University of Jordan
Dept. of Chemical Engineering

0935474
Wastewater Treatment

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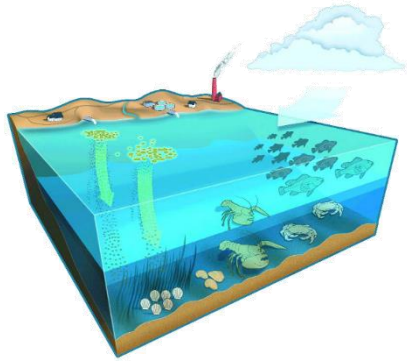
Chapter-1
Introduction & Overview

INTRODUCTION

- **Wastewater**

  Discarded or previously used water from a municipality, industry or other activity.

- **Types:**
  1. Domestic (household)
  2. Industrial effluents
  3. Other (storm runoff, agricultural runoff, mine drainage)
- **Sources:**
  1. Urban areas (Residential & commercial)
  2. Industrial parks
  3. Agricultural lands (Farms)



Characteristics of Wastewater

- **Quantity**
  1. Minimum, maximum and average
  2. Production variability pattern

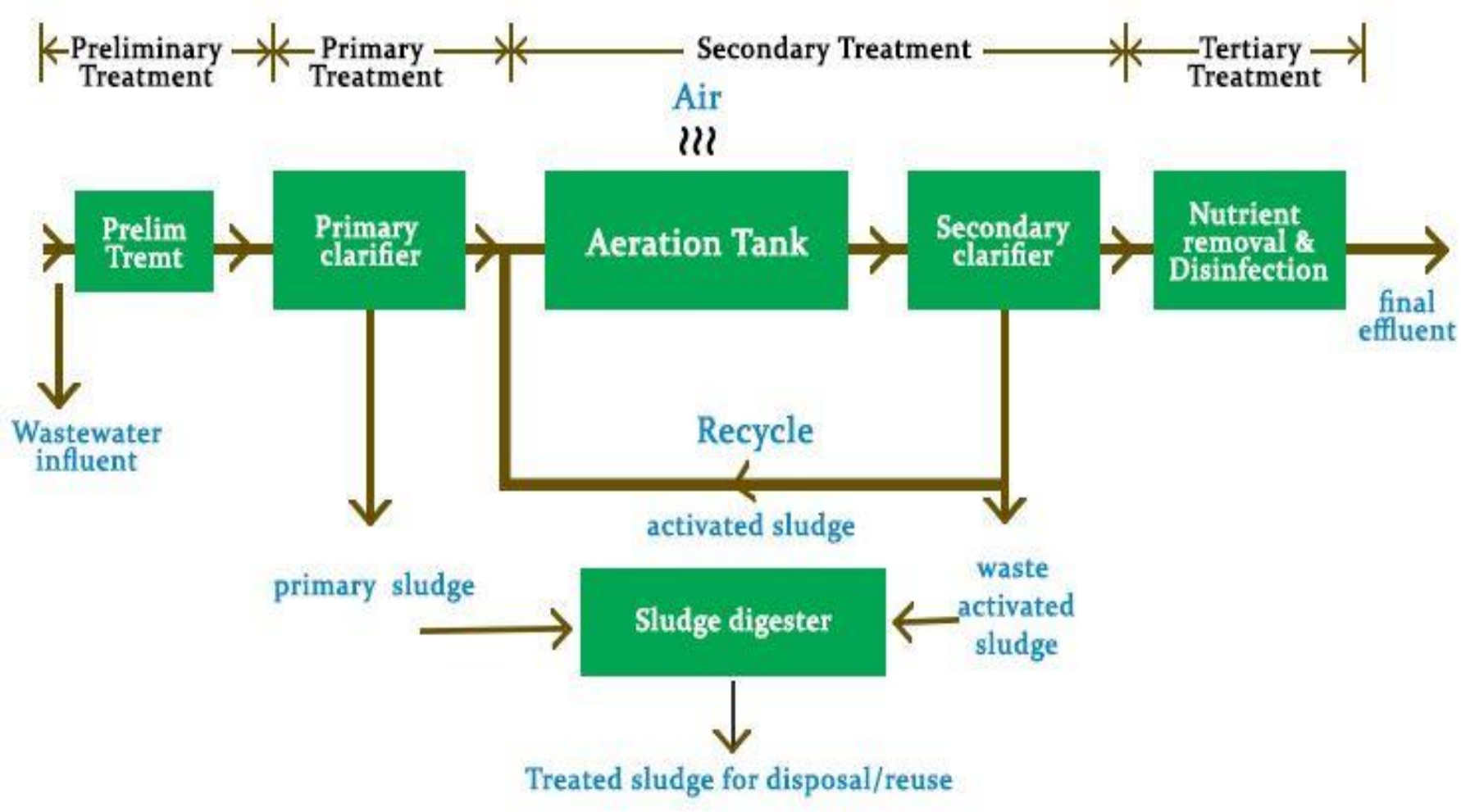
- **Quality (composition):**
  1. Physical
  2. Chemical
  3. Biological
  4. Priority pollutants

- **Combination wastewaters:**
  - Domestic + Industrial = Municipal

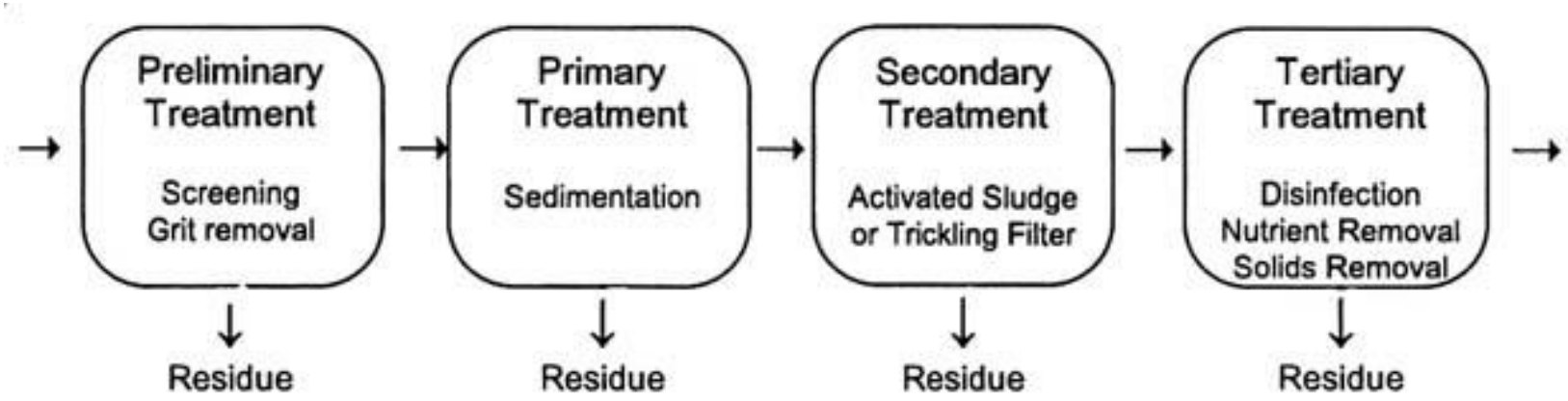
Wastewater Treatment Systems

1. Centralized:

Municipal wastewater treatment plant (facility)

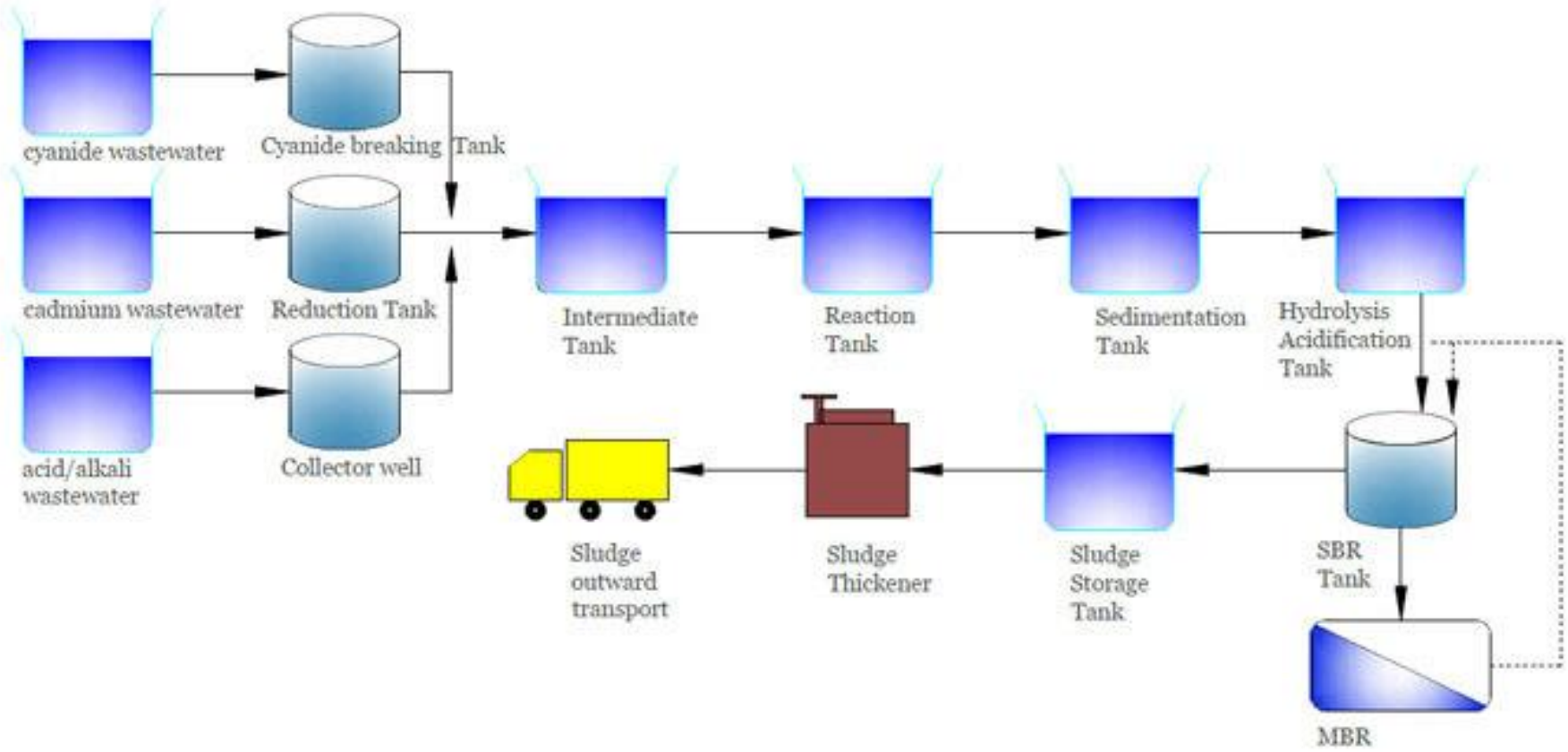


Sludge Management:
Solids are produced during wastewater treatment

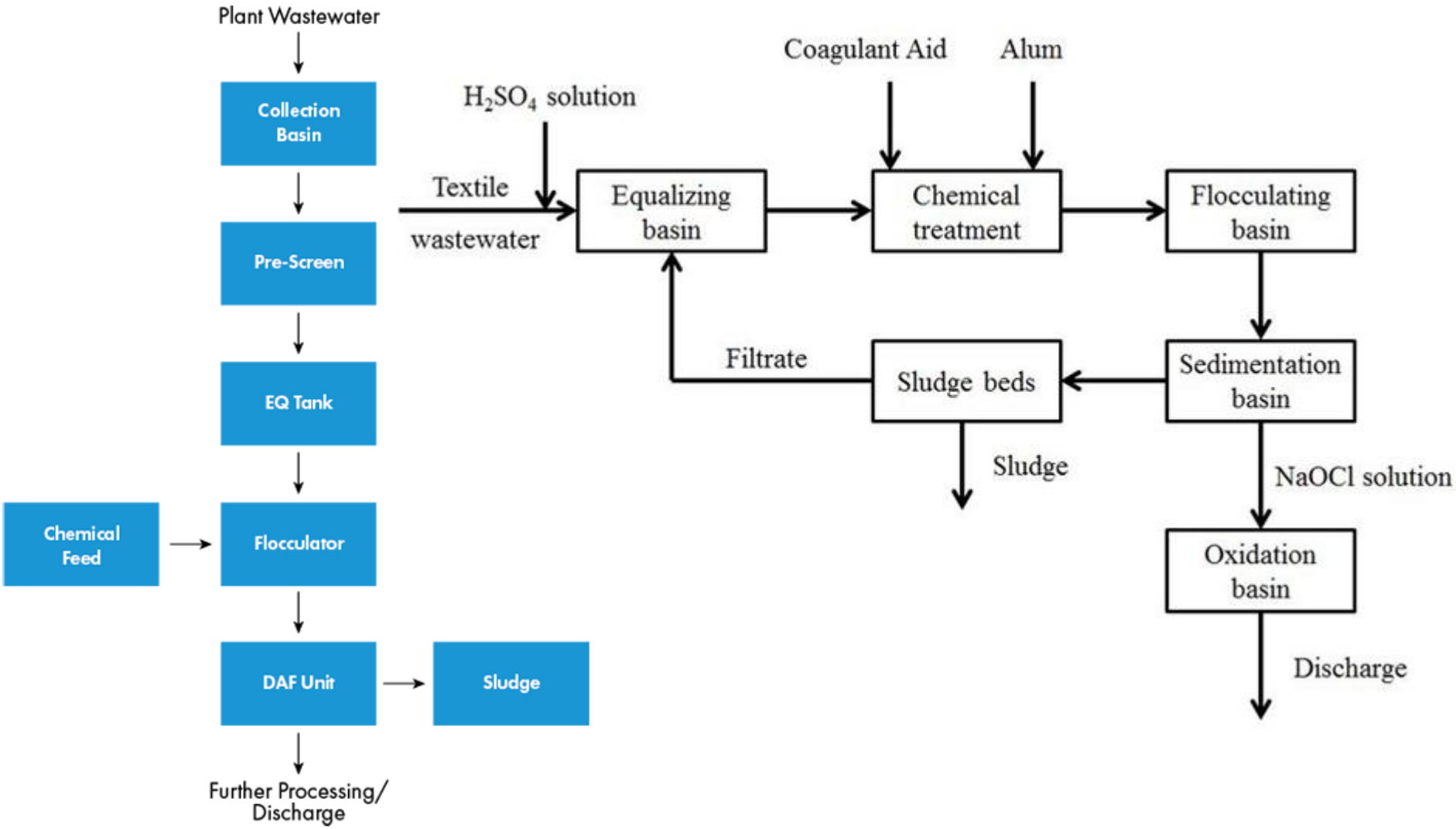


- Biosolids and /or chemical sludge need to be handled, treated and utilized, or properly disposed

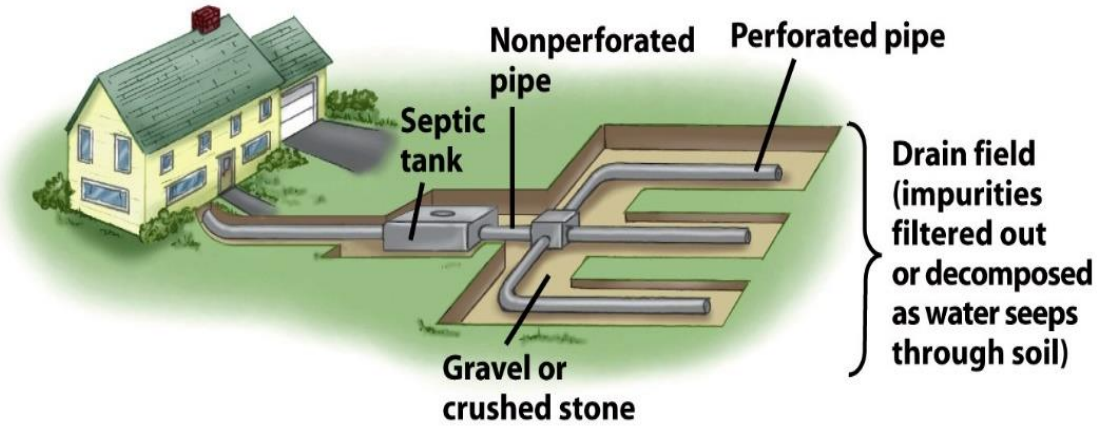
2. Centralized: Industrial effluents treatment plants-1



2. Centralized: Industrial effluents treatment plants-2

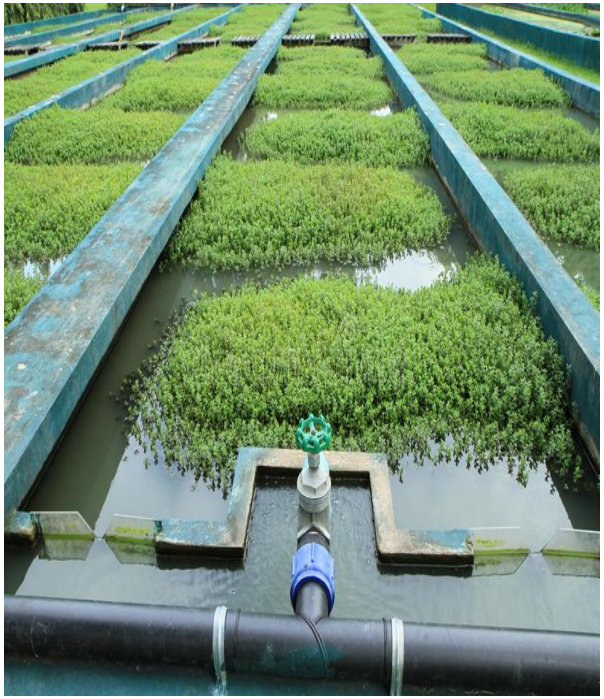


Wastewater Treatment Systems

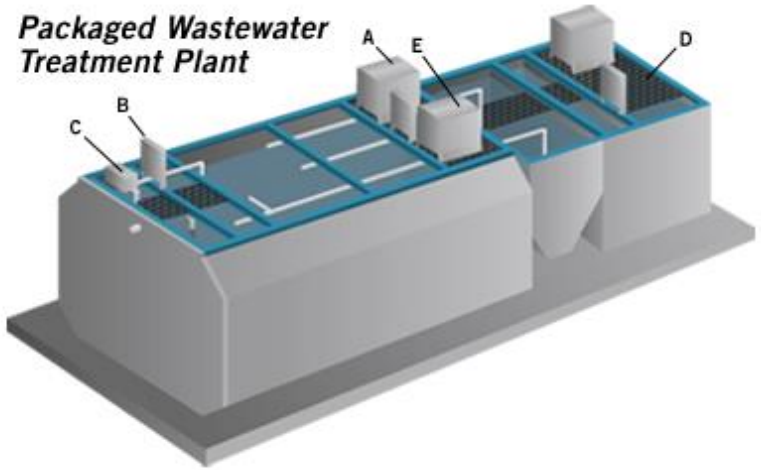


2. Decentralized:

a) Septic tanks
b) Land application
c) Constructed wetland
d) Packaged /mobile units



Packaged / Mobile WWT Units



<u>Used in the following applications</u>: Electrochemical metals removal process, pH adjustment, multi-media filtration, air stripping, activated carbon adsorption, sludge dewatering units.

WWT Technologies

1) Physical methods

- Settling, Flotation, filtration
- Membrane filtration, e.g. ultra-filtration, reverse osmosis, electrodialysis
- Adsorption

2) Chemical methods

- Coagulation and flocculation
- Chemical precipitation *(using hydroxides, carbonates, phosphates, etc…)*
- Chemical oxidation *(using e.g. O_2 at high T & P, O_3, H_2O_2, Cl_2, chlorate, perchlorate, Hypochlorite, dichromate, permanganate, …)*
- Ion exchange.

3) Biological methods

- Microbial biodegradation using mixed culture (mainly bacteria plus fungi and other microbes); both *aerobic and anaerobic.*

Physical Methods

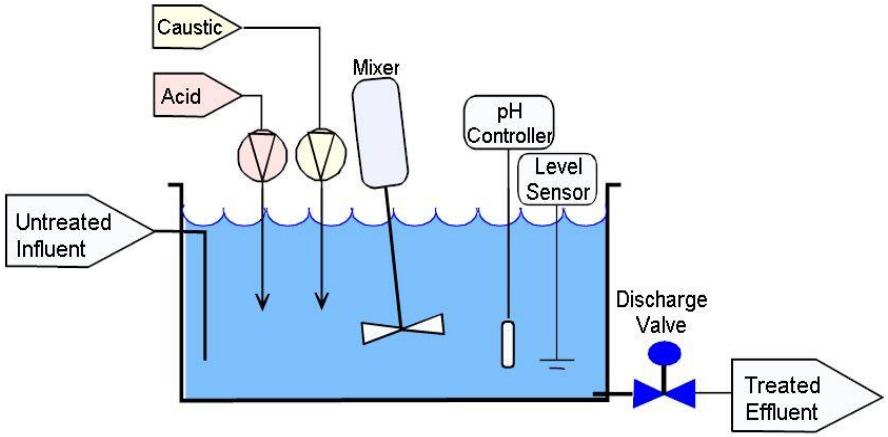
Advantages :

1) No consumption of chemicals and thus no chemicals handling hazards.
2) Simple operation.

Disadvantages :

1) May be slow (flocculation and settling)
2) Requires large space (volume or area)
3) Some are expensive (membrane separation), both in capital and operating costs.

Chemical Methods



Advantages :

1) Rapid and efficient process.
2) Possible to remove all pollutant types to produce a high-quality treated effluent.

Disadvantages :

1) Handling and cost of required chemicals.
2) High energy cost.
3) Although the pollutants are removed, accumulation of concentrated sludge creates a solids disposal problem.
4) Many chemicals are hazardous thus causing safety problems.

Biological Methods

Advantages :

1) Economically attractive for large amounts of wastewater.
2) Acceptable quality of effluent (within the standards).

Disadvantages :

1) Slow process.
2) Requires extensive land area.
3) Needs continuous maintenance.
4) Necessary to create an optimal favorable “reactor” environment including nutrition requirements.
5) Weather and climate affected.

Main Reasons for WW Treatment

1. Adverse Impacts of Wastewaters:
   a) Health risk
   b) Environmental pollution
2. Water scarcity – Reuse potential

Impacts of Wastewater Discharge

- **Impacts on Human Health**
  1. Contamination of drinking water and food causes spread of infectious diseases that endangers public health.
  2. Toxic priority pollutants may be lethal poisons or carcinogens.

- **Impacts on Environment**
  1. Depletion of dissolved oxygen in natural aquatic systems causes deterioration of aquatic ecosystems.
  2. Adversely affects biodiversity.
  3. May cause odor and air other pollution problems.

- **Loss in economic assets**
  1. Soil pollution lead to agricultural degradation and crop loss.
  2. Stream/ lake/ coast pollution leads to loss in tourism.

Regulations التشريعات

Environmental Legislation in Jordan:

1. Laws: القوانين issued by Parliament.
2. Regulations (or By-Laws):الانظمة issued by Government (Council of Ministers).
3. Instructions: التعليمات issued by Ministers or Heads of Govt. Institutions
4. Standards (or Specifications): المواصفات "Technical Regulations" issued by Jordan Institution for Standards and Metrology (JISM).

http://moenv.gov.jo/AR/Pages/mainpage.aspx

Relevant Jordanian Laws القوانين *

1. **Environ Protection Law # 6, 2017**
2. Public Health Law,
3. Agriculture Law,
4. Water Authority Law,
5. Municipalities Law,
6. Standards and Metrology Law,
7. Other laws:
   — Development Zones , Industrial Real Estates Corporation , Aqaba Special Economic Zone.

Environmental Regulations الانظمة

- Groundwater Control Regulation (No. 85, 2002), Issued pursuant to Articles 6 and 32 of Water Authority Law No. 18 for the year 1988.
- Regulation of Harmful and Hazardous Waste Management, Transfer & Handling (No. 24, 2005)
- Soil Protection Regulation (No. 25,2005)
- Regulation for the Protection of the Environment from Pollution in Emergency Situations (No. 26, 2005)
- Regulation of Solid Waste Management (No. 27, 2005)
- Air Protection Regulation (No. 28, 2005)
- The Environmental Impact Assessment Regulation (No. 37, 2005)
- Land use planning Regulation (No. 6, 2007)

- Regulation No. 66, 1994: Wastewater Collection and Disposal (Based on WAJ, No. 18, 1988)
- Regulation No. 21, 2001: Protection of Environment in Aqaba Special Economic Zone (Based on ASEZ Law No. 32, 2000)

Key Instructions التعليمات

سلطة المياه
Water Authority of Jordan

1. Instruction of management and handling of hazardous wastes, 2003.
2. Instructions of *site selection for development activities*, 2007.
3. Instructions of spent oil management and handling, 2003.
4. Instructions of spent oil management and handling in ASEZ No. 68, 2005.
5. Instructions of classification of various establishments according to their *threat to environment*, 2010.
6. Instructions of use of waste, treated, saline and brackish water in agriculture, 2004.
7. Instructions for disposal of industrial wastewater to sewers public sewer of the year 1998 / Water Authority of Jordan (WAJ)

Jordanian Standards المواصفات القياسية

1. Jordanian Standard JS893/2006: Water- Reclaimed domestic wastewater.
2. Jordanian Standard JS202/2007: Water- Industrial reclaimed wastewater.
3. Jordanian Standards JS1145/2006: Sludge- Reuse of treated sludge in agriculture.
4. Jordanian Standard JS 1176/2008 Water- Reclaimed gray water in rural areas.

Standards are important as they are the reference for:

- The basic goal for design of new WWTPs
- Monitoring & performance evaluation for existing WWTPs for necessary maintenance and upgrading.
- Enforcement of water (environment) protection regulation to ensure compliance and handle illegal wastewater discharge and violations.

JS 893/2006
Reclaimed Domestic Wastewater Standard

- This standard was first published by JISM in 1995;then amended in 2002 & 2006 to widen the reuse activities and is currently applied to all municipal wastewater treatment systems.

  - The Reclaimed Domestic Wastewater standard has two primary components:
  - A) Reclaimed water discharged to streams, wadis or water bodies.
  - B) Reclaimed water for reuse.
  - Reclaimed water must comply with the conditions stated in this standard for each of its planned end uses.
  - It is not permitted to dilute by mixing reclaimed water before being discharged from wastewater treatment plants with pure water intentionally to comply with the requirements set in this standard.

JS 893/2006 Reclaimed Domestic Wastewater Standard

- The 2006 Standard #JS 893 includes the following **categories of wastewater reuse standards** depending on the fate of domestic wastewater after it is released from the wastewater treatment facility:
    1. Recycling of water for irrigation of vegetables that are normally cooked,
    2. Recycling of water used for tree crops, forestry and industrial processes,
    3. Discharges to receiving water such as wadis and catchments areas,
    4. Use in artificial recharge to aquifers not used for drinking purposes,
    5. Discharge to public parks or recreational areas,
    6. Use in irrigation of animal fodder.
    7. Use of reclaimed water for cut flowers.

JS 893/2006

Allowable limits for the reuse of treated wastewater in Jordan (MWI 2006)
الحدود المسموح بها لإعادة استخدام المياه العادمة المعالجة في الأردن (وزارة المياه والري 2006)

Parameter	Unit	Cooked Vegetables, Parks, Playgrounds and Sides of Roads within city limits	Fruit Trees, Sides of Roads outside city limits, and landscape	Field Crops, Industrial Crops and Forest Trees	Water discharge to wadies, streams and water bodies	Artificial recharge of groundwater aquifers
		A	B	C		
Biological Oxygen Demand	mg/l	30	200	300	60	15
Chemical Oxygen Demand	mg/l	100	500	500	150	50
Dissolved Oxygen	mg/l	>2	-	-	>1	>2
Total suspended solids	mg/l	50	150	150	60	50
pH	unit	6-9	6-9	6-9	6-9	6-9
Turbidity	NTU	10	-	-	-	<2
Nitrate	mg/l	30	45	45	45	30
Total Nitrogen	mg/l	45	70	70	70	45
Escherichia Coli	MPN or CFU*/100 ml	100	1000	-	1000	<2.2
Intestinal Helminthes Eggs	Egg/l	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1

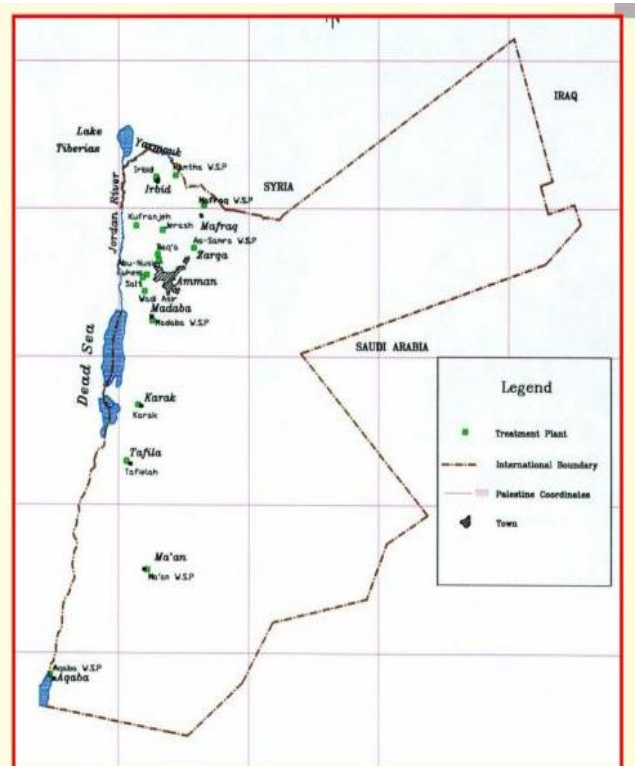
*Most probable number or colony forming unit

Category A: Most sensitive use, Category B: Medium sensitive use, Category C: Less sensitive use

Industrial Wastewater Standard Specification No 202/2007 .

- This standard defines the quality for final discharge of industrial wastewater to water bodies or irrigation.
- Standard 202 incorporated the standard JS 893/2006 for the reuse of industrial wastewater that included the following categories:

1. Irrigation
2. Recycle inside the industrial establishment.
3. Discharge to Wadis, Rivers and Catchments Areas.



JS 202/2007
Water – Reclaimed Industrial Wastewater

Characteristic	Unit	Limit, according to crop irrigated		
		A*	B**	C***
BOD	mg/L	30	200	300
COD	mg/L	100	500	500
DO	mg/L	> 2	--	--
TSS	mg/L	50	100	150
PH	pH units	6-9	6-9	6-9
Turbidity	turbidity units	10	--	--
NO_3	mg/L	30	45	45
Total nitrogen	mg/L	45	70	70
E. coli	MPN/100mL	100	1,000	--
Helminth	eggs/L	1	1	1

*Cooked vegetables, parks, playgrounds, urban landscaping ** Fruit trees, highway landscaping *** Field crops, industrial crops and timber trees

JS 202/2007:
Water – Reclaimed Industrial Wastewater

Trace and Heavy Metals	
Constituent	**Irrigation Limits**
Aluminum	**5.0**
Arsenic	**0.1**
Beryllium	**0.1**
Copper	**0.2**
Fluoride	**1.5**
Iron	**5.0**
Lithium (in acidic soils)	**2.5 (0.075*)**
Manganese	**0.2**
Molybdenum	**0.01**
Nickel	**0.2**
Lead	**5.0**
Selenium	**0.05**
Cadmium	**0.01**
Zinc	**5.0**
Total Chromium	**0.1**
Mercury	**0.002**
Vanadium	**0.1**
Cobalt	**0.05**
Boron	**1.0**

Constituent	Irrigation Limits
Phenol (mg/L)	0.002
Detergents (mg/L)	100
Total Dissolved Solids	2,000
Total phosphate (mg/L)	30
Chloride (mg/L)	400
Sulfur (mg/L)	500
Bicarbonate (mg/L)	400
Sodium (mg/L)	230
Magnesium (mg/L)	100
Calcium (mg/L)	230
Sodium Adsorption Ratio (mg/L)	9.0

Cyanide	**0.1**

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