

CHAPTER 4
INSPECTION

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INTRODUCTION

A continuous sewer system inspection program is an important part of any preventive maintenance program. Inspections are required regardless of flow monitoring results. In addition to locating sources and quantities of infiltration/inflow, inspections are necessary to reveal blockages in the sewer system, to identify structural defects in the system, to identify potential safety hazards, and to observe the condition of control mechanisms.

Sewer system defects due to poor structural condition or poor construction practices can cause surcharging, overflowing manholes, sewer backups in buildings, exfiltration of wastewater into the ground, infiltration of groundwater, collapse of roadways, sewer sag, and increased sand and gravel deposits in lift station wet wells. A continuous inspection program serves to identify the system defects which contribute to sewer system failures before a failure occurs. The defects identified during a continuous inspection program can be scheduled for routine repair before it becomes necessary to make an expensive emergency repair.

A continuous inspection program must be developed, to include manholes, sewer lines, lift stations, and other appurtenances such as junction chambers and siphons. The program should also include the inspection of private buildings for illegal connections to the sanitary sewer system and the inspection of new construction. In some cases smoke testing and dye testing may be required in problem areas to identify sections of the sewer system that warrant detailed inspections.

Figure 4-1 shows some of the defects and private building connections that typically allow infiltration and inflow to enter the sanitary sewer system. These sources of I/I can be identified and scheduled for repair only if a continuous inspection program is implemented.

MANHOLE INSPECTION

General

Manholes are subject to a variety of forces which cause them to structurally deteriorate over time allowing for infiltration and inflow to enter the sanitary sewer system through the defects. The most common forces which cause manholes to deteriorate include vibration and pounding from traffic passing over them, freeze-thaw cycles, settlement which usually occurs at a different rate for manholes than for the sewers to which they are connected, and chemical attack due to the nature of the wastewater being conveyed through the system.

Manhole inspections should be done immediately on newly constructed manholes before they are accepted for use. Existing manholes should be routinely inspected at the suggested cycle of once every five years. Areas subject to heavy traffic and areas where many defects have been found in past inspections should be inspected more frequently.

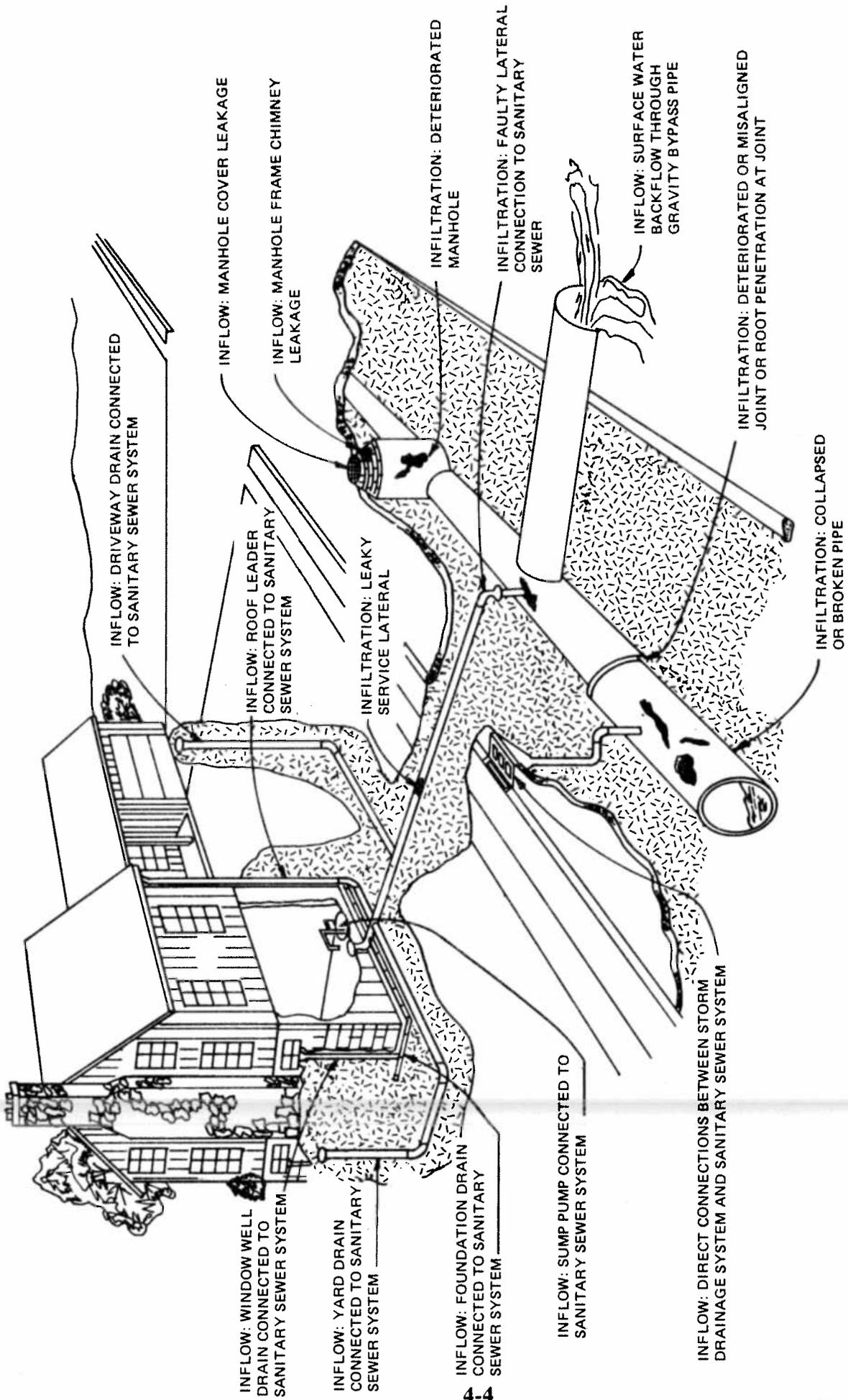


FIGURE 4-1. TYPICAL SOURCES OF INFILTRATION AND INFLOW

Inspection Procedure

WARNING: MANHOLES ARE CONFINED SPACES AND MAY HAVE DANGEROUS ATMOSPHERES. FOLLOW PROPER SAFETY PRECAUTIONS WHEN WORKING NEAR AND BEFORE EVER ENTERING A MANHOLE.

Proper procedures must be followed when inspecting manholes and recording data. Manhole inspections require entering manhole structures. Manhole inspection crews must be instructed or reminded of the safety requirements that must be followed when inspecting manholes. Details regarding safety procedures are included in Chapter 9 of this manual.

An inspection procedure that can be used to help identify manhole defects is as follows:

1. Check the area around the lid for proper drainage away from the lid. Use a straight edge to see if the manhole is at proper elevation and grade with the surrounding ground.
2. Check for combustible gases inside the manhole before removing the manhole cover.
3. Prior to entering a manhole verify that the atmosphere within is safe. Manholes can be flushed prior to entry. Flushing will remove gases, slime and debris from the walls, and clean ladder rungs for better inspection and footing. If a power jetter is available, chlorine can be added to the water supply.
4. With a flashlight or other adequate portable lighting, inspect all surfaces and joints inside the manhole for:
 - a. Cracks or breaks in manhole walls and bottom.
 - b. Sources of infiltration.
 - c. Joint security.
 - d. Offsets and misalignments.
 - e. Root intrusion.
 - f. Grease accumulation around the arch or inside of sewers.
 - g. Gravel or debris in invert.
 - h. Grout bed of frame and condition of frame seal.
 - i. Condition of steps.
 - j. Debris on shelf or steps.
 - k. Sluggish flow or backed up wastewater.
 - l. Separation of grade rings.

- m. Corrosion.
 - n. Manhole section lifting holes that have not been plugged.
 - o. Surcharge line.
 - p. Wetness or condensation on walls that indicates the groundwater level.
5. Clean the ledge of the manhole ring and inspect for cracks in the metal parts.
 6. Replace the lid and check for warped or misfit lid and rattling or rocking of lid.

While inspecting manholes, wastewater flow characteristics through the manhole should be observed. Grease and scum present in the sewer can usually be detected by these observations. Excessive or sluggish flows can also be detected through manhole observations. Comparisons should be made between the amount of flow passing through adjacent manholes. If low flow is found in a manhole downstream of one which has larger flows, it is likely that an obstruction of some sort exists in the sewer line between the two manholes which is causing wastewater to either backup into private sewers and possibly into buildings or exfiltrate into the ground. Further inspections are required when a sewer obstruction is suspected.

Recording Inspection Data

An important part of every manhole inspection is the recording of all observations on an inspection record. The following information should be recorded:

1. The manhole identification number and location.
2. The materials and condition of the manhole including construction type, cover, ring, frame seal, cone, chimney, walls, steps, lift holes, benches, and channels.
3. The manhole depth and opening size.
4. The number and size of holes in the manhole cover.
5. The frame grade and alignment.
6. Visible infiltration sources and estimated flow rates.
7. Evidence and location of leaks.
8. The level of the high water mark.
9. The type and depth of debris found in the manhole.
10. The groundwater level at manhole (indicated by wet marks on the wall).
11. Specific problems and conditions such as inflow sources, overflows, bypasses, and manholes in natural ponding areas.
12. Date of inspection.

13. Names of the inspectors.
14. Weather conditions.

An example data sheet for manhole inspection is shown in Figure 4-2.

SEWER INSPECTION

General

As a sewer system ages the sewer pipes are subject to deterioration or damage due to a variety of reasons. Some of the more common causes of sewer deterioration and damage include:

1. Poor construction practices such as improper placement of pipe bedding and backfill, improper installation of the pipe material, not installing the sewer to the specified grade, and improper connection of private service laterals to the public system.
2. A poor structural base beneath the sewer allowing settlement to occur.
3. Corrosion both externally and internally.
4. Poor system maintenance allowing small problems to become big problems.
5. Carelessness on the part of contractors installing or maintaining other utilities and constructing new buildings and roadways.
6. Live loads which exceed the pipe strength.
7. Earth movement from freeze-thaw cycles.

To ensure that the sewer system will not deteriorate to the point of requiring emergency repairs and to identify any damage done to the sewers, periodic sewer inspections should be made. It is suggested that all sewers be inspected on a cycle of once every five years. More frequent sewer inspections may be necessary where sewers pass beneath waterways, roads, railroads, low lying areas subject to ponding of rainwater, large trees (especially Willow trees), and in areas with a history of sewer defects.

Sewer inspections can be done by looking into a sewer segment from inside a manhole, by walking through the sewer line if it is large enough, or by pulling a closed circuit television camera through the sewer. Visual inspections may be adequate for short-term inspections or to indicate if infiltration or blockages exist, but the limitations of visually inspecting sewers from adjacent manholes warrants periodic televising of the entire system.

Inspection Procedures

WARNING: SEWER LINE INSPECTIONS REQUIRE ENTERING CONFINED SPACES WHICH MAY HAVE DANGEROUS ATMOSPHERES. FOLLOW PROPER SAFETY PRECAUTIONS WHEN WORKING NEAR AND BEFORE EVER ENTERING A MANHOLE OR SEWER LINE.

Walk-through. Sewers that are large enough to accommodate workers should be inspected by walking through the sewer. The structural integrity of the sewer should be assessed. This includes checking for loose bricks, deteriorated concrete or cement, cave-ins, cracks, crushed pipe, misalignments, sags, open joints, and protruding taps. Any visible inflow and infiltration sources should be noted with an estimate of the flow rate observed.

The sewer pipes should also be inspected for root intrusion so that if found, proper corrective measures can be taken to eliminate them before they seriously damage the sewer system. Other problems with the sewer pipes should be noted during the walk-through such as illegal house connections.

Lamping. Small sewers can be inspected for obstructions and infiltration using a mirror and/or light beam. Reflected sunlight or a powerful beam of light is directed down the pipe from one manhole. If the light can be seen from the next manhole, it indicates that the line is open and straight. The number of sewer segments in a system that can be successfully inspected visually using the lamping technique is normally limited by the distance between manholes, slight bends in the sewer between manholes, sagging sewers, root blockages, collapsed pipe, and other types of blockages. Just because light cannot be seen at the next manhole does not mean that a sewer blockage exists. If a section of pipe cannot be successfully lamped, past sewer records should be reviewed to determine if there is a reason other than blockage explaining why the light beam did not pass through the sewer. If the review of records points toward a blockage it may be necessary to televise the pipe segment in order to pinpoint the problem.

Even when sewer lamping indicates that a sewer segment is open and straight, it does not provide any information about the structural condition of the sewer except for maybe a few feet adjacent to each manhole.

Sewer lamping is normally done in conjunction with manhole inspections since manhole entry is required for both types of inspections and the additional work necessary to do both inspections simultaneously is only slightly more than doing either one individually.

Closed Circuit Television. Closed circuit television (CCTV) inspection is a very effective and useful technique for observing the condition of the sewer. In this method, a TV camera is pulled through the sewer while the picture is shown on a monitor and observed by a worker outside the manhole. CCTV inspection is applicable to sewers four to forty-eight inches in diameter. CCTV inspection can help to generate inspection reports and provides a permanent visual record of all sewer conditions. The use of a color camera system gives added depth perception although black-and-white systems are usually adequate. Light sewer cleaning is usually required prior to inspection with a closed circuit television to allow the camera to pass through each line giving an unobstructed view of the pipe interior to assess its condition.

Televised pictures can be recorded on video tapes which can later be played back for further inspections. An audio portion of each tape can be provided by a technician commenting on

the pipe conditions seen on the television monitor. The following can be accomplished through CCTV inspection:

1. Inspect the structural condition of the sewer and to determine the location of problem areas such as pipe or joint separations, drops, ruptures, leaks, service connections, obstructions, corrosion, misalignments, and root intrusion.
2. Identify damage done by excavation and construction on utilities, roads, and buildings.
3. Locate unrecorded connections and illegal taps.
4. Determine inflow and infiltration amounts.
5. Examine newly installed and/or repaired taps or pipes.
6. Help evaluate the effectiveness of corrective methods.
7. Assist in rehabilitation techniques such as grouting, sliplining, and inversion lining.

The equipment requirements for closed circuit television inspection are extensive and costly. It is possible to hire a company which specializes in CCTV inspection. Larger communities may wish to purchase equipment, while smaller ones may decide to rent because of the cost. The decision to rent or to buy equipment, or to contract with a specialty company, depends on many factors. These include the amount of pipe to be televised, how long it will take, how much money is available, and whether or not qualified maintenance personnel are available to do the job.

Recording Inspection Data

Like manhole inspections, every sewer inspection requires a detailed inspection record on which the following typical information should be recorded:

1. The length, size, type, and depth of the pipe, along with an estimate of the amount of work required or preventive maintenance needed.
2. The depth of flow for assessment of pipe capacity and detection of extraneous inflow of water.
3. Extent of root intrusion and suggested control techniques.
4. Type and depth of deposits and recommended cleaning methods.
5. The location of visible infiltration and inflow sources such as open joints, misaligned joints, cracked pipe, and mineral deposits. If infiltration or inflow is observed, an estimate of the flow rate should be recorded.
6. The structural condition of the pipe.
7. The presence of special problems and conditions such as collapsed pipe, sagging sewers, and corrosion.

8. The location, type, and condition of all service lateral connections and other tap-ins that are observed.
9. The date of inspection.
10. The names of the inspectors.
11. The weather conditions during the inspections.
12. The type of surface over the sewer being inspected.
13. The groundwater level if available.

Figure 4-3 shows an example sewer inspection data sheet designed for closed circuit TV inspections. The data sheet could be modified slightly for use during a walk-through inspection in large sewers.

Figure 4-4 shows an example data sheet for sewer lamping inspections. Although sewer lamping does not provide a large amount of data about sewer conditions, it is still important to keep a record of where it was done and what observations were made.

LIFT STATION INSPECTION

General

Inspection of lift stations, like sewers and manholes, should be performed routinely as part of an effective preventive maintenance program. The typical problems encountered in lift stations include power failures such as electrical circuit failures and burned out motors; control system failure; pumping failures; mechanical failures such as breakdown of a bearing, vibrations, poor shaft alignment, etc.; and solids depositions such as grit, grease or floating debris in the wet well, or force mains becoming restricted or plugged. Through a carefully followed inspection program many of these failures can be prevented or corrected before further, more serious problems occur.

Inspection Procedures

Before entering any lift station facility, inspection and maintenance personnel must be fully aware of the safety procedures that need to be followed. Safety procedures are presented in Chapter 9 of this manual.

Lift stations are normally designed to operate with limited operator attention, but their operation depends on the condition of the equipment. Regardless of the level of work required to operate and inspect a lift station, a minimum of two operators should make the round of inspections for safety reasons. Inspections must be made frequently to ensure smooth operation.

VIDEO TAPE NO. _____

COMMUNITY _____

DATE: _____

PIPE LOCATION _____

SURFACE OVER SEWER: ASPHALT CONCRETE GRASS OTHER _____

PIPE SIZE / DEPTH / MAT'L _____ / _____ / _____

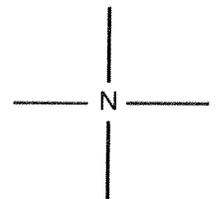
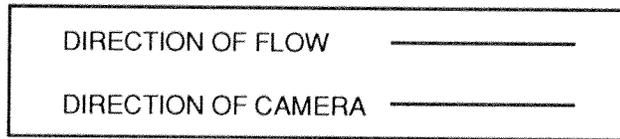
WEATHER: SUNNY RAIN SNOW TEMP: _____

CLEANING: NONE JET ROOT CUTTING OTHER _____

IN CONJUNCTION WITH DYE-FLOODING: YES NO

CREW CHIEF: _____

MH# MH#
0 0



FOOTAGE	SERVICE CONNECTIONS	REMARKS	I/I (gpm)

EXAMPLE REMARKS:

- Brick demortared, but still intact
- Brick missing, backfill showing
- Camera blocked; unable to proceed
- Camera submerged
- Crack in pipe - lateral
- Crack in pipe - transverse
- Corrosion (indicate severity)
- Collapsed pipe
- Damage (specify type)
- Debris accumulated in invert
- Distorted shape
- Flow depth
- Infiltration flow rate

- Inflow rate
- Grease accumulation
- Invert damage (specify)
- Offset joint
- Separated joint
- Leakage observed
- Mineral deposits
- Root intrusion
- Sagged line
- Abandoned tap
- Protruding tap
- Tap with roots
- Structural damage (spalled concrete, loose bricks)

FIGURE 4-3. EXAMPLE SEWER INSPECTION DATA SHEET

COMMUNITY: _____

INSPECTION CREW: _____

WEATHER: TEMP: _____ SUNNY RAIN SNOW

DATE	SECTIONS LAMPED (MH TO MH, LIN. FT.)	OBSERVATIONS

FIGURE 4-4. EXAMPLE SEWER LAMPING DATA SHEET
4-13

Suggested inspection and maintenance tasks that should be performed on a daily basis include:

NOTE: Follow manufacturers inspections for operation and maintenance of all equipment. Requirements vary from manufacturer to manufacturer.

1. Check to make certain the electric power is on.
2. Make sure no circuit breakers have been tripped.
3. Read and record values on counters and timers.
4. Inspect, clean, and lubricate motors and rings.
5. Inspect and clean wet well level sensor electrodes and bubbler tubes.
6. Inspect and clean motor starters and relays.
7. Check the operation of the gland water pump motors and electric valves.
8. Inspect and clean all automatic gate controls.
9. Check kilowatt meters and charts and record data.
10. Check the motor, heating elements and belts on auxiliary equipment such as heaters, fans, and dehumidifiers. Replace any broken or badly worn parts when they are detected.
11. Check the float switches and motors on lift station sump pumps.
12. Inspect and clean bar screen or communitor and controls.
13. Inspect indicating lights on all equipment and telemetry equipment controls if applicable.
14. Inspect pumps and bearings. If needed lubricate and repack bearings following manufacturer instructions.
15. Inspect and lubricate line shaft bearings.
16. Inspect and lubricate gland water pumps and bearings.

NOTE: Never substitute a cheap or economy lubricant for the type recommended by the pump or equipment supplier.

17. Make sure the pump packing is not leaking too much water and is not too tight.
18. Inspect check valves and verify that they are not stuck either open or particularly closed.
19. Inspect sump pump floats and all discharge piping and valves.
20. Check the position and operation of all flow control gates.

21. Check the drives and screens on all mechanically cleaned bar screens.
22. Inspect comminutors for proper operations.
23. Inspect, clean, and lubricate all air compressors.
24. Manually clean bar screens.
25. Make sure all vent fans and lights are operating properly.
26. Enter any observed problems in to the lift station log books.
27. Pick up all debris in side and outside of the facility.
28. Before leaving the facility make sure it is secure.
29. Plow snow if necessary.

Suggested inspection and maintenance tasks that should be performed once a week include:

1. Check all equipment, piping and valves for leakage.
2. Operate each wastewater pump in the "manual" or "hand" position and inspect the pump and motor for excessive noise or vibration.
3. Check all motors for excessive temperature increases.
4. Check all pressure and vacuum gauges.
5. Inspect and clean sump pump wells if necessary.
6. Clean and reposition floats and level sensor electrodes in the wet well.
7. Inspect wet well piping and ladders.
8. Mow the lift station yard if necessary.
9. Wipe down all equipment.
10. Replace recording charts as required.
11. Exercise standby equipment to dry out water, redistribute lubricant and ensure operational readiness.
12. Check operation of all lift station alarm systems.

Suggested inspection and maintenance tasks that should be performed once a month include:

1. Operate all flow control gates and valves to prevent them from seizing.
2. Remove the pump casing inspection plates and remove any debris that has accumulated.

3. Check calibration and recalibrate flow meters if necessary in accordance with the manufacturer's instructions.
4. Clean all ventilation openings.
5. Check first aid supplies.
6. Take inventory of spare parts. Verify that depleted parts have been ordered.
7. Check the condition of paint both inside and outside the lift station.

Suggested inspection and maintenance tasks that should be performed once a year include:

1. Dismantle the wastewater pumps to inspect the impellers, shafts, and shaft sleeves.
2. Inspect and clean all components of the ventilating fans, heaters, sump pumps, and dehumidifiers.
3. Inspect the condition of all electrical equipment.
4. Paint areas both inside and outside of the lift station as needed.
5. Inspect the inlet and outlet piping at the lift station. Clean the piping if needed.
6. Clean the wet well of accumulated grease, floating debris, and grit. Grease and floating debris can be removed with a vacuum unit mounted on a truck or trailer. Grit can be removed by pumping down the wet well level and vacuuming out the grit. Grit can also be removed by using a clam shell or bucket machine if there is available access. Commonly grit is removed by resuspending it using a high pressure water stream and allowing it to be pumped through the collection system. This method of cleaning grit from wet wells has the disadvantage of causing additional wear on the pumps.
7. Check flowmeter calibration and recalibrate if necessary.
(NOTE: Calibration requirements vary from supplier to supplier. Manufacturer calibration requirements must be followed.)

Daily visits to pump stations may seem excessive for some communities, or may not be feasible due to employee and/or time constraints.

Equipment lubrication reservoirs must be large enough to supply lubricants between station visits. A telemetry system can also be installed to increase the amount of time between station inspections. At the minimum, a high water alarm should be installed. Other recommended alarms include those for the water level in the sump pump pit of the dry well, power failure, air compressor failure and intrusion. Auxiliary alarms can be used to indicate water supply pressure, chlorine leaks, and high temperature of motors and engines.

Every lift station must have a well-organized operation and maintenance manual that can be used during routine inspections and maintenance. The operation and maintenance manual for the lift station should include:

1. A functional description of the lift station.
2. The lift station location, which can be indicated on an area map.
3. Equipment data sheets for all mechanical and electrical equipment including:
 - a. Manufacturer's name.
 - b. Model number.
 - c. Type.
 - d. Size/capacity parameters. (gpm, hp, rpm, kv, etc.)
 - e. Spare parts.
 - f. Any other pertinent data.
4. Valve and piping data.
5. A schematic drawing or flow diagram showing all important equipment.
6. Schematic wiring diagrams for all electrical equipment.
7. A description of lift station startup procedures and normal mode of operation.
8. Description of alternate operating modes.
9. A description of potential emergency situations and emergency modes of operation.
10. Safety instructions associated with operating and maintaining the lift station.
11. A summary of the preventive maintenance schedule using the equipment manufacturer's literature to develop the schedule.
12. Operation and maintenance manuals supplied by the equipment manufacturers.
13. Emergency phone numbers and key contact personnel.

Recording Inspection Data

All inspections and routine maintenance tasks, along with problems encountered and repairs should be recorded on data sheets. The data sheets should be designed to include all specific inspections and maintenance tasks at each lift station.

Most lift stations will be unique with respect to the pump station type (wet well/dry well or wet well), type and number of equipment units, and equipment manufacturers. Therefore inspection and maintenance requirements will vary at each lift station making it difficult to use a standard data sheet for recording data at all lift stations. Inspection and maintenance tasks at each lift station should be recorded on data sheets designed in accordance with the preventive maintenance program dictated by the design, equipment, and operation of each station.

Data should be entered on data sheets developed separately for daily, weekly, monthly, and annual maintenance and inspection tasks. The data sheets should be stored in a log book at the lift station with at least one duplicate copy stored in the community's central office area. The data sheets generally should include the following basic information:

1. The date.
2. The inspectors names.
3. Time inspectors arrived/time inspectors left (important for budgeting and manpower projections).
4. The pump running time for each pump.
5. Readings indicated on all station meters and gauges including utility company meters.
6. Check off all equipment inspected and note any unusual observations.
7. Check off the routine maintenance tasks that were completed on specific equipment and controls i.e. cleaning and lubricating.
8. Indicate if wet wells were cleaned.
9. Indicate if sump pump wells were cleaned.
10. Note any emergency conditions encountered.
11. Record station equipment failures.
12. Indicate if cleaning of debris was done inside and outside of the lift station.
13. Indicate if yard mowing was done.
14. Check off if painted areas were inspected and indicate if painting work was completed or if it is required.

Equipment failures and emergency conditions encountered should be recorded on a separate data sheet and stored in the lift station log in an area designated for emergency conditions and equipment failures.

INVERTED SIPHON INSPECTION

General

An inverted siphon can be defined as any sag or depression purposely designed into a sewer to allow for it to pass under manmade or natural obstructions such as other utilities, rivers, streams, subways, and valleys. Inverted siphons normally remain full of wastewater even during low flow conditions. Most inverted siphons contain at least two parallel pipe barrels, each a different diameter. The smaller pipe barrel conveys wastewater during low flows at a velocity high enough to scour solids from the invert of the siphon.

During higher flows the larger siphon barrel would convey the larger flows. For maintenance and inspection purposes an inlet and outlet structure are designed as part of the inverted siphon.

Because solids tend to settle out in inverted siphons, the siphons must be inspected and flushed regularly. Inverted siphons also allow for odors to be released if provisions have not been made to allow sewer gases to be transferred from the upstream end of the siphon to the downstream end.

Inspection Procedures

WARNING: INVERTED SIPHONS AND THEIR INLET AND OUTLET STRUCTURES ARE CONFINED SPACES AND MAY HAVE DANGEROUS ATMOSPHERES. FOLLOW PROPER SAFETY PRECAUTIONS WHEN WORKING NEAR AND BEFORE EVER ENTERING AN INVERTED SIPHON OR RELATED STRUCTURES.

Inverted siphons must be inspected routinely to verify that they are operating properly. Since the routine inspections require entry of siphon inlet and outlet structures where dangerous atmospheres can exist, proper safety precautions must be followed.

Frequent inspections are necessary to make sure obstructions are not affecting the operation of the inverted siphon. These inspections should include:

1. Observing flows upstream and downstream of the siphon. Sluggish upstream flows with lower than usual flows observed downstream would indicate a blockage.
2. All mechanical parts should be inspected for accumulated debris and cleaned if necessary.
3. The entrance hatches for the inlet and the outlet structures should be checked for security.
4. If the siphon is equipped with air vent piping between the inlet and outlet structures, it should be checked for proper operation.
5. Slide gates should be exercised to prevent seizing.

To assist during the inspection procedure, an operation and maintenance manual should be available for each inverted siphon in the system. The design and operation may be different at each siphon location. The operation and maintenance manual should include as a minimum the following information:

1. A location map.
2. A functional description of the inverted siphon and appurtenances.
3. Description of startup and normal operation.
4. Description of alternate operating modes.
5. Description of emergency operation.

6. A schematic including all piping, valves, gates, and weirs.
7. Mechanical and electrical components if any.
8. A listing of tasks and procedures that need to be followed during routine visits.
9. A listing of emergency phone numbers and key contact personnel.
10. Safety associated with the various tasks required.

Recording Inspection Data

During each routine inspection at an inverted siphon a data sheet should be completed which summarizes the inspections and any routine maintenance that was completed. The data sheets should be stored in a log book for the inverted siphon and associated appurtenances. The data sheet typically should include:

1. The date of inspection.
2. The inspector's names.
3. General weather conditions.
4. The arrival and departure time of the inspection crew.
5. Observations regarding accumulated debris in the inlet and outlet structure.
6. Flow observations.
7. Note any cleaning or rodding which was required.
8. Note if odors were detected.
9. The condition and operation of air vent piping.
10. Record any unusual observations.

JUNCTION CHAMBER INSPECTION

General

Junction chambers are required when one or more branch sewers join with or enter a main sewer resulting in changes in sewer diameter, direction of flow, and sewer slope.

For small diameter sewers, the junction can be made at a standard size manhole. When sewers are too large to join at a standard sized manhole structure, a junction chamber must be provided in conjunction with manhole riser sections.

Junction chambers are normally designed to minimize turbulence at the structure in order to minimize the release of odors. Design features also are aimed at minimizing the accumulation of grit, rags, and other typical wastewater debris in the junction chamber.

Inspection Procedures

WARNING: JUNCTION MANHOLES AND CHAMBERS ARE CONFINED SPACES AND MAY HAVE DANGEROUS ATMOSPHERES. FOLLOW PROPER SAFETY PRECAUTIONS WHEN WORKING NEAR AND BEFORE EVER ENTERING A SEWER JUNCTION CHAMBER.

Junction chambers must be routinely inspected to ensure that the junction outlet does not become obstructed. The structure itself needs to be periodically inspected following the procedures for a typical manhole. A junction chamber will require more frequent cleaning than a standard manhole.

Recording Inspection Data

During each routine junction chamber inspection, observations should be recorded. Frequent inspections require only a small amount of data to be recorded such as:

1. Date of inspection.
2. Inspector's names.
3. Observed flow conditions.
4. Amount and type of debris accumulated.
5. Unusual conditions observed at the junction chamber site.
6. Indication of odors.

Data from less frequent inspections of the junction chamber structure can be summarized on a modified manhole inspection form.

PRIVATE PROPERTY INSPECTIONS

General

Each local agency must periodically inspect all buildings with potential illegal connections to the sanitary sewer system. When illegal connections are found, they must be removed regardless of the actual system flows. Some agencies may initiate a program where all buildings are inspected for compliance with local plumbing ordinances each time a building is put up for sale. In areas where excessive wet weather flows have been measured and private property illegal connections have been a problem in the past, inspections should be done more frequently to ensure that reconnections have not been made.

Building to Building Inspection Procedures

Building inspections are conducted to identify private sector sources of infiltration and inflow. These sources typically include sump pumps, downspouts, foundation drains, area drains, and defective service laterals.

All personnel assigned to inspecting buildings for illegal connections must be trained to know what to look for and how to communicate with the public. The training should also cover collecting and recording data.

Before starting the field inspections, all property owners should be notified by letter or flier delivered to each building in the scheduled inspection program.

At each building (residential, commercial, or industrial) the inspector must request permission to inspect the basement or crawl space and the outside of the building. Basements are inspected for sump pumps that discharge stormwater or groundwater to the sanitary sewer system. Commonly a basement will have one sump pump well which collects groundwater from foundation drains around the building and also wastewater from floor drains and laundry tubs located in the basement. When this type of plumbing exists it needs to be modified so that the floor drain and laundry tub discharge to the sanitary sewer system and the foundation drainage is discharged to the ground surface around the building or to a storm sewer. Outside of the building, the inspectors should look for exterior sump pumps, downspouts that discharge below grade, and area drains such as patio, window well, and driveway drains.

If permission to enter a building is denied, it should be noted and legal options pursued to gain the necessary access.

Recording Inspection Data

Each time a building inspection is conducted, observations made should be recorded on a data sheet. Typical information that should be recorded on the building inspection data sheet includes:

1. The date of inspection.
2. The inspector's names.
3. The address and building owner's name.
4. The building type; residential, industrial, commercial, or other.
5. Status of entry, allowed or refused.
6. Whether a basement exists or not.
7. The number, type, and discharge points for sump pumps identified.
8. Number, type and discharge points for floor drains, foundation drains, window well drains, stairwell drains, downspouts, driveway drains, and types of yard drains identified.
9. Answers to interview questions regarding:
 - a. Number of years owner has owned property.
 - b. Number of basement flooding occurrences.
 - c. Factors that may have caused basement flooding, if any.

10. Status of building, in violation or in compliance.

An example data sheet for building inspection is shown in Figure 4-5.

NEW CONSTRUCTION INSPECTION

General

New construction of sewer system components in the public and private sector must be thoroughly inspected before they can be accepted and put into service as part of the sewage collection system. As well as assuring compliance with plans, specifications, local plumbing ordinances, and safety regulations, early inspection will alert personnel to any unexpected modifications that have been made to the plans. Inspection of new construction will also decrease the need for future maintenance, and when documented will also provide a record of construction progress useful for future maintenance which may be required. It is important to remember to record any new data generated due to construction on the existing sewer maps. This should be done as quickly as possible. Remember to give new sewers and new manholes their own unique identification numbers.

Inspection of New Sewers

Inspections during the construction of new sewers begins when the new sewer pipe is delivered to the construction site. The quality of the pipe delivered must be as specified. Pipe not meeting the specified quality requirements must be rejected. Inspections must continue during the pipe installation to ensure that the trenching operations, pipe laying procedures, and trench backfilling are all done in accordance with the specified requirements.

When the sewer pipe first arrives at the construction site it should be inspected for:

1. Proper unloading procedures. High impacts and point loadings on the pipe during unloading should be avoided.
2. Cracks or other defects that are visible.
3. Compliance with the specifications with respect to diameter, length, and thickness.
4. The specified pipe class.
5. Proper certification from the pipe supplier which states that the pipe supplied is in compliance with the pipe specifications.

As the sewer trench is being excavated for the open cut installation method inspect for:

1. Correct trench width at the bottom and top of the trench as specified for the type of pipe being installed.
2. A solid base at the bottom of the trench to place the pipe bedding on. Overexcavation may be required if the trench bottom is not suitable for supporting the sewer pipe. Stable material must be used to replace the unsuitable material removed.

DATE: _____ VIOLATION: YES NO ENTRY REFUSED
COMMUNITY: _____ INSPECTOR: _____
BUILDING TYPE: RESIDENTIAL COMMERCIAL INDUSTRIAL
ADDRESS: _____ OWNER: _____
BASEMENT: YES NO CRAWL SPACE: _____
SUMP PUMPS:

TYPE	DISCHARGE TO	SUMP BOTTOM SEALED?	TYPE	DISCHARGE TO
			A. SANITARY	SANITARY SEWER
			B. STORM	STORM SEWER
			C. COMBINED	OUTSIDE SURFACE
			D. NONE	UNKNOWN

IF TWO OR MORE SUMPS EXIST, ARE THEY PIPED TOGETHER?

INFLOW SOURCE	NUMBER	DISCHARGE TO:
Foundation Drains		
Window Wells		
Stairwell Drain		
Floor Drain		
Downspout		Underground
Downspout		Surface
Yard Drains		
Driveway Drains		
Other (Specify)		

How long has owner lived there?
Have they experienced any sewer backups?
REMARKS:

FIGURE 4-5. EXAMPLE BUILDING INSPECTION DATA SHEET

During the pipe laying procedures inspect for:

1. Proper placement and compaction of pipe bedding. The bedding should be placed at the specified thickness, it should be firm, and placed uniformly at the proper grade to provide support under the entire length of the pipe barrel. Make sure the specified bedding material is being used.
2. Proper handling of pipe. Handling should not introduce high impacts or point loadings on the pipe.
3. Debris on the bell and spigot end of the two pipe sections being connected. The pipe ends should be cleaned before making each joint.
4. Proper seating of the joint gasket.
5. Debris left inside of the pipe. Before each pipe section is installed make sure rags, boards, buckets, tools, and other debris have been removed from the last section of pipe installed.

During the backfilling operations inspect for:

1. Proper placement and compaction of select granular backfill around the pipe. Be sure that backfill placement does not cause lateral or horizontal displacement of the pipe.
2. Large hard objects such as rock, in the backfill material that could induce damaging point loads on the installed pipe.
3. Proper compaction techniques. Compaction limits vary depending on the location of the sewer main. Backfill compaction can be tested with soil density meters.
4. Proper restoration of the ground surface to preconstruction conditions or other conditions as specified.

Sewer Acceptance Tests. Before accepting a newly constructed sewer main the sewer main should be tested for potential infiltration of groundwater, exfiltration of wastewater and intrusion of tree roots, using one or several common leakage tests. The sewers should also be checked for any obstructions that may exist.

One test for locating obstructions is done by pulling a cylindrical plug with a diameter equal to 95 percent of the pipes inside diameter through the pipe. The plug locates obstructions such as deflections, offsets, and protrusion of building sewer connections. This test is particularly helpful in the inspection of new construction of plastic sewer pipes which have a tendency to be more flexible and to become misaligned or deflected. Any obstructions identified should be repaired before accepting a sewer main for use.

Air testing can be used to locate potential leaks in pipes. An air compressor is used to pump air into a section of sewer pipe, raising the pressure inside the pipe to a value greater than the pressure on the outside of the pipe. If a leak is present, the air pressure inside the pipe will decrease. More specific procedures for air testing sewer lines are available from the American Society for Testing and Materials (ASTM). A drawback of air testing is that air can leak through smaller cracks than wastewater can, and the results of such a test can yield results indicating a more serious problem than actually exists. The results of air tests

can also be influenced by high groundwater conditions if the actual static groundwater level is not compensated for during the test.

Air testing sewers can be dangerous to personnel if proper safety precautions are not followed. If the sewer plugs are not installed properly or if the sewer line is accidentally covered the plugs can blow out and possibly cause severe injury. Therefore the following safety precautions should be observed:

1. The sewer plugs should be installed properly and be securely braced.
2. No one should be allowed in the trench or manhole while the air test is being performed.
3. Plugs should not be removed until the pressure has been reduced to equal the outside air pressure.
4. Do not overpressurize the sewer.
5. Install a pressure relief valve on the testing equipment to prevent the possibility of overpressurizing the sewer.

An infiltration test can be conducted on a new sewer if the groundwater elevation is known to be at least 4 feet above the top of the sewer pipe. A flow measuring device, typically a v-notch weir, is installed downstream of the new construction and flows are measured. If no leakage is measured the pipe passes the infiltration test. Based on the types of pipe material, and pipe joint design available today, infiltration rates can be limited to 50-200 gpd/inch-diameter-mile of sewer pipe or less.

If the groundwater level is less than 4 feet above the top of the pipe an exfiltration test can be performed by plugging the pipe at the manhole downstream of the test section and filling the test section with water. At the manhole upstream of the test section, the upstream sewer should also be plugged so that the manhole can be filled with enough water to exceed the groundwater level surrounding the test section. After a specified amount of time has passed, the water level in the manhole at the upstream end of the test section is measured and a leakage rate is determined. If the leakage rate is greater than the specified limit, the leaks must be located and repaired. This test is limited to sewers where no building services have been connected and where full lengths between manholes can be tested at one time.

Inspection of New Manholes

New manholes must also be inspected for any defects or potential problem areas. When a manhole is being constructed the following items should be inspected:

1. The manhole foundation. The manhole base whether cast-in-place or precast should be installed on a firm foundation.
2. The manhole barrel. Typically the manhole barrel is delivered to a construction site in the form of precast sections. Normally the sections are available in a range of lengths and diameters with manhole steps included. The barrel sections should be inspected for structural damage and the steps should be checked to make sure they are not loose.

3. The barrel joints. When the manhole barrel is assembled, the barrel joints should be made watertight by using elastomeric gaskets or a joint filler.
4. The manhole frame and cover. Make sure the manhole cover provided is the specified size. Make sure the frame and cover supplied meet the specifications for loading, especially if they will be subject to traffic loads. Make sure the frame and cover fit without rattling. Make sure the cover is as specified with respect to the number and type of pick holes.
5. The grading around the manhole cover. When the construction of a manhole is complete the grade around the manhole cover should not allow for water to pond over the manhole cover.
6. The connection between the manhole and sewer. Flexible gaskets and couplings are available for making connections to manholes which allow for some differential settlement which normally would break a pipe. Proper methods for connecting different material pipes to manholes must be observed.
7. The manhole steps. After a manhole has been constructed, the steps should be inspected to verify that they are secure and spaced properly.
8. The manhole channel and bench. The channel and bench should be inspected to make sure they were installed according to specifications.

Manhole Acceptance Tests. Before accepting a newly constructed manhole, it should be tested for infiltration. The manhole can either be visually inspected for infiltration if the groundwater level is known to be much higher than the bottom of the manhole or the manhole can be air tested. When a manhole does not pass an infiltration test, it should be repaired before accepting it. Manholes typically can be constructed so that infiltration rates should not exceed 0.1 gal. per hour/ft. diam./ft. static head.

Inspection of New Lift Stations

During the design of a new lift station, it is important to verify that considerations for maintenance and safety have been incorporated into the design. Some common safety and maintenance design features include:

1. Make sure access has been provided so equipment can be removed from the lift station.
2. Make certain that emergency lighting is available.
3. Make certain that adequate head room and floor space has been provided for performing routine maintenance.
4. Make sure hose stations have been provided for cleaning wet wells, sump pump wells, floors, etc.
5. Make sure proper ventilation has been provided.
6. Make sure the design has provided for safe access into wet wells and dry wells.

If a new lift station is being built, the following items should be inspected before accepting the station for use:

1. Inspect the electrical equipment and major circuits.
2. Verify the location of all electrical lines.
3. Inspect the pumps for correct direction of rotation, for proper alignment of drive and pump, and for clear suction and discharge lines.
4. Check that the engine has sufficient oil, water, and fuel.
5. Make certain that all controls are easily operated.
6. Pressure test suction and discharge piping for leaks.
7. Check to make sure the wet well is clean of debris.
8. Perform leakage tests on sluice gates and slide gates.
9. Load test standby generators.
10. Balance the ventilation system and check for proper operation.
11. Verify pump performance curves.
12. Inspect fences for security.
13. Make sure all paved surfaces adequately drain to the stormwater collection system.

Inspection of New Private Building Construction

When new buildings are constructed within an agency's service area the inside plumbing and service connection should be inspected. The inside plumbing should be inspected for compliance with local plumbing ordinances. Foundation drainage collected in basement or crawl space sumps should be discharged to the ground outside of the building or to a storm sewer. Downspouts, window well drains, driveway drains, stairwell drains, and other types of yard or area drains must be inspected to verify that they are not connected to the sanitary sewer system. Service laterals should be tested for infiltration and inspected for proper connection to the sewer main. The builder should be required to submit certification that all local plumbing codes have been complied with and that no illegal connections to the sanitary sewer system exist.

DYED WATER TESTING

General

In areas where problems exist with complaints and sewerage backups, dyed water tests may be required to identify sources of inflow that are difficult to locate with other inspection techniques. If problems do exist dyed water tests should be considered in areas where:

1. The storm sewers run parallel to or cross the sanitary sewers and service laterals and are located above the sanitary sewer system.
2. Stream sections, stormwater drainage ditches, and areas subject to ponding are located above the sanitary sewer system.
3. Flows from private property drains, sump pumps, and downspouts are suspected to be connected to the sanitary sewer system.

Testing Procedures

To conduct a dyed water test the following materials are needed:

1. Water Supply.
 - a. Fire hydrant.
 - b. Tanker truck.
2. Sandbags or sewer pipe plugs.
3. Fluorescent dyes selected on the basis of:
 - a. Safety in handling.
 - b. Easy to see at low concentrations.
 - c. Non-reactive with soils and debris in the sewers.
 - d. Biodegradability.
4. Portable flow metering equipment.

Before starting a dyed water testing program the testing crew must be trained or reminded of safety requirements for entering manholes. The testing personnel should also be advised of safety requirements necessary for using pipe plugs and fire hydrant hoses. Also the testing crew should be warned of potential overflows if certain sewer segments are plugged off. If applicable, traffic control and safety must also be considered.

To conduct dyed water tests on stormwater drainage systems the following procedures should be followed:

1. Block off the section of storm drain that is suspected to contribute inflow to the sanitary sewer system. For stormwater drainage ditches use sand bags and for storm sewers use sewer plugs.
2. Fill the storm sewer or stormwater drainage ditch with dyed water.

3. Observe the flow in the downstream sanitary sewer manholes for the presence of dye.
4. Measure flows in the downstream manhole before and during the dyed water tests.
5. If dye is detected in the sanitary sewer and the flowrate measured during the dyed water test increases significantly, the dyed water test should be repeated while a closed circuit TV camera is pulled through the sanitary sewer to identify the location of the sewer defect.

To conduct dyed water tests on private property drains the following procedure should be used:

1. Notify the building owner of the impending dyed water tests.
2. Pour dyed water down the suspect drain, downspout, or into the sump pump well.
3. Check the sewer flow for the presence of dye at the first downstream manhole in the sanitary sewer system.

Recording Testing Results

Dyed water testing results should be recorded on a data sheet for each test set up. The data sheet should include information such as:

1. The date.
2. The names of the personnel conducting the test.
3. The location of the setup. A sketch should be included on the data sheet which clearly indicates what was flooded with dyed water and the relationship to the sanitary sewer system. The sketch should include the manhole numbers where dye was checked for.
4. The type of setup,
 - Storm sewer.
 - Stormwater drainage ditch.
 - Catch basin.
 - Private property drain or discharge (specify type).
5. The time that flooding began and ended.
6. The time that dye was observed and the concentration of the dye.
7. The time that the checking for dye ended if none was observed.
8. Flow measurements (or depth of flow) before testing began and during the time dye was observed in the sanitary sewer.
9. The length of storm sewer or ditch that was flooded.

10. The diameter of the storm sewer flooded or general ditch dimensions.
11. The amount of water that was used for the set up.
12. Remarks related to the set up such as:
 - a. Soil conditions.
 - b. Previous weather conditions and weather conditions during the set up.
 - c. Unusual observations made during the test.
 - d. Problems encountered during the test.
 - e. Type and description of private property fixture that were tested.

An example data sheet for dyed water testing is shown in Figure 4-6.

SMOKE TESTING

General

In areas where complaints pertaining to the sanitary sewer system are common and in areas where sewers backup, smoke testing may be required to identify sources of inflow that are difficult to locate with other inspection techniques. Smoke testing is an inexpensive and simple preventive maintenance and troubleshooting tool. Sewer lines don't have to be cleaned prior to testing, and a smoke testing crew of 3 can test up to 10,000 feet of sewer per day. Smoke testing is also useful for tracing and verifying sewer map data. Like dyed water testing, smoke testing can locate cross connections between the storm and sanitary sewers, private property drains connected to the sanitary sewer, defective service connections, and defects in the public sewer mains.

Unlike dyed water testing, smoke testing has several limitations that may lead to false conclusions when smoke testing results are negative. When smoke testing produces negative results, it should not be assumed that the section of sanitary sewer tested is free of inflow sources. The following conditions will produce negative but inconclusive smoke testing results:

1. Sewer lines with sags or dips filled with water or sewer lines equipped with water traps.
2. High groundwater conditions where the groundwater level is above the sewer line.
3. Sewers that are flowing full.
4. If the soil above the sewer line is saturated, frozen, or covered with snow.
5. If it is very windy smoke rising from the ground may be dispersed by the wind before it can be detected.
6. If private sector drains have been installed with water traps.

Testing Procedures

The smoke testing technique involves blowing a large volume of smoke filled air through a manhole into the sanitary sewer collection system. The smoke follows the sewer main and other passageways leading to the ground surface, disclosing points of infiltration and inflow, stoppages, and breaks. The equipment required includes:

1. Portable air blower (normally gasoline powered) with a minimum capacity of 1,500 cubic feet per minute.
2. Camera and film.
3. Sewer line plugs and sand bags.
4. Sewer maps and/or plans.
5. Smoke bombs with 3-5 minute capacity.

Before a smoke testing program actually begins the following preliminary steps should be taken:

1. Personnel should be trained or reminded of manhole entry safety precautions (see Chapter 9).
2. Personnel should be trained in proper traffic control and safety methods.
3. Personnel should be trained how to use the smoke testing equipment including the safety aspects of using sewer plugs. Potential sewer backups when using plugs must also be addressed.
4. Alert the fire and police departments of the smoke testing schedule. Update them from time to time on the progress and if the schedule has changed.
5. Notify the property owners in the areas scheduled for smoke testing so that they will not be alarmed when smoke enters their building or rises from their yards.

The following procedures should be followed when conducting a smoke test:

1. Isolate the section of sewer to be testing by plugging adjacent sewer lines and sand bagging over manhole openings. Typically 1000 feet of sanitary sewer can be tested at a time.
2. Locate a manhole near the center of the test section for introducing smoke with the blower.
3. Begin blowing smoke through the system. The number of smoke bombs used depends on the size and length of the sewer section being tested.
4. The smoke should be generated constantly while visual inspections are made above the sewer line, and around private property. Special attention should

be given to storm sewer inlets, downspouts, driveway drains, and building foundations. Most buildings have vent stacks which should always smoke. If they do not there is probably a water trap in the service lateral. Suspect drains on these properties should then be tested with dyed water.

5. Take photographs of all locations where smoke was observed. Photographs should be taken while the smoke is rising. Each photo should be numbered for future reference.
6. When the smoke testing is complete, remove the sewer plugs following the necessary safety precautions.

Recording Testing Results

Smoke testing results should be recorded on a data sheet for each section of sanitary sewer tested. The data sheet should include information such as:

1. The date.
2. The names of the personnel conducting the test.
3. The two manholes between which the smoke test was done.
4. The length and diameter of the sewer section tested.
5. The manhole identification number for the manhole where the smoke was introduced to the sewer system.
6. The type of smoke bomb used.
7. Identification and description of smoke sources.
8. The photograph number for each smoke source.
9. An estimate of the area drained by each smoke source. Also include the type of surface area drained.
10. The address of buildings where no smoke was observed emerging from the vent pipes.
11. A sketch of the setup including:
 - a. The manhole identification numbers in the test section and the manhole where smoke was blown in.
 - b. The north arrow.
 - c. Locations of all smoke sources. The smoke sources should be tied to landmarks so they can be easily found again at a later date.
 - d. At each source of smoke the corresponding photograph number should be recorded.

An example data sheet for smoke testing is shown in Figure 4-7.

COMMUNITY: _____ DATE: _____

CREW NAMES: _____

Set-Up Information: Pipe Size Smoked: _____

Length of Pipe/MH to MH: _____ ft/ MH No. _____ to MH No. _____

Type of Smoke Bomb Used: _____ 3 min. _____ 5 min. _____ other _____

LEGEND		SKETCH OF SET-UP		
●	Sanitary MH			
○	Storm MH			
—	Sanitary Sewer			
.....	Storm Sewer			
Source of Smoke	Description of Source of Smoke (address/other)	Surface Type/Area Drained by Source of Smoke	Address Where Vent Pipes Showed No Smoke	Photo No.

POTENTIAL SOURCES OF SMOKE

- | | |
|------------------------|-----------------------|
| 01 Downspout | 07 Cracked Pavement |
| 02 Roof Drain | 08 Lateral |
| 03 Yard Drain | 09 Surface Over Sewer |
| 04 Catch Basin | 10 Sump Pump |
| 05 Storm Sewer Manhole | 11 Foundation Wall |
| 06 Manhole Frame | 12 Driveway Drain |
| | 13 Other - Describe |

Additional Observations: _____

FIGURE 4-7. EXAMPLE SMOKE TESTING DATA SHEET