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Industrial Water Reuse: Perspectives from Emerging Countries

the international water association

WEBINAR

26 April 2022 | 10:00 BST

iwa-network.org/webinars

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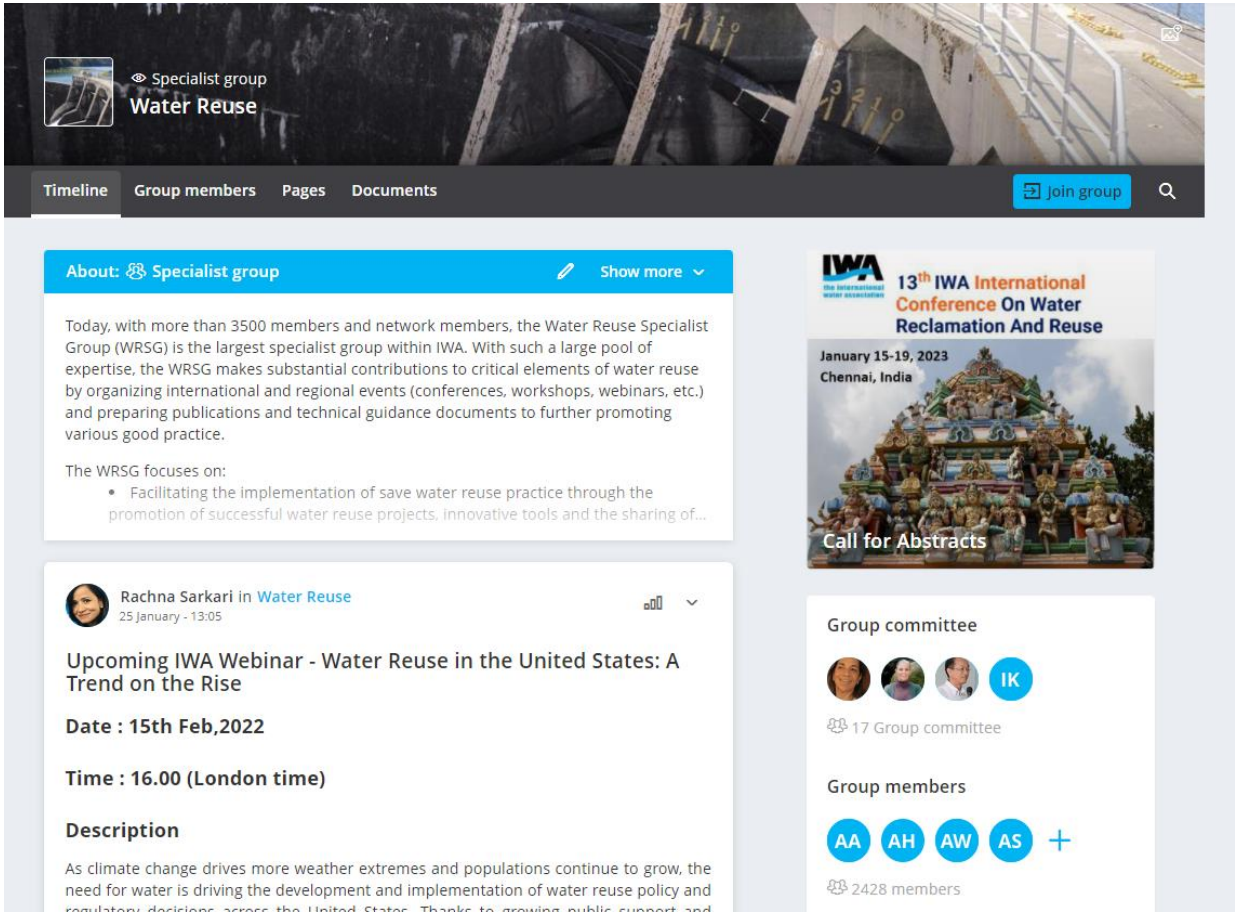
ON THE ROAD TO CHENNAI 2023

- This webinar is being hosted by the Water Reuse Specialist Group and is the second of 4-part series titled "On the Road to Chennai 2023".

- 1st webinar:

- Next webinar: May 12

IWA WATER REUSE SG



The IWA WRSG makes substantial contributions to critical elements of water reuse by organizing international and regional events (conferences, workshops, webinars, etc.) and preparing publications and technical guidance documents to further promoting various good practice.

Join the IWA Water Reuse SG on IWA Connect!

https://iwa-connect.org/group/water-reuse/timeline

IWA WATER REUSE CONFERENCE

Submit your abstract for the Conference by May 15! https://iwareuse2023.com

WEBINAR INFORMATION

- This webinar will be **recorded and made available "on-demand"** on the IWA website, with presentation slides, and other information.
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WEBINAR INFORMATION

- **'Chat' box**: please use this for general requests and for interactive activities.
- **'Q&A' box**: please use this to send questions to the panelists. (We will answer these during the discussions)

Please Note: *Attendees' microphones are muted. We cannot respond to 'Raise Hand'.*

AGENDA

- Welcome, introduction, housekeeping rules
  Olivier Lefebvre
- A short introduction to industrial water reuse
  Josef Lahnsteiner
- India ensuring industrial water security
  Nupur Bahadur
- Industrial Wastewater Reclamation, Windhoek Namibia
  James Villet
- Water reclamation to industrial user
  Varanon Laosuwan
- Poll and Q&A Panel Discussion
- Final remarks and conclusion
  Olivier Lefebvre

MODERATORS & PANELISTS

Olivier Lefebvre
National University of Singapore, Singapore

Josef Lahnsteiner
R&D bei WABAG, Austria

James Villet
Ujams Wastewater Treatment, Namibia

Nupur Bahadur
The Energy & Resources Institute, India

Varanon Laosuwan
WHA Utilities and Power, Thailand

LEARNING OBJECTIVES

1. Understand the negative impact associated with untreated industry wastewater and how to minimise environmental risks
2. Get an overview of the importance of industrial wastewater management and the challenges inherent to this type of wastewater
3. Learn about best practices of water reuse applicable in various geographical zones, with a particular focus on solutions tailored to emerging economies

SHARE YOUR THOUGHTS ON SOCIAL MEDIA

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THE 13TH IWA INTERNATIONAL CONFERENCE ON WATER RECLAMATION AND REUSE

Tag @IWAHQ on social media and tell us:

Why water reuse is important?

How does it affect your life?

What is the main contribution to the SDG6 and the 2030 Agenda?

Don't forget to include the hashtags #IWA & #WaterReuse.

A SHORT INTRODUCTION TO INDUSTRIAL WATER REUSE

JOSEF LAHNSTEINER
WABAG GROUP, AUSTRIA & INDIA

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DRIVERS FOR INDUSTRIAL WATER REUSE

- Water Shortage caused by
  - Climate change
  - Population growth
  - Industrialization in developing and emerging economies
- Boost in water supply security
  - A shutdown of a production facility could cause an enormous financial damage
- Further economic reasons
  - Reclaimed water is normally cheaper than municipal water
  - Reduced wastewater discharge fees
  - Resource recovery
- Policies, regulations and guidelines
  - E.g. *Treated Wastewater Reuse Policy for Tamil Nadu, India, 2019*
- Brand protection
  - Green image
  - Reputational risk minimization – water can be a constraint upon growth

MAJOR INDUSTRIAL REUSE APPLICATIONS

- Reclaimed water reused as cooling make-up in
  - Power generation
  - Various processes such as oil refining
- Reclaimed water reused as boiler make-up in
  - Thermal power plants of utilities
  - Thermal power plants of various industries such as pulp and paper mills
- Reclaimed water reused for various purposes
  - Transport e.g. in mining
  - Washing e.g. in food industry
  - Quenching e.g. of refinery coke
  - Dust suppression e.g. in coal gasification
  - Maintaining pressure in oil recovery
  - Manufacturing e.g. of steel

SOURCES FOR INDUSTRIAL WATER REUSE

- Municipal (secondary) effluents

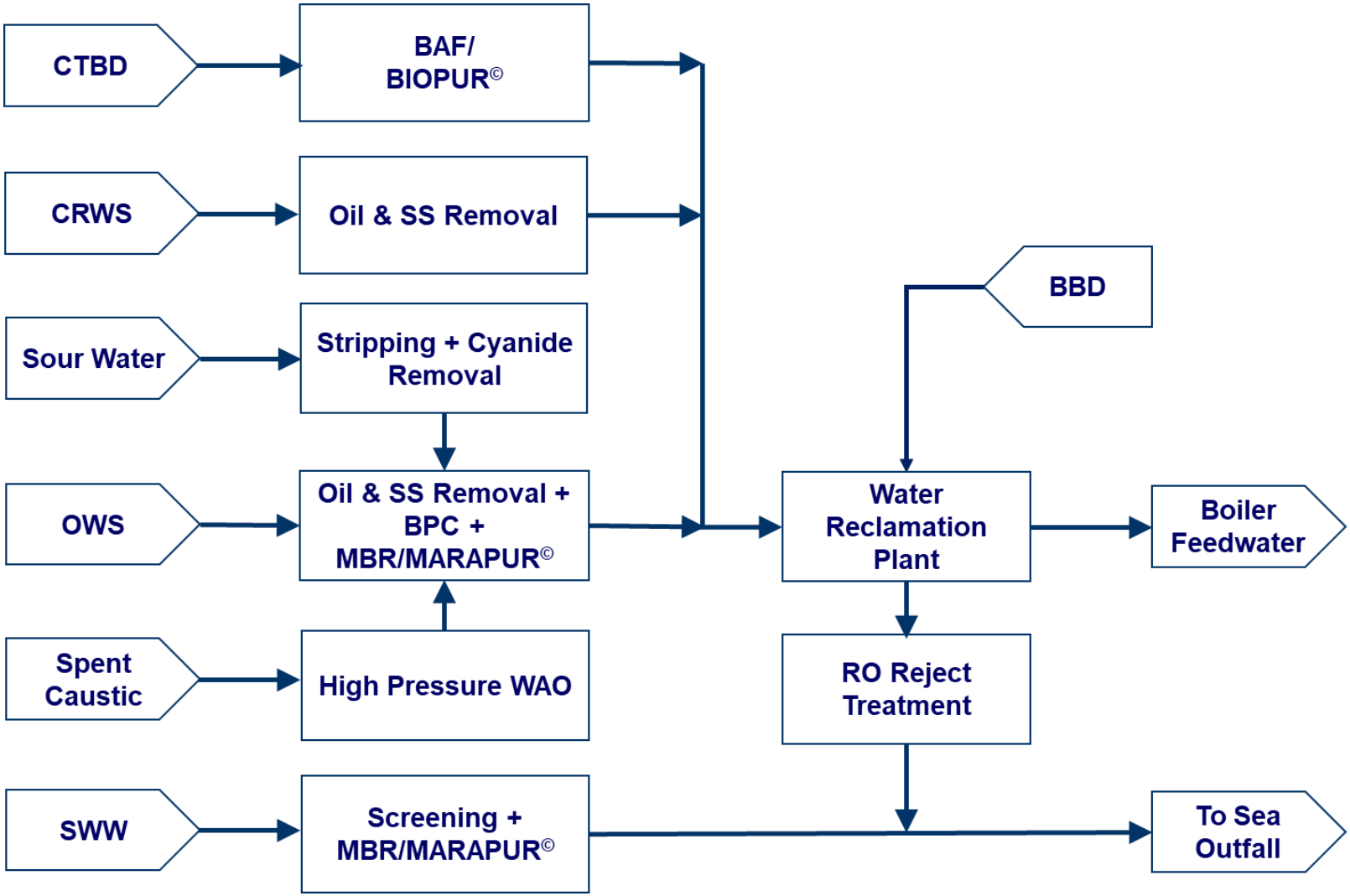
Secondary effluent reservoir for water reclamation and industrial reuse

- Industrial “in-house“/on-site effluents
  - Secondary effluents from ETPs
  - Various pretreated and untreated process effluents
  - Cooling tower and boiler blow-downs
- Effluents from one industry reused in another industry
  - E.g. cross-sectional reuse at multi-company sites (industry parks)

CASE STUDY IN WEST AFRICA - NIGERIA

- Nigeria
  - Most populous country in Africa - 211 million
  - Largest economy in Africa
  - Worldwide 12th largest producer of petroleum
- Dangote Group, founded by Aliko Dangote, is one of the largest companies in Africa
  - Oil refining & manufacture of petrochemical products
  - Fertilizer production
  - Automotive supply industry
  - Cement manufacturing
  - Agriculture (tomato & rice farming, etc.)
- Dangote Refinery & Petrochemical Complex (R & PC)
  - Lagos State, Lekki Free Zone, Lekki peninsular south east of Lagos
  - R & PC under construction, completion in Q.4 2022
  - Largest single train refinery, 650,000 bdp
  - Water management by raw water treatment, effluent treatment and water reclamation

DANGOTE WATER RECLAMATION SYSTEM



DANGOTE REFINERY - OILY WASTEWATER STREAM

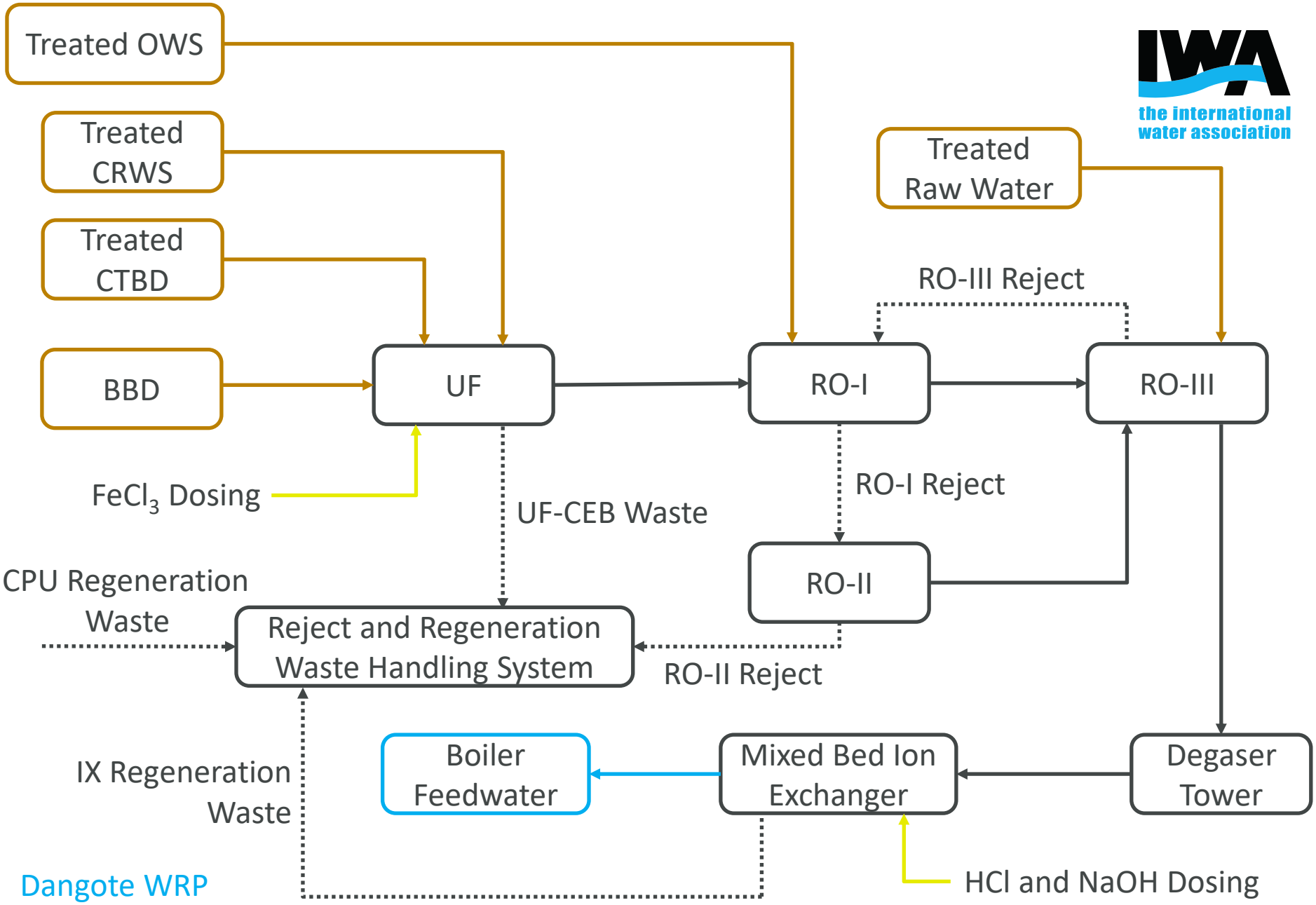
Parameter	Unit	Wastewater Characteristcs	Treated Effluent Standards
pH	-	6 – 9	6 – 9
Total Dissolved Solids	mg/L	3,000 – 5,000	5,000
Oil & Grease	mg/L	1,000 – 5,000	< 5
BOD_5 at 20 °C	mg/L	250 – 1,300	< 10
COD	mg/L	500 – 2,100	< 50
TSS	mg/L	100 – 500	< 5
Sulfides	mg/L	10 – 30	< 0.1
Phenols	mg/L	10 – 100	< 0.2
Total Nitrogen	mg/L	100	< 5
Total Phosphorus	mg/L	10	< 3

BOD – Biochemical Oxygen Demand
COD – Chemical Oxygen Demand
TSS – Total Suspended Solids

DANGOTE REFINERY- RECLAIMED WATER STANDARDS

Parameter	Unit	RO Feed Characteristics	Reclaimed Water Standards
Flow	m^3/h	-	1,200
pH	-	6.5 – 8.5	6.5 – 7.5
Temperature	°C	15 – 30	≤ 35
Turbidity	NTU	-	BDL
Conductivity at 20°C	µS/cm	-	< 0.2
Calcium	mg/L	144	-
Magnesium	mg/L	30	-
TSS	mg/L	-	BDL
Total Reactive Silica	mg/L	15	< 0.02
Total Iron	mg/L	0.9	< 0.03
Total Copper	mg/L	-	< 0.003
Sodium	mg/L	318	< 0.01
$KMnO_4$	mg/L	47	< 1.0
Oil Content	mg/L	-	BDL
TDS	mg/L	2,600	0.1

BDL – Below Detection Limit
KMnO4 – Potassium Permanganate
TDS- Total Dissolved Solids
TSS – Total Suspended Solids


Treated OWS
Treated CRWS
Treated CTBD
BBD
UF
RO-I
RO-III
Treated Raw Water
RO-III Reject
FeCl3 Dosing
UF-CEB Waste
RO-I Reject
RO-II
CPU Regeneration Waste
Reject and Regeneration Waste Handling System
RO-II Reject
IX Regeneration Waste
Boiler Feedwater
Mixed Bed Ion Exchanger
Degaser Tower
HCl and NaOH Dosing
Dangote WRP

DANGOTE WATER RECLAMATION PLANT

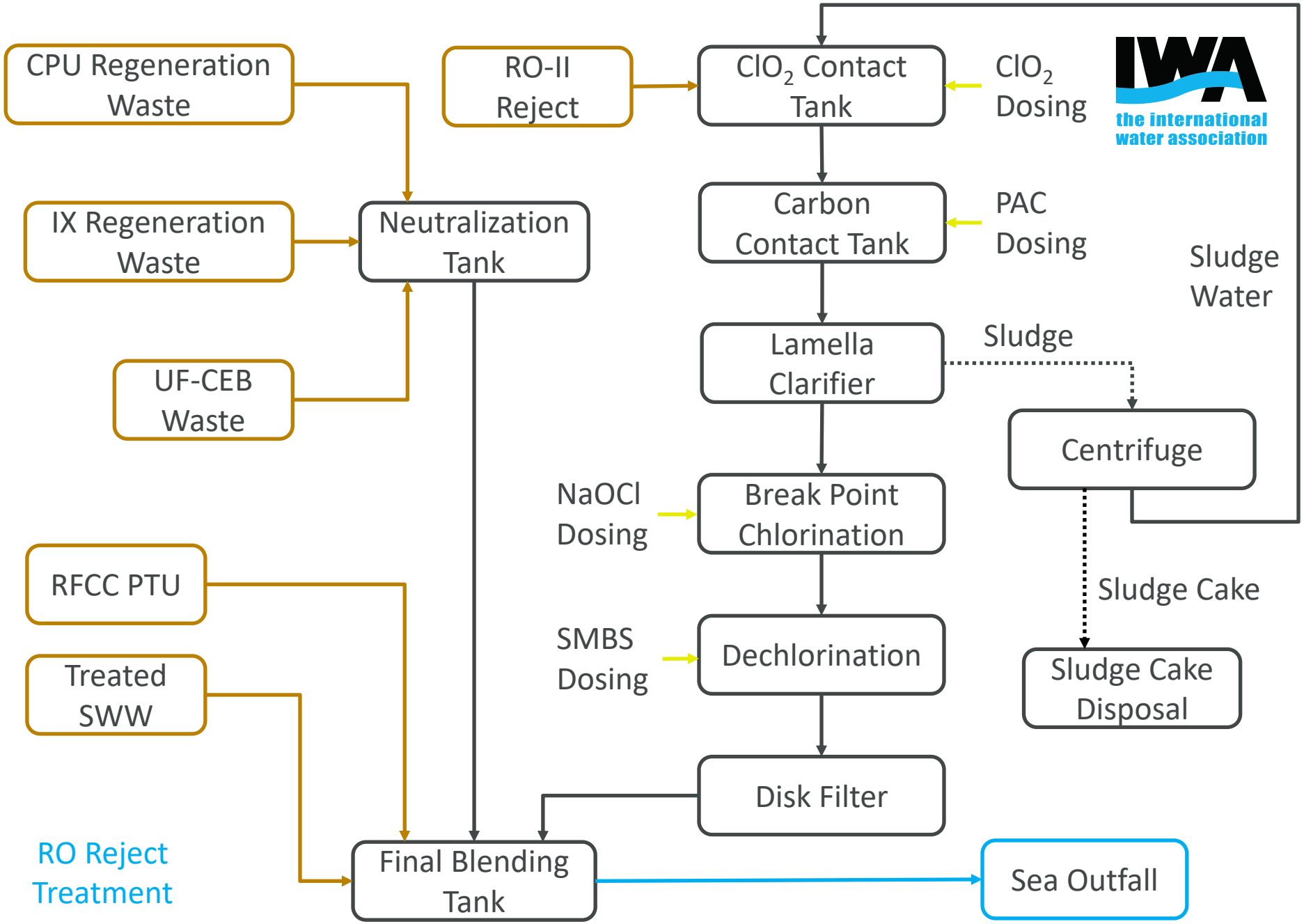
Cooling Tower Blowdown and UF Feed Collection Tanks

DANGOTE WATER RECLAMATION PLANT

Ultrafiltration Process Unit (in installation phase)

DANGOTE WATER RECLAMATION PLANT

Installation of the Reverse Osmosis Process Unit


CPU Regeneration Waste
RO-II Reject
ClO_2 Contact Tank
ClO_2 Dosing
IX Regeneration Waste
Neutralization Tank
Carbon Contact Tank
PAC Dosing
Sludge Water
Lamella Clarifier
Sludge
UF-CEB Waste
Centrifuge
NaOCl Dosing
Break Point Chlorination
RFCC PTU
Sludge Cake
SMBS Dosing
Dechlorination
Sludge Cake Disposal
Treated SWW
Disk Filter
RO Reject Treatment
Final Blending Tank
Sea Outfall

Key Issues for successful Industrial Water Reuse/Recycling

- Water reuse concepts must provide social, environmental and economical sustainability
- Water reclamation plant financing (BOT, etc.), is very important, particularly in developing countries
- In order to promote water reuse/recycling, longer pay back periods should be accepted by industrial investors
- The risk which is avoided by a higher industrial water supply reliability should be valued in feasibility studies
- Price of freshwater from public supply shouldn’t be subsidized (true cost of water)

Key Issues for successful Industrial Water Reuse/Recycling (continued)

- Proper Water Reclamation plant design
  - Use of existing experience
  - Pilot testing
  - Multiple barrier systems provide a high degree of safety
  - New technologies such as ceramic membranes
- Proper concentrate reuse and/or disposal concepts
  - “Brine mining” (e.g. selective recovery of salts)
  - Minimum Liquid Discharge
  - Proper treatment prior to discharge
- Proper operation by well trained and skilled personnel
  - Training abroad (outside of own plant)
  - Audits with regard to operation and maintenance

Thanks you for your attention!

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INDIA ENSURING INDUSTRIAL WATER SECURITY

DR NUPUR BAHADUR
THE ENERGY & RESOURCES INSTITUTE (TERI), NEW DELHI

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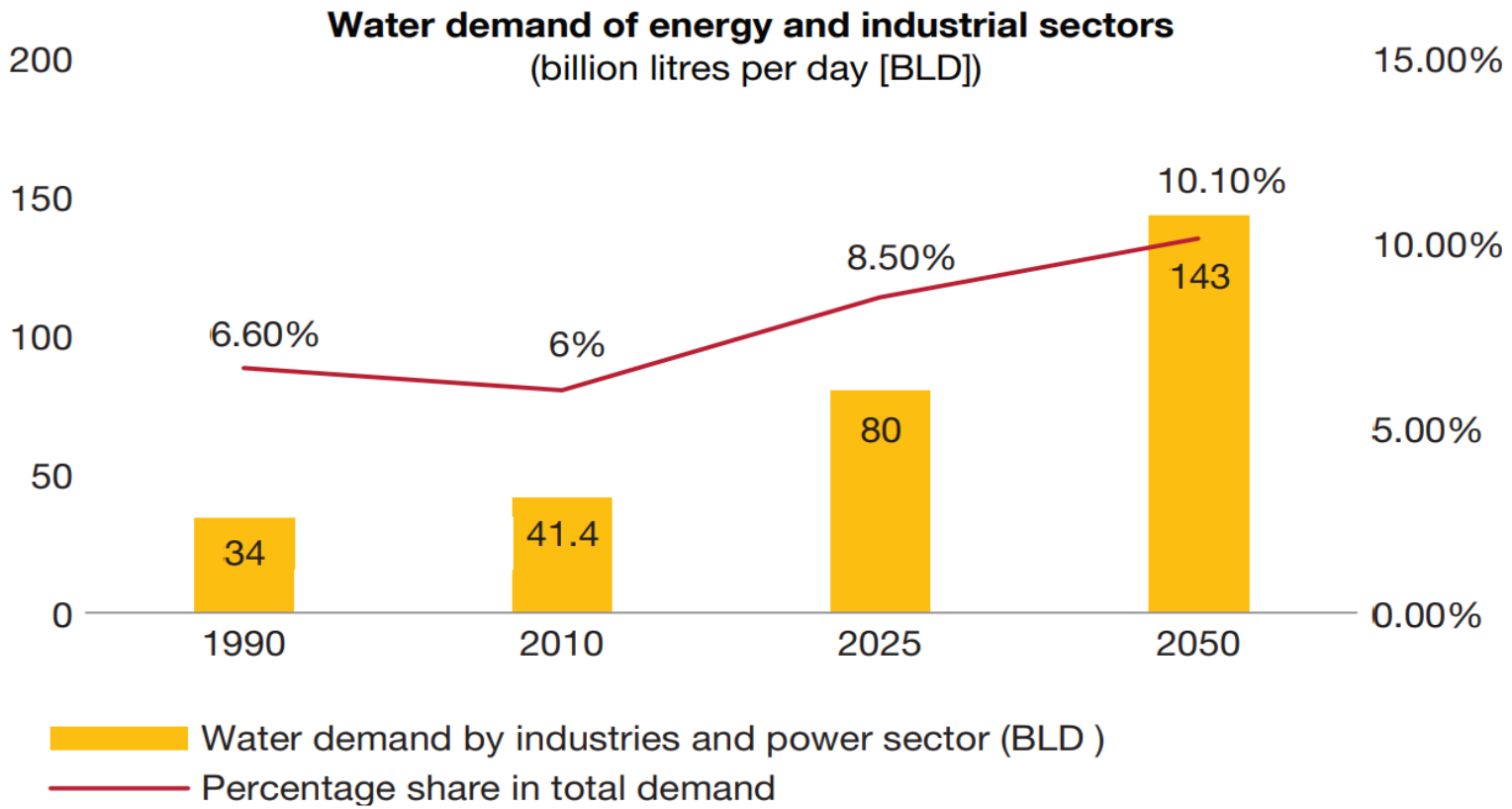
CONTENT

- Key drivers for ensuring Industrial Water Security in India
- Category 1: Case Studies: Treated Industrial wastewater for reuse
- Category 2: Case Studies: Reclaimed water for Industrial reuse
- Category 3: Status of R&D in Industrial Water Reuse

KEY DRIVERS FOR ENSURING INDUSTRIAL WATER SECURITY IN INDIA

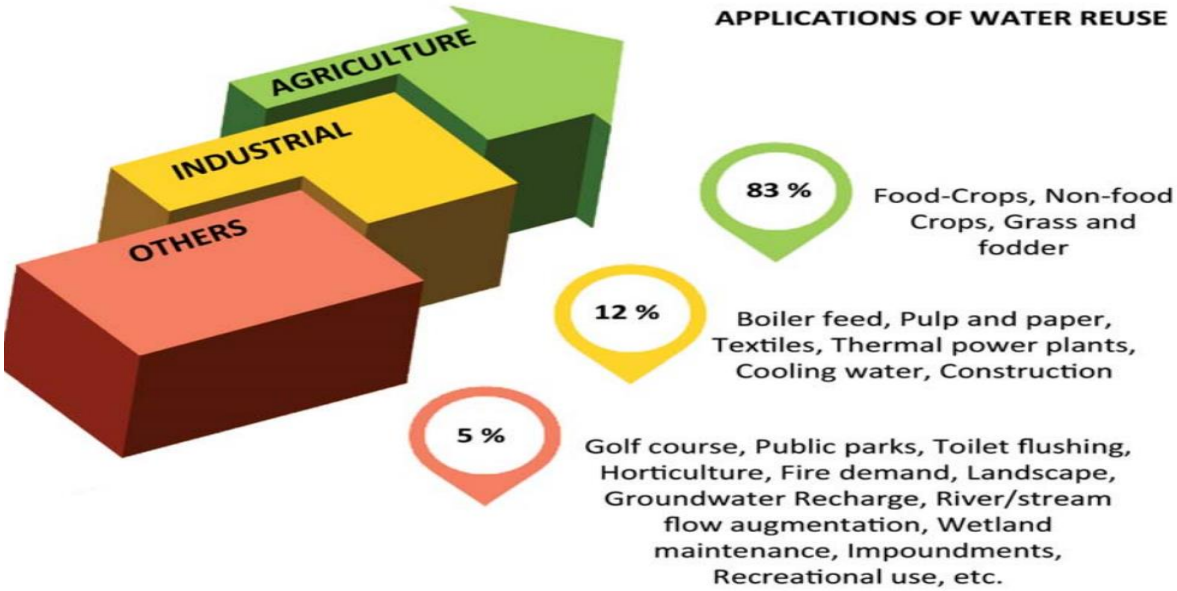
- **1. Industrial Water Demand**



Source: India Infrastructure Report, 2011, Chapter 18

KEY DRIVERS FOR ENSURING INDUSTRIAL WATER SECURITY IN INDIA

- **2. Water stress and the need for industrial water supply security**

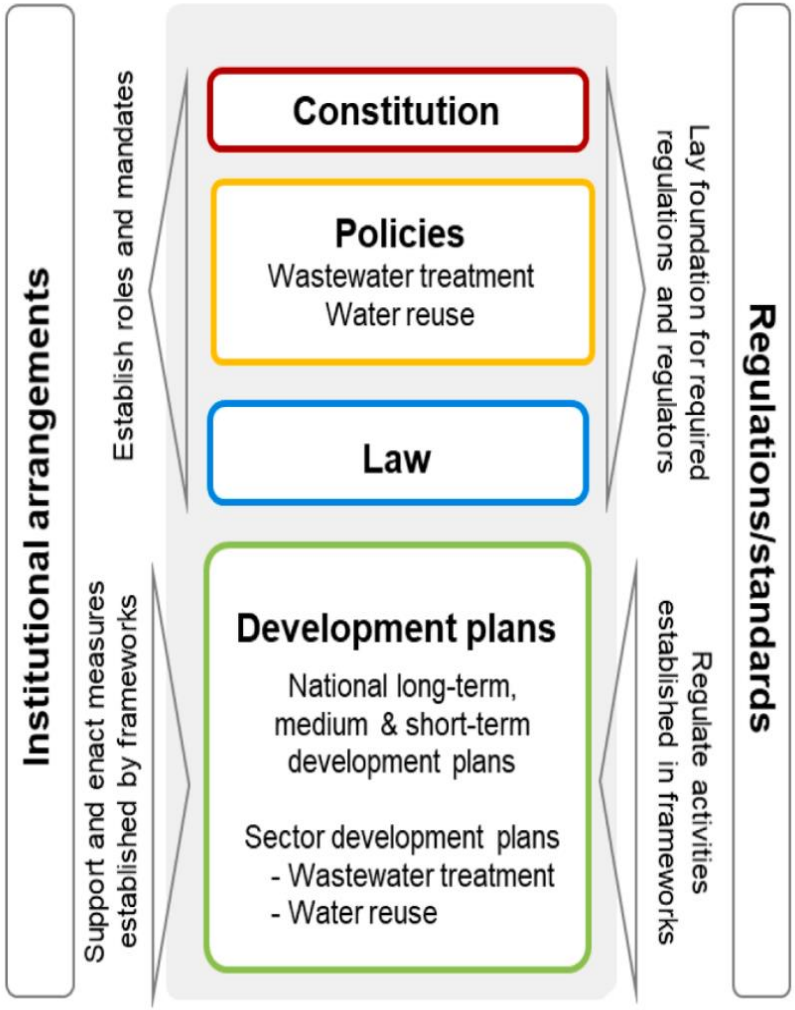


Source: Kriti Goyal and Arun Kumar, "Water Reuse: A vital step towards water value", IIT Roorkee World Water Day Report, March 2021

- **3. Shortage of potable supply and the regional resourse limitations i.e. droughts**
- **4. Zero Liquid Discharge (ZLD) compliance as per the Central Pollution Control Board (CPCB), Govt. of India.**

KEY DRIVERS FOR ENSURING INDUSTRIAL WATER SECURITY IN INDIA

- **5. Govt. of India Policies and Programs from time-to-time**



The Indian Constitution, 1950, Article 246 & 248

The National Urban Sanitation Policy, 2008

The National Water Policy, 2012

ZLD policy, 2016

Tariff Policy, 2016

The Water (Prevention and Control of Pollution) Act, 1974

The Environment (Protection) Act, 1986

The Ganga Action Plan I & II, 1986-2014

Namami Gange Mission, 2014-2023

Swacch Bharat Mission, 2014-2019

AMRUT Mission, 2015-2023

Smart City Initiative, 2017-2023

KEY DRIVERS FOR ENSURING INDUSTRIAL WATER SECURITY IN INDIA

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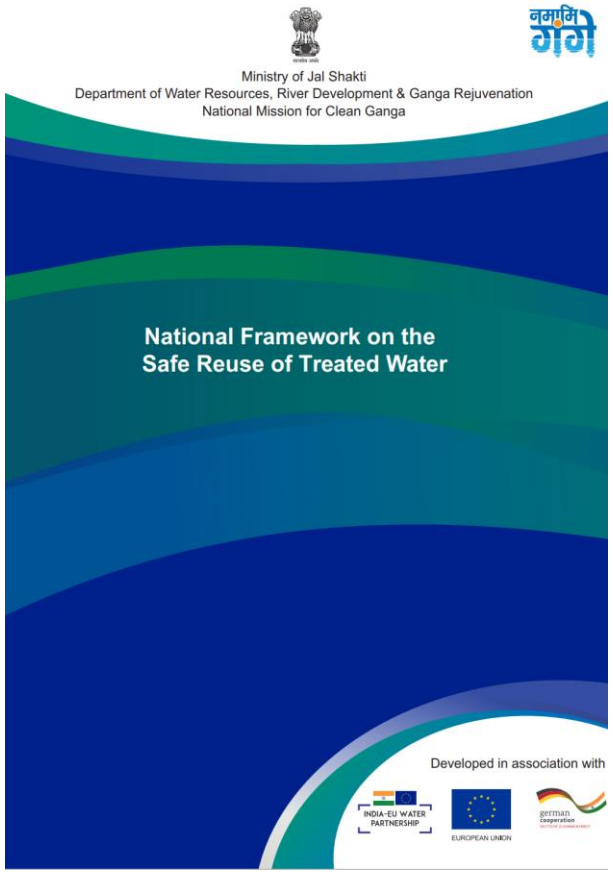
- **6. National framework for Safe Reuse of Treated Water**



TREATED INDUSTRIAL WASTEWATER FOR REUSE

a. **High Grade Water (COD <10 mg/L and TDS <250 mg/L)**
   - i. Use in Boiler feedwater
   - ii. Use directly in process

b. **Medium Grade Water (COD <50 mg/L and TDS <500 mg/L)**
   - i. Use in Cooling Tower plants, Scrubbers etc.
   - ii. Use directly for vessel washing, floor washing etc.

c. **Low Grade Water (COD <250 mg/L and TDS <2100mg/L)**
   - i. Use in horticulture development
   - ii. Dust suppression and common area sprinkling
   - iii. Use for construction purposes in nearby development

TREATED MUNICIPAL WASTEWATER FOR INDUSTRIAL REUSE

a. **High Grade Water (BOD <5 mg/L, COD <30 mg/L, TDS <250 mg/L)**
   - i Flushing
   - ii Cooling tower/ HVAC - AHU Plants

b. **Moderate/ Low Grade Water (BOD < 30 mg/L, COD <150 mg/L and TDS <1000 mg/L)**
   - i. Horticulture
   - ii. Floor washing
   - iii. Dust suppression
   - iv. Fire Fighting

CATEGORY 1: TREATED INDUSTRIAL WASTEWATER FOR REUSE

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Case Study 1:
ETP/Recycling – IOCL Refinery, Paradip, Odisha

Paradip, India

Client:	**Indian Oil Corporation (IOCL)**
Location:	**Paradip, Odisha, India**
Project:	**ETP & Recycling Plant for Refinery Complex Paradip, 54,000 m³/day**
Type:	**EPC – turnkey execution**
Start-up:	**2015**

What makes it UNIQUE?

- Largest industrial water recycling plant in India
- Achieving water recovery of around 75 per cent
- Exclusive treatment of effluents from various streams.

Effluents from various streams are treated exclusively.

ETP & Recycling Plant for Refinery Complex 54,000 m^3/day

Effluent streams :

- Oily water and contaminated rain water
- Salty oily water
- Stripped sour water
- Cooling tower blow down and side stream filter backwash
- Coke Pile surface water run-off
- Sulphidic and naphthenic spent caustic
- Landfill site leachate
- Sanitary wastewater
- Steam system blow down
- DM plant regeneration waste

ETP - Main process steps:

- API separator
- TPI Separator
- DAF system
- Intermediate equalization tank and slop oil tanks
- VOC treatment
- Biotower
- Aeration tank
- Secondary clarification
- Bio DAF
- Intermediate check basin for monitoring performance parameters

TTP - Main process steps:

- Rapid gravity sand filters
- Basket strainers
- Ultrafiltration
- Reverse Osmosis
- RO reject treatment in hard COD management unit before discharging into the sea.

Water Recycling

Case Study 2:
ETP/Recycling – Balkrishna Industries, Bhuj, Gujarat, India

Bhuj, India

BKT GROWING TOGETHER

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Manufacturing Process and Water Consumption Area

1. TYRE PLANT

- Rubber
- Carbon
- Process Oil
- Chemicals

Input → MIXING → Input/Output: Mixed Rubber → CALENDARING & EXTRUSION → Input/Output: Bead, Ply & Tread etc. → TYRE BUILDING → Input/Output: Green Tyre → CURING

Steam & Hot Water for Tyre Curing → CURING

CURING → Cured Tyre; Wastewater (Recycle); Steam Condensate Water (Recycle)

Water For Cooling Purpose in Cooling Tower, TCU, Air Washer, AHU & Chiller (Evaporation loss & Blow Down Recycle) → MIXING, CALENDARING & EXTRUSION, TYRE BUILDING

2. POWER PLANT

Fresh Water from GWIL, Rain Water → WTP

WTP → WTP Treated Water (For Industrial Use) → BOILER

WTP → WTP Rejected Water(Recycle) → BOILER

Fuel: Coal/Off Gas → BOILER

BOILER → Input/Output: High Pressurized Steam → TURBINE

BOILER → Boiler Blow Down (Recycle)

Water For Cooling Purpose (Evp. Loss & Blow Down Recycle) → BOILER

TURBINE → Output → Low Pressurized Steam for Tyre Plant; Power; Steam Condensate Water (Recycle)

3. CARBON BLACK PLANT

- CBFS → Input → REACTOR / BAG FILTER

Water For quenching (Converted into Off Gas) → REACTOR / BAG FILTER

REACTOR / BAG FILTER → Out Put from filtration/Input:
- Carbon Black
- Off Gas As fuel to Boiler / Dryer

→ PALLETIZER/ DRYER

Fuel : Off Gas → PALLETIZER/ DRYER

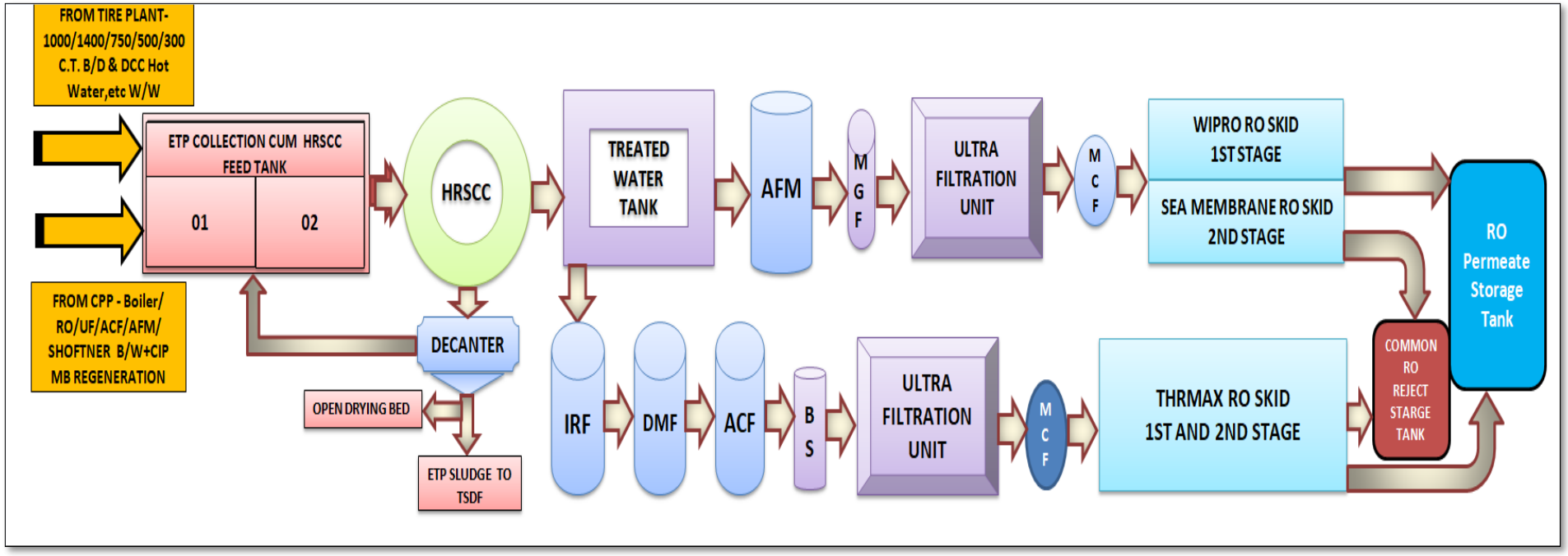
Water With molasses → PALLETIZER/ DRYER

PALLETIZER/ DRYER → Output → Carbon Black; Blow off Water (in from of Steam) along with Air from Bag Filter

Wastewater Source & Management

Source of Waste Water	Treatment Facility provided & Scheme
Industrial 1. WTP (Filter rejects, RO-DM, Softener reject etc) 2. Blow down water from Cooling Tower, Boiler, Chillar & TCUs. 3. Floor Washing Water.	1. ETP 1 (1320 KLD) with Second Stage RO for Tire & CPP 2. ETP 2 (90 KLD) with Second Stage RO for Carbon Black 3. Second Stage RO Reject from both ETPs is clubbing together at one common reject recycle RO. 4. Reject of Third Stage Recycle RO is feeding to MEE. 5. Treated water Recycling back to Industrial process 6. ETP Sludge & MEE Salt sent to TSDF for disposal
Domestic Sewage	With 600 KLD STPs of combine capacity, treated water is being utilized for flushing & gardening purposes.

SCHEMATIC FLOW DIAGRAM OF CPP- ETP AND SECOND STAGE RO



Daily Water Monitoring & Review Mechanisms

Tire Plant & CPP

	Particular	UoM	Target	Sep'20	June'21	July'21	Aug'21	24	25	26	27	28	Avg/Day
Electricity (PGVCL + Own Generation)	PGVCL	KwH		43724	76172	80772	72000	115320	100440	98280	95400	104280	100337
	Power Plant (CPP)	KwH		417201	443628	446181	451086	442720	447088	444528	451216	451728	432382
	Solar Power	KwH		4340	4423	3569	3130	3435	4194	3505	2336	3714	3260
	4.2 MW DG	KwH		0	0	0	0	0	0	0	0	0	2420
Specific Ratios	Electricity	KwH/MT	910	1058	976	946	980	1060	1010	1014	1015	1046	1007
	Coal	Kg/MT	401	450	402	401	429	409	429	409	404	401	417
	Water	KL/MT	3.2	3.2	3.12	3.21	3.26	3.35	3.13	3.39	3.09	3.29	3.38
	Steam	MT/MT	2.6	2.6	2.29	2.28	2.44	2.33	2.44	2.33	2.30	2.29	2.37
Coal-Power Ratio		Kg./KwH		0.085	0.069	0.019	0.009	0.000	0.000	0.000	0.000	0.000	0.000
Water Available		Days						29.88	29.76	29.98	29.89	30.12	
Power Cost	Unit Cost With Generation Duty (Excl.Exemption on Auxilliaries for Power Generation from Jan'19)	Rs/kwh		3.77	4.33	4.32	4.77	4.94	4.94	4.94	4.92	4.93	4.98
Production (Tons.)				311.80	393.06	408.67	383.89	400.04	403.74	401.04	397.10	399.40	388.96
Average Compound Stock in MT-				1578	1974	1887	2072	1864	1939	1945	2005	2118	1803

	Particular	UoM	June'21	July'21	Aug'21	24	25	26	27	28	Avg/Day
ETP	Water coming to ETP	KL	1112	1039	1195	964	1040	949	967	1072	1050
ZLD	Total ZLD Product Water (RO+MEE)	KL	1463	1604	1554	1507	1401	1533	1409	1483	1547
Carbon plant	Raw Water	KL	1014	1027	1055	910	972	850	934	1090	992
Fresh water	From R-1,R-2 & R-4	KL	3754	3231	3361	3081	3154	2945	2925	3168	3124

Carbon Black Plant

WTP- WATER QUALITY & CONSUMPTION

	Consumpion (KL)
Total Water	936
Process water	531
Plant water	339
DM water	0
CB PRODUCED (MT)	262.0
KL/MT OF CB PRODUCED	3.6

Description	Raw water	Process water	Plant water	DM Water
PH	8.1	8.49	9.7	8.22
TDS	486	32.6	142	4.05
Chlorides	170	10	38	

SPECIFIC WATER CONSUMPTION DATA

Plant / Area	Year 2020	Year 2019	% Reduction
Tire Plant	3.78 KL / MT	4.63 KL / MT	18 %
Carbon Black	4.11 KL / MT	4.83 KL / MT	15 %
Power Plant (CPP)	0.42 KL / MW	2.49 KL / MW	83 %
Specific Water in year : Total Fresh Water (Industrial + Domestic) consumed / Total Production			

Good practices led to better water management as follows:

1. Tire Plant & Carbon Black Plant focused on **reduction of water consumption by leakage arrest & optimisation of water uses** by re-use at different area.
2. Power Plant, reduced water consumption by optimisation of water use, and also by **elimination of water uses point like replacement of Water Cooling with Air Cooling.**
3. Company installed Third stage common reject recycle water RO system to **enhance recycling capacity** up to 98 %.
4. In gardens, company introduced system for **collection of run-off water and re-uses**, resultant in to reduction of use of fresh water.
5. **Increase in rain water holding capacity** 14 times (new holding capacity is 56,700 KL), installed pumping & filtration system and started use of rain water in industrial process @ 140 KLD which is **3.5 % of total Fresh water requirement.**

CATEGORY 2:
RECLAIMED WATER FOR INDUSTRIAL REUSE

Case Study 1:

STP/Recycling – Surat Municipal Corporation, Surat, India

Surat, India

Liquid waste management activities

- Population catered : 99.5 % * of present population
- Sewage Collected & Treated : 970 MLD
- Length of sewer network : > 2022 km
- Sewage Pumping Stations : 63 Nos (2109 MLD)
- Sewage Treatment Plants : 11 Nos (1655.5 MLD)
- **Treated Wastewater**

  Recycled & Reused : 319.00 MLD
- SCADA system for operations monitoring and efficiency enhancement

* Before city limit extension

- Re-use of treated water
- **Recovery of 100% O&M costs** of networks/STPs/FSTPs
- Complaint Redressal mechanism
- Safe discharge of sewage from CT/PT/IHHL
- Safe cleaning of Sewer and Septic tanks
- Sufficient capacity of desludging vehicles

SURAT MUNICIPAL CORPORATION RE-USE SCENARIO

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Treated Wastewater Reused: 319.00 MLD

1. **Textile Clusters – 160 MLD**
2. **Industrial Use – 112 MLD**
3. **Rejuvenation of Lakes – 2 MLD**
4. **Bio-diversity park – 0.5 MLD**
5. **Dream City Project – 0.5 MLD**
6. **Land Fill Closer – Ecological Park – 5 MLD**
7. **Waste to Compose Facility – 1 MLD**
8. **Agriculture – Mass Plantation – 28 MLD**
9. **Gardening, Traffic Circles, Road dividers etc through Tanker Filling Station – 10 MLD**
10. **<u>Next up Coming -</u> Construction Purpose, Metro Rail Project, Bio-diversity park, Watering of Trench Lines, Rejuvenation of Lakes with heavy water Board – 20 MLD**

TERTIARY SEWAGE TREATMENT PLANT : SUCCESSFUL FINANCIAL MODEL

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- **COSTS**
  - Total **O & M Cost** towards maintaining complete sewerage system – INR 110.00 Cr **(USD 14.38 Million)**

    (Including O & M and Electricity Cost)
  - Total Tertiary Treatment Plant Capacity : 115 MLD (40+35+40) plus 10% additional capacity on demand.
  - **Capital Project Cost**: INR 314.39 Cr **(USD 41.11 Million)**
  - **O & M Cost**: INR 300 crore **(USD 39.22 Million)** (For 10 Years)
  - Total Recycle water Supplied to Industries till Date : 1,08,604.29 ML

- **REVENUE**
  - Started with INR 18.20 per KL **(USD 0.24)** in year 2014, rate increased yearly based on actual increase in O & M cost & RBI indexation, **present rate of Treated Wastewater** is @ **INR 31.82 per KL (USD 0.42)**
  - **Annual Revenue Generation**:

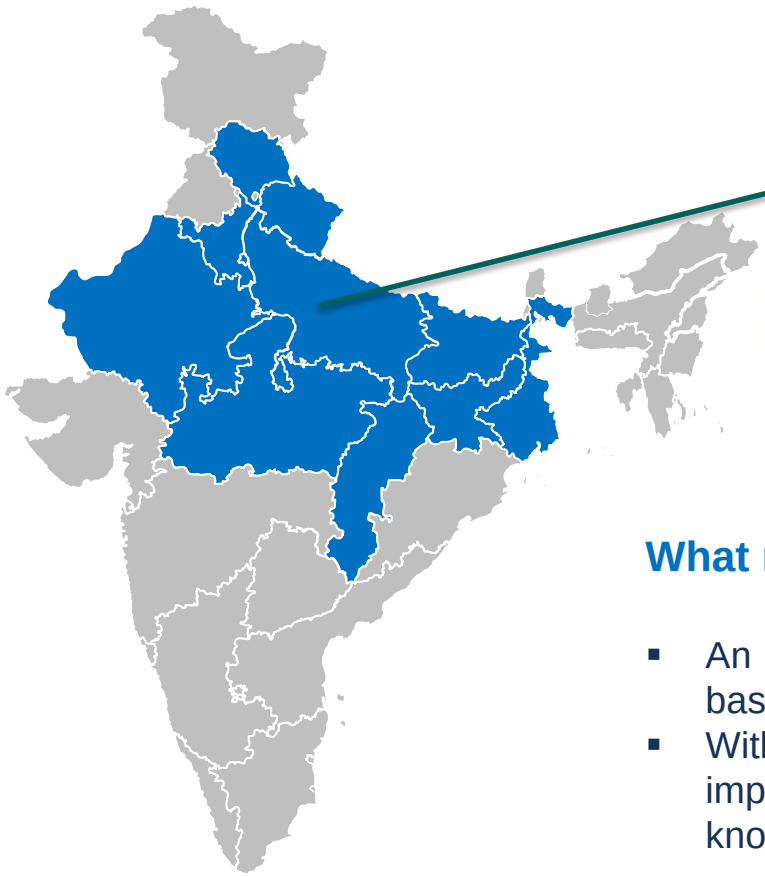
    INR 140 Cr **(USD 18.30 Million)**

Such examples are also there in other cities like Indore, Prayagraj, Nagpur etc.

Case Study 2:
STP/Recycling – NMCG, MoJS, GoI and IOCL, Mathura Refinery, India

Mathura, India

National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Govt. of India



What makes Namami Gange Program UNIQUE?

- An integrated river conservation mission for the Ganga basin (River Ganga flows 2500 Kms, across 11 States)
- With a holistic approach, works on pollution abatement, improving ecology and flow, strengthening R&D and knowledge base and people-river connect

MATHURA SEWAGE PROJECT

- **First Project under the concept of One city –One operator under HAM.**
- **Paradigm shift – Integration of existing sewage infrastructure with the development of new STPs.**
- **Re Use of Water for ensuring sustainability of assets and resources.**

Project features:

- Development of 30 MLD STP at Masani zone
- Rehabilitation of 3 existing STPs - (16 MLD UASB & 14.5 MLD WSP at Trans Yamuna and 6.5 MLD WSP at Masani) & associated infrastructure
- Development of 20 MLD TTP for supply of water to Mathura Refinery of IOCL.
- IOCL to share full O & M cost and partial capital cost of TTP through water tariff.

Payment Arrangements with IOCL:

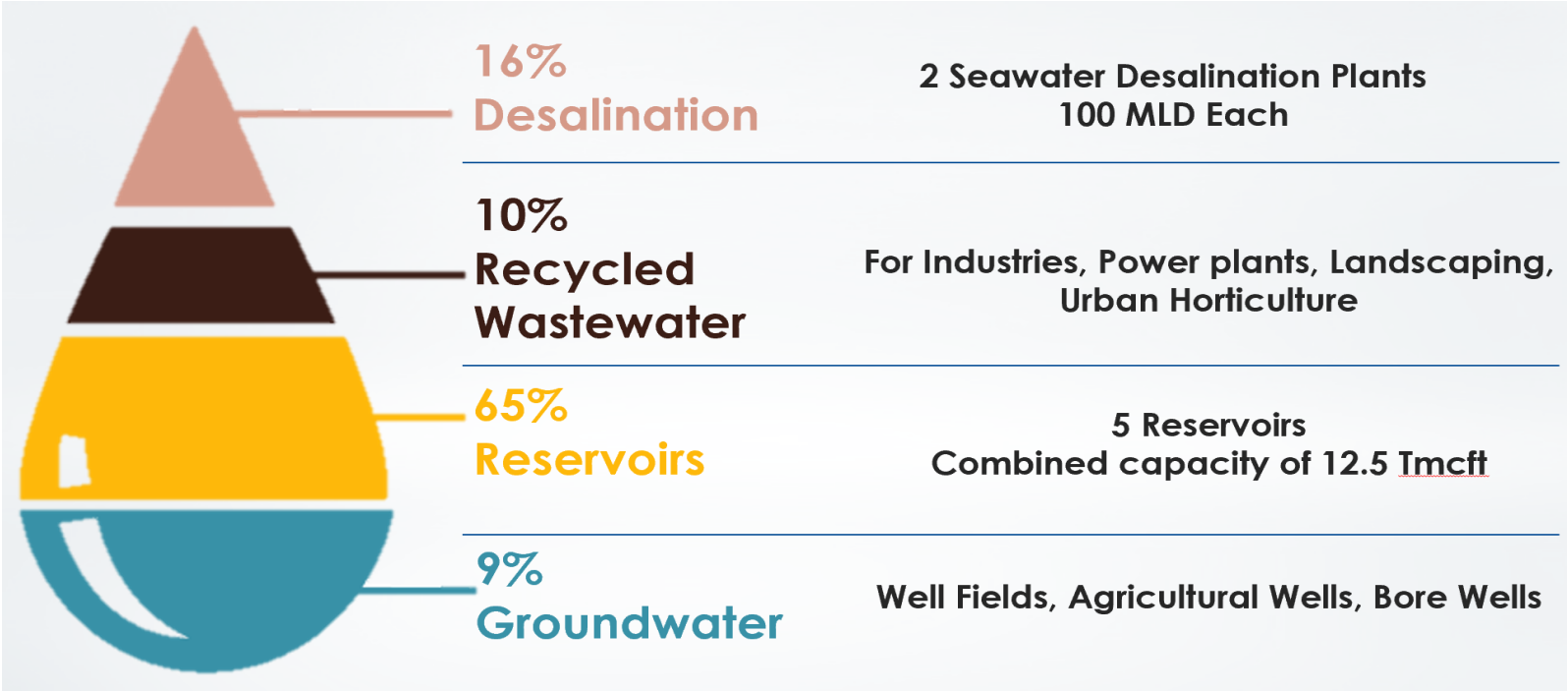
- **Power charges** of INR 42.67 Cr **(USD 5.56 Million)** and **O & M cost for TTP** at INR 39.72 Cr **(USD 5.18 Million) borne by Mathura Refinery of IOCL**.
- IOCL to pay a tariff of Rs 8.70 per KLD of water consumed towards the portion of capital cost.
- Under a tripartite agreement between IOCL, NMCG and UP Jal Nigam.
- **Volume of water to be supplied to Mathura Refinery: 20 MLD**
- Water to be delivered at Gokul Barage from which IOCL will use the existing infrastructure to pump to the refinery premises.
- Payment to the contractor is independent of the payment received from IOCL.

Case Study 3:
STP/Recycling – Chennai Metropolitan Water Supply & Sewerage Board, Chennai

Chennai, India

CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD

WATER SUPPLY IN CHENNAI
DIVERSIFIED SOURCES OF SUPPLY TO BECOME *FUTURE-READY*



WATER RECYCLING FOR INDUSTRIAL WATER SECURITY

SETTING BENCHMARK FOR URBAN WATER GOVERNANCE

45 MLD Koyambedu TTRO, Chennai, India

- Secondary treated Municipal Wastewater treated upto **potable standards**
- Multistage Treatment scheme**:** **Ultrafiltration (UF) & Reverse Osmosis**

Parameter	Influent	Effluent
BOD	20 mg/l	BDL
TDS	1500 mg/l	<70 mg/l
COD	160 mg/l	BDL

- **Treated Water supplied to Industrial Clusters in South Chennai**
- Ensuring Industrial Water Security**, Promotes Municipal-Industrial Partnerships**
- **Robust Revenue Generation model** from sale of treated wastewater
- Chennai Metro **sells treated water** to SIPCOT @ **INR 80/KL (USD 1.05),** payback period of 4 years

CATEGORY 3:
STATUS OF R&D IN INDUSTRIAL WATER REUSE

New Delhi, India

teri THE ENERGY AND RESOURCES INSTITUTE
Creating Innovative Solutions For A Sustainable Future

NAMAMI GANGE

NMCG-TERI CoE on Water Reuse

Challenges in Industrial Wastewater Treatment, ZLD & Reuse

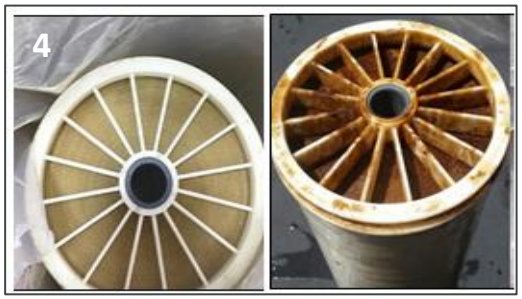
(1) Colour, COD & toxicity,

(2) Sludge,

(3) Low biodegradability, lack of shock load bearing capacity

(4) Fouling, choking, high O&M costs of membranes

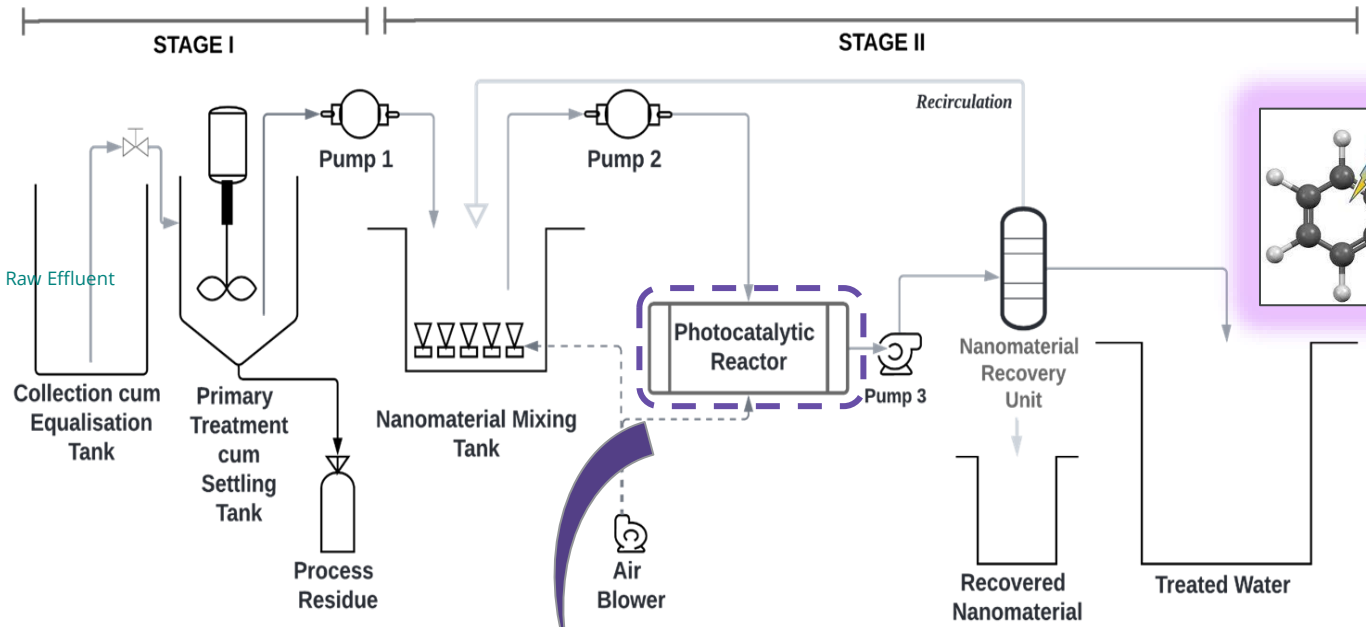
(5,6) Highly resource & energy intensive tertiary treatment, which makes ZLD costlier, unsustainable, unacceptable and non-compliant



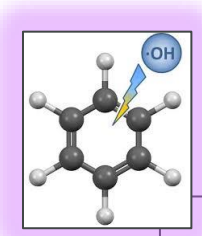
TERI ADVANCED OXIDATION TECHNOLOGY

tadox® TERI Advanced Oxidation Technology

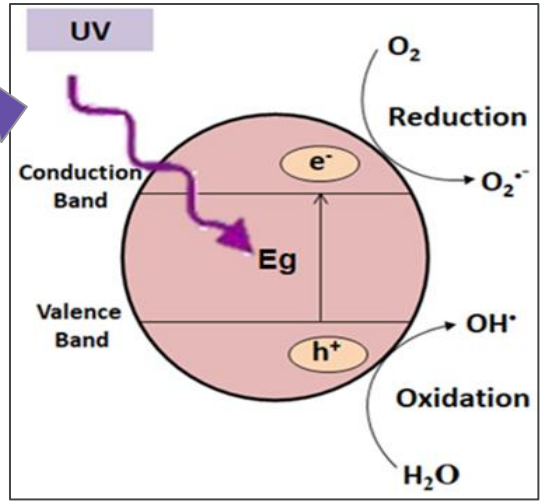
IWA the international water association



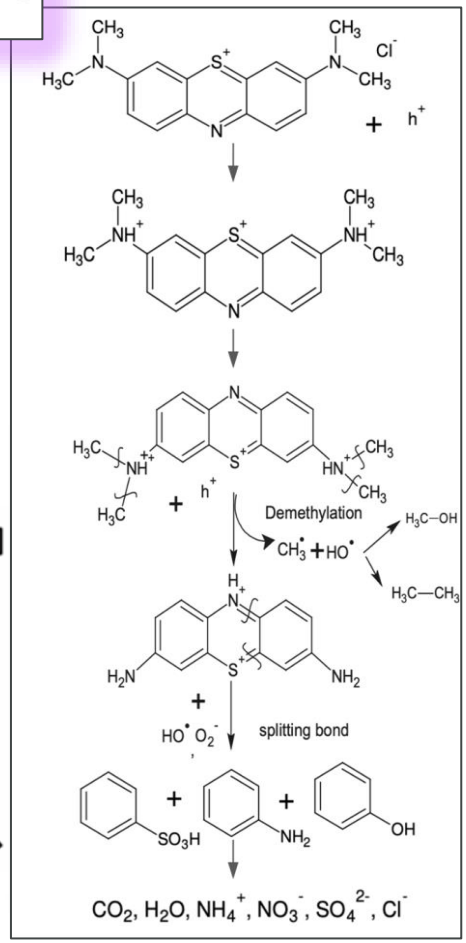
PROCESS FLOW DIAGRAM



Breaking of chemical bonds, & mineralization of pollutants in effluents

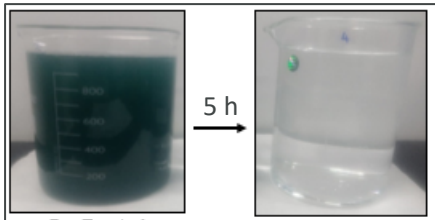


Photocatalysis

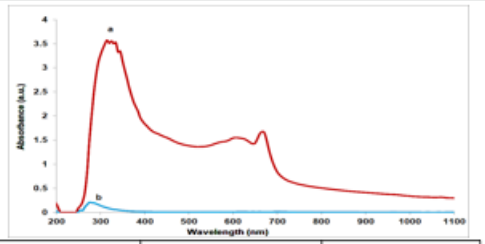


Case Study 1: Treating Industrial Wastewater at different stages as per requirement

TADOX® in Textiles WWT

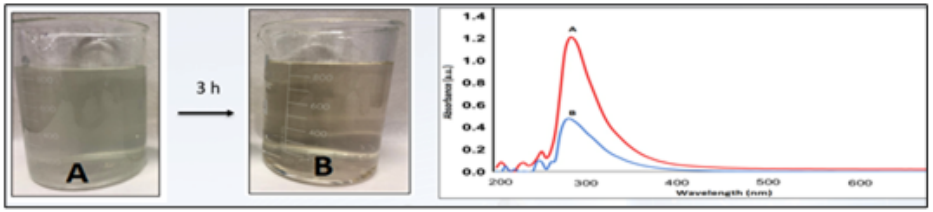


a. Pre Treated b. Post treated



S. No.	*Parameter (mg/l)*	Pre Treated	Post Treated	% change
1	pH	7.62	9.1	-
2	Conductivity (µmho/cm)	3470	130	96%
4	TSS	850	4	99.53%
5	TDS	3823	163.3	96%
6	Chloride	240	30	88%
7	Hardness	60	ND	100%
8	BOD_5	255	12	95%
9	COD	1360	128	91%

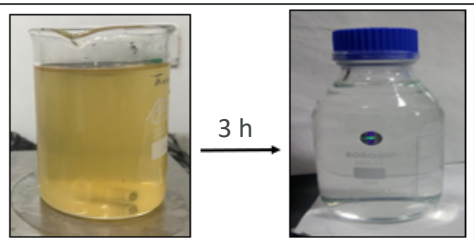
TADOX® in Oil & Gas WWT



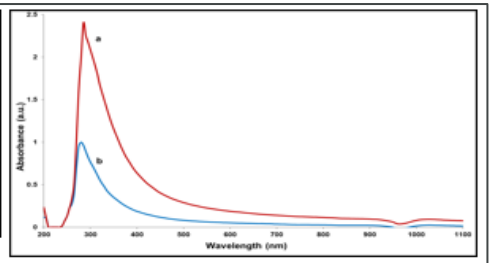
Pre-TADOX® Post-TADOX®

Parameters	Pre-TADOX®	Post-TADOX®
pH	8.16	8.91
BOD_5, mg/L	20.96	41.96
COD, mg/L	128 *BOD/COD=0.09*	80 *BOD/COD=0.38 (biodegradability improved)*
TDS, mg/L	7041	3357
Oil & Grease, mg/L	588	31.20
Zn, mg/L	0.20	0.05
Pb, mg/L	0.40	Nil

TADOX® in Pharmaceutical WWT

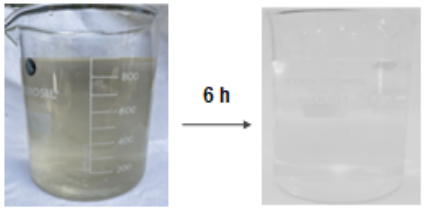


a. Tertiary treated ETP Outlet b. Finally Treated

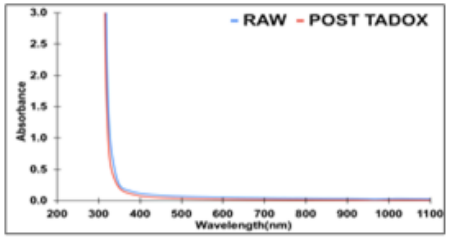


S. No.	Parameter (mg/l)	Pre-treated	Post-treated	%Change
1	pH Value	6.2	8.1	_
2	BOD_5	255	11	96
3	COD	1200	80	93
4	Total Nitrogen (Organic Nitrogen+ Ammonical Nitrogen)	10.1	1.0	90
5	Total Ammonia	ND	3.39	_
6	Reactive Phosphorous	5.5	0.1	98.18

TADOX® for MEE Condensate



Pre-TADOX® Post TADOX



Parameters	Pre-TADOX®	Post-TADOX®
pH	10.96	8.01
Color, Pt-Co Colour Units (CU)	92.21	10.5
Total Dissolved Solids (TDS), mg/l	228	144
Total Suspended Solids (TSS), mg/l	157	106
Turbidity, NTU	9.31	2.02
Chemical Oxygen Demand (COD), mg/l	2400	600
Nitrate, mg/l	65.01	45.3
Phosphate, mg/l	0.265	0.23

Case Study 2: Treating Municipal Wastewater for Industrial Reuse (Delhi STP)

PHYSICAL CHARACTERISTICS

pH	7.2
Colour, Hazen	292.4
TDS, mg/L	342.0
Total Solids, mg/L	780.0
TSS, mg/L	438.0

STP Inlet

5 h

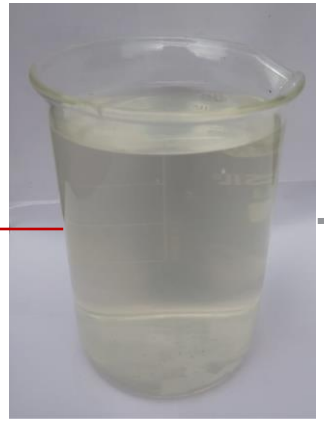
Direct TADOX®

pH	8.0	-
Colour, Hazen	1.4	99.5%
TDS, mg/L	91.3	73%
Total Solids, mg/L	101.0	87%
TSS, mg/L	9.7	98%

Current Conventional Treatment

24 h

pH	7.2	-
Colour, Hazen	116.4	60%
TDS, mg/L	368.0	-
Total Solids, mg/L	650.0	17%
TSS, mg/L	282.0	36%



STP Outlet

3 h

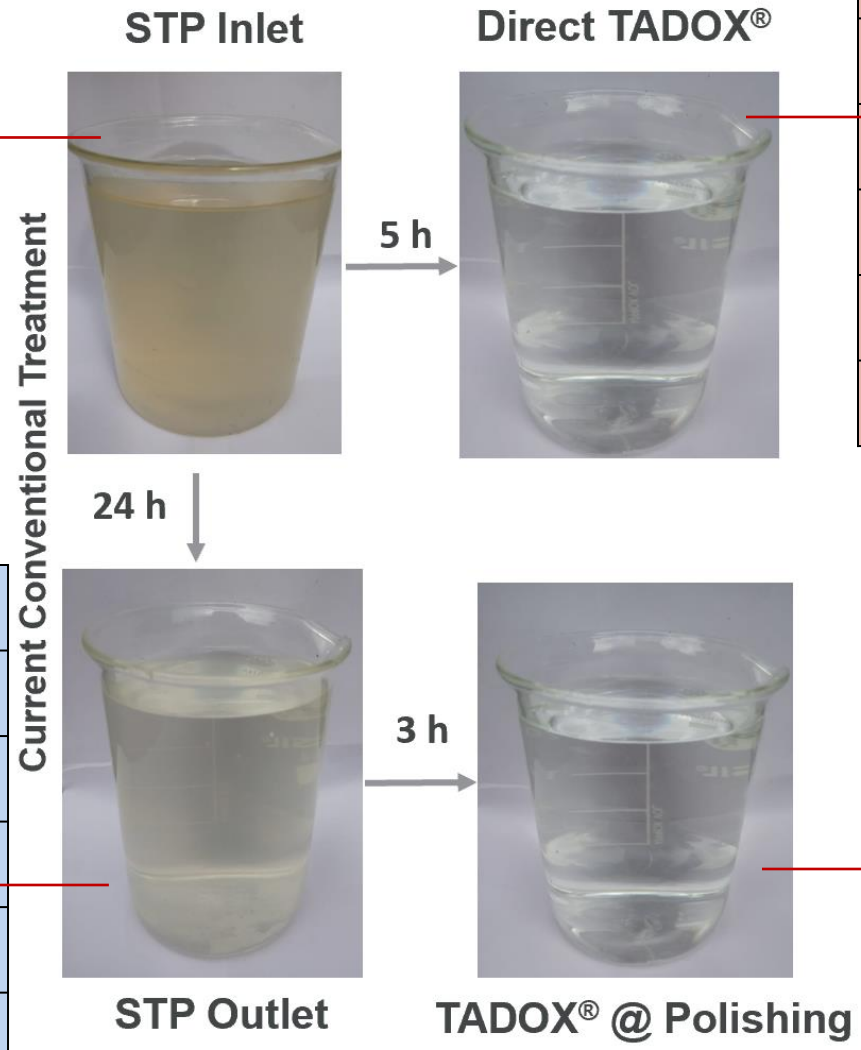
TADOX® @ Polishing

pH	8.8	-
Colour, Hazen	<1	100%
TDS, mg/L	119.0	65%
Total Solids, mg/L	132.0	83%
TSS, mg/L	13.0	97%

CHEMICAL CHARACTERISTICS

COD, mg/L	352.00
BOD, mg/L	115.00
NO_3, mg/L	17.51
PO_4, mg/L	4.45
NO_2, mg/L	0.11
NH_4, mg/L	7.20

COD, mg/L	21.50	94%
BOD, mg/L	<2	99%
NO_3, mg/L	6.19	65%
PO_4, mg/L	0.08	98%
NO_2, mg/L	0.75	-
NH_4, mg/L	3.40	53%



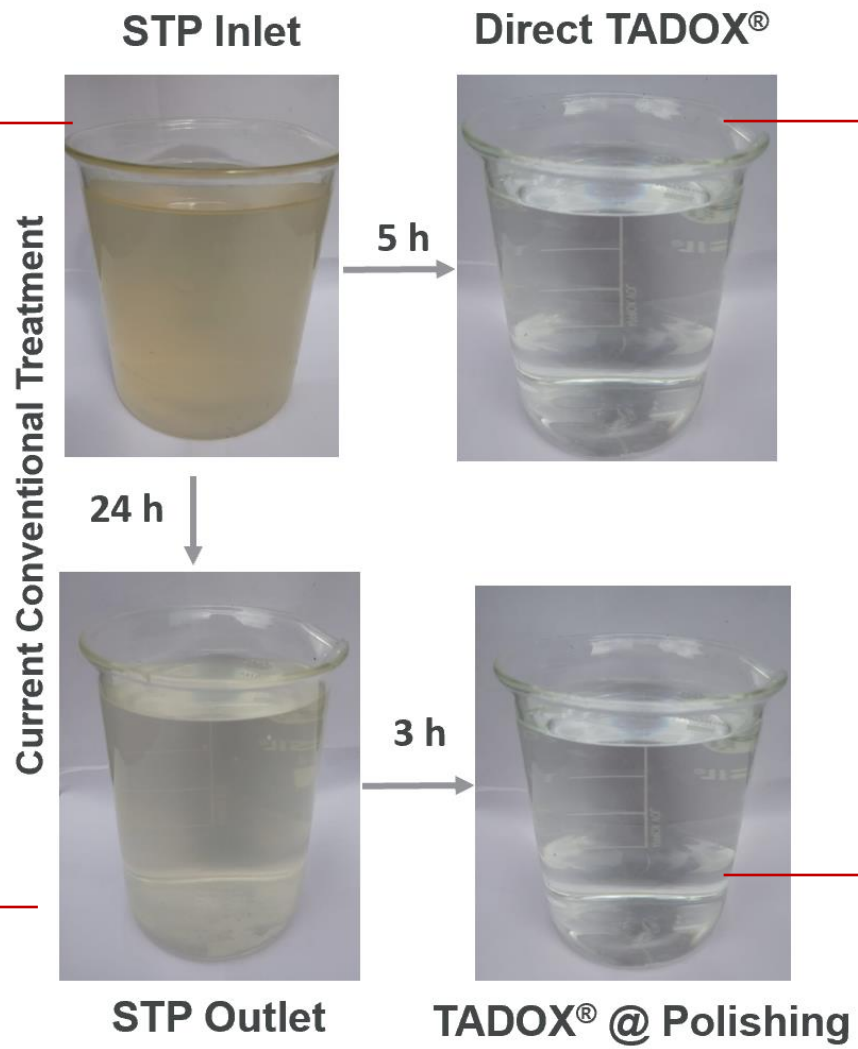
COD, mg/L	88.00	75%
BOD, mg/L	32.00	72%
NO_3, mg/L	14.10	20%
PO_4, mg/L	0.50	89%
NO_2, mg/L	0.19	-
NH_4, mg/L	3.20	55%

COD, mg/L	24.0	93%
BOD, mg/L	<2	99%
NO_3, mg/L	2.99	83%
PO_4, mg/L	0.03	99%
NO_2, mg/L	0.11	-
NH_4, mg/L	2.10	71%

BIOLOGICAL CHARACTERISTICS

E Coli, MPN/100ml	1.32×10^4
Total Coli, MPN/100ml	8.9×10^4
Total Aerobic Count, CFU/ml	7.13×10^5
SARS CoV2	Present

E Coli, MPN/100ml	ND
Total Coli, MPN/100ml	3
Total Aerobic Count, CFU/ml	7
SARS CoV2	Absent



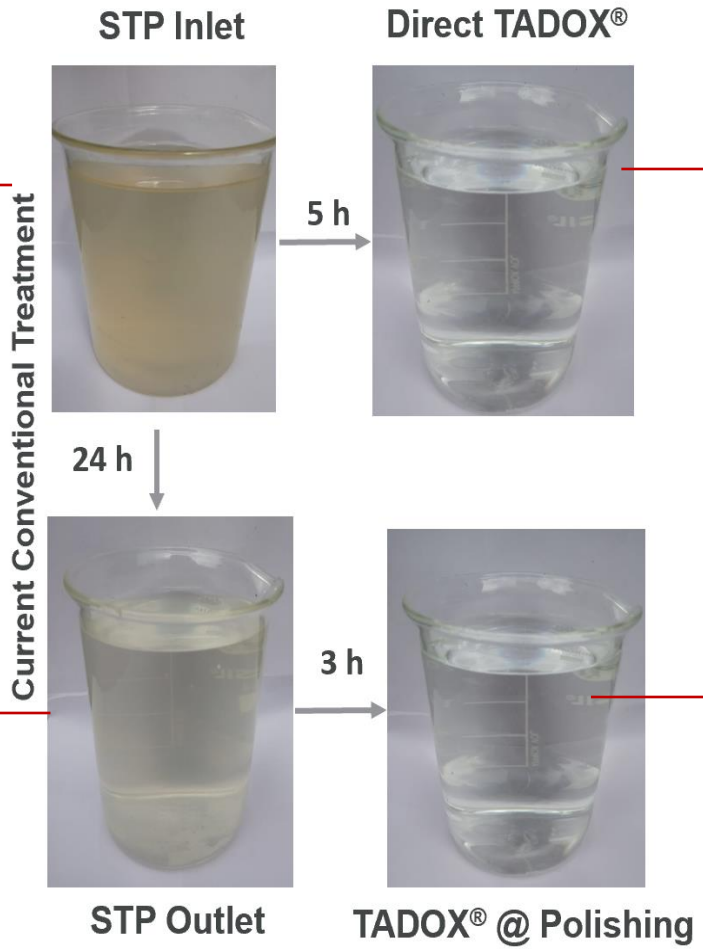
E Coli, MPN/100ml	6.0×10^4
Total Coli, MPN/100ml	2.3×10^4
Total Aerobic Count, CFU/ml	6.07×10^4
SARS CoV2	Absent

E Coli, MPN/100ml	ND
Total Coli, MPN/100ml	1
Total Aerobic Count, CFU/ml	5
SARS CoV2	Absent

MICROPOLLUTANT (ug/L) CHARACTERISTICS

Caffeine (CFF)	2.34
Naproxen (NPX)	1.32
Bisphenol A (BPA)	0.42
Sulfamethoxazole (SMX)	0.18
Acetaminophen (ACN)	12.40
Ibuprofen (IBU)	34.50
Diclofenac (DCF)	91.23

Caffeine (CFF)	<0.05	99%
Naproxen (NPX)	0.11	92%
Bisphenol A (BPA)	0.09	79%
Sulfamethoxazole (SMX)	0.06	99%
Acetaminophen (ACN)	0.19	98%
Ibuprofen (IBU)	0.71	98%
Diclofenac (DCF)	1.20	99%



Caffeine (CFF)	0.83	64%
Naproxen (NPX)	0.78	41%
Bisphenol A (BPA)	0.324	23%
Sulfamethoxazole (SMX)	0.17	5%
Acetaminophen (ACN)	11.20	9%
Ibuprofen (IBU)	28.10	19%
Diclofenac (DCF)	83.20	9%

Caffeine (CFF)	0.07	97%
Naproxen (NPX)	0.08	94%
Bisphenol A (BPA)	0.05	88%
Sulfamethoxazole (SMX)	ND	100%
Acetaminophen (ACN)	0.23	98%
Ibuprofen (IBU)	0.63	98%
Diclofenac (DCF)	0.98	99%

ACKNOWLEDGEMENT

- IWA Water Reuse Specialist Group
- National Mission for Clean Ganga (NMCG), MoJS, Govt. of India
- DST-Water Mission, Water Technology Initiative (WTI), Ministry of Science & Technology, Govt. of India
- Chennai Metropolitan Water Supply & Sewerage Board, Chennai
- VA Tech Wabag, Chennai
- Balkrishna Industries (BKT), Bhuj, Gujarat
- Surat Municipal Corporation, Surat
- Indian Oil Corporation Ltd. (IOCL), Mathura
- All other partners and funders

INDUSTRIAL WASTEWATER RECLAMATION, WINDHOEK NAMIBIA

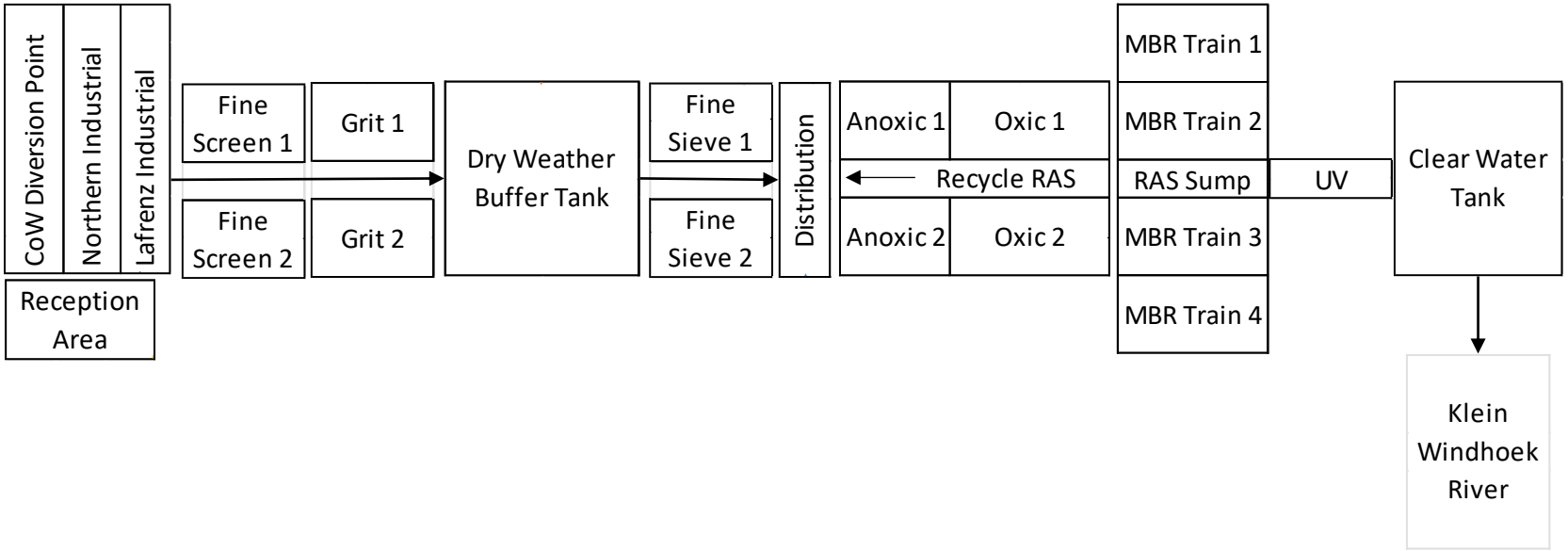
JAMES VILLET
UJAMS WASTEWATER TREATMENT COMPANY. WINDHOEK, NAMIBIA

inspiring change

UJAMS WATER RECLAMATION PLANT

- Operated by Ujams Wastewater Treatment Company (UWTC) for a period of 21 years according to the BOOT contract signed with City of Windhoek (PPP)
- Commercial operation since 14th November 2014
- Design Treatment Capacity of 5.2 ML/day
- Designed to receive wastewater from Windhoek's Northern & LaFrenz Industrial Areas
- Waste Producers: Meatco (abattoir), Namibia Breweries Ltd (brewery), Nakara (tannery), Namibia Beverages (Coca Cola)
- Designed for operation up to the year 2035, Ujams employs the use of a diversion valve to channel municipal waste from the Klein Windhoek and Eros residential areas to meet design treatment capacities at present.

PROCESS OVERVIEW



FINE SCREEN & GRIT PROCESS

Fine Screen

- 5mm Bar spacing
- Differential Level Cleaning
- Compactor to remove excess water

BOOT contract specifications:

- 25% Dry Solids

Plant Achievement:

- Average 55% DS for period 2014 to date.

Grit Removal

- 650m^3/h circular flow chamber
- Mixer with scraper blades
- Grit slurry pumped to classifier
- Cleaned Grit conveyed into skip

BOOT contract specifications:

- 25% Dry Solids

Plant Achievement:

- Average 80% DS for period 2014 to date.

DWBT & FINE SIEVE PROCESS

DWBT

- 1225 m^3 volume, 3-4 hours retention time
- 2 x Mixers and 1 x submersible aerator
- pH stabilisation – HCl and NaOH dosing
- Cl_2 neutralisation – Sodium Metabisulphite

Plant Loading Profile:

- COD: 1500 - 4500 mg/l
- NH4: 60-120 mg/l
- TKN: 100 – 175 mg/l
- TP: 65 – 155 mg/l
- PO4-P: 25 – 55 mg/l

Fine Sieve

- Texture Mesh size: Fine Sieve – 500 µm
- CIPs with KOH solution to remove FOG

BOOT contract specifications:

- 25% Dry Solids

Plant Achievement:

- Average 27% DS for period 2014 to date.

BIOLOGICAL & MBR PROCESS

Biological

- 2 trains in parallel operation
- Denitrification chambers with mixers
- Nitrification chambers with fine bubble dome diffusers
- Sludge Retention Time design – 12 days. Typical SRT 8-10 days
- Aeration achieve 1.0 mg/l O_2

MBR

- 4 trains Zeeweed 500D membranes
- MCs - weekly per MBR train. NaOCl and Citric Acid
- 12m filtration, 60s relaxation, 45s backflush per 5 cycles of filtration
- 2 x RC's conducted annually.

Plant Achievement:

- 200 – 300 lm^2hbar

UV DISINFECTION & CWST PROCESS

UV

- Second microbiological barrier.
- CIPs with citric acid every 3 months

BOOT contract specifications

- Faecal coliforms < 200 CFU/ml

Plant Achievement:

- Faecal Coliforms <1 CFU/100ml
- Somatic Coliphages <1PFU/100ml

CWST

- Effluent discharge - Klein Windhoek river.
- Supporting the rehabilitation of the Upper Swakoppoort River Basin System.
- Effluent quality meets the BOOT contract specifications > 99.0% of the operational period.
- Plant production average at 92% of design capacity from 2014 to date.

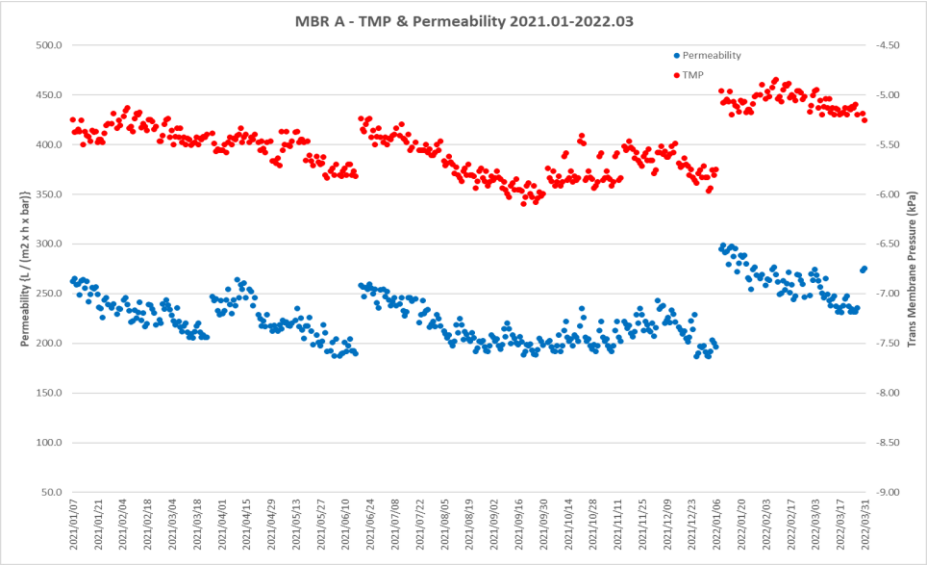
PERMEATE & MBR PERFORMANCE

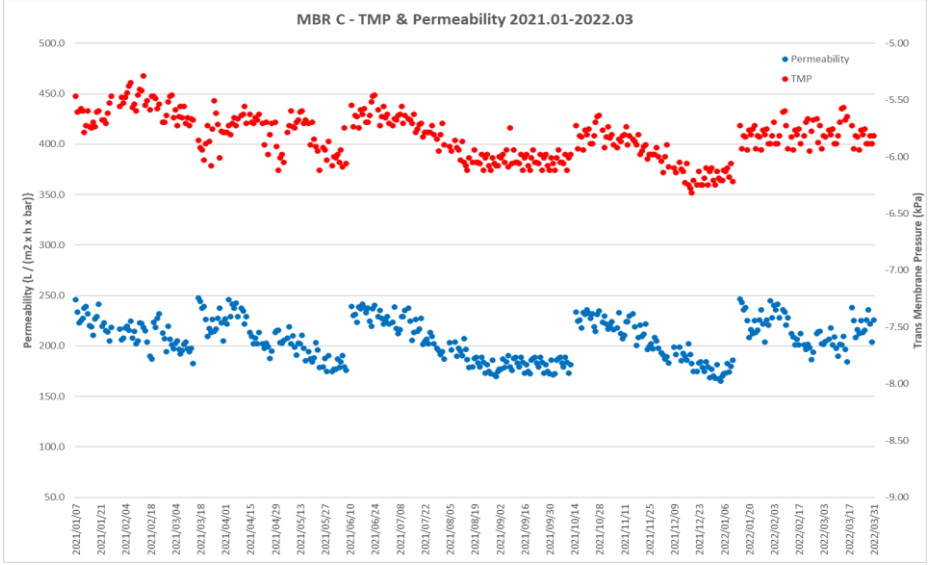
Permeate Quality Profile:

COD:	40-50 mg/l
BOD5	< 2 mg/l
NH4	0.1-0.5 mg/l
TKN	1-3 mg/l
TP	0.2-0.5mg/l
PO4-P	0.1-0.3 mg/l

MBR Performance Profile: lm^2hbar

2014:	400
2015:	373
2016:	342
2017:	327
2018:	314
2019:	297
2020:	284
2021:	271





PERMEATE POTENTIAL REUSE OPTIONS

- Planned Eros Golf Course and existing Windhoek Golf Course
- Dust Suppression - A1 dual carriage highway construction
- Private use with Gantry installation
- Dobra Informal Settlement use of flowing water
- Informal Farming water reuse for Cattle and Goats and RO system for vegetable production
- Mining operations, Mittel and Lodestone Mines
- Formal agriculture reuse

UWRP PHASE 2 POSSIBILITY

- Increasing plant capacity- 6250 m^3/day.
- Biogas production through anaerobic digestion of sludge with Co-substrates from identified industries.
- Produce 100% of power required on site, daily power demand, 7-8 MWh/day.
- Solar drying installation will receive dewatered stabilized sludge
- Secondary usage of stabilized dried sludge. Filler material for construction.
- Plant could become a net zero CO_2 emitter in future.

Thank You

WATER RECLAMATION TO INDUSTRIAL USER

MR. VARANON LAOSUWAN
WHA UTILITIES & POWER PCL, THAILAND

inspiring change

ABOUT WHAUP

- WHAUP is the Flagship Company in Utilities and Power Business of WHA Group

Logistics

- #1 Logistics developers, with more than 2.5 million sqm under owned and managed
- Built-to-Suit (BTS): Providing the premium and world-class logistic facilities and factories for lease that match requirements in terms of location, design, and expansion of clients' businesses
- Warehouse Farm: Combination of Built-to-Suit and Ready-Built Projects in the same strategic location.
- Built-to-Own (BTO): Warehouse or factory customized to client's special needs then transfer the asset to the client
- Potential geographical expansion in cross-border provinces and overseas investment

Industrial Development

- #1 Industrial Estate Developer
- 12 Industrial Estates in Thailand's and Vietnam's most strategic industrial locations
- Ample Land stock – Net developed/to develop industrial land in Thailand approx. 7,700 in existing strategic industrial estates and over net 3,500 rai to develop in the 3 upcoming industrial estates plus another commercial land approx. 2,700 rai
- WHA Industrial Zone - Nghe An Phase1 in Vietnam, covering a gross area of 145 ha or 900 rai, is now completed. 56% of the sellable land has been leased. For Phase2 of WHA Industrial Zone -Nghe An, covering 355 Ha or 2,200 rai, will start construction in early 2022
- Ready-Built factory & warehouse in IEs and logistic park
- Potential geographical expansion in cross-border provinces and overseas investment

Utilities & Power

- Exclusive utilities provider in the industrial estates with high margin products and steady growth
- Active power investor with strategic partnership with reputable partners.
- **135 mm^3** utility sales & management volume in Thailand and Vietnam in 2021
- **607** Operational Equity MW* and growing to 642 Equity MW by 2022 from projects under construction and in pipeline.

* As of 31 December 2021

Digital Platform

- To be one-stop service for Data Center developer and provider by way of business collaboration with reputable partners
- Be part of the Government Initiative to promote digital economy

ABOUT WHAUP

- Business Overview

Utilities Business

Sole provider of utilities to manufacturers/ factories in WHA ID's Industrial Estates with a concrete plan to capture increasing demand from heavy users and expand outside i.e. other IEs, non-IE area and international

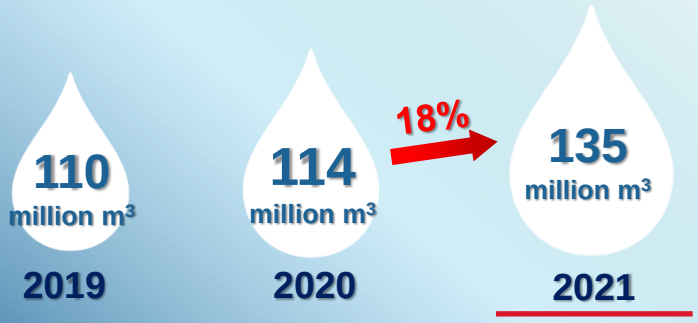
Raw Water

Industrial Water
- *Process water*
- *Clarified water*

Demineralized Water

Wastewater Treatment

Reclaimed Water



Water Sale and Management Volume

Power Business

Active power investor with strategic partnership with leading Thai and international power companies

547 MWeq

Conventional

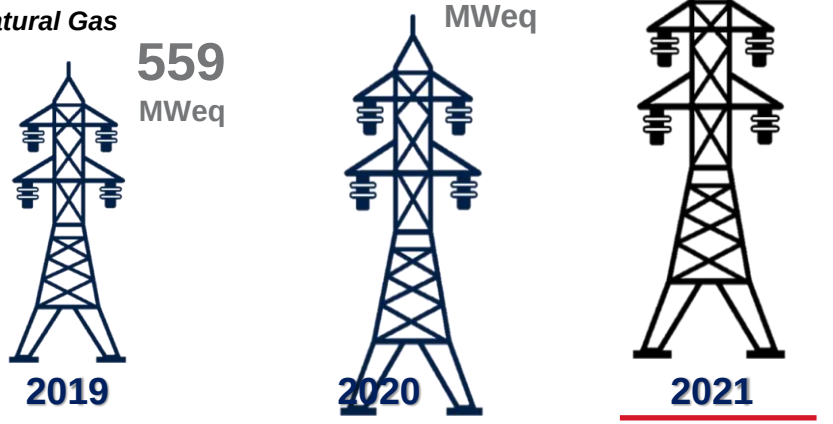
2.9 MWeq

Industrial Waste to Energy

57.1 MWeq

Renewable

Natural Gas



Installed Equity MW under Operation

* Data as of Q4/2021

ABOUT WHAUP

- **Business Overview - Vietnam**

4.4 Million m³/year
Water Distribution Capacity

WHA Nghe An Industrial Zone 1
(100% Shareholding equity)

Increasing water distribution volume and utilization of wastewater treatment capability from the commissioning of customers' plants

Duong River Surface Water Treatment Plant
(34% Shareholding equity)

Increasing customers base and water supply coverage areas to nearby provinces (Bac Ninh, Hung Yen)

110 Million m³/year
Water Distribution Capacity

Cua Lo Water Plant
(47% Shareholding equity)

Expanding capacity to accommodate the expanding demand from industrialization and urbanization

4.7 Million m³/year
Water Distribution Capacity

Actively exploring for greenfield utilities project and M&A opportunities in Vietnam

UTILITIES BUSINESS IN THAILAND

- WHAUP provides utilities services to 11 operating WHA Industrial Estates plus developing Zones (SIL Phase 2, IER and Vietnam) in the future

WHA ESIE1
Capacity : 54,000 m3/day

- **Water Treatment Plant**
  System: Hydro Ripple

WHA CIE2
Capacity : 6,000 m3/day

- **Water Treatment Plant**
  System: Hydro Ripple

WHA ESIE2
Capacity : 12,000 m3/day

- **Water Treatment Plant**
  System: Hydro Ripple

WHA ESIE1
Capacity : 18,200 m3/day

- **Wastewater Treatment Plant**
  System: Constructed Wetlands

WHA CIE2
Capacity : 1,600 m3/day

- **Wastewater Treatment Plant**
  System: Aerated Lagoon

WHA ESIE2
Capacity : 10,000 m3/day

- **Wastewater Treatment Plant**
  System: Aerated Lagoon

UTILITIES BUSINESS IN THAILAND

- WHAUP provides utilities services to 11 operating WHA Industrial Estates plus developing Zones (SIL Phase 2, IER and Vietnam) in the future

- **Water Treatment Plant**
  System: Solid Contact

- **Water Treatment Plant**
  System: Hydro Ripple

- **Water Treatment Plant**
  System: Pulsator & Sand Filter

- **Wastewater Treatment Plant**
  System: Activated Sludge

- **Wastewater Treatment Plant**
  System: Aerated Lagoon

- **Wastewater Treatment Plant**
  System: Activated Sludge

WHAUP WATER & WASTEWATER INNOVATION TIMELINE

the international water association

2000

The collaboration with AIT regarding the state of the art wastewater treatment system **"Vertical Flow Constructed Wetland : VFCW"**

2001

- **2001**: The first VFCW plant has been construct in ESIE (Rayong) as the first large scale constructed wetland in Thailand which also proven to treat wastewater in industrial estate
- Later , the VFCW contribute for the Eco Industrial Estate success for WHA Group
- VFCW later has been implemented by various organization , EECi in 2020

2016

- **2016** : WHA initiated the corporate CSR : **Clean Water for Planet** in order to integrate group's expertise and innovation on water & wastewater to others

Clean Water for Planet

- **Dec 2016** : The pilot test of the Wastewater Reclamation in WHAEIE

2019 - 2021

- **Mar 2019: Demineralized Reclamation Water (DRW)** has been introduced and start service to the Power plant in WHA EIE
- **Aug 2021**: WHAUP's DRW ***"the Real Sustainable Resource for Future Development*** has been awarded in 2021 SET Innovation Company Award

1997

The first Wastewater recycle plant

was introduced to ESIE (Rayong) in order to service the "second grade water" to the manufacturer

2001

- The largest industrial central wastewater treatment plant by **Activated Sludge (AS)** – 60,000 cmd at WHA EIE

2015

At WHA SIL, the first **Hybrid RBC (Rotating Biological Contractor)** has been implemented to improve the efficiency of the wastewater treatment system

2017

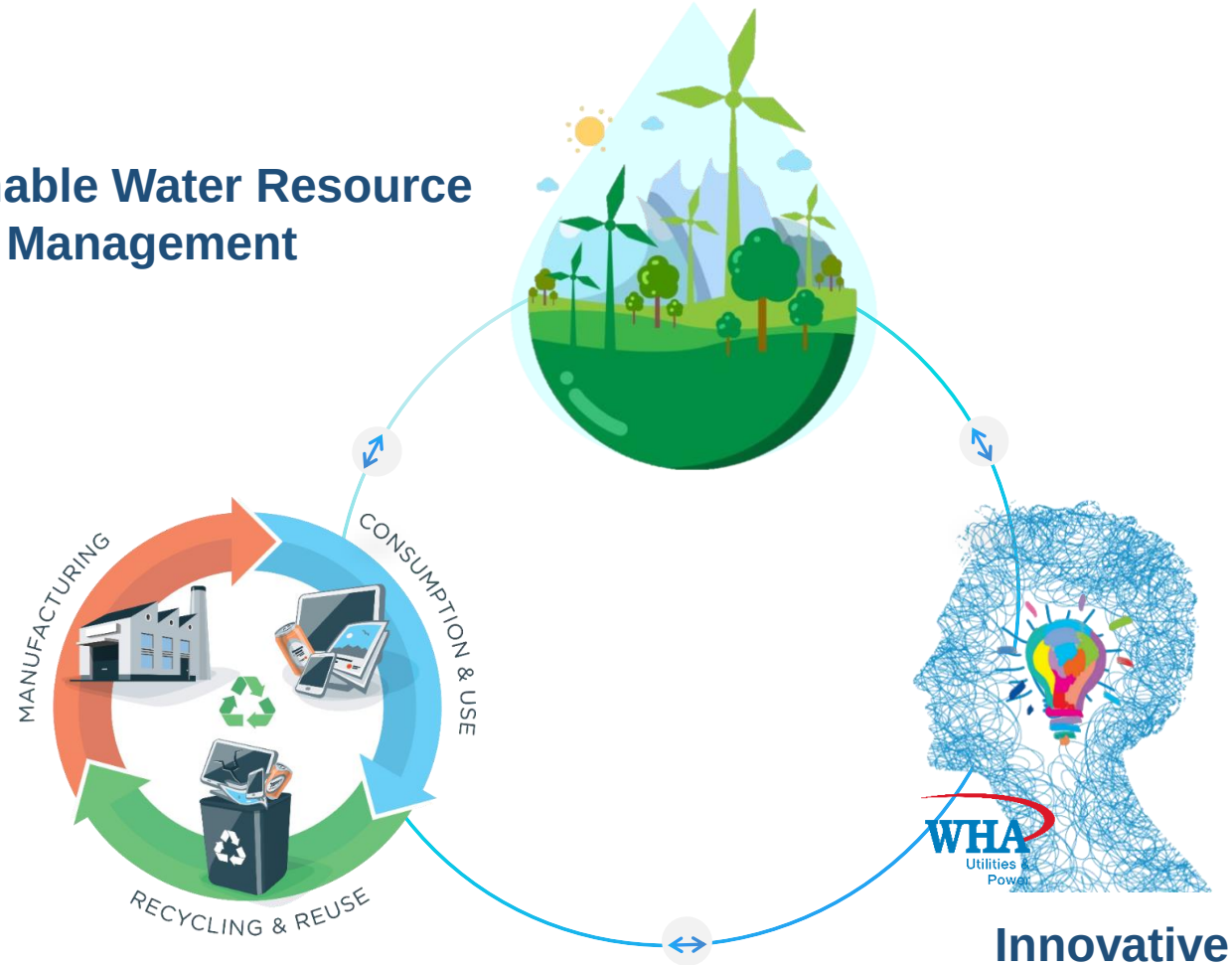
Jun 2017:

- The first 7,500 cmd of **Wastewater Reclamation** plant using Submerged UF and RO has been construct and then COD in the next year
- Now the total capacity at WHA EIE is 25,000 cmd

CONCEPT OF WHAUP'S SUSTAINABLE INNOVATION

the international water association

Sustainable Water Resource Management



Circular Economy

Innovative Corporate Culture

CONCEPT OF WHAUP'S SUSTAINABLE INNOVATION

the international water association

A Conventional Water Management

Reservoir

Raw water

- Invested by Government
- Conflict of users (Industrial vs Domestic)
- Drought Situation

Central WTP

WHA Utilities & Power — Industrial Water

Industrial Users

Central WWTP

WHA Utilities & Power — Wastewater

Environment

Individual Water Plant

Pain points :

- ✖ No space to expand utilities area
- ✖ Cannot focus on the core business

B Change to the Sustainable Water Resource Management

Reservoir

Raw water

~~Invested by Government~~
Conflict of users (Industrial vs Domestic)
Drought Situation

Central WTP

WHA Utilities & Power — Industrial Water

Industrial Users

Central WWTP

WHA Utilities & Power — Wastewater

Environment

WHAUP's Demineralized Plant

Reclamation Plant

WHA Utilities & Power — RO Water

Strong points :

- ✔ Better water quality
- ✔ Lower cost
- ✔ Environmental-friendly method

CONCEPT OF WHAUP'S SUSTAINABLE INNOVATION

the international water association

B

Change to the Sustainable Water Resource Management

Industrial Users

WHA EIE Wastewater Treatment Plant Capacity 60,000 cmd

Wastewater Treatment Plant
Activated Sludge Process

Effluent Tank

Feed in Treated Water

Demineralized Plant Capacity 12,000 cmd

8,400 cmd

Mixed Bed Polisher
final polishing done by Cation and Anion to remove remaining ions in water prior to use

Demin water storage tank
Total Volume: 400 cu.m.

Mixed Bed Unit
50/50 mixture of Cation and Anion resin combined in ion-exchange column

Reclamation Plant Capacity 25,000 cmd

UF Membrane Unit
To reduce remaining turbidity in water
- Membrane Type: Submerged
- Filtration mode: Outside-in
- Operating Flux: 52 LMH
- Recovery rate: 94%

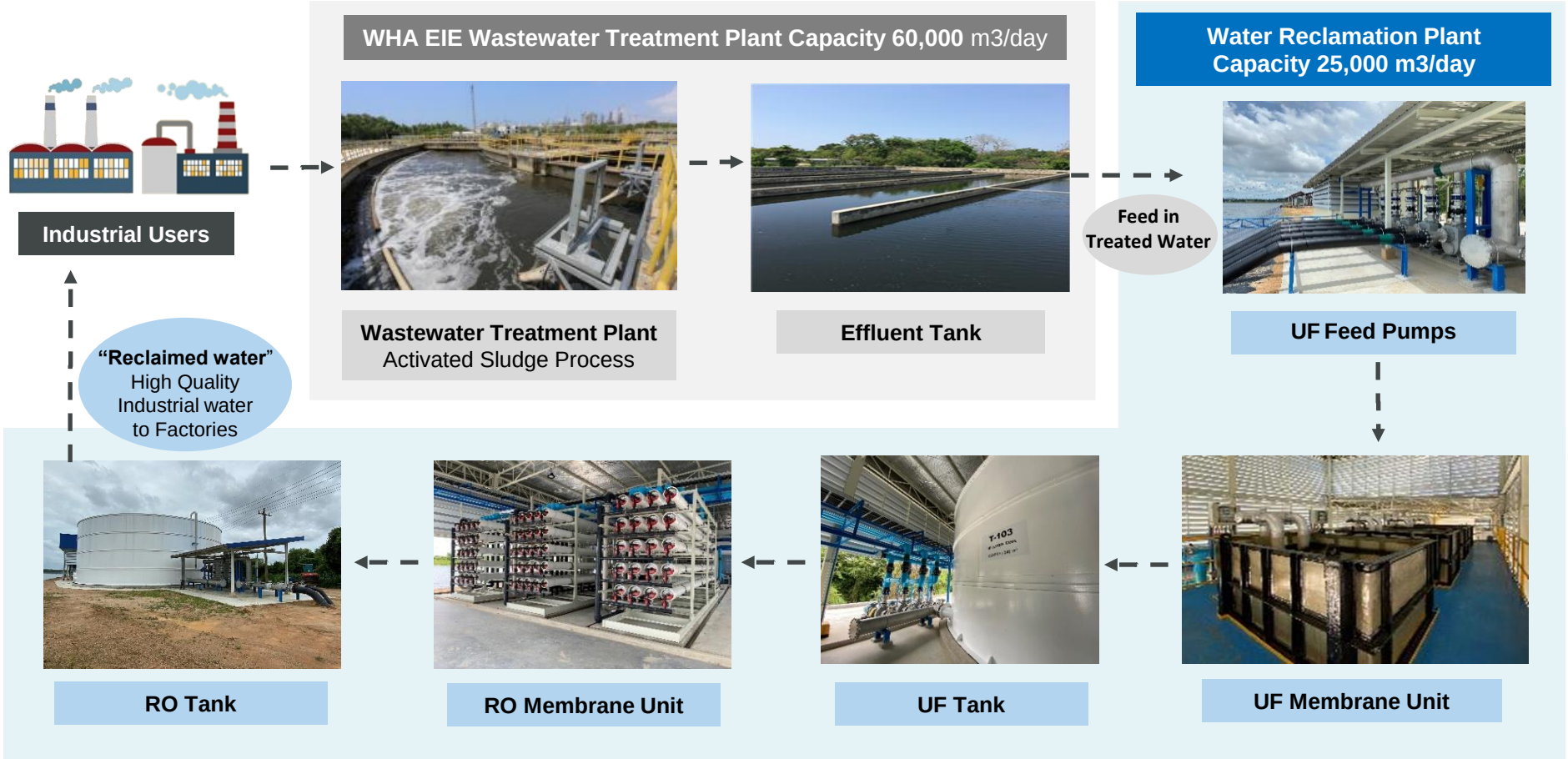
RO Unit
To reduce total dissolved solids (TDS)
- Flux rate: 15.7 LMH
- Production capacity: 25,000 m3/d
- System recovery rate: 66%
- Projected salt rejection: ≥ 95%

WATER RECLAMATION

- **WHA EIE (Map Ta Phut):** Total Water Solutions

WATER RECLAMATION

- **Basic System Flow diagram of Water Reclamation System**



WATER RECLAMATION

- **Water Reclamation to Indutrial User**

Concept is the solution to enhance the proven water technologies and expertise in water businesses of WHAUP

HIGHER QUALITY AT LOWER PRICE : USER enjoy the higher quality of industrial water at the lower price compared to existing provider during the contractual period.

CONCENTRATE ON CORE BUSINESS : Because the product is RO quality, in general no need for further treatment works, give USER more time to strengthen and focus on core business process and mission.

ENVIRONMENTAL IMPACT MITIGATION : Implementing this solution will minimize the impact to environment and social significantly as the wastewater to be discharged to public is reduced substantially. USER can claim the use of reclaimed water as one of its effort in taking care environment & water resources.

SECURE FOR FUTURE RESOURCES : Particularly in EEC & High consumption area, water resources is limited, water reclamation will be the solution to secure the sustainability development for industrial users.

WATER RECLAMATION TO INDUSTRIAL USER

- **Thailand Largest Water Reclamation Plant in WHA EIE (Map Ta Phut)**

Capacity: 25,000 m3/day
System: RO Unit + UF Membrane Unit
Product type: RO Water specification (Application for Clarified Water and Pre-Demin Water)

- **Demineralized Water for GPSC**

Location: WHA EIE (Map Ta Phut)
Capacity: 12,000 m3/day
System: RO Unit + Mixed Bed Unit
Product type: Demineralized Water for GPSC CUP-1

WATER RECLAMATION TO INDUSTRIAL USER

- **Premium Clarified Water from Water Reclamation Plant**

  Gulf VTP and Gulf TS1&2

Location: ESIE (Rayong)
Capacity: 5,200 m3/day
System: RO Unit + UF Membrane Unit
Product type: Premium Clarified Water

Gulf TS3&4 (Under construction)

Location: WHA ESIE1
Capacity: 3,800 m3/day
System: RO Unit + UF Membrane Unit
Product type: Premium Clarified Water

WATER RECLAMATION TO INDUSTRIAL USER

- **Asia Industrial Estate Water Reclamation and Demineralized Plant**
  (Under construction)

Location: Asia industrial estate
Capacity: 2,200 m3/day (expended to 7,500 m3/day)
System: RO Unit + Mixed Bed Unit
Product type: Demineralized Water

Thank You

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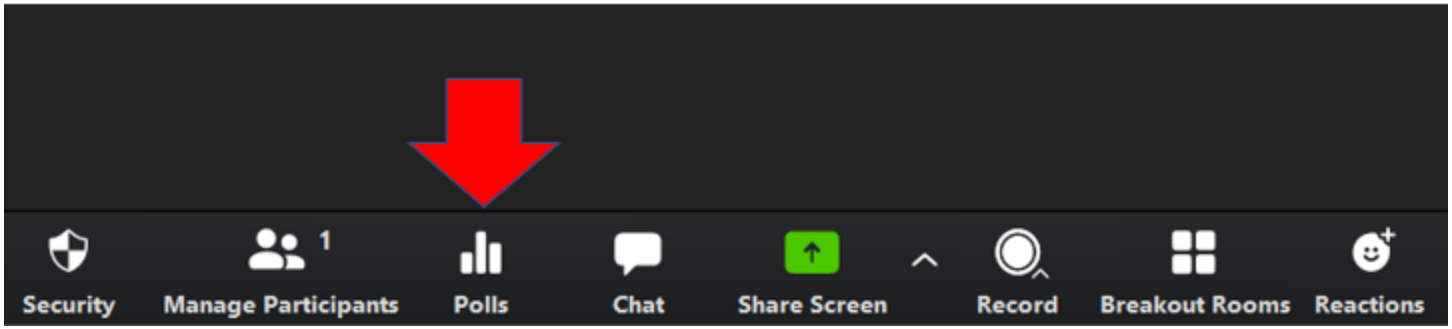
Poll & Q&A Discussion

MODERATOR: OLIVIER LEFEBVRE

inspiring change

POLL



Participate in the poll and share your answer with us!

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Stay tunned for our next webinars:

https://iwa-network.org/learn/process-emissions-masterclass-2

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