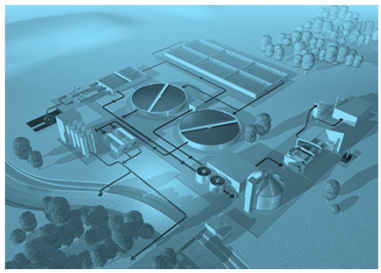
Sustainable wastewater-management



1

Waste Water Technologies

Awareness-Kick-off

(Basics) 05-07-2021

2

Overview Workshop series

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- Basics
- Food Processing
- Semicon and electronics
- Chemicals and plastics

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Content of this presentation

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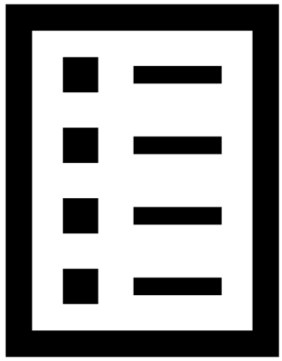
Agenda

- Philippine's water and wastewater sector
- Wastewater
  - Categories
  - Water and sanitation cycle
  - specification
- Treatment
  - in general
  - obligations in Philippines
  - steps
- summary



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Water - Sanitation

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Philippines
Water and wastewater sector

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UN-Water Country Brief 2011

		year
Total population (UN Population Division)	96.47 million inhabitants	2012
Total area	300 000 km²	
Population density	322 inhabitants/km²	2012
Human Development Index (UNDP) (between 0 and 1; 1 is highest)	0.654	
Country rank (total 186 countries; 1 is highest)	114	2012
Gender Inequality Index (0 is equality between women and men; 1 is least equality)	0.418	
Water, sanitation and hygiene-related deaths % of total deaths (WHO)	5.5 %	2004
Long-term average annual precipitation (CRU CL 2.0)	2 348 mm/year	
Long-term average actual renewable water resources (FAO AQUASTAT)	479 000 million m³/year	
Actual annual renewable water resources per capita (FAO AQUASTAT)	4 965 m³/inhabitant	2012
% of total actual renewable freshwater resources withdrawn (MDG Water Indicator) (FAO AQUASTAT)	17 %	2009
Groundwater withdrawal as % of total freshwater withdrawal (FAO AQUASTAT)	4 %	2009
Total area equipped for irrigation (FAO AQUASTAT)	1 879 000 ha	2006
% of irrigation potential equipped for irrigation (FAO AQUASTAT and AQUASTAT)	60 %	2006
Ramsar sites (Ramsar) – number	5 sites	2013
– total area	154 234 hectares	

UN WATER

Philippines

UN-Water Country Brief

Water withdrawals by sector (total 81 819 million m³ in 2009)

- 82.0% Agricultural
- 10.1% Industrial
- 7.6% Municipal
- 0.3% Cooling of thermoelectric plants

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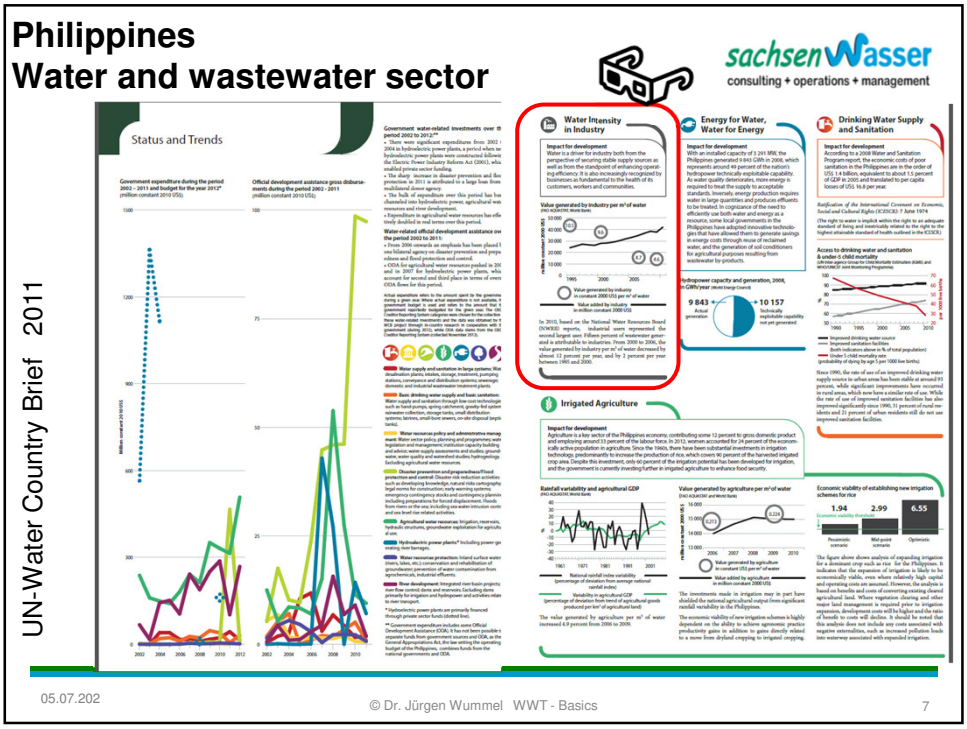
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UN-Water Country Brief 2011
Status and Trends
Water Intensity in Industry
Energy for Water, Water for Energy
Drinking Water Supply and Sanitation
Irrigated Agriculture
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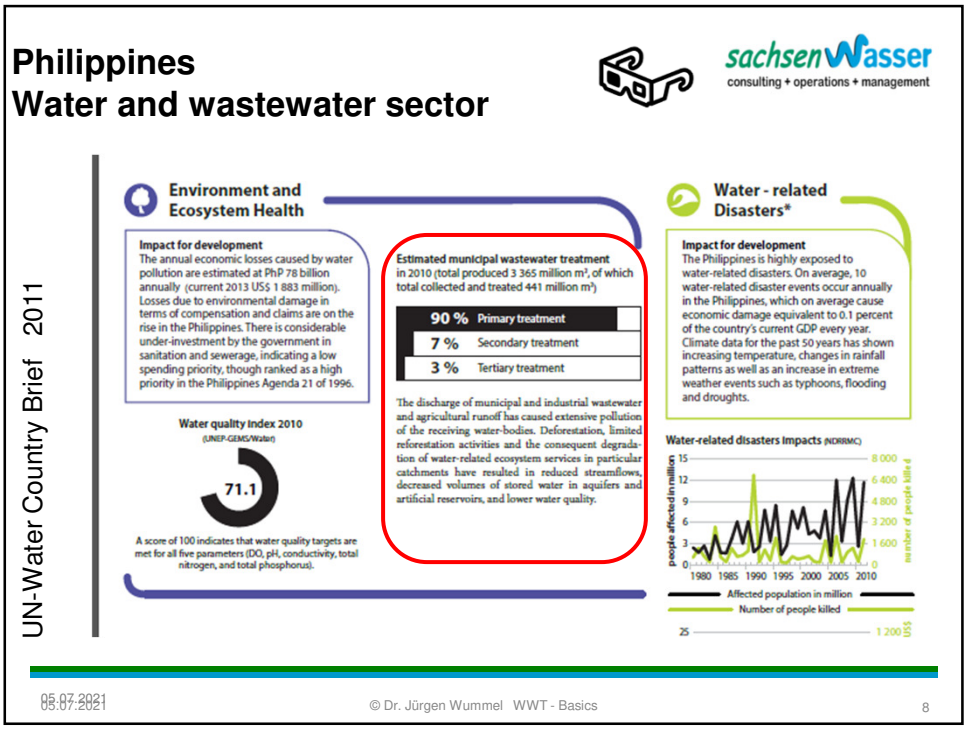
Philippines
Water and wastewater sector
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UN-Water Country Brief 2011
Environment and Ecosystem Health
Impact for development
The annual economic losses caused by water pollution are estimated at PhP 78 billion annually (current 2013 US$ 1 883 million). Losses due to environmental damage in terms of compensation and claims are on the rise in the Philippines. There is considerable under-investment by the government in sanitation and sewerage, indicating a low spending priority, though ranked as a high priority in the Philippines Agenda 21 of 1996.
Water quality index 2010
(UNEP-GEMS/Water)
71.1
A score of 100 indicates that water quality targets are met for all five parameters (DO, pH, conductivity, total nitrogen, and total phosphorus).
Estimated municipal wastewater treatment in 2010 (total produced 3 365 million m³, of which total collected and treated 441 million m³)
90 % Primary treatment
7 % Secondary treatment
3 % Tertiary treatment
The discharge of municipal and industrial wastewater and agricultural runoff has caused extensive pollution of the receiving water-bodies. Deforestation, limited reforestation activities and the consequent degradation of water-related ecosystem services in particular catchments have resulted in reduced streamflows, decreased volumes of stored water in aquifers and artificial reservoirs, and lower water quality.
Water - related Disasters*
Impact for development
The Philippines is highly exposed to water-related disasters. On average, 10 water-related disaster events occur annually in the Philippines, which on average cause economic damage equivalent to 0.1 percent of the country's current GDP every year. Climate data for the past 50 years has shown increasing temperature, changes in rainfall patterns as well as an increase in extreme weather events such as typhoons, flooding and droughts.
Water-related disasters Impacts (NDRRMC)
Affected population in million
Number of people killed
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Philippines
Water and wastewater sector

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- Only about 7% have access to sewerage or wastewater treatment programs
- While more than 80% of households have septic tanks, most are unmaintained. Most septic tank dispose of septage in the wrong way
- Raw sewage ends up in rivers, streams and empty fields, creating hazards for anyone exposed to it

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Philippines
Water boby – treatment obligations

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Table 1. Water Body Classification and Usage of Freshwater

Classification	Intended Beneficial Use
Class AA	Public Water Supply Class I – Intended primarily for waters having watersheds, which are uninhabited and/or otherwise declared as protected areas, and which require only approved disinfection to meet the latest PNSDW
Class A	Public Water Supply Class II – Intended as sources of water supply requiring conventional treatment (coagulation, sedimentation, filtration and disinfection) to meet the latest PNSDW
Class B	Recreational Water Class I – Intended for primary contact recreation (bathing, swimming, etc.)
Class C	1. Fishery Water for the propagation and growth of fish and other aquatic resources 2. Recreational Water Class II – For boating, fishing, or similar activities *3. For agriculture, irrigation, and livestock watering*
Class D	Navigable waters

Note: For unclassified water bodies, classification shall be based on the beneficial use as determined by the Environmental Management Bureau (EMB).

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Philippines example: for FOOD

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PSIC Code	Industry Category	Significant Parameters
08914	Rock phosphate mining	pH, COD, Total Suspended Solids, Ammonia, Phosphate, Fluoride, Surfactants
C. Manufacturing		
10110	Slaughtering and meat packing	Temperature, pH, BOD, Total Suspended Solids, Ammonia, Nitrate, Phosphate, Oil and Grease
10120	**Production processing and preserving of meat and meat products**	Temperature, pH, BOD, Total Suspended Solids, Oil and Grease
1020	Processing and preserving of fish, crustaceans and mollusks (except carrageenan)	Temperature, pH, BOD, Total Suspended Solids, Nitrate, Oil and Grease
10205	Processing of seaweeds; manufacture of agar-agar or carrageenan	Temperature, pH, COD, Total Suspended Solids
1030	Processing and preserving of fruits and vegetables	Temperature, pH, BOD, Total Suspended Solids, Oil and Grease
104	Manufacture of vegetable and animal oils and fats	Temperature, pH, BOD, Total Suspended Solids, Nitrate, Ammonia, Oil and Grease

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Philippines Compliance Action plan

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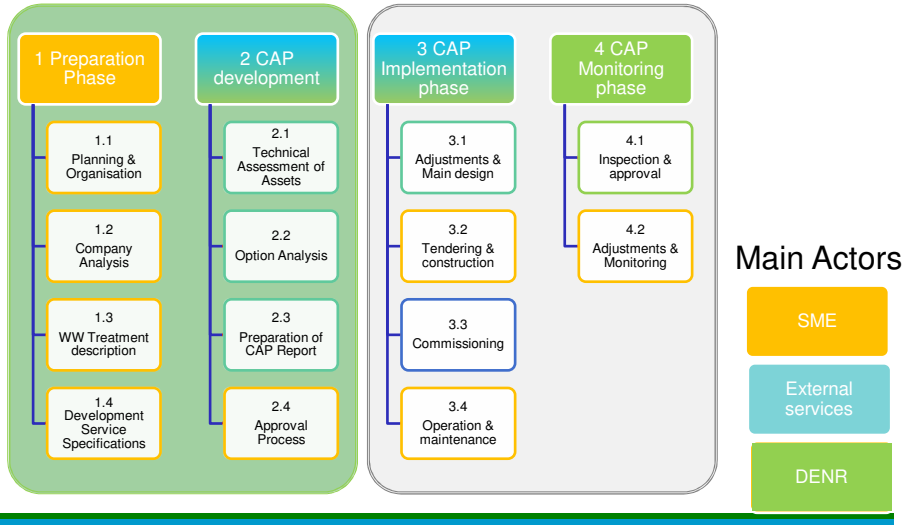

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Categories Definition

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Wastewater

- is water that has been used.
- It is any water whose quality has been adversely compromised by anthropogenic (human) influence.
- It can originate from a combination of domestic, industrial, commercial, agricultural activities, surface runoff or storm water, and from sewer inflow or infiltration.
- Treated wastewater is subsequently discharged into receiving water/artificial lake/storage tank via a discharge pipe.

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Categories

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Industrial waste water

- serious pollution problems
- negatives effects to the ecosystem
- human's life

Required limitation for

- Colour
- Turbidity
- Temperature
- Odour
- pH
- total solids (suspended and dissolved)
- Hardness
- chemical oxygen demand (COD)
- …

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Categories

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High-concentration

- wastewater may sometimes be concentrated further, treated, and recycled or disposed as solid wastes.

Medium-concentration

- may be treated on site or discharged into public sewers.

Low-concentration

- such as indirect cooling water may be discharged without any treatment.

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Categories classification

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domestic

Blackwater:
- Organic matter
- Pathogens
- Nutrients

Greywater:
- Organic matter; grease
- Nutrients
- Solids

industries

- Organic matter; grease
- Heavy metals
- Chemicals
- Nutrients

Rainfall Run-off

- Organic matter
- Heavy metals
- Solids
- Nutrients

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Categories

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- blackwater
- greywater
- Stormwater
- Industrial water

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Categories
Origin and types

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Domestic	industrial	agricultural
• Black water • Gray water • (yellow water)	• Chemical • Food and beverage • Steel • Textile • …	• Farming • Irrigation • Slaughter houses

The treatment of wastewater must be designed specifically for the particular type of effluent produced and for the local conditions of discharge

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Water and sanitation cycle

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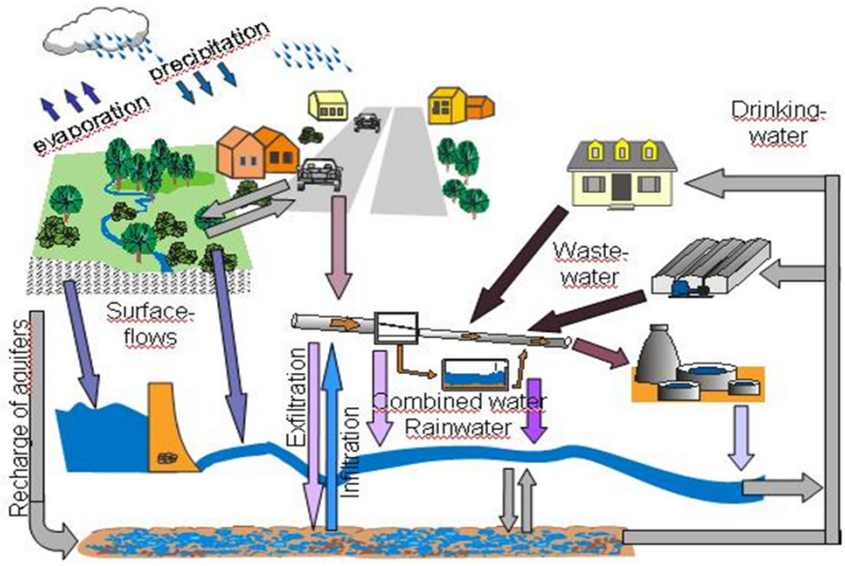

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Water and sanitation cycle
Wastewater discharge in rivers effects

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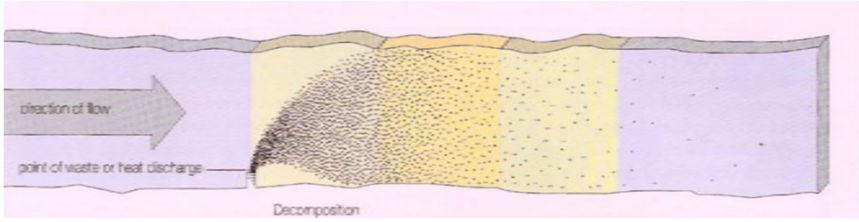

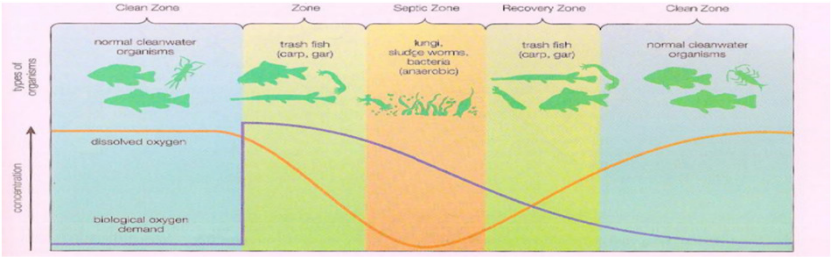

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Water and sanitation cycle
Effects in Laguna Lake

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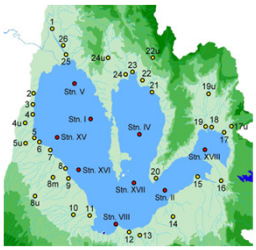
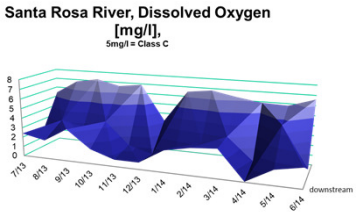
- Pollution of superficial water bodies due to unsatisfactory treated wastewater
- Decrease fishery production (food chain!)
- WW related diseases





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Specification
Sources

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- Organic or non-bio-degradable/difficult-to-treat waste (pharmaceutical or pesticide manufacturing)
- Extreme pH waste (from acid/alkali manufacturing, metal plating)
- Toxic waste (metal plating, cyanide production, pesticide manufacturing, etc.)
- Solids and emulsions (paper manufacturing, foodstuffs, lubricating and hydraulic oil manufacturing, etc.)
- Manmade liquids (illegal disposal of pesticides, used oils, etc.)
- Agricultural drainage, direct and diffuse
- Hydraulic fracturing
- Produced water from oil & natural gas production

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Specification Combination

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Wastewater can be diluted or mixed with other types of water in the form of:

- Seawater ingress (high volumes of salt and microbes)
- Direct ingress of river water
- Rainfall collected on roofs, yards, hard-standings, etc.
- Groundwater infiltrated into sewage

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Specification constituents

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Wastewater contains:

- Water (more than 95 percent), which is often added during flushing to carry waste down a drain;
- Pathogens such as bacteria, viruses, prions and parasitic worms;
- Non-pathogenic bacteria;
- Organic particles such as faeces, hairs, food, vomit, paper fibers, plant material, humus, etc.;
- Soluble organic material such as urea, fruit sugars, soluble proteins etc.;
- Inorganic particles such as sand, grit, metal particles, ceramics, etc.;
- Soluble inorganic material such as ammonia, road-salt, sea-salt, cyanide, thiocyanates, thiosulfates, etc.;
- Animals such as protozoa, insects, arthropods, small fish, etc.;
- Macro-solids such as sanitary napkins, nappies/diapers, condoms, needles, children's toys, dead animals or plants, etc.;
- Gases such as hydrogen sulfide, carbon dioxide, methane, etc.;
- Emulsions such as paints, adhesives, mayonnaise, hair colorants, emulsified oils, etc.;
- Toxins such as pesticides, poisons, herbicides, etc.
- Pharmaceuticals and hormones and other hazardous substances

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Specification Quality

The quality of wastewater may be defined by its physical, chemical and biological characteristics.

- Physical parameters - Temperature, pH, electrical conductivity, colour, odour, and turbidity.
- Chemical Parameters - Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Organic Carbon (TOC), Total Oxygen Demand (TOD), Inorganic chemical parameters (alkalinity, salinity, hardness, acidity and concentrations of cations such as Manganese, Iron, Anions (sulfates, chlorides, nitrates and phosphates).
- Biological Parameters - (Coliform, E-Coli, algae, protozoa, specific pathogens and viruses)

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Specification Challenge

Pollution from untreated wastewater has adverse effects on human health:

- 1.8 billion People use sources of drinking water contaminated with faeces.
- The combination of inadequate sanitation, poor hygiene, and unsafe drinking water results into an estimated annual burden of 2 million diarrheal deaths (WHO/UNICEF, 2014).
- 663 million peoples still lack improved drinking water sources, and global demand for water is expected to increase by 50% by 2030.

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Specification Challenge

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- In view of the above, the opportunities from exploiting wastewater as a resource are therefore enormous:
- Safely managed wastewater provides an affordable and sustainable sources of water, energy, nutrients and other recoverable materials.

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Specification Possible damages

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- Increased illness or mortality due to ingestion or skin contact with contaminated water, raising direct health care cost (treatment expenses, lost income) and indirect opportunity cost
- It makes additional treatment costs necessary in the drinking and industrial water productivity sector
- Farmers loose income due to loss of productive days
- Tourism industry depends on environmentally attractive areas; poor water quality deters tourists, lowering revenue to the government.
- The use of wastewater containing toxic wastes can cause an increase in water-borne diseases and environmental degradation

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Specification
Possible damages

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- It can also affect groundwater quality when nutrients leached to the sub-soil polluting underground water;
- Near surface aquifer in intensely irrigated areas using wastewater can become polluted, thereby reducing aquifer potability.

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Treatment
Water and sanitation process

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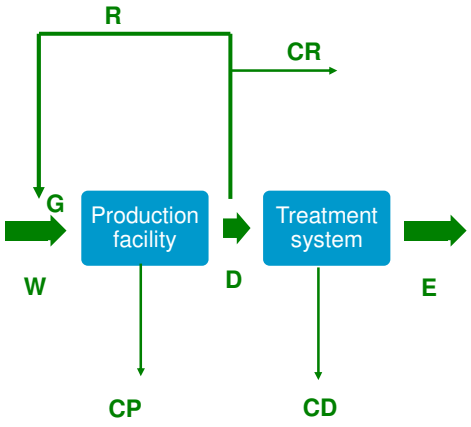

	description
W	Intake Water
R	Recirculated water
G	Gross watter applied
CR	Consumtive use for recirculation system
CP	Consumtive use for production system
CD	Consumtive use for waste water disposal s system
D	Waste water discharge from the production process
E	Final effluent from the production unit (available for reuse?)

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Treatment

necessary activities: Department of Environmental and natural Resources

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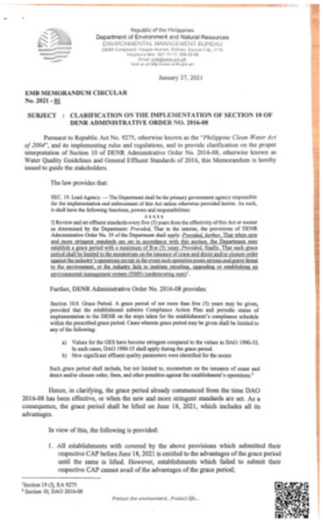

Republic of the Philippines
Department of Environment and Natural Resources
ENVIRONMENTAL MANAGEMENT BUREAU
DENR Compound, Visayas Avenue, Diliman, Quezon City, 1116
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Email: ad@emb.gov.ph
Visit us at http://www.emb.gov.ph

January 27, 2021

EMB MEMORANDUM CIRCULAR
No. 2021 - 02

SUBJECT : CLARIFICATION ON THE IMPLEMENTATION OF SECTION 10 OF DENR ADMINISTRATIVE ORDER NO. 2016-08

Pursuant to Republic Act No. 9275, otherwise known as the "*Philippine Clean Water Act of 2004*", and its implementing rules and regulations, and to provide clarification on the proper interpretation of Section 10 of DENR Administrative Order No. 2016-08, otherwise known as Water Quality Guidelines and General Effluent Standards of 2016, this Memorandum is hereby issued to guide the stakeholders.

The law provides that:

SEC. 19. Lead Agency. — The Department shall be the primary government agency responsible for the implementation and enforcement of this Act unless otherwise provided herein. As such, it shall have the following functions, powers and responsibilities:

* * * * *

f) Review and set effluent standards every five (5) years from the effectivity of this Act or sooner as determined by the Department: *Provided*, That in the interim, the provisions of DENR Administrative Order No. 35 of the Department shall apply: *Provided further*, That when new and more stringent standards are set in accordance with this section, the Department may establish a grace period with a maximum of five (5) years: *Provided finally*, That such grace period shall be limited to the necessary time required to comply with the new standards and shall not exceed the industry's capacity to recover such operation costs and/or cause undue harm to the environment, or the industry fails to institute retrofitting, upgrading or establishing an environmental management system (EMS) (underscoring ours)[1].

Further, DENR Administrative Order No. 2016-08 provides:

Section 10.0. Grace Period. A grace period of not more than five (5) years may be given, provided that the establishment submits Compliance Action Plan and periodic status of implementation to the DENR on the steps taken for the establishment's compliance schedule within the prescribed grace period. Cases wherein grace period may be given shall be limited to any of the following:

a) Values for the GES have become stringent compared to the values in DAO 1990-35. In such cases, DAO 1990-35 shall apply during the grace period.
b) New significant effluent quality parameters were identified for the sector

Such grace period shall include, but not limited to, moratorium on the issuance of cease and desist and/or closure order, fines, and other penalties against the establishment's operations.[2]

Hence, in clarifying, the grace period already commenced from the time DAO 2016-08 has been effective, or when the new and more stringent standards are set. As a consequence, the grace period shall be lifted on June 18, 2021, which includes all its advantages.

In view of this, the following is provided:

1. All establishments with covered by the above provisions which submitted their respective CAP before June 18, 2021 is entitled to the advantages of the grace period until the same is lifted. However, establishments which failed to submit their respective CAP cannot avail of the advantages of the grace period;

[1] Section 19 (f), RA 9275
[2] Section 10, DAO 2016-08

Protect the environment... Protect life...

2. CAPs approved with work plans extending beyond June 18, 2021, may only be benefited by the advantages of the grace period until the same is lifted;

3. Upon the lifting of the grace period, regular compliance is expected. Hence, any violation committed by establishments from June 18, 2021, either with approved CAP or otherwise, shall be subject to imposable penalties provided under RA. 9275 and its implementing rules and regulations.

EMB Memorandum Circular No. 2019-001[1], and all other related previous issuances of this Office inconsistent with this clarification are herein revoked.

This Memorandum Circular shall take effect immediately after its publication in a newspaper of general circulation and upon acknowledgement of receipt of a copy thereof by the Office of the National Administrative Register (ONAR).

ENGR. WILLIAM P. CUÑADO
Director

[1] Supplementary Clarification on the Coverage of DAO 2016-08 Relative to the Granting of Not More Than Five Years Grace Period

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Treatment
Waste water - philosophy

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Traditional sanitary approach

- if you are a food processor you produce wastewaters, and for that you have to develop processes and equipment to treat that wastewater.

Better approach

- The most important aspect of this approach is that wastewater problems are generally associated with organics (BOD) in the effluent which are food products diluted in water.

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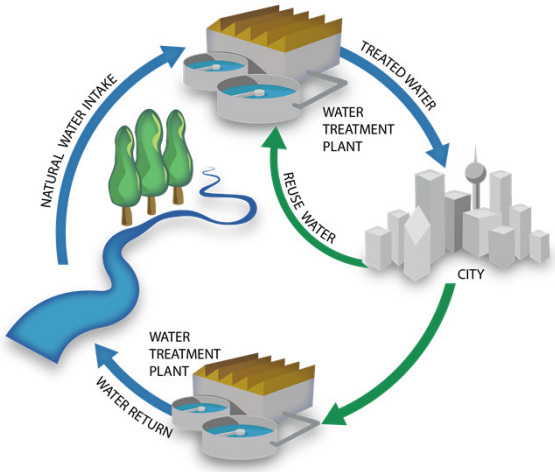
Treatment
Waste water - reuse



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Treatment
options

- Discharge directly to a municipal treatment plant
- Pretreatment and discharge to a municipal treatment plant
- Treatment plan on site
- Stream discharge or land application

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Treatment aspects

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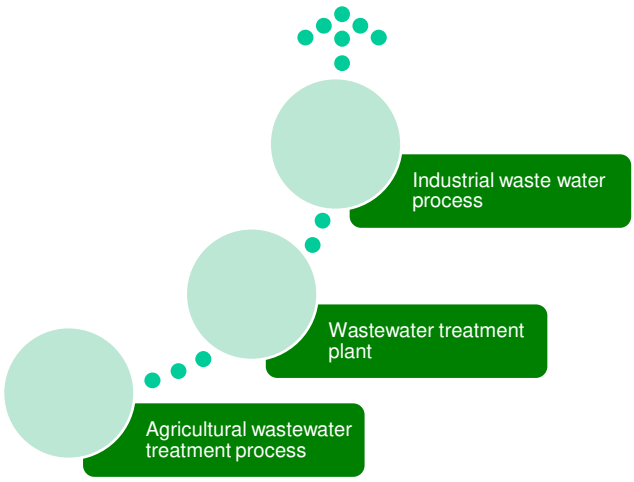

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Treatment

Legal framework for wastewater system in Philippines

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LEGAL FRAMEWORK	SALIENT FEATURES
PD 198, Section 5	… providing, maintaining, and operating waste water collection, treatment, and disposal facilites
Clean Water Act (CWA)	Section 6 of the CWA directs LGUs, WDs, and Water Utilities shall be responsible for sewerage and septage treatment facilities
Supreme Court Mandamus	"Clean Up of Manila Bay" … provide, install, operate, maintain, wastewater treatment facilities in Metro Manila, Rizal, Cavite, Laguna, Bulacan, Pampanga, and Bataan (MWSS, LWUA) … direct all LGUs to inspect all factories, commercial, and homes along major rivers in their jusrisdiction; they should have wastewater treatment facilities (DILG/LGU)

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Treatment

Legal framework for wastewater system in Philippines

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LEGAL FRAMEWORK	SALIENT FEATURES
LLDA Resolution	… adopting fines and penalties imposed under Section 28 of the CWA … PhP10,000-200,000 per day or imprisonment of 2-6 years
DPWH Memorandum Circular for Engineers of Cities and Municipalities	… mandatory provision of sewage treatment plant … when STP is not in place, septic tanks should produce effluents consistent with acceptable standards … to initiate the plugging/sealing of improperly disposed sewage system from residential, industrial, and commercial buildings
CWA-National Sewerage and Septage Management Program (NSSMP)	IRR of Clean Water Act

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Treatment steps

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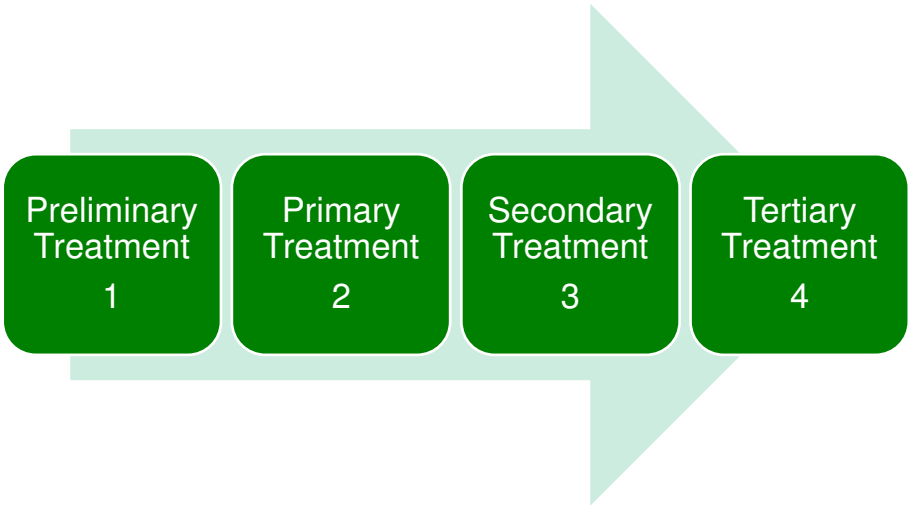

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WWTP with 4 Steps

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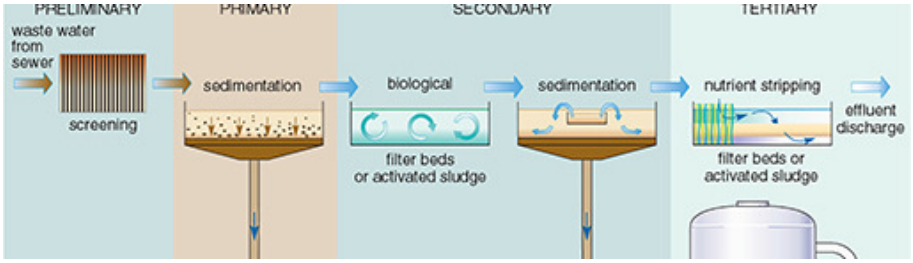

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Preliminary treatment

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- Removal of coarse solids by interception – racks and coarse screens (hand-cleaned or mechanically cleaned);
- Removal of grit, sand and gravel - grit chambers;
- Equalization (equalization of flow and mass loading of BOD and TSS) -equalization tanks;
- Removal of oil and grease – oil and grease tanks.
- Pre-aeration (control of odors, improve treatability, removal of grease and grit)
- Flocculation

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Preliminary treatment

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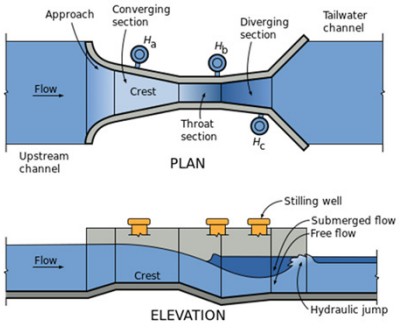

GRIT REMOVAL AND FLOW MEASUREMENT (DOSIFICATION)

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Preliminary treatment

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SCREEN

OIL AND GREASE REMOVAL TANK

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Primary treatment

- Removal of settleable solids and floating material (removal of organic and inorganic suspended solids)
- Primary sedimentation tanks (rectangular or circular)
- Primary sludge (typically 3 to 5% solids concentration)
- Efficiencies: TSS (50 – 70 %) ; BOD5 (20 – 50 %); Bacterial removal (25 – 75 %)
- Enhanced Primary Treatment (with added chemicals: alum, iron salts flocculation)
- Physic-chemical treatment (inorganic loaded wastewater)

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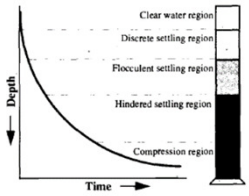
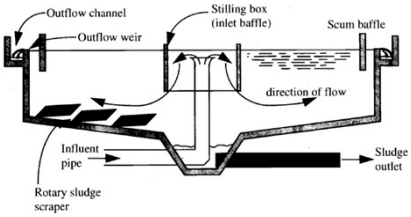
Primary treatment main design criteria

- Detention time – 1,5 to 2,5 h (average flow)
- Surface loading Rate (SLR) – 30 to 120 m³/m²/day (average to peak hourly flow)
- Depth - >3m





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Secondary treatment (Biological)

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Attached-growth treatment (Bio-film) processes

- Biological treatment processes
- Microorganisms responsible for the conversion of the organic matter are attached to some inert medium,
- Materials: rocks or specially designed ceramic or plastic materials

Suspended-growth treatment (active sludge) processes

- Biological treatment processes
- Microorganisms responsible for the conversion of the organic matter are maintained in suspension within the liquid

Pond processes

- Biological treatment by natural processes, involving the use of bacteria (and/or algae)
- Several ponds: anaerobic, facultative, aerobic, maturation

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Secondary treatment Attached Growth

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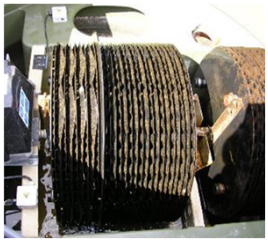
Trickling filters

Bio disc reactors



Packed-bed reactors

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Secondary treatment
Design Information for Trickling Filters

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ITEM	Low rate	Middle rate	High rate
Filter medium	Rock, slag	Rock, plastic	Plastic
Hydraulic load [m³/m²*d]	1 - 4	9 - 30	30 - 84
BOD_5 load [kg/m³*d]	0,08 – 0,40	0,5 – 1,0	0,5 – 1,6
Depth [m]	1,5 – 2,4	0,9 – 1,5	3,0 – 12,0
Recirculation ratio	0	1 – 2	1 – 2
Feeding	intermittent	continuous	continuous
BOD_5 removal efficiency	80 – 90	68 – 85	65 – 80

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Secondary treatment
Suspended Growth

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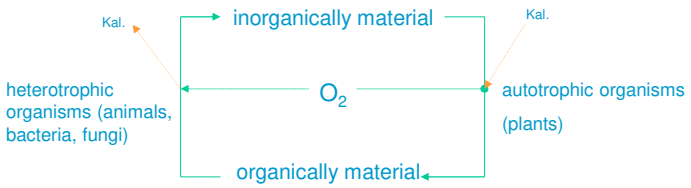
- production of an activate mass of microorganisms capable of aerobically stabilizing a organically waste
- Many versions of the original process are in use, but fundamentally they are all similar.

The theoretical oxygen requirement:

$$6\ CO_2 + 6\ H_2O + 2826\ \text{Joule} \leftrightarrow C_6H_{12}O_6 + 6\ O_2$$



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Secondary treatment Suspended Growth

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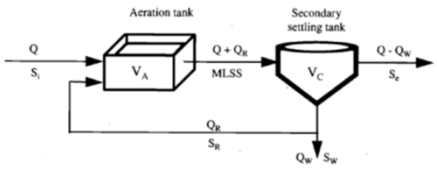

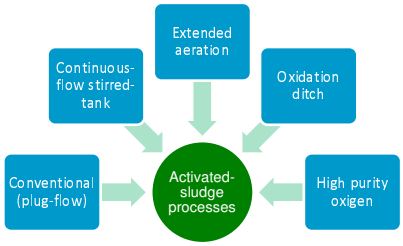

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Secondary treatment Suspended Growth

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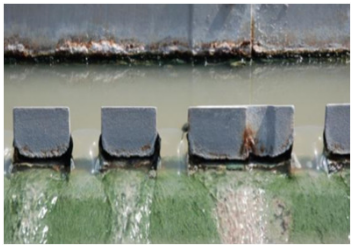

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Secondary Treatment

Design information for suspended growth processes

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ITEM	Conven-tional	Complete - mix	Extended aeration	High purity Oxygen	Oxidation ditch
Volumetric load [kg BOD_5/m^3*d]	0,3 – 0,6	0,8 – 1,9	0,16 – 0,4	1,6 – 3,2	0,08 – 0,5
F / M ratio [kg BOD5/ kg MLVSS*d]	0,2 – 0,4	0,2 – 0,6	0,05 – 0,15	0,25 – 1,0	0,05 – 0,30
Depth [m]	3,5 – 6,0	3,5 – 6,0	3,5 – 6,0	3,5 – 6,0	2,5 – 4,0
Recirculation ratio Q_R / Q_I [%]	25 - 75	25 - 100	50 - 150	25 - 50	75 - 150
Sludge retention time [d]	5 - 15	5 - 15	20 - 30	3 - 10	10 - 30

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Secondary Treatment

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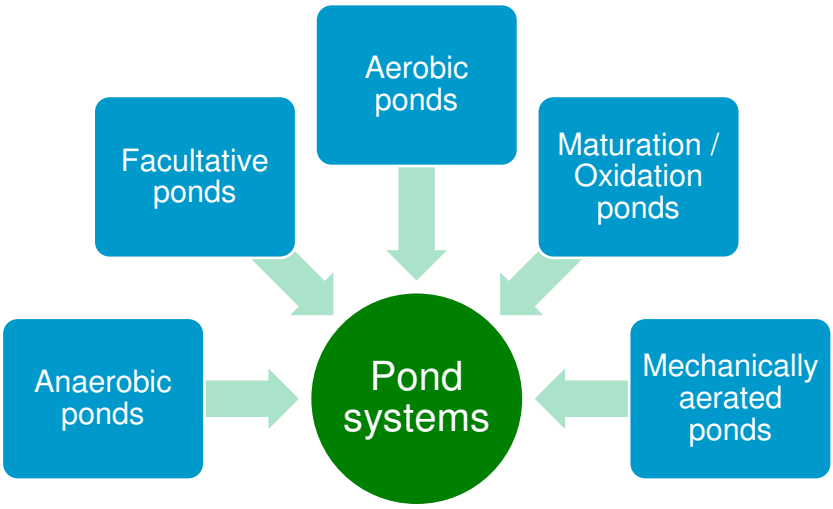

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Secondary treatment
Pond systems

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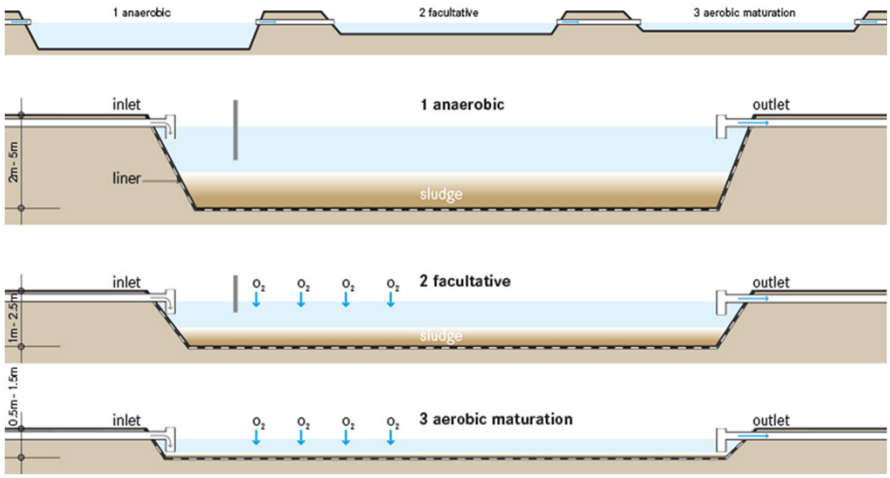

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Secondary Treatment
Design Information for Pond Systems

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ITEM	Aerobic, low rate	Aerobic maturation	Facultative	Anaerobic	Aerated
Detention time [d]	10 – 40	5 – 20	5 – 30	20 – 50	3 – 10
Depth [m]	0,9 – 1,2	0,9 – 1,5	1,2 – 2,4	2,4 – 4,8	1,8 – 6,0
Operation	Series or parallel	Series or parallel	Series or parallel	Series	Series or parallel
Volumetric load [kg BOD/ha*d]	67 – 135	< 17	56 – 202	224 – 560	20
BOD removal [%]	80 – 95	60 – 80	80 – 95	50 – 85	80 – 95
Suspended solids effluent [mg/l]	80 – 140	10 – 30	40 – 60	80 – 160	80 – 250

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Tertiary treatment

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Removal	Treatment method
Total suspended solids (TSS)	• Filtration and microscreening
Microorganisms	• Sand filtration • UV disinfection • Maturation ponds • Disinfection with chlorine or ozone • Membrane technologies (microfiltration)
Nitrogen	• Nitrification /denitrification
Phosphorus	• Chemical precipitation • Biological processes
Special substances	• Physical-chemical processes

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Tertiary treatment
Filtration and Disinfection

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Tertiary treatment
Sludge WW Treatment

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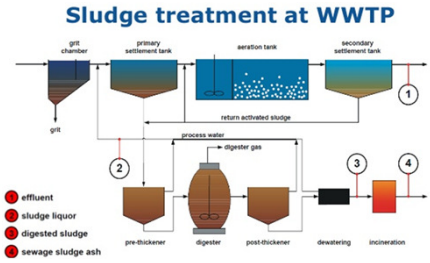
Main purpose:

- sludge stabilization control of pathogenics and odor
- dewatering reduce the water content in the sludge
- Energy recovery Methane



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Treatment steps

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Primary Treatment	• Solid waste removal • Simple • Low costs, simple handling	< 40%
Secondary treatment	• Carbon, nitrogen, Phosphorous removal • Moderate costs, high know how, stable operation	< 85%
Tertiary treatment	• Polishing of the effluent by filtration or disinfection • High costs und know how	< 99%
Advanced treatment	• Removal of medical residues • Removal of finest particles • Very hifh costs and know how	> 99%

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Summary Requirements

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Preparation of Compliance Action Plan

- Minimum content of the compliance action plan to avail of the maximum 5-year grace period under Section 10 of DAO 2016-08:
  - a) description of the establishment,
  - b) process production flow (including flow rate, volume of discharge),
  - c) characterization or nature/description of wastewater,
  - d) modification of the WWTF, and
  - e) timeline of the project (corrective action), among others

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Summary Closes loop

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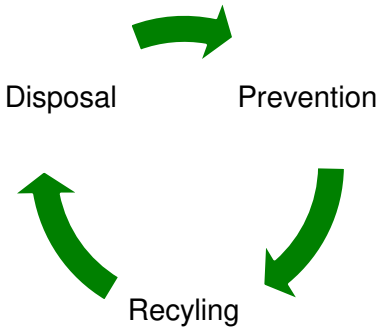
Prevention
Reduction of volume and harmfulness

Recycling
Product recycling
- Reuse
- Further use

Material recycling
- Reuse
- Further use
- Energy recovery



Disposal
Environmentally correct removal out of the circular flow

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Summary
General criteria for WWTP selection

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- Wastewater quality and quantity
- Typical efficiency and performance of the technology
- Reliability of the technology
- Manageability (by own or external)
- Financial sustainability, application in reuse schemes
- Regulatory determinants, special conditions

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Summary
Comparison of effluent quality in different WWTP

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WWTS	BOD	Suspended solids	Ammonia	Phosphorous	Faecal coliform
Septic tank	60%	40-70 mg/L	40-60 mg/L	6-7 mg/L	1-2 Log removal
Septic tank + soil	0-10 mg/L	0-10 mg/L	0-40 mg/L	0-2 mg/L	6-7 Log removal
Lagoons	20-30 mg/L	30-80 mg/L	20-30 mg/L	5-7 mg/L	3-5 Log removal
Wetlands	5-30 mg/L	5-20 mg/L	5-15 mg/L	0-10 mg/L	1-3 Log removal
Preliminary treatment	0% removal	0-10% removal	0% removal	0% removal	0 Log removal
Primary treatment	25-40 % removal	40-70 % removal	0-10 % removal	0-10 % removal	0-1 Log removal
Primary treatment chem. enhanced	45-65% removal	60-82% removal	ni	ni	ni
Secondary treatment	5-40 mg/L 86-98% removal	5-40 mg/L 89-97% removal	1-10 mg/L	5-10 mg/L	1-2 Log removal
Nutrient removal	5-30 mg/L	5-30 mg/L	0.1-5 mg/L	0.1-1 mg/L	0-1 Log removal
Disinfection	0% removal	0% removal	0% removal	0% removal	5-6 Log removal

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Summary
Planning stage analysis

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- Invest time in **assessing needs, resources and capabilities**.
- Evaluate the **characteristic factors** of the neighborhood.
- **Consider alternatives** for cluster WWT solutions (Off-site treatment), disposal and management
- Bear in mind the **cost** and **complexity** of **operations**, **maintenance**, and **management.**

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Summary
Project costs vs. planning stage

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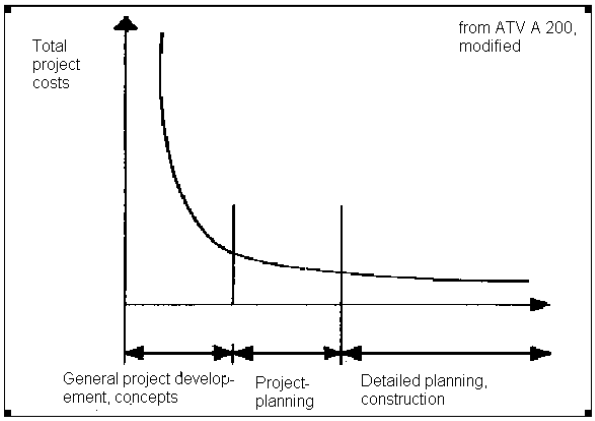
Possibilities of influence on project costs dependant on the stage of planning



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Summary Recommendations

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- Rather than letting water literally go down the drain, this precious commodity has to be reused, recycled and used as efficiently as possible. Most especially, wastewater MUST be reduced.
- Wastewater should no longer be seen as a problem, but as part of the solution to challenges that all societies are facing.
- Treated wastewater can be a cost-efficient, sustainable, safe and reliable alternative source of water for a variety of purposes – from irrigation and industrial uses to drinking water, particularly under conditions of water scarcity.
- For this, we need to change mind-sets, to raise awareness and redouble educational efforts to share the benefits of wastewater reuse

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QUESTIONS & ANSWERS

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Thank you for your attention

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