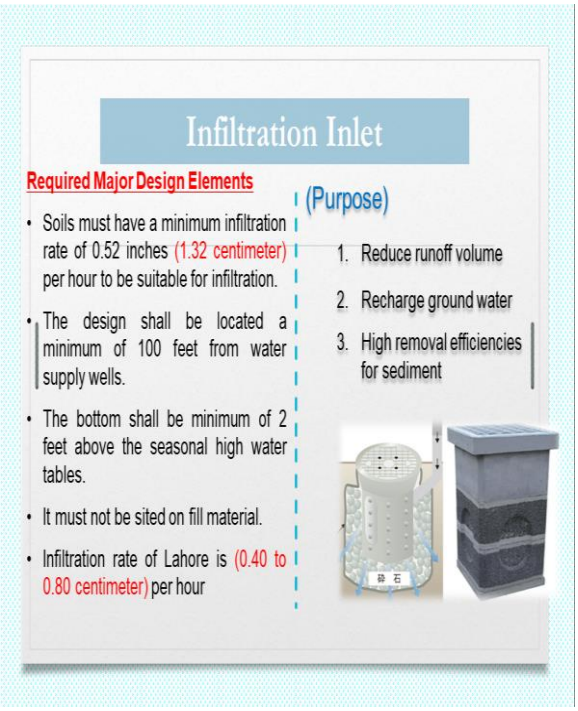
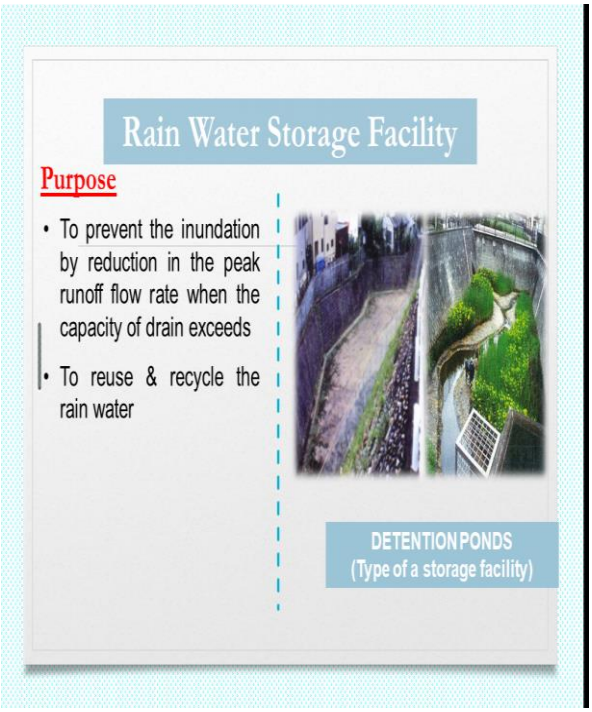
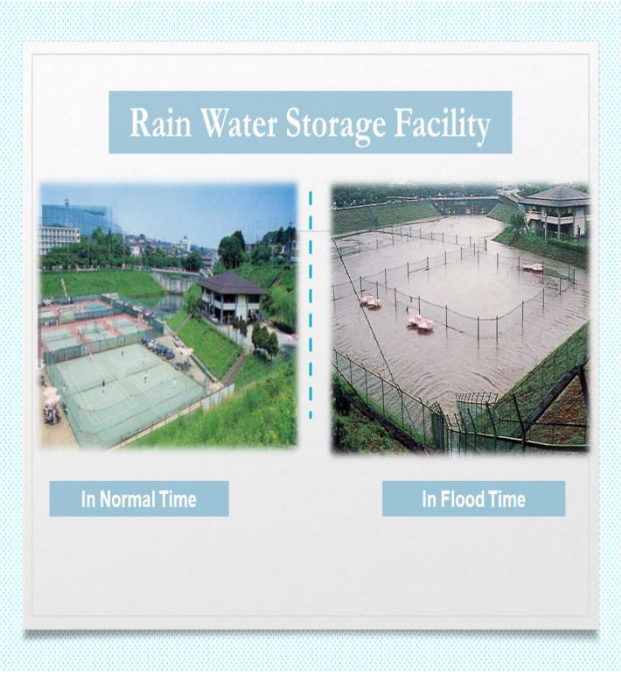
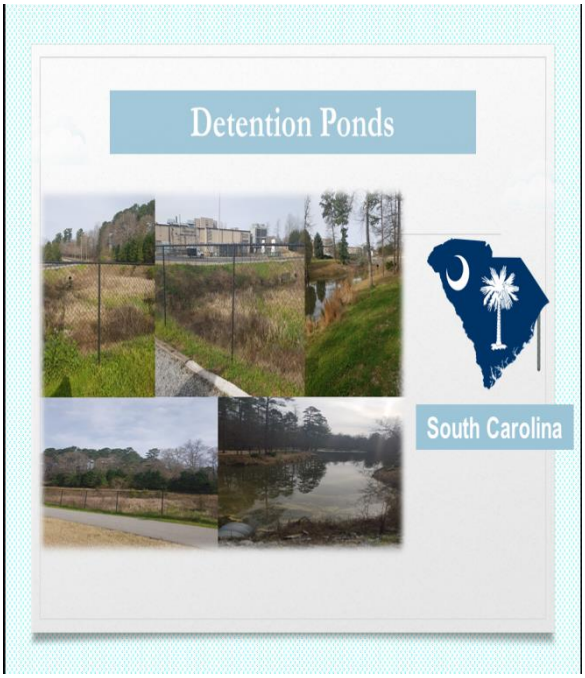
Huge investment and time required


Infiltration Vs Storage

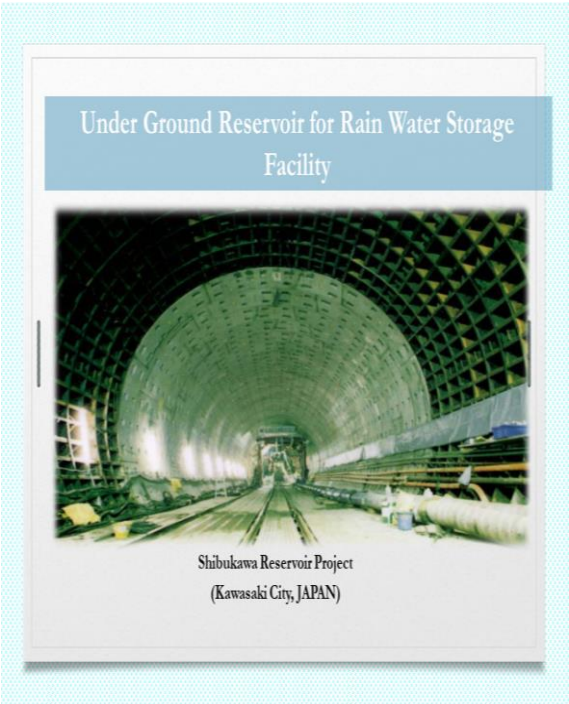

Infiltration Inlet
Required Major Design Elements
Soils must have a minimum infiltration rate of 0.52 inches (1.32 centimeter) per hour to be suitable for infiltration.
The design shall be located a minimum of 100 feet from water supply wells.
The bottom shall be minimum of 2 feet above the seasonal high water tables.
It must not be sited on fill material.
Infiltration rate of Lahore is (0.40 to 0.80 centimeter) per hour
(Purpose)
1. Reduce runoff volume
2. Recharge ground water
3. High removal efficiencies for sediment

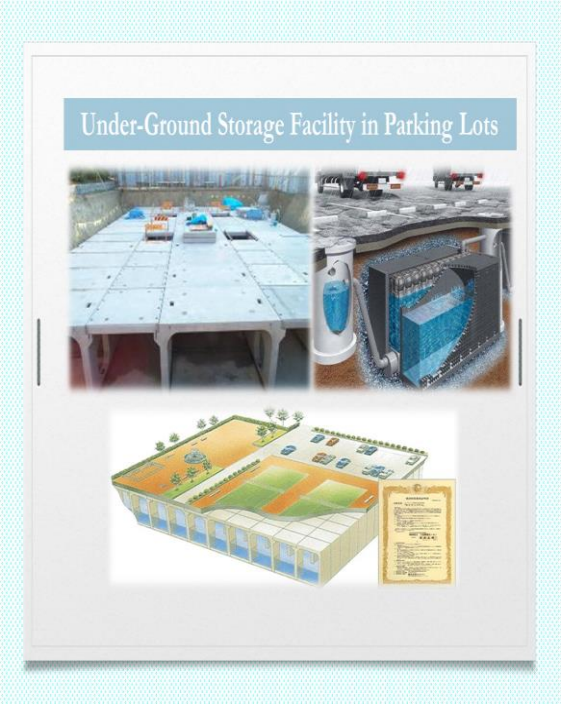

Rain Water Storage Facility
Purpose
To prevent the inundation by reduction in the peak runoff flow rate when the capacity of drain exceeds
To reuse & recycle the rain water
DETENTION PONDS
(Type of a storage facility)


Rain Water Storage Facility
In Normal Time
In Flood Time

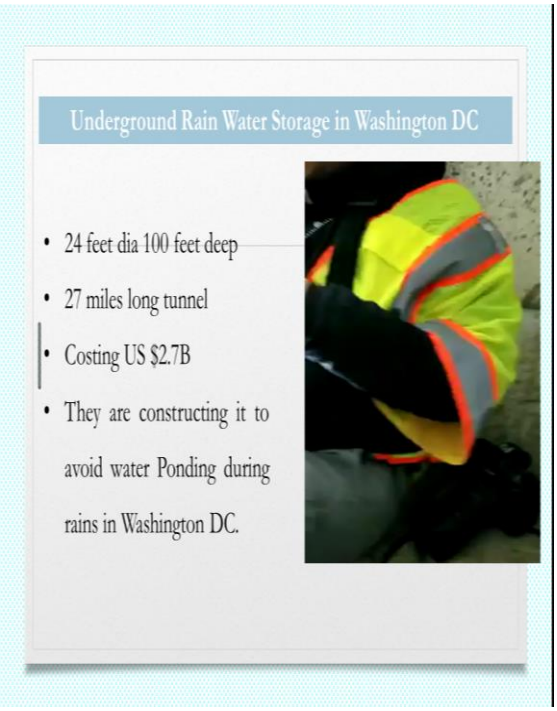

Detention Ponds
South Carolina

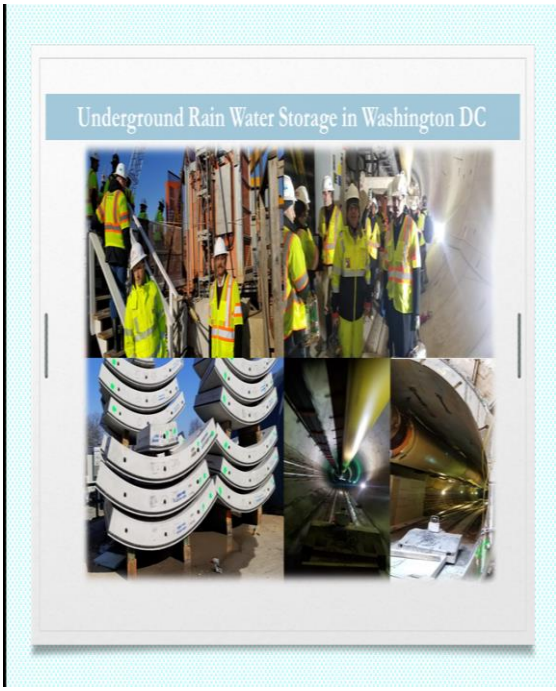

Rain Water Storage Facility
Drain
Rain Water Storage Pipe
RAINWATER STORAGE PIPE FACILITY

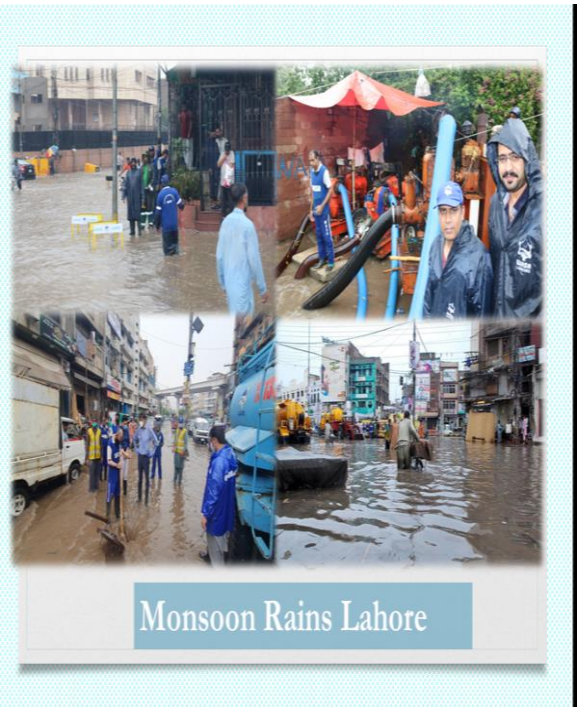

Under Ground Reservoir for Rain Water Storage Facility
Shibukawa Reservoir Project
(Kawasaki City, JAPAN)

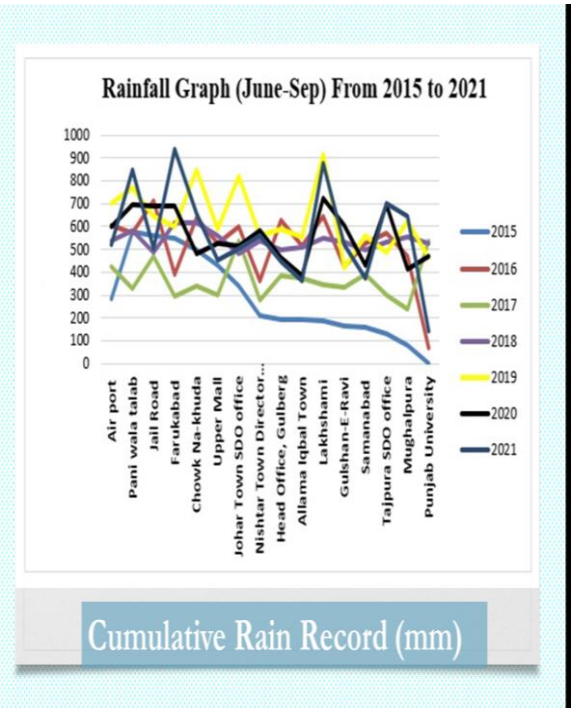

Under-Ground Storage Facility in Parking Lots


Rain Water Storage Facility (Underground Storage)
School Ground
Sports Ground
Parks Area
Car Parking Area

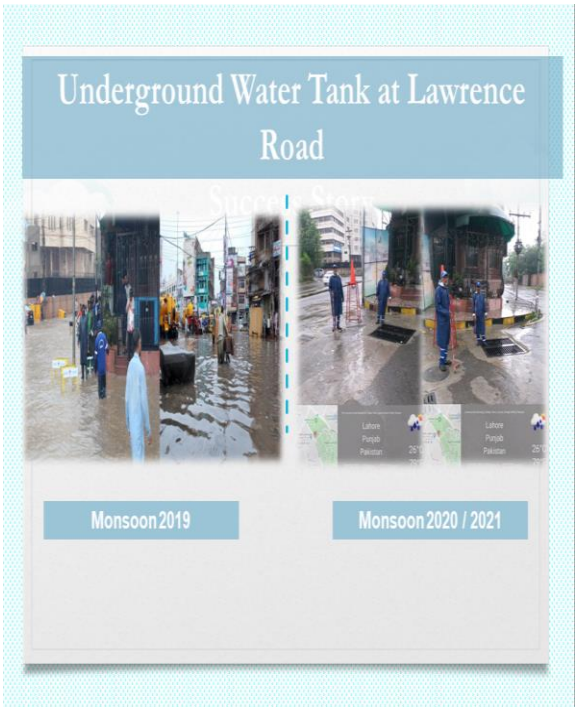

Underground Rain Water Storage in Washington DC
• 24 feet dia 100 feet deep
• 27 miles long tunnel
• Costing US $2.7B
• They are constructing it to avoid water Ponding during rains in Washington DC.

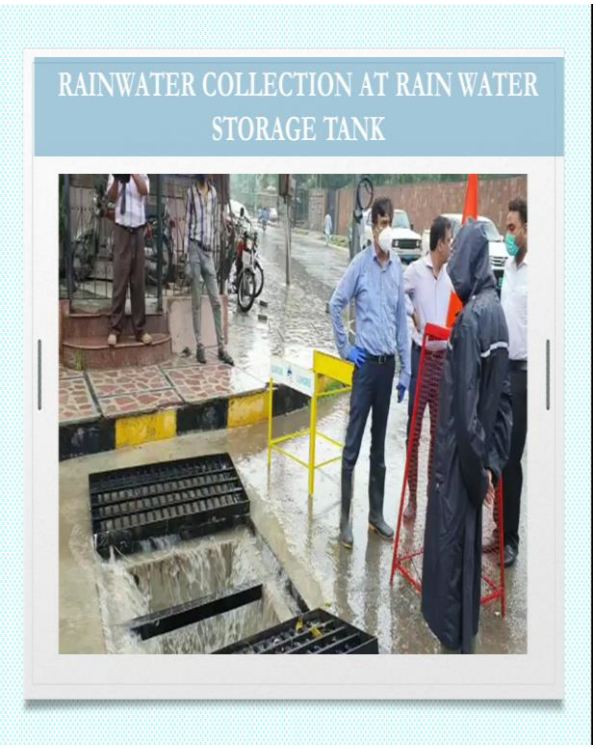

Underground Rain Water Storage in Washington DC

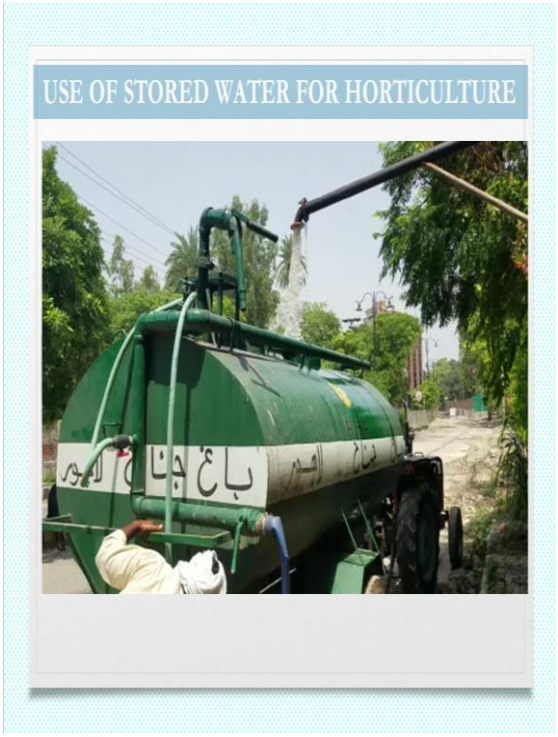

Monsoon Rains Lahore


Rainfall Graph (June-Sep) From 2015 to 2021
1000
900
800
700
600
500
400
300
200
100
0
Air port
Pani wala talab
Jail Road
Farukabad
Chowk Na-khuda
Upper Mall
Johar Town SDO office
Nishtar Town Director...
Head Office, Gulberg
Allama Iqbal Town
Lakhshami
Gulshan-E-Ravi
Samanabad
Tajpura SDO office
Mughalpura
Punjab University
2015
2016
2017
2018
2019
2020
2021
Cumulative Rain Record (mm)


ACHIEVEMENTS
UNDERGROUND WATER TANK AT LAWRENCE ROAD, LAHORE
• Catchment area = 30-Acres
• Ponding area = 03-Acres
• U/G water tank capacity = 1.4 MG
• Zero ponding during recent monsoon
• Control on Urban Flooding
• Rain-water used for horticulture purpose
Functional and Water Being Re-used for Horticulture
A SUCCESS STORY


Underground Water Tank at Lawrence Road
Monsoon 2019
Monsoon 2020 / 2021

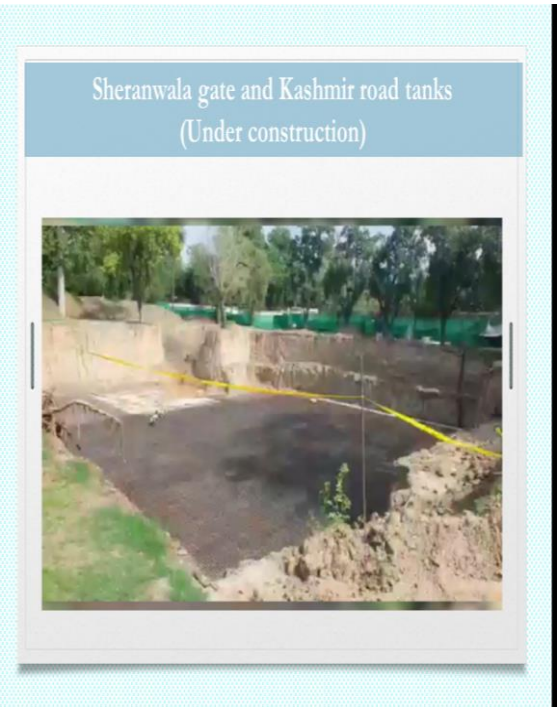

RAINWATER COLLECTION AT RAIN WATER STORAGE TANK


USE OF STORED WATER FOR HORTICULTURE

Current situation of Storage tank

Construction of rain water storage tanks (in progress)

Sr No.	Name	Date of Initiation	Timeline for completion	Budget (M)	Remarks
1	Rain Water management-Drainage arrangement for sore point at Sheranwala Gate, Lahore	18.06.21	9 months	197.610	Work in progress
2	Rain Water management-Drainage arrangment for sore point at Kashmir Road, Lahore	18.06.21	9 months	199.200	Work in progress
3	Rain Water Management – Drainage Arrangement for Sore Point at Qaddafi Stadium, Lahore (GoPb. Share 40%)	Principally approved on 23.04.21 , cost clearance and A.A awaited	1 year	653.213	NOC from Punjab Sports Board , PCSIR and irrigation Department awaited


Sheranwala gate and Kashmir road tanks
(Under construction)


Way Forward
SR. NO. LOCATION OF URBAN FLOODING / SORE POINT (MG)
1 Lawrence Road (1.4MG)
2 Sheranwala Gate (1.5MG)
3 Kashmir Road (1.5MG)
4 Qaddafi Stadium (approved) (4.0MG)
5 Karim Park Ravi Road (1.8MG)
6 Rasool Park (Shama Road) (1.5MG)
7 Railway Station Park (1.8MG)
8 Fruit and Vegetable Market (AIT)(1.5MG)
9 Waris Road (1.5MG)
10 Cooper Road (1.5MG)
11 Tajpura B-Block (3.2GM)
PROJECT COST PKR 2.3 BILLION
PLAN TO SAVE 21 MILLION GALLON OF WATER


Thanks

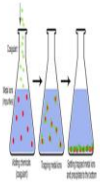
Annexure E:Presentation 1 Environmental & Social Considerations in WWTP Design, Construction and Operation

Environment & Social Considerations in WWTP Design, Construction and Operation

PUNJAB CITIES PROGRAM

1. Introduction




Water Pollution Prevention | Disease Prevention | Nutrient removal | Chemicals & Heavy Metals Removal | Groundwater Protection

1. Introduction

2. Environmental Considerations in Wastewater Treatment Plants-At Planning & Design Phase

01 **Site Selection** Considerations should include proximity to water bodies, Topography, soil condition, sensitive ecological areas, residential areas, and other environmentally sensitive locations

02 **Environmental Impact Assessment (EIA)** This assessment considers factors such as air quality, water quality, noise pollution, habitat disruption, and potential impacts on flora and fauna

03 **Treatment Process Selection** Technologies that minimize energy consumption, chemical usage, and waste generation should be preferred.

04 **Energy Efficiency and Renewable Energy**: This includes optimizing process layouts, considering natural ventilation and lighting, and exploring the potential for on-site renewable energy generation, such as solar or wind power

2. Environmental Considerations in Wastewater Treatment Plants-At Planning & Design Phase

05 **Odor and Noise Control:** Planning for effective odor control measures, such as enclosing process areas, implementing proper ventilation systems, and utilizing odor-neutralizing technologies, is important.

06 **Green Space and Landscape Design:** Incorporating native vegetation, green buffers, and creating wildlife habitats can help mitigate the visual impact and promote environmental sustainability.

07 **Water Reuse Opportunities:** Consideration should be given to potential water reuse opportunities during the planning and design phase.

08 **Community Engagement:** Engaging with local communities, stakeholders, and environmental organizations during the planning and design phase is essential.

3. Social Considerations in Wastewater Treatment Plants-At Planning & Design Phase

01 **Stakeholder Engagement:** Conducting public consultations, meetings, and information sessions can help ensure that the community's perspectives and needs are taken into account during the planning and design process.

02 **Health and Safety:** Designing the facility to minimize potential hazards, such as proper containment systems, safety barriers, and emergency response plans, is essential.

03 **Visual Impact and Aesthetics:** Design elements such as landscaping, architectural features, and appropriate site integration can help mitigate the visual impact and create a more aesthetically pleasing facility.

04 **Community Integration:** Considerations may include incorporating community spaces, providing educational opportunities, or integrating the facility into the overall urban or rural landscape.

3. Social Considerations in Wastewater Treatment Plants-At Planning & Design Phase

05 **Cultural and Heritage Preservation:** This involves understanding and respecting any cultural heritage or archaeological artifacts that may be present, and incorporating appropriate measures to protect and preserve them during construction and operation.

06 **Economic Opportunities:** During the planning and design phase, consideration should be given to maximizing local job creation, supporting local businesses, and promoting the use of local resources and services.

07 **Community Benefits:** Identifying and communicating the benefits that the wastewater treatment plant will bring to the community is crucial. This may include improved water quality, protection of public health, enhanced environmental conditions, and potential resource recovery.

08 **Land Acquisition:** Preferably state land, cases where land acquisition may impact local communities, it is important to engage in meaningful consultation and dialogue. Providing information about the project, addressing concerns, and incorporating community feedback can help build trust and minimize social conflicts related to land acquisition.

Overall Environmental & Social Aspects

Social Aspects	Environmental Aspects
• Land Entitlement	• Cutting of trees
• Resettlement	• Water Resources
• Displacement	• Natural Hazards
• Structures losses	• Buffer Zone for tree plantation and avoidance of odor
• Livelihoods impact	
• Type of land and existing uses	• Environmental Approvals and Regulations
• Data verification of ownership of land	• Ecological Sensitivity
• Community Acceptance and Engagement	• Hydrogeology
• Cultural and Historical Considerations	• Soil Conditions
• Economic Opportunities	• Ecology and Biodiversity
• Closeness to Residential Areas	
• Accessibility and Infrastructure	

4. Considerations of Site Alternatives

01 **Geographic Considerations** : The proximity of the site to the source of wastewater, such as residential areas or industrial zones, is crucial.

02 **Environmental Impact:**. Factors like topography, soil conditions, hydrology, and the presence of sensitive ecosystems or protected areas should be considered

03 **Regulatory Compliance:** The site must adhere to zoning restrictions, land-use policies, and environmental regulations governing wastewater treatment facilities.

04 **Infrastructure Availability:** The availability of necessary infrastructure, such as power supply, water supply, and transportation networks, should be considered.

05 **Community and Public** Perception. Public opinion and community acceptance play a crucial role in the selection of a site

5. World Bank Guidelines for Construction of WWTP under PCP

- (a) Conflict-free land and should be owned by MCs or the provincial government (further transferred to MCs) and should be available at technically feasible location preferably near the discharge point/pumping stations of the drain.
- (b) Simplest wastewater treatment technology with least operational cost should be selected after alternative analyses, for example, OPs or WSPs.
- (c) ESIA should be done as per the requirements of PEPA 2012, and accordingly, NOC should be obtained from PEPA before execution of project.
- (d) Capacity of wastewater treatment of 50,000 m3/day has been established based on present and projected population of cities for the next 20 years, average water consumption per person per day, wastewater discharges per day, and pollution load of wastewater.
- (e) Effluent from wastewater treatment should comply with the PEQS established under PEPA 2012 and WHO/FAO guidelines for reuse.

6. Design Aspects of WWTP

1. Gravitational Flow
2. Baseline of design (Flow, BOD, Temperature, Water Table, Geo Investigations)
3. Water Reuse Considerations
4. Monitoring laboratory for sustainability of project
5. Emergency Disaster Management Considerations
6. Considerations for Natural Hazards (flood, earthquake etc.)
7. Downstream Impacts
8. O&M Cost-Economic Viability

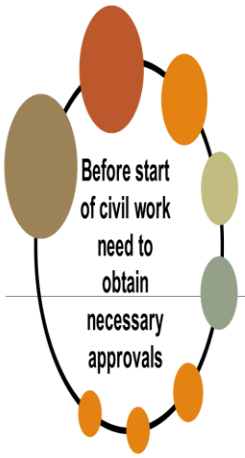
7. Policy and Regulatory Framework

Punjab Environment Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations 2022
Schedule II (F3) requires EIA

F. Water supply, Sewerage System and treatment

1. Water supply schemes and treatment plants (excluding the Reverse Osmosis, Ultra filtration and such like) with total cost more than Rs. 50 million
2. Wastewater channels / Sewerage System Schemes
3. Combined Wastewater Treatment Plants with treatment capacity greater than 100m³/hr

8. Necessary Approvals



01 Preparation of ESIA

02 Environmental Approval from Punjab EPA

03 Clearance from World Bank

9.E&S Considerations During Construction Phase

Project Activity	Potential Impacts	Proposed Mitigation measures
• Site clearing and preparation Fueling and operation of heavy machinery transport vehicles • Storage and handling of chemicals • Storage, handling and disposal of construction waste • Generation of sanitary effluent	• Soil • compaction • Soil • contamination through spills and leaks • Soil contamination through spills and leaks	• Demarcation of routes for movement of heavy vehicles. • Stripping and placing soils when dry, and not when wet. • Preparation of guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals. • Storage areas for oil, fuel and chemicals to be surrounded by bunds or other containment devices to prevent any spilled oil, fuel or chemicals from contaminating soils, water or groundwater. • Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce. • Septic tank and soak pit will be provided to treat domestic waste water.

9.E&S Considerations During Construction Phase

Project Activity	Potential Impacts	Proposed Mitigation measures
• Operation of heavy machinery and transport vehicles • C&D waste management	• Exhaust Emissions • Dust	• Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NOx, PM10 and SO2; • During construction, the approach road will be regularly maintained to keep it clean, free from mud and slurry. The approach road will be properly shaped and compacted by rolling to an even and uniform surface to receive pavement. Totally enclose any skips for material transport with impervious sheeting; and • No waste will be burnt on or around the Project site.
• General construction activities	• Health and safety of construction workforce	• Personal Protective Equipment (PPE) shall be worn at all times on the Site. • If labor will be working in the hazard prone areas, then the contractor needs to ensure proper outfit and PPEs. • Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order;

9.E&S Considerations During Construction Phase

Project Activity	Potential Impacts	Proposed Mitigation measures
Influx of construction workers Road transportation	Community Health and Safety	• Barriers will be provided to prevent ingress of persons into the construction site and also to protect the public from exposure to hazards associated with the construction activities; Screening, surveillance and treatment of workers, through the provision of medical facilities and, where required, immunization programmed; Undertaking health awareness and education initiatives among workers; • Avoiding collection of stagnant water; • Road safety awareness building for residents living along the transportation route

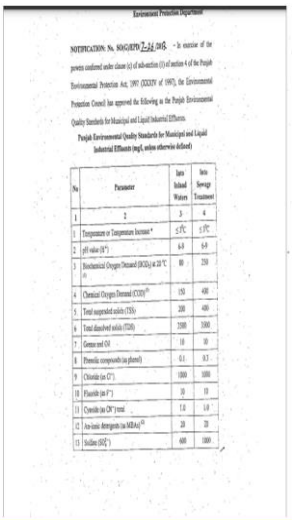
9.E&S Considerations During Operational Phase

Project Activity	Potential Impacts	Proposed Mitigation measures
Re-use and discharge of Treated water into surface water body	Ecological and health hazards	▪ WWTP facility shall ensure BOD, temperature, flow and other parameters monitoring at entry point (influent) to the last exit (effluent) after treatment through anaerobic ponds, facultative ponds and through bioremediation by introducing floating wetlands. ▪ Sludge dry beds will be used to prepare the compost for further selling to the local farmers which will be a source of revenue generation for the MC. ▪ After disinfection and chlorination and helminths and pathogens removal, treated water will be reused for irrigation purposes and during monsoon or no irrigation usage seasons, treated water shall be pumped through watercourse to the nearest canal which is 4-5km away from the WWTP. ▪ For discharge of treated water into surface water body, PEQSs shall be strictly followed (Attached as Annexure B) ▪ As Pakistan has no Guidelines/Standards for treated water re-use, so WHO, FAO and USEPA Guidelines and Standards (attached as Annexure L) shall be used to ensure the environmental and ecological safety

9.E&S Considerations During Operational Phase

Project Activity	Potential Impacts	Proposed Mitigation measures
▪ Monitoring of overall performance of WWTP	• Lab analysis of all parameters • All inlet and outlets flow data management • Data management of the reuse of treated water by community people around	• A specialized lab will always onboard for the analysis of treated water parameters and to ensure its availability to reuse or mixing with water channel will be safe • There will be the hiring of a skilled team for the management of WWTP throughout the sub-project working span. • Management of all related data of WWTP plant working efficiency, flow rate and characteristics of inlet and flow rate and characteristic of outlets, species of plants used for the floating wetland purpose will be assured. • There will be proper maintenance of all machinery and equipment's used during the operation phase. • Regular analysis report of the structure of WWTP will be made to assure that compatibility of structure and to avoid any accident like seepage or any other contact of highly contaminated water present in ponds with other resources.

10. PEQs Municipal and Liquid Industrial Effluents

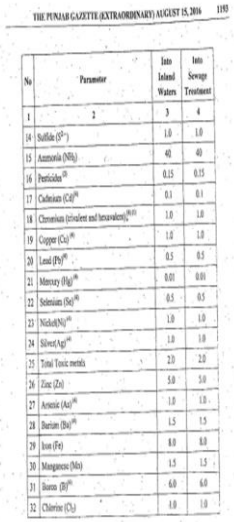


Environment Protection Department

NOTIFICATION No. SO(EPD)Z-24/2015. - In exercise of the powers conferred under clause (c) of sub-section (1) of section 6 of the Punjab Environmental Protection Act, 1997 (XXXIV of 1997), the Environmental Protection Council has approved the following as the Punjab Environmental Quality Standards for Municipal and Liquid Industrial Effluents.

Punjab Environmental Quality Standards for Municipal and Liquid Industrial Effluents (mg/L, unless otherwise defined)

No	Parameter	Into Inland Waters	Into Sewage Treatment
1	2	3	4
1	Temperature or Temperature Increase *	≤ 3°C	≤ 3°C
2	pH value (h*)	6-9	6-9
3	Biochemical Oxygen Demand (BOD5) at 20 °C **	80	250
4	Chemical Oxygen Demand (COD)**	150	400
5	Total suspended solids (TSS)	200	400
6	Total dissolved solids (TDS)	2500	3000
7	Grease and Oil	10	10
8	Phenolic compounds (as phenol)	0.1	0.3
9	Chloride (as Cl-)	1000	1000
10	Fluoride (as F-)	10	10
11	Cyanide (as CN-) total	1.0	1.0
12	Anionic detergents (as MBAS)**	20	20
13	Sulfides (S2-)	600	1000



THE PUNJAB GAZETTE (EXTRAORDINARY) AUGUST 15, 2016 1193

No	Parameter	Into Inland Waters	Into Sewage Treatment
1	2	3	4
14	Sulfide (S^{2-})	1.0	1.0
15	Ammonia (NH_3)	40	40
16	Pesticides[3]	0.15	0.15
17	Cadmium (Cd)[4]	0.1	0.1
18	Chromium (trivalent and hexavalent)[4],[5]	1.0	1.0
19	Copper (Cu)[4]	1.0	1.0
20	Lead (Pb)[4]	0.5	0.5
21	Mercury (Hg)[4]	0.01	0.01
22	Selenium (Se)[4]	0.5	0.5
23	Nickel(Ni)[4]	1.0	1.0
24	Silver(Ag)[4]	1.0	1.0
25	Total Toxic metals	2.0	2.0
26	Zinc (Zn)	5.0	5.0
27	Arsenic (As)[4]	1.0	1.0
28	Barium (Ba)[4]	1.5	1.5
29	Iron (Fe)	8.0	8.0
30	Manganese (Mn)	1.5	1.5
31	Boron (B)[4]	6.0	6.0
32	Chlorine (Cl_2)	1.0	1.0

11. US EPA (2012) suggested regulatory guidelines for irrigation wastewater reuse

Reuse Category	Treatment	Water Quality	Monitoring	Setback Distances
Unrestricted Urban Reuse	Secondary + Filtration + Disinfection	pH 6.0–9.0 BOD_5 10 mg/L Turbidity 2 NTU Fecal coliform 0/100 mL Cl_2 residual 1.0 mg/L (min)	pH weekly BOD_5 weekly Turbidity continuous Fecal coliform daily Cl_2 residual continuous	15 m from potable water supply wells
Restricted Urban Reuse	Secondary + Disinfection	pH 6.0–9.0 BOD_5 30 mg/L TSS 30 mg/L Fecal coliform 200/100 mL Cl_2 residual 1.0 mg/L (min)	pH weekly BOD_5 weekly TSS daily Fecal coliform daily Cl_2 residual continuous	90 m from potable water supply wells 30 m to public access areas
Agriculture Food Crops	Secondary + Filtration + Disinfection	pH 6.0–9.0 BOD_5 30 mg/L TSS 30 mg/L Fecal coliform 0/100 mL Cl_2 residual 1.0 mg/L (min)	pH weekly BOD_5 weekly Turbidity continuous Fecal coliform daily Cl_2 residual continuous	15 m from potable water supply wells
Agriculture Processed Food Crops Non-Food Crops	Secondary + Disinfection	pH 6.0–9.0 BOD_5 30 mg/L TSS 30 mg/L Fecal coliform 200/100 mL Cl_2 residual 1.0 mg/L (min)	pH weekly BOD_5 weekly TSS daily Fecal coliform daily Cl_2 residual continuous	90 m from potable water supply wells 30 m to public access areas

THANK YOU

Annexure F:Presentation 3 Wastewater Treatment and Its reuse

WASTEWATER TREATMENT AND ITS REUSE

Main constituents of wastewater

Wastewater by weight – is 99.9% water – it is the 0.1% that we have to remove	
That 0.1% contains	1. Organic matter (Carbon based compounds from humans, animals and plants)
	2. Microorganisms (a few of which are pathogenic)
	3. Inorganic compounds (metals, minerals and salts etc)

- The most important key player in Wastewater Treatment are Microbes which are the prime movers in the biogeochemical cycles of oxygen, carbon and nitrogen. ..

Wastewater Treatment processes

Treatment Processes mostly adopted:

- WSP
- Aerated Lagoons
- Conventional activated sludge
- Trickling filters

Activated sludge variants

- Oxidation ditches
- Extended Aeration
- Sequential Batch reactors(SBR)
- (MBBR) Moving Bed Biofilm Reactor (Dual Process)
- Integrated fixed film activated sludge (IFAS)

Additional Technologies used for reuse of wastewater

Main Technologies

- (MBR) Membrane Biofilm Reactor
- Reverse Osmosis(RO)
- Ultraviolet (UV) Disinfection
- **Additional Technologies** (according to the constituents in wastewater)
- Activated carbon filtration
- Sand filtration
- Ozonation
- Coagulation/Flocculation


TYPICAL FLOWSHEET OF A WWTP
RAW WASTEWATER
SCREENING
GRIT OIL AND GREASE REMOVAL
PRIMARY SEDIMENTATION
BIOLOGICAL REACTOR
SECONDARY SEDIMENTATION
TREATED WASTEWATER
Coarse solids
Grit, sand and gravel oils and grease
Primary sludge
Recirculated sludge
Excess sludge
PRELIMINARY TREATMENT
PRIMARY TREATMENT
SECONDARY TREATMENT
TERTIARY TREATMENT

The main effluent quality standards

Parameter	PEQS (mg/l)	Indian Standards	EU	US EPA
PH	06-09	5.5-9.0		
BOD5	80	10	25	≤30 mg/l
COD	150	50	125	
TSS	200	20	35	≤ 30 mg/l TSS
TN[mg/l]	-	10	10-15	
Fecal Coliform [MPN/100ml]	-	<230		≤ 200

PEQS: Assuming minimum dilution of 1:10 on discharge. Lower ratio would attract progressively stringent standards to be determined by the Environmental Protection Agency

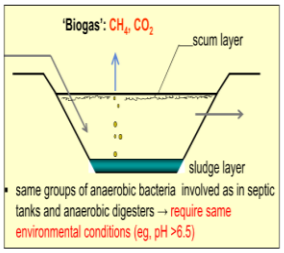
WASTE STABILIZATION PONDS

- **Entirely natural processes** involving both **algae and bacteria.**
- Since these processes are unaided by wastewater treatment engineers the rate of oxidation is slower, and as a result hydraulic retention times are longer.
- **Three types: Anaerobic ponds, Facultative ponds and Maturation ponds**
- **Anaerobic and facultative ponds are designed for BOD removal,**
- **while maturation ponds are designed for pathogen removal.**

Anaerobic pond

(No oxygen involved)

They are **2–5 m deep** and contain **no dissolved oxygen and no algae**



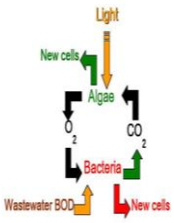
- same groups of anaerobic bacteria involved as in septic tanks and anaerobic digesters → require same environmental conditions (eg, pH >6.5)

- **They function much like open septic tanks, and their primary function is BOD**
- **BOD_5 removal is achieved by sedimentation of solids, and subsequent anaerobic digestion of the resulting sludge.**
- A short retention time **(1.0 day)** is commonly used.
- The overall process can be described by the chemical reaction, where **organic material such as glucose is biochemically digested into carbon dioxide (CO2) and methane (CH4) by the anaerobic microorganisms.**

$C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH_4$

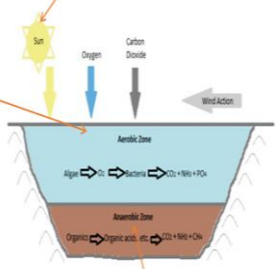
"Domestic Wastewater Treatment in Developing Countries" 2003 by Duncan Mara

Facultative ponds



- **Algae use carbon dioxide in the presence of sunlight.**
- **Oxygen released as a byproduct of photosynthesis is used by the bacteria that stabilize the suspended organic material in wastewater.**

Sunlight is the driving force for photosynthesis and the production of oxygen in a pond.



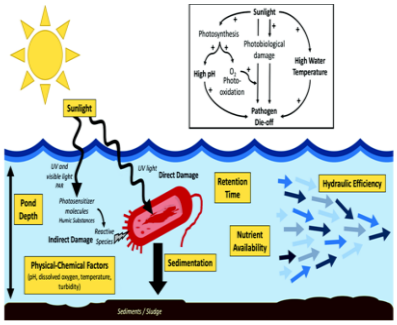
Aerobic zone, an area at the surface of the pond with available free-oxygen

Depths are usually in the range 1–1.8 m, with 1.5 m being the most commonly used.

Retention time in pond series: depends on climate (temperature), but in general ~5–50 days

Anaerobic zone, which is a lower depth area with no available free oxygen.

Maturation Ponds



- Main objective to remove FC.
- **The UV portion of sunlight directly damages pathogen genomes.**
- In order to ensure the sunlight penetration in maturation ponds these are kept about 1 m deep.
- **Most bacterial pathogens are vulnerable to high pH. At peak algae activity, the pH of water can rise to above 9, leading to Fecal Coliform (FC) inactivation** and promoting ammonia volatilization(ammonia gas).

Advantages and Disadvantages of WSP

ADVANTAGES	DISADVANTAGES
Reduced construction and operation cost	High land requirement
No mechanical equipment required therefore no energy requirement	Difficulty in satisfying restrictive discharge standards
Satisfactory BOD removal efficiency	Variable performance with climatic conditions
Simple construction operation and maintenance	Possible insect growth
Satisfactory resistance to load variations	Possible need for removing algae from effluent to comply with stringent discharge standards

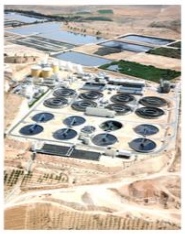
Von Sperling: Biological wastewater treatment in warm climate regions.2005 chapter-4

WSP maintenance is mistakenly interpreted

- **The simplicity of routine WSP maintenance is sometimes mistakenly interpreted as "low maintenance equals no maintenance".**
- As a result, routine preventive maintenance is often not done, or not done correctly, and the WSPs are "maintained" only when a serious problem has developed – for example,
- odour, mosquito breeding,
- excessive sludge accumulation in anaerobic ponds,
- or excessive vegetation growth in facultative ponds and maturation ponds

As a rough guide one full-time operator is required at WSPs receiving wastewater flows up to about 1,000 m3/d(0.4 Cusec), two operators for wastewaters flows up to about 2,500 m3/d(1.0 cusec) and pro rata for higher flows (Arthur, 1983).
Duncan Mara

Once Largest WSP plants converted to Activated Sludge process



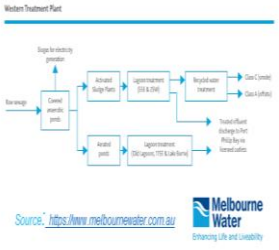
As-Samra WWTP Jordan:

Previously 2nd largest WSP is now completely converted to Activated Sludge Plant

https://www.suezwaterhandbook.com/.../As-Samra-wastewater-treatment-plant-Jordan

Western Treatment Plant Werribee Melbourne

- Previously largest WSP was Werribee Western Treatment Plant Melbourne that has been converted to Activated Sludge and Aerated lagoon process.
- Anaerobic ponds are now used as primary treatment and Facultative ponds converted to aerated lagoons.



Source: https://www.melbournewater.com.au

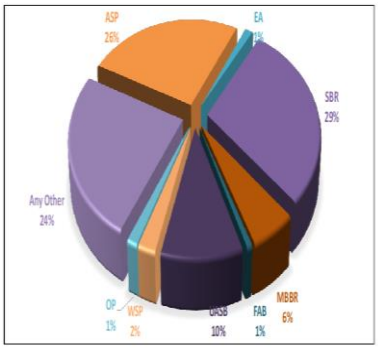
CURRENTLY KNOWN LARGEST WSP PLANTS IN THE WORLD

Name	Flow MGD	Land (acres)	Acres/MGD	Remarks
Dandora, Nairobi	26	741	21	In operation Land available for phase III (total will **be 33 if extended).**
Faisalabad	20	383	19.15	In operation but poor maintenance

WSP IN EUROPE:

- The European countries like **Germany** has more than 2000 operational systems and **France** about 2500 plants.
- **Spain** has more than 10 operational plants and in **Denmark** there are 50 ponds for tertiary treatment.
- A survey found that WSP are particularly appropriate for full treatment from small communities (less than 5000 population equivalent) **(about 0.5 cusec with our water consumption.** https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1747-6593.1992.tb00708.x

Indian scenario of wastewater treatment



Total Capacity of Activated sludge plus its variants is=63%
Total Capacity of WSP plus oxidation ponds is=3%
4951 MGD with 783 As and its variants
257.6 MGD with 97 WSP or OP (average capacity 2.6MGD)
Source: Central pollution Control Board 2021

Maximum Capacity Of WSP in Nearing Indian States Having Similar Climate Like Pakistan

State	Biggest WSP capacity	Total Plants
Punjab	14000 m3/day (3MGD)	16 plants
RAJASTAN	24000m3/day (5.3MGD)	11 plants
UP	18000m3/day (4MGD)	13 plants

So overall no WSP is bigger than 5.3MGD **(10 cusec)** capacity

Source: Central pollution Control Board 2021

AERATED LAGOONS

- It is similar to a facultative pond but mechanical aerators are used.
- Detention time **is 5-10 days**
- **Usually 2.5-4 meters deep**
- The aerators more frequently used for aerated lagoons are the mechanical vertical-shaft high-speed floating aerators.
- **Requires frequent desludging**

Von Sperling: Biological wastewater treatment in warm climate regions 2005

Advantages & Disadvantages of AL

Advantages

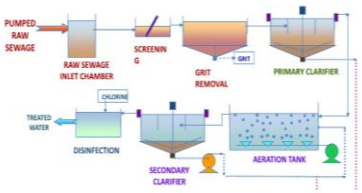
- Lower land requirements than WSP
- Satisfactory resistance to load variations
- Reduced possibilities of bad odours

Disadvantages:

- Land requirements still high
- Relatively high energy requirements
- Low coliform removal efficiency
- Need for periodic (some years interval) removal of sludge from aerated pond

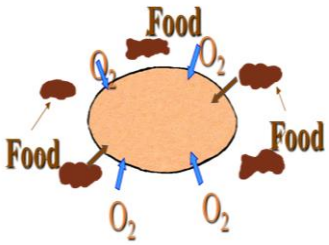
Von Sperling: Biological wastewater treatment in warm climate regions.2005

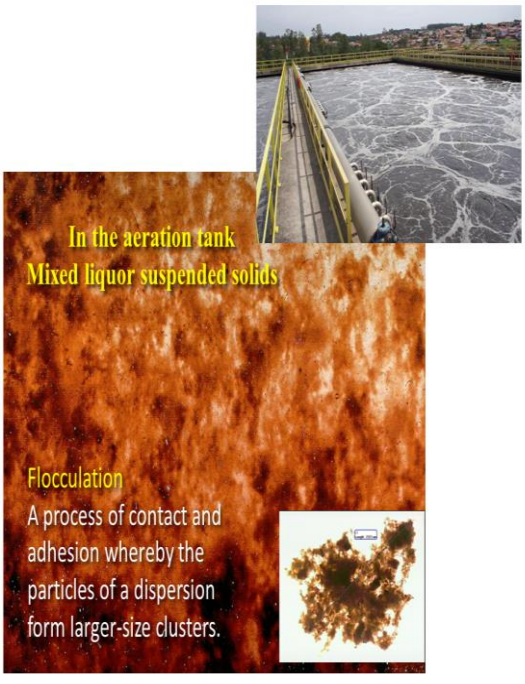
Conventional activated sludge Process



Microorganisms consume organic matter from the wastewater, using oxygen for respiration

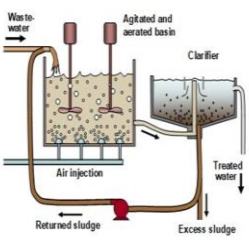
Biological Reactor: The biochemical reactions associated with the removal of the organic matter **take place in the biological reactor or aeration tank).**





PARTS OF CONVENTIONAL AS PROCESS

- **Clarification of Solids (biomass):** The settling of the solids (biomass), which lead to a clarified final effluent, occurs in the **secondary sedimentation tank.**
- ***Return sludge:*** A part of the solids that settle in the bottom of the secondary sedimentation tank is recirculated to the reactor **(*return sludge*)**, **to maintain a large biomass concentration in the reactor, which is responsible for the high efficiency of the system.**
- **Excess or waste sludge:** Excess sludge is called "surplus activated sludge" or "waste activated sludge" and is removed from the treatment process **to keep "food to biomass" (F/M) ratio in balance** (where biomass refers to the activated sludge).



Von Sperling: Biological wastewater treatment in warm climate regions.2005

Metcalf and Eddy Wastewater Engineering treatment and reuse 4rth edition

Fundamental control factors of AS process

Biological Reactor

SRT/MCRT(Mean Cell Residence Time):

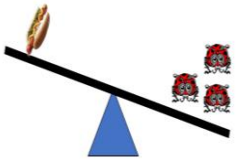
- **The average time suspended solids remain in the activated sludge system. Typical sludge age are:**
  θc = 4 to 10 days

Food to microorganisms ratio(F/M)

- F/M is a measurement of the organic matter(food for the microorganisms) microorganisms(bacteria) in the aeration tanks.
- F/M ratio for CAS= 0.25–0.5 By maintaining this ratio through return activated sludge bacteria will consume high percentage of the food

Hydraulic retention time(HRT). Typical 6-8 hours

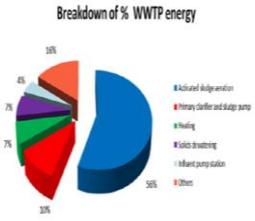
- **The average amount of time that liquid and soluble compounds stay in a reactor or tank. It is calculated by dividing the volume of a reactor (e.g. m3) by the influent flow rate (e.t. m3/day).**



F/M=

Von Sperling "Activated sludge and aerobic biofilm reactors"

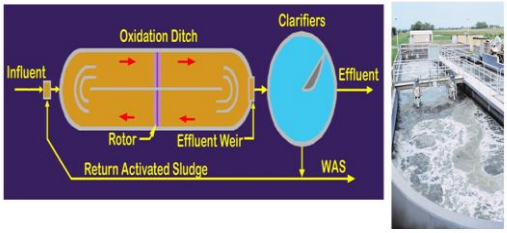
Advantages and Disadvantages of conventional ASP



ADVANTAGES	DISADVANTAGES
Low land requirements	High construction and operation costs
High BOD removal efficiency	High energy consumption, due to sophisticated operation required
Biological removal of N and P is possible	High mechanization level
Low land requirement	Requires complete treatment and final disposal of the sludge
Reliable process, as long as it is supervised	Low coliform removal efficiency
Operational flexibility	Relatively sensitive to toxic discharges

Von Sperling" Biological wastewater treatment in warm climate regions" 2005 chapter-1

https://www.researchgate.net/figure/Breakdown-of-energy-use-across-the-different-processes-of-a-WWTP-7_fig1_264895673



- **An oxidation ditch is a modified activated sludge biological treatment process that utilizes long solids retention times (SRTs) to remove biodegradable organics.**
- **No primary clarifier required in it.**
- **Requires more aeration energy than conventional CAS options;**
- **Applicable in plants that require nitrification because the basins can be sized using an appropriate SRT to achieve nitrification at the mixed liquor.**
- **it requires more land than conventional treatment plants.**
- oxidation ditches achieve BOD, suspended solids, and ammonia nitrogen removal of **greater than 90 percent.**

US EPA "wastewater Technology Fact Sheet Oxidation Ditches"

OXIDATION DITCH PLANT

CONTINUOUS NITIFICATION & DENITRIFICATION

Anoxic – No Free Oxygen (Combined Oxygen

$C + NO_3 \longrightarrow CO2 + N_2$

Nitrification (Presence of free oxygen(Oxic)

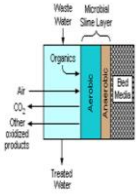
Step1: $NH4+ + 3/2O_2 \rightarrow NO^{2-}_2 + 2H^+ + H_2O$

Step 2: $NO^{2-} + 1/2O_2 \rightarrow NO^{3-}$

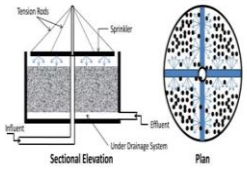
A carbon source is required for DE nitrification to occur. It may be wastewater with sufficient carbon source.

TRICKLING FILTERS

- **An attached growth process.** The influent wastewater is **distributed/sprinkled over the rock or plastic filter and then trickles down the packing material,**
- microorganisms already in the water gradually attach themselves to the media surface and form a biofilm(approximately 0.1 to 0.2 mm thick).
- The sewage is oxidized by the bacteria producing effluent in the form of water, gases and new cells.

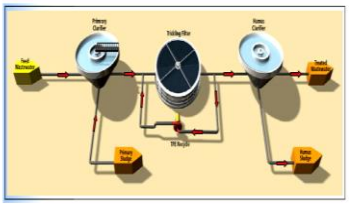


Trickling Filter



Metcalf and Eddy Wastewater Engineering treatment and reuse 4rth edition

FLOW PROCESS OF TF



- The filter media (75 to 100 mm rock material or plastic packing),
- the underdrain system, which collects the wastewater that has passed through the filter and provide an open area for the movement of air.
- Hydraulically driven rotary distributors use pneumatically-controlled gates that either open or close distributor orifices that adjust with varying pumped flows to maintain a constant preset rotational speed (left). Electrically driven rotary distributors are also used.

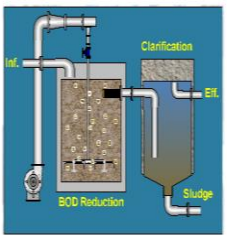
Advantages and Disadvantages of Trickling Filters

Advantages	Disadvantages
Simple & easy to operate as compared to activated sludge	Difficulty in accomplishing biological nitrogen & phosphorus removal
Less energy required due to natural ventilation	Flies, worms and snails& odor can be nuisance
Appropriate for small- to medium-sized communities.	Additional treatment may be needed to meet more stringent discharge standards.
Less O&M	Clogging if overloaded
Possible energy production from sludge digestion	Not as efficient as CAS

US EPA "Technology Fact Sheet Trickling Filters"

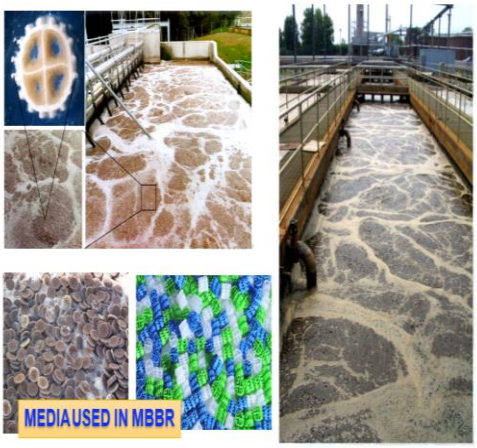
Moving Bed Biofilm Reactor (MBBR)

- It combines the best of Conventional Activated Sludge (CAS) and biofilter processes, **making use of suspended biomass and attached biomass.**
- This system requires less space than CAS.
- The MBBR system consists of an activated sludge aeration system where the sludge is collected on recycled plastic carriers. These carriers have an internal large surface for optimal contact water, air and bacteria.



https://www.sciencedirect.com/science/article/pii/S2352484720315833
https://www.lenntech.com/processes/mbbr.htm

The Moving Bed Biofilm Reactor



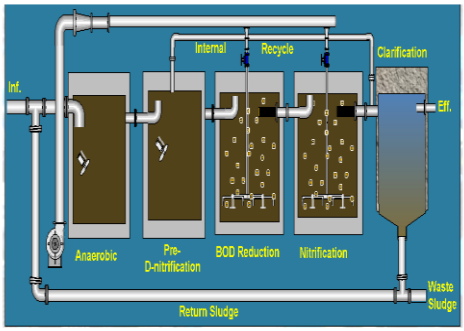
The media are made from high density **polyethylene or polypropylene** with a diameter of **13 – 25mm**, and therefore have a large surface area which helps the biomass to grow inside the surface and are in constant motion due to the compressed air that is blown from under the tank.

Advantages/Disadvantages of MBBR

- Good for high organic loading applications.
- Typical performance characteristics are – BOD in effluent <3 mg/L.
- Smaller foot prints. 1/4 the tank volume than AS.
- A typical HRT for MBBR is 2 – 3 hours, compared to 12 – 24 HRT for ASPs.
- No need for sludge recirculation
- Self regulating biomass.
- Energy consumption 0.17 – 0.27 kWh/m3 (for domestic sewage).

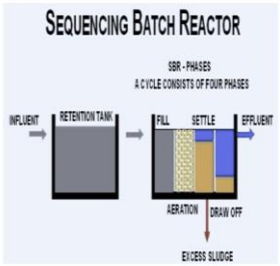
INTERGRATED FIXED FILM ACTIVATED SLUDGE(IFAC)

Intergration of both suspended growth and attached growth process for < 10 mg/l BOD (after clarification).



Small foot print. Quick process for BOD, Nitrogen and Phosphorus removal. Return sludge involved

Sequencing Batch Reactor



- SBR are a special form of activated sludge treatment in which all of the **treatment process takes place in the reactor tank and clarifiers are not required**
- This process treats the wastewater in batch mode.
- Flow is neither entering nor leaving the reactor i.e. **flow enters, is treated, and then is discharged and the cycle repeats**

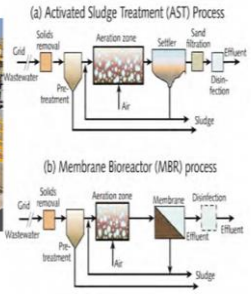
Membrane Bioreactor: MBR

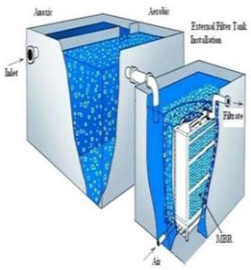
- Membrane is integrated with a biological process. Vacuum-driven membranes may be immersed directly into the activated sludge reactor or in a separate membrane separation tank.
- To clean the exterior of the membranes, **air is introduced below the membranes.**
- While the CAS process uses a secondary clarifier for solid/liquid separation, **an MBR uses a membrane for this function.**
- The idea behind this technology is to get **extremely good quality effluent**

Vacuum Driven Micro membranes

Metcalf & Eddy | AECOM: Water Reuse Issues, Technologies, and Applications 2007. Chapter-7-3

Membrane Bioreactor





Aeration plus membrane energy consumption is 76 %

The best available process

- Select the process that is suitable to your requirement
- Select the process that is suitable to your available land or require less land
- Select the process that has less life cycle cost
- Select the process that has less O&M cost
- Institutional manageability. Appropriate technical and managerial expertise. Extensive education and training.

REUSE OF TREATED WASTEWATER

year	Location	Reuse application
1929	City of Panama	Irrigation of Lawn and Gardens
1960	City of Colorado springs	Golf courses
1962	Los Angles County	Ground water recharge
1987	Monterey, CA	Irrigation of food crops
1984	Tokyo	Providing reclaimed water to 19 high-rise buildings in Shinjuku
2003	Singapore	Portable water

Major types of reuse of treated wastewater

Two major types of reuse have been developed and practiced throughout the world:

(1) POTABLE USES

- Direct, use of reclaimed water to augment drinking water supply following high levels of treatment
- Indirect after passing through the natural environment

(2) NON-POTABLE USES

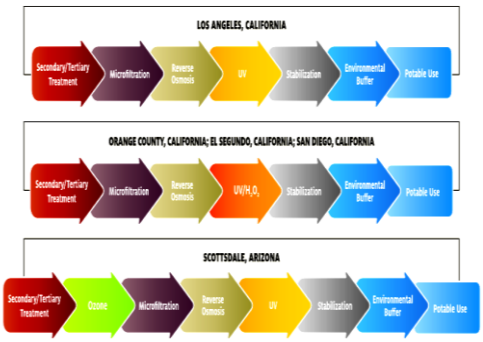
- irrigated agriculture
- use for irrigating parks, public places of forestry (fastest reuse application in Europe: Irrigation of golf courses)
- use for aquaculture
- aquifer recharge (indirect reuse)
- or uses in industry and urban settlements

From toilet to tap: NEWater Singapore

(Reclaimed water use up to 115 MGD, 30% of total demand)

- The most difficult challenge for Singapore to overcome was persuading people to drink treated wastewater.
- A dedicated communications team conducted a massive public education campaign which included a TV documentary.
- Psychologically, this extra step was vital in helping the people of Singapore accept NEWater as drinkable water..

INDIRECT POTABLE REUSE



How Namibia turns sewage into drinking water. 9 MGD plant?

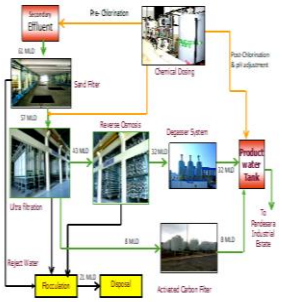
Conventional treatment + Powdered activated carbon + Pre-ozonation + Coagulation/Flocculation + DAF + Rapid sand filtration + Ozonation + activated carbon filtration + Ultrafiltration +Chlorination

https://www.planet.veolia.com/en/wastewater-recycling-drinking-water-windhoek-namibia

INDUSTRIAL REUSE IN INDIA

- Agra 60 cusec MBBR plant+Membranes+ Chlorination and distribution
- BOD_5 less than 2mg/l, TSS 0.5mg/l and Turbidity less than 0.5 mg/l

30 cusec Direct reuse in Bamroli,2019



UASB+ Extended Aeration
Sand Filtration,
Ultra-filtration (UF),
Reverse Osmosis (RO),
Activated Carbon Filter,
BOD less than 5

AWWAIndia

Technologies at WWTP of Surat(Gujrat) Municipal Corporation: Planned to add tertiary treatment at all plants by 2030

SR. No	Location of treatment plant	CAPACITY (MGD)	PROCESS	Reuse
1	Anjana	27	Conventional Activated Sludge + IFAS	Gardening, Road washing
2	Bhesan	22	Conventional Activated Sludge+ IFAS +OD	Agriculture use
3	Bhatar	36	Conventional Activated Sludge + SBR	Gardening, Road washing
4	Karanj	31	Conventional Activated Sludge + IFAS	Gardening, Road washing
5	Singanpore	34	Conventional Activated Sludge + SBR+ IFAS	Gardening, Road washing
6	Bamroli	24	UASB+ Extended Aeration+SBR (converted to reuse facility after adding UF,RO etc)	Industrial & Gardening use
7	Asarma	3.3	MBBR	Gardening, Road washing
8	Khajod	5.5	MBBR	
9	Variav-Kosad	30	UASB + Moving Bed Bio Reactor + SBR	Industrial
10	Dindoli	14.5	Conventional Activated Sludge	Industrial & Gardening use
11	Gavier	12	SBR	
	Grand Total	239.3		

Integrated fixed film activated sludge (IFAS)

1.Industrial reuseage in large cities-Mumbai, Chennai, Surat, Delhi

55 cusec Tertiary WWTP at Kosad, Gujrat

10 cusec Tertiary WWTP at RCF, Mumbai

Tertiary treatment is through RO and UV

2. Lake restoration with UF membranes: Hyderabad, Bhopal, Delhi, Bangalore, Jaipur

8 cusec Plant - Hussain Sagar Lake A2O process.

Completed in 2012

The **A2O Treatment Process** is Advanced activated sludge process for Nitrogen and phosphorus removal.

It is done through **Oxidation Ditches**

AWWAIndia

Source:W210324_Water_Reuse_India_Handout.p

NJS Engineers India Pvt. Ltd.

From toilet to tap: NEWater Singapore

(Reclaimed water use up to 115 MGD, 30% of total demand)

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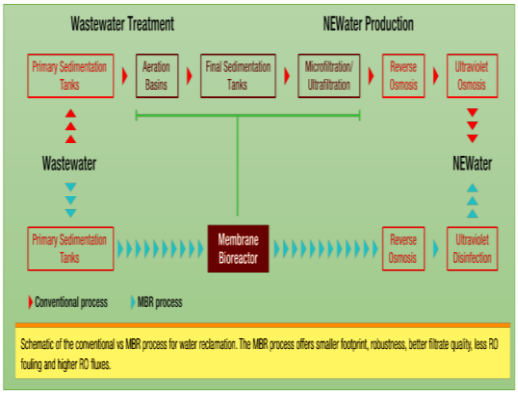
- A dedicated communications team conducted a massive public education campaign which included a TV documentary.
- Psychologically, this extra step was vital in helping the people of Singapore accept NEWater as drinkable water..

Recycling of wastewater in Singapore :MBR



Incorporating a more compact aeration tank and space-efficient inclined lamella primary settling tank and eliminating the need for an additional sedimentation tank. Low sludge production

176 MGD capacity Singapore Changi reclamation Plant Micro/Uf, RO, UV

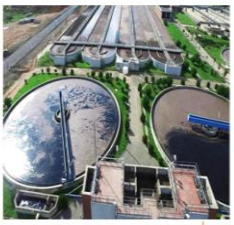
Micro filter

RO

UV

WASTEWATER REUSE FOR IRRIGATION

PROCESS OF PASAKOY WWT ISTANBUL. No membrane used

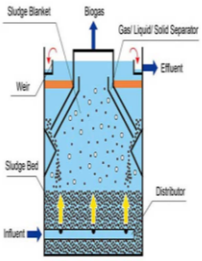


Final effluent ready for irrigation of plants

Chandigarh,India wastewater reuse for irrigating all parks

3 WWTP plants in Chandigarh having following technology for secondary treatment:

1. MBBR
2. AS
3. UASB



- All plants are producing effluent BOD below 40mg/l.
- but,their effluent standards are very stringent now(10mg/l) therefore, they have started upgradion with tertiary treatment (Sand filtration or UF and disinfection).
- WSP are incapable to meet with effluent standards

International guidelines and quality criteria for agricultural reuse of wastewater

❖ Manual of wastewater reuse (USEPA, 2012).

❖ The WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater 2006.

Volume I, Policy and regulatory aspects;
Volume II, Wastewater use in agriculture;
Volume III, Wastewater and excreta use in aquaculture;
Volume IV, Excreta and grey water use in agriculture.

❖ ISO Guidelines for treated wastewater use for irrigation projects (ISO-16075-2,2020), EU adopted the same standards

❖ In Pakistan no specific standards exist for wastewater reuse.

Health and environmental risks considered for agricultural irrigation:(WHO)

- Ingestion of irrigated crops by consumers.
- Ingestion of droplets (produced by sprinkler irrigation) by workers, bystanders and residents in nearby communities.
- Inhalation of aerosols (produced by sprinkler irrigation) by workers, bystanders and residents in nearby communities.
- Dermal exposure by workers, bystanders and residents in nearby communities.
- Ingestion of soil particles by workers, bystanders and residents in nearby communities.
- Ingestion of pastures and fodder by milk- or meat-producing animals (human and animal health).
- Contamination of drinking water sources.

Sprinkle Irrigation

Surface Irrigation

Drip Irrigation

Types of crops

- Types of crops: **(WHO, USEPA, 2012; ISO-2020).**

- Food crops consumed raw: crops, which are intended for human consumption to be eaten raw or unprocessed.

- Processed food crops: crops, which are intended for human consumption not to be eaten raw but after a treatment process (i.e. cooked, industrially processed).

- Non-food crops: crops, which are not intended for human consumption (e.g. pastures, forage, fiber, ornamental, seed, energy and turf crops).

WHO :Unrestricted & Restricted Irrigation

Unrestricted Irrigation:

- **Use of high quality effluents, instead of freshwater, to irrigate any crop on any type of soil, which means without limitations.**
- **Contact and even accidental drinking do not pose health risks.**
- Crops without any restriction include also **vegetables eaten raw.**

Restricted Irrigation:

- **Use of low quality effluents in limited areas** and for specific crops only
- Restrictions are imposed based on the **type of soil, irrigation method, crop harvesting technique, and fertilizer application rate**
- **Imposed crop limitation must be enforced and controlled.**
- Farmers must be trained to handle the low-quality effluent

Microbiological parameters for monitoring

- **Biochemical Oxygen Demand (BOD_5):** BOD_5 **appears in the USEPA guidelines for agricultural irrigation, as well as in other guidelines ISO 16075, 2020).** Some states include BOD_5 in their water reuse legislations for agricultural irrigation **(Cyprus, Greece and Italy).**
- **Total suspended solids (TSS):** TSS is included in the **USEPA guidelines** for monitoring of processed food crops and non-food crops irrigation (USEPA, 2012), **The ISO guidelines**
- **Turbidity:** Turbidity appears in the **USEPA guidelines** for food crops eaten raw and aquifer recharge, similarly to the **ISO guidelines.**
- **Bacteria:** (*E. coli*) the most suitable indicator of fecal contamination. Appears in all guidelines like WHO,USEPA,ISO etc.

Log Reduction	Reduction Factor	Percent Reduced
1	10	90%
2	100	99%
3	1,000	99.9%
4	10,000	99.99%
5	100,000	99.999%
6	1,000,000	99.9999%

WHO microbiological quality guidelines for wastewater use in agriculture

Category	Reuse conditions	Exposed group	Intestinal nematodes (no of eggs per litrer)	Fecal coliforms (geometric mean no per 100 ML)
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parksd	Workers, consumers, public	≤1	≤ 1000
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture	Workers	≤1	No standard recommended
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable

WHO water quality guidelines for irrigation

Parameter	value	Unit	Degree of restriction		
			None	Slight to moderate	severe
TDS		mg/l	<450	450-2000	>2000
TSS		mg/l	<50	50-100	>100
Salinity ECWa		ds/m	<0.7	0.7-3.0	>3
Sodium(Na+)	Sprinkler irrigation	meq/l	<3	>3	
Sodium(Na+)	Surface irrigation	meq/l	<3	3-9	>9
Chloride	Sprinkler irrigation	meq/l	<3	>3	
Chloride	Surface irrigation	meq/l	<4	4-10	>10
Chlorine	Total residual	mg/l	<1	1-5	>5
Boron(B)		mg/l	<0.7	0.7-3.0	>3
Iron(Fe)	Drip irrigation	mg/l	<0.1	0.1-1.5	>1.5
Mangnanese	Drip irrigation	mg/l	<0.1	0.1-1.5	>1.5
Total Nitrogen		mg/l	<5	5-30	>30
pH				6.5-8	6.5-8
E-COLI cfu/100ml			≤1000		≤10,000
Helminthes (eggs/100 cm3)			≤1		≤1

Quality guidelines/standards for irrigation according to EPA, WHO,ISO, FAO UN and India

	EPA		WHO		ISO		FAO UN		India	
PARAMETERS	Non food crops	Processed Food crops	Un-restricted	restricted	food crops	Non food crops	Food crops	Non food	Un-restricted	restricted
BOD5 (mg/l)	≤10	≤30	-	-	≤10	≤20	<10	<30	10	20
TSS (mg/l)	≤2 NTU turbidity	≤30	-	-	≤10	≤25	<30	<30	Nil	30
E-COLI cfu/100ml	No detectable	≤200	≤1000	≤10,000	≤100	1000	<14 NMP	<200 NMP	Nil	230
Helminthes (eggs/100 cm3)	-		≤1	≤1	≤1		≤1		≤1	≤1

Parameter	US EPA	US EPA	WHO	EU
	restriction	No restriction	Slight to moderate restrictions	Slight to moderate restrictions
TDS(mg/l)	<450	175	450 – 2000	525

Treatment process for reuse for irrigation

Primary Treatment

Secondary Treatment Process:

- Any secondary treatment process including WSP, ASP or TF or any other process like OD.
- Treated effluent will be as per PEQS.
- **Disinfection** of treated effluent. If chlorination is used residual chlorine should be < 1 mg/L just before mixing into water body. Fecal coliform should be less than 10,000/100mL of treated water.
- **Minimum 1:10 Dilution in a water body**
- In most of the cases US,EU,INDIA use membrane technology even for irrigation of Public parks, Golf Courses etc due to stringent quality standards.

How to meet irrigation standards in Pakistan

BOD REQUIREMENTAS PER PEQS:

- If effluent of a WWTP meet the NEQ standards (BOD of 80mg/L), and a 10:1 dilution to the water body (River, Irrigation canal) is also available, then this would meet the levels required for irrigation water use (BOD of 8mg/L).
- **For direct use of treated wastewater effluent quality of BOD may be of 8 mg/L**

WHO E-COLI CFU/100ML LIMIT IS ≤1000 FOR UNRESTRICTED IRRIGATION.

- Currently there are no standards for fecal coliform limit in **PEQS however we can follow WHO.**
- If the WWTP effluent meets a fecal coliform limit of 10,000/100mL, with a 10:1 dilution, then **this would meet the levels required by WHO for irrigation water use (fecal coliforms of 1000/100mL) for unrestricted irrigation.**
- Chlorination is necessary in any case after treatment by restricting residual level to< 1 mg/L in case the effluent is diluted in a canal because many downstream residents use canal water for drinking purpose and they may raise any issue any time
- In case of direct use of treated effluent for irrigation the safe disinfection is UV eradication if one can bears the cost because keeping the residual chlorine less tha 1mg/l will be a critical task.