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Unit 4

Sewerage schemes and their importance, collection & conveyance of sewage, storm water quantity, fluctuation in sewage flow, flow through sewer, design of sewer, construction & Maintenance of sewer, sewer appurtenances, pumps & pumping station

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Some Important Definitions

- Industrial wastewater: It is the wastewater generated from the industrial and commercial areas. This wastewater contains objectionable organic and inorganic compounds that may not be amenable to conventional treatment processes.
- Night Soil: It is a term used to indicate the human and animal excreta.
- Sanitary sewage: Sewage originated from the residential buildings comes under this category. This is very foul in nature. It is the wastewater generated from the lavatory basins, urinals and water closets of residential buildings, office building, theatre and other institutions. It is also referred as domestic wastewater.
- Sewage: It indicates the liquid waste originating from the domestic uses of water. It includes sullage, discharge from toilets, urinals, wastewater generated from commercial establishments, institutions, industrial establishments and also the groundwater and stormwater that may enter into the sewers. Its decomposition produces large quantities of malodorous gases, and it contains numerous pathogenic or disease producing bacteria, along with high concentration of organic matter and suspended solids.
- Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems or land. It is combination of unit operations and unit processes developed to treat the sewage to desirable standards to suit effluent norms defined by regulating authority.
- Sewer: It is an underground conduit or drain through which sewage is carried to a point of discharge or disposal.
- Sewerage: The term sewerage refers the infrastructure which includes device, equipment and appurtenances for the collection, transportation and pumping of sewage, but excluding works for the treatment of sewage. Basically it is a water carriage system designed and constructed for collecting and carrying of sewage through sewers.
- Subsoil water: Groundwater that enters into the sewers through leakages is called subsoil water.
- Sullage: This refers to the wastewater generated from bathrooms, kitchens, washing place and wash basins, etc. Composition of this waste does not involve higher concentration of organic matter and it is less polluted water as compared to sewage.

Wastewater: The term wastewater includes both organic and inorganic constituents, in soluble or suspended form, and mineral content of liquid waste carried through liquid media. Generally the organic portion of the wastewater undergoes biological decompositions and the mineral matter may combine with water to form dissolved solids.

Wastewater Quantity Estimation

The flow of sanitary sewage alone in the absence of storms in dry season is known as dry weather flow (DWF).

Quantity= Per capita sewage contributed per day x Population

Sanitary sewage is mostly the spent water of the community draining into the sewer system. It has been observed that a small portion of spent water is lost in evaporation, seepage in ground, leakage, etc. Usually 80% of the water supply may be expected to reach the sewers.

Fluctuations in Dry Weather Flow

Since dry weather flow depends on the quantity of water used, and as there are fluctuations in rate of water consumption, there will be fluctuations in dry weather flow also. In general, it can be assumed that

(i) Maximum daily flow = 2 x average daily flow and

(ii) Minimum daily flow = 2/3 x (average daily flow).

Collection & conveyance of sewage-

For the disposal of waste products of towns two works are required

- Collection Works
- Disposal Works

- The disposal works mainly consist of treatment works which are essential to treat waste water and dispose it off in such a way that it may not cause any harm to the health of public nor pollute the nearby water sources. The collection works are the works which are done to collect the waste products. In olden days it was done by conservancy method, but in modern cities it is done by water- carriage method.

Methods of Collection

The sanitation of town or city is done by two methods:

- Conservancy System
- Water-Carriage System

The collection system is meant for collection of the sewage generated from individual houses and transporting it to a common point where it can be treated as per the needs before disposal. In olden days, waste generated from water closets was collected by conservancy methods and other liquid waste was transported through open drain to finally join natural drains. Since, the excreta was carried through carts, it was not hygienic method for transportation to the disposal point. Now, collection and conveyance of sewage is done in water carriage system, where it is transported in closed conduit using water as a medium.

Collection of Sewage

Mainly it is divided into two waste disposal methods.

1. Conservancy System
2. Water Carriage System

1. Conservancy System

This type of waste disposal / refuse are collected separately and disposed of.

A. Garbage is collected separately in dustbins and conveyed by covered carts or Lorries to suitable place. The combustible and non-combustible garbage is sorted out. The former is burnt and the later is buried in low lying areas.

B. The human and animal waste (feces and urine) are collected in pans from lavatories and is then carried by labors in carts or Lorries for disposal outside the city where it is buried for manure. The human and animal waste are also called night-soil.

C. The storm water is conveyed separately by close and open channels and discharge into natural streams. This system is obsolete now and can be used in rural areas where there is scarcity of water.

This system has the following disadvantages.

a. Cost- The system has less initial cost but the maintenance cost is high because of working labors.

b. Design of building- The lavatory has to be built away from the residential building which causes inconvenience.

c. Insanitary condition- The night soil is carried once in 24 hours while it becomes insanitary after 5-6 hours causing bad smell and fly nuisance.

d. Labor problem- If the labour goes on strike the system totally fails.

e. Land requirements- The night soil trenching ground required large areas of disposal.

f. Foul appearance- It is highly undesirable to allow night soil carts to pass through roads of the city.

i. Open drains- Storm water following in open drains cause unhygienic condition in the area.

j. Pollution of water-The liquid wastes from lavatories may seep into the ground polluting groundwater.

k. Risk of epidemic- The sewage is conveyed openly and is not properly disposed of causing risk of epidemic.

2. Water Carriage System

In this system water is used as a medium to carry wastes to the point of final disposal. The quantity of water is so high (99.9%) that wastes becomes liquid which is carried by the sewers. The garbage is collected separately as in conservancy system. The storm water may be disposed of separately or combined with sanitary sewage.

This system is universally used nowadays because of the following advantages.

a) Cost- Though the initial cost of the system is high but the maintenance cost is less.

b) Compact design- The lavatories can be accommodated inside the building which causes compact design of building and also convenience.

c) Hygienic conditions- The sewage is carried in covered drains thus the risk of epidemic are reduced.

d) Land requirement- Less land is required for treatment and disposal thus making the system economical.

e) Treatment- Proper treatment of sewage is possible to make the sewage suitable for disposal.

The only disadvantage of this system is the wastage of water (99.9% of water).

Merits of Conservancy System

The following are the merits of Conservancy System

- It is cheaper in Initial cost because storm water can pass in open drains and conservancy latrines are much economical.
- The quantity of sewage reaching at the treatment plant before disposal is low.
- As the storm water goes 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 sewer-lines.
- In floods if the water level of river rises at the out-fall, it will not be costly to pump the sewage for disposal

Demerits

- It is possible that storm water may go in sewer causing heavy load on treatment plants, therefore it is to be watched.
- In crowded lanes it is very difficult to lay two sewers or construct road side drains, causing great inconvenience to the traffic.
- Buildings cannot be designed as compact unit, because latrines are to be designed away from the living rooms due to foul smell, which are also inconvenient.
- In the presence of conservancy system, the aesthetic appearance of the city cannot be increased.
- Decomposition of sewage causes insanitary conditions which are dangerous to public health.
- This system completely depends on the mercy of sweepers.

Water Carriage System

With the development and advantages of the cities, urgent need was felt to replace conservancy system with some more improved types of system in which human agencies should not be used for the collection and conveyance of the sewage. After a large number of trials it was found that the water is the only cheapest substance, which can be easily used for collection and conveyance of sewage. Therefore it is called Water-Carriage System. In this system the excremental matters are mixed up in large quantity of water and are disposed off after necessary treatment in a satisfactory manner.

Merits & Demerits of Water Carriage System

Merits

- It is hygienic method, because all the excremental matters are collected and conveyed by water only and no human agency is employed for it.
- There is no nuisance in the street of the town due to offensive matters, because all the sewage goes in closed sewers under the ground. The risk of epidemic is reduced.
- As only one sewer is laid, therefore it occupies less space in crowded lane.
- Due to more quantity of sewage, self-cleansing velocity can be obtained even at less gradients.
- Buildings can be designed as compact one unit.
- The land required for the disposal work is less as compared with conservancy system in which more area is required.
- The usual water supply is sufficient and no additional water is required in water carriage system
- This system does not depend on the manual labour
- Sewage after proper treatment can be used for various purposes.

Demerits

- The following are the demerits of water carriage System
- This system is very costly in initial cost. • The maintenance of this system is also costly.
- During monsoon large volume of sewage is to be treated whereas very small volume is to be treated in the remaining period of the year.

Sewerage System

- The Sewerage System are classified as follows:

1. Combined System
2. Separate System
3. Partially Separate System

When only one set of sewer is laid, carrying both the sanitary sewage and storm water it is called combined system. In the separate system, if a portion of storm water is allowed to enter in the sewers carrying sewage and the remaining storm water flows in separate set of sewers it is called partially separate system. The combined system is most suited in areas having small rainfall which is evenly distributed throughout the area, because at such places self-cleaning velocity will be available in every season. As only one sewer is laid in this system, therefore it can also be used in crowded areas, where it is very difficult to lay two sewers. If rainfall is heavy and it is for short time, it is better to provide separate system, because in combined system self-cleaning velocity will not be available for most of the period of the year.

Sewerage System Merits and Demerits of Separate System

Followings are the merits of Separate System.

- The sewage flows in separate sewer; therefore the quantity to be treated is small which results in economical design of treatment works.
- Separate system is cheaper than combined system, because only sanitary sewage flows in closed sewer and the storm water which is unfold in nature can be taken through open gutter or drains, whereas both types of sewage is to be carried in closed sewer in case of combined system
- During disposal if the sewage is to be pumped, the separate system is cheaper.
- There is no fear of stream pollution

o Sewerage System Followings are the demerits of separate System

o Generally self-cleaning velocity is not available, due to small quantity of sewage, therefore flushing is required at various points.

- There is always a risk that storm water may enter the sanitary sewer and cause over flowing of sewer and heavy load on the treatment plant.
- As two sets of sewer are laid, therefore its maintenance cost is more.
- In busy lanes laying of two sewers is difficult which also causes great inconvenience to the traffic during repairs.

Sewerage System Merits and Demerits of Combined System

Merits of Combined System

- There is no need of flushing, because self-cleansing velocity is easily available at every place due to more quantity of sewage.
- Rain water dilutes the sewage, therefore it can be easily and economically treated.
- House plumbing can be done easily because only one set of pipes will be required
- The following are the demerits of Combined System
- Initial cost is high as compared with separate System
- It is not suitable for areas having rainfall for small period of the year, because the dry weather flow will be small due to which self-cleaning velocities will not be available resulting in silting up of the sewers.
- If the whole sewage is to be disposed of by pumping, it is uneconomical
- During heavy rains, the overflowing of sewers will endanger the public health.

Rational method

For hydraulic designs on very small watersheds, a complete hydrograph of runoff is not always required. The maximum, or peak, of the hydrograph is sufficient for design of the structure in question. Therefore, a number of methods for estimating a design discharge, that is, the maximum value of the flood runoff hydrograph, have been developed. The rational method is a simple technique for estimating a design discharge from a small watershed. It was developed by Kuching (1889) for small drainage basins in urban areas. The rational method is the basis for design of many small structures. In particular, the size of the drainage basin is limited to a few tens of acres.

Storm water quantity can be estimated by rational method as below:

Storm water quantity, Q = C.I.A / 360

Where,

Q = Quantity of storm water, m3/sec.

C = Coefficient of runoff

I = intensity of rainfall (mm/hour) for the duration equal to time of concentration, and

A = Drainage area in hectares

Minimum Velocity: Self-Cleansing Velocity

The velocity that would not permit the solids to settle down and even scour the deposited particles of a given size is called as self-cleansing velocity. This minimum velocity should at least develop once in a day so as not to allow any deposition in the sewers. Otherwise, if such deposition takes place, it will obstruct free flow causing further deposition and finally leading to the complete blocking of the sewers. This minimum velocity or self-cleansing velocity can

Will be worked out as below:

Vs = 8k (Ss-1) g.d'/f'

K= constant, for clean inorganic solids = 0.04 and for organic solids = 0.06

f' = Darcy Weisbach friction factor (for sewers = 0.03)

Ss = Specific gravity of sediments

g = gravity acceleration

d' = diameter of grain, m

- **Hence, for removing the impurities present in sewage i.e., sand up to 1 mm diameter with specific gravity 2.65 and organic particles up to 5 mm diameter with specific gravity of 1.2, it is necessary that a minimum velocity of about 0.45 m/sec and an average velocity of about 0.9 m/sec should be developed in sewers.**

- **Hence, while finalizing the sizes and gradients of the sewers, they must be checked for the minimum velocity that would be generated at minimum discharge, i.e., about 1/3 of the average** discharge. While designing the sewers the flow velocity at full depth is generally kept at about 0.8 m/sec or so. Since, sewers are generally designed for ½ to ¾ full, the velocity at 'designed discharge' (i.e., ½ to ¾ full) will even be more than 0.8 m/sec. Thus, the

Pattern of sewerage system

The network of sewers consists of house sewers discharging the sewage to laterals. The lateral discharges the sewage into branch sewers or sub-mains and sub-mains discharge it into main sewer or trunk sewer. The trunk sewer carries sewage to the common point where adequate treatment is given to the sewage and then it is discharged. The patterns of collection system depend upon:

- The topographical and hydro-logical features of the area.
- The location and methods of treatment and disposal works.
- The type of sewerage system employed, and extent of area to be served.

Single treatment plant is required in this pattern.

- The drawback in this pattern is that larger diameter sewer is required near to the treatment plant as entire sewage is collected at a common point.
- In addition, with new development of the city the load on existing treatment plant increases.

Figure: Fan pattern of collection system Zone Pattern

- More numbers of interceptors are provided in this pattern.
- This pattern is suitable for sloping area than flat areas.

Water Carriage System

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This system is universally used nowadays because of the following advantages.

1. Cost. Though the initial cost of the system is high but the maintenance cost is less.

2. Compact design. The lavatories can be accommodated inside the building which causes compact design of building and also convenience.

3. Hygienic conditions. The sewage is carried in covered drains thus the risk of epidemic are reduced.

4. Land requirement. Less land is required for treatment and disposal thus making the system economical.

5. Treatment. Proper treatment of sewage is possible to make the sewage suit

Disposal of the sewage generated from a locality efficient collection, conveyance, adequate treatment and proper disposal of treated sewage is necessary. To achieve this, following conditions should be satisfied:

1. Sewage should not pollute the drinking water source, either surface or groundwater, or water bodies that are used for bathing or recreational purposes.

2. The untreated sewage during conveyance should not be exposed so as to have access to human being or animals and should not give unsightly appearances or odor nuisance, and should not become a place for breeding flies.

3. It should not cause harm to public health and adversely affect the receiving environment.

Fluctuation in sewage flow:

Where possible, gauging of flow in existing sewers should be made in order to determine actual variations. Recording gauges are available or can be devised that will give depths of sewage in the outfall sewer or in the main leading from a district. In order to design a system for a previously unseward town or section of a city, an estimate must be made of the fluctuations to be expected in the flow. This is of importance, as the sewers must be large enough to accommodate the maximum rate, or there may be a backing up of sewage into the lower plumbing fixtures of buildings.

As in water consumption, the rate of sewage production will vary according to the season of the year, weather conditions, day of the week, and time of day. The variations do not depart so far from the average as for water because of the storage space in the sewers and because of the time required for the sewage to run to the point of gauging. That is, the peaks are flattened because it requires considerable sewage to fill the sewers to the high flow point, and the high from various sections will reach the gauging point after various time of flow. When the peak occurs will depend upon the flow time in the sewers and the type of district served.

- **Sewage flow rates vary by source and with time (time of the day, day of the week, season of the year, weather conditions)**

- **In most municipalities, the sources may be residences institutions such as hospital and school, commercial establishments and industries.**

- **It is thus necessary for the designers and managers to determine the mix of these elements and to estimate their contributions.**

- A case-by-case assessment should always be made before sewers are sized or treatment plant capacities set.

- For institutions, flows may vary as low as 10 gpcd (Gallons Per Capita Daily) (40 lpcd (Litres per Capita per Day)) for schools to 175 gpcd (700 lpcd) for hospitals.

- Hotels may produce flows of about 100 gpcd (400 lpcd) while small business may generally only about 2060 gpcd (8,240 lpcd) per employee.

- Sewage flow patterns in residential areas resemble water use pattern for those areas, with the exception of time lag, as shown in figure.

- The magnitude of this lay varies with the situation, but it is usually on the order of a few hours, where infiltration from rainfall hydrographs produced in the sewers, the hydrographs produced in the sewers may vary considerably during dry periods.

- Otherwise, the variation in daily flow pattern for most residential areas is quite small.

- Where sewers receive significant quantities of wastes from industrial operations, the amount and timing of flows are affected by prevailing industrial practices.

- Table (below) gives an indication of the variation in residential waste water flows as ratios to the average.

- In the absence of site-specific data, such figures may be used to estimate high and low flows.

Description	Ratio to the average
Max daily	2.25:1
Max hourly / peak hourly	3:1
Max daily	0.67:1
Min hourly	Min hourly0.33:1

Residential waste water flows at ratio to the average:

- Data on the ratio of peak flows and min flows to the average daily flow summarized by Gupta show that the peak to average daily flow ratio ranges from about 3.0 for cities of about 10,000 to about 1.5 for cities of 10,00,000 (one million)

* If less population, so less peeking factor and vice versa because less population has less sewage and water consumption.

Flow through sewer

A sanitary sewer or "foul sewer" is an underground carriage system specifically for transporting sewage from houses and commercial buildings through pipes to treatment facilities or disposal. Sanitary sewers are part of an overall system called a sewage system or sewerage.

Sewage may be treated to control water pollution before discharge to surface waters.[1][2] Sanitary sewers serving industrial areas also carry industrial wastewater.

Separate sanitary sewer systems are designed to transport sewage alone. In municipalities served by sanitary sewers, separate drains may convey surface runoff directly to surface waters. Sanitary sewers are distinguished from combined sewers, which combine sewage with storm water runoff in one pipe. Sanitary sewer systems are beneficial because they avoid combined sewer overflows.

Types

Conventional gravity sewers

In the developed world, sewers are pipes from buildings to one or more levels of larger underground trunk mains, which transport the sewage to sewage treatment facilities. Vertical pipes, usually made of precast concrete, called manholes, connect the mains to the surface. Depending upon site application and use, these vertical pipes can be cylindrical, eccentric or concentric. The manholes are used for access to the sewer pipes for inspection and maintenance, and as a means to vent sewer gases. They also facilitate vertical and horizontal angles in otherwise straight pipelines.

Pipes conveying sewage from an individual building to a common gravity sewer line are called laterals. Branch sewers typically run under streets receiving laterals from buildings along that street and discharge by gravity into trunk sewers at manholes. Larger cities may have sewers called interceptors receiving flow from multiple trunk sewers.[6]

Design and sizing of sanitary sewers considers the population to be served over the anticipated life of the sewer, per capita wastewater production, and flow peaking from timing of daily routines. Minimum sewer diameters are often specified to prevent blockage by solid materials flushed down toilets; and gradients may be selected to maintain flow velocities generating sufficient turbulence to minimize solids deposition within the sewer. Commercial and industrial wastewater flows are also considered, but diversion of surface runoff to storm drains eliminates wet weather flow peaks of inefficient combined sewers.[7]

Force mains

Pumps may be necessary where gravity sewers serve areas at lower elevations than the sewage treatment plant, or distant areas at similar elevations. A lift station is a sewer sump that lifts accumulated sewage to a higher elevation. The pump may discharge to another gravity sewer at that location or may discharge through a pressurized force main to some distant location

Effluent sewer

Effluent sewer systems, also called septic tank effluent drainage (STED) or solids-free sewer (SFS) systems, have septic tanks that collect sewage from residences and businesses, and the effluent that comes out of the tank is sent to either a centralized sewage treatment plant or a distributed treatment system for further treatment. Most of the solids are removed by the septic tanks, so the treatment plant can be much smaller than a typical plant. In addition, because of the vast reduction in solid waste, a pumping system can be used to move the wastewater rather than a gravity system. The pipes have small diameters, typically 1.5 to 4 inches, or 4 to 10 cm. Because the waste stream is pressurized, they can be laid just below the ground surface along the land's contour.

Design of Sewer System Sewer system plays a vital role in the economic development of a country. Sewers are must for the drainage of waste water. In order to have an effective sewage system the sewers should be properly designed and more care should be taken in finding the invert levels otherwise whole design may get wrong. Design of Sewer System. Sewers are designed for the drainage of waste water coming from houses, industries, streets, runoff etc to protect the environment and people from serious diseases, as more than 50 diseases spread from sewage. So for a good living, the sewers should be properly designed and the sewage should be treated properly before discharging it into the river.

Design of Sewers

The hydraulic design of sewers and drains, which means finding out their sections and gradients, is generally carried out on the same lines as that of the water supply pipes. However, there are two major differences between characteristics of flows in sewers and water supply pipes. They are:

- The sewage contain particles in suspension, the heavier of which may settle down at the bottom of the sewers, as and when the flow velocity reduces, resulting in the clogging of sewers. To avoid silting of sewers, it is necessary that the sewer pipes be laid at such a gradient, as to generate self-cleansing velocities at different possible discharges.

- The sewer pipes carry sewage as gravity conduits, and are therefore laid at a continuous gradient in the downward direction upto the outfall point, from where it will be lifted up, treated and disposed of.

Hazen-William's formula

$$U=0.85\ C\ r_H^{0.63}S^{0.54}$$

Manning's formula

$$U=1/n\ r_H^{2/3}S^{1/2}$$

Where, U= velocity, m/s; rH= hydraulic radius, m; S= slope, C= Hazen-William's coefficient, and n = Manning's coefficient.

Darcy-Weisbach formula

$$h_L= (fLU^2)/ (2gd)$$

Minimum Velocity

The flow velocity in the sewers should be such that the suspended materials in sewage do not get silted up; i.e. the velocity should be such as to cause automatic self-cleansing effect. The generation of such a minimum self-cleansing velocity in the sewer, atleast once a day, is important, because if certain deposition takes place and is not removed, it will obstruct free flow, causing further deposition and finally leading to the complete blocking of the sewer.

Maximum Velocity

The smooth interior surface of a sewer pipe gets scoured due to continuous abrasion caused by the suspended solids present in sewage. It is, therefore, necessary to limit the maximum velocity in the sewer pipe. This limiting or non-scouring velocity will mainly depend upon the material of the sewer.

Effects of Flow Variation on Velocity in a Sewer

Due to variation in discharge, the depth of flow varies, and hence the hydraulic mean depth (r) varies. Due to the change in the hydraulic mean depth, the flow velocity (which depends directly on r2/3) gets affected from time to time. It is necessary to check the sewer for maintaining a minimum velocity of about 0.45 m/s at the time of minimum flow (assumed to be 1/3rd of average flow). The designer should also ensure that a velocity of 0.9 m/s is developed atleast at the time of maximum flow and preferably during the average flow periods also. Moreover, care should be taken to see that at the time of maximum flow, the velocity generated does not exceed the scouring value.

Sewer Appurtenances

Sewer appurtenances are the various accessories on the sewerage system and are necessary for the efficient operation of the system. They include man holes, lamp holes, street inlets, catch basins, inverted siphons, and so on.

Man-holes: Man holes are the openings of either circular or rectangular in shape constructed on the alignment of a sewer line to enable a person to enter the sewer for inspection, cleaning and flushing. They serve as ventilators for sewers, by the provisions of perforated man-hole covers. Also they facilitate the laying of sewer lines in convenient length.

Man-holes are provided at all junctions of two or more sewers, whenever diameter of sewer changes, whenever direction of sewer line changes and when sewers of different elevations join together.

Special Man-holes:

Junction chambers: Man-hole constructed at the intersection of two large sewers.

Drop man-hole: When the difference in elevation of the invert levels of the incoming and outgoing sewers of the man-hole is more than 60 cm, the interception is made by dropping the incoming sewer vertically outside and then it is jointed to the man-hole chamber.

Flushing man-holes: They are located at the head of a sewer to flush out the deposits in the sewer with water.

Lamp-holes: Lamp holes are the openings constructed on the straight sewer lines between two man-holes which are far apart and permit the insertion of a lamp into the sewer to find out obstructions if any inside the sewers from the next man-hole.

Street inlets: Street inlets are the openings through which storm water is admitted and conveyed to the storm sewer or combined sewer. The inlets are located by the sides of pavement with maximum spacing of 30 m.

Catch Basins: Catch basins are small settling chambers of diameter 60 - 90 cm and 60 - 75 cm deep, which are constructed below the street inlets. They interrupt the velocity of storm water entering through the inlets and allow grit, sand, debris and so on to settle in the basin, instead of allowing them to enter into the sewers.

Inverted siphons: These are depressed portions of sewers, which flow full under pressure more than the atmospheric pressure due to flow line being below the hydraulic grade line. They are constructed when a sewer crosses a stream or deep cut or road or railway line. To clean the siphon pipe sluice valve is opened, thus increasing the head causing flow. Due to increased velocity deposits of siphon pipe are washed into the sump, from where they are removed.

Pumping of Sewage

Pumping of sewage is required when it is not possible to have a gravitational flow for the entire sewerage project.

Sufficient pumping capacity has to be provided to meet the peak flow, at least 50% as stand by.

Types of pumps:

1. Centrifugal pumps either axial, mixed or radial flow.

2. Pneumatic ejector pumps.

3. Centrifugal pumps are a sub-class of dynamic axisymmetric work-absorbing turbo machinery Centrifugal pumps are used to transport fluids by the conversion of rotational kinetic energy to the hydrodynamic energy of the fluid flow. The rotational energy typically comes from an engine or electric motor. The fluid enters the pump impeller along or near to the rotating axis and is accelerated by the impeller, flowing radially outward into a diffuser or volute chamber (casing), from where it exits.

4. Common uses include water, sewage, petroleum and petrochemical pumping; a centrifugal fan is commonly used to implement a vacuum cleaner. The reverse function of the centrifugal pump is a water turbine converting potential energy of water pressure into mechanical rotational energy.

Axial Flow Pumps

Axial-flow pumps differ from radial-flow in that the fluid enters and exits along the same direction parallel to the rotating shaft. The fluid is not accelerated but instead "lifted" by the action of the impeller. They may be likened to a propeller spinning in a length of tube. Axial-flow pumps operate at much lower pressures and higher flow rates than radial-flow pumps.

Mixed/Radial Flow Pumps

Often simply referred to as centrifugal pumps. The fluid enters along the axial plane, is accelerated by the impeller and exits at right angles to the shaft(radially). Radial-flow pumps operate at higher pressures and lower flow rates than axial and mixed-flow pumps.

Mixed-flow pumps function as a compromise between radial and axial-flow pumps. The fluid experiences both radial acceleration and lift and exits the impeller somewhere between 0 and 90 degrees from the axial direction. As a consequence mixed-flow pumps operate at higher pressures than axial-flow pumps while delivering higher discharges than radial-flow pumps. The exit angle of the flow dictates the pressure head-discharge characteristic in relation to radial and mixed-flow.

Peripheral Pumps

A peripheral pump is also called a turbine, or regenerative, pump. The impeller has vanes on both sides of the rim that rotate in a ring like channel in the pump’s casing. The fluid does not discharge freely from the tip of the impeller but is recirculated back to a lower point on the impeller diameter. This recirculation, or regeneration, increases the head developed.

The Pneumatic Ejector Pump:-

The pneumatic ejector is a extremely simple yet reliable mechanism. Fundamentally, it consists of a receiver or "pot' that allows liquids and solids to enter without restriction. When the pot becomes filled, compressed air is introduced to displace the contents up to a higher discharge line. The Pneumatic Ejector is unique as a pumping mechanism because no mechanical parts are involved in the actual pumping of the material... and it has no practical limitations on head. Under normal flow conditions, the equipment is designed to operate with a one minute cycle. The cycle consists of two phases. Filling the pot, and then the discharging of its contents. Operation is fully automatic with a choice of electric or mechanical control systems.

