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WASTEWATER COLLECTION SYSTEM OPERATION AND MAINTENANCE

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WASTEWATER COLLECTION SYSTEM OPERATION AND MAINTENANCE

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WASTEWATER COLLECTION SYSTEM OPERATION AND MAINTENANCE

Table of Contents

WASTEWATER COLLECTION SYSTEM OPERATION AND MAINTENANCE

1.0 INTRODUCTION

This publication describes the operation and maintenance requirements for a wastewater collection system.

The descriptions and procedures in this publication are intended for band maintenance workers and supervisors. They do not replace instructions provided by site specific operation and maintenance manuals, but form a supplement to them.

The purpose of a wastewater collection system is to convey wastewater (sewage) to a treatment facility. This should be carried out in a way that both protects the health of the community, and is a minimum environmental hazard.

Wastewater, or sewage as it is commonly called, is the domestic waste from a community. It contains human waste products, as well as food and cleaning wastes from households.

Although wastewater is about 99% water, a small portion is solid waste products, consisting mostly of organic material. This organic or biodegradable material will decay or decompose.

In addition to this organic material, wastewater also contains oxygen and many bacteria. This is very important, because the bacteria in the wastewater will use the organic material as a food source and thus decompose it. This is the basic principle used in sewage treatment plants.

2.0 SEWAGE DECOMPOSITION

2.1 General Remarks

The treatment or decomposition of the organic wastes in wastewater takes place in a sewage treatment plant. It is useful for a wastewater collection system worker to understand some of the basic principles involved, because they may affect conditions in the sewers.

There are two ways that wastewater will decompose. These are:

a. aerobic decomposition, and
b. anaerobic decomposition.

2.2 Aerobic decomposition

As shown in Figure 1, aerobic bacteria in the wastewater decompose the organic material, while using some of the oxygen present. The products formed from aerobic decomposition are water, carbon dioxide (which is a harmless gas), and more bacteria. More bacteria are formed as they are using the organic material as food to grow and reproduce.

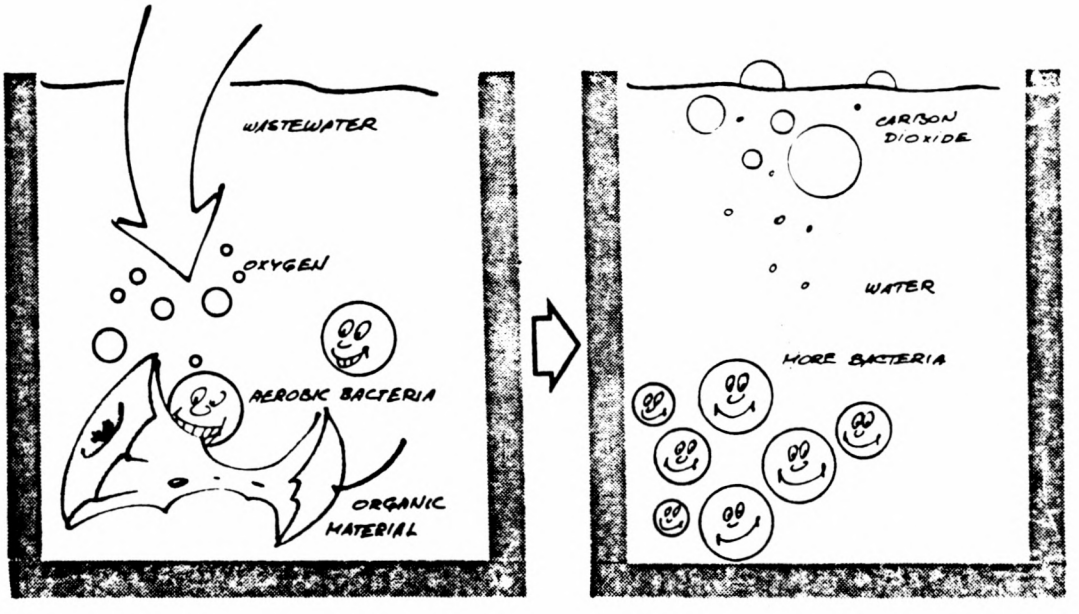

Fig. 1 Aerobic Decomposition

2.3 Anaerobic Decomposition

As shown in Figure 2, anaerobic bacteria in the wastewater decompose the organic material, but do so without oxygen.

The products formed from anaerobic decomposition are carbon dioxide, as well as foul smelling and dangerous gases such as methane and hydrogen sulphide. Additional anaerobic bacteria are also formed.

Because these gases are poisonous, explosive, and produce foul odours, anaerobic conditions should be avoided. Anaerobic conditions are also referred to as septic conditions.

It is important to avoid septic conditions in the wastewater collection system. This is discussed later in section 8.0.

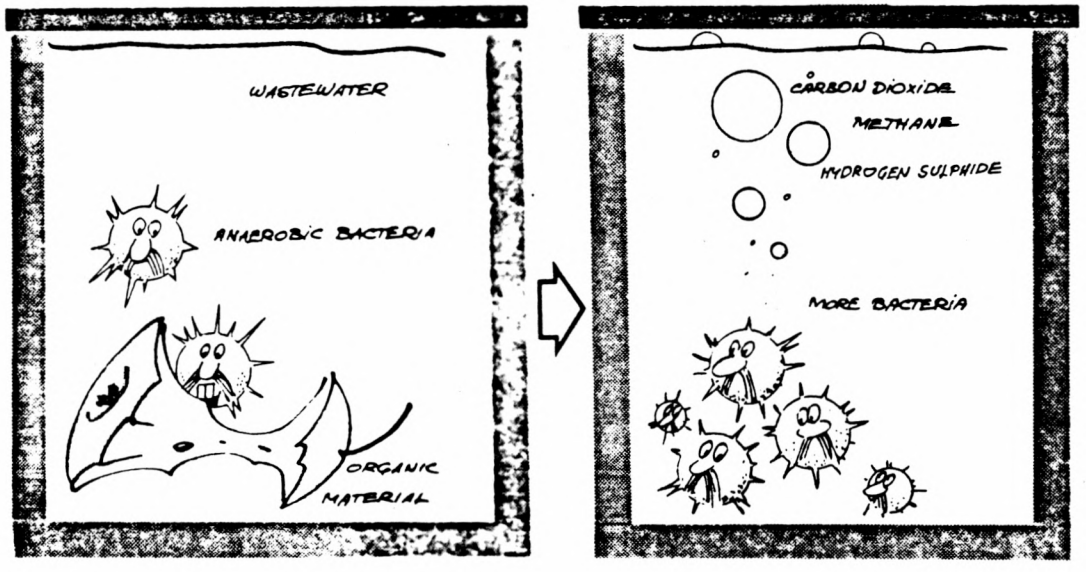

Figure 2 Anaerobic Decomposition

3.0 COLLECTION SYSTEM COMPONENTS

3.1 Sewer Mains and House Connections

As shown in Figure 3, domestic wastes are carried from houses and other buildings in a community through a small pipe called a house connection or house service. They flow from the house connection into the sewer main, which is a pipe with a larger diameter. The wastewater flows through the main (or a series of mains) to the sewage treatment plant.

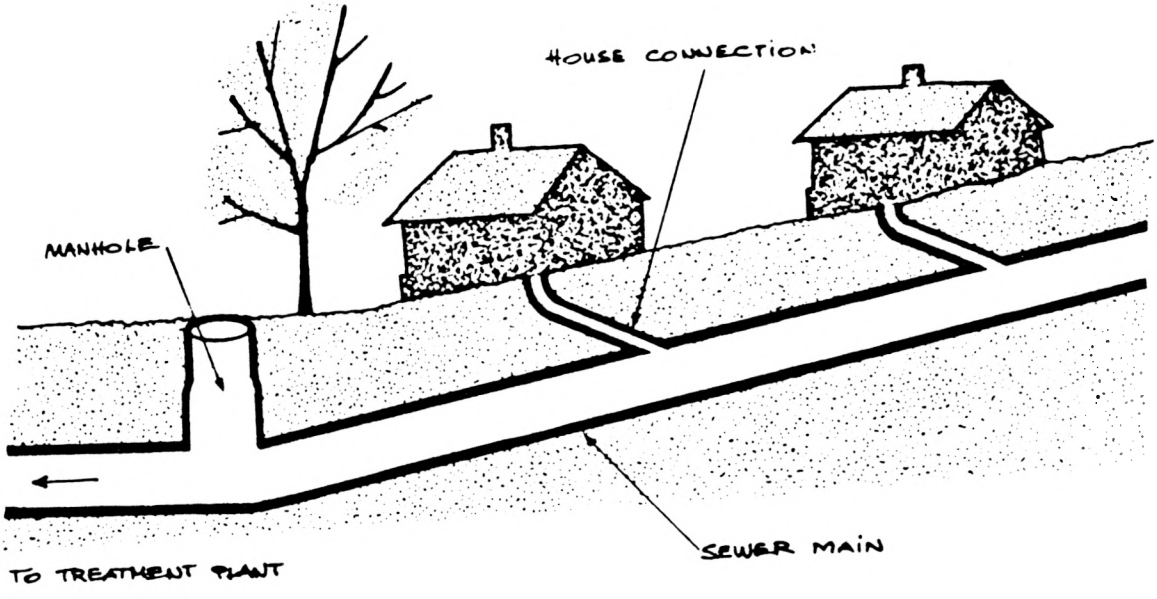

Figure 3 Sewer Mains and House Connections

3.2 Manholes

Manholes are access chambers to the sewer which permit cleaning and inspection. Manholes are always placed whenever the sewer changes direction, elevation or slope, and at regular intervals along straight sections of mains (generally about every 100 m.).

3.3 Cleanouts

Cleanouts are often installed in collection systems (see Figure 4) as a means of removing any debris that might block the house service. If the service pipe becomes plugged, access is provided through the cleanout to remove the obstruction.

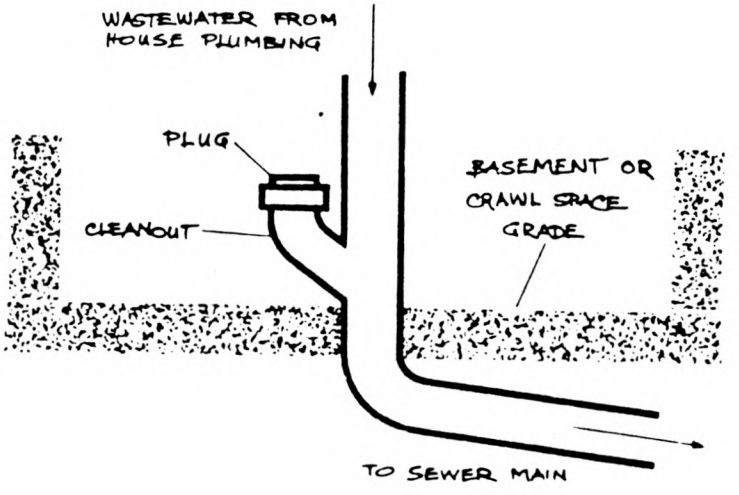

Figure 4 Cleanouts

3.4 Vents

A vent is provided in all houses to allow for the circulation of air, and permits the escape of any gases that might otherwise build up in the house plumbing (see Figure 5).

The vent also assists the rapid gravity draining of wastewater.

3.5 Backflow Preventer

A backflow preventer is sometimes used to stop wastewater from accidentally backing up into buildings because of floods or blockages downstream. The most common type of check valve backflow preventer is a one-way flapper seal (see Figure 5).

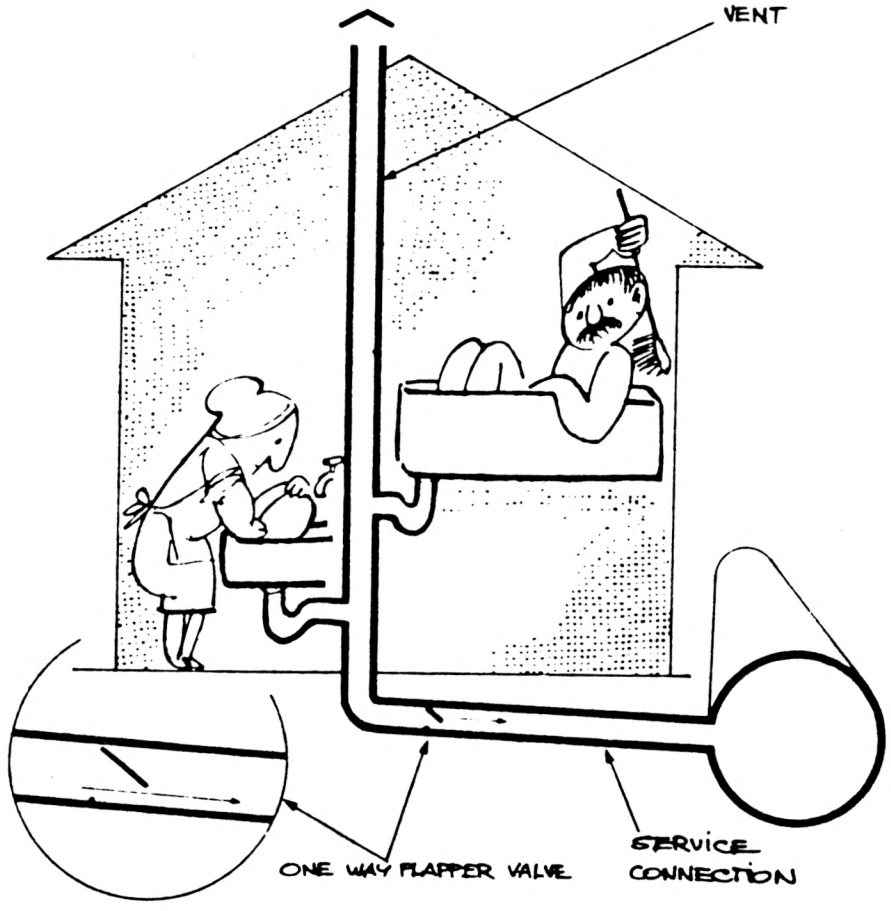

Figure 5 Vent and Backflow Preventer

3.6 Sewage Lift Station

A sewage lift or pumping station is used in a collection system whenever an all gravity system is not possible. This often occurs when sewage must be pumped over hills or across flat land to the treatment plant. The lift station pumps the wastewater to a higher elevation, so that it can again fall by gravity.

When sewage is pumped through the sewer, rather than falling by gravity, that section of sewer is known as a force main (see Figure 6).

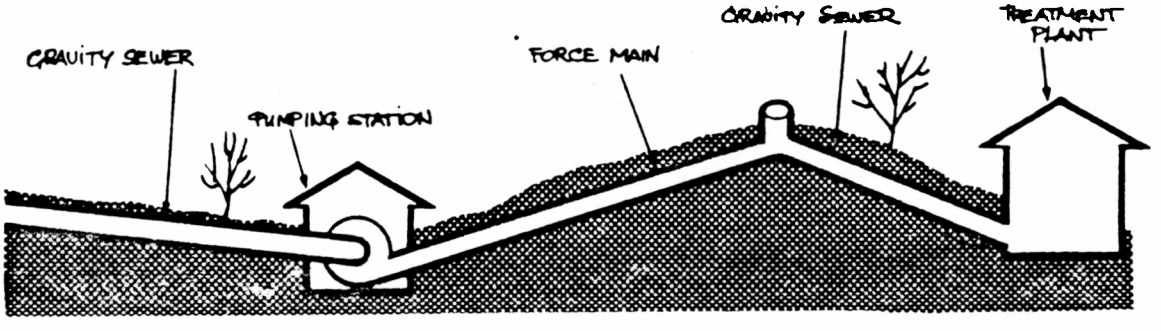

Figure 6 Sewage Lift or Pumping Station

4.0 WASTEWATER FLOW

The quantity of wastewater flow from houses and other buildings will vary depending on many factors that will be discussed later in this section.

4.1 Peak Flows

Most wastewater originates from domestic sources such as houses. The flow of domestic sewage will vary during the day, with peaks occurring at times when more water is being used such as at meals and bedtime. Figure 7 illustrates this change in flow. In addition, more water is used during summer than winter and so, generally, wastewater flows are also higher.

The operator should become familiar with the variation in wastewater flow during the day and the seasons. In this way, if the pattern of flow changes, the operator can recognize it, and attempt to determine the cause.

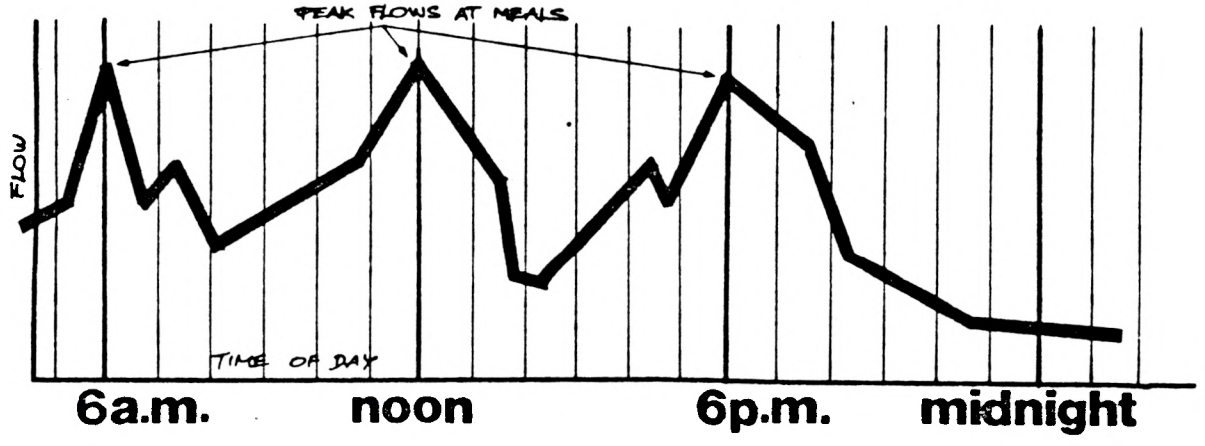

Figure 7 Daily Wastewater Flow

4.2 Infiltration

Infiltration occurs when the level of groundwater is above the sewer resulting in additional water entering the sewer. This will increase the flow in the pipe. Unsealed manholes or damaged pipes and joints are often responsible for groundwater infiltrating into the sewer system (as illustrated by Figure 8). Basement or roof drain pipes connected to the sanitary sewer will also cause an increase in flow. These should never be connected to the sanitary sewer as the resulting higher flows in the sewer following every storm can overload the wastewater treatment plant and cause basement flooding. Infiltration will often result in soil being washed into the sewer, and so the development of ground depressions above a sewer line may indicate that a large amount of infiltration is taking place.

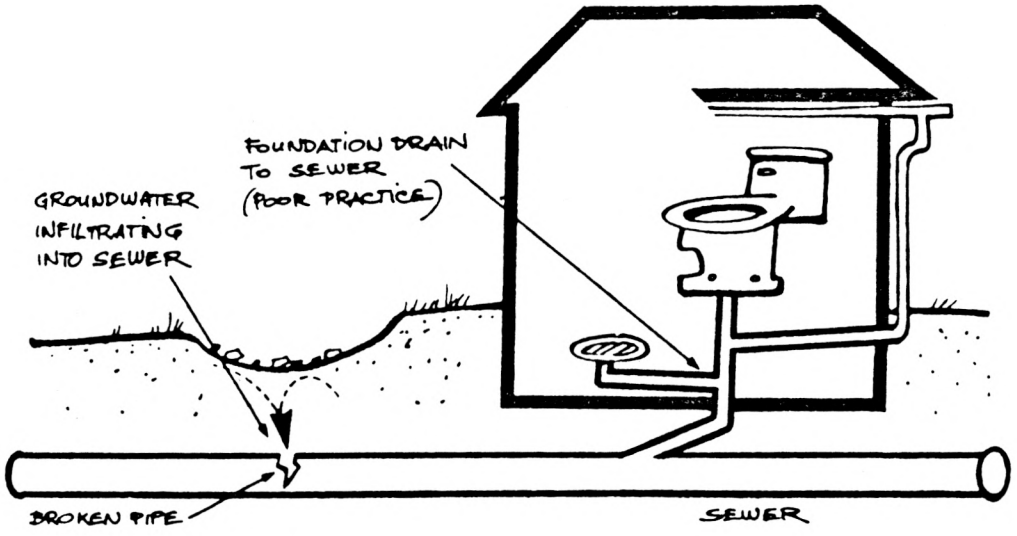

Figure 8 Infiltration

4.3 Exfiltration

Exfiltration is the opposite of infiltration and occurs when wastewater leaks out of sewers because of broken pipes or joints (see Figure 9). This could pollute either the soil or the groundwater and result in a serious health hazard.

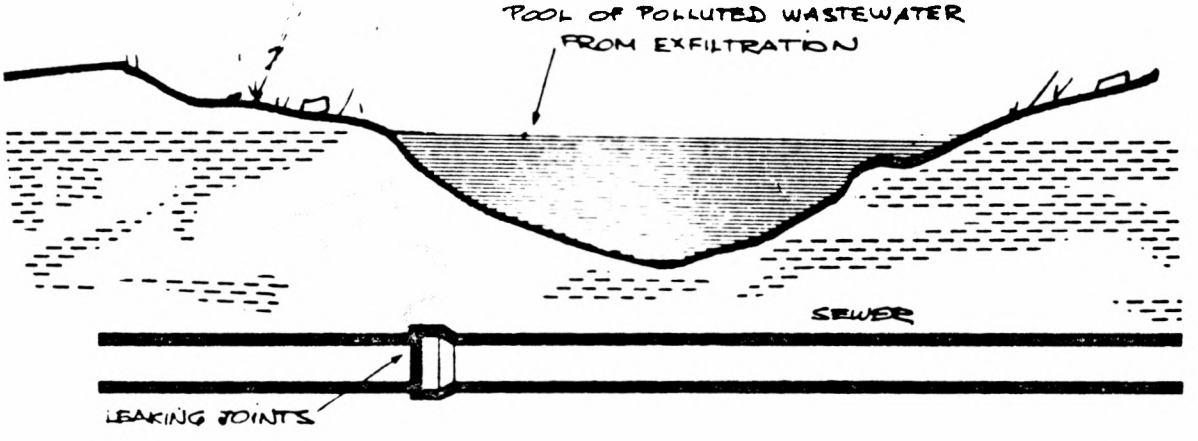

Figure 9 Exfiltration

4.4 Physical Blockage

The operator should be aware that there are many ways that a sewer can become blocked, including tree roots, broken pipes, and debris accumulating in it (see Figure 10).

Blockages in the line usually create an emergency situation for maintenance workers, because the blockage must be cleared before sewage backs up and overflows into houses.

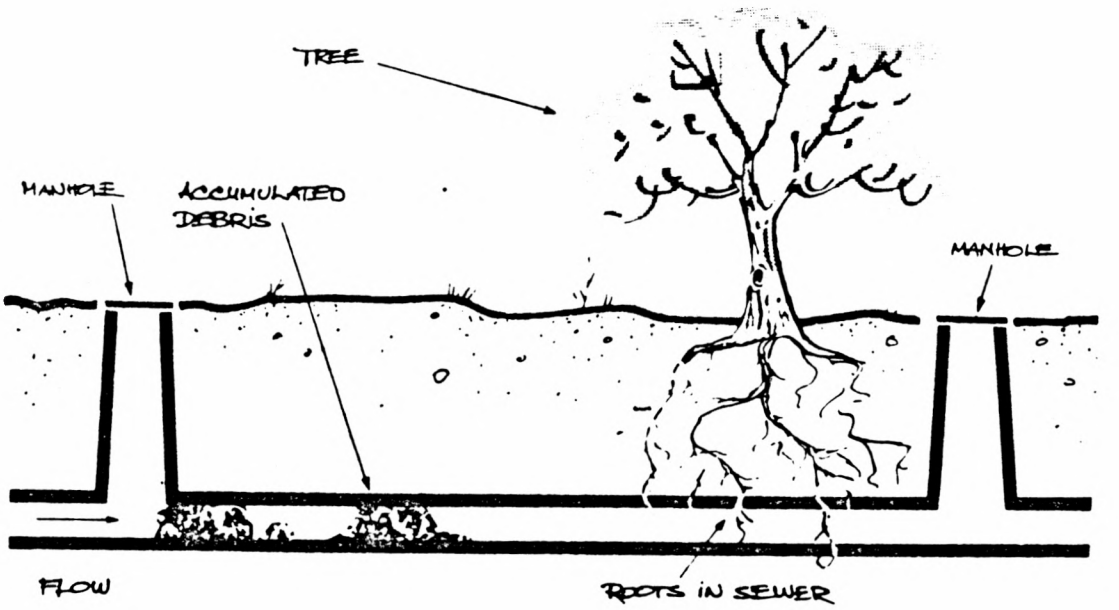

Figure 10 Sewer Blockage

5.0 MANHOLE SAFETY

5.1 General Remarks

Manholes are access chambers to the sewers for carrying out maintenance tasks such as cleaning.

Manholes can be extremely hazardous places to enter if workers do not observe the proper safety precautions. The following sections describe some of these hazards and what precautions to take if hazardous conditions are suspected. It is emphasized that any manhole maintenance or inspections should be carried out by a work crew having a minimum of 2 persons.

5.2 Hazardous Gases

If anaerobic decomposition of sewage takes place in the sewers, hazardous gases such as methane and hydrogen sulfide may be produced. Hydrogen sulphide is the greatest danger because it is toxic and heavier than air. It will therefore settle to the bottom of a manhole.

Hydrogen sulphide (the rotten egg smell) presents an additional danger because it weakens the sense of smell. What sometimes happens is that a worker smells hydrogen sulphide when first entering a manhole, then the smell seems to disappear. The gas is still present; however, the worker can no longer smell it.

If you smell hydrogen sulphide in a manhole, get out immediately.

Hazardous atmospheric conditions are most likely to occur in the following locations:

- at the low end of the collection system;
- in manholes deeper than 12 feet;
- in wet pits at lift stations; and
- downstream of industrial discharge.

5.3 Ventilation

It is good practice to thoroughly ventilate a manhole for 10 minutes before entering, and at all times while anyone is working in a manhole. A small air blower can be used. Proper ventilation should be considered essential prior to entering any manholes in hazardous locations, such as those described in 5.2.

5.4 Atmospheric Test Kits

Test kits are also available. They measure the presence of oxygen and other gases such as methane and hydrogen sulphide. These test kits can be used to check the atmosphere in a manhole prior to entering.

Workers should be aware, however, that gas detection instruments are expensive and require considerable maintenance. In addition, such test kits should never be used as a substitute for proper ventilation. If the test kit is not operating properly it will provide a false sense of security. A small air blower can provide several air changes per minute, which ensures that the air quality is acceptable.

5.5 Other Manhole Hazards

5.5.1 Falls and Falling Objects

Use caution when working around an open manhole, it may be a long way to the bottom. Never leave an open manhole unattended. Place barricades as a warning.

When leaving equipment on the ground at the top of an open manhole, keep it at least 1 m (3 ft.) back from the edge.

Always wear a hard hat in a manhole! This will provide some protection against head injuries caused by falling objects. Steel toed safety boots should also be worn.

5.5.2 Cuts and Infections

Because wastewater contains many infectious organisms, any open cuts or abrasions can cause serious infections. For this reason, it is good practice to cover as much of the skin as possible by wearing gloves and overalls.

5.5.3 Safety Harness and Tripod

A safety harness should always be worn in a manhole.

A person wearing a proper harness can be removed by one other worker using a tripod and winch. If a tripod is not available, then there should be a 2 person crew available at the surface in case somebody has to be pulled out.

Many of the safety precautions that should be followed when working around manholes are illustrated in Figure 11.

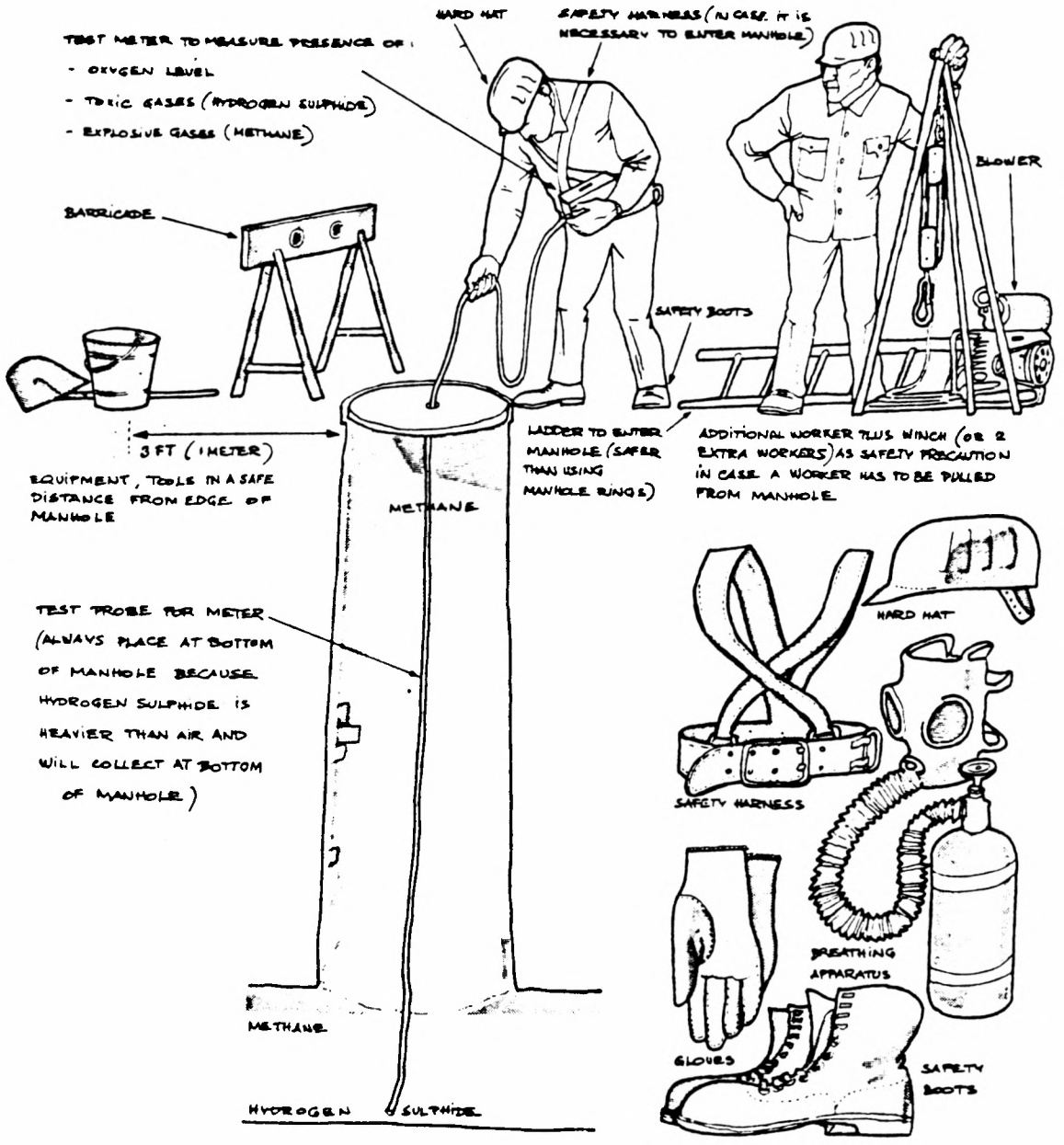

Figure 11 Manhole Safety

6.0 MANHOLE INSPECTION

It is important that manholes be inspected at least once a year to identify possible problems before they become too serious.

6.1 Safety

A proper manhole inspection can be made from the surface, using a flashlight. This saves the need to enter the manhole. Manholes can be hazardous: observe the proper safety precautions such as ventilation if you enter one to carry out an inspection.

6.2 Inspection Procedures

a. Ensure that the manhole cover fits properly, especially if there will be traffic passing over it. Vibration from cars and trucks pounding on an improperly fitting cover can cause cracking in the manhole rings.

b. Check for any cracks in the manhole rings through which ground water may infiltrate into the collection system. If cracks become large enough, the soil surrounding a manhole will also wash into the system. This will not only undermine the outside of the manhole, but could cause blockage in the line. Soil in the wastewater also interferes with the normal wastewater treatment plant operation.

c. Ensure that manhole ladder rungs are not deteriorating because of rust. If this happens, rusting rungs should be replaced, or a ladder used to enter the manhole.

d. The collection of solids or other debris on the manhole benching or ladder rungs may indicate that the sewer is being surcharged during certain periods.

   Surcharging means that wastewater is not able to pass through the sewer, usually because of an obstruction. This causes the sewage to "back up" in the manhole or into houses, and can result in flooding (see Figure 12).

   If evidence of surcharging is noticed in the manhole, the sewers should probably be flushed.

e. Check for any grease or other debris collecting in the portion of the sewer passing through the manhole. This will give a general indication of

the condition of other portions of the sewer that cannot be easily observed.

f. Observe for any signs of infiltration into the collection system. This might be evident if flows are higher than expected.

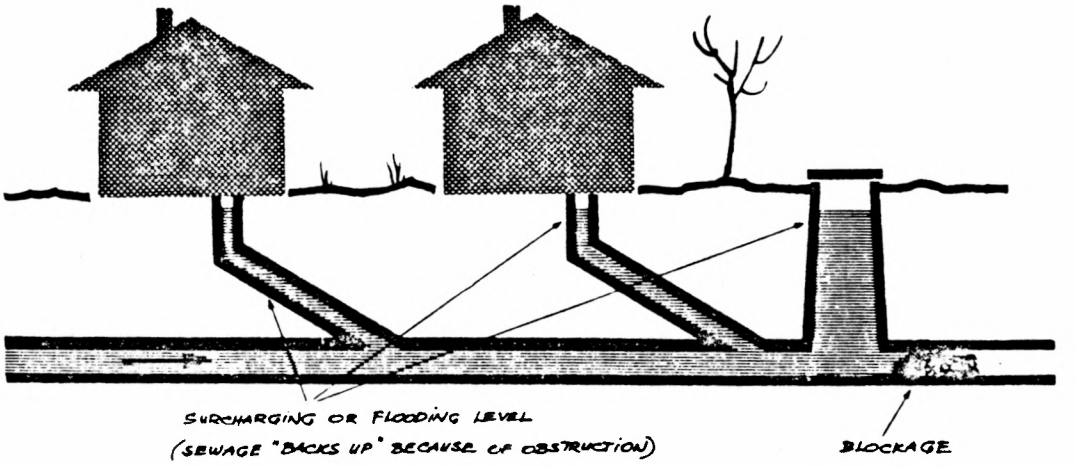

Figure 12 Surcharging

7.0 SEWER INSPECTION

7.1 Lamping

Lamping is an easy visual way to inspect a portion of sewer. As illustrated in Figure 13, one worker enters a manhole and shines a bright light down the sewer. Another worker enters the next manhole in the line and holds a mirror to see the reflection. If the light can be seen, then the sewer line must be relatively straight and free from obstructions.

When experienced workers perform this test, a good visual inspection is provided of sewer conditions within viewing distance of the manhole. Any obstructions in the sewer such as tree roots or accumulated solids, can then be identified and corrected.

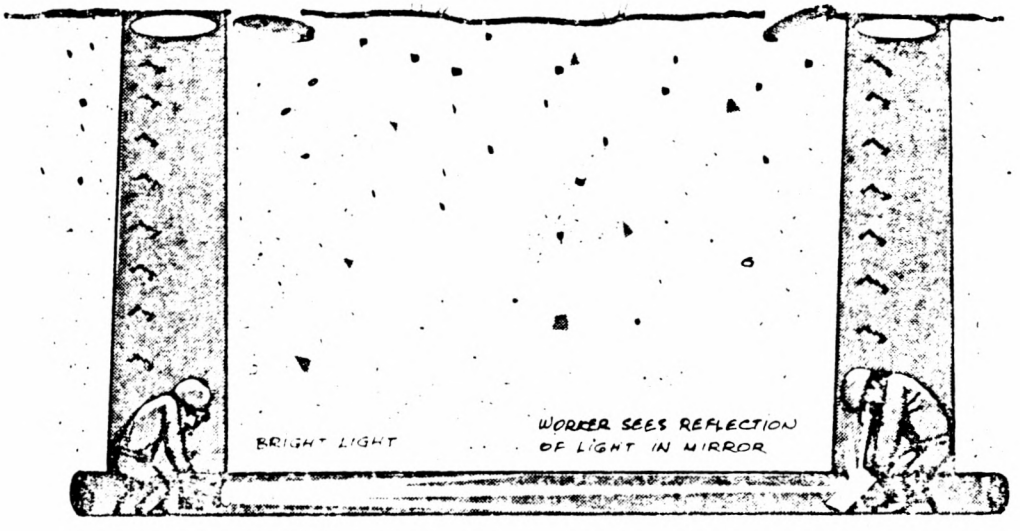

Figure 13 Inspecting a Sewer Line by Lamping

7.2 TV Inspection

Closed circuit television inspection is used to provide detailed information about conditions in the sewer mains.

The procedure consists of pulling a TV camera through a section of sewer. The picture on the TV screen allows a visual inspection of the sewer (see Figure 14).

This type of procedure is very useful following construction of new sewer systems because it provides an inspection of construction quality that is not possible any other way. Any cracked pipes or loose joints can be detected, and problems corrected before the contractor leaves the site.

TV inspection is also an excellent method of inspecting existing sewers and providing detailed information on problems such as infiltration, broken or cracked pipes, and roots growing into the sewers. This procedure is often used in badly deteriorated sewers to determine the extent of problems. Following the TV inspection, a decision can be made on whether to repair only damaged sections or completely replace the entire sewer system.

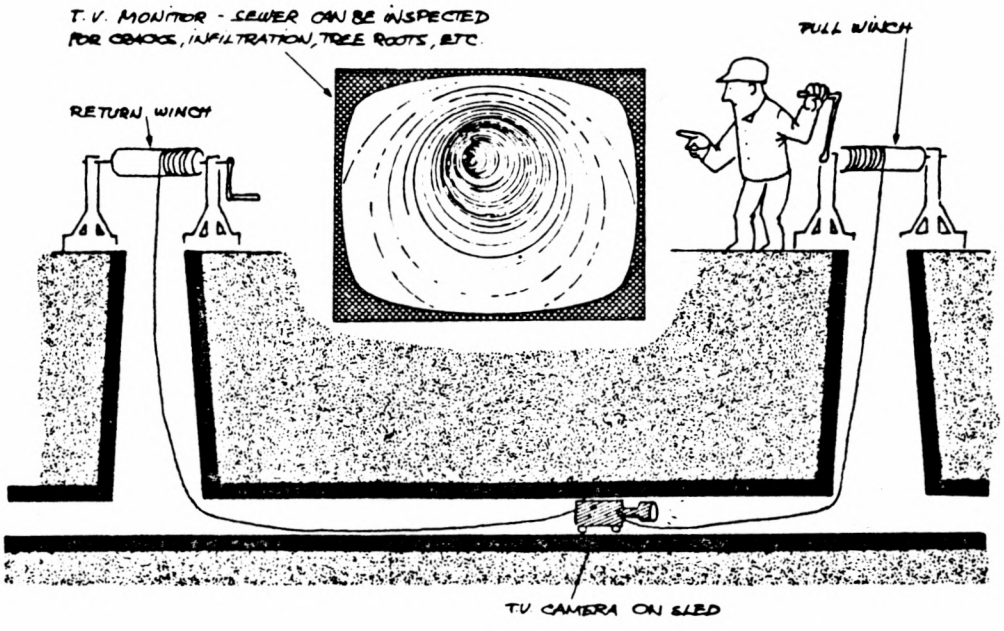

Figure 14 TV Inspection

8.0 SEWER CLEANING

8.1 General Remarks

Sewers are normally designed so that the flow of wastewater carries the solid material along and does not allow it to settle out. Occasionally, however, some sections of the sewer must be cleaned to prevent solids and other debris accumulating and forming a blockage in the line. If a blockage does form, the flow of wastewater could be stopped completely, causing flooding in houses.

In addition, a buildup of solids can also promote anaerobic conditions in the sewer causing the production of gases such as hydrogen sulphide (see 2.0).

Note: Because manholes are used as access chambers to clean the sewers, it is important that the worker be aware of the proper manhole safety procedures as discussed in section 5.0.

8.2 Hydraulic Cleaning - Flushing

This is the simplest and most common method of cleaning sewers. A large amount of water is "flushed" through the line, using either a fire hydrant or pumper truck to provide the necessary volumes (see Figure 15).

The large flow of water will remove accumulated debris and solids, and also help to control insects and rats in the sewer system.

Care must be taken not to flush too much water through the main. This could result in surcharging the sewer, and water "backing up" into houses causing flooding (see 6.2).

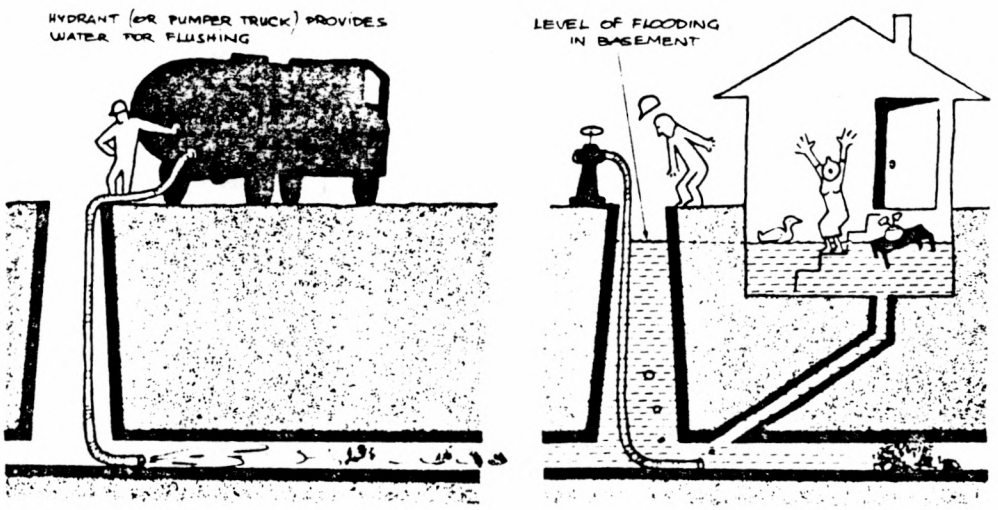

Figure 15 Sewer Cleaning by Flushing

8.3 Power Jetting

The most effective method of cleaning is power jetting. This method uses high pressure water jets to clean the sewer. As water is pumped through the jets,

the pressure is concentrated and can be as high as 2000 psi.

The equipment required consists of a truck containing a water storage tank and the necessary pumping equipment. The hose is fed into the sewer system at a manhole and the pump provides the necessary pressure for high velocity jets to clean the sewer. This method is usually carried out by a specialized cleaning company when other cleaning methods such as flushing are no longer effective.

9.0 CHEMICAL CONTROL OF ODOURS

Most odour problems in collection systems are caused by long, flat sewers that are poorly maintained. The maintenance worker should first attempt to determine and correct the cause of any odour in the system rather than simply masking it by using a chemical.

The most common odour problem in collection systems is caused by hydrogen sulphide gas, which can be controlled by either chlorine or hydrogen peroxide:

a. Chlorine will control the build-up of hydrogen sulphide in the sewers, but care must be taken not to apply too much, because it could interfere with the treatment plant operation. Chlorine should be used only by persons familiar with its use.

b. Hydrogen peroxide is a chemical which adds oxygen to the wastewater. This helps to prevent anaerobic conditions (discussed in 2.0) that promote the production of hydrogen sulphide.

   Although hydrogen peroxide is much safer to use than chlorine, it is recommended that it be applied only by persons familiar with its use.

10.0 RECORDS AND MONITORING

10.1 General Remarks

It is important to maintain complete records of any maintenance carried out on the collection system. This will help to identify any problem areas so that proper corrective steps can be taken.

A complete set of documents should be available on site including any reports and contract documents relating to the collection system.

The operation and maintenance manual is the most important document on site. It should contain:

a. instructions and requirements for day-to-day operation, ongoing tests, and monitoring;

b. preventive maintenance required; and

c. emergency procedures in case of system breakdown.

In addition, keep a complete set of as-built drawings on site. These should reflect the facility as it was constructed, and should indicate any changes in the system since construction.

10.2 Daily Records

Records should be kept on a day-to-day basis indicating the nature and extent of any work done. The following information should be recorded:

a. the operator's name, date and nature of work carried out such as manhole inspection or sewer flushing;

b. the labour and equipment used;

c. the amount and type of any chemicals or material used; and

d. any user complaints and action taken.

10.3 Monitoring Flow

The operator should monitor the flow of wastewater into the treatment plant. This is usually done by means of an overflow weir which can be connected to automatic recording equipment.

With experience, the operator comes to know how much wastewater flows into the plant under different conditions. For instance less flow takes place at night, more following mealtimes. In addition, the operator should note any increases in sewer flow during spring runoff. This can alert maintenance workers that excessive infiltration may be taking place.

In this way, if the quantity of flow changes unexpectedly, the operator recognizes it, and is then in a better position to determine the cause and take steps to correct it.

11.0 PUBLIC RELATIONS

It is important that maintenance staff help band members to understand the basic operating principles of a wastewater collection system.

As an example, if users are aware that the collection system is an underground network of small pipes, they can then appreciate that certain bulky items such as discarded towels or food packaging can cause blockage if flushed down the toilet.

In addition, maintenance staff should advise band members that materials such as greases, oils, cleaning solvents, fuels and acids should not be discharged into toilets. These materials should be disposed of in a sanitary landfill or other suitable means.

Good relations between the maintenance staff and the band members can assist workers in carrying out their duties, and will also benefit band members, because there is less chance of a sewer blockage or breakdown causing inconvenience.

12.0 MAINTENANCE CHECKLIST

Manhole and Sewer Inspections (once a year)

Inspect all manholes at least once a year:

Use proper ventilation

- Observe all safety precautions:
  - proper clothing,
  - hard hat,
  - safety boots, and
  - safety harness, and tripod and winch.
- Check manhole for cracks.
- Look for signs of infiltration.
- Check for roots growing into the system.
- Make sure the manhole cover fits properly.
- Note the height of water marks on manhole walls (to indicate surcharging).

Sewers:

- Check as required by lamping or TV inspection (generally lamping should be carried out at least once a year).

Sewer Cleaning (as required):

- flushing,
- scraping ball, or
- mechanical cleaning.