

**GONDAR UNIVERSITY
INSTITUTE OF
TECHNOLOGY
SCHOOL OF CIVIL AND HYDRAULIC
ENGINEERING**

**SEWAGE TREATMENT AND DISPOSAL
(WWT)**

Lecture 1

Outlines

1. Introduction to sewage(WW) treatment
 - 1.1 General about Wastewater Treatment
 - 1.2 Objectives of Wastewater Treatment
 - 1.3 Types of sewage, sources and collection methods
 - 1.4 Flow Sheets for Wastewater Treatment Systems

Chapter One

Introduction to sewage(WW) treatment

➤ Wastewater or sewage is the byproduct of many uses of water.

- Is **water** by mass (99.9%) and **contaminants** in either floating, suspended/dissolved form.
- **Sewage treatment** is the process of **removing contaminants** from wastewater and household sewage. It includes **physical, chemical, and biological** processes.
- **WW treatment:** Any process to which wastewater is subjected to **make it suitable for subsequent use**.

Wastewater Contaminants

- Suspended solids
 - Biodegradable organics (e.g., BOD)
 - Pathogenic bacteria

Objectives of Wastewater Treatment

- To remove **pollutants** from waste water for its recycling.
- To promote **health concern** and public hygiene.
- To preserve **aquatic life** and wildlife habitat.
- To promote **recreation and quality of life.**

Another important aim of waste water treatment include

Energy production

Nutrient recovery &

Water reuse

Wastewater Treatment Standards

Effluents from different establishments should be treated before being discharged to receiving bodies so that it should be:

- Free from materials and heat in quantities which are harmful to human, animal, aquatic life.
- Free from anything that will settle in receiving waters forming putrescence or otherwise objectionable sludge deposits, or that will adversely affect aquatic life.
- Free from floating debris, oil, scum and other materials in amounts sufficient to be noticeable in receiving waters;
- Free from materials and heat that alone, or in combination with other materials will produce color, turbidity, taste or odor in sufficient concentration to create a nuisance or adversely affect aquatic life in receiving waters;
- Free from nutrients in concentrations that create nuisance growths of aquatic weeds

Specific Limits

Effluents discharged to receiving water bodies should achieved the following minimum wastewater quality limits:

<u>Parameter</u>	<u>Effluent Limit</u>
<u>BOD₅</u>	<u>20mg/l</u>
<u>TSS</u>	<u>30mg/l</u>
<u>Nitrates (as Nitrogen)</u>	<u>30mg/l</u>
<u>Phosphate</u>	<u>10mg/l</u>
<u>COD</u>	<u>100mg/l</u>
<u>pH</u>	<u>6 – 9</u>
<u>Faecal coliform</u>	<u>1000MPN/100ml</u>
<u>Residual chlorine</u>	<u>1.5mg/l</u>

MPN- Most Probable
Number

Types of sewage

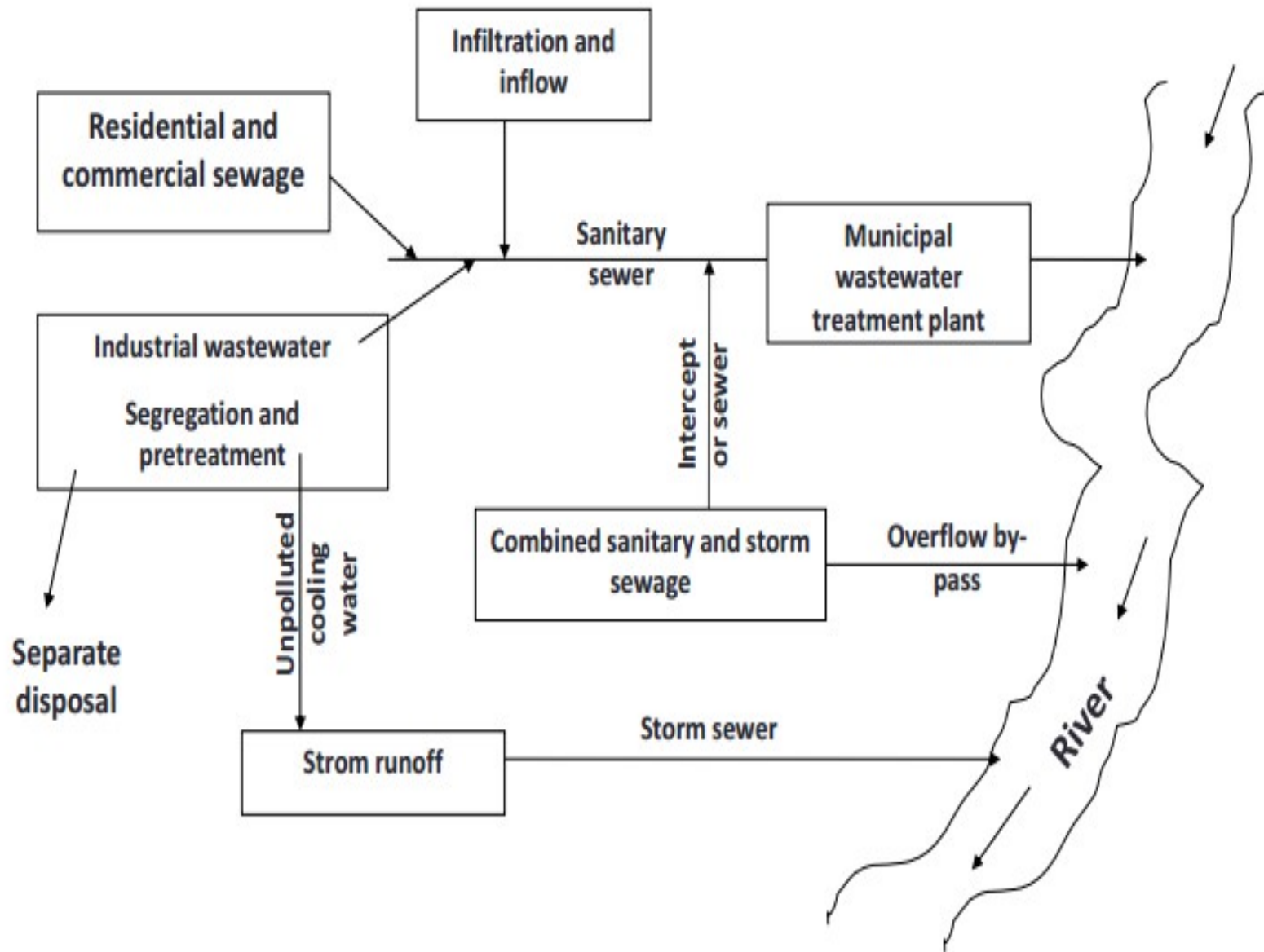
Sewage: It is a liquid waste or foul water of the community conveyed by sewer.

Depending on the nature and sources sewage can be classified as:

- **Domestic Sewage:** The sewage from residential buildings, business centers, institutions also contain human body waste (faeces and urine) and also sullage.
- **Industrial Sewage:** The liquid wastes obtained from industrial process such as dying, papermaking etc.
- **Sanitary Sewage:** is a combination of domestic and industrial sewages. It contains organic matters and other pollutant that are harmful in nature.
- **Storm sewage** : is surface run-off which is flowing in sewer during or following a period of rainfall.
- **Sullage:** It is the waste water resulting from personal washing, bathing, laundry, food preparation and cleansing of utensils.

Garbage: It is the dry refuse of town containing organic, inorganic solids, semisolids, combustible, noncombustible, putrescible and non putrescible substances.

Sources of sewage



Sources of sewage -----

Domestic (also called sanitary) sewage: From residential and commercial districts

- Other sources include institutional and recreational facilities.

Industrial waste water (Non-domestic): wastewater in which industrial wastes predominate.

Infiltration: groundwater entering sewers through defective joints, and broken or cracked or broken pipes and manholes.

High during wet period, especially sewers constructed in or close to streambeds

Inflow is storm water that enters the sewer system from storm drain connections (catch basins), roof leaders, foundation and basement drains, or through manhole covers.

Storm Sewage

- During rainfall, a part of rainfall water percolates into the ground and a part is evaporated in the atmosphere.
- The remaining part flows over the ground surface and is termed as surface run off, flood water, or storm water or storm sewage.

SYSTEMS OF SEWARAGE

Basic Terms

Sewerage:
the system
that is used
for collecting
sewage

Sewer: Individual
pipe line used to
collect sewage /
Underground
conduit (drain)
through which
sewage is
conveyed

Sewage:
municipal
wastewater
and storm
runoff

SEWAGE SYSTEMS

Building sewers/connections: bring wastewater from the houses to the laterals/branch lines

Laterals/ branch sewers: They are used to collect wastewater from one or more building sewers and convey it to a main sewer.

Main sewers are used to convey wastewater from one or more lateral to trunk sewers or intercepting sewers.

Trunk sewers are large sewers that are used to convey wastewater from main sewers to treatment or other disposal facilities or large intercepting sewers.

Intercepting sewers are large sewers that are used to intercept a number of main or trunk sewers and convey the wastewater to treatment or other disposal facilities.

- **Relief sewer-** built to carry a portion of the flow in a system with inadequate capacity.
- **Outfall sewer-** carries the collected waste to a point of treatment or disposal.

Based on the function of the sewers, the principal types found in most collection system are

Building sewers

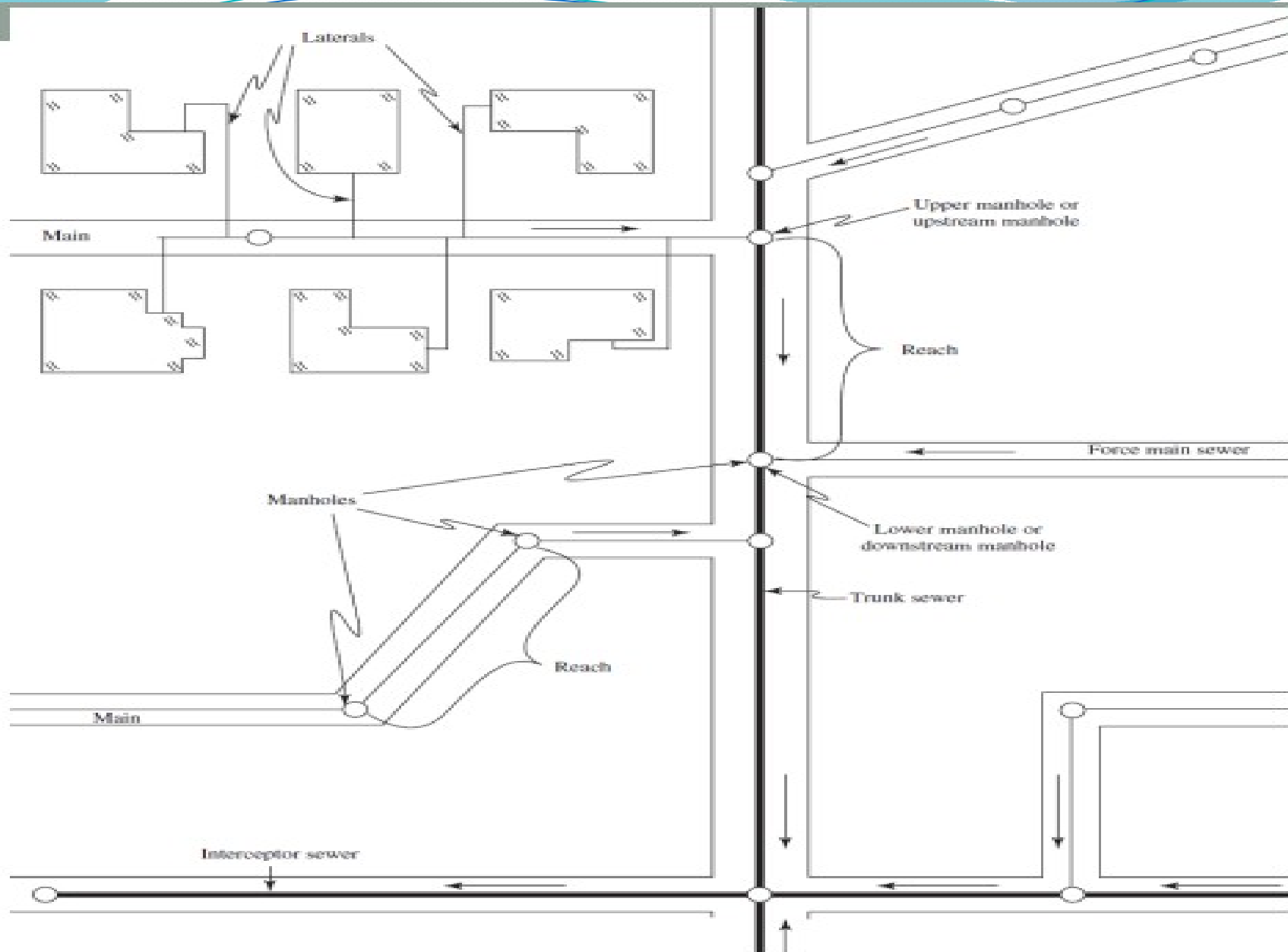
Lateral or branch sewers

Main sewers

-Trunk sewers

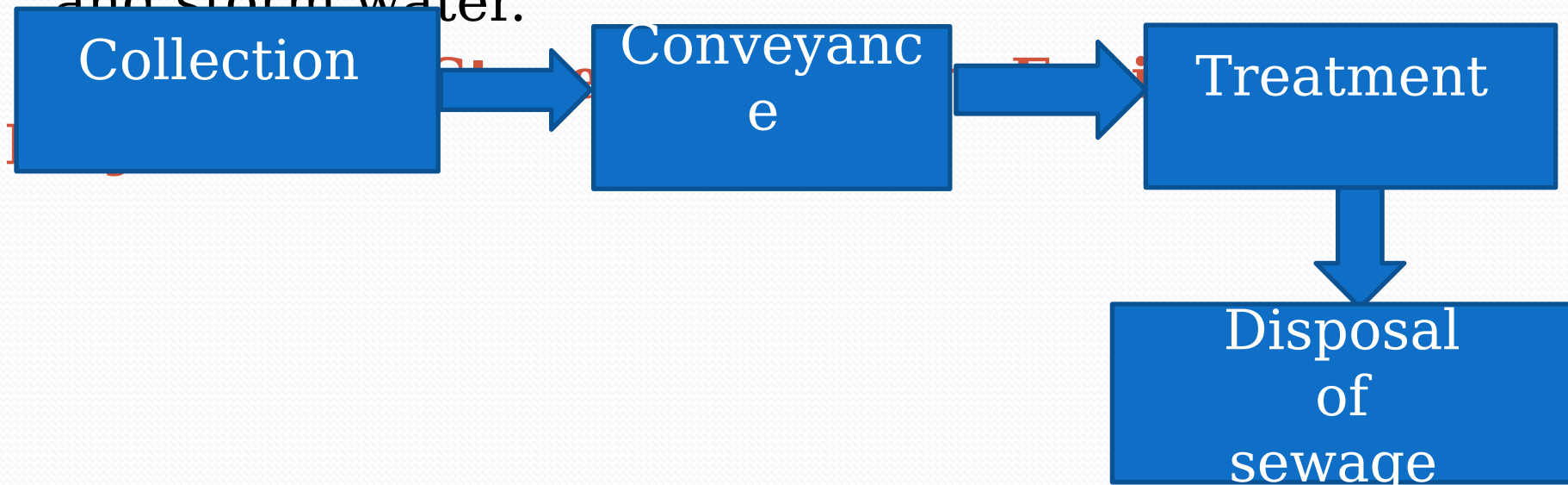
-Intercepting sewers

SEWARAGE SYSTEMS



Based on the method (systems) of **collection and conveyance, sewers** are divided into three:

- **Sanitary sewer** is one, which carries **sanitary sewage** and excludes storm sewage as far as possible.
- **Storm sewer** carries storm water only, including surface runoff and street wash.
- **Combined sewer** is designed to carry **all types of sewage**, such as domestic sewage, industrial wastes, and storm water.



- **Sewerage System:** - is the system of sewers including all appurtenances required for sewage disposal. A sewerage system will consist of mainly:

- i.) collection work
- ii.) Treatment works if any
- iii.) Disposal works.

I. Collection works: are provided for collecting sewage from different points of occurrence and conveying sewage to any desired points with the help of a sewer system.

II. Treatment work: sewerage treatment covers any process to which the sewage is subjected in order to remove or alter its objectionable constituents so as to render it less dangerous or offensive.

III. Disposal work: sewage disposal applies to the act of disposing of sewage by any method to a body of water or on land.

Collection and Conveyance of Sewage

- System of sanitation is classified on the basis of **collection** and **conveyance** of waste produced in a community.
- This is mainly related to excreta disposal.
- The **methods of collection** adopted are mainly the following two types:

(a) Non-water carriage sanitation systems / **Dry or Conservancy system**

(b) Water carriage sanitation system.

Non-water carriage / Dry or Conservancy system

- **Old and outdated system of disposal**
- This is adopted where **no sewerage system** exists.
- In this system all sorts of refuse from a community is **collected first in dust bins or garbage** vats, which are located at **suitable points** inside the township.
- **Disposal of refuse** is done by means of **land filling, incineration, composting or dumping in the sea.**
- **Mostly used in villages / undeveloped urban areas**
- **Sewerage system (wastewater collection and treatment)** is not available for the disposal of sanitary wastes in most **towns and all rural areas** of our country.

- Therefore, **privies** are in use for collection and disposal of night soils.
- **Conservancy** is chosen and in such system human excreta is collected in various types of privies
- The types of privies that may be adopted are the following:
 - Bore -hole latrines
 - Pour- flush latrines
 - Conventional unimproved pit latrines
 - Ventilated improved pit latrines(VIP)
 - Double tank latrines
 - Septic tank latrines
 - Aqua privy
 - Chemical toilets
 - Working type privy

The following are the merits of the conservancy system

- It is very cheap in **initial cost**
- Storm water is carried in usually surface drains, hence **no problem of pumping the storm water**.
- The quantity of waste liquid reaching the disposal point is less, hence it can be disposed of **without any treatment**
- As the storm water is carried in open drains, the sewer section will be small and will run full for the major portion of the year, due to which there will be **no silting and deposits in the sewer lines**.

Disadvantage

- **Liquid** from latrines get **into ground**
- Cause **contamination** of groundwater
- Openly disposed non-liquid wastes also **cause diseases**

Water Carriage Systems

- **Collection, Conveyance and Disposal** of the Wastes is done **with the help of water**
- **Latrines** used are of **special design** called Water Closets (WCs)
- **Flushing** of WCs is done with water **5 to 10 l**
- **WC's waste** and **Sullage** from kitchen and bathroom form **sewage**
- **Sewage flows** through **underground pipes** to **treatment plants** and **disposed** of for irrigation or as dilution

Water Carriage ...

- In such a system
 - Garbage is disposed as in conservancy system
 - **Storm water may or may not be allowed** to enter the sewers (storm water can also be disposed off through an open surface drains / not dirty)
- Water carriage system is **most modern method** of disposal and is recommended
- **Initial cost** of installation is **very high** and might be difficult to install it for **poor communities**
- It might need to be **implemented by phase**

Sanitary System Choice

- Water carriage system is the **most modern**
- It has so **many advantages** over **conservancy**
- It is more **advantageous for big cities** where there is large concentration of population
- Can be **economical for big cities** where there is a possibility to raise fund
- However for **small cities** and towns **adoption of water carriage system** becomes difficult as it is not easy to raise fund
- Thus **conservancy system** is recommended **for small cities and towns** as they prove to be economical
- Availability of **space in small towns** and lack of it in **big cities** is also the cause for the **different choice of the system**

Comparison of water-carriage and non water-carriage system

Conservancy system

- Cheaper as it has no initial cost
- As the waste liquid is less foul in nature and small in volume it needs no treatment.
- Storm water carried in open drains, generally does not require pumping
- Sanitation is of lower degree as storm water may get polluted with organic load while conveyed through open drains
- Excreta is removed after causing putrefaction and resulting nuisance of smell, fly and unhygienic condition.

Water-carriage system

- It has high initial cost
- The sewage is highly polluted in nature and huge in amount it needs treatment before disposal. So it is costlier in operation also
- Pumping of sewage is frequently required
- Sewage treatment before disposal gives a required degree of sanitation
- Excreta are immediately removed, so no such problem arises. This system is much more hygienic

Comparison of water-carriage and non water-carriage cont'd...

Conservancy system

- The cities aesthetic appearance cannot be increased
- Disposal of excremental matters by burial will require extensive areas
- Possibility of foul liquid from latrines to pollute the ground water is high
- Buildings cannot be designed as one compact unit due to smell

Water-carriage system

- Aesthetically the system is much more acceptable
- Compact unit of modern sewage treatment work will require much less area
- The chances of underground water getting polluted are less
- Latrines can be attached to the living rooms and buildings can be designed as one compact unit

Factors in Sewerage Project

- Population of the city to be served
 - Availability of funds
 - Quality of sewage to be handled
 - Rainfall in the locality
 - Rate of sewage expected
 - Sources of sewage
 - Present disposal arrangements of disposal
 - Topographical features of the area
 - Treatment methods
 - Trend of town development

Flow Sheets for Wastewater Treatment Systems

- The term "flow sheet" is used to describe a particular combination of unit operations and processes used to achieve a specific treatment objective.
- **Unit Operation:** this involves removal of contaminants by physical forces.
- **Unit Process:** this involves biological and/or chemical removal of contaminants.
- **Physical Unit Operations:** Screening, mixing, flocculation, sedimentation, floatation, filtration.
- **Chemical Unit Processes:** Coagulation flocculation, precipitation, adsorption.

unit operations and processes

PHYSICAL UNIT	OPERATIONS
OPERATION	APPLICATION
Screening	Removal of coarse and settleable solids by surface straining
Comminution	Grinding of coarse solids
Flow Equalization	Equalization of flow and mass loadings of BOD suspended solids.
Mixing	Mixing of chemicals and gases with waste water and maintaining solids in suspension
Flocculation	Promotion of aggregation of smaller particles into larger ones.
Sedimentation	Removal of settleable solids and thickening of sludge
Filtration	Removal of fine residual suspended solids remaining after biological or chemical treatment.
Floatation	Removal of finely divided suspended solids and particles. Also thickens biological sludge
Micro screening	Same as filtration. Also removal of algae from stabilization pond effluents

CHEMICAL UNIT PROCESSES

PROCESS	APPLICATION
1. Chemical Precipitation	Removal of phosphorous and enhancement of suspended solids removal in primary sedimentation
2. Gas Transfer	Addition and removal of gases
3. Adsorption	Removal of organics
4. Disinfection	Disinfection of disease causing organisms
5. Dechlorination	Removal of total combined chlorine residuals
6. Miscellaneous	Achievement of specific objectives in waste water treatment

Biological Unit Processes: Aerobic and anaerobic treatment processes

➤ Flow sheet preparation is **important step** in overall design of wastewater treatment and requires thorough understanding of the treatment units which are generally described as,

- ✓ **preliminary treatment** (large suspensions and floating matter removal)
- ✓ **primary** (suspended solids removing units)
- ✓ **Secondary** (biological organic matter removal units)
- ✓ **Tertiary treatment system** (polishing units)
- ✓ **Sludge treatment** (stabilizing and

Flow Sheets for Wastewater Treatment Systems

