

THESIS

On

**CONSTRUCTION OF SMALL BORE  
SEWERAGE SYSTEM FOR RURAL  
HABITATION AND IT'S  
ENVIRONMENTAL ASSESSMENT**

In the partial fulfillment for the award of Degree

**MASTER OF TECHNOLOGY**

in

**ENVIRONMENTAL SCIENCE & TECHNOLOGY**

by

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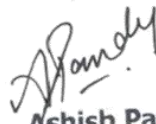


**THAPAR UNIVERSITY  
PATIALA (PUNJAB)-147004  
March 2016**

## Declaration and Certificate

I hereby declare that the work embodied in thesis entitled "**Construction of Small Bore Sewerage System For Rural Habitation and It's Environmental Assessment**" submitted in the School of Energy and Environment, Thapar University Patiala on 31-Mar-2016 is the record of the work carried out by me under the guidance of Dr. Amit Dhir, Asst. Professor, School of Energy and Environment. The matter presented in this thesis has not been submitted in part or full, to this or any other University/ Institute for any degree or diploma.

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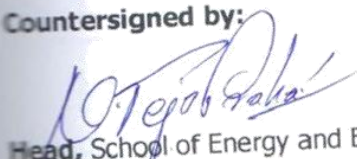
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*Thank You all for making this a reality.*

**AshishPandey**

## **ABSTRACT**

Sewer systems are the most efficient and effective way to remove waste water from the source. However, sewer systems are usually very expensive. The laying of distribution again is a very tedious process. The concept and technology of small bore was developed to cater the need of offsite treatment of waste water generated from houses, where laying out of conventional sewer was either not required or too expensive and difficult. Moreover, the solid waste generated is also digested in interceptor which can be emptied after 5 years or so. Small bore sewer system help in partial fulfillment of removing waste from the individual houses. The system has been quite successful in developing countries with limited land availability and financial constraints. Furthermore, if 70% or more household in a habitation are already having septic tanks, then small bore sewer becomes a very viable option. In the present study, selected village Tasoli of district Patiala was chosen for the study. In the study area, Wastewater from the cattle shed is allowed to flow into the open surface drain and block the drains. As a result of it, water over flows on the road. This creates unhygienic condition for villagers. So an effort is needed to provide an appropriate sewerage scheme for a rural area, keeping in view the typical requirements and problems related with village area that includes scattered population, lack of skilled man power and resources, so proper discharge and treatment of domestic waste water is essential. The methodology used here is a step wise approach which in totality includes all social, financial and design constraints. The construction and execution aspects have been focused to see the practical feasibility. Contents of this thesis/Project have been organized into steps and are summarized in individual chapters as mentioned. The study here goes beyond only theoretical aspects and tries to execute practically the design work in field. It tries to bridge the gap and experiment with the social gesture and rural habitations and explore the possibility of implementation of idea with all the social, financial, technical aspects working together.

This thesis starts from the introduction part which describes the topic and the objectives of this work. It gradually moves on to the literature review portion which gives the insight of the related work that has been done in this field. Next in line comes the design, methodology which discusses step wise approach followed to achieve the objectives of this work. This also includes the material selection, design calculation and strategy adopted for the design of various components. The design methodology part is followed by execution process which describes the overview of execution steps, material selection and Quality Control Aspects for Sanitation works

relating to small bore sewer system. The later part of thesis covers the environmental assessment and management detailing environmental issues and their mitigation during various stages like execution, Operation and Maintenance of small bore sewer system. Various problems/ issues that are likely to arise during the activities are also discussed along with the possible remedies for maintaining good operation and control. In the end a brief conclusion summarizes the feasibility of scheme and outcomes of study.

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# CHAPTER 1

## INTRODUCTION

### 1.1. BACKGROUND

The term sewage treatment means the removal of contaminants and individual components from waste water. The process may involve physical, biological and chemical processes for removal of such contaminants. The aim is to produce environmentally safe treated waste water/ treated effluent. By-product of the process usually includes semi-solids waste/ also known as sewage sludge and more commonly known as slurry. This slurry may or may not need further treatment before final disposal.

Sometimes another commonly used term instead is waste water treatment. However, waste water treatment is a broader term and may also include waste water from industries as well. At many places, sewer systems may also include waste water generated from industries after a pre-treatment received at industries itself so that the load on treatment unit is reduced.

In addition to it, if the system is a combined sewer, that it will also carry surface runoff or more commonly known as storm water (discussed in later parts)

Now, Sewage can be treated as follows:

- **On Site Treatment:** This is a decentralized system wherein the sewage is treated close to where sewage is created. E.g.; Septic Tanks.
- **Off Site Treatment:** This is a centralized system wherein the sewage is collected from where it is produced and transferred to different sites with the help of a distribution network of pipes and pump stations to treatment plants (Mara, 1996).

Sewage is generated by any activity related directly / indirectly to humans, animals alike. It includes waste from households, toilets, baths, and showers. During transportation to treatment plants it may also get mixed with storm water or Run-Off water. Such design was very common when urban sewage systems were initially developed.

However, this was a very expensive and difficult practice and also treatments were complicated (Mara, 1996). During heavy rains, large volumes of water overloaded the sewage treatment systems which also led to overflow or spill. These are now a day's being substituted by separate distribution systems for sewerage and storm because precipitation has a very varied nature, which in turn causes unstable flows and hence affects the efficiency of the sewerage system. Also, water during rainfall falling on rooftops, grounds and hence may get contaminated by various contaminants like soil particles, minerals, salts and other organic

matter including oil, grease and hence causes additional load of varied nature on sewerage system.

### **1.1.1 Defining The Problem**

The existing sanitation facilities in the village lead to problem of collection, treatment and disposal for waste water/ sewage which has following effects:

- i) 80% diseases like cholera, typhoid, diarrhea, jaundice, hepatitis and malaria etc. are caused by polluted water.
- ii) Contamination of underground water and existing surface water due to unsafe disposal of waste water.
- iii) Creation of Cess pools resulting water logging and smell nuisance.
- iv) Poor sanitation and unhygienic conditions.
- v) High risk of infection to community.
- vi) Effect on natural eco system.

In rural areas, State Govt. has extended its efforts with the objective of improving the environmental condition with specific reference to water supply and sanitation in selected villages within the State.

In most of the rural areas of Punjab, the wastewater is generated through individual households including the cattle sheds. This wastewater flows into surface drains leading to stagnation of lanes. Due to inadequate arrangement of treatment and disposal, the wastewater start seeping into hand pumps, open dug wells & water pipelines, which results in deterioration of ground water quality as well as water quality of the village ponds. Due to the poor sanitation conditions, several diseases like diarrhea, malaria, typhoid are mostly found in the rural area.

With an objective of improving the sustainability and standard of rural sanitation services, State Govt. has introduced a new rural water supply and sanitation policy which states that each rural area has its own rural water supply and sanitation facilities. The two facilities potable safe water & conditions of hygienic sanitation are required for the healthy living. Hence, these two facilities are gaining importance in our country especially for small towns, communities and rural human settlement. Professional services provided by a reputed consulting firm assists the executing department for delivering the best of its services.

## **1.2. SEWERAGE SYSTEM**

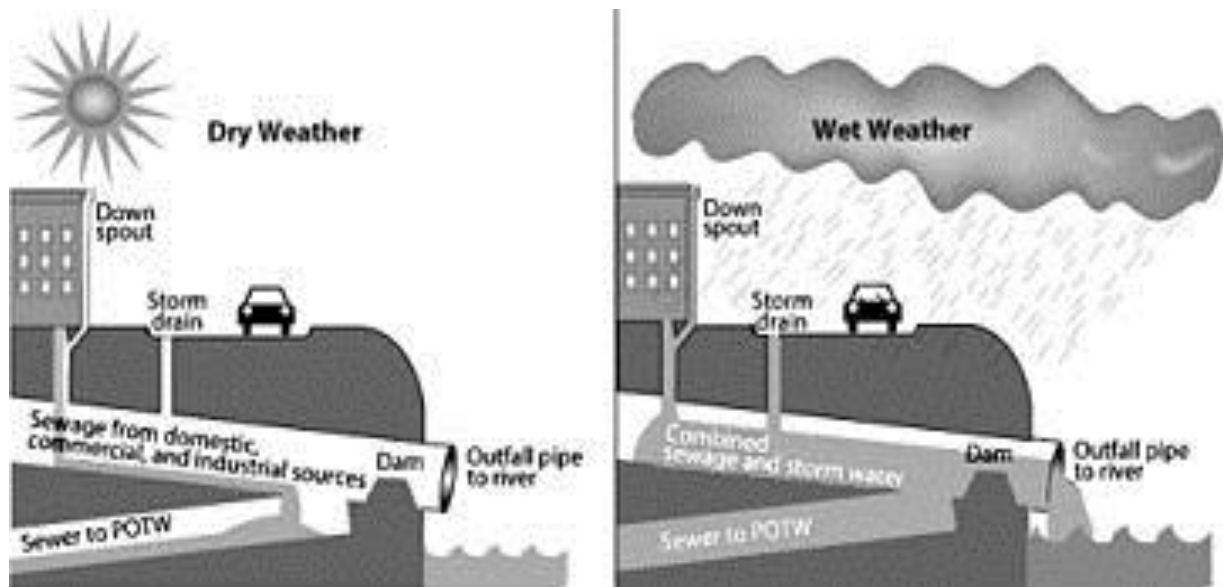
Sewerage system is set up with the objective of collection, conveyance and safe offsite disposal of the entire quantity of spent water generated by a community to ensure its safety in health and environment. It is a network or system of sewer and associated works designed for

the collection of foul sewage or wastewater, conveying it via pipes, discharging it at a treatment work or other place to disposal. It consists of various sub systems and each sub system is required to be designed in detail keeping in view the objective, data and background information available.

On the basis of carrying water, broadly three types of sewerage systems exists which are mentioned as below:

### 1.2.1 Combined Sewerage System

In the Combined Sewerage System both the waters (i.e. Domestic water + Storm water) is carried by single pipe line. Combined volume of wastewater and storm water runoff entering in sewerage system often exceeds conveyance capacity during wet weather. As such, design of a combined sewerage system is done to accommodate occasional overflow & for direct discharge of excess water into nearby stream, river or water bodies. The overflowing wastewater travels through creeks, rivers, lakes, and streams; resulting in contamination of all bodies of water fed by the waterways & all creatures/ plants coming in contact with the waste water Fig 1.1 here shows different types of flows during dry and wet weather in a combined sewer system.



**Figure 1.1 Combined Sewer during dry weather and Wet weather flow (Source: US EPA)**

### 1.2.2 Storm Sewerage System

In this system, rainwater from roof paved areas, pavements and roads is carried. In general, Storm Sewers are much larger in size than sanitary sewer as they are designed to cater much large amount of water. Entry of clear water into sanitary sewer systems makes it dirty and polluted and it is required to be transported & treated like sanitary wastewater. In order to

reduce the unnecessary overloading in sewage treatment plant and avoiding the variation of flow, these two systems are used separately. In this sewerage system, sediments are mainly inorganic and non-cohesive.

### 1.2.3 Sanitary Sewerage System

It is used for domestic sewage. This system is comprised of various sewer lines which terminate at a common meeting point or junction of a large sewer line. This large sewer line further concludes to a still larger sewer line finally, terminating it to the main sewer line at the outfall (Bakalian, 1994). This sewerage system carries the sediments to the treatment plants, where it can be removed. Generally due to presence of greases & biological slimes, the sediments in sanitary sewer possess cohesive like properties.

The Small Bore Sewerage System has some of the advantages as compared with conventional sewerage system which are given in the Table 1.1.

S. No.	Parameter	Conventional Sewers	Small Bore Sewers	Effect
1	Excavation	Deeper	Shallow	+ve for Solid Free
2	Water Supply	More Water Supply (12-135 lpcd) required for self cleansing	Less water supply (40 lpcd) is sufficient	+ve for Solid Free
3	Capital Cost	High	Low	+ve for Solid Free
4	Individual Septic Tanks	Not required	Required	+ve for Conventional
5	O & M cost	Very High	Very Low	+ve for Solid Free

**Table No. 1.1 Comparison of conventional sewers with small bore sewer**

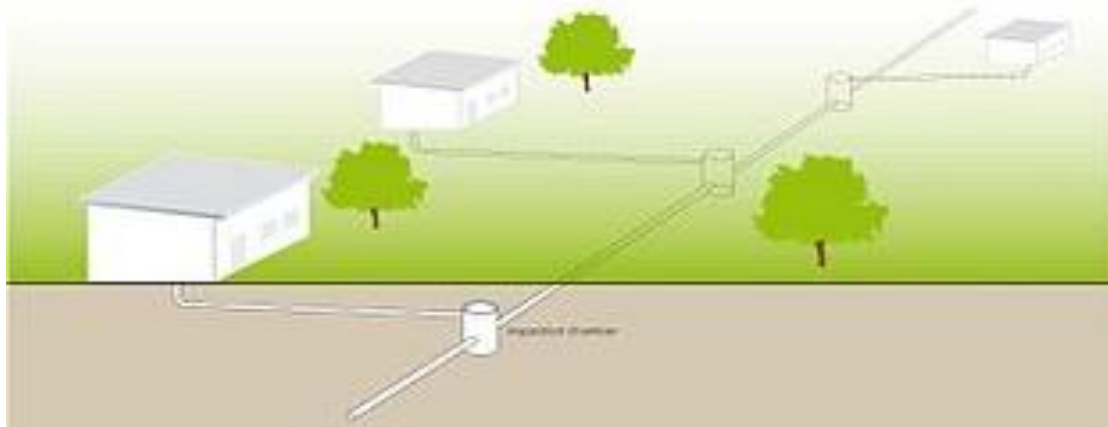
### 1.3 SMALL BORE SEWAGE SYSTEM AND WORKING

Small Bore Sewage System transfers liquid only, generated from septic tanks and does not transfer any solid. Due to this reason, many times it is predominantly also called Solid Free Sewage System (Design of Small Bore Sewerage System, World Bank). In countries like United Kingdom and also in countries like Australia it is called Septic Tank Effluent Drainage. They are, in many ways, different from Conventional system. One of the differences being that they are not designed at self-cleansing velocity. Other differences

include benefits such as low costs. Low costs can be attributed to no. Of reasons such as smaller pipe diameter, reduced excavation etc.(Mara, 1996).

The study of feasibility of small bore sewer and the concept itself dates to as early as 1935. The earliest of the small bore could be traced to Zambia in 1960, Australia in 1962, and Nigeria in 1964(Mara, 1996). It is quite popular in developing countries because of its reduced cost and cheaper maintenance. The concept of small bore revolves around receiving liquid portion of the household wastewater for an offsite treatment and then disposal. The steps include removing of grit, grease and other troublesome solids which may cause blockage by entering the pipes. This process is carried out in interceptor tanks itself installed upstream at every individual household (Sinnatamby GS, 1986).These accumulated solid can be removed periodically for disposal. The schematic diagram is shown in Fig. 1.2.

The objective of this project here is to analyze how far the technology of small bore could be extended.The work begins with the projection of population, the facilities and data collection to be used for planning.



**Figure: 1.2 Schematic Diagram of Simplified Sewer (Source: Tilley, 2014)**

The data can be further collected through field survey or by taking help from the authorities responsible. This collected data is used as the basis of designing for the wastewater pipeline distribution. This includes the planning of laying out pipe distribution system and includes service area, planning period and waste water processing unit. Other steps may or may not include designing of alternate routes.

The theory above has four basic advantages(Sinnatamby GS, 1986):

- a) Water required for running the sewerage system greatly reduced as not much water is needed for solid transport.
- b) The excavation part is greatly reduced as these need not be designed as self-cleansing velocity.

- c) The Material cost and treatment requirement is also greatly reduced
- d) Other expenditures and labor such as pumping requirement, screening, grit removal etc. is also reduced.

The concept can be greatly beneficial in area where majority households have septic tanks. Even though, the concept has many benefits it also has certain drawbacks. The blockage risk is much higher than conventional system. Main reason for this being small diameter of pipe, as a result, maintenance activity should be periodic.

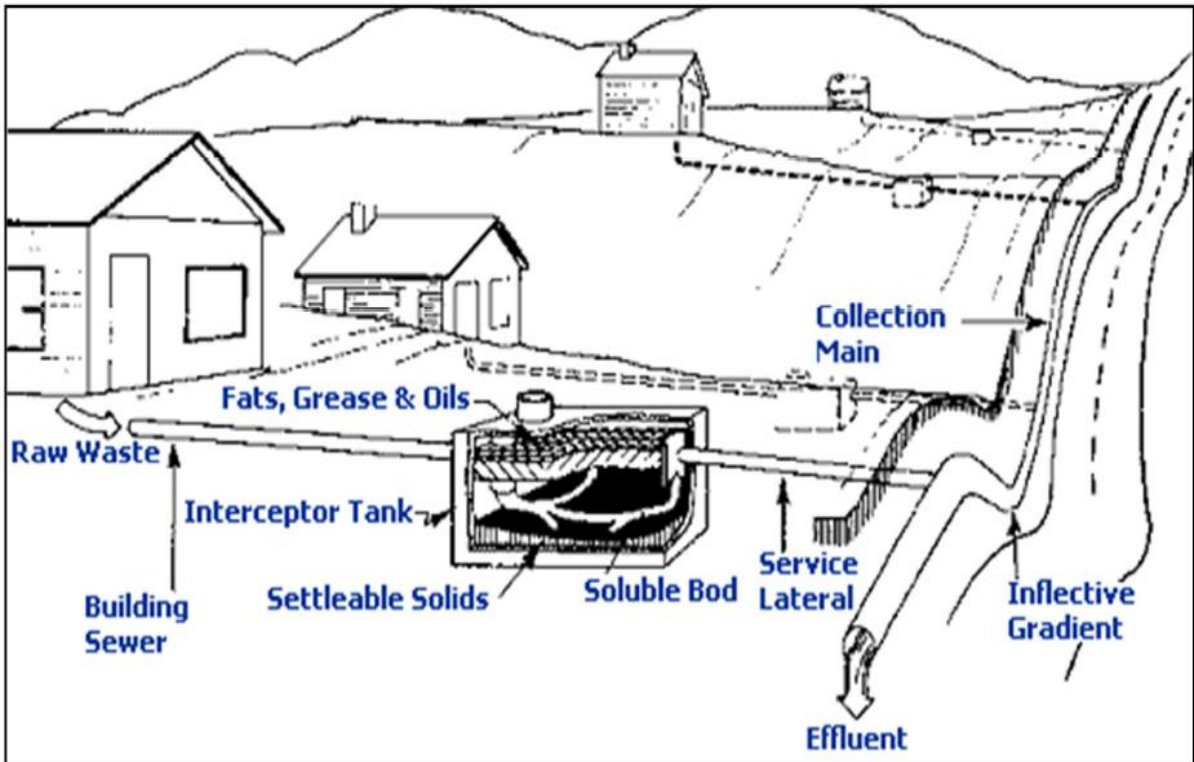
Its cleaning part requires skilled personnel's. Without regular cleaning there is a risk of settle-able solids overflowing into the sewer causing blockages and as a result community involvement is necessary. Fig 1.3 shows representation of small bore sewer in rural habitation.

#### **1.4 COMPONENTS OF SMALL BORE**

Solid Free Small Bore Size Sewerage System is non-conventional technology where discharge of waste water from the houses is carried to the septic tank and/ or a single compartment intercepting Chamber (IC) to trap the solids and resulting solid effluent free flow in to the sewer pipes. In this system, lesser excavation depth is involved and sewer pipes are laid at relatively flat gradients. Reduced water requirements, treatment requirements, excavation and material costs make Solid Free Sewerage System most durable option for the village.

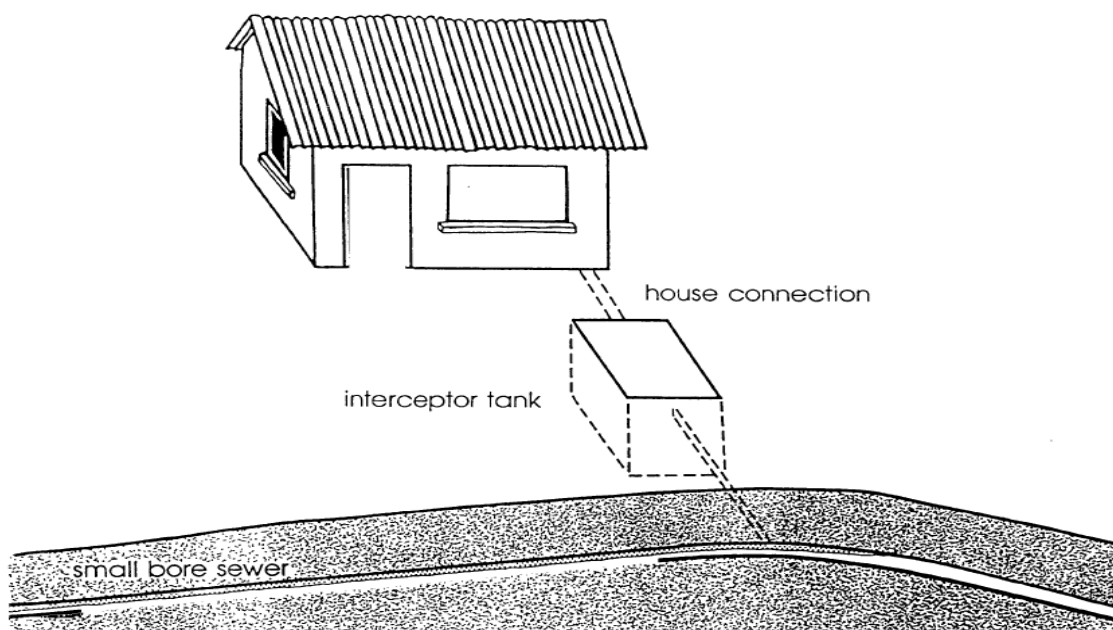
The main components of a Small Bore Sized Sewerage System or the brief systematic description of the scheme is as under(**Design of Small Bore Sewerage System, World Bank**):

- i) **House Hold Connections:** Each individual house is provided with a separate household sewer connection at inlet point. Waste water from kitchen, latrine etc. from the entire house is collected in the septic tank through this connection so as to carry waste water for offsite treatment. Fig. 1.4 shows diagrammatic representation of Household connections with main sewer.
- ii) **Septic Tank/ Intercepting Chamber (IC):** Its main function is to retain the floating & settle able solids and to allow solid free effluent to the main sewer through connected pipes. Fig 1.5 shows cross- Section of Intercepting Chamber also commonly known as Septic Tank.

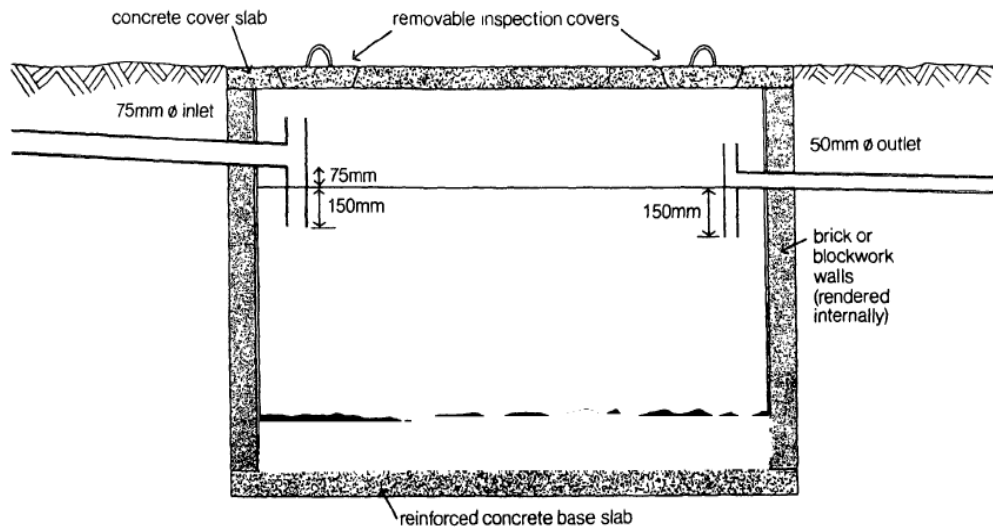


**Figure 1.3 Typical diagram of Small Bore Sewer in Rural Habitation**

- iii) **Sewerage Pipe:** Small diameter pipes with bore size 110 mm OD and above are used for the purpose of carrying solid free effluent from Septic tank/ IC to the final disposal point.
- iv) **Inspection Chamber:** To facilitate and to clean out clogging material, if any, the Inspection Chambers in 1:5. Brick Masonry are provided at a shallow depth of less than 1.2 m. Fig 1.6 shows pre-cast concrete inspection chambers.



**Figure 1.4 Household connections with main sewer (Source: Mara D, 1996)**



**Figure 1.5 Typical X- Section of Septic Tank/ Intercepting Chamber (Source: Otis and Mara, 1985)**



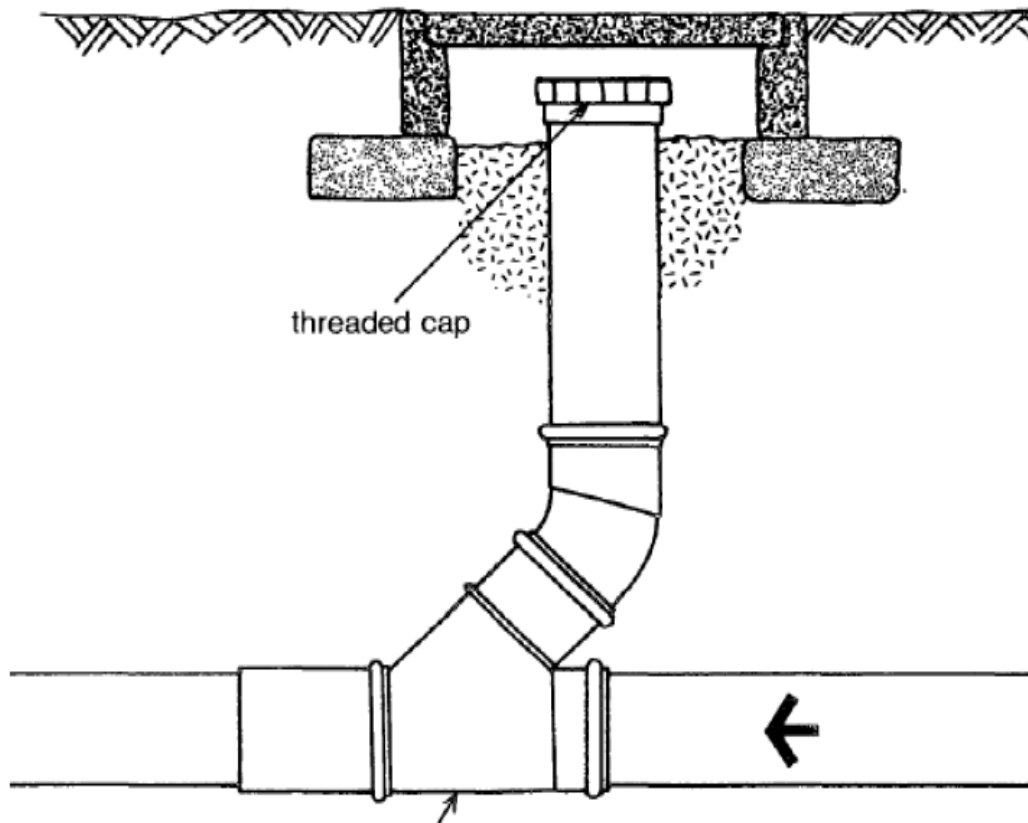
**Figure 1.6 Precast Concrete Inspection Chamber (Source: Mara D, Sleigh , 2001)**

Many a times PVC or other non-concrete Inspection Chambers may also be used as per availability and to ease the laying of sewer. These may also be preferred sometimes as they provide a leak proof joint and also to expedite the construction. Fig 1.7 shows a commonly used PVC inspection chamber.



**Figure 1.7 PVC Inspection Chamber (Source: Melo, 2005)**

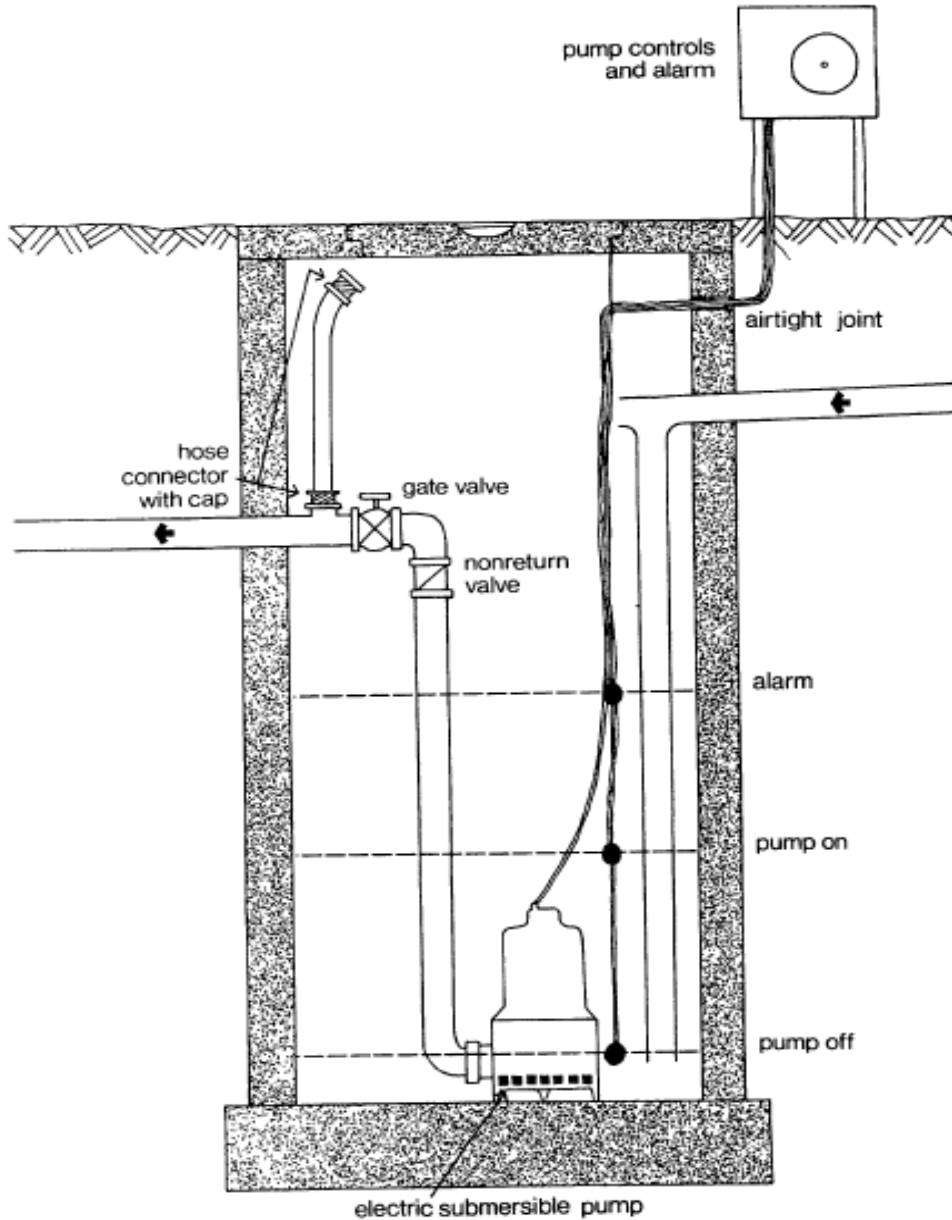
- v) **Clean Outs:** These are provided for the purpose of flushing of system if required by using pressure pumps. Fig 1.8 shows a diagram of clean out.



**Figure 1.8 Clean Out for Small Bore Sewer (Source: Design of Small Bore Sewerage System, World Bank)**

- vi) **Vent Pipes:** For the vent of gases generated in the sewerage system, vent pipes are provided.

vii) **Pumping Station:** Sewage from the households through connecting pipes will fall in to the inlet collecting tank at disposal site. Since the ground levels of disposal site do not permits any gravity flow as such, a pumping station is introduced in the system. Fig 1.9 shows a pumping station.



**Figure 1.9 Intermediate Pumping Station Provided near STP (Source: Design of Small Bore Sewerage System, World Bank)**

viii) **Sewage Treatment Units:** Before final disposal the sewage is treated by using following sewage treatment units:

- i. Influent V-notch haudi to measure the quantity at Inlet.
- ii. Influent collecting tank.
- iii. Facultative pond and Maturation Ponds.

- iv. Effluent V-notch haudi to measure the quantity at outlet.
- v. Effluent collecting tank.
- vi. Rest Room-cum-generator room.
- vii. Sludge drying bed.
- viii. Curing and composting Platforms.

### 1.5 TREATMENT TECHNOLOGIES

Before disposing the sewage to final point, proper treatment is must so that there is no chance of spreading any kind of water borne diseases and it is also necessary to ensure that there is no adverse effect on underground water, health and natural eco system, due to the sewage being disposedoff. Merits, limitations and suitability of various treatment technologies is given in Table 1.2.

S. No.	Technology	Merits/ Demerits	Suitability/ Recommendations
1.	<b>Stabilization Pond</b>	<b>Merits:</b> <ul style="list-style-type: none"> <li>• In Stabilization Pond, treatment of sewage requires only the Natural Sunlight. Hence no requirement/ consumption of Power.</li> <li>• Stabilization Pond is very simple in construction. As such, no skilled labor or any expertise is required.</li> <li>• Very less or negligible Operation &amp; maintenance is involved.</li> <li>• Much cheaper than other waste water treatment technologies.</li> <li>• Quite suitable for Indian conditions where lot of sunshine is available throughout the year.</li> <li>• BOD removal efficiency was</li> </ul>	<ul style="list-style-type: none"> <li>• The technology is very much suitable for villages where sufficient land is available for sewage treatment at cheaper rates.</li> <li>• Non availability of regular power.</li> <li>• Non availability of trained and skilled manpower.</li> <li>• Non availability of proper resources for maintenance</li> </ul>

		<p>found to be in the range of 80-90%</p> <ul style="list-style-type: none"> <li>• During winter season the treatment process shall be slow but more number of sunny days will compensate for this..</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Larger area of land is required.</li> </ul>	
2.	<b>Duckweed</b>	<p><b>Merits:</b></p> <ul style="list-style-type: none"> <li>• The growth rate of plants is more rapid and shows efficient nutrient consumption under wide range of environmental conditions.</li> <li>• It has been able to absorb heavy metals efficiently.</li> <li>• It has rich protein content and less fiber contents comparatively which makes it suitable for utilizing as a high quality feed.</li> <li>• Decomposition of algae on water body is prevented by duckweed cover which helps in clearing the effluent with low TSS content.</li> <li>• Report reveals that duckweed cover helps in decreasing the growth of mosquitoes in the water body.</li> <li>• It has been reported to have positive effect on odour control when covering a</li> </ul>	<ul style="list-style-type: none"> <li>• Where land is readily available and is comparatively cheaper.</li> <li>• Non availability of regular power.</li> <li>• Where weather is fairly stable and wind velocity is less</li> </ul>

		<p>wastewater body.</p> <ul style="list-style-type: none"> <li>• Harvested duckweed may have an easy local market for chicken, cattle or fish feed.</li> <li>• With utilization for aquaculture, this process is capable of generating revenue.</li> <li>• No moving parts and no energy requirement except that requires for pumping station.</li> <li>• BOD reduction is 80-90%.</li> <li>• Duckweed based treatment system is suitable only for waste water having lower organic strength.</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Duckweeds are sensitive plants, which are affected by weather conditions. Cold regions are not suitable for the duckweed based treatment system.</li> <li>• Duckweeds are sensitive to organic shock loads.</li> <li>• Blowing wind affects duckweed cover. As due to blowing wind, the duckweed cover easily gets swept off from water surface to one side.</li> <li>• Regular attendance &amp; care is</li> </ul>	
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		<p>required.</p> <ul style="list-style-type: none"> <li>• Microbial pollution reduction is rarely within safe limits</li> </ul>	
3.	<b>Tree Plantation</b>	<p><b>Merits :</b></p> <ul style="list-style-type: none"> <li>• Relatively cheaper involving less capital &amp; recurring cost.</li> <li>• Economically viable as it generates monetary returns from the sale of trees.</li> <li>• Restores environment.</li> <li>• Highly skilled manpower is not required.</li> <li>• Suitable for imparting fertility to less fertile land.</li> <li>• No power requirement and moving parts.</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• The technology is not applicable where ground water table is high (in depth)</li> <li>• Improper application of sewage to the forestry may cause soil sickness.</li> <li>• Possibility of ground water pollution during non-irrigation period.</li> <li>• Large chunk of land is required.</li> <li>• Difficulty in controlling odor, fly and mosquito breeding problems.</li> </ul>	<ul style="list-style-type: none"> <li>• Where treatment site is available away from the population.</li> <li>• Fertility of waste land is required to be improved.</li> <li>• It is appropriate for the rural areas where bio mass forest can be raised.</li> <li>• It is applicable for villages where sufficient land is available</li> </ul>
4.	<b>Root Zone</b>	<p><b>Merits:</b></p> <ul style="list-style-type: none"> <li>• No requirement of energy and</li> </ul>	<ul style="list-style-type: none"> <li>• Where swamp (wetlands) is available nearby.</li> </ul>

		<p>mechanical equipment for aeration.</p> <ul style="list-style-type: none"> <li>• Self-regeneration of reed bed and virtually maintenance free.</li> <li>• System can prove natural habitat for fauna.</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Large land areas are required.</li> <li>• Difficulty in controlling fly and mosquito breeding problem.</li> <li>• Microbial pollution reduction is rarely within safe limits.</li> </ul>	<ul style="list-style-type: none"> <li>• Where water table is high and is likely to create swamp during rainy season</li> </ul>
5.	<b>Aerated lagoon</b>	<p><b>Merits:</b></p> <ul style="list-style-type: none"> <li>• Comparatively less land area is required.</li> <li>• Power requirement is very nominal.</li> <li>• O &amp; M is very simple.</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Since Aeration is done by artificial means, as such, regular power is required for operation of moving parts (i.e. aerators).</li> <li>• Regular attendance is required.</li> <li>• Microbial pollution reduction is rarely within safe limits.</li> </ul>	<ul style="list-style-type: none"> <li>• Regular power supply is assured.</li> <li>• Land area available is limited.</li> </ul>
6.	<b>Filtration &amp; Polishing Ponds</b>	<p><b>Merits:</b> Land requirement is medium.</p> <ul style="list-style-type: none"> <li>• Leads to reasonable microbial pollution reduction if used with</li> </ul>	<ul style="list-style-type: none"> <li>• Where skilled and trained manpower is available.</li> <li>• Availability of land is</li> </ul>

		<p>polishing pond or UV radiation or chlorination.</p> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Regular attendance is required.</li> <li>• Frequent washing is required</li> </ul>	restricted
7.	<b>Oxidation Ditch</b>	<p><b>Merits:</b></p> <ul style="list-style-type: none"> <li>• Requires less land area.</li> </ul> <p><b>Demerits:</b></p> <ul style="list-style-type: none"> <li>• Continuous power supply is required for operation.</li> <li>• High O&amp;M cost.</li> <li>• Proper operation requires skilled supervision.</li> <li>• For efficient operation, de-sludging from sludge drying beds is necessary on regular basis.</li> </ul>	<ul style="list-style-type: none"> <li>• Where regular power supply is available.</li> <li>• Availability of land is limited and costly.</li> <li>• Skilled manpower is available</li> </ul>

**Table 1.2 Comparison of various treatment technologies.**

The suitability of various treatment technologies for house hold wastewater in rural areas can be summed up as follows:

- i. **Aerated Lagoon:** -Not recommended due to non-availability of regular power (24 hr basis) and necessity of regular attendance.
- ii. **Oxidation Ditch:** -Not recommended due to non-availability of regular power (24 hr basis) and necessity of regular attendance by skilled man power.
- iii. **Tree Plantation:** -Not suitable, as required area of flat land is not available away from the habitation area.
- iv. **Root Zone:** -Not recommended as this technology has not been tried & established also fly and mosquito control is a deterrent.
- v. **Filtration & Polishing Pond:** -Not recommended as this technology has not been established and regular skilled manpower is required.
- vi. **Duck weed:** -Not recommended as technology is sensitive to temperature variation & shock organic loads. Performance during winters shall be low.

- vii. **Stabilization Ponds:** - Required area of suitable land is available and can be maintained with the unskilled man power available locally, no power is required for treatment. This technology is highly suitable for Indian conditions as lot of sunshine is available throughout the years.

## **1.6. TECHNICAL SUITABILITY & SUSTAINABILITY**

In Punjab, solid free sewerage scheme has already been adopted in many villages and efforts have been made to integrate lessons learnt in current design in order to ensure its sustainability. Past experiences show failure of the system on account of following main reasons:

- Clogging of sewers due to solid material entrapped
- Reluctance of modification in existing household wastewater plumbing with sewer
- Direct connection with sewer without IC/Septic Tank
- Wrong design of IC/Septic Tanks
- Lack of complete awareness of scheme in community
- Joining of wastewater from kitchen and cattle shed with existing IC/Septic tank effluent
- Poor cleaning frequency or not cleaning of IC/Septic Tanks
- Reluctance in carrying out any plumbing work with existing septic tanks
- Existing Septic Tanks buried under pucca structures or constructed after property line under road
- Total flow generated is of small quantity and not adequate to generate self-cleansing velocity
- Rupture of poor quality sewer pipe due to overburden
- Rupture of poor quality material used for IC Construction
- Difficulty in identifying Clean Out locations meant for cleaning clogged sewer lines
- Irregularity in Operation & Maintenance of system
- Laying & jointing of sewer pipe not as per specification
- Difficulty in providing new connection or providing household connection at latter stage with provision left out with tee connection
- Poor quality of household connection joints with sewer pipes at frequent places making vulnerable for leakages

- Lack of community spirit in taking responsibility for sewer infrastructure outside their property boundary

In this way, it is clear that there are many governing factors which require due consideration in its design, implementation, Operation and Maintenance(O & M), institutional and community capacity building aspects in order to have sustainable sewerage scheme. This system is technically suitable mainly under the following conditions, where:

- On-site disposal of house hold sullage and effluent from pour-flush toilets cannot be done.
- The waste water generation should be on the lower side
- Installation of new schemes is taken up, especially for extremely located areas
- Road and lane widths are narrow and it is very difficult to lay deep conventional sewers
- Topography of the area is flat and not suitable for conventional system to achieve minimum self-cleansing velocities without deep excavations or pumping
- Situation where availability of O&M support is low.

### **1.7. AIM OF PROJECT**

The implementation of project of providing sewerage scheme in the village is having an objective to curtail open defecation practices in rural areas by upgrading existing on-site sanitation facilities by introducing off-site sanitation facility economical for the community and ensures its safety in terms of health and environment.

To make rural habitation open defecation free & to improve the sanitation conditions of rural area is one of the prime concerns in modern scenario of India. Rural habitation produces waste water which is generated by household activities. However, in India, it is a common practice to discharge this water in to nearby ponds or into open drains. Also, the waste water generated by house hold latrines is discharged into kutchha septic tank which over a period of time fills up.

These practices have a tendency to pollute ground water or even lead to diseases, if discharged in to open. Proper discharge and treatment of this waste water is essential. Onsite treatment is not very effective procedure. Offsite practices are often very expensive. A need for sewage system for proper and safe disposal of waste water is unanimously acknowledged. Sewer systems are the most efficient and effective way to remove waste from the source. However, sewer systems are usually very expensive. The laying of distribution again is a very

tedious process. Often constraints such as limited finances and non-availability of land requires us to go ahead with onsite treatment process or no treatment at all. These constraints forces to look beyond the standard available option of conventional sewer. One such concept/ technology of small bore sewer is quite useful in this scenario. The main objectives of these thesis/ project are as follow:

- Designing of low cost sewage system for rural habitation
- Execution of small bore sewer system
- Assessing its environmental impact and long term sustainability.

The successful implementation will also include maintaining the working of treatment plants and training the local bodies about how to operate the sewer system. Other benefits/ advantages will include:

- This will help in curbing the practice of discharging kitchen waste/ toilet waste etc. into open drain which can be used for storm water drainage.
- The problem of discharge of waste water into ponds would be discouraged.
- Seepage of untreated waste water into ground water leads to polluting it.
- By transporting this waste water to a treating plant and then treating it before discharging will help in preventing ground water pollution.
- This will also help to avoid outbreak of many diseases.

The construction points here include all the process from obtaining land, purchasing material, testing and all the other financial and social aspects

## CHAPTER -2

### LITERATURE REVIEW

#### 2.1. INTRODUCTION

Literature Review/Assessment is an effort of exploring & study the literature relevant to the design and construction procedure thereof relating to the different sanitary sewerage system.

Adequate sanitation facilities along with good hygiene & safe water are fundamental of good health and to the social and economic development. Emphasizing on this in the year 2008, the Prime Minister of India quoted Mahatma Gandhi who said in 1923, “sanitation is more important than independence” (*Mara D, Lane J, Scott B, Trouba D (2010) Sanitation and Health*)

Keeping in view the sustainability aspects, Sewerage system offers important advantages and possibilities for sustainable development. As such, the concept of sustainable rural sewerage system is being reviewed in this work. A Sewerage System in rural area not only serves as a basic facility for waste water drainage but also contributes for protection of rural environment and public water bodies by ensuring reinstatement of the water environment hence accommodates in ensuring a healthy social water cycle.

#### 2.2 HEALTH & SANITATION

Improved Sanitation conditions not only affect on health, but also have considerable impacts on social and economic growth of a developing country. A community who lacks in sanitation facilities leads to disease. Of human excreta, the most dangerous part to health is feces. A small quantity of one gram fresh feces of an infected person contains around  $10^6$  viral pathogens,  $10^6$ - $10^8$  bacterial pathogens,  $10^4$  protozoan cysts and  $10$ - $10^4$  helminthes eggs (*Mara D et al. Sanitation and Health.2010*).

As such, arrangement for safe disposal of human excreta can be termed as sanitation system. The term "safe Disposal" means only hygienically excretion but also to contain or treat excreta to avoid adverse affects on their health as well as to that of the other people.

These sediments when deposit in the sewer causes the problem. These sediments vary from (100 – 500mg/l) and particle size from (10-60 $\mu$  m). If water carries the 100mg/l and 10 $\mu$  m sediment load then it is referred to as low strength wastewater. If it carries the 350mg/l & 500mg/l then it is referred to as medium and low strength wastewater, respectively (*Butler.2003*). Sediments after entering into the flow travels in suspension or sometimes travels as a bed load. The material which is finer and lighter tends to travel in

suspension due to influence of turbulent fluctuations of the flow, whereas the heavier material travels in flow by rolling, sliding or slanting along the pipe invert as bed load.

#### **a. Conventional Sewerage System**

Conventional sewer system is an offsite technology to carry the wastewater from house to the treatment plant. These are typically used in urban areas with consistently sloping ground and these are used in city. These are not very good for the hilly or flat areas as it results in deep excavations. Conventional Sewerage Systems are also not good for the areas where water level is high. In conventional sewerage system, the human excreta is diluted with flushing water, mixed with other water and finally treated.

#### **b. Simplified Sewerage System**

Simplified sewerage removes all wastewater from the household environment. Simplified sewerage is an off-site sanitation technology. This system was developed for low-income areas and where there is insufficient space problem for onsite system. This system has been found to be reliable, upgradeable and extendable. It is applicable in all situations. However, it is most suited for areas characterized by topography of gentle slope, high and low-density population with reasonable water supply, small homesteads with lack of space, high water table, impervious soil & shallow bedrock. This system can be used in rural areas having low to medium density, where space is not the problem for onsite treatment while in high population density area; there is no space for the onsite treatment.

**Key features** of this system are: Capital cost is half than the conventional sewerage (Mara, 2008). These are laid on shallow depth and away the traffic load simplified systems are designed in a way that the wastewater from households in the same block is collected by a shallow and small diameter pipeline and then, delivered to the trunk sewers by a single (or just a few) connection (Sarmiento, 2001).

Manholes are not needed instead of this junction box are provided. Major junction Manholes are provided. Plastic pipes can be used instead of concrete and asbestos pipe because sewers are laden far from the traffic loads (Sinnatamby, 1986; Bakalian et al. 1994). Concrete and asbestos pipe are not recommended in simplified sewerage due to high probability of sulphide attack on the pipe material (Mara, 1996).

#### **c. Small Bore Sewerage System**

Small Bore Sewerage System is a cost effective sustainable technology which is designed for offsite treatment and disposal of only for the liquid portion of household wastewater. Troublesome solids which might cause obstruction in the sewer like Grit, grease & other material are separated from the waste flow in septic tank which results in reducing

the potential for clogging. Due to this, smaller diameter pipes for downstream of the septic tank in the lateral as well as in the sewer main can be used. They can also be effective where the topography is too flat without deep excavation, where the soil is rocky or unstable and where ground water level is high, domestic water consumption is low, water-saving plumbing fixtures and appliances are widely used. Cleanouts are provided for flushing, manholes are rarely used and Air release risers are required at or slightly downstream. Plastic pipe are typically used as they resist to erosion.

A Small bore Sewer collects only settled wastewater in which has following advantages:

- **Reduced Water Requirements:** Since the solids are not carried in the sewers therefore large quantities of water are not needed for solids transport.
- **Reduced Excavation Cost:** With the troublesome solids removed, the sewers do not need to be designed to maintain a minimum flow velocity for self-cleansing. Therefore, rather than being installed on a straight path with a uniform gradient, they may be laid with curvilinear alignment with a variable or inflective gradient.
- **Reduced Materials Cost:** There is a reduction of sewer size and pumping equipment (pumps handling only liquids are simpler). In addition, expensive manholes can be replaced with much less costly cleanouts or flushing points, since mechanical cleaning equipment is not necessary to maintain the sewers in a free-flowing condition.
- **Reduced Treatment Requirements:** Since the unit processes are performed in the interceptor tanks as such, process like screening, grit removal & primary sedimentation or treatments in anaerobic ponds are not needed at the treatment works.

### 2.3. COMPARISON OF TREATMENT TECHNOLOGIES

Various treatment technologies that are available for treatment of waste water and can be used for rural habitations are summarized in Table 2.1.

S. No.	Factors	NAME OF TREATMENT TECHNOLOGY						
		Stabilization Pond	Duck-weed	Tree Plantation	Root zone	Aerated Lagoons	Filtration & Polishing Ponds	Oxidation Ditch
1	BOD removal (%)	80-90	80-90	75-85	80-90	80-95	75-90	80-95
2	Microbial Pollution	Up to 99.99	Up to 90	-	Up to 95	Up to 90	Up to 95	Up to 90

S. No.	Factors	NAME OF TREATMENT TECHNOLOGY						
		Stabilization Pond	Duck-weed	Tree Plantation	Root zone	Aerated Lagoons	Filtration & Polishing Ponds	Oxidation Ditch
	removal (%)							
3	Land Requirement	1.5-1.7	0.8-1.0	10.0	2.8-3.1	0.3-0.4	0.7-0.8	0.18-0.32
	(a) In m <sup>2</sup> per person (b) Hect/MLD	1.5-2.0	1.0-1.5	3.0-5.0	3.9-4.25	0.40-0.55	0.9-1.20	0.25-0.30
4	Per Capita cost of construction	245-300	185-250	40-240 depending upon length of rising main.	110-150	200-250	160-200	275-325
5	Power required (KWh) per person per year)	Nil	Nil	Nil	Nil	12-15	4-6	9-16
6	Moving Parts	Nil	Nil	Nil	Nil	Aerators	-	Aerator and recycling Pumping
7	Need of skilled manpower	Simplest	Simple	Simple	Simple	Medium	Skilled Medium	Skilled Medium
8	Sludge Handling	Not Required	Not Required	Not Required	Not Required	Not Required	Required	Required
9	O&M	Simple & Cheap	Requirement of regular attendance, recovery from sale of	Regular attendance is required but there is	Simple & Cheap	Regular attendance is required	Regular attendance is required by skilled	Skilled and Regular attendance is required.

S. No.	Factors	NAME OF TREATMENT TECHNOLOGY						
		Stabilization Pond	Duck-weed	Tree Plantation	Root zone	Aerated Lagoons	Filtration & Polishing Ponds	Oxidation Ditch
			fish.	recovery in terms of wood.			manpower	

**Table 2.1 Comparison of Various Waste Water Treatment Technologies.**

**Note: Data from CPHEEO manual**

#### **2.4. SHORTCOMINGS/ LIMITATIONS**

The Small Bore Sewerage System has some limitations also which are as below:

- i. UPVC pipes cannot be laid at large depth and under very heavy traffic load.
- ii. To ensure satisfactory performance & efficient operations, regular maintenance (periodic cleaning & disposal of solids) of interceptors is required.
- iii. Illegal direct connections without interceptor into the Sewers need to be avoided. Also proper check is required to avoid dumping of solid waste in to interceptors, cleanouts and in manholes.
- iv. UPVC pipes, beyond a nominal diameter of 200 mm becomes considerably expensive over pipes of other material.

UPVC pipes generally will require a well graded bedding all around.

## **CHAPTER -3**

### **METHODOLOGY**

#### **3.1 SELECTION OF SITE**

In consultation with the department of Water Supply & Sanitation, the village TASOLI of district Patiala, which is 46 Km from Patiala and is on Patiala- Rajpura-Manakpur Road. It is 35 Km from State Capital Chandigarh. The h. Bast no. is 273. The nearest Post Office is Manakpur at a distance of 2 Km. The nearest Railway Station is Rajpura at distance of 18 Km. The village is located within excellent natural settings with scattered habitations over a large area topography is flat. Present Water Supply service level in village TASOLI is 120 lpcd. As per census 2001 combined literacy rate of the village TASOLI is 64.33% as 1084 persons (624 male and 460 female), out of 1685 were literate. Rate of literacy of males was 57.56% and that of woman was 42.44%. Village has total present population of 1913 persons and having a total 304 households. Out of these 275 households are already having septic tanks in their houses. This is one basic criteria that is to be fulfilled as this reduces the cost of the project greatly. Also, the village panchayat has been successfully running the water supply scheme since last 3 years and are also willing to run the sewer system at village level so that even in the absence of any govt. funding, the sewer will be self-sustainable. This village, thus, fulfills the required condition for providing a sewerage system.

Current sanitation conditions of the village are not satisfactory. Although most of the houses have their own septic tanks, but there is no proper disposal mechanism of effluent coming out from septic tanks. Both side drains of village roads are flooded with wastewater coming from kitchen, toilets, bathrooms and sometimes cattle sheds of a household. Pool of this wastewater poses public health at high risks.

The village water bodies are acting as recipient of waste water through long period and mostly contaminated to severe extent. The water bodies have lost their utility as key elements of environmental and social asset

Hence, as per the topography and suitability of site conditions small bore sewerage system is most suitable for this village

#### **3.2. SELECTION OF SEWERAGE SCHEME**

The topography of the area is flat and not suitable for conventional system to achieve minimum self-cleansing velocities without deep excavations or pumping. Road and lane width in the village is narrow and it is very difficult to lay deep conventional sewers

Also, availability of water for consumption by rural community is the key factor towards adoption of Sewerage System for the village, as a waterborne system adequate quantity of water to transport solids generated along with the waste water. Minimum water supply required for the running of small bore sewer system is 70 lpcd. The village is having service level as 120 lpcd. Hence, the available water supply is sufficient for the running of small bore sewer system and therefore, system is set up with the objective of collection, conveyance and safe offsite disposal of the entire quantity of spent water.

Hence the scheme is technically as well as financially viable

### **3.3. DESIGN CONSIDERATIONS**

- Underground sewers shall be laid for collecting the sewage of the village into a series of facultative pond and maturation ponds, located at site of STP. Design of facultative pond and maturation ponds has been done as per manual from National River Conservative Directorate (NRCD), Ministry of Environment and Forest. As per this manual, size and no of maturation ponds are mainly governed by optimum BOD surface loadings, detention time, fecal coliform no (effluent quality), first order BOD rate constant. As per NRCD manual, detention time calculated for three options are given below:
  - a. When  $n=1$ ,  $T_m = 11.97$  days
  - b. When  $n=2$ ,  $T_m = 2.36$  days for each
  - c. When  $n=3$ ,  $T_m = 1.19$  days for each

As the minimum detention time for each maturation pond is 3 days for less than mean 20 degree centigrade during winter season, option 2 i.e. two no. maturation ponds pertain to the least land requirement. Hence, 2 no maturation ponds have been selected. Based on literature review including NRCD manual, performance of series of maturation pond is better in pathogens removal including 25 % BOD removal by each pond. Since, treated effluent is to be used for agriculture purpose, effluent quality in terms of pathogen assumes significance and as such two maturation ponds provision will ensure pathogen removal more effectively. As per guidelines, range of maturation ponds depth varies from 0.9 m to 1.5 m. Land availability permits to take lesser depth of 1 meter of maturation ponds in order to avoid any possibility of anaerobic condition development in maturation ponds.

- Proposed village is having water supply @ 120 lpcd. As per CPHEEO manual, continuous water supply villages are having flatter consumption pattern and as such peak factor of 2 is the most suitable factor for design of small bore sewer as per CPHEEO manual. In this particular case water supply is intermittent. As such, based on the present

supply pattern peak factor for designing this sewerage scheme has been taken as 3.0 based on water supply consumption pattern.

- As per CPHEEO Manual on water Supply & Treatment; it is desired that the minimum velocity in the reaches should be maintained between 0.3 m/sec to 0.6 m/sec. considering the non-acceptance of smaller diameter pipes by the community, it was principally decided with the Funding Authorities and operating wing of department, to keep minimum size of PVC pipes as 160 mm o/d. Also the slope cannot be maintained too steep as it will add to the cost beyond the desirable limits. Under these circumstances, all out efforts have been made to maintain the minimum velocity as per CPHEEO manual provisions i.e. 0.3 m/sec. But in certain reaches it is not feasible to maintain this minimum velocity value. In such reaches, clean outs have been provided in the initial reaches and manholes/inspection chambers at all junctions and at the places where spacing exceeds 100 m.
- Clean outs are to be provided in the initial reaches where velocity is quite less. Manholes/inspection chambers will be proposed at all junctions and at the places where spacing exceeds 100 m. All households' connections will be made through Tee Connection. 600 mm x 900 mm inspection chambers are proposed to be provided where sewer depth is less than 1.2 mtr., to facilitate proper maintenance of sewer and conventional manholes 900x1500mm upto 3.00 m depth and 1200x1800mm for depths more than 3.00 mtr
- Waste Stabilization Pond based Sewage Treatment Plant, Sludge Drying Beds, Curing Platform, Composting Pits, Collecting Tank and Rest Room - cum - Generator Room shall be proposed. The treated sewage from pond meeting the BOD, TSS norms shall be utilized for irrigation purposes for 10 months.
- Facultative and Maturation Ponds will be brick lined along sides and bottom and LDPE sheet shall be laid below brick lining.

From the intercepting tank, the waste water including sludge shall be taken to the sludge drying beds. The dewatered sludge is transported to composting pits & further cured on platform, before final use as manure.

## CHAPTER -4

### DESIGN PROCEDURES

#### 4.1. DESIGN STANDARDS

While designing Sewerage System including Sewage Treatment Plant, Design Standards as prescribed in the manual on sewerage and sewage treatment prepared by CPHEEO under Ministry of Urban Development, Design Manual for waste stabilization ponds by Duncan-Mara, Technology Advisory Group (TAG) Tech note No. 14 for design of small bore sewer system has been adopted. For design of sewage treatment plant, National River Conservation Directorate (NRCD), Ministry of Environment and Forest approved guideline has been referred.

#### 4.2. DESIGN PERIOD

The various components of the Sewerage System are designed for following life period are as shown in Table 4.1 below

S. No.	Component	Recommended Design Period in Years
1.	Collection System i.e. Sewer network	30
2.	Pumping Station (Civil Works)	30
3.	Pumping Machinery	15
4.	Sewerage Treatment Plant	30
5.	Effluent Disposal and utilization	30

**Table 4.1. Design parameters for various components of sewerage system**

#### 4.3. PER CAPITA SEWAGE FLOW

It is expected that 75% of water supply will reach the sewer. The sewers have been designed for flow of waste water against per capita supply rate of 120 LPCD. Design Criteria as per CPHEEO Manual on water Supply & Treatment; for institutions like Schools & Hospital is given as:

Day Schools/Colleges	: 45 lpcd
Hospitals (including laundry)	
(a) Beds exceeding 100 Nos.	: 450 (per bed)
(b) Beds limiting to 100 Nos.	: 340 (per bed)

This requirement is basically for urban areas. As no data for rural area was given in the manual, a data from typical rural water supply village of district SAS Nagar with metered

supply was studied and accordingly certain norms for Schools/Hospitals/Gurudwaras were devised. These have been given as:

Schools	: 5 lpcd per student
Veterinary Hospitals/Rural dispensaries	: 10 lpcd per visitor
Gurudwaras	: 10 lpcd per visitor

#### **4.4. PROJECTED POPULATION, WATER SUPPLY DEMAND & WASTE WATER GENERATION**

Prevailing Practice is to use the 2001 census population as base and calculate the present population of the base year by taking average annual growth during the last decade @ 1.228%. For estimating the projected population for the design next intermediate year the present population is increased by 20% and for estimating the population for the design ultimate year the present population is increased by 35%.

The prevailing practice:-

- Allows a growth rate of 1.228% per year over 2001 population upto the base year
- The same growth rate is adopted to continue for intermediate years to a total 20% increase which corresponds to 1.228% annual growth.
- A growth rate increased by about 20% is adopted for the next 15 years with an overall increase of 35% over the population of 2012.

The prevailing practice is being adopted by all agencies involved in development interventions and hence adoption of the same pattern will allow synchronized integrated development. The village has a population of 1685 persons as per 2001 census. At the annual average rate of growth of 1.228% the village has a present population (2012) of about 1913 persons. The population figures are likely to grow to a total of 2295 and 2582 persons by the year 2028 and 2042, respectively.

A breakup of Water Supply and sewage generation for the year 2012 and 2042 is given in the Table 4.2 below:

<b>WASTE WATER BREAK UP DETAILS VILLAGE TASOLI</b>				
<b>Sr. No</b>	<b>SOURCE &amp; YEAR</b>	<b>Water Usage In Liters</b>	<b>Sewage Generation @ 70% of 120 Lpcd in Liters</b>	
	<b>2012</b>			
1)	Domestic Sewage from Households			
	1913 x 120 LPCD = <b>229560</b> Lts	<b>229560</b>	<b>172170</b>	
2)	Gurudwaras/Temple (1 Nos )			

	100 Visitors @ 1 Visits per day in Gurudwaras @10 LPCD	<b>1000</b>	<b>750</b>	
3)	Schools (1 Nos. )			
	190 Students @ 5 lpcd per Student = (190*5)=	<b>950</b>	<b>713</b>	
4)	Dispensary (1 No)			
	5 Patients @ 5 LPCD =(5*5) = 25 Lts	<b>25</b>	<b>18.8</b>	
6)	Add for Infiltration			
	Infiltration rate considered here is average of 500 and 5000 litersper kilometers i.e Length of Sewer line laid x Average of 500 & 5000 lts = 5159 x 2750 ) /1000	<b>14187.3</b>	<b>14187.3</b>	
	<b>Total</b>		<b>187839</b>	
	<b>Say</b>		<b>0.188</b>	<b>MLD</b>
	<b>2042</b>			
1)	Domestic Sewage from Households			
	2582 x 120 LPCD = <b>309840</b> Lts	<b>309840</b>	<b>232380</b>	
2)	Gurudwaras/Temple (1 Nos )100 Visitors @ 1 Visits per day in Gurudwaras @10 LPCD		<b>750</b>	
3)	Schools (1 Nos. ): 190 Students @ 5 lpcd per Student = (190*5)=		<b>713</b>	
4)	Dispensary (1 No) 5 Patients @ 5 LPCD = (5*5) = 25 Lts		<b>18.8</b>	
6)	<b>Add for Infiltration</b>			
	Infiltration rate considered here is average of 500 and 5000 litersper kilometers i.e Length of Sewer line laid x Average of 500 & 5000 lts = 5159 x 2750 ) /1000	<b>14187</b>	<b>14187</b>	
	<b>Total</b>		<b>248049</b>	
	<b>Say</b>		<b>0.249</b>	<b>MLD</b>

**Table 4.2 Wastewater break-up details village Tasouli**

#### **4.5. DESIGN OF SEWER SYSTEM**

Flow characteristics in simplified & conventional sewers are of open channel flow. Hence some free open space above the flow of wastewater is always there in the sewer. These are designed based on the properties of a circular section and Manning's equation (Mara, 1996). While in case of small bore sewerage system sewer is in open channel flow and in pressure flow (Otis, 1985).

The hydraulic design of simplified sewers requires knowledge of two variable parameters i.e. Area of flow and the hydraulic radius.

#### **4.6. DESIGN OF SMALL BORE SEWER**

As per CPHEEO manual, design peak flow factor for small bore sewer is recommended as 2.0. At peak flow sewer shall run almost full. Minimum pipe diameter recommended is 110 mm O/D minimum velocity of 0.3 to 0.6 m/sec can be adopted.

#### 4.7. PIPE MATERIAL & MINIMUM SIZE DIA

For wider streets, uPVC pipe system shall be followed with provision of manhole. This is because manholes are required from operation and maintenance point of view in terms of future connections, diversion, cleaning of chokes etc. for this kind of sewerage system, HDPE pipe are not suitable because of susceptibility of breaking while rodding and cleaning of sewers etc. also, for main roads with heavy traffic loads, both these pipes have problem of excessive deflection. Moreover, CI/DI pipe seem to be the better option, the cost of CI/DI is prohibitive. RCC pipes are susceptible to corrosion and souring by sewage thus reducing their life. Hence, uPVC pipes widely available and resistant to corrosion are best suited for wider streets where sewerage system needs with manholes needs to be followed. The solids are not considered to be allowed to enter in the Sewerage System.

Thus, uPVC pipe are recommended along mains roads in this village. As principally decided with the Funding authorities, operation wing and Department concerned that the size of Sewer shall be minimum 160 mm O/D, hence sewer of size 160 mm O/D minimum has been provided. A comparison between UPVC pipes and GI pipes is shown in Table 4.3.

Parameter	UPVC Pipe	Galvanized Iron Pipe (GI Pipe)	Benefits of PVC Pipes
Weight	It is light in weight	Heavy in weight	Due to light weight, it helps in lot of saving in handling & transportation costs and also makes installation easier.
Inside Surface	Smooth	Rough	Smooth inner surface reduces frictional losses hence saving in pumping cost.
Resistance to corrosion	Offers good resistance against strong acids, alkalis and other salt solutions	poor	Longer in life. Hence maintenance and replacement cost is less
Formation of deposits	Zero formation of deposits throughout its life and pipe bore remains same.	Formation of deposit occurs and reduces bore size of pipe	Uniform flow of water is ensured throughout and minimizes the danger of contamination.
Installation	Very simple and less time consuming	Difficult and takes more time	Reduces installation time and also saves in cost.
Material cost	Low	High	Saves in initial investment.

### **Table 4.3 Comparison of UPVC pipes with pipe of other material**

In other words, merits of uPVC pipes can be summarized in following points:

- Plastic pipes are light in weight, tough, resistant to chemical attack and available in large lengths.
- They reduce the cost of handling, transportation and installation.
- Less number of joints facilitates the speed and reduces chances of leakage.
- They are rust resistant.
- These pipes have good elastic properties.
- Their adaptability to earth movements is superior.
- Smooth internal surface of the pipes offer less friction.
- Due to less friction it saves the energy in the conveyance of water

### **4.8. DESIGN OF PUMPING MACHINERY**

As per CPHEEO Manual on Sewerage & Sewage Treatment; it is a general practice to provide 3 pumps for small capacity pumping station comprising 1 Pump of 1 Dry Whether Flow (DWF), 1 of 2 DWF and third of 3 DWF. Accordingly; Sewage pumping sets are designed with capacities half of Average flow, Average Flow and Peak Flow i.e. 80, 160 & 470 LPM at a head of 6 m for influent collecting tank and 80, 150 and 450 LPM for effluent collecting tank at a head of 8 m with solid opening not less than 25mm. Pumps will be running as per the need of the influent and effluent to STP. However, for calculating the O & M cost running of 8 hours for each set (8 x 3 = 24 hours) on an average flow of 160 LPM and 150 LPM for influent and effluent collecting tank respectively has been taken. Power availability in rural areas of Punjab is observed to be satisfactory and is likely to improve further as per State Government plan. However; it is assumed for O&M calculation purpose that DG set of capacity 6 KVA for influent and effluent to STP will run on an average 200 hours per year in case of failure of power supply.

### **4.9. DESIGN OF RISING MAIN**

The rising main carry discharge to elevated tank for a period of 10 months and to available nearby drain, at a distance of 72 m for a period of 2 months during rainy season. The calculated values are as under-

Average discharge of sludge = 150 LPM

Daily Discharge = 216000 liters

Hence, provide 110 o/d uPVC rising main, which can carry a discharge of 220000 liters per day with a head loss of 1.75 m/1000m at a velocity of 0.32 m/sec against a required discharge 216000 liters/day.

Length of rising main	=	72m
Loss of head in rising main	=	(72 x 1.75)/1000
	=	0.13 m

#### **4.10. DEVELOPMENT OF DISPOSAL SITE**

Necessary provision for construction of corner pillars, brick on edge paving and barbed wire fencing, gates etc. has been made in the estimate.

##### **4.10.1. Sludge Disposal**

The light watery sludge's being generated from septic tanks and inspection chambers shall be emptied out with the help of vacuum pumps mounted on the tankers & transferred to the sludge drying beds. It has been worked out that four intercepting chamber / septic tanks shall be emptied out daily by assuming average cleaning periods of inspection chambers / septic tanks as 2 years.

The supernatant from the sludge drying beds (4 nos.) shall be discharged into the existing facultative pond through 110 mm OD UPVC pipe. The sludge generation from the sludge drying beds has been estimated as 0.42 m<sup>3</sup> per day on the basis of sludge generation of 0.06 m<sup>3</sup> per person per year.

The sludge being removed from the sludge drying beds as and when required and is transferred to composting pits for a period of 180 days. Intermittent layers of bulking agent (woodchips / wheat husk) are also laid over the sludge. A clay layer of 30 cm is put on the top of sludge stored in the pits to achieving anaerobic condition and also to avoid odor & fly nuisance. After digestion period of 180 days, the digested sludge shall be taken out from the pits & transferred to sludge Curing Platform for its curing for a period of 15 days. Thereafter this sludge shall be used as manure in the agriculture fields.

Sludge drying beds	=	4no, 4m x 4m x 0.3m each
Composting pits	=	2 no, 5.10 m x 10.10 m x 1.5 m each
Sludge curing Platforms	=	1.80 m x 3.60 m

The solid waste such as scum, dead weeds, grasses etc. shall be processed along with the sludge being generated from the Septic Tanks to the composting unit proposed at STP site. Sludge drying beds shall be bricks lined with underlying drain pipes leading stabilization pond to avoid contamination of ground water.

#### **4.10.2. PROPOSED SLUDGE HANDLING SYSTEM**

Operational system of sludge handling involves following steps:

**Step – 1-** Sludge is to be collected from Septic Tanks by suction machine and transported to the STP site by covered vehicles.

- No significant nuisance is envisaged.
- On an average everyday about 4 septic tanks are estimated to be emptied.
- Average volume of sludge likely to reach the plant @  $0.42\text{m}^3$  per person per year when septic tanks/intercepting tanks are cleaned.

**Step – 2-** The collected sludge from septic tanks is with large quantity of liquid and hence discharged into sludge drying beds. Sludge is allowed to dry in the sludge drying beds for 8 days.

**Step – 3 -** Dewatered sludge is transferred to 2 no. composting pits of size 5.10 m x 10.10 m x 1.5 m each for storage for 180 days.

**Step – 4-** Digested sludge from composting pit is stored on curing platform (Size 1.80 m x 3.60 m for 15 days storage), which is in the form of cakes and having good manure properties to be taken away for agricultural use.

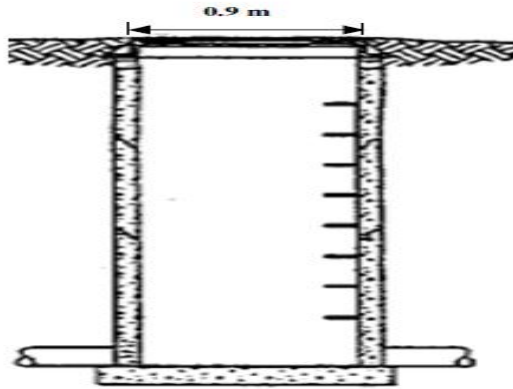
#### **4.11 DESIGN MODIFICATIONS**

In order to suit the local prevailing situation to have a sustainable solid free sewerage system and to minimise the deficiencies, some of in-built measures have been integrated during construction and implementation stages by modifying designs.

##### **4.11.1 Provision of Manholes/ Inspection Chambers**

Although principally, manholes/inspection chambers are not required in solid free sewerage system, but in view of possibility of sewer lines clogged due to negligence of community using it, provision of manholes/inspection chambers as per depth of sewer line has been provided in design at all junctions. Provision of Man Holes/Inception Chambers has also been made in between the junctions where spacing exceeds 100 m. All households' connections will be made through Tee Connection.

By providing manholes/inspection chambers at suitable location, existing solid free system will have flexibility in its conversion of conventional sewer system in future when water supply service level will be further augmented. Experience shows that cast iron cover of manholes/inspection chambers are generally stolen and facilitate in dumping solid waste generated from near-by household. Heavy RCC cover with proper hook and locking system will be fixed in grooves by lean cement slurry so that it cannot be easily removed from its place by a person.



**Figure. 4.1 Simplified Manhole (Source: Bakalian, 1994)**

#### **4.11.2. INTERCEPTING CHAMBER/ SEPTIC TANK & HOUSEHOLD CONNECTION**

Proper household connection is key component for sustainability of sewerage scheme. As per rural scenario of Punjab, wastewater disposal system varies from household to household as mentioned below:

- No toilet in household, open defecation and wastewater from bathing place, kitchen and cattle shed either disposed to open drain or agriculture land or partly to both places
- Soak pit toilets and same as above for wastewater from different sources
- Septic tank toilets receiving wastewater only from toilets, but disposal of wastewater from other sources as mentioned above
- Septic tank toilets receiving wastewater from all sources except kitchen and cattle shed
- Septic tank toilets receiving wastewater from all sources except cattle shed.

In addition, existing septic tanks location is generally not easily accessible. In some cases, it is deeply buried under some *pucca* structure and sometimes it is located inside courtyard with underground effluent drains. Sometimes, toilet superstructure is constructed above on septic tanks. There is general reluctance among household owner in disturbing existing septic tanks and plumbing work in a major way as per site requirements. Depending upon different existing sanitary conditions of households as mentioned above, household connection should be provided under strict monitoring of Department and GPWSC as proposed below:

- Where ever possible depending upon location and accessibility of existing septic tanks, all sources of wastewater must be routed through existing tanks with minor modifications of existing drains.
- Where major modification is required depending on septic tank location, irrespective of existing septic tanks, connection must be provided from newly constructed Intercepting Chamber as per design specification located in premises of each household. All sources of wastewater in house except rainwater should be connected to IC with minor modification of existing drains. IC location should be such that only minor modification in existing drain should be required.
- In case of no toilets or soak pit toilets, new septic tanks/ICs should be constructed as per design specifications and all sources of wastewater generation should be connected to it.
- An additional *Haudi* can be provided inside the premises to safe guard against chocking of main sewer line.

#### **4.11.3. Provision of Siphons**

In order to avoid minor clogging due to light settle able suspended particles by flushing along initial stretches or newly developing area with scattered households, siphons may be provided. Siphons may be placed either with septic tanks/IC outlets within household premises or along sewer pipeline on road. While fitting along sewer lines on roads, some precaution is required from is hydraulic design consideration. A minimum horizontal distance with desired slope of sewer line on both sides of siphon is required in order to ensure proper function of siphon. Siphon portion is embedded in concrete in order to avoid disturbance in its hydraulic setting. Siphon devices are useful for flushing where flow is very less and likely to be clogged with light settle able solids. It is pertinent to mention here that siphon devices may even further aggravate clogging along upper side of sewer lines if it is choked with heavy solid material. In such case, removal of choked material is difficult due to its embedding in concrete blocks. It can only help in removing minor clogging by flushing. It is always advisable to provide it in new developing area if fitted along sewer line. Under current proposal, there is no such developing area covered. Moreover, likelihood of coming heavy solids with less flow from household premises cannot be overruled. In order to maintain slope requirement of sewer on both sides of siphon along initial stretches, overall depth of sewer may increase having financial repercussion.

Hence provision of siphons is not recommended in this scheme.

#### 4.11.4. Minimum Diameter of Pipe

Keeping in view the hydraulic load on sewerage system, minimum diameter 110 O/D of pipes may be adopted for initial stretches under solid free sewerage scheme. As principally decided with the Funding authorities, operation wing of department in line with demand of GPWSC and Community that the size of Sewer shall be minimum 160 mm O/D, hence sewer of size 160 mm O/D minimum has been adopted under this scheme. At the later stage, it will help in converting this system into conventional design.

#### 4.12. DESIGN CALCULATIONS

##### 4.12.1. Design of Pumping Station For Inlet & Outlet Collecting Tank

The design steps of pumping station have been summarized in tabular form as shown in Table 4.4 and 4.5 as follows:

<b>(a) Sump Size</b>		
Discharge of sewage as per average sewage flow in 2012 (LPS)	=	2.176 LPS
Discharge of sewage as per average sewage flow in 2027 (LPS)	=	2.572 LPS
Peak Flow from the Sewerage System at STP	=	2.572 X 3
	=	7.716 LPS
Capacity of Collecting Tank for untreated influent Sewerage System	=	20 minutes at peak flow
	=	$\frac{7.716 \times 60 \times 20}{1000}$
	=	9.260 Cum
Provide 1 No Collecting Influent Tank of 3.0 m diameter with working depth of 1.32 m		
<b>(b) Pumping Machinery</b>		
Provide 3 working pumps with each pumping capacity of half, full and peak flow		
I. Discharge with Half of Average flow	=	1.286 LPS
	=	1.286 LPS or 77.16 LPM
		<b>Say 80 LPM</b>
II. Discharge with Average flow	=	2.572 LPS
	=	2.572 LPS or 154.32 LPM
		<b>Say 160 LPM</b>

III. Discharge with Thrice of Average flow i.e. Peak Flow	=	7.716 LPS
	=	462.96 LPM
	=	<b>Say 470 LPM</b>
<b>(c) Pumping Head</b>		
Difference in level between FSL of bed level of Collecting Tank and inlet at F.T. (m)	=	3.47
Losses in pumps and fittings (m)	=	1
Delivery head reqd.(m)	=	1
Total head	=	3.47+1+1 = 5.47
<b>(d) BHP of Motor:-</b>		
BHP of pump set with <b>peak discharge</b> (Assuming 60 % overall combined efficiency of the pumping unit)	=	$\frac{7.716 \times 6}{75 \times 0.6}$
	=	1.03
Add 10 % margin	=	0.10
Total	=	1.13
Suggested BHP	=	<b>1.5</b>
BHP of pump set with <i>half the average</i> discharge (Assuming 60 % overall efficiency of the pumping unit)	=	$\frac{1.286 \times 6}{75 \times 0.6}$
	=	0.17
Add 10 % margin	=	0.02
Total	=	0.19
Suggested BHP	=	<b>1.0</b>
BHP of pump set with <i>averagedischarge</i> (Assuming 60 % overall efficiency of the pumping unit)	=	$\frac{2.572 \times 6}{75 \times 0.6}$
	=	0.34
Add 10 % margin	=	0.03
Total	=	0.38
Suggested BHP	=	<b>1.0</b>
Hence it is proposed to provide 3 pumps with capacities half of Average flow, Average Flow and Peak Flow i.e 80,160 and 470 LPM at head of 6 m with solid opening not less than 25 mm. Pumps will be running as per the need of the influent to STP.		

**Table 4.4 Design steps pumping stations for influent**

<b>(a) Sump Size</b>		
Discharge of sewage as per average sewage flow in 2012	=	2.083 LPS

Discharge of sewage as per average sewage flow in 2027	=	2.465 LPS
Peak Flow from the Sewerage System at STP	=	2.466 X 3
	=	7.396 LPS
Capacity of Collecting Tank for treated Effluent Sewerage System	=	20 minutes at peak flow
	=	$\frac{7.398 \times 60 \times 20}{1000}$
	=	8.875 Cum
Provide 1 No Collecting Effluent Tank of 3.0 m diameter with working depth of 1.26 m		
<b>(b) Pumping Machinery</b>		
Provide 3 working pumps with each pumping capacity of half, full and peak flow		
I. Discharge with Half of Average flow	=	1.233 LPS
	=	1.233 LPS or 73.98 LPM
		<b>Say 80 LPM</b>
II. Discharge with Average flow	=	2.465 LPS
	=	147.92LPM
		<b>Say 150 LPM</b>
III. Discharge with Thrice of Average flow i.e. Peak Flow	=	7.396 LPS
	=	443.75 LPM
	=	<b>Say 450 LPM</b>
<b>(c) Pumping Head</b>		
Difference in level between FSL of bed level of Collecting Tank and center line of inlet pipe at F.T. (m)	=	2.87
Losses in pumps and fittings (m)	=	1
Head for elevated Tank (m)	=	3
Delivery head reqd. (m)	=	1
Loss of Head in the delivery pipe to irrigation fields 500m away from STP site/ to pond at distance of 72m	=	0.13 (To be consider if it will be greater than head of elevated tank as stated above i.e. 3 m)
Total Head	=	2.87+1+3+1 = 7.87
		<b>Say 8 m</b>

<b>(d) BHP of Motor:-</b>		
BHP of pump set with <b>Peak discharge</b> (Assuming 60 % overall combined efficiency of the pumping unit)	=	<u>7.396 X 8</u>
		75 X 0.6
	=	1.31
Add 10 % margin	=	0.13
Total	=	1.45
Suggested BHP	=	<b>1.5</b>
BHP of pump set with <b>half the average</b> discharge (Assuming 60 % overall efficiency of the pumping unit)	=	<u>1.233 X 8</u>
		75 X 0.6
	=	0.22
Add 10 % margin	=	0.02
Total	=	0.24
Suggested BHP	=	<b>1.0</b>
BHP of pump set with <b>averagedischarge</b> (Assuming 60 % overall efficiency of the pumping unit)	=	<u>2.466 X 8</u>
		75 X 0.6
	=	0.44
Add 10 % margin	=	0.04
Total	=	0.48
Suggested BHP	=	<b>1.0</b>
Hence it is proposed to provide 3 pumps with capacities half of Average flow, Average Flow and Peak Flow i.e. 80,150 and 450 LPS at head of 8 m with solid opening not less than 25 mm. Pumps will be running as per the need of the effluent at STP.		

**Table 4.5 Design steps pumping stations for effluent**

#### 4.12.2. Design of Sewage Treatment Plant Basedon Stabilization Pond Technology

Table 4.6 shows the expected quantity of waste water from the village. Thedesign steps of Waste Stabilization Pond have been summarized in tabular form as shown in Table 4.7.

Village Name	Population		Sewage Flow (Q)		No. of HH	Influent
			(MLD)			BOD Load
	2027	2042	2027	2042		mg/l
Tasoli	2295.0	2582.0	0.223	0.249	304	180

Includes domestic waste, institutions etc.	2295.0	2582.0	0.223	0.249	304	
Capacity of the STP	0.249	MLD				

**Table 4.6 Quantity waste water from the village**

<b><u>Relevant Design Parameter</u></b>			Reference
Influent BOD <sub>5</sub> at 19.5°C (L <sub>i</sub> )	mg/l	180	Refer relevant section of DPR
No of Faecal coliform in influent (Ni)	per 100 ml	1400000	
Max. ambient Temperature (T <sub>max</sub> )	°C	45.00	Climatological table
Min. ambient temperature (T <sub>min</sub> )	°C	1.00	
Average ambient temperature (T)	°C	16	metereological station
Average elevation above MSL	M	287	
Latitude of the place (L <sub>t</sub> )	°	31	Collected Data
Average rate of evaporation (e)	mm/day	5	
<b><u>Design of Anaerobic Pond</u></b>			
Permissible Volumetric BOD loadings at 27° C (L <sub>p</sub> )	g/m <sup>3</sup> d	220	NRCD Manual Table 4.1
			As 20T – 100, and T is 16C
Volume of Pond Required V <sub>a</sub> = (QxL <sub>1</sub> )/L <sub>p</sub>	m <sup>3</sup>	203.7	NRCD Manual equation 4.2
Detention Time t = (V <sub>a</sub> /Q)	day	0.8	NRCD Manual equation 4.3
Adopted Detention time	day	1	It has been recommended in manual to consider minimum retention time as 1 day as the worked out det. Time < 1 day
Adopted Volume of Pond, V	m <sup>3</sup>	249	
Vol. of each Tank	m <sup>3</sup>	249	
Assume depth of water, D	m	3	Range 2 m to 5 m
Area of Pond Required A <sub>a</sub> = (V/D)	m <sup>2</sup>	83.0	
Calculated Width B = (A <sub>a</sub> /2) <sup>0.5</sup>	m	6.44	

Adopted Length	m	12.9	
Adopted area, A	m <sup>2</sup>	83.205	
Actual Volumetric Loading $L_a = (Q \times L_1) / (A \times D)$	g/m <sup>3</sup> d	180.0	
At 16° C Percentage of BOD Removal, n	%	52.000	Refer Table 4.2
BOD in anaerobic pond effluent is $L_{ea} = (1-n) \times L_1$	mg/l	86.4	
<b><u>Design of Facultative Pond</u></b>			
<b>Working out Permissible BOD loading rate in</b>			
<b><u>A. Based on Latitude</u></b>			
BOD loading rate is given by	$L_{sl} =$	$375 - 6.25 \times L_t$	NRCD Manual equation 4.5
	kg/ha/day	=181.25	
After modification for elevation,	$L_{slm} =$	$L_{sl} / [1 + 0.0003 \times \text{MSL}]$	
	kg/ha/day	=166.88	Equation for elevation correction
<b><u>B. Based on temperature</u></b>			
BOD loading rate from temperature consideration is given by			
	$L_{st} =$	$350 \times [1.107 - 0.002T]^{(T - 25)}$	
	kg/ha/day	=182.55	NRCD Manual equation 4.8
<b><u>Adopted BOD value</u></b>			
As per recommendation furnished in section 4.4.2 of the NRCD design manual for design of WSP in India, the BOD loading rate as worked out from Temperature consideration is adopted.			
Permissible BOD loading	kg/ha/day	182.55	Adopted

<b><u>Calculation of Pond Dimensions</u></b>			
Pond area required , $A_f = (10 \times L_i \times Q)/L_s$	m <sup>2</sup>	1178	NRCD Manual equation 4.4
Provided depth, D	m	1.5	Range of depth 1 m to 2 m
Retention time of Facultative Pond (t)	day	$(2 \times A_f \times D)/(2 \times Q - 0.001 \times A_f \times e)$	
	day	7.18	NRCD Manual equation 4.12
Adopt retention time	day	7.20	Adopted as temperature < 20°C
As it is recommended in the manual, A minimum value of Tf of 5 days should be adopted for temperatures below 20°C and 4 days for temperatures above 20°C.			
Adopted area	m <sup>2</sup>	1181	NRCD Manual equation 4.12
One no. facultative pond are provided	m <sup>2</sup>	1181	
The BOD removal in d facultative pond system is assumed to be 75 %, n			
Hence effluent BOD	Lef =	$(1 - n) \times L_i$	
	mg/l	45	
<b><u>Design of Maturation Pond</u></b>			
<b><u>Fecal coliform removal</u></b>			
Maturation ponds in the waste stabilization process are normally provided to bring down the influent coliform count to acceptable limit for disposal into natural system or reuse of effluent for irrigation. Hence, under the sizing done for the maturation pond, detention time as recommended by the WSP manual has been provided.			
<b>For a series of Septic, Facultative and Maturation pond</b>			
Number of maturation ponds	No	1	option 1
	No	2	option 2
	No	3	option 3
Fecal coliform count in effluent is given by	Ne =	$N_i / (1 + K_t \times T_a)(1 + K_t \times T_f)(1 + K_t \times T_m)^n$	NRCD Manual equation 4.14
No of Fecal coliform in effluent (Ne)	Per 100 ml	1000	
No of Fecal coliform in influent (Ni)	Per 100 ml	1400000	

First order BOD rate constant Kt at 16°C	per day	1.30	Refer equation 4.15
Retention time in anaerobic Pond (Ta)	day	1	As adopted earlier
Retention time in Facultative pond (Tf)	day	7.20	As adopted earlier
<b>Calculation Retention time in Maturation Pond (Tm)</b>			
Retention time in maturation pond is given by			
$T_m =$	$\left[ \left( \frac{N_i}{N_e} \times (1 + K_t \times T_a) \times (1 + K_t \times T_f) \right)^{1/n} - 1 \right] / K_t$		
Retention time in Maturation Pond For n = 1	day	11.97	
Retention time in Maturation Pond For n = 2	day	2.36	
Retention time in Maturation Pond For n = 3	day	1.19	
Adopted retention time, Tm For n=2	day	<b>3.00</b>	NRCD Manual recommends
Hence, providing 2 nos. of Maturation Pond in parallel with 3 days retention time.		3	a minimum of 3 days detention time if the Temperature is for temp. < 20°C
Inflow to the pond $Q_{im1} = (Q - 0.001 \times e \times A_f)$	m <sup>3</sup> /day	294.84	NRCD Manual equation 4.11
			considering negligible seepage
Assumed depth (m)	m	1	Range being 1 to 1.5 m
BOD loading of the first Maturation Pond	Lsm1 =	$(10 \times 0.25 \times Li \times D) / T_m$	
	kg/ha/day	150.000	NRCD Manual equation 4.16
With the consideration that 75% BOD has been removed in the series of Septic Tank and Facultative Pond		150.000	this BOD loading is less than permissible BOD Loading as per table 4.3 in NRCD's Manual, i.e. 182.56 and hence 150 at 16 ° is acceptable

Area of first Maturation Pond is given by	$A_{m1} = (2 \times Q_{im1} \times T_m) / (2 \times D + 0.001 \times e \times T_m)$		
<b>Area of first Maturation Pond</b>	m <sup>2</sup>	724	Refer equation 4.18
The effluent flow is given by: $Q_e = Q_i - 0.001A_{m1}e$	m <sup>3</sup> /day	239.48	
<b>Similarly the area of the second maturation pond and its effluent flow are given by :</b>			
<b>Area of second Maturation Pond</b>	m <sup>2</sup>	713	
Q <sub>e</sub>	m <sup>3</sup> /day	235.9	
% Evaporation Loss		1	
with the consideration that 75% BOD has been removed in the primary system of Septic tank and Facultative pond and further 25% removal in Maturation Pond			
The final effluent BOD	Le =	$L_i \times 0.25 \times 0.75 \times 0.75$	
The final effluent BOD	mg/l	25.31	< Permissible value of 30 mg/l
Permissible BOD loading for disposal to inland surface water	mg/l	30	<b>Meeting Stipulated Standard</b>

Check for Fecal Coliform			
	$N_e = N_i / [(1 + K_t \times T_a)(1 + K_t \times T_f)(1 + K_t \times T_m)^n]$		
	N <sub>e</sub> =	2467.12	
<b>Thus for unrestricted irrigation, the mid depth area requirements are:</b>			
Facultative Pond, 1 no.	m <sup>2</sup>	1181.0	
First Maturation Pond	m <sup>2</sup>	723.9	
Total Area Required	m <sup>2</sup>	2618.0	Total Land Area Required <b>3272.4</b> <b>52</b>

**Table 4.7 Design steps of waste stabilization ponds**

### 4.12.3. Design of Sludge Disposal System

Present population of Village Tasoli (Year 2012)	=	1435		Nos.
	=	229		Material of Sewer
Population per house	=	6.27		
Design Population of Village (2042)	=	1938		

Expected future houses with 20% increase	=	275		
Average cleaning period of I.C	=	2		
Avg. number of Cleaning days in a year	=	250		
No. of IC to be cleaning daily	=	275		
		2 X	250	
		1		
Avg. liquid in one I.C.	=	1500		
Daily sludge	=	1500		
	=	1.5		
Considering Sludge for 3 days shall be put into 1 sludge drying bed &				
Depth of application	=	0.3		
Area of SDB Required	=	1.5	x 3	
		0.3		
	=	15		
Size of sludge Drying Bed Proposed	=	4 m X 4 m		
Average drying cycle	=	8 Days		
No of Bed Required		4		
Hence provided 4 nos. of Sludge Drying Beds, each of size 4mx4m		19.2		

**Table 4.8 Design steps of sludge disposal system**

Quantity of sludge	=	0.06 m <sup>3</sup> /person / year	
(Ref. page 77, Low cost urban Sanitation, Duncan Mara)			
Daily sludge	=	2582 X	0.06
		365.00	
	=	0.42	
Storage period	=	15.00	
Vol. of sludge to be stored on platform	=	15.00	X 0.42
	=	6.40	
Depth of sludge heap	=	1.00	
Area of platform required	=	6.40	
Size of Curing Platform	=	1.8 m X 3.6 m	
Provide a 1 No. of platform of Size 1.8 m X 3.6 m which shall also facilitate overturning /mixing of sludge			

**Table 4.9 Design steps of sludge curing platform**

## CHAPTER 5

### EXECUTION PROCESS

#### 5.1 MATERIAL USED DURING CONSTRUCTION PHASE

**Interceptor Tank:** These are commonly constructed of brick, concrete and plastered inside for better finish. The base of tank is usually 100 mm. Many a times pre constructed concrete tanks are also used.

**Pipes:** PVC pipes are quite popular option. These are most commonly made of thermoplastic PVC etc. It is more advantageous because of longer length and ease in laying. They are quite light in weight so transportation too is not a problem. They are easily operable in field. They can be outfitted and joined easily in field with help of elastomeric gasket and rubber seal. This further reduces the risk of leaking joints.

**Cleanouts and manholes:** These can be made up of pvc and are usually occurring in standard shapes and sizes. Other options include plain cement concrete pre casted boxes of circular or rectangular shapes.

#### 5.2 CONSTRUCTION PHASE

##### **Interceptor Tank:**

- The most important thing to be taken care of is its location. They should be such located so that they can be easily reached for cleaning. In addition to this these tanks should be away from vehicular traffic as mostly the covers are not strong enough to take vehicular loads.
- The lids/ cover should be properly sealed as any filtration could cause blockage. For sealing and water/ dust proof sealing may be used.
- Tanks should be kept on undisturbed base. If the soil beneath is soft or yielding, crushed rocks or bricks with cement mortar could be used. At the same time during back filling large stone, organic material or any other unsuitable material should be avoided and should be tempted properly.

**Sewer connection:** The connection should be such that the connection from the pipe top main should be made with Tee fitting for making leak proof. Any overflow material will lead to blockage.

**Installation of Sewer:** Procedure for installation of small bore sewer is somewhat similar to conventional sewer. Usually the sewer laying begins at treatment and disposal facility and is gradually moved upstream.

- Initial Layout: Before starting of work right of ways, working area, clearing limit, pavement should be marked to protect adjacent properties. Access roads, barricading etc. should be taken care of advance to avoid any last minute hitch.
- Setting up of line and grade: The designer should initially set the line along which the sewer would be laid. Centre line process should be followed. All the high points should be marked and no higher point should be above the last downstream line.
- Excavation: While excavating one of the most important point of concern is to protect utilities or properties. They should be contacted before excavation. Since excavation in small bore system is not much, hence over excavation or high gradient different is not a major point of concern. Also fear of land slide / wall slide is not a major issue. The pipes can even be joined and laid in the trench if the pipes are being used of plastic or pvc as they are light in weight.
- Bedding / back filling: The pipe must be embedded in well compact bedding material. The soil being used should be well graded to avoid any loosening of soil in later case by minimizing the pore spaces. Back filling should be free from bio / organic waste, rubbish, large pieces of stone.
- Marking of pipes: after the pipeline is embedded, proper marking should be done so that the pipe can be easily located in future. This can be done with help of special colored stones and tracer wires also can be used below ground along with pvc pipe. As pvc pipe is made of plastic and is not deducted by instruments.

### **5.3 MAINTENANCE**

Routine Maintenance of Small bore sewer requires little maintenance and repair work. However, routine maintenance by cleaning interceptor tank is must. This is required so as to avoid any solid matter, which is settled, from avoiding entering the pipe lines. In routine flushing has not been found of any importance. However, periodic flushing like after rainy season can be done to avoid/ prevent any blockage.

### **5.4 ADMINISTRATION**

- Small bore sewer should be operated and maintained by local agencies. This is because they would be having easy access to call the households. They could keep an easy watch if all the households are following the set norms for easy operations. Regular cleaning of tanks can be easily monitored by any such local agency. Also any local blockages/ leakage could be quickly treated so as to avoid any bigger problems. Tanks throughout the habitations can be cleaned in one go with help of pumping

trucks and record can be easily maintained by local agency. However small amount of solids should be lifted inside the tank so that it act as a imitator / seed for fresh sludge.

- In case blockage occurs, pipes should be flushed. The flushing should be done from upstream to downstream with each pipe length being flushed successfully. However, if flushing is not successful, then a particular portion of pipe line can be replaced. This is quite easy in case the pipes are of uPVC and this is an added advantage.
- Flow monitors can be established at the downstream terminal ends.. These can be used to take an idea if there is blockage along the pipe length. Also the quality of inflow can be checked.

## **5.5 QUALITY CONTROL PROCEDURE FOR SANITATION WORKS**

### **5.5.1 Excavation in Trenches For Laying of Sewers**

Excavation for sewer trenches for laying sewers shall be in straight lines and to the correct depths and gradients required for the pipes as specified in the drawings. The material excavated from the trench shall not be deposited very close to the trench to prevent the weight of the materials from causing the sides of the trench to slip or fall. The sides of the trench shall, however, be supported by shoring where necessary to ensure proper and speedy excavation. In case, the width of the road or lane where the work of excavation is to be carried out is so narrow as to warrant the stacking of materials near the trench, the same shall be taken away to a place to be decided by Engineer-in-Charge. This excavated material shall be brought back to the site of work for filling the trench.

### **5.5.2 Laying of Sewers**

In laying sewers, the centre of each manhole shall be marked by a peg. Two wooden posts 100mm x 100mm x 1800mm high shall be fixed on either side at nearly equal distance from the peg or sufficiently clear of all intended excavation. The sight rail when fixed on these posts shall cross the centre of manhole. The sight rails made from 250mm wide x 40 mm thick wooden planks and screwed with the top edge against the level marks shall be fixed at distances more than 30m apart along the sewer alignment. The centre line of the sewer shall be marked on the sight rail. These vertical posts and the sight rails shall be perfectly square and planed smooth on all sides and edges. The sight rails shall be painted half white and half black alternately on both the sides and the tee heads and cross pieces of the boning rods shall be painted black. When the sewers converging to a manhole come in at various levels there shall be a rail fixed for every different level.

The boning rods with cross section 75mm x 50mm of various lengths shall be prepared from wood. Each length shall be a certain number of meters' and shall have a fixed tee head and fixed intermediate cross pieces, each about 300mm long. The top edge of the cross pieces shall be fixed at a distance below the top edge equal to, the outside dia, of the pipe, the thickness of the concrete bedding or the bottom of excavation, as the case may be. The boning staff shall be marked on both sides to indicate its full length. The posts and the sight rails shall in no case be removed until the trench is excavated, the pipes are laid, jointed and the filling is started.

The stoneware pipes shall be laid with sockets facing up the gradient, on desired bedding. Special bedding, hunching or encasing may be provided where conditions so demand. All the pipes shall be laid perfectly true, both to line and gradient. (IS: 4127-1983). At the close of each day's work or at such other times when pipe is not being laid, the end of the pipe should be protected by a close fitting stopper.

### **5.5.3 Hydraulic Testing Sewers**

Each section of sewer shall be tested for water tightness preferably between manholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete cradle, partial covering of the pipe is not necessary.

In case of concrete and stoneware pipes with cement mortar joints, pipes shall be tested three days after the cement mortar joints have been made. It is necessary that the pipelines are filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall. The sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock. The water is filled through a funnel connected at the end provided with a plug. After the air has been expelled through the air outlet, the stop cock is closed and water level in the funnel is raised to 2.5 m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and the quantity of water required to restore the original water level in the funnel is determined. The pipe line under pressure is then inspected while the funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on the pipe surface is permitted). Any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again. The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 liters/mm dia. of pipes per kilometer

length per day.

#### **5.5.4 Backfilling of Trenches**

Backfilling of the sewer trench is a very important consideration in sewer construction. The method of backfilling to be used varies with the width of the trench, the character of the material excavated, the method of excavation and the degree of compaction required. In developed streets, a high degree of compaction is required to minimize the load while in less important streets, a more moderate specification for back fill may be justified. In open country it may be sufficient to mound the trench and after natural settlement return to regard the areas.

No trench shall be filled in unless the sewer stretches have tested and approved for water tightness of joints. However, partial filling may be done keeping the joints open to avoid disturbance. The refilling shall proceed around and above the pipes. Soft material screened free from stones or hard substances shall first be used and hand pressed under and around the pipes to half their height. Similar soft material shall then be put up to a height of 30cm above the top of the pipe and this will be moistened with water and well rammed. The remainder of the trench can be filled with hard material, in stages, each not exceeding 60cm. At each stage the filling shall be well rammed, consolidated and completely saturated with water and then only further filling shall be continued. Before and during the backfilling of a trench, precautions shall be taken against the floatation of the pipe line due to the entry of large quantities of water into the trench causing an uplift of the empty or the partly filled pipe line. Upon completion of the backfill, the surface shall be restored fully to the level that existed prior to the construction of the sewer.

### **5.6 CORROSION PREVENTION AND CONTROL**

#### **5.6.1 General**

Corrosion is phenomenon of the interaction of a material with the environment (water, soil or air) resulting in its deterioration. There are many types of corrosion, major types being galvanic, concentration cell, stray current, stress and bacterial. Wastewater collection and treatment systems are more prone to corrosion in view of the nature of the wastewater. Since wastewater contains solids which are more likely to cause abrasion in sewers, pumps and their components thus removing the protective coating and accelerating the corrosion process, corrosion control becomes all the more important in wastewater systems. It is particularly acute in areas where sewage strength is high, sulphate content of water is substantial and average temperature is above 20° C.

### **5.6.2 Sewer-Protection**

Protection of sewer structures by coating against H<sub>2</sub>S attack can also be considered if other methods of control are impracticable.

### **5.6.3 Liners**

A plastic polyvinyl chloride sheet, having T-shaped protections on the back which key into the pipe wall at the time of manufacture is one of the successful lining materials. Vitrified clay of low porosity has also been used as a liner. In regions where high sulphides and high production of H<sub>2</sub>SO<sub>4</sub> can be expected, problems still remain. Cement mortar joints are subject to attack. Bituminous are emulsified and dissolved by soaps, oil and grease. Acid cement joints offer the best protection but they are costly. Some type of plastic coatings and/or linings for sewers and other structures have proved moderately successful, given continued inspection and maintenance. The function of these linings is to isolate the concrete from the corrosive atmosphere. To be effective, the lining including joints must be sealed completely to protect the sewer system throughout its expected life.

The interior of cast iron and ductile iron pipe usually is lined with cement mortar. Steel pipe sometimes is lined similarly. Smooth walled steel pipe also may be protected by cementing plasticized polyvinyl chloride sheets to the pipe and sealing the joints. Corrugated metal pipe may be coated inside and out with bituminous material. For added protection, asbestos fibers' may be embedded in the molten zinc before it is bituminous coated (Asbestos bonded). Such coatings should be of impermeable material of sufficient thickness and free of flaws such as pin holes.

### **5.6.4 Protective Coatings**

Any protective coating used should possess the following qualities:

- It should be resistant to acid attack.
- It should bond securely to the concrete.
- It should be economical.
- It should be resistant to abrasive action by flow of sewage, and when applied.
- It should be thin enough to fill all pores and irregularities in the surface.
- The coating should be continuous with no pin holes or other breaks

The effectiveness of a coating thus depends on its inherent resistance to acid attack and also on its ability to form impervious membrane. In practice, coating can apply without discontinuity. Inspection and maintenance must be periodical. Plastic-base paints and coal tar epoxy coatings have proved to be good.

### **5.6.5 Sewage Pumps**

For pumps and pumping equipment, proper materials selection is of paramount importance. The pump casing is normally of close grained cast iron capable of resisting erosion on account of abrasive material in the waste. For handling sewage and other corrosive wastes, the impeller is generally made of high grade phosphor bronze or equivalent materials. The wearing rings for impeller should be of good corrosion resistant materials such as bronze. The shafts are normally made of high tensile steel and replaceable shaft sleeves are recommended.

For pump and pumping equipment, painting is the usual protective measure. Both the interior and exterior surfaces of pumps should be painted after rust scale and deposits are removed by sand blasting, wire brushing or rubbing with sand paper.

# **CHAPTER 6**

## **ENVIRONMENT ASSESSMENT & MANAGEMENT**

### **6.1. INTRODUCTION**

Environment refers to the surrounding of a man or organism in which he lives. Environment Pollution is an undesirable change in the physical, chemical and Biological characteristics of Air, Water and Soil that may harmfully effects on the life or creates a potential health hazard to any living organism.

In the project of Providing Sewerage System in TASOLI Village, the main source of Pollution is the domestic sewage. Untreated waste water/sewage is the cause of many diseases and contaminates underground water.

Under this Scheme the human excreta and other kitchen and bathroom liquid waste will be collected in septic tank/ICs. Septic tank/ICs in each house will be provided by the users. After septic tank/ICs, the solid free effluent will be carried to the Sewage Treatment Plant through the sewer lines. Sewage Treatment Plant will be provided outside the village. The sewage treatment plant is based on waste stabilization pond technology consisting of Facultative & Maturation Ponds. Waste Stabilization ponds are quite suitable for Indian conditions and much cheaper than other waste water treatment technologies. In this pond putriscible organic matter in the waste is stabilized in the pond through symbiotic relationship between bacteria and algae. In this pond the BOD removal is upto 90% and coliform removal is upto 99%. Proposed project contributes in overall environmental improvement of village by scientific disposal of wastewater reducing risk of overall public health impact. No significant and irreversible negative impact is anticipated due to construction and implementation of project.

The study of environmental impact for the proposed sewerage system in the village will be highly useful in:-

- i) Assessing the durability of the sewerage system.
- ii) Making the structure more economical.
- iii) Planning for better construction management.
- iv) Planning for sewerage system to meet the requirements of the future also.

### **6.2. EXISTING ENVIRONMENTAL PROFILE**

Existing environmental data could be assessed from the existing conditions of the village. Village has some of the *Katcha* streets and some of them lined with brick/concrete. Brick/concrete lined streets have partly or fully developed side drains. Liquid waste from

houses as well as rainwater runoff leads to depressions called village pond. There is organized water supply system but no sewerage system or solid waste management system. Since literacy rate is improving and overall people are fast becoming conscious of developing good environment. After reviewing the existing environmental conditions due care has been taken to consider the following points in to design aspects:

- No suitable disposal mechanism of effluent from households resulting contamination of local depressions and village ponds.
- Although no major outbreak of water borne disease in the past reported by community, but potential of threat is very high.
- Topography of the area is almost flat.
- No critical parameter in groundwater reported.
- Sewage Treatment Plant site is located suitably from environmental point of view.

### **6.3. CONSTRUCTION STAGE ENVIRONMENTAL ISSUES**

It includes potential impacts, mitigation measures which are summarized as below:

<b>Parameter</b>	<b>Issue</b>	<b>Mitigation measure</b>
Water availability	N.A	NA
Water quality	Contamination of shallow ground water due to seepage through lining of ponds.	Monitoring of water quality from the nearest Hand-pump/Tube-well shall be carried out quarterly to check the ground water contamination. Provision of LDPE Lining sheet (0.75 mm thick) conforming to BIS 3873 in facultative and maturation ponds to avoid any percolation to ground. The treated effluent will be discharged into the agricultural fields and to available nallah adjacent to STP site. After achieving the characteristics as per norms prescribed by State Pollution Control Board. Hence the effluent will

<b>Parameter</b>	<b>Issue</b>	<b>Mitigation measure</b>
Sanitation	<p>1. Unsafe disposal of waste water through open surface drain leading to stagnation in the lanes.</p> <p>2. Blocking of existing open drains during excavation for laying of sewage pipes.</p> <p>3. Quality of disposal of effluent</p> <p>4. Disposal of sludge.</p>	<p>1. Small Bore sewer system is being proposed for eliminating the environmental and public health hazards associated with open drains system. The villagers will be advised for properly cleaning of the existing open drains which will carry out the rainy water towards the existing ponds.</p> <p>2. Constructing agency will be directed to take preventive measures to avoid blockage.</p> <p>3. The waste water will be treated in the Sewage Treatment Plant. After treatment the effluent will be discharged into nearby agricultural fields and to available nallah adjacent to STP site after achieving the characteristics prescribed by the State Pollution Control Board. The quality of effluent will be monitored regularly.</p> <p>4. The sludge being generated from septic tanks and inspection chambers shall be transferred to sludge drying beds through tankers and after composting will be converted into organic manure. The organic manure will be used for agriculture purposes after testing from Punjab Agriculture University.</p>

Parameter	Issue	Mitigation measure
	5. Chemical use and pest management	<p>The operation and maintenance will be carried out by the contractor initially for five years who has expertise in such a field and have skilled labour to handle the sludge.</p> <p>5. No chemical or pesticide will be used in the treatment process. However, the pesticides shall be used as per allowable list prepared and adopted by Agriculture Department/State PCBs. No pesticide which is in list of “not to be used” by these departments shall be used to control mosquitoes and flies etc.”</p>
Construction	Hindrane created during construction activities and safety measures provided.	<p>Construction work will be carried out on Panchayat land as per proper site plan after taking all safety measures to avoid any interruption to residents. Sign boards, barbed wire fencing etc. shall be used by contractor during construction work. Construction agency will also be advised to provide temporary approaches along with direction signs to avoid accidents and inconvenience to the villagers.</p> <p>Proper Barbed wire fencing will be provided around the STP to prevent the entry of public/ children. The contractor is fully bound by the labour laws as described in the bid document to safeguard the interest of the labour.</p>

<b>Parameter</b>	<b>Issue</b>	<b>Mitigation measure</b>
Disposal of construction wastes	Earth disposal	Disposal earth will be used at treatment site for making embankments and for filling low laying areas of village if any. The Contractor shall follow the mitigation measures as described in the Bid document.
Odor and Mosquito Nuisance	Site Selection of STP	Site has been selected on the out skirts of village
Disposal of Treated Wastewater	Water Logging, Acceptability for Irrigation Use, Suitable Disposal Site Availability. Effluent quality.	Utilized for irrigation purpose and discharged in to nallah adjacent to STP site during rainy season.
Disposal of Sludge	Odor, Insects and mosquito breeding, ground water quality deterioration, public health.	Provision of Sludge drying beds and composting.
Cattle Waste	Chocking of drains	Solid waste will be separated at household level and disposal will be done separately through GPWSC under solid waste management scheme.

**Table 6.1 Anticipated environmental issues & mitigation measures during implementations**

#### **6.4. WASTE WATER TREATMENT & ITS IMPACT ON ENVIRONMENT**

Proper treatment of waste water before its final disposal is necessary to avoid spread of Water borne diseases and adverse affect on underground water, health and natural eco system. Main parameters for treating sewage are as mentioned below:

- B.O.D. (Biochemical Oxygen Demand)
- C.O.D. (Chemical Oxygen Demand)
- T.S.S. (Total Suspended Solids)
- pH
- Fecal coliform
- Total Nitrogen

- Total Phosphorous

## 6.5. ENVIRONMENT MANAGEMENT PLAN DURING OPERATION & MAINTENANCE OF SCHEME

S. No.	Project Activity/ Environmental Issues	Mitigation Measure	Monitoring Frequency
1	2	3	4
1	Sewer condition Assessment	Routine inspections of sewers and inspection chambers	Quarterly
		Regular cleaning of inspection chambers (removal of blockages, debris, etc.) shall be ensured.	once in two – three years)
		Inspection Chambers/manholes, leakage in sewers	Yearly(Interception Chamber quarterly)
2	STP	In case of stabilization ponds, <ul style="list-style-type: none"> <li>– Its characteristic changes in colour and odour shall be observed.</li> <li>– The ponds shall be cleared of floating mats of algae at the corners and sides.</li> <li>– All marginal growth of weeds and vegetation shall be removed. It also helps prevent mosquito breeding.</li> </ul>	Half Yearly
3	Tree Plantation	Routine maintenance of plants shall be organized.	Weekly
4	Influent characteristics	pH, TSS, BOD, COD, Total Nitrogen, Total Phosphorus, Fecal Coliform	Quarterly
5	Effluent characteristics	pH, TSS, BOD, COD, Total Nitrogen, Total Phosphorus, Fecal Coliform,	Quarterly
6	Industrial waste discharge, if any	Checking of pretreatment of waste and its characteristics	Monthly
7	Sludge and compost Quality	pH, BOD, COD, Sodium, Nitrogen, Phosphorous and Fecal coliforms,	Half Yearly

**Table 6.2 Environmental management plan**

## CHAPTER-7

### SUGGESTIONS& TROUBLESHOOTING

Problem can develop with pond system in spite of their relative operational simplicity, and these can cause a reduction in operational efficiency, nuisance, and/ or damage to the system. Many of these problems can be avoided or minimized by good design, and the rest can be prevented if good operational control is maintained. The following is a list of possible problems and solutions commencing with those likely to occur during start – up. Table 7.1 shows various problems that were faced during the construction of sewer system and various steps that were taken to resolve such problems.

S. No.	Problem	Solutions
1	Odour during start – up anaerobic ponds	(a) If pH below 7, add lime (preferably as slurry) at inlet to anaerobic pond. (b) If dissolved oxygen present in pond increase loading rate to maintain anaerobic conditions. (c) Use straw or polystyrene etc., to help establish a good scum mat.
2	High rate seepage during early stages of pond operation	Under most circumstances ponds will eventually seal themselves. If this does not occur and high seepage persists, ponds will require draining and sealing with impermeable soil or plastic membrane. Alternatively, expensive sealing clay such as “Volclay” may be added to the pond.
3	Vegetation growth as ponds are filled	All vegetation should be removed from the pond bottom before filing. Final pond liquid depth should be greater than 1 m. Ponds should be filled as rapidly as possible. Any vegetation growing through water surface during filling should be removed from a boat.
4	Poor algal development during start up	Check nature of discharges to ponds, particularly from industrial / commercial concerns. Algal inhibition may be due to poor nutrient balance or toxic compounds in influent Pretreated wastewater concerned before discharge to sewerage system.
5	Development of algal scum on facultative and maturation ponds	Break up scum (usually blue – green algae) with water jets or from boats. In extreme and persistent cases, copper sulphate may be added to give approximately a

S. No.	Problem	Solutions
		1 mg/l solution in the pond concerned. Scum removed from ponds and dried should be applied to grass embankment or buried.
6	Vegetation of Water's edge	Weeds will be removed and uprooted mechanically with a Hoe and then raked out of the pond.
7	High vegetation growth on embankment.	Periodic mowing or bushing is best control method. Grazing animals may be used but will also add organic material and fecal bacteria to the ponds systems.
8	Vegetation growth through pond surface	Increase pond depth or loading rate to shut light off pond bottom. Remove care should be taken to avoid damaging pond seal when removing clumps of weeds. Remove any sludge banks causing shallow areas.
9	Burrowing animals or insects in embankments	Plug holes as they occur, remove any animal food supply going close to ponds. Trap or poison animals if necessary; spray insects.
10	Fly or mosquito nuisance	<p>The nuisance caused by mosquitoes can be controlled by</p> <ul style="list-style-type: none"> <li>• Of all the biological control methods, the use of larvivorous fish (Species Gambusia and Guppy) has been the most successful in stabilization ponds in many parts of India. Development of bat habitat around stabilization pond is also effective method for reducing adult mosquitoes and other flying insects.</li> <li>• Under chemical control measures, larva sides and other insecticides/pesticides recommended by local Malaria Department / registered under Environmental Protection Agency (EPA) such as Mathoprene, Malathionetc will be used.</li> <li>• Similarly, approved aduenticides by local Malaria Department under organophosphates</li> </ul>

S. No.	Problem	Solutions
		<p>group will be fogged and sprayed with truck mounted Ultra Low Volume (ULV) spray posing unreasonable risk to human health or environment.</p> <p>Proper maintenance of pond is essential to avoid flies. Chironomous larvae or look worms are often found in stabilization ponds seasonally. Removing floating matter along with its egg masses from the corners and sides of the ponds and weed clearance help to remove entrapped egg masses.</p>
11	High algal concentration if effluent flowing to the receiving stream	Draw off effluent from below the surface or wherever algal population is low (may vary). Use horizontal rock filters.
12	Lightly loaded ponds causing waste of space and dominance of filamentous algae causing algal mats	Use fewer ponds but beware of effect on final effluent quality particularly with regard to increased fecal bacteria concentration.

**Table 7.1 Various problems faced during construction process**

## **CHAPTER-8**

### **CONCLUSION**

Village Tasoli located near Patiala was selected for study & execution of Small bore sewer. This was very much required as current sanitation conditions of the village are not satisfactory. Although most of the houses have their own septic tanks, but there is no proper disposal of effluent coming from septic tanks. Both side drains of village roads are flooded with wastewater generated by households. Pool of this wastewater poses public health at high risks. The *Panchayat* of village showed their willingness to contribute towards the execution of the sewer by giving land area for STP and mobilizing village population by motivating them to opt for household sewer connections.

During design various aspects of rural population were considered. The water consumption per head was taken between 70 – 120 LPCD. PVC pipe 160 mm dia were used for reducing infiltration and corrosion. In the project of Providing Sewerage System in TASOLI Village, the main source of Pollution is the domestic sewage. Untreated waste water/sewage is the cause of many diseases and contaminates underground water. The Small bore system helped in managing Wastewater of the houses. The daily discharge from household activities was running into open drains of village, is now systematically being transported to STP. Many a time drains get clogged and the water being discharged from houses overflows and run into open drains and clogging was very common. Earlier the waste water was being discharged into open ponds or *Chappar*, as they are locally called, which seeps through these ponds & deteriorates the groundwater table, thus polluting the ground water & the same gets entered in to food cycle through direct intake or by means of irrigation of crops in the fields. Now, after execution of project, waste water is being treated at STP and treated water is being used for irrigation purposes in the fields. Under the Scheme, human excreta & other waste will be collected in septic tank/ICs provided by the users. From here, the solid free effluent will be carried to Sewage Treatment Plant through sewer lines. The mobilization that was involved to make people aware about the benefits of sewer has greatly helped in curbing the practice of open defecation. People were motivated to construct and use in- house toilets. This helped in making village open defecation free.

Proposed project contributes in overall environmental improvement of village by scientific disposal of wastewater reducing risk of overall public health impact. No significant and irreversible negative impact is anticipated due to construction and implementation of project.

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