Treated Effluent (TSE) Reuse Applications and Challenges

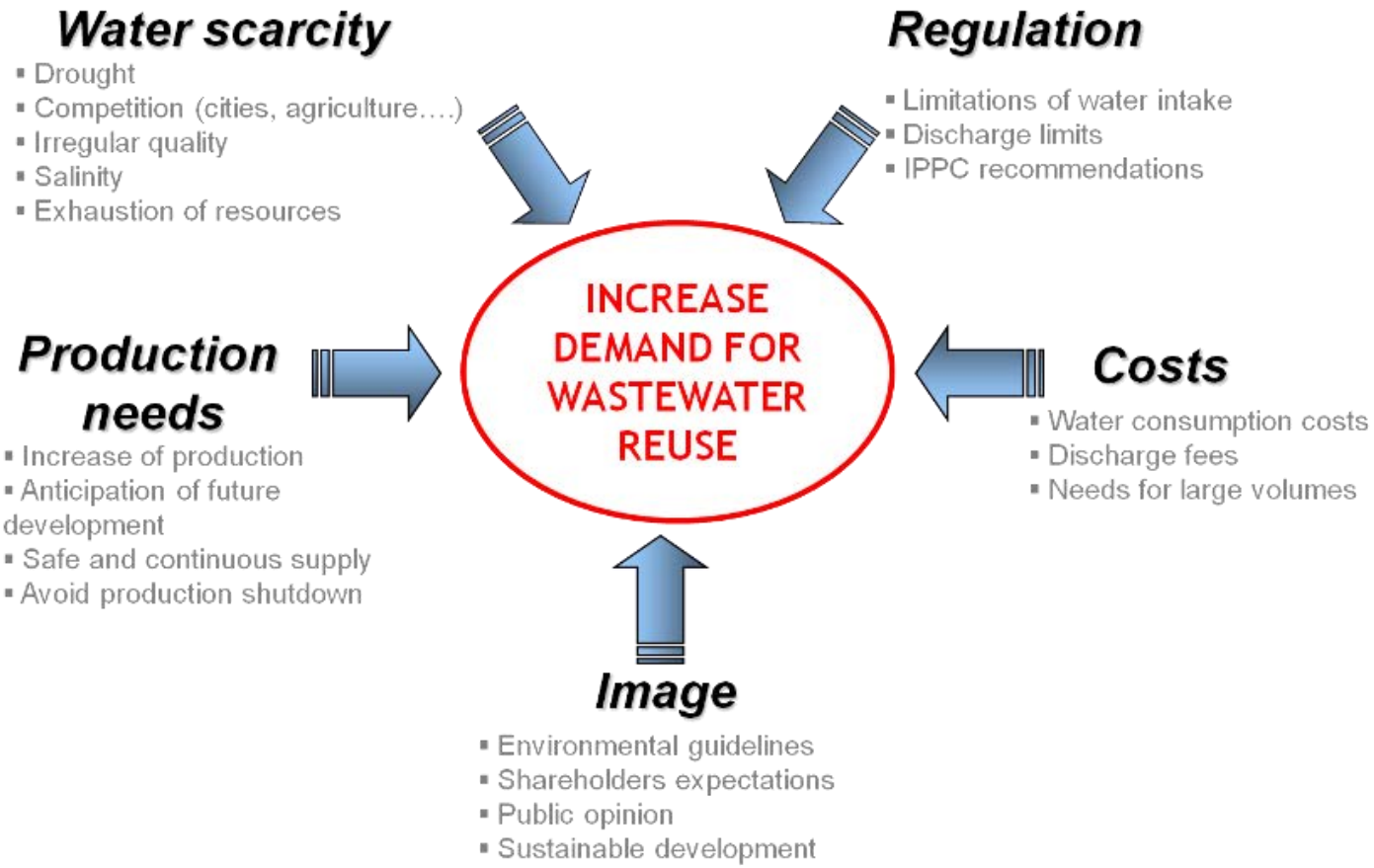
Saudi Arabia

WATER TECHNOLOGIES

Agenda

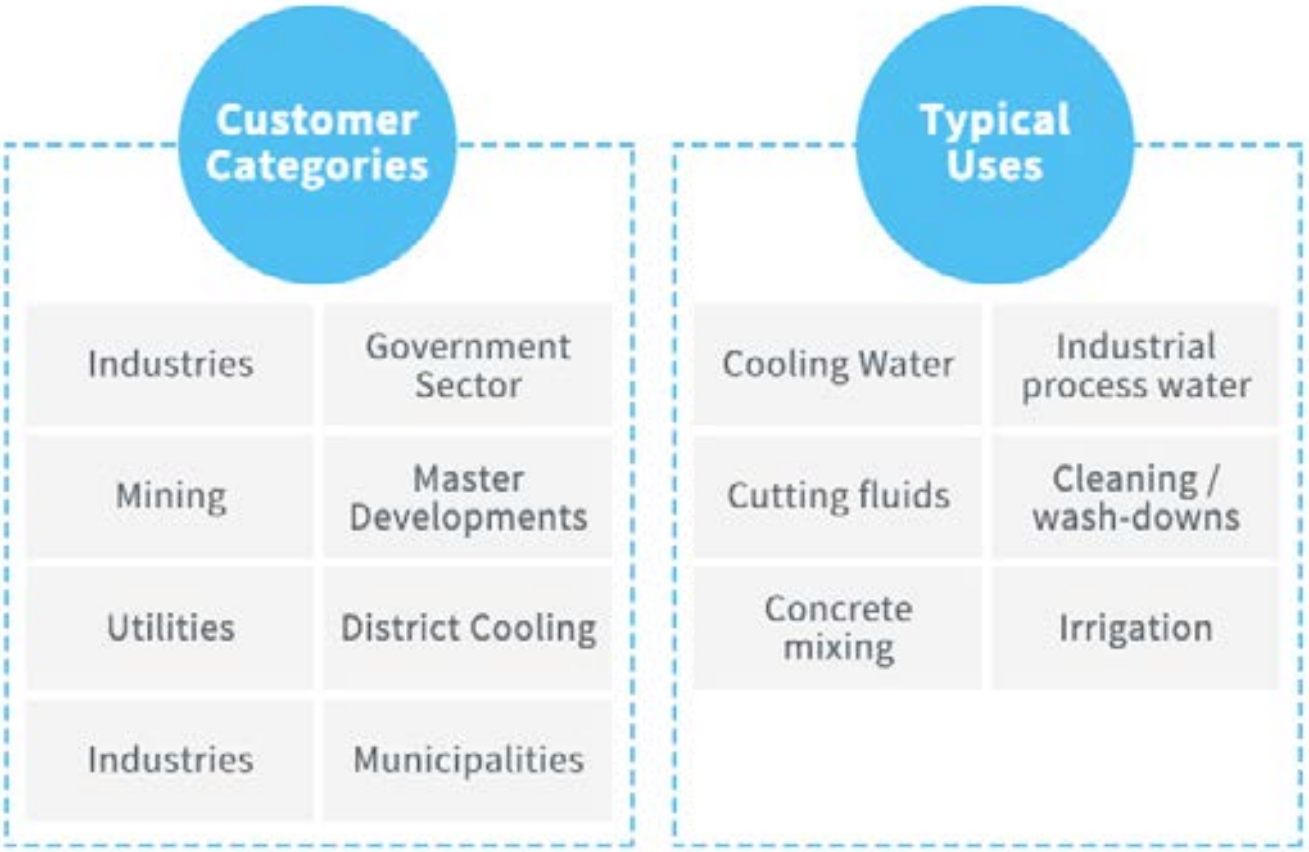
- General
- Treatment Technologies
- Cooling Towers Application
- Power Application
- Industry Application
- Brine Disposal

WATER REUSE DRIVERS



TSE – AGRICULTURE / LANDSCAPE

TSE CUSTOMER CATEGORIES AND USES



Source: www.nwc.com.sa

TSE CONTRACTUAL SUCCESSES

City	Existing Customer	Contract Quantity (M3/Day)
Riyadh	KAFD ITCC Mohamad Al-Dosari	72,200
Jeddah	Mohamad Al-Dosari	65,000
Makkah/ Taif		22,850
Medina		116,000
Other Cities		6,100

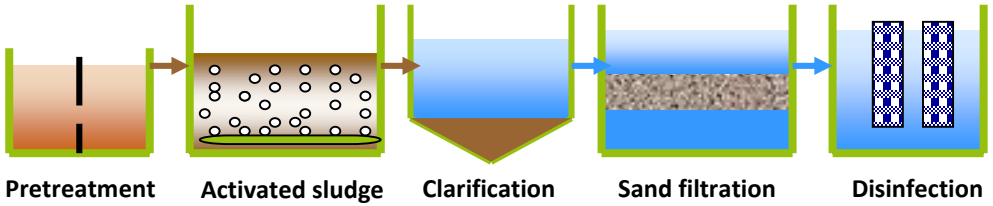
Source: www.nwc.com.sa

- The total value of TSE contracts is around 5.3 Billion SAR signed, this was achieved before TSE BU was spun off after incubation, as a separate Business Unit (BU) on 13th/October/2012.The TSE BU's contracts of approximately 20years duration with a total volume of 281,950 m3/day till October/2012 are as follows

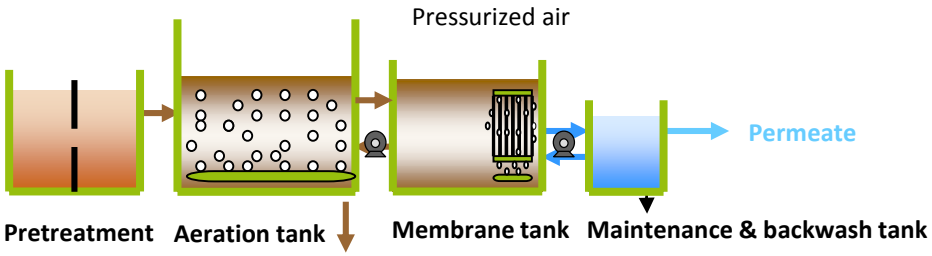
City	Existing Customer	Contract Quantity (M3/Day)
Riyadh & Madinah	Masheed Arabia Marafiq Taiba	65,000

SEWAGE TREATMENT PROCESSES

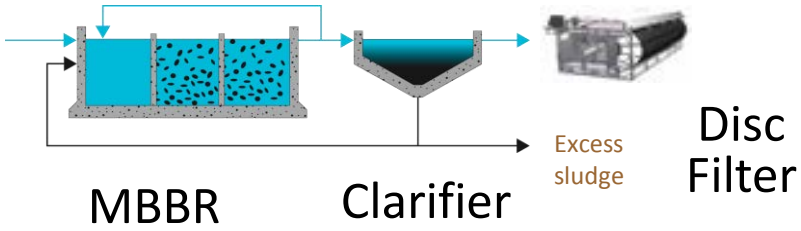
- **Sewage Treatment Plant with activated sludge**



- **Sewage Treatment Plant with MBR**



- **Sewage Treatment Plant with MBBR**



- **Sewage Treatment Plant Anaerobic / Attached Growth**

TSE CHARACTERISTICS

Location:

- Characteristics of WWT
- Discharge
- System

TSE CHARACTERISTICS

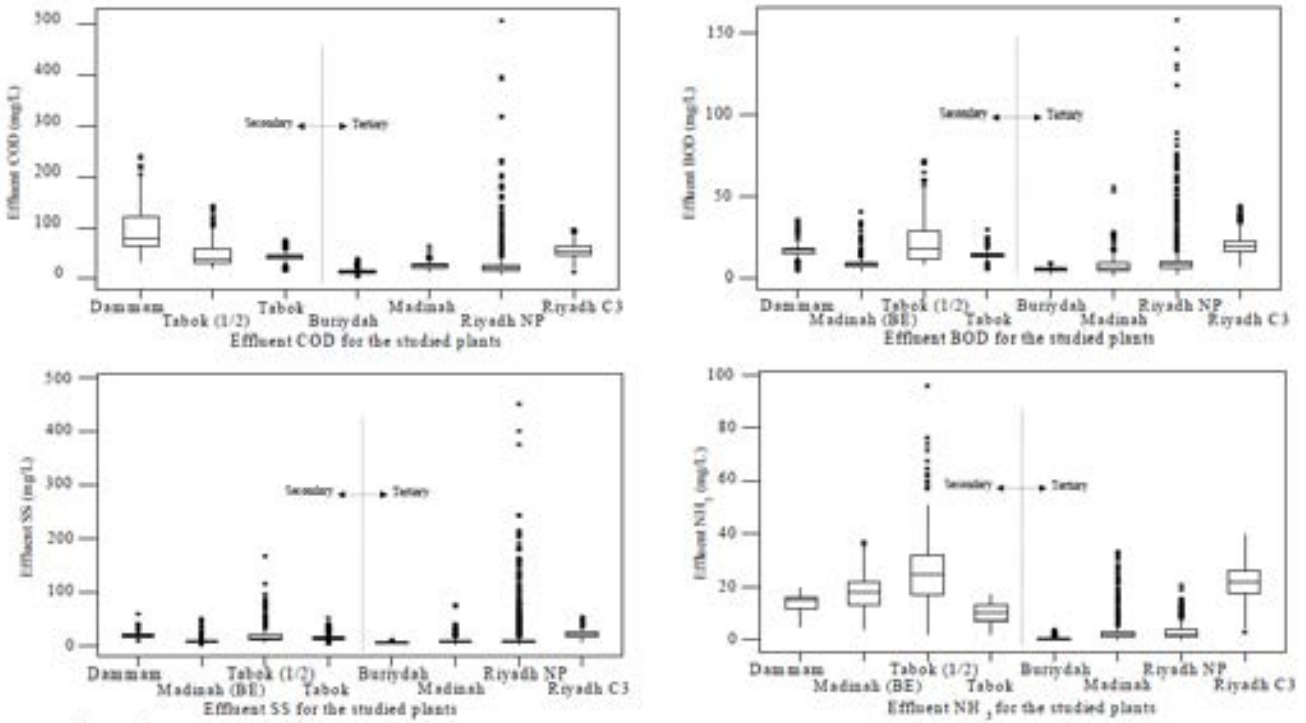


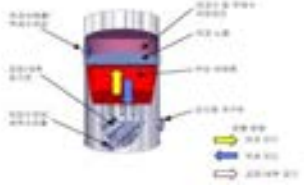
Figure 4-1
Box-and-Whisker plots for influent and effluent *COD*, BOD, *SS* and NH_3 data for the studied plants. The plots represent the medians (horizontal lines inside the boxes), the spreads (vertical distances), the outliers (points), and range between 25th and 75th percentiles (distance between upper and lower sides of boxes).
Note: BE: Before Expansion, NP: North Plant, and (1/2): half capacity.

Source: Saleem Al Saleem, King Saud University, Ms thesis

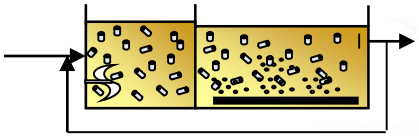
TSE CHARACTERISTICS

Parameter	PME-Costal	MOW-Central	MOW-TSE	TSE - TYP
TDS mg/l		2000-2500	2000-2500	800-2500
TSS mg/l	15	600	10	5-40
Turbidity NTU	75		5	2-30
BOD mg/l	25	500	10	5-30
NH3-N mg/l	1	80	5	1-30
NO3-N mg/l			10	5-40
PO4-P mg/l	1	25		<15

TECHNOLOGIES FOR WATER REUSE



Biofilter
Biostyr™



MBBR
Anox-kaldness™

VEOLIA

Actiflo™ / Multiflo

Disc Filters™

3FM™

UF skid

RO skid for TSE

Green-house STPs
Organica™

Biological → Settling → Filters → MF / UF → RO

Sludge

ZLD

Green-house Drying Beds
Solia™

Anaerobic Treatment
UASB™

MBR
Biosep™ or Crossflow

Benzine Treatment
MPPE™

Evaporators
Evaled™

Dewatering + Dryer
Inos™

Dryer
Biocon™

Technologies for water REUSE - General Concept

- There is not a single specific technology for water REUSE: water REUSE is very often obtained after association of several processes/technologies adapted to each case.

The main Processes/Technologies implemented for water REUSE are usually:

- Clarification/Filtration.
- Membranes.
- Activated carbon.
- Biological Treatment
- UV/Ozone/Chlorination
- Evaportaion

Technologies for REUSE water - General Concept

- **CLARIFICATION/FILTRATION .**

For Removal of Turbidity and Total Suspended Solids .

Conventional Sand Filter

High Speed Flexible Fibre Filter

Hydrotech Compact Disc Filter

Technologies for REUSE water - General Concept

- **CLARIFICATION/FILTRATION .**

For Removal of Turbidity and Total Suspended Solids .

ULTRA FILTRATION

SCREEN FILTER

ACTIFLO

Technologies for REUSE water - General Concept

- **BIOLOGICAL TREATMENT**

For Removal of BOD, COD, TOC.

MBR
Membrane Bio Reactor

MBBR
Moving Bed Bio Reactor

BIO FILTER

Technologies for REUSE water - General Concept

- **MEMBRANES**

  For Removal of Dissolved Solids.

Reverse Osmoses

Technologies for REUSE water - General Concept

- **DISINFECTION & STERLIZATION**

For Removal of Micro-organism – Bacterial & Algae.

Ultraviolet

Ozone

Chlorine Dosing System

Technologies for REUSE water - General Concept

- **ACTIVATED CARBON**

For Removal of Organics.

Granular Active Carbon Vessels

Granular Active Carbon

Note: **High carbon consumption is always a key factor when using active carbon.**

Technologies for REUSE water - General Concept

EVAPORATORS AND CRISTALLIZERS

A technology for Zero Liquid Discharge (ZLD) to generate high quality water for upstream processes meanwhile no liquid waste and production of landfilable waste

HPD® Cristallizer

Evaled® Evaporator

Technologies for REUSE water - General Concept

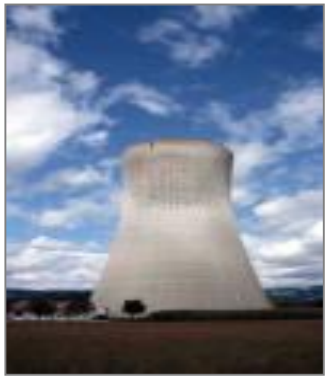
Association of these technologies will depend most of the time of the following criteria:

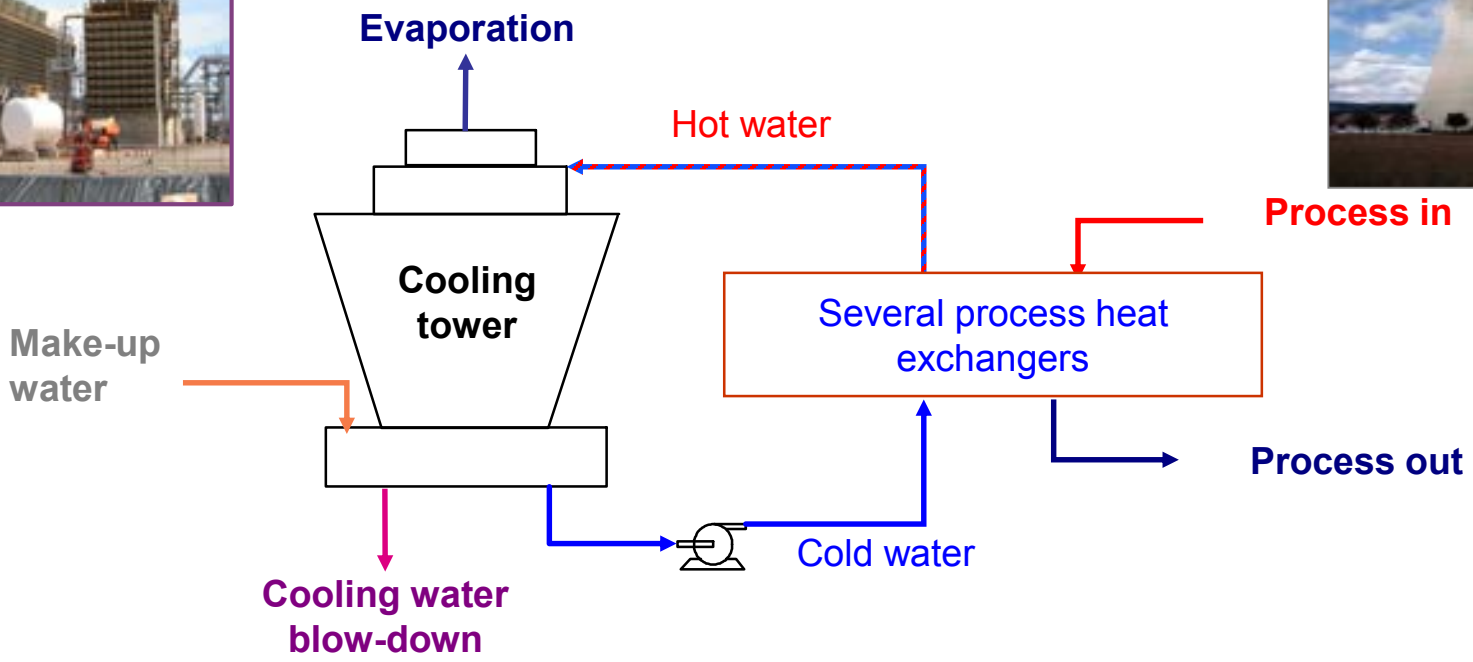
- Type of **pollutants** into the water to be treated before REUSE.
- Plant **capacity**.
- **Concentration** of the pollutants into the water to be treated before REUSE.
- **Usage** of REUSED water after treatment.
- Land / Area / Space / Volume… available for the treatment plant.
- Cost of treatment

COOLING TOWERS

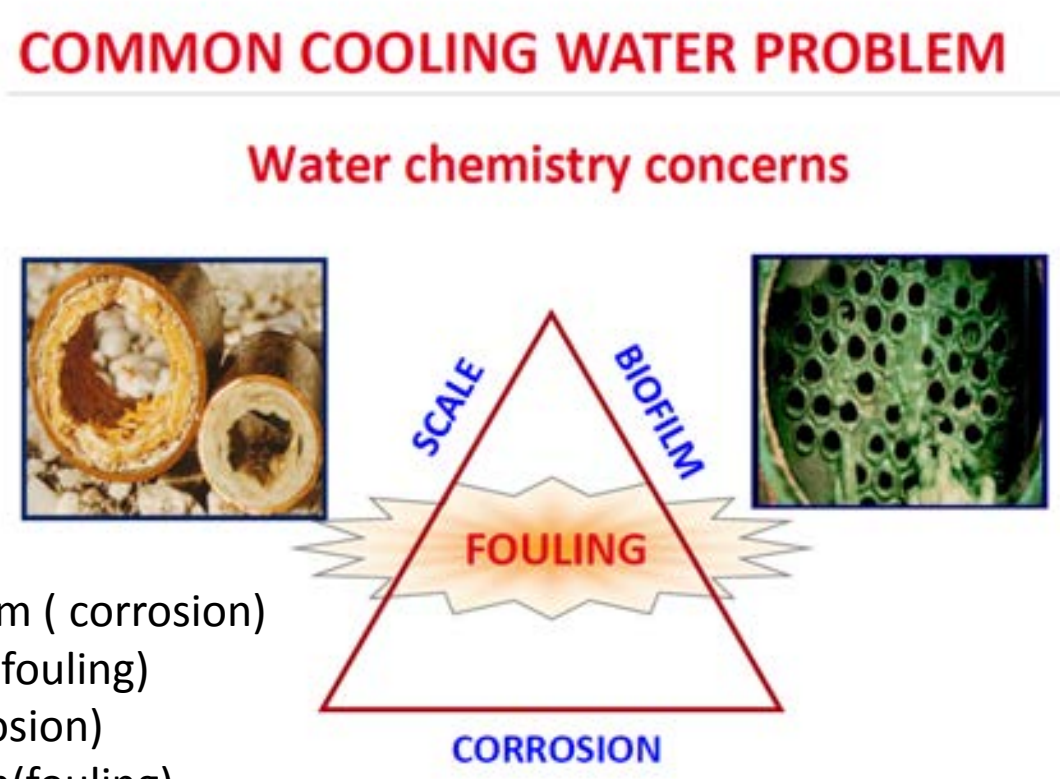
1 ton of cooling needs 0.3 m3

DISTRICT COOLING - TSE





COOLING - ISSUES



TDS: 2500 ppm (corrosion)
TSS: 25 ppm (fouling)
NH4 <1 (corrosion)
PO4 < 10 ppm(fouling)

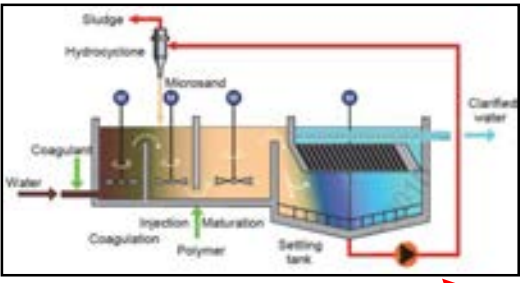
Case Study: Filtration Requirement
World's Largest District Cooling Plant; Haram

Parameters	Units	Inlet	Outlet
TSS	mg/L	10-13	< 5
BOD	Mg/L	10	< 4

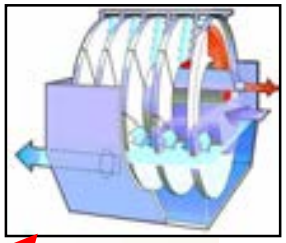
180 000 TR cooling capacity
Year of delivery : 2013 (on going)
Capacity : 44,000 m^3/day
Technology : Hydrotech™

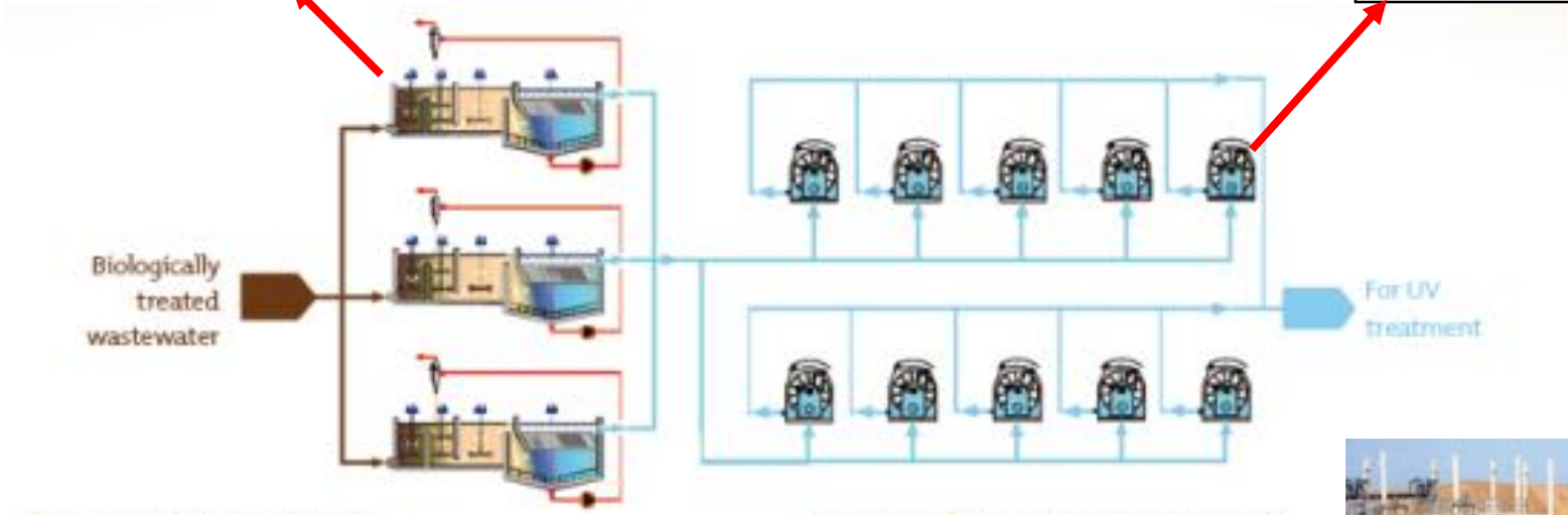
Case Study: BARCELONA (Spain) – REUSE for Agriculture & Aquifer

Process Flow Diagram of Chosen REUSE Treatment Line



Paramers	Inlet	Outlet
BOD_5	≤ 20 mg/l	≤ 5 mg/l
TSS	≤ 50 mg/l	≤ 5 mg/l av. 2,4 mg/l





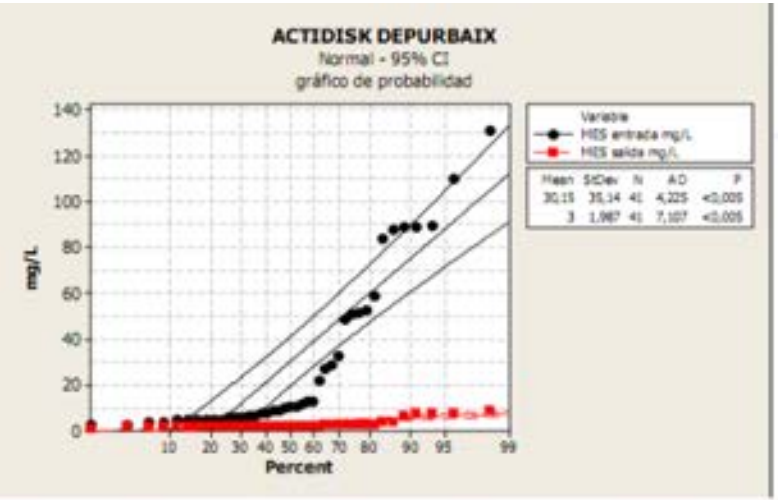
The ACTIFLO™ process
Settling by means of ballasted sand
Maximum treatment capacity: 3 x 4,800 m³/t
Settling capacity: 120 m/t

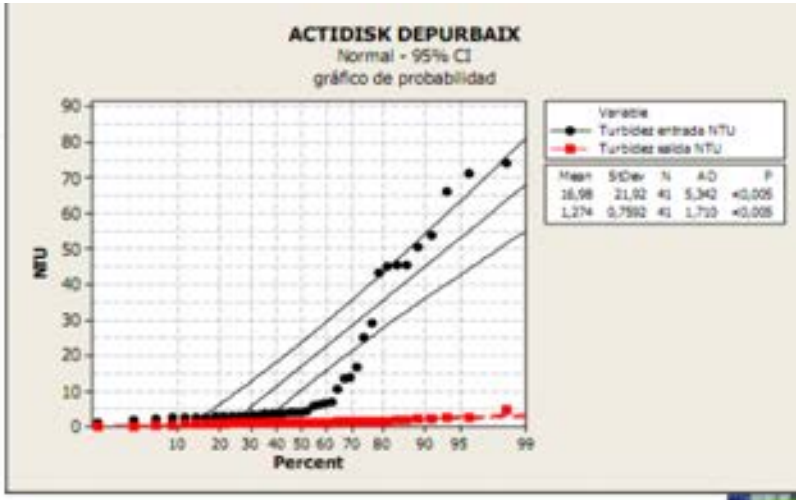
Tertiary filtration Hydrotech®
Maximum treatment capacity: 10x1,440 m³/t
Mesh width: 10 µm.

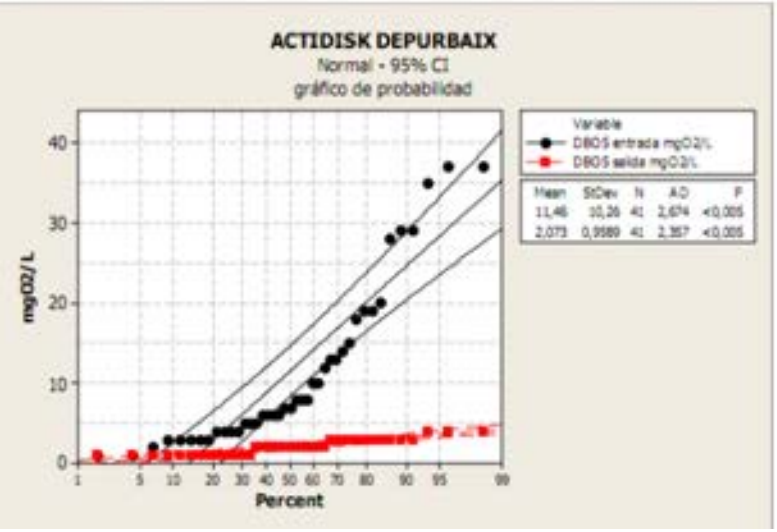
Case Study: BARCELONA (Spain) – REUSE for Agriculture & Aquifer

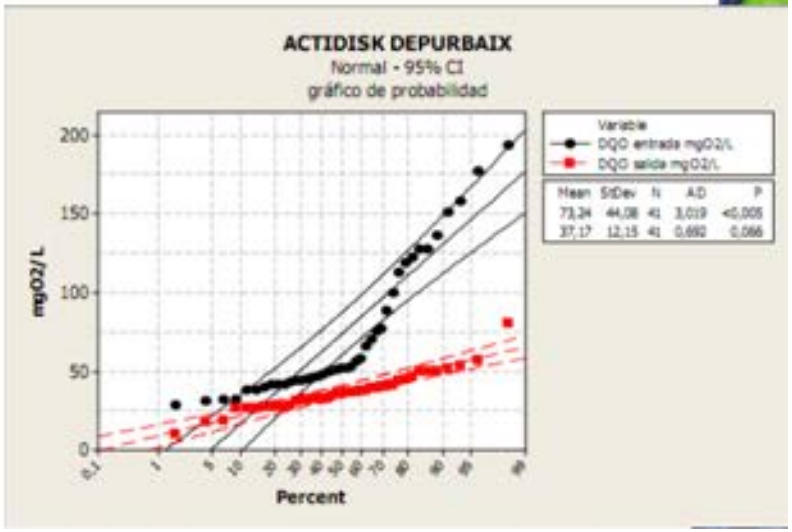
	Raw water	Actiflo™ outlet	Discfilter outlet	Reduction (%)
Turbidity, NTU	12.0-43.6	1.2-2.1	0.8-1.7	92-97
TSS, mg/l	15-56	2.9-5.1	<2-3.7	81-94
Total Phosphorus, mg P/l	0.94-3.32	0.12-0.25	0.08-0.20	74-94
COD, mg O_2/l	57.6-112.3	<30-54.9	<30-52.0	36-67
BOD_5, mg O_2/l	9.0-10.0	<3.0-4.0	<3.0-4.0	56-80
Total Coliforms, cfu/100 ml	2.3×10^3 - 6.0×10^6	3.2×10^4-3.0×10^5	7.0×10^3-3.0×10^5	39-99

Case Study: BARCELONA (Spain) – REUSE for Agriculture & Aquifer

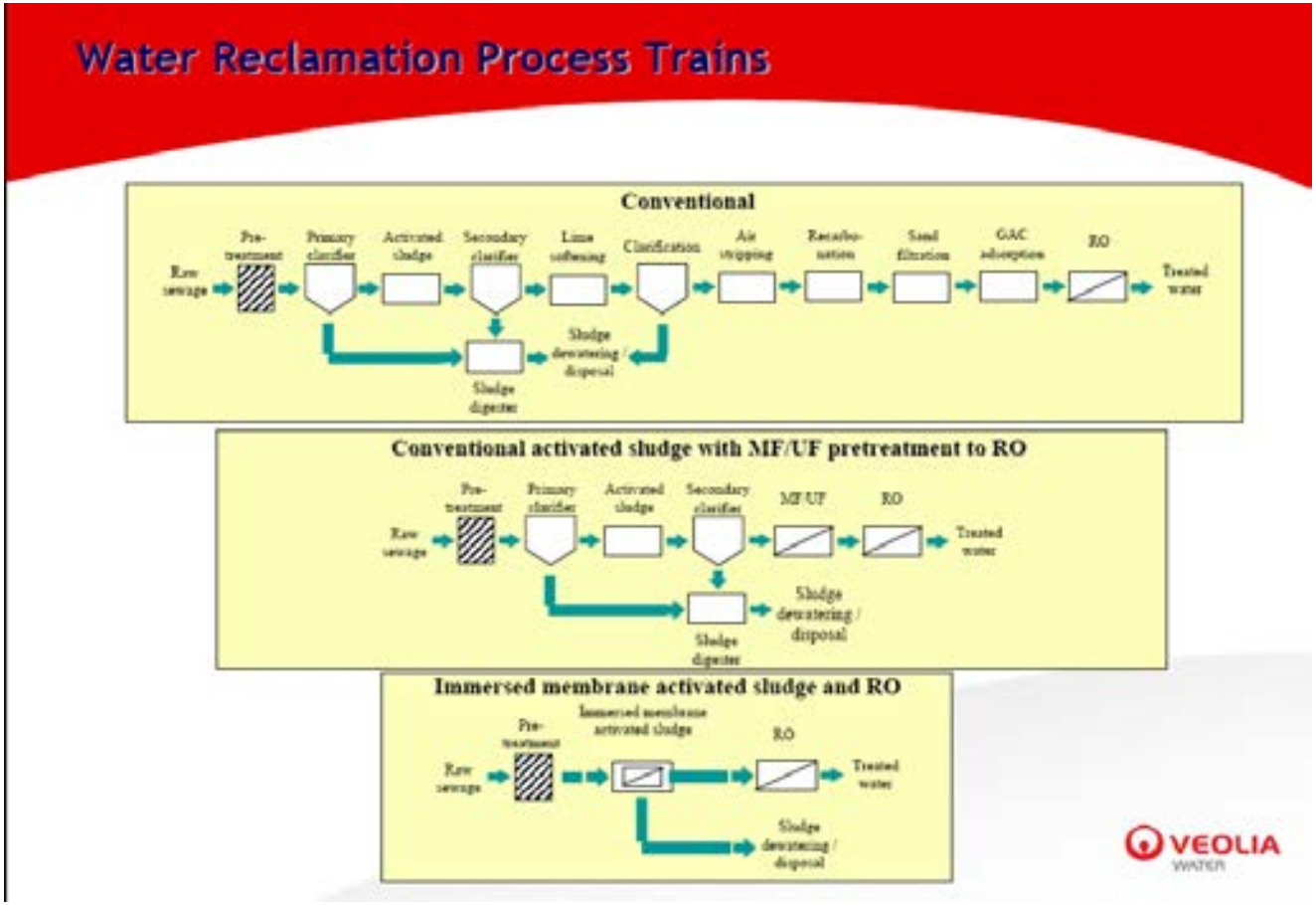








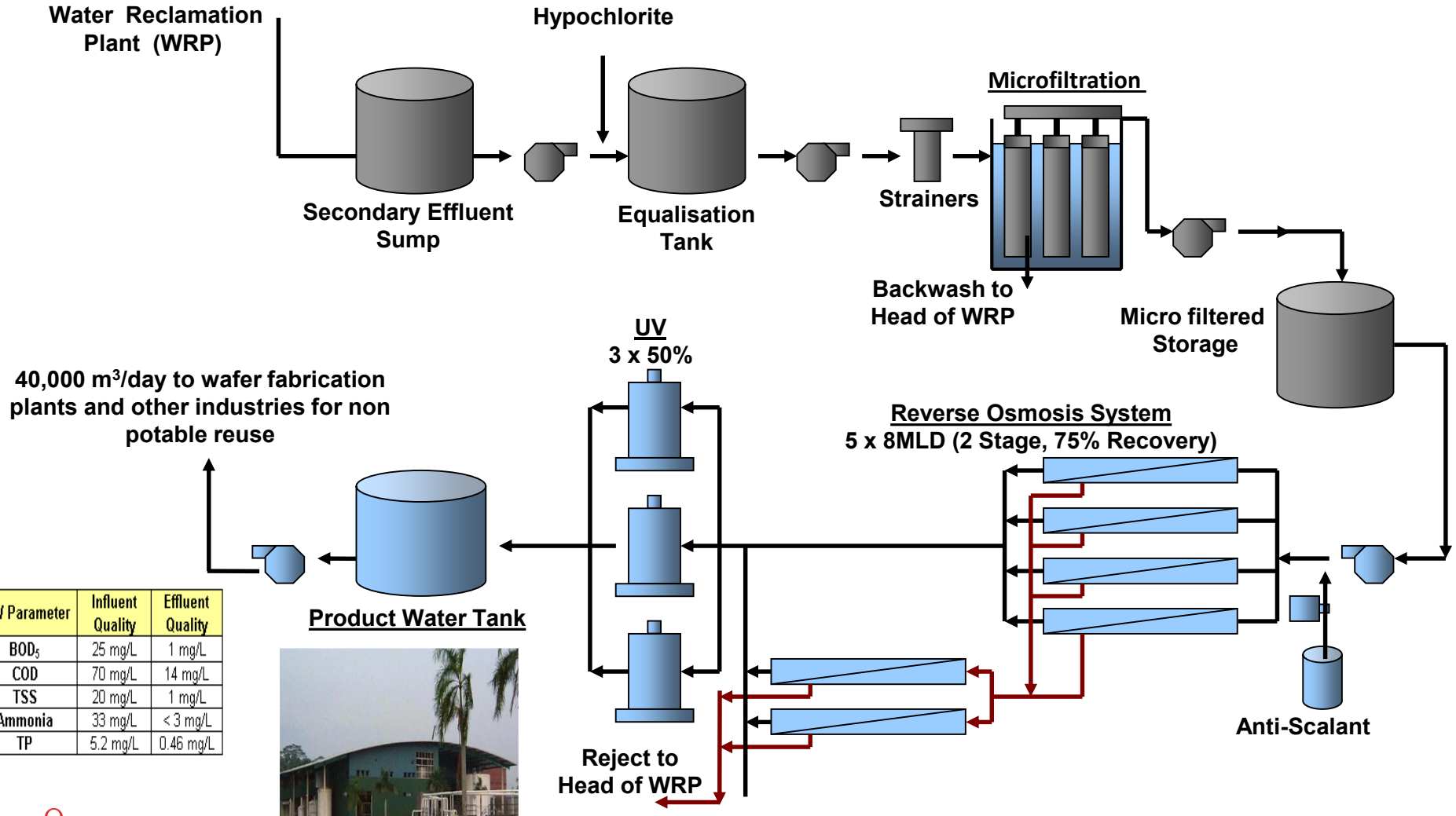
Case Study: TDS & NH4 Reduction Requirement



Conventional X Membrane
MBR X UF

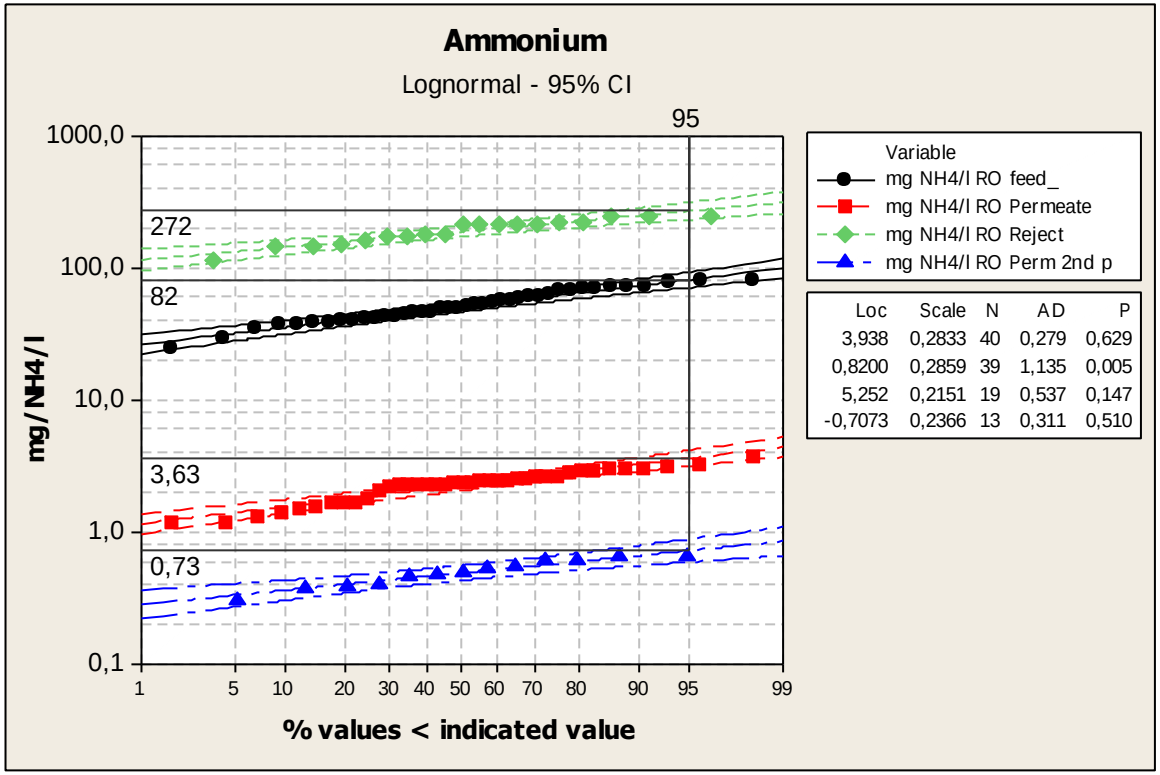
Case Study: KRANJI (Singapore) – REUSE for Industry

Process Flow Diagram of Chosen REUSE Treatment Line



WW Parameter	Influent Quality	Effluent Quality
BOD_5	25 mg/L	1 mg/L
COD	70 mg/L	14 mg/L
TSS	20 mg/L	1 mg/L
Ammonia	33 mg/L	< 3 mg/L
TP	5.2 mg/L	0.46 mg/L

Case Study: NH3 Reduction Requirement

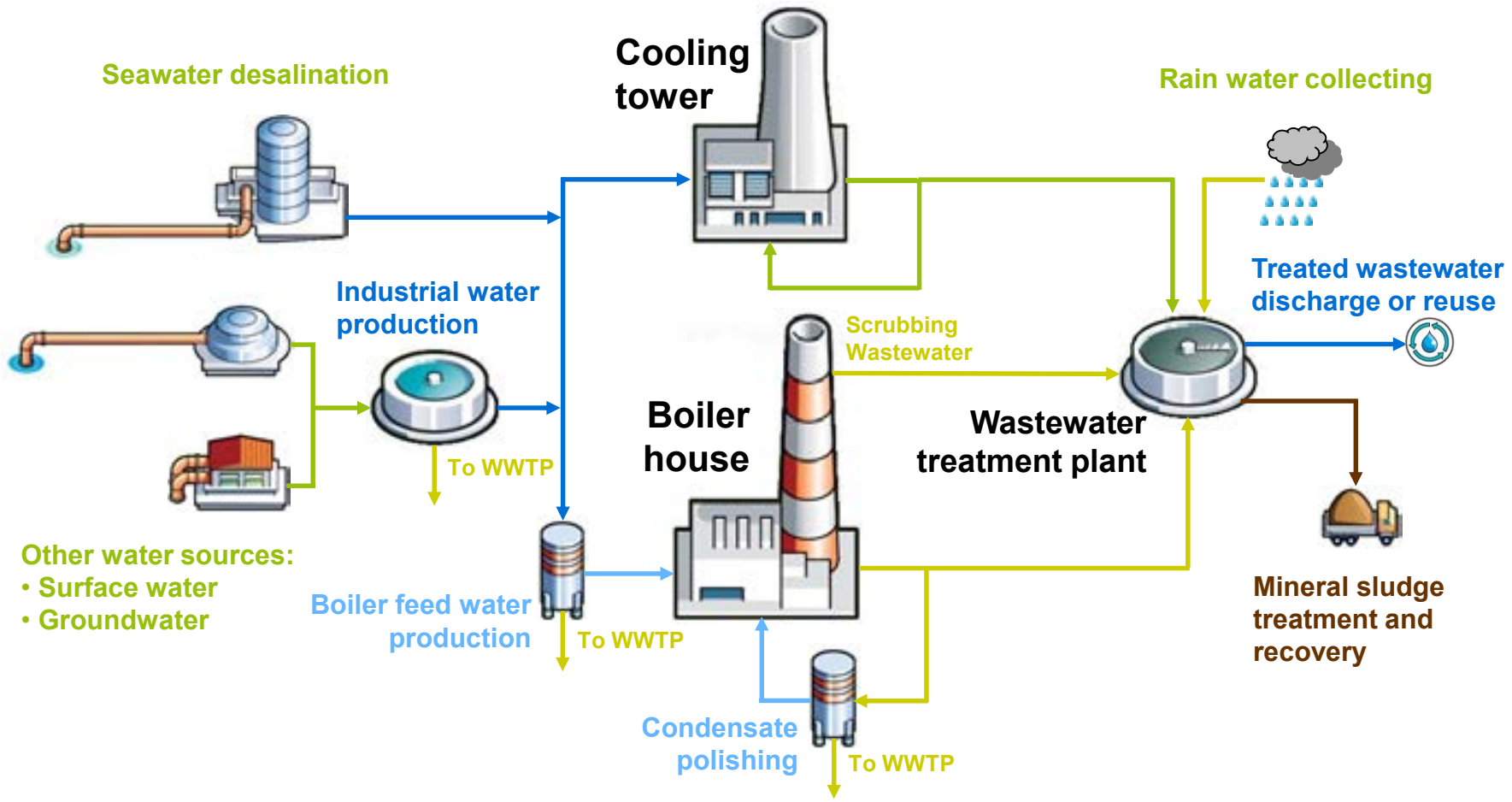


NH3/NH4

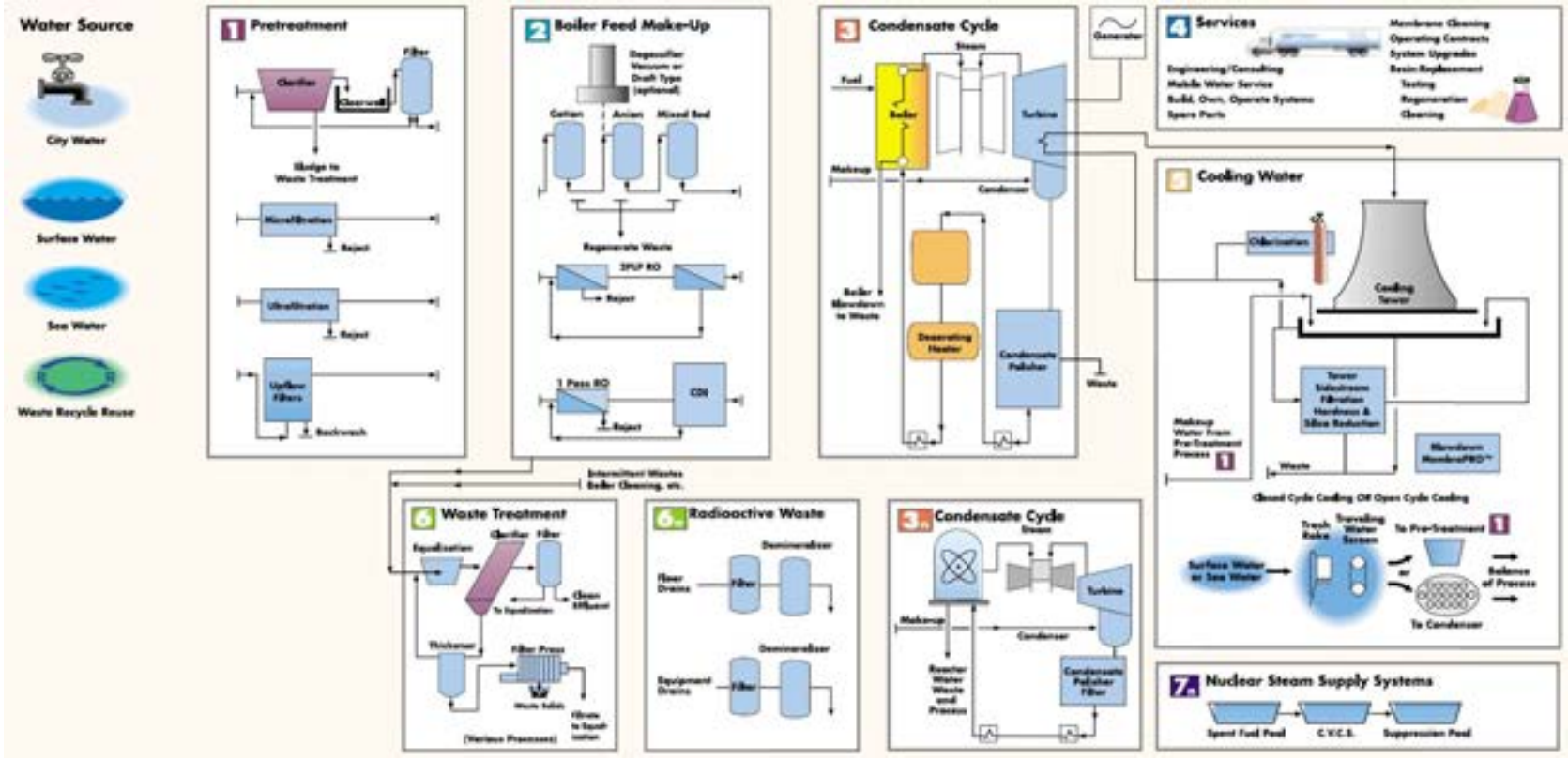
NH3/NO3 – STP performance

Power Generation Industry

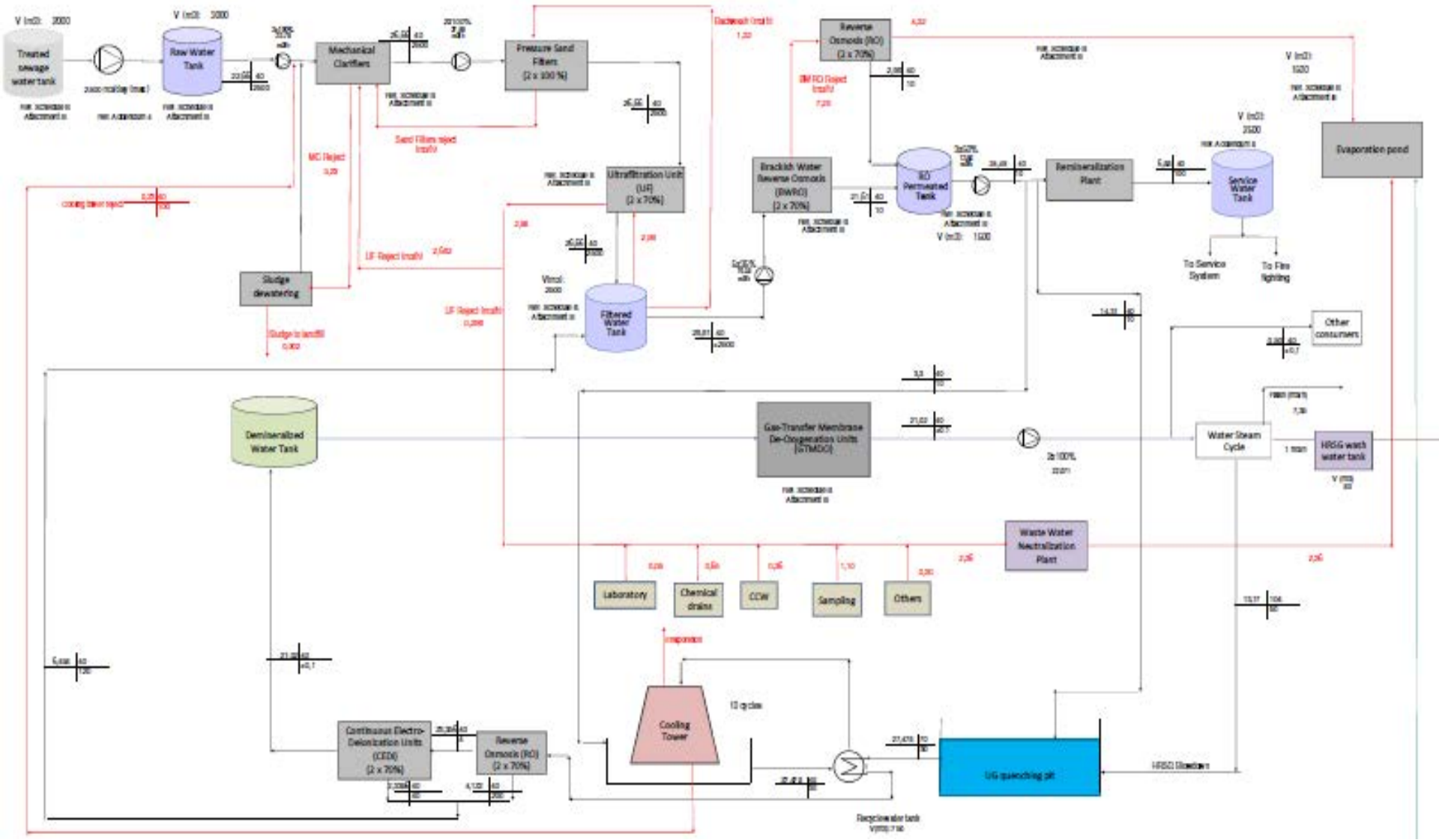
Understand | General process flow diagram



Understand | Detailed PFDfor Power



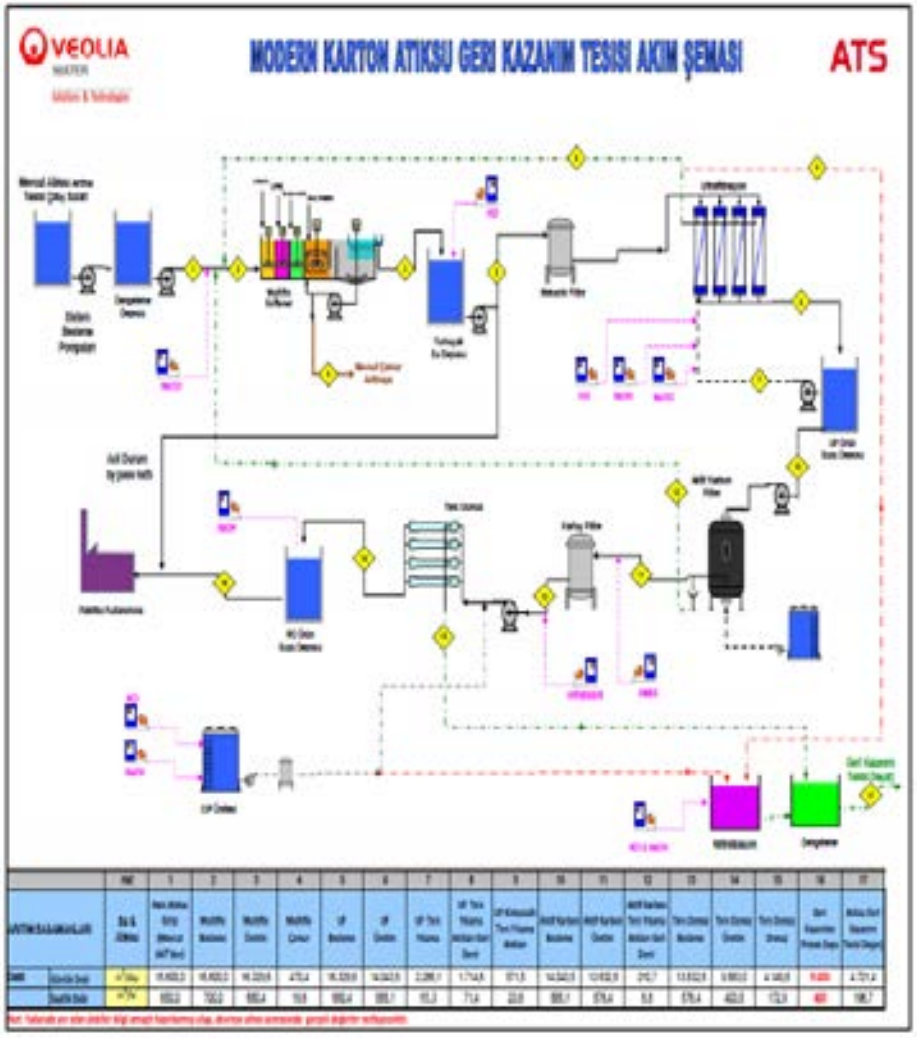
Case Study: Power – HAIL II PP



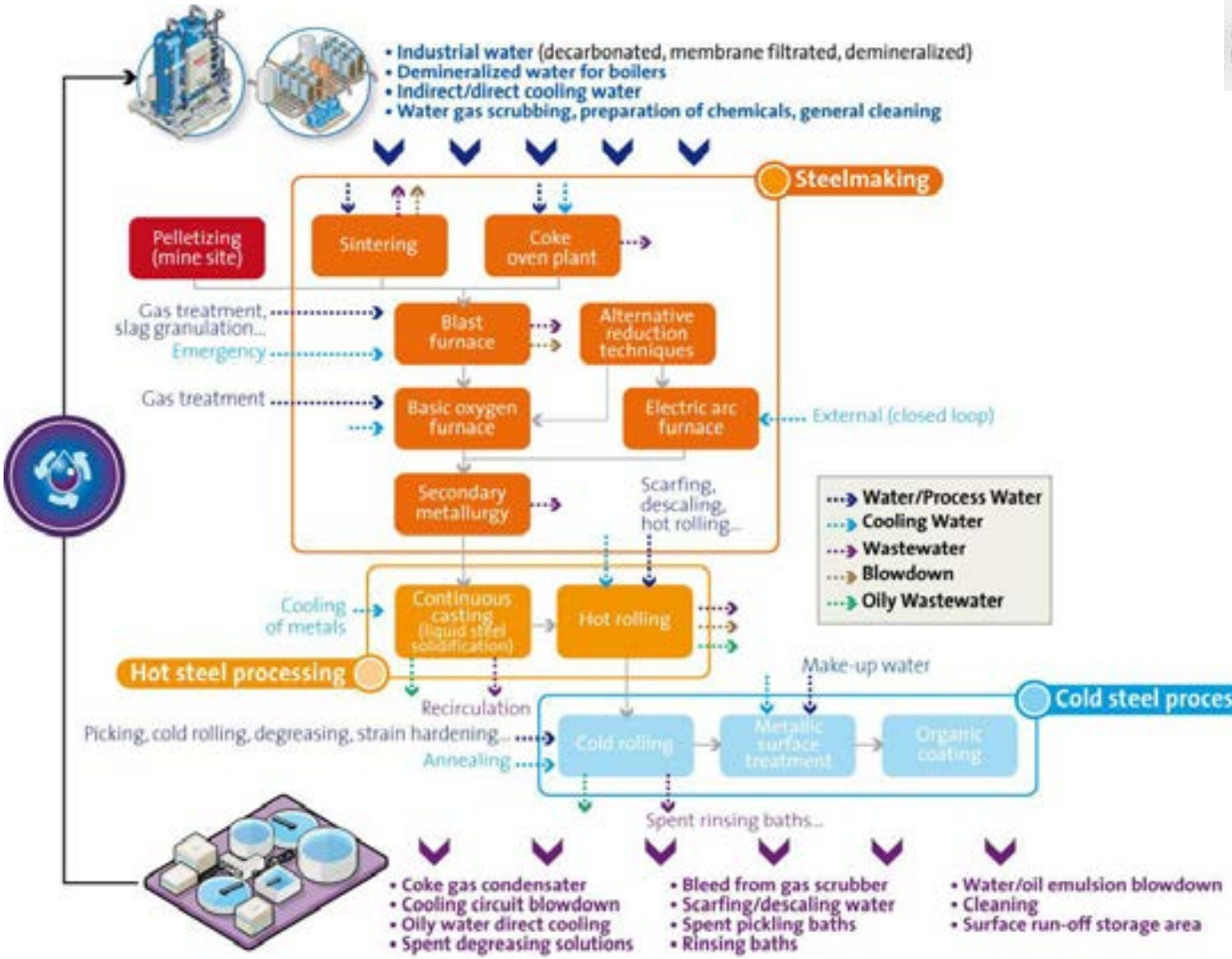
Re-Use Industry

Reuse Industry

Modern Karton Waste and Reuse *plant*



Overview of water uses – Steel Industry



Brine Treatment

Case Study: Mopco phase 2 – Brine Treatment

Cooling towers

Waste water RO reject

Permeate 7 m^3/h

Maximum Distillate water 2.5 m^3/h

10 m^3/h

3 m^3/h

Intermediate tank (50m^3)

Multiflow softener

DM& Activated Carbon filters

Brine water RO (1×10 m3)

0.1 m^3/h

Evaporator

0.5 – 1m^3/h

sludge

Demineralization Unit (Existing)

Cation regeneration waste

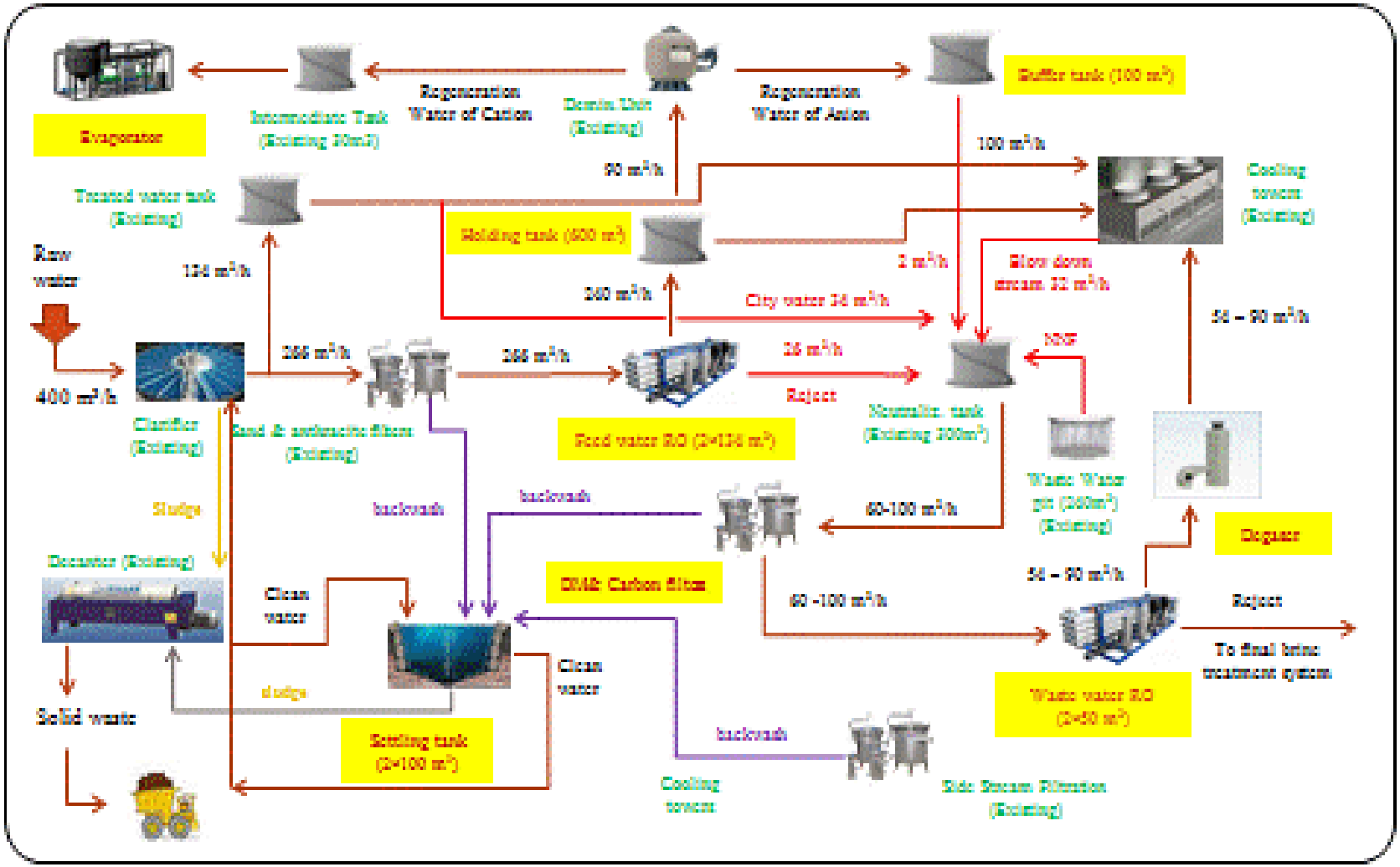
1.5 - 2 T/D

Solid waste

Filter press

Evaporation ponds

Case Study: Mopco phase 2 – Brine Treatment



REUSE, Key factors of success

Site analysis	Mass balance	Definition of Quality	Process	Costs	Validation
Identity: all water flows	Character: Quantity Quality Parameter pH	Usage: Product Operation Equipment	Develop: Combination Interaction Reduction Residue	Conduct: Capex Opex Risk	Validate: Reference Pilot test