BS EN 13508-1:2012

BSI Standards Publication

# Investigation and assessment of drain and sewer systems outside buildings

## Part 1: General Requirements

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**National foreword**

This British Standard is the UK implementation of EN 13508-1:2012. It supersedes BS EN 13508-1:2003 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/505, Wastewater engineering.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.



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**Compliance with a British Standard cannot confer immunity from legal obligations.**

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# Investigation and assessment of drain and sewer systems outside buildings - Part 1: General Requirements

Investigation et évaluation des réseaux d'assainissement à l'extérieur des bâtiments - Partie 1: Exigences générales

Untersuchung und Beurteilung von Entwässerungssystemen außerhalb von Gebäuden - Teil 1: Allgemeine Anforderungen

This European Standard was approved by CEN on 18 August 2012.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

**Management Centre: Avenue Marnix 17, B-1000 Brussels**



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# Foreword

This document (EN 13508-1:2012) has been prepared by Technical Committee CEN/TC 165 “Waste water engineering”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13508-1:2003.

This European Standard, EN 13508, *Investigation and assessment of drain and sewer systems outside buildings*, contains the following parts:

— *Part 1: General requirements* (the present document)

— *Part 2: Visual inspection coding system*

Other parts, dealing with other investigation and assessment aspects may be added later.

In drafting this document, account has been taken of other available standards, in particular EN 752, *Drain and sewer systems outside buildings*.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# Introduction

Drain and sewer systems are part of the overall wastewater system that provides a service to the community.

This can be briefly described as:

— removal of wastewater from premises for public health and hygienic reasons;

— prevention of flooding in urbanised areas;

— protection of the environment.

The overall wastewater system has four successive functions:

— collection;

— transport;

— treatment;

— discharge.

Drain and sewer systems provide for the collection and transport of wastewater.

Historically, drain and sewer systems were installed because there was a need to remove the polluted water to prevent diseases.

Traditionally, drain and sewer systems were constructed to collect and transport all types of wastewater together, irrespective of the initial source. This led to difficulties in handling the peak flows in times of heavy rainfall and to the introduction of combined sewer overflows, which discharged polluted water to surface receiving waters.

Although many drain and sewer systems started out as combined systems there are arguments for considering the separation of foul wastewater and surface water. The pollutant effects are not the same and the separation of effluents allows for the different treatment for each element of wastewater, providing more environmentally friendly solutions.

This concept is included in the approach of integrated sewer system management.

EN 752 provides a framework for the design, construction, rehabilitation, maintenance and operation of drain and sewer systems outside buildings. This is illustrated in the upper part of Figure 1. EN 752 is supported by more detailed standards for the investigation, design, construction, organisation and control of drain and sewer systems such as those listed in the lower part of the diagram.

This standard is one of a number of standards which support the general principles set out in EN 752. The relationship between these standards is illustrated in Figure 1.

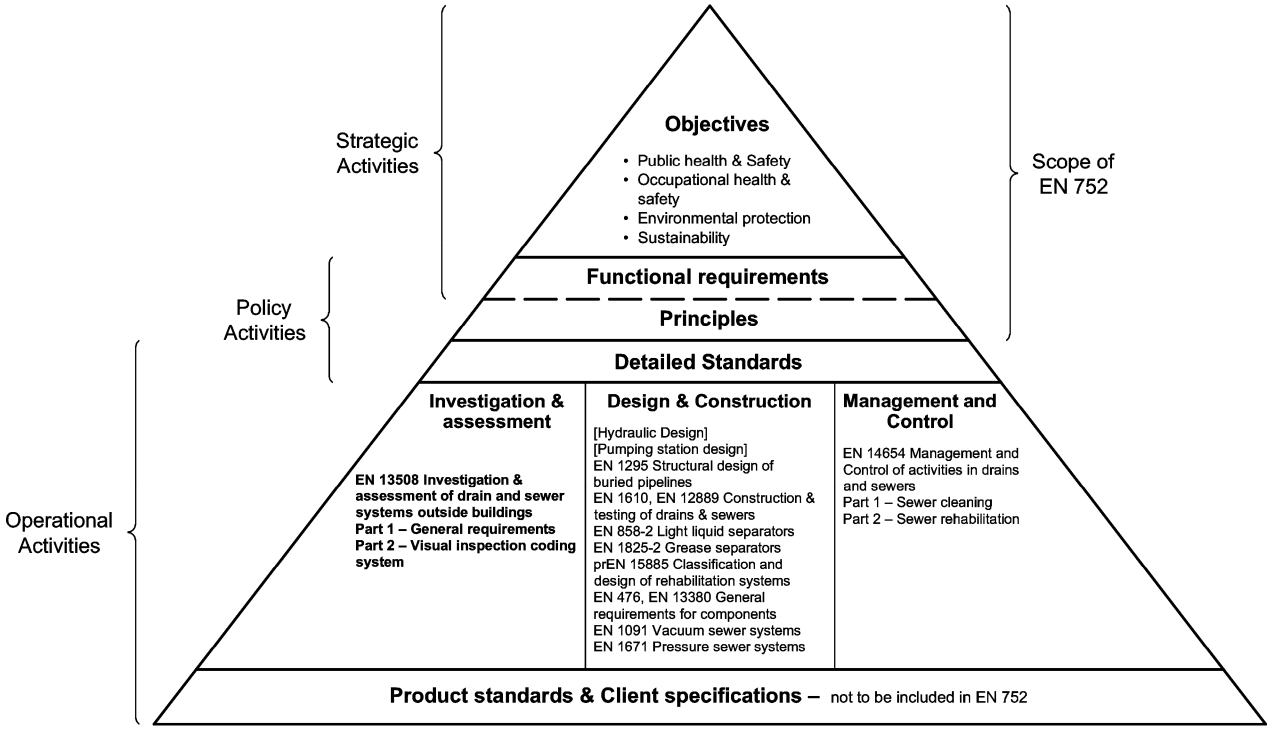


**Figure 1 — Relationship between EN 752 and other drain and sewer standards**

# 1 Scope

This European Standard is applicable to the investigation and assessment of drain and sewer systems outside buildings. It is applicable to drain and sewer systems, which operate essentially under gravity, from the point where the sewage leaves a building or roof drainage system, or enters a road gully, to the point where it is discharged into a treatment works or receiving water. Drains and sewers below buildings are included provided that they do not form part of the drainage system of the building.

This part of this European Standard specifies general requirements for the investigation and assessment of drain and sewer systems outside buildings.

# 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 752:2008, *Drain and sewer systems outside buildings*

EN 13508-2, *Investigation and assessment of drain and sewer systems outside buildings — Part 2: Visual inspection coding system*

EN 14654 (all parts), *Management and control of cleaning operations in drains and sewers*

# 3 Terms and definitions

For the purposes of this document, the following term and definition together with those given in EN 752:2008 apply.

**3.1**
**resilience**
ability of a component or group of components to continue to perform or quickly recover from an endangering incident

# 4 General

EN 752:2008, Clause 6, describes the process for integrated sewer system management. This process involves the integrated planning of the rehabilitation, maintenance and operation of existing drain and sewer systems.

This European Standard specifies general requirements for the investigation and assessment of aspects of the integrated sewer system management procedure (see Figure 2) to establish the condition of drain and sewer systems. This process can be applied to the development of the integrated sewer system management plan in accordance with EN 752:2008, Clause 6, as well as in the development of programmes of work and projects in accordance with EN 14654 (all parts).

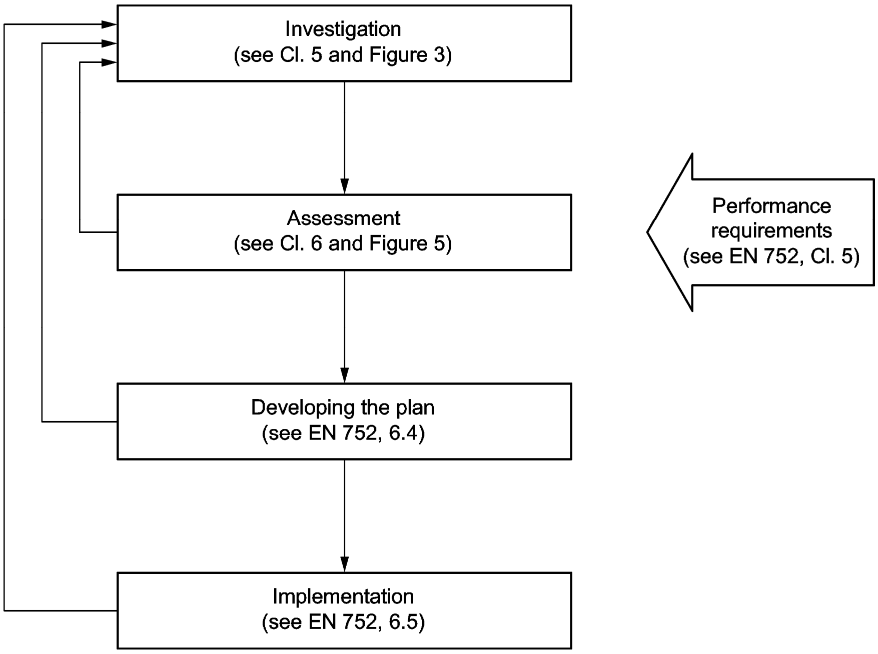


**Figure 2 — Integrated sewer system management process**

The investigation and assessment can be used in developing the integrated sewer system management plan which includes the

— new development plan,

— rehabilitation plan,

— operational plan and

— maintenance plan.

It can also be used in the development of any programmes and projects to implement the integrated sewer system management plan (see EN 14654, all parts). The approach can also be applied at different levels of complexity across a sewer system. For example, it can be applied at a strategic level across a large catchment (e.g. a whole city) and then at a more detailed level in the major sub-catchments and also at the still more detailed level of individual components.

The performance of the system can be measured in terms of the functional requirements of the system listed in EN 752:2008, 5.1 (for example protection from flooding, protection of surface receiving waters and maintaining the flow etc.). In some cases, it is only possible to determine the performance at one of the strategic or sub-catchment levels of detail (for example protection from flooding). In other cases, performance can be determined at the component level (for example maintaining the flow).

The investigation and assessment of a drain and sewer system and its components is a necessary part of the process of the establishment of the condition and the performance of the system. The components can include:

a) gravity drains, sewers and ancillary structures such as manholes, inspection chambers, combined sewer overflows, tanks and outfalls;

b) pumping installation including rising mains, vacuum mains and associated control and monitoring equipment;

c) gullies and associated structures such as grit separators, light liquid separators and grease separators.

# 5 Investigation

## 5.1 Introduction

The process of investigation of drain and sewer systems is outlined in EN 752:2008, 6.2. This process is summarised in Figure 3. This process involves the investigation of the hydraulic, environmental, structural and operational condition of the system. This should be in an integrated manner as the results from many of the investigations will cover more than one of these aspects.

The stages of the investigation are described in more detail in Figure 3.

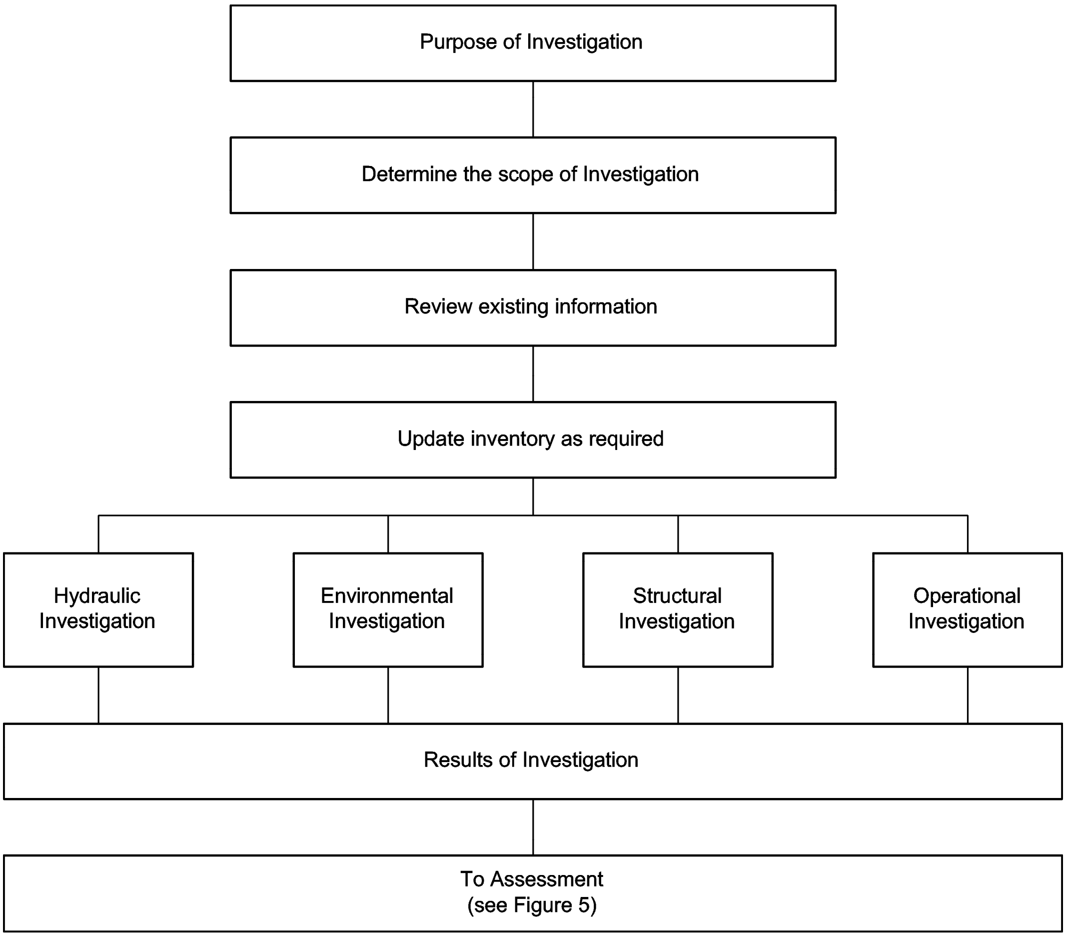


**Figure 3 — The process for investigation (based on EN 752:2008, Figure 6)**

## 5.2 Purpose of investigation

Prior to commencing the investigation, the purpose of the investigation should be established. The purpose of the investigation can include:

a) an investigation to establish an overview of the condition and performance of a drain and sewer system in order to produce an integrated sewer system management plan in accordance with EN 752:2008, Clause 6;

b) a more detailed investigation in order to establish a programme of measures to implement the proposals in an integrated sewer system management plan in accordance with EN 14654 (all parts);

c) investigation as part of the development of a specification for works to implement all or part of an integrated sewer system management plan;

d) the investigation of a drain or sewer system following an incident in order to determine the maintenance requirements;

e) an investigation of the resilience of a drain or sewer system to various hazards or threats.

### 5.3 Determine the scope of the investigation

The scope of the investigation should be determined, including:

a) the geographical extent of the investigation;

b) the level of detail at which the system is to be investigated (e.g. at strategic level of whole catchment, more detailed level of sub-catchment or detailed level of components);

c) which components of the system are to be included in the investigation;

d) which aspects of condition or performance are to be investigated for example:

   1) protection from flooding (see EN 752:2008, 5.1.2);

   2) maintainability (see EN 752:2008, 5.1.3);

   3) protection of surface receiving waters (see EN 752:2008, 5.1.4);

   4) protection of groundwater (see EN 752:2008, 5.1.5);

   5) prevention of odours and toxic, explosive and corrosive gases (see EN 752:2008, 5.1.6);

   6) prevention of noise and vibration (see EN 752:2008, 5.1.7);

   7) sustainable use of products and materials (see EN 752:2008, 5.1.8);

   8) sustainable use of energy (see EN 752:2008, 5.1.9);

   9) structural integrity and design life (see EN 752:2008, 5.1.10);

   10) maintaining the flow (see EN 752:2008, 5.1.11);

   11) watertightness (see EN 752:2008, 5.1.12);

   12) not endangering adjacent structures and utility services (see EN 752:2008, 5.1.13);

   13) inputs quality (see EN 752:2008, 5.1.14).

e) the extent to which each aspect of condition or performance is investigated;

f) the interactions with other parts of drain and sewer systems;

g) the external influences on the system and its components (e.g. soil conditions, traffic loads);

h) the interactions with other infrastructure (e.g. other utility services, urban environment);

i) the resilience of the system.

The scope should be set to enable the likelihood and consequences of all significant performance deficiencies to be described. Records of past incidents and any other relevant information should be brought together and a detailed review should be carried out to establish the scope of the investigations.

Past performance can be established from existing records, including:

i) records of flooding incidents;

ii) pipe blockage incidents;

iii) sewer collapse incidents;

iv) rising mains failures;

v) disease, injury or fatal incidents to operators;

vi) disease, injury or fatal incidents to members of the public;

vii) sewer damage incidents;

viii) compliance with discharge consents into and out of the system;

ix) closed circuit television (CCTV) survey and visual inspection data;

x) wastewater related odour complaint incidents;

xi) hydraulic performance analysis;

xii) performance of mechanical/electrical equipment;

xiii) results of monitoring, performance and condition of flow control structures;

xiv) sewer surcharge incidents;

xv) groundwater contamination incidents.

Information about possible future changes in the systems should also include:

— new developments;

— other infrastructure works.

The costs and benefits of collecting information and carrying out investigations should be considered, taking into account the known performance problems in the system and any requirements of the relevant authority.

## 5.4 Review existing information

The collection and review of all available relevant information about the sewer system shall be carried out and is the basis from which all other investigations are subsequently planned. This information should include historical records. In addition to the performance information listed in 5.3, examples are:

a) inventory, including the items listed in 5.5;

b) relevant permits and legal requirements;

c) previous operational, maintenance, structural and safety measures to overcome the problems and associated costs;

d) nature and quantities of trade effluent;

e) previous inspections;

f) previous hydraulic measurements (flow, depth, velocity);

g) results of previous hydraulic calculations or hydraulic models;

h) previous assessments of environmental impact;

i) existing drain and sewer condition data;

j) receiving water quality and use;

k) groundwater levels and velocities;

l) ground type and conditions including infiltration capacity;

m) groundwater protection zones;

n) previous test information;

o) characterisation of wastewater;

p) information on proposed new development or redevelopment within the catchment area;

q) records and forecasts of traffic volumes;

r) results of previous investigations.

Some of this information can be available from as-constructed drawings.

This information should be assessed to determine what further information is required in order to carry out the investigation.

Before use, the quality of the information should be assessed taking into account whether it is:

1) complete;

2) compatible;

3) accurate;

4) at a suitable scale;

5) consistent;

6) current;

7) credible.

Where there is insufficient information, the inventory should first be updated where required (see 5.5) and any other information should then be collected during the hydraulic investigation (see 5.6), environmental investigation (see 5.7), structural investigation (see 5.8), and operational investigation (see 5.9).

## 5.5 Update inventory as required

The inventory information is used by all the other investigations. Where the review of existing information (see 5.4) concludes that the inventory is incomplete it shall be updated so that a sufficient record of the drain and sewer system is available to carry out the other investigations. After review and updating, the inventory of the system should contain the following information, for example:

a) For each drain or sewer system:

   1) the type of system (e.g. combined system or separate system);

   2) whether the system is a gravity system, a pressure system or a vacuum system.

b) For each drain or sewer pipe:

   1) the location of the pipe;

   2) the depth of cover and invert levels at the upstream and the downstream ends of the pipe;

   3) the shape, size (e.g. diameter) and material.

c) For each manhole or inspection chamber:

   1) the cover level and invert levels;

   2) the dimensions and materials;

   3) the connecting pipes.

d) For each pumping station;

   1) the number and the flow and discharge pressure characteristics of the pumps;

   2) the dimensions of the wet well.

e) For each other ancillary structure:

   1) the dimensions of the structure;

   2) the connecting pipes;

   3) details of ancillary equipment (e.g. valves, flow controls).

The survey method used should reflect the scale and level of the investigation and can include:

   i) physical surveys (e.g. to determine the dimensions of accessible pipes, chambers and other features);

   ii) terrestrial survey techniques (e.g. to determine the location and level of the features);

   iii) global positioning system (GPS) for the position and level of surface features;

   iv) light detection and ranging (Lidar) is a technique for the determination of the surface profile of the ground from aerial surveys.

## 5.6 Hydraulic investigation

### 5.6.1 Introduction

The aim of the hydraulic investigation is to establish the hydraulic characteristics of the flow in the drain and sewer system, the available capacity in the system and the extent of any surcharge and flooding.

The investigation techniques include:

a) flow and water level measurement;

b) rainfall measurement;

c) hydraulic calculations;

d) other techniques.

### 5.6.2 Flow and water level measurement

Velocity and depth sensors can be used in drains and sewers to measure the flows. Long or short term flow measurements can be used to:

a) investigate the hydraulic characteristics of foul wastewater flows;

b) investigate the extent and location of entry infiltration;

c) investigate the extent and location of any other extraneous water e.g. flow through gaps in manhole tops (between the cover and frame) or wrong connections;

d) in combination with rainfall measurement (see 5.6.3) to validate hydraulic calculations (see 5.6.4).

The sensors used should be selected so that they are capable of achieving an acceptable accuracy over the full range of flow conditions expected. Measurement sites should be selected so that they avoid excessive turbulence or other factors which could lead to unacceptable measurement errors. Periodic checks should be carried out of the accuracy of the sensors.

### 5.6.3 Rainfall measurement

Rainfall measurement is commonly used in conjunction with flow measurement (see 5.6.2) to investigate the surface water and other rainfall related flows in the drains and sewers. The rainfall intensity should be measured at time intervals appropriate to the sewer flow simulation model being used.

Rainfall intensity across the catchment of a drain and sewer system can be measured using a network of recording raingauges which should be spaced sufficiently closely to measure the spatial variation in the rainfall. Where possible, use should be made of official meteorological recording stations. However, where these do not provide sufficient coverage, additional raingauges should be provided. Raingauges should be selected that are capable of accurately recording the expected rainfall intensities. The raingauge sites should be selected to minimise the effects of any local meteorological effects (e.g. local cross winds) that could adversely affect the accuracy of the measurements.

Alternatively temporary or permanent rainfall radar stations, calibrated from raingauge data, can be used to measure the rainfall intensity. The spatial resolution of the measurements will depend on the capabilities of the radar and the distance from the radar station.

### 5.6.4 Hydraulic calculations

Hydraulic calculations should be carried out where:

a) there are known hydraulic problems; or,

b) there are environmental problems that are suspected to be due to discharges from combined sewer overflows; or,

c) significant new developments are proposed within the system; or,

d) physical changes are proposed to the system.

Hydraulic calculations can be carried out at various levels of complexity from simple hand calculations to detailed mathematical models. The choice of method will depend on the scope of the investigation. In many cases it is not possible to understand the hydraulics of the system without using a mathematical model. The model should be based on an as-built report updated after onsite investigation of the main works.

A variety of sewer flow simulation models have been developed to assist in the investigation of drain and sewer systems. In all cases, the runoff process has been simplified.

Some models can also simulate surface flooding by one of two approaches:

— a simple 1-dimensional approach in which the flow is routed along a single predefined flow path;

— more complex 2-dimensional approaches in which the flow is routed across a surface which simulates the ground surface profile including any barriers (e.g. walls, embankments).

Calibration and/or validation of the models shall be carried out whenever sufficient information is available. The procedures used depend on the sewer flow simulation model used. If suitable agreement between the model and the measurements is not obtained, the model input data should be checked and then the sewer records. Having identified possible causes of error, it will often be necessary to confirm these by site inspection and then adjust the model accordingly. Data shall not be modified without justification based on an inspection of the system.

### 5.6.5 Other techniques

Other investigations can include:

a) Infra-red inspections – Groundwater infiltration is typically at lower temperatures than the wastewater flow in the sewer. Infra-red inspection can be used to identify locations where parts of the flow are at a lower temperature than the main flow and therefore potentially identify locations where there is infiltration.

b) Effluent dilution measurement – The extent of groundwater infiltration into the sewer system can also be determined by using sewer quality measurements (see 5.7.3) to estimate the dilution of effluent in dry weather flow.

c) Leaktightness testing (see 5.7.7) – Where infiltration is seasonal, depending on the groundwater level, the location of leaks during periods of low groundwater levels can identify locations where infiltration is likely to be found during higher groundwater periods.

d) Visual inspection (see 5.8.3) – Infiltration that occurs above the level of the flow in the sewer can be observed from visual inspection of the sewer. However, visual inspection cannot establish conclusively whether the whole structure is leaktight unless the whole of the pipe wall is visible and there is a high groundwater level at the time of the inspection. Visual inspections can also be used to provide information to estimate the pipeline roughness including, for example, the extent of deposits in the pipeline, and any deviations in line or level.

e) Testing for wrong connections – Smoke testing, sound testing, tracers and temperature measurements can be used to identify wrong connections.

## 5.7 Environmental investigation

### 5.7.1 Introduction

The environmental investigation can be used to investigate the impact of the drain and sewer system on the surface receiving waters and groundwater. It can also consider other environmental impacts including noise, odours and toxic gas emissions from the system.

The investigation can include:

— review of inputs quality;

— wastewater quality measurement;

— wastewater quality simulation modelling;

— surface receiving water impact surveys;

— leaktightness testing;

— groundwater quality investigations;

— odour and noise surveys.

The scale of the investigation should reflect the risk of environmental impact (see Clause 6) with regard to:

a) the possible sources of pollution (e.g. the presence of particularly toxic components in the wastewater, mechanical equipment that makes noise or a discharge from a long rising main that would be a source of septic sewage that might produce odours);

b) the existence of pathways that might exist to transfer these (e.g. the presence of a combined sewer overflow, a damaged pipe, a permeable soil around the pipe, or a ventilated cover); and

c) the nature and use of the receptors that might be impacted (e.g. a receiving water that is used for abstraction of drinking water, an aquifer protection zone or houses near to a source of noise or odour).

### 5.7.2 Review of inputs quality

The location of trade effluent sources and contaminated surface water sources shall be identified and the nature, quality, quantity and the potential environmental hazards reviewed to evaluate possible sources of pollution in the wastewater. Possible sources of information include:

a) information in trade effluent permits;

b) results from trade effluent monitoring samples;

c) results from other inputs sampling.

Where necessary, surveys shall be carried out to provide any data not available from records.

### 5.7.3 Wastewater quality measurement

The concentrations of a variety of determinants contained in wastewater can be established. This is usually carried out by the collection and analysis of wastewater samples. Samples can be individual samples taken manually or an auto-sampler can be used to collect samples at predetermined intervals for later collection and analysis. A number of sensors are now available that can undertake continuous monitoring of some determinants without the need to collect and analyse samples. Where these are used, care should be taken to ensure that they are suitable for installation in a sewer environment.

The determinants commonly measured in wastewater flows include: biological oxygen demand (BOD), total suspended solids (TSS), ammonia and conductivity. However, where other polluting materials (e.g. metals) are of concern, measurement of these determinants should also be considered.

Wastewater quality measurements can be used independently or they can be used to calibrate and/or validate wastewater quality simulations models (see 5.7.4).

### 5.7.4 Wastewater quality simulation modelling

Wastewater quality simulation models can be used to estimate the quality of any wastewater discharged into the environment (e.g. from surface water outfalls or combined sewer overflows).

Wastewater quality simulation models should be based on validated sewer flow simulation model of the system (see 5.6.4) and should be calibrated and validated by the use of measurements of wastewater quality (see 5.7.3), flow measurements and rainfall measurements (see 5.6.3). Different data sets should be used for calibration and validation.

### 5.7.5 Surface receiving water impact surveys

The impact of sewer systems on receiving waters can be an aesthetic impact, or a bio-chemical/ecological impact. Surveys can be undertaken to quantify the aesthetic pollution, to measure the concentrations of various determinants (e.g. BOD, TSS or Ammonia) in the surface receiving waters. The possibility of other sources of any pollution should be considered. Surveys can sometimes identify whether the impact is due to the drain or sewer system. However, in some cases this can only be established by means of a surface receiving water impact model.

### 5.7.6 Surface receiving water modelling

Models of the surface receiving water can be used to investigate the impact of any wastewater discharged into the environment (e.g. from surface water outfalls or combined sewer overflows). Surface receiving water impact models should be based on validated flow simulation model of the surface receiving water and should be calibrated and validated by the use of measurements of water quality (see 5.7.3), flow measurements (see 5.6.2) and rainfall measurements (see 5.6.3). Different data sets should be used for calibration and validation.

### 5.7.7 Leaktightness testing

Investigations can be required to determine where leakage from drains and sewers is affecting groundwater quality, giving priority to drains or sewers which pass through aquifer protection zones or where they carry particularly hazardous substances.

The following test methods are available for leaktightness testing:

a) the pressure test with air;

b) the pressure test with water;

c) the vacuum test;

d) infiltration measurements.

Testing requirements and acceptance criteria for existing drains and sewers can be specified by the relevant authority. EN 1610 [1] gives test requirements for new pipelines including pressure tests with air and with water. These can also be used for existing pipelines with or without modification.

### 5.7.8 Groundwater quality investigations

Measurements of groundwater quality can be used to identify the potential impact of the drain and sewer system on aquifers. The possibility of other sources of any pollution (e.g. surface spillage of chemicals) should be considered. It is often possible to identify whether an impact comes from the drain or sewer system by measuring the concentrations of certain determinands that are only commonly found in the effluent.

#### 5.7.9 Odour and noise surveys

Odour measurements (e.g. by olfactometry) can be mapped and compared to wind directions in order to identify the potential sources of any odours.

Noise and/or vibration surveys can be undertaken to establish the source and impact of any noise or vibration that could be related to the sewer system.

### 5.8 Structural investigation

#### 5.8.1 Introduction

The aim of the structural investigation is to establish the structural integrity of the components of the drain or sewer system. This is usually undertaken by means of an inspection programme using visual inspection. This can be supplemented where appropriate by other more specialist techniques. These are illustrated in Figure 4.

#### 5.8.2 Prepare inspection programme

An inspection programme can involve the inspection of all components or a sample of components. The approach taken will depend on the purpose of the investigations (see 5.2). Sampling techniques can also be used to prioritise the inspection where the inspection of all components is being phased over an extended period. Where a sample of components is inspected, the objectives of the inspection programme can influence the sampling regime.

The objectives of the inspection programme typically include the following:

a) To obtain an overview of the condition of the whole system (e.g. the average proportion of pipes or manholes in poor condition). In this case the sample shall be selected so that it is representative of the whole system.

b) To identify locations where structural rehabilitation (renovation, repair or replacement) is necessary. In this case the sample would ideally be biased towards those parts of the system in poor condition.

c) Visual inspection of those parts of the system where the consequences of structural failure are highest.

d) Visual inspection carried out as part of the hydraulic, environmental or operational investigations. This can also influence the inspection programme.

The sampling approaches for one objective can be incompatible with the approach for another objective. Where there is a number of different objectives the sample selection needs to be considered carefully, for example, in some cases the use of a stratified sampling approach in which the system is divided into different groups of assets with similar attributes, called cohorts. Inspection of a representative sample of the assets in each cohort is then carried out. The proportion of assets inspected in each cohort can be varied to reflect the different objectives while maintaining a statistically representative sample. For structural investigation methods see Figure 4.

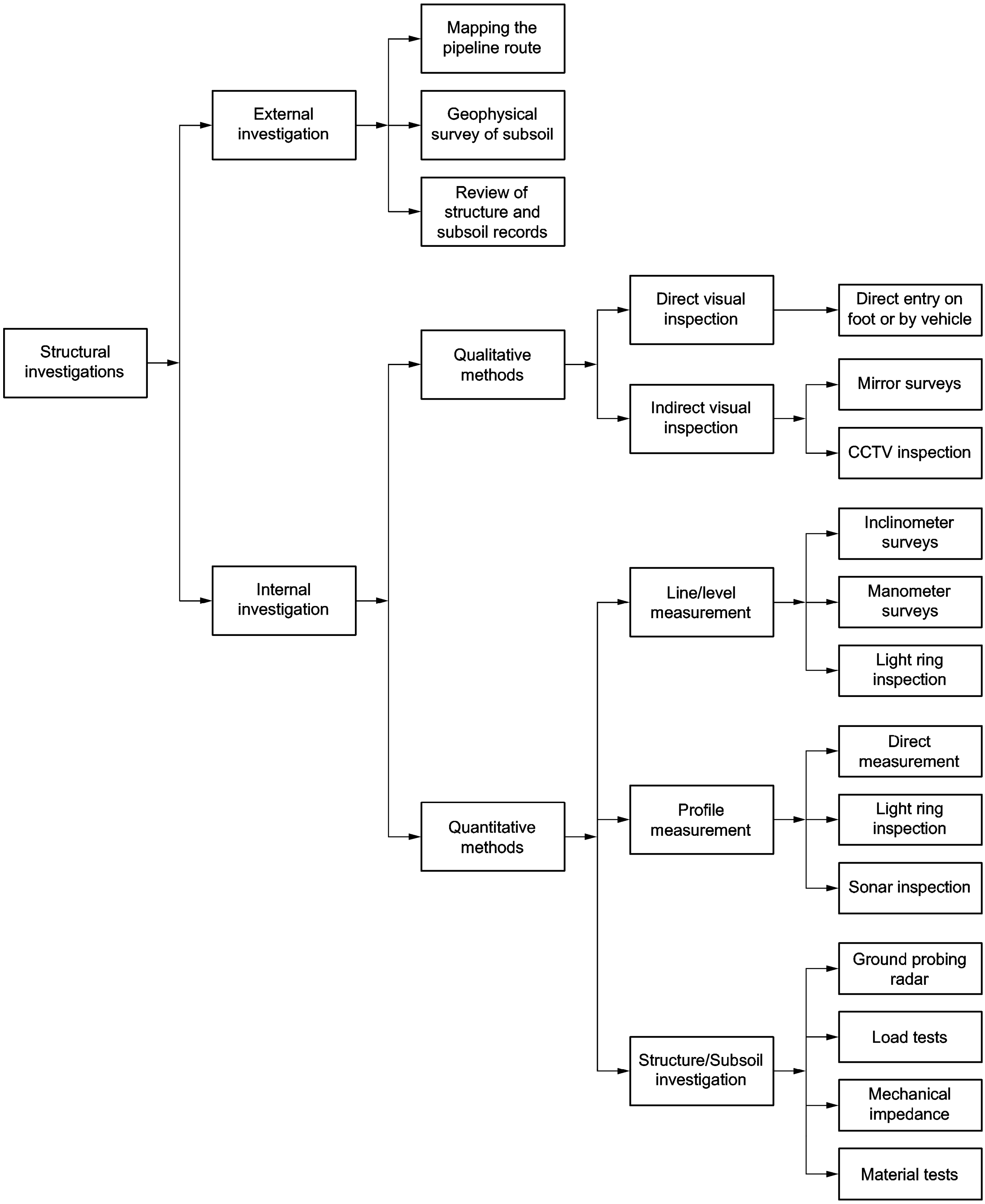


**Figure 4 — Structural investigation methods**

### 5.8.3 Visual inspection

The condition of the system shall be observed and recorded as accurately and comprehensively as practicable. A uniform coding system complying with the requirements of EN 13508-2 shall be used to ensure that the results can be compared.

NOTE EN 13508-2 gives requirements for the method of recording observations from inspections. It does not give requirements as to which observations should be recorded.

The observations recorded shall include all those that could affect the structural integrity of the system.

Examples include:

a) cracks and fractures;

b) deformation;

c) displaced joints;

d) defective connections;

e) roots, infiltration, settled deposits, attached deposits and other obstacles;

f) subsidence;

g) defects in manholes and inspection chambers;

h) mechanical damage or chemical attack.

The visual inspection can be carried out in one of the following ways:

1) inspection of the pipeline from within the pipeline;

2) inspection of the pipeline from within the manhole or inspection chamber;

3) inspection of the manhole or inspection chamber from within the manhole or inspection chamber;

4) inspection of the manhole or inspection chamber from the surface.

Several inspection techniques can be used such as:

— remotely controlled CCTV camera;

— man entry;

— mirrors;

— photographic camera.

Wherever practicable, the recording of the structural condition of drain and sewer systems should be carried out by an indirect system (e.g. closed circuit television (CCTV) system) in order to avoid personnel entering the system (see EN 752:2008, Clause 7). Where it is not possible to obtain sufficient information from indirect inspection then direct inspection (e.g. by walking through the pipeline) may be used. National regulations or the relevant authority can give requirements for the circumstances in which direct inspection may be used. The drain and sewer system shall be cleaned as necessary to make it possible to record and assess the actual condition. The nature and quantity of any material removed can be relevant to the structural investigation. During the survey, the system shall be kept free from wastewater as far as necessary.

### 5.8.4 Other techniques

Other investigations can include:

a) Profile measurement by sonar inspection – Sonar inspection can be used to determine the cross sectional profile of a submerged sewer. This can be used to identify deformation of the wall of the drain or sewer.

b) Profile measurement by light-ring surveys – Light ring surveys involve projecting a ring of light from a laser onto the wall of a pipe and recording the shape of the projected image of the ring on the pipe wall by visual inspection. Processing of the recorded image can be used to accurately determine the shape of the pipe and the amount of deformation.

c) Ground probing radar inspection – Radar inspection can be used to evaluate the thickness of the structure and identify the presence of cavities. When pulse electromagnetic very high frequency comes up against variable dielectric parameters in the material, it is partially reflected and picked up by receiver antenna. The distance covered in a specified time and the amplitude of the signal picked allow to the user to plot a radar profile.

d) Loading Test – Internal jacking can be carried out to measure mechanical resistance applied by the soil and the wall of the pipe. This is used to evaluate the rigidity of a pipe by measuring its deformation.

e) Mechanical Impedance Method – This method is used to identify the presence of cavities, by analysis of the vibratory response of impacted structure. The signals collected (strength and vibrations) and processed allow the user to plot mobility curves as a function of the frequency and to work out particular values such as local or global stiffness (to qualify the structure) and structural absorption (to locate cavities behind the structure).

f) Materials tests – Testing of the materials in the fabric of the drain and sewer system can be carried out to determine the residual strength e.g. by removal of a core or other sample for testing in the laboratory or by use of a hammer. This can be used where there is material degradation e.g. due to biological oxidation of hydrogen sulphide from septic wastewater in contact with cementitious or ferrous materials. Structural calculations should then be used to establish whether the material has sufficient strength.

g) Wastewater quality measurement – Analysis of the nature of the wastewater (see 5.7.3) can be used to detect the presence of chemicals that might be detrimental to the drain or sewer system e.g. the effect of septicity on cementitious materials and the effect of some solvents on plastics.

h) Watertightness testing (see 5.7.7) – Watertightness testing can be used to establish the potential for creation of voids due to small soil particles around the sewer being washed into the pipe, consequently reducing the ground support.

i) Infra-red inspections – Infra-red inspections can also be used to identify the locations of infiltration which might cause the formation of voids and loss of support to the drain or sewer.

j) Inclinometer surveys – Inclinometer surveys can also be used to establish the longitudinal profile of the pipe and any subsidence that could have occurred.

k) Smoke testing – Smoke testing is a method where smoke is introduced into a drain or sewer. Smoke discharges from the joints, holes or wrong connections.

## 5.9 Operational investigation

### 5.9.1 Introduction

The operational investigation involves the investigation of the extent of operational activities and the effects of operational failures. EN 752:2008, Clause 11, requires that all operational failures and activities are recorded.

Operational activities can include:

— routine inspections;

— routine cleaning;

— rodent baiting;

— cockroach control.

Operational records can include:

— blockages in drains, sewers, pumps, valves etc. and their effects;

— complete structural failure of components of the system (e.g. sewer collapse, rising mains burst) and their effects;

— failures of mechanical and electrical equipment (e.g. pumping stations) and their effects;

— failure of other ancillary equipment (e.g. non-return valves, flow control devices);

— pollution events.

#### 5.9.2 Review operational activities

Records of operational activities should be reviewed to establish the frequencies, costs and effectiveness of the activities.

#### 5.9.3 Review events

Records of operational events should be reviewed to establish the frequency of occurrence and the consequences in particular types of component. The analysis should be used to identify those parts of the system at greatest risk of operational failure and to investigate the causes.

#### 5.9.4 Other investigations

Other investigations can include:

a) Inclinometer surveys - can also be used to establish the longitudinal profile of the pipe and any subsidence that could be causing blockage.

b) Sonar inspection – can be used to determine the extent of submerged sediments in drains or sewers.

c) Visual inspection (see 5.8.3) – can be used to identify sediment levels, grease and other debris in the sewer and to identify features in the drain or sewer system which could be causing blockages.

d) Wastewater quality measurements (see 5.7.3) – can be used to establish whether problems could be caused by the nature of individual inputs (e.g. of trade effluent) or a combination of inputs.

## 6 Assessment

### 6.1 Introduction

The assessment involves evaluation of the performance against the performance requirements. The assessment is used to determine the priority and type of measures that should be taken (see EN 752 and EN 14654 (all parts)). The assessment of the performance should involve consideration of both the frequency and the consequences of each type of performance failure. This involves understanding the performance requirements (see EN 752:2008, 5.2). The performance requirements should cover the following functional requirements:

a) protection from flooding (see EN 752:2008, 5.1.2);

b) maintainability (see EN 752:2008, 5.1.3);

c) protection of surface receiving waters (see EN 752:2008, 5.1.4);

d) protection of groundwater (see EN 752:2008, 5.1.5);

e) prevention of odours and toxic, explosive and corrosive gases (see EN 752:2008, 5.1.6);

f) prevention of noise and vibration (see EN 752:2008, 5.1.7);

g) sustainable use of products and materials (see EN 752:2008, 5.1.8);

h) sustainable use of energy (see EN 752:2008, 5.1.9);

i) structural integrity and design life (see EN 752:2008, 5.1.10);

j) maintaining the flow (see EN 752:2008, 5.1.11);

k) watertightness (see EN 752:2008, 5.1.12);

l) not endangering adjacent structures and utility services (see EN 752:2008, 5.1.13);

m) inputs quality (see EN 752:2008, 5.1.14).

The performance requirements considered shall be those determined in the scope of the investigation (see 5.3).

Performance indicators are one way of measuring compliance with performance requirements either at object or system level as appropriate.

The assessment should be based on the risk of performance deficiencies taking into account the probability of each potential performance deficiency (details are given in 6.2) and the consequences of the performance deficiency if it was to occur (details are given in 6.3).

The assessment process is summarised in Figure 5.

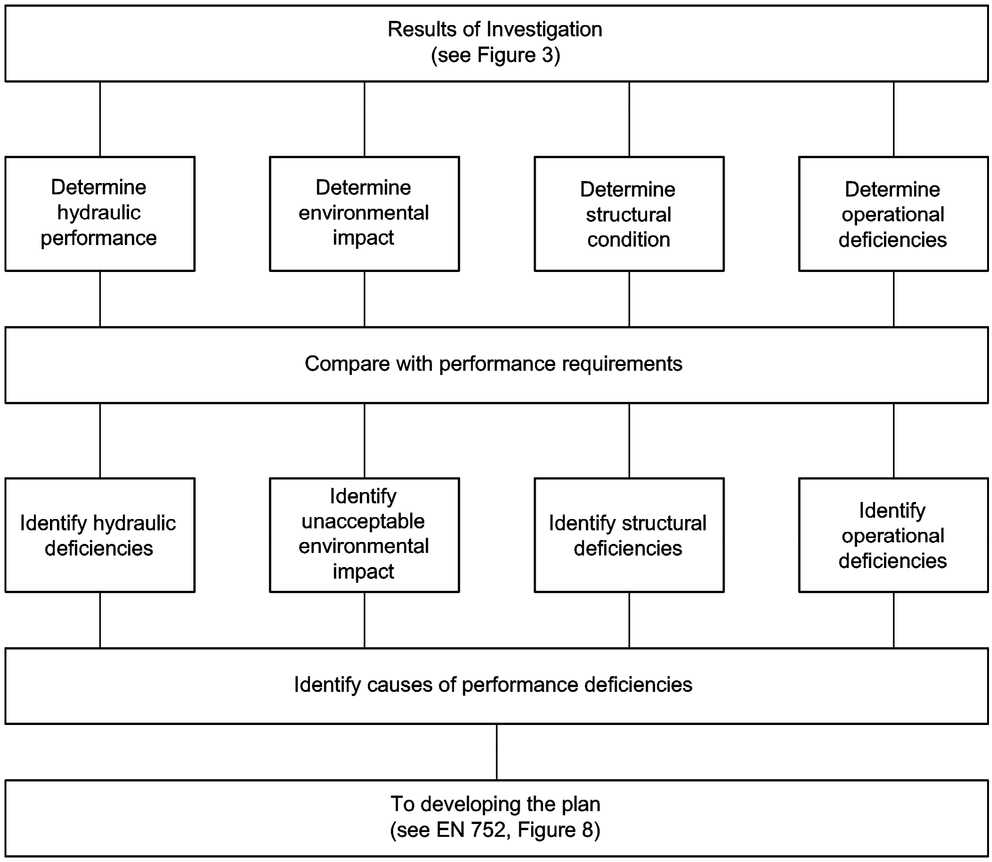


**Figure 5 — The assessment process**

## 6.2 Performance deficiencies

### 6.2.1 Introduction

Knowledge of the possible performance deficiencies is necessary in order to assess the performance.

The likelihood of performance deficiencies should be established from the results of the investigation (see Clause 5). Some performance deficiencies will relate to an individual component, other will relate to groups of components or wider parts of the system. Performance deficiencies that are usually related to individual components are considered by type of component as follows:

— drains and sewers, gullies, manholes and inspection chambers (see 6.2.2);

— combined sewer overflows and detention tanks (see 6.2.3);

— pumping stations, rising mains and vacuum mains (see 6.2.4).

Hydraulic capacity, which usually relates to groups of components or wider parts of the system, is considered in 6.2.5.

### 6.2.2 Drains and sewers, gullies, manholes and inspection chambers

All likely performance deficiencies shall be considered including the following:

a) Environmental – Defective joints or other defects causing leaks. Where there are no legal requirements for testing, a consideration of the likely effect of any leaks (see 7.4) may be useful in determining whether testing is necessary. Leaks may cause infiltration of groundwater into the component or exfiltration.

b) Structural -

  1) Collapse of the component, which could cause blockage or subsidence. The likelihood of collapse should be considered taking account of all relevant factors including the:

    i) observed structural condition of the component;

    ii) type of soil;

    iii) whether there is ingress of soil;

    iv) presence of infiltration or evidence of exfiltration;

    v) loading on the pipeline.

  2) Corrosion of the pipeline.

  3) Wear and tear of the material.

c) Operational -

  1) Complete or partial blockage of the element component. When considering the likelihood of blockage, the following factors should be taken into account:

    i) the likelihood that a partial obstruction will increase;

    ii) the likelihood that an existing defect could cause a blockage.

  2) Other operational or safety defects, for example defective steps and ladders, and defective or displaced covers.

#### 6.2.3 Combined sewer overflows and detention tanks

In addition to those listed in 6.2.2, the following performance deficiencies can occur:

a) complete or partial blockage of the continuation pipe;

b) complete or partial blockage of flow control devices or screens;

c) poor efficiency in retaining solids in the drain or sewer system;

d) electrical or mechanical failure;

e) unplanned build up of sediment.

#### 6.2.4 Pumping stations, rising mains and vacuum mains

In addition to those listed in 6.2.2, the following performance deficiencies can occur:

a) complete or partial blockage of pumps or pipes;

b) electrical or mechanical failure of the pumps, motors or ancillary equipment;

c) power supply failure;

d) complete blockage of flow control devices or screens;

e) failure of valves (including air valves, non-return valves, washout valves and gate valves);

f) rupture of the pipeline;

g) septicity.

### 6.2.5 Insufficient hydraulic capacity

Insufficient hydraulic capacity to convey the current flow requirements is a performance deficiency. In a complex system it is not always possible to attribute a hydraulic problem to a lack of capacity in a single pipe. In such instances this aspect of performance can only be dealt with in terms of the system as a whole.

## 6.3 Consequences of performance deficiencies

### 6.3.1 General

An understanding of the nature and extent of the consequences of performance deficiencies is necessary in order to assess the performance. Possible consequences of performance deficiencies shall be considered including the following.

### 6.3.2 Subsidence

Subsidence resulting from collapse or ingress of soil through a defect can cause damage to the road surface, other utility services, buildings or other structures.

The impact will principally depend on:

a) the proximity of the services or structures;

b) their susceptibility to damage.

### 6.3.3 Flooding

Flooding can result from excess flows or complete or partial blockage. The impact of flooding will principally depend on the:

a) point of egress of the flow;

b) overland route of the flow;

c) nature, use and extent of the areas affected;

d) duration of the flooding.

### 6.3.4 Pollution of groundwater and soil

Pollution of groundwater and soil can result from exfiltration caused by defects such as cracks, fractures or holes or from defective joints. The impact will principally depend on the:

a) permeability of the soil;

b) proximity and use of groundwater sources;

c) capacity of the soil to filter out pollutants;

d) nature of the sewage.

#### 6.3.5 Pollution of surface waters

Pollution of surface waters may be the result of exfiltration, flooding or discharges outside permitted limits from drain or sewers systems. The impact will principally depend on the:

a) quality and use of the surface water;

b) nature of the sewage;

c) rate of flow, duration and the dilution.

#### 6.3.6 Decreased treatment efficiency

Decreased efficiency of wastewater treatment plants may result from abnormal flow rates (e.g. due to infiltration, extraneous water etc.), from the abnormal nature of wastewater or from excessive variability in the nature of the wastewater.

#### 6.3.7 Other consequences

Other consequences can include:

a) direct financial costs (e.g. cost of rehabilitation or increased energy costs due to infiltration);

b) indirect financial costs (e.g. damage to buildings and contents);

c) social disruption;

d) public health or safety effects;

e) other environmental damage (e.g. odour, noise or vermin).

### 6.4 Causes of performance deficiencies

Using the information from the investigation (see Clause 5), the causes of all the performance deficiencies should be established. Where there is more than one potential cause then each cause should be investigated. For example, a blockage can be caused by the contents of the blockage, or some feature that caused it to collect at that point and flooding upstream of a pumping station can be caused by inadequate network capacity or reliability of the pumping station.

### 6.5 Reporting

The information and conclusions from the assessment should be summarised in a report.

# Annex A
(informative)

# Sources of additional information

The titles of the documents are translated for information. Only those documents where the title is marked with an asterisk (*) are available in the language of the title.

## A.1 Austria

### A.1.1 Austrian Water and Waste Management Association - Rules of Practice (ÖWAV - Österreichischer Wasser- und Abfallwirtschaftsverband - Regelblätter)

[1] ÖWAV-Regelblatt 21, *Kanalkataster,* 2. Auflage, 1998*
(en: ÖWAV-Rule 21, Documentation of sewer systems, 2nd edition, 1998)

[2] ÖWAV-Regelblatt 40, *Leitungsinformationssystem – Wasser und Abwasser*, 2010*
(en: ÖWAV-Rule 40, Pipeline Information System, Water and Wastewater, 2010)

[3] ÖWAV-Regelblatt 43, *Optische Kanalinspektion*, (in Arbeit, 2011)*
(en: ÖWAV-Rule 43, Optical Sewer Inspection, (in progress, 2011))

### A.1.2 Other guidelines

[4] *Technische Richtlinien für die Siedlungswasserwirtschaft* 2006 (Bundesministerium für Land- und Forstwirtschaft und Umwelt und Wasserwirtschaft)*
(en: Technical guidelines for water supply and wastewater systems 2006 (Federal Ministry for Agriculture, Forestry, Environment and Water Management))

## A.2 Denmark

[5] *Renovering af afløbsledninger- retningslinier for valg, dimensionering og udførelse*. 1989. Teknologisk Institut *
(en: Rehabilitation of sewer systems –guidelines for design and performance)

[6] *Renovering af afløbsledninger – retningslinier for dokumentaion og kvalitetskontrol*. 1993. Teknologisk Institut *
(en: Rehabilitation of sewer systems – guidelines for documentation and quality control)

[7] *TV-inspektion af afløbsledninger –standarddefinitioner og fotomanual*. 1997. Teknologisk Institut *
(en: CCTV-inspection of sewer systems – standard definitions and photo manual)

## A.3 Finland

[8] *Vesijohtojen ja viemäreiden saneeraustöiden yleinen työselitys* ISBN 952-5000-06-0*,
(en: Work specification for water and sewer system rehabilitation)

[9] *Vesijohtojen ja viemäreiden saneeraustöiden rakennuttamisasiakirjat* 2000 ISBN 952-5000-27-3*,
(en: Bidding documents for water and sewer system rehabilitation)

[10] *Viemäreiden ja vesijohtojen TV-kuvauksen teettämisohjeet* ISBN 952-5000-15-X*,
(en: Instructions for commissioning CCTV-inspection of sewer and water system)

[11] *Viemäreiden TV-kuvauksen tulkintaohje* ISBN 952-5000-50-8*,
(en: Decoding guide for sewer CCTV-inspection)

[12] *Vesihuoltoverkkojen suunnittelu – perusteet ja toiminnallisuus* ISBN 978-951-758-526-2*,
(en: Planning of water and sewer networks – criteria and functionary)

[13] *Vesihuoltoverkkojen suunnittelu – mitoitus ja suunnittelu* ISBN 978-951-978-521-7*,
(en: Planning of water and sewer networks – design and planning)

[14] *Kiinteistöjen tonttivesijohtojen ja -viemäreiden saneeraus* ISBN 952-5000-33-8*,
(en: Rehabilitation of houseconnection pipes)

[15] *Vesihuollon verkostojen ylläpidon perusteet* ISBN 952-5000-49-4*,
(en: Basics of maintenance for water and sewer networks)

## A.4 France

[16] *Recommandations pour la réhabilitation des réseaux d'assainissement, partie A inspection télévisée*, Cederom A.G.H.T.M., vol.1 édition 1998.*
(en: Recommendations for sewerage rehabilitation: part A TV inspection, Cederom A.G.H.T.M., vol 1 edition 1998)

## A.5 Germany

[17] DIN 1986-30, *Entwässerungsanlagen für Gebäude und Grundstücke - Teil 30: Instandhaltung*.*
(en: DIN 1986-30, Drainage systems on private ground - Part 30: Maintenance)

[18] ATV-DVWK-M 143-1, *Inspektion, Instandsetzung, Sanierung und Erneuerung von Entwässerungskanälen und - leitungen; Teil 1: Grundlagen*
(en: ATV-DVWK-M 143-1, Inspection, repair, rehabilitation and renewal of drainage sewers and pipelines — Part 1: Principles*)

[19] DWA-M 149-2, *Zustandserfassung und –beurteilung von Entwässerungssystemen außerhalb von Gebäuden; Teil 2: Kodiersystem für die optische Inspektion* *

DWA-M 149-2, Conditions and Assessment of Drain and Sewer Systems Outside Buildings — Part 2: Visual Inspection Coding System *

[20] DWA-M 149-3, *Zustandserfassung und –beurteilung von Entwässerungssystemen außerhalb von Gebäuden; Teil 3: Zustandsklassifizierung und –bewertung* *

DWA-M 149-3, Conditions and Assessment of Drain and Sewer Systems Outside Buildings — Part 3: Condition Classification and Assessment*

[21] DWA-M 149-4, *Zustandserfassung und –beurteilung von Entwässerungssystemen außerhalb von Gebäuden; Teil 4: Zustandserfassung durch Detektion von Lagerungsdefekten**

DWA-M 149-4, Conditions and Assessment of Drain and Sewer Systems Outside Buildings — Part 4: Detection of Bedding Defects and Cavities by Means of Geophysical Techniques*

[22] DWA-M 149-5, *Zustandserfassung und -beurteilung von Entwässerungssystemen außerhalb von Gebäuden - Teil 5: optische Inspektion**

DWA-M 149-5, Conditions and Assessment of Drain and Sewer Systems Outside Buildings — Part 5: Visual inspection*

[23] CD-ROM *Hydraulik-Expert – Hydraulische Berechnung von Kanälen und Sonderbauwerken in der Kanalisation**

CD-ROM Hydraulics-Expert – Hydraulic calculation of sewer pipes and sewer network structures[2)]

[24] CD-ROM Drain and Sewer Inspection Expert [2)]

[25] CD-ROM *Kanalinspektions-Expert – Durchführung und Beurteilung von Kanalinspektionen**

## A.6 Netherlands

[26] NPR 3218, *Buitenriolering onder vrij verval – Aanleg en onderhoud**
(en: Drainage and sewerage gravity systems outside buildings – Installation and maintenance)

[27] Ontwerp NPR 3219, *Buitenriolering – Aanduidingen op tekeningen**
(en: Drainage and sewerage outside buildings – Symbols for drawings)

[28] NPR 3220, *Buitenriolering – Beheer**
(en: Sewerage systems outside buildings – Management)

[29] NEN 3300, *Buitenriolering – Termen en definities**
(en: Drainage and sewerage outside buildings – Terminology)

[30] NPR 3398, *Buitenriolering – Inspectie en toestandsbeoordeling van riolen**
(en: Sewerage systems outside buildings – Inspection and condition assessment of sewers)

[31] NEN 3399, *Buitenriolering – Classificatiesysteem bij visuele inspectie van riolen**
(en: Sewerage systems outside buildings – Classification system for visual inspection of sewers)

[32] BRL K10014, *Reinigen van riolen, putten en kolken**
(en: Cleaning of sewers, manholes and gullies)

[33] BRL K10015, *Inspecteren van rioleringsobjecten**
(en: Inspection of sewer components)

[34] *Modules van de Leidraad Riolering**
(en: Parts from the Drainage and Sewerage Guideline)

[35] A 1050, *Inhoud en opzet gemeentelijk rioleringsplan**
(en: Content and intention municipal drainage and sewerage plan)

[36] A 1100, *Doelen, functionele eisen, maatstaven en meetmethoden**
(en: Targets, functional requirements, criterions and measure methods)

[37] A 2000, *Juridische aspecten bij rioleringsactiviteiten**
(en: Juridical aspects for drainage and sewerage activities)

[38] A 3000, *Taakafbakening rioleringszorg**
(en: *Demarcation of tasks for the drainage and sewerage concern)*

[39] A 3100, *Aansluitingen op de riolering**
(en: Connections to drainage and sewerage systems)

[40] A 3200, *Overdracht van afvalwater**
(en: Devolution concerning wastewater)

2) English language version is in preparation.

[41] B 1000, *Optimalisatie afvalwatersystemen**
(en: Optimalization of wastewater systems)

[42] B 1100, *Stelselkeuze en hoofdstructuur nieuwe riolering**
(en: Choice of system and main structure for new drainage and sewerage system)

[43] B 1200, *Verbetering bestaande riolering**
(en: Improvement of existing drainage and sewerage systems)

[44] B 2000, *Functioneel ontwerp**
(en: Functional design.)

[45] B 2100*, Alternatieven voor afvoer van hemelwater**
(en: Alternatives for drainage of rainwater

[46] B 3000, *Detaillering en aanleg**
(en: Specification and installation)

[47] B 3100, *Milieugerichte levenscyclusanalyse**
(en: Life time analyses with environmental impact)

[48] C 1000, *Wegwijzer operationele planning**
(en: Manual for operational planning)

[49] C 1100*, Operationele programma's**
(en: Operational programs)

[50] C 1200, *Hulpmiddel bij de keuze en volgorde van maatregelen**
(en: Aid for the choice and order of measures)

[51] C 2000, *Onderzoek en interpretatie van resultaten**
(en: Research methods and interpretation of results)

[52] C 2100, *Rioleringsberekeningen, Hydraulisch functioneren**
(en: Calculations of drainage and sewerage systems, Hydraulic functioning)

[53] C 2300, *Meten**
(en: Measurements for non-functioning)

[54] C 2400, *Inspectie en beoordeling**
(en: Inspection and assessment)

[55] C 3000, *Keuze en uitvoering van beheersmaatregelen**
(en: Choice and realization of management measures)

[56] C 4000, *Handhaving van goed rioolgebruik**
(en: Maintenance of good use of sewers)

[57] C 4100, *Incidentenplan riolering**
(en: Plan for incidents in drainage and sewerage systems)

[58] C 5000, *Doel en opzet van de informatievoorziening**
(en: Target and organization for the provision of information)

[59] C 5100, *Inventarisatie en beheer van gegevens**
(en: Stock-taking and data management)

[60] D 2000, *Personele aspecten van gemeentelijke rioleringszorg**
(en: Staff for municipal drainage and sewerage concern)

## A.7 Norway

[61] *Renovering av avløpsledninger. Retningslinjer for valg dimensjonering og utførelse* Norsk Rørsenter Nr. 4 *(1989)**
(en: Rehabilitation of sewer systems – Guidelines for design and performance)

## A.8 Sweden

[62] *TV-inspektion av avloppsledningar i mark*. Svenskt Vatten P93, Sept 2006 ISSN 1651-4947,
(en: Inspection of pipelines in sewer systems)

[63] *Inspektion av avloppsbrunnar*. Svenskt Vatten P103, mar 2010 ISSN 1651-4947,
(en: Inspection of manholes in sewer systems)

[64] *Schaktfritt byggande av markförlagda VA-ledningar av plast*. Svenskt vatten P101, nov 2010 ISSN 1651-4947.
(en: Trenchless Construction of water and sewer pipelines made by plastic pipe material)

## A.9 United Kingdom

[65] *Sewer Risk Management*[3] *WRc 2008*. Available at http://srm.wrcplc.co.uk *

[66] FR/CL0009*, Urban Pollution Management (UPM) Manual — A planning guide for the management of urban wastewater discharges during wet weather*. 2nd Edition Foundation for Water Research, Marlow 1998. FR/CL0009*

3) The Sewer Risk Management has superseded the Sewerage Rehabilitation Manual.

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