Chapter 6: Environmental Preservation Part 2 (The Wastewater Treatment Plant)

I. Definition of a Wastewater Treatment Plant

It is a facility designed to purify domestic or industrial wastewater and rainwater before discharging it into the natural environment. The goal of the treatment is to separate water from substances that are undesirable for the receiving environment. The first attempt at wastewater purification was invented in 1914 by English scientists.

Aerial view of a wastewater treatment plant

II. Main Objectives of a Wastewater Treatment Plant

- Protection of the groundwater table against pollution;
- Avoiding the irrigation of agricultural land with wastewater by farmers;
- Minimizing the risk of waterborne diseases;
- Reusing purified water in the field of irrigation;
- Significant water savings;
- Avoiding the overexploitation of underground aquifers.

III. Conditions for Implementing a Wastewater Treatment Plant

The wastewater treatment plant must be implemented according to the following conditions:

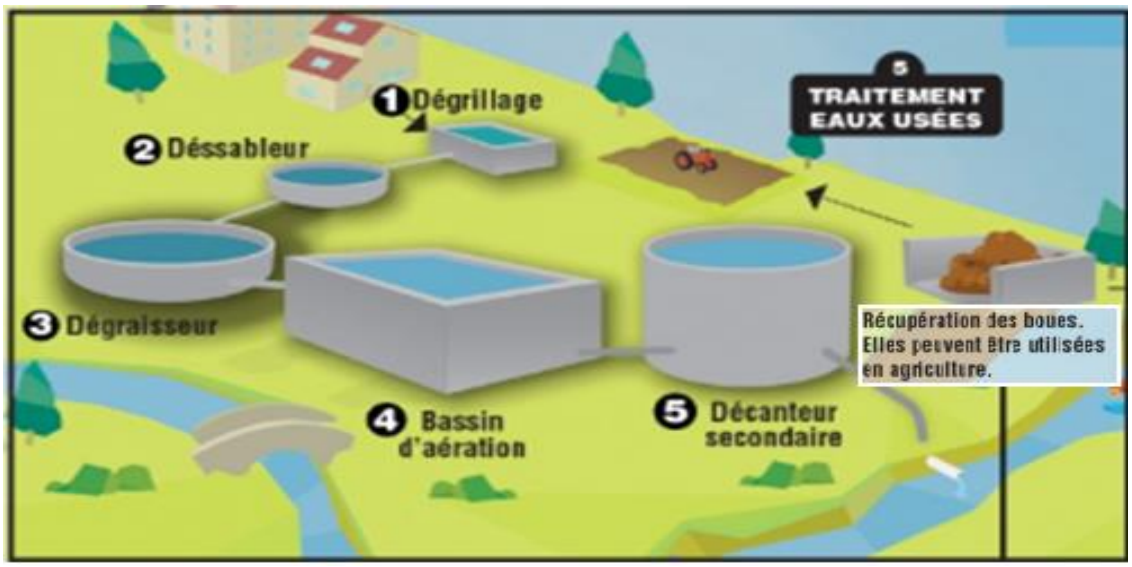
- Avoid flood-prone areas as much as possible;
- Take into account urbanized and potentially urbanizable areas due to unpleasant odors, airborne diseases, etc.;
- The location must be downstream of the sanitation network (at the outlet) to avoid lifting (pumping) and consequently high costs.

IV. Operation of a Wastewater Treatment Plant

Wastewater is conveyed to the treatment plant via the sanitation network.

Three main operations can be distinguished in water treatment:

- **Pre-treatment** and **primary treatment**, which includes **screening** (eliminating bulky waste), **grit removal** (extracting sand), **oil removal** (ridding the water of fatty substances), and **primary settling** where sludge is recovered at the bottom of the basin.
- **Secondary treatment**is most often done "biologically," but a "physico-chemical" method can replace or be added to it. Physico-chemical treatment allows for better coagulation of sludge and notably favors the fixation of phosphates coming from fertilizers or agricultural activities. Secondary treatment includes oxygenation (oxygen is inserted into the water to break down remaining fatty substances) and secondary settling (which allows for extracting a second quantity of sludge).
- **Sludge treatment**is carried out in parallel with water treatments (using sludge harvested from settling basins and during clarification).



The 5 Steps of Wastewater Treatment

Lifting Station:

This structure allows the pumping of screened wastewater towards pre-treatment. The waters are loaded with suspended solids (eliminating particles larger than 80 to 60 mm).

Pumping Station

Pre-treatment and Primary Treatment

1st Step:

Screening

The wastewater leaving your home is conveyed to the treatment plant by sanitation networks.

Screening machine

Coarse Screening:

The coarse screen allows effluents to be rid of waste larger than 40 mm in order to protect the lifting pumps against clogging; this waste is rejected into refuse skips.

Fine Screening:

Fine screens are used to eliminate particles between 6 mm and 15 mm in size.

2nd Step: Grit Removal and Oil Removal

The following steps allow the water to be rid of materials that were not stopped by screening. Thanks to the reduction of flow velocity, it is possible to recover sands (by pumping) and greases (which are scraped off the surface).

The waters first flow into a first basin (called the "grit chamber" or "desander") where materials heavier than water (sand, gravel, etc.) settle to the bottom.

Grit Chamber – Oil Separator

Then they pass into a second basin where greases are recovered on the surface. The basins are equipped with a self-propelled bridge and aeration pumps. These pumps, installed along each structure, diffuse fine air bubbles which favor the rising of greases and floating bodies to the surface. The self-propelled bridge ensures surface scraping to push floating matter onto chutes and pumping sumps. The recovered products are evacuated for subsequent treatment (Sludge Treatment). The waters are then evacuated and continue their purification in the plant.

3rd Step: Biological Treatment

This is the essential part of the treatment. It consists of reproducing, but in an accelerated manner, the natural process that exists in rivers. The waters arrive in a basin where bacteria have developed. These microscopic living beings will digest impurities and transform them into sludge.

Biological treatment in a settling basin

These techniques are carried out with oxygen (aerobic) or without oxygen (anaerobic). The wastewater must then be rid of its organic compounds, nitrogen, and phosphorus.

To do this, various basins are used where bacteria fed with oxygen have developed; they will digest impurities very quickly and transform them into sludge.

- **Elimination of organic compounds**is done with aerobic bacteria that degrade them through an oxidation phenomenon. These bacteria are capable of transforming organic or mineral molecules thanks to their enzymes.
- **Elimination of ammoniacal nitrogen (NH_4^+)** is done with bacteriological treatments of "nitrification-denitrification". Nitrification is a transformation by bacteria of ammoniacal nitrogen into nitrates. Then these nitrates are transformed into gaseous nitrogen which escapes naturally into the atmosphere.
- **Elimination of phosphorus**is obtained by its accumulation in the bacterial cultures of the sludge.

4th Step: Clarification

This step consists of separating water from sludge or secondary residues resulting from the degradation of organic matter. This settling is operated in special basins called "clarifiers". The sludge settles at the bottom of the basin, where it is scraped and evacuated.

Clarifier

The water, rid of 80 to 90% of its impurities, then undergoes analyses and checks before being discharged into the natural environment.

5th Step: Sludge Treatment

A treatment plant produces 2 liters of residual sludge per inhabitant per day. The sludge recovered during settling, biological treatment, and clarification must be treated. There are differenttypes:

- **Primary sludge** resulting from the settling of suspended solids.
- **Secondary sludge** resulting from a residue dissolved by bacterial cultures.

Sludge stabilization aims to reduce its fermentability to attenuate bad odors. Biological stabilization is carried out in aeration basins or in digesters with biogas production. The sludge can also pass through centrifuges which will accelerate the separation of water from the rest of the compounds by spinning at 6000 rpm. The residual sludge is scraped by a screw conveyor towards a skip.

This sludge is generally used in agriculture as fertilizer. Once dry, it can also be incinerated or put in a landfill.

dryingbeds

Sludg estorage