

Drain and sewer systems outside buildings

ICS 93.030

National foreword

This British Standard is the UK implementation of EN 752:2008. It supersedes BS EN 752, Parts 1 to 7, which have been withdrawn.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.

The British Standard contains both the text of the European Standard together with a National Annex, which gives further UK-specific guidance on the application of the European text. The European Standard should therefore be read in conjunction with the National Annex and, to assist in this, cross references to the clauses in the European text are included in the headings in the National Annex.

This revision of EN 752 includes some important and timely changes. It takes a more integrated view of sewer system management in the context of the wider urban drainage system and the wider water environment. This both supports the current initiative on integrated urban drainage management in the UK and is essential for the proper implementation of the Water Framework Directive. In response to climate change, the European text introduces the concept of exceedence flood risk assessment and further UK guidance on this is given in the National Annex.

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

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2008

© The British Standards Institution 2013.
Published by BSI Standards Limited 2013

ISBN 978 0 580 84887 2

Amendments/corrigenda issued since publication

Date	Comments
31 October 2009	Correction to N.A 5.8, value <i>b</i>
30 November 2013	National Annex NA revised

English Version

Drain and sewer systems outside buildings

Réseaux d'évacuation et d'assainissement à l'extérieur des
bâtiments

Entwässerungssysteme außerhalb von Gebäuden

This European Standard was approved by CEN on 24 November 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Foreword

This document (EN 752:2008) has been prepared by Technical Committee CEN/TC 165 “Wastewater 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 July 2008, and conflicting national standards shall be withdrawn at the latest by July 2008.

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 752-1:1995, EN 752-2:1996, EN 752-3:1996, EN 752-4:1997, EN 752-5:1997, EN 752-6:1998, EN 752-7:1998.

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

Contents

Page

1	Scope	10
2	Normative references	10
3	Terms and definitions	11
4	Objectives	19
4.1	General	19
4.2	Public Health and Safety	20
4.3	Occupational Health and Safety	20
4.4	Environmental Protection	20
4.5	Sustainable Development	20
5	Requirements	21
5.1	Functional Requirements	21
5.1.1	Introduction	21
5.1.2	Protection from flooding	22
5.1.3	Maintainability	22
5.1.4	Protection of surface receiving waters	22
5.1.5	Protection of groundwater	22
5.1.6	Prevention of odours and toxic, explosive and corrosive gases	23
5.1.7	Prevention of noise and vibration	23
5.1.8	Sustainable use of products and materials	23
5.1.9	Sustainable use of energy	23
5.1.10	Structural integrity and design life	23
5.1.11	Maintaining the flow	23
5.1.12	Watertightness	23
5.1.13	Not endangering adjacent structures and utility services	23
5.1.14	Inputs quality	23
5.2	Determination of performance requirements for the drain and sewer system	23
6	Integrated Sewer System Management	26
6.1	Introduction	26
6.2	Investigation	27
6.2.1	Introduction	27
6.2.2	Purpose of investigation	28
6.2.3	Review of performance information	28
6.2.4	Determine the scope of the investigation	30
6.2.5	Review existing information	30
6.2.6	Inventory update	31
6.2.7	Hydraulic investigation	31
6.2.8	Environmental investigation	31
6.2.9	Structural investigation	32
6.2.10	Operational Investigation	32
6.3	Assessment	33
6.3.1	Introduction	33
6.3.2	Assessment of the hydraulic performance	33
6.3.3	Assessment of environmental impact	33
6.3.4	Assess structural condition	34
6.3.5	Assess operational performance	34
6.3.6	Compare with performance requirements	34
6.3.7	Identify unacceptable impacts	34
6.3.8	Identify causes of performance deficiencies	34

6.4	Developing the Plan	34
6.4.1	Introduction.....	34
6.4.2	Develop integrated solutions	35
6.4.3	Assess Solutions.....	38
6.4.4	Prepare action plan	39
6.5	Implementation	40
6.5.1	Introduction.....	40
6.5.2	Carry out work	40
6.5.3	Monitoring performance	41
6.5.4	Review performance requirements and update plan.....	41
7	Health and Safety Principles	41
8	Design Principles	42
8.1	General	42
8.2	Types of systems	42
8.3	Layout and profile	43
8.4	Hydraulic Design	44
8.4.1	General	44
8.4.2	Foul drains and sewers.....	44
8.4.3	Surface water drains and sewers	45
8.4.4	Combined drains and sewers	47
8.5	Environmental Considerations	47
8.5.1	General	47
8.5.2	Protection of surface receiving waters	49
8.5.3	Protection of Groundwater.....	49
8.5.4	Prevention of septicity	49
8.5.5	Combined sewer overflows and surface water treatment.....	50
8.5.6	Emergency overflows	50
8.6	Structural Design.....	50
8.6.1	Introduction.....	50
8.6.2	Structural design of pipelines	51
8.6.3	Structural design of other components	51
8.6.4	Materials selection	51
8.7	Operational Considerations	52
8.7.1	General	52
8.7.2	Separators	52
8.7.3	Self-cleansing conditions.....	52
8.7.4	Access to drains and sewers	53
9	Detailed Design.....	53
9.1	Introduction.....	53
9.2	Layout and profile	53
9.2.1	Introduction.....	53
9.2.2	Layout	53
9.2.3	Accessibility.....	54
9.2.4	Depth.....	54
9.2.5	Need for pumping.....	55
9.2.6	Pumping Installations	55
9.3	Preliminary Investigations.....	56
9.3.1	General	56
9.3.2	Topography.....	56
9.3.3	Geotechnical Survey	56
9.3.4	Groundwater	57
9.3.5	Existing drainage services	57
9.3.6	Other existing utility services	57
9.3.7	Extraneous water.....	57
9.4	Hydraulic Design	57
9.4.1	Introduction.....	57
9.4.2	Foul drains and sewers.....	57
9.4.3	Surface water drains and sewers	58

9.4.4	Combined drains and sewers	58
9.4.5	Capacity of pipelines	59
9.4.6	Sewers with steep gradients	59
9.4.7	Outfall Design Requirements	60
9.5	Environmental Considerations.....	60
9.5.1	Introduction	60
9.5.2	Outfall Design Requirements	60
9.5.3	Prevention of septicity	60
9.5.4	Drains and sewers near water abstraction areas	61
9.6	Operational Considerations.....	61
9.6.1	Introduction	61
9.6.2	Separators	61
9.6.3	Design for self-cleansing	61
9.6.4	Access to drains and sewers	62
10	Construction Principles	63
10.1	General.....	63
10.2	Pipelines	63
10.3	Ancillaries.....	63
11	Operations and Maintenance.....	64
11.1	Introduction	64
11.2	Objectives.....	65
11.3	Data requirements	65
11.4	Investigation and analysis of operational problems.....	66
12	Performance testing	67
13	Qualifications and Training	67
14	Sources of Additional Information.....	68
Annex A	(informative) Relevant EU Directives	69
A.1	Introduction	69
A.2	Relevant Directives.....	69
Annex B	(informative) Sources of Additional Information.....	70
B.1	National Standards Bodies	70
B.2	Austria.....	70
B.2.1	Regulatory Bodies	70
B.2.2	Other organisations.....	70
B.3	Denmark.....	71
B.3.1	Regulatory Bodies	71
B.3.2	Other organisations.....	71
B.4	France	72
B.4.1	Regulatory Bodies	72
B.4.2	Other organisations.....	72
B.5	Germany	72
B.5.1	Regulatory Bodies	72
B.5.2	Other organisations.....	73
B.6	Ireland	73
B.7	Italy	73
B.7.1	Regulatory Bodies	73
B.7.2	Other organisations.....	73
B.8	The Netherlands.....	74
B.8.1	Regulatory Bodies	74
B.8.2	Other organisations.....	74
B.9	Norway	75
B.9.1	Regulatory Bodies	75
B.9.2	Other organisations.....	75
B.10	Portugal	75
B.10.1	Regulatory Bodies	75
B.10.2	Other organisations.....	76

B.11	Sweden	76
B.11.1	Regulatory Bodies	76
B.11.2	Other organisations	76
B.12	Switzerland	76
B.12.1	Regulatory Bodies	76
B.12.2	Other organisations	77
B.13	United Kingdom	77
B.13.1	Regulatory Bodies	77
B.13.2	Other organisations	79
Annex C	(normative) Operations and maintenance	80
C.1	Introduction	80
C.2	Operations planning	80
C.2.1	Inspection routines	80
C.2.2	Operations procedures	80
C.2.3	Contingency Planning	80
C.3	Pipelines	81
C.3.1	General	81
C.3.2	Functional problems	81
C.3.3	Structural problems	82
C.4	Manholes and Inspection Chambers	83
C.5	Combined sewer overflows	83
C.6	Detention tanks	84
C.7	Separators, settling chambers and gullies	84
C.8	Pumping installations	85
C.9	Inverted siphons	85
C.10	Pest control	86
C.11	Making connections to existing drains and sewers	86
C.12	Control of disused drains and sewers	87
C.13	Control of building over or adjacent to sewers	87
Annex D	(normative) Health and Safety	88
D.1	Safe systems of work	88
D.2	Training and supervision	88
D.3	Hazardous atmospheres	88
D.3.1	Oxygen deficient and toxic atmospheres	88
D.3.2	Potentially explosive atmospheres	88
D.4	Traffic control	89
D.5	Protective equipment and welfare facilities	89
D.6	Emergency procedures	89
D.7	Temporary works	89
D.8	Excavation work	89
D.9	Hazardous materials	90
D.10	Vaccinations	90
Annex E	(normative) Hydraulic Design	91
E.1	General	91
E.1.1	Introduction	91
E.1.2	Selection of Flow Simulation Method	91
E.2	Hydraulic calculations	92
E.2.1	Velocity equations	92
E.2.2	The Saint Venant equations	94
E.3	Methods of calculating runoff from small development schemes	96
E.4	Calculation of foul wastewater flows for drain systems	97
E.5	Calculation of foul wastewater flows for sewer system	97
E.6	Combined sewer overflows	98
Annex F	(normative) Pumping Installations	99
F.1	General	99
F.2	Planning of pumping installations	99
F.2.1	Preliminary Considerations	99

F.2.2	Planning.....	100
F.3	Design of pumping stations	101
F.3.1	Layout	101
F.3.2	Wet well design	102
F.3.3	External layout and access.....	103
F.3.4	Environmental impact	103
F.3.5	Structural design	103
F.3.6	Maintenance considerations	103
F.4	Design of rising mains	104
F.4.1	Principal considerations	104
F.4.2	Choice of route.....	104
F.4.3	Choice of diameter.....	104
F.4.4	Pressures and external loads	104
F.4.5	Choice of materials.....	105
F.4.6	Thrust.....	105
F.4.7	Discharge points.....	105
F.4.8	Control of Septicity.....	105
F.4.9	Valve chambers.....	105
F.5	Components and appliances	106
F.5.1	Pumps	106
F.5.2	Prime Movers and Drives	106
F.5.3	Valves.....	107
F.5.4	Controls and electrical equipment.....	107
F.5.5	Instrumentation.....	108
F.5.6	Alarms	108
F.6	Health and Safety.....	108
	Bibliography	110

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.

It was later recognised that separate systems, where foul wastewater was kept separate from runoff derived from surface water, would be an improvement over such combined systems.

Although many drain and sewer systems started out as combined systems there are strong 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 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 the diagram below. 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. To support these detailed standards information will come from specifications produced by individual organisations for their own use. Product standards should also take into account the functional requirements in EN 752 through EN 476, EN 773, EN 1293, EN 13380 and EN 14457.

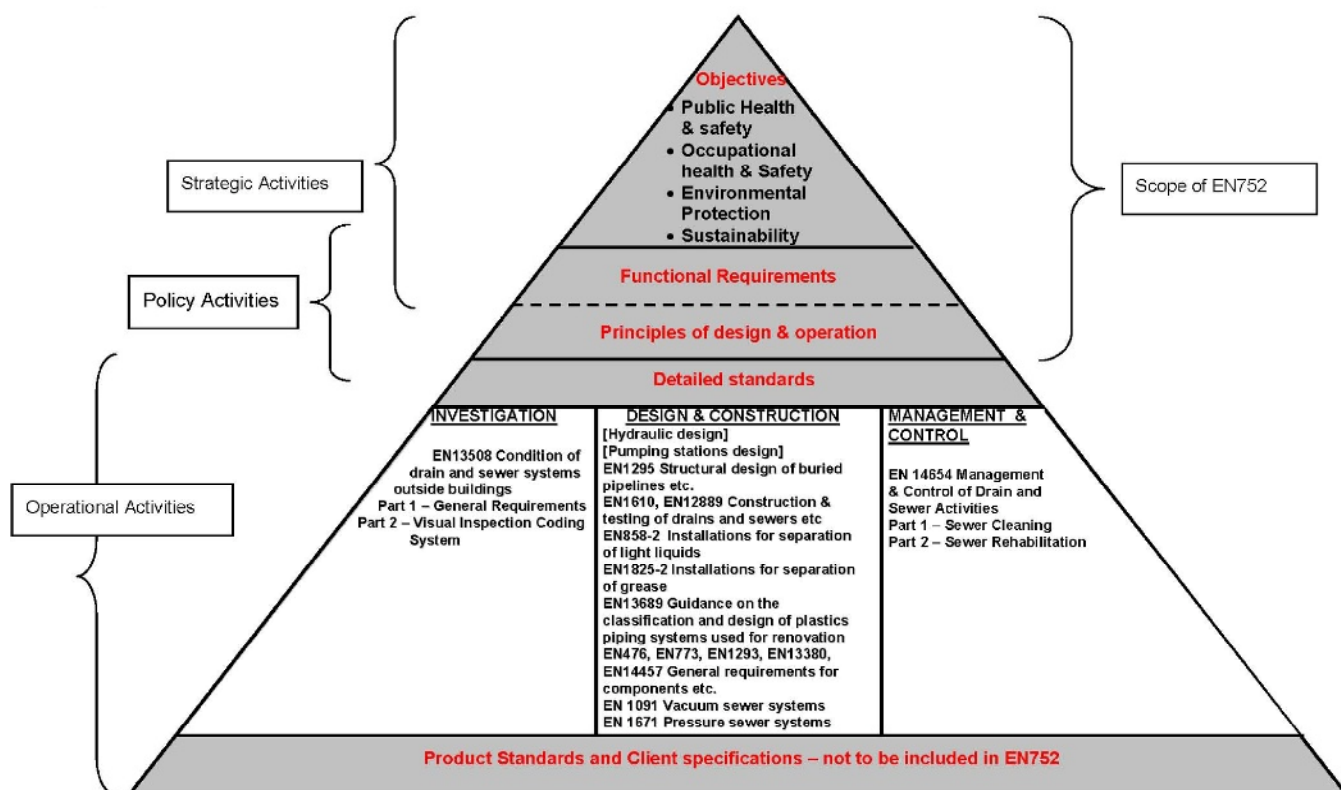


Figure 1 — Pyramid Diagram

1 Scope

This European Standard sets out the objectives for drain and sewer systems outside buildings. It specifies the functional requirements for achieving these objectives and the principles for strategic and policy activities relating to planning, design, installation, operation, maintenance and rehabilitation.

It is applicable to drain and sewer systems, which operate essentially under gravity, from the point where wastewater leaves a building, roof drainage system, or paved area, to the point where it is discharged into a wastewater treatment plant or receiving water.

Drains and sewers below buildings are included provided that they do not form part of the drainage system for the building.

2 Normative references

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

EN 476:1997, *General requirements for components used in discharge pipes, drains and sewers for gravity systems*

EN 858-1, *Separator systems for light liquids (e.g. oil and petrol) — Part 1: Principles of product design, performance and testing, marking and quality control*

EN 858-2, *Separator systems for light liquids (e.g. oil and petrol) — Part 2: Selection of nominal size, installation, operation and maintenance*

EN 1295-1, *Structural design of buried pipelines under various conditions of loading — Part 1: General requirements*

EN 1610, *Construction and testing of drains and sewers*

EN 1825-1, *Grease separators — Part 1: Principles of design, performance and testing, marking and quality control*

EN 1825-2, *Grease separators — Part 2: Selection of nominal size, installation, operation and maintenance*

EN 1990, *Eurocode — Basis of structural design*

EN 1991-1-1, *Eurocode 1 — Actions on structures — Part 1-1: General actions Densities — self-weight, imposed loads for buildings*

EN 1991-1-2, *Eurocode 1 — Actions on structures — Part 1-2: General actions — Actions on structures exposed to fire*

EN 1991-1-3, *Eurocode 1 — Actions on structures — Part 1-3: General actions — Snow loads*

EN 1991-1-5, *Eurocode 1 — Actions on structures — Part 1-5: General actions — Thermal actions*

EN 1991-2, *Eurocode 1 — Actions on structures — Part 2: Traffic loads on bridges*

EN 1991-4, *Eurocode 1 — Actions on structures — Part 4: Silos and tanks*

- EN 1992-1-1, *Eurocode 2 — Design of concrete structures — Part 1-1: General rules and rules for buildings*
- EN 1992-1-2, *Eurocode 2 — Design of concrete structures — Part 1-2: General rules - Structural fire design*
- EN 1992-3, *Eurocode 2 — Design of concrete structures — Part 3: Liquid retaining and containment structures*
- ENV 1993-1-1, *Eurocode 3 — Design of steel structures — Part 1-1: General rules and rules for buildings*
- EN 1994-1-1, *Eurocode 4 — Design of composite steel and concrete structures — Part 1-1: General rules and rules for buildings*
- EN 1996-1-1, *Eurocode 6: Design of masonry structures — Part 1-1: General rules for reinforced and unreinforced masonry structures*
- EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules* EN 1998-1, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*
- EN 1998-3, *Eurocode 8: Design of structures for earthquake resistance — Part 3: Assessment and retrofitting of buildings*
- EN 1998-1, *Eurocode 8: Design of structures for earthquake resistance — Part 1: General rules, seismic actions and rules for buildings*
- EN 1999-1-1, *Eurocode 9: Design of aluminium structures — Part 1-1: General structural rules*
- EN 12889, *Trenchless construction and testing of drains and sewers*
- EN 13508-2, *Condition of drain and sewer systems outside buildings — Part 2: Visual inspection coding system*
- EN 14654-1, *Management and control of cleaning operations in drains and sewers — Part 1: Sewer cleaning*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

aerobic

dissolved oxygen is present

[EN 1085:2007, definition 4100]

3.2

aesthetic

<of pollution> aspects sensed by sight or smell, e.g. floating solids, oil films or bank-side litter

3.3

air valve

valve used to allow air to escape from or enter into a rising main

3.4

anaerobic

dissolved oxygen, nitrate, nitrite and sulfate is absent

[EN 1085:2007, definition 4120]

3.5

backdrop manhole

manhole with a connection, by means of a vertical pipe, at or just above invert, from a drain or sewer at a higher level

3.6

backwater level

elevation of the surface of the wastewater predicted or occurring in a drain or sewer system due to the hydraulic conditions downstream

3.7

biochemical oxygen demand (BOD)

concentration of dissolved oxygen consumed under specific conditions (t days at 20 °C with or without nitrification inhibition) by the biological oxidation of organic and/or inorganic matter in water

[EN 1085:2007, definition 3110]

3.8

catchment area

area draining to a drain, sewer or watercourse

[EN 1085:2007, definition 1270]

3.9

cleaning ball

spherical device, having an indented surface, designed to be carried through a drain or sewer by the flow to facilitate removal of sediments

3.10

confined space

space in which the ventilation is restricted to the extent that special safety precautions need to be taken

3.11

combined sewer overflow

device, on a combined system that relieves the system of excess flow

[EN 1085:2007, definition 2130]

3.12

combined system

drain and sewer system designed to carry both foul wastewater and surface water in the same pipeline(s)

[EN 1085:2007, definition 2110]

3.13

common trench

trench in which more than one pipe is located

3.14

dam board

removable plank or section placed across a sewer or drain to divert or hold back the flow

3.15

depression storage

precipitation retained in surface hollows that does not contribute to runoff

3.16

design life

notional lifetime of an asset used for the purposes of design

3.17

detention tank

tank or reservoir for the temporary storage of wastewater

[EN 1085:2007, definition 2240]

3.18

domestic wastewater

water discharged from kitchens, laundry rooms, lavatories, bathrooms, toilets and similar facilities

[EN 1085:2007, definition 2030]

3.19

drain

pipeline, usually underground, designed to carry wastewater from a source to a sewer

[EN 1085:2007, definition 2250]

3.20

drainage service

natural or artificial system for the draining of a catchment area

3.21

dry weather flow

flow not affected by rainfall or snow melt

[EN 1085:2007, definition 3050]

3.22

dry well

dry chamber forming part of a pumping station and containing pumping equipment, normally used in conjunction with a wet well

3.23

duty point

rate of flow and the corresponding total head for which a pump is designed or selected

3.24

exfiltration

escape of wastewater from a drain or sewer system into surrounding ground

[EN 1085:2007, definition 2230]

3.25

extraneous water

unwanted flow in a drain or sewer system

3.26

explosion proof

protected from causing ignition of flammable gases

3.27

flooding

condition where wastewater and/or surface water escapes from or cannot enter a drain or sewer system and either lies on the surface or enters buildings (see also surface flooding)

3.28

flow balancing

reduction in peak discharge by means of temporary storage of flow

3.29

flushing

use of a temporary substantially increased flow to facilitate removal of obstructions or sediments from drains or sewers

3.30

gravity system

drain or sewer system where flow is caused by the force of gravity and where the pipeline is designed usually to operate partially full

[EN1085:2007, definition 2260]

3.31

hydro-biological stress

detrimental impact on aquatic flora and fauna, caused by high flow velocity and scour

3.32

infiltration

⟨into the ground⟩ the movement of surface water or treated effluent into the ground

[EN 1085:2007, definition 2210]

3.33

infiltration

⟨into the drain or sewer system⟩ unwanted flow resulting from an ingress of groundwater into a drain or sewer system (see Figure 2)

[EN 1085:2007, definition 2220]

3.34

inspection chamber

chamber with a removable cover constructed on a drain or sewer that permits the introduction of cleaning and inspection equipment from surface level, but does not provide access for personnel

3.35

integrated sewer system management

co-ordinated management of the planning, design, construction, rehabilitation, operation and maintenance of all drain and sewer systems in a catchment area taking into account all aspects of their performance

3.36

integrated urban drainage management

co-ordinated management of the planning, design, construction, rehabilitation, operation and maintenance of all urban drainage systems in a catchment area taking into account all aspects of their performance

3.37

integrated water policies

co-ordinated policies for the management of all bodies of water within a river basin including urban drainage systems within it

3.38

inverted siphon

length of gravity drain or sewer that is lower than upstream or downstream lengths to allow the pipeline to pass below an obstacle, and which consequently operates under pressure

3.39

jetting

use of high-pressure water jetting equipment to facilitate removal of obstructions or sediments from drains or sewers

3.40

maintenance

routine work undertaken to ensure the continuing performance of drain and sewer systems

3.41

manhole

chamber with a removable cover constructed on a drain or sewer to permit entry by personnel

3.42

outfall

structure or point from which wastewater is discharged to a wastewater treatment plant or receiving water

[EN 1085:2007, definition 1280]

3.43

operations

actions taken in the course of normal functioning of drain and sewer systems (e.g. monitoring and regulation or diversion of wastewater)

3.44

pumping installation

pumping station together with any associated rising main(s)

3.45

pumping station

building, structures and equipment used to transfer wastewater through a rising main or otherwise to raise the wastewater

3.46

rainfall intensity

depth of rain falling in unit time, or volume of rain falling in unit time per unit area

3.47

ramp manhole

manhole with a steeply inclined pipe or channel from a drain or sewer at a higher level

3.48

rain water

water arising from atmospheric precipitation, which has not yet collected matter from the surface (see Figure 2)

[EN 1085:2007, definition 2060]

3.49

receiving water

any type of water body where water or wastewater is discharged

[EN 1085:2007, definition 1100]

3.50

rehabilitation

measures for restoring or upgrading the performance of existing drain and sewer systems

3.51

relevant authority

organisation with appropriate statutory powers of control

3.52

renovation

work incorporating all or part of the original fabric of the drain or sewer by means of which its current performance is improved

3.53

repair

rectification of local damage

3.54

replacement

construction of a new drain or sewer, on or off the line of an existing drain or sewer, the function of the new drain or sewer incorporating that of the old

3.55

retention time

time during which wastewater is held within the pumping installation

3.56

rising main

pipe through which wastewater is pumped

[EN 1085:2007, definition 2170]

3.57

rodding

use of appropriate device on the end of flexible rods to facilitate removal of obstructions (or sediments) from drains or sewers

3.58

rodding point

small diameter non-man access connection to a drain or sewer that facilitates cleaning or inspection

3.59

runoff

water from precipitation which flows off a surface to reach a drain, sewer or receiving water (see Figure 2)

3.60

runoff coefficient

factor dependent on the ground catchment, and by which the rain water quantity per unit of time must be multiplied in order to indicate the flow expected to be carried to the drain or sewer system

3.61

self-cleansing

ability of the flow in a drain or sewer to carry away solid particles, which would otherwise be deposited in the pipe

3.62

self-purifying capacity

ability of receiving waters to recover from pollution by natural processes

3.63

separate system

drain and sewer system, usually of two pipelines, one carrying foul wastewater and the other surface water

[EN 1085:2007, definition 2120]

3.64

septic wastewater

anaerobic wastewater which usually contains hydrogen sulphide

[EN 1085:2007, definition 2020]

3.65

sewer

pipeline or other construction, usually underground, designed to carry wastewater from more than one source

[EN 1085:2007, definition 2270]

3.66

sewer system

network of pipelines and ancillary works which conveys wastewater from drains to a treatment plant or other place of disposal

[EN 1085:2007, definition 2270]

3.67

structural condition

state of a drain or sewer in matters relating to the integrity of its fabric

3.68

sub-critical flow

state of flow when the water velocity is less than the velocity of the small surface wave with water levels tending to be stable

3.69

super-critical flow

state of flow when the water velocity is greater than the velocity of the small surface wave with violent fluctuations in water level being possible

3.70

surcharge

condition in which wastewater and/or surface water is held under pressure within a gravity drain or sewer system, but does not escape to the surface to cause flooding

3.71

surface flooding

condition where wastewater and/or surface water escapes from, or cannot enter, a drain or sewer system and either lies on the surface or enters buildings from the surface (see also flooding)

3.72

surface receiving water

receiving water body that is on the surface of the ground (e.g. river, lake or sea) (see Figure 2)

3.73

surface water

water from precipitation, which has not seeped into the ground and which is discharged to the drain or sewer system directly from the ground or from exterior building surfaces (see Figure 2)

[EN 1085:2007, definition 2070]

3.74

time of concentration

time taken for runoff to travel from the hydraulically most distant point of the catchment area to a defined point in the drain or sewer

3.75

tank sewer

section of sewer which acts as a detention tank

3.76

trade effluent

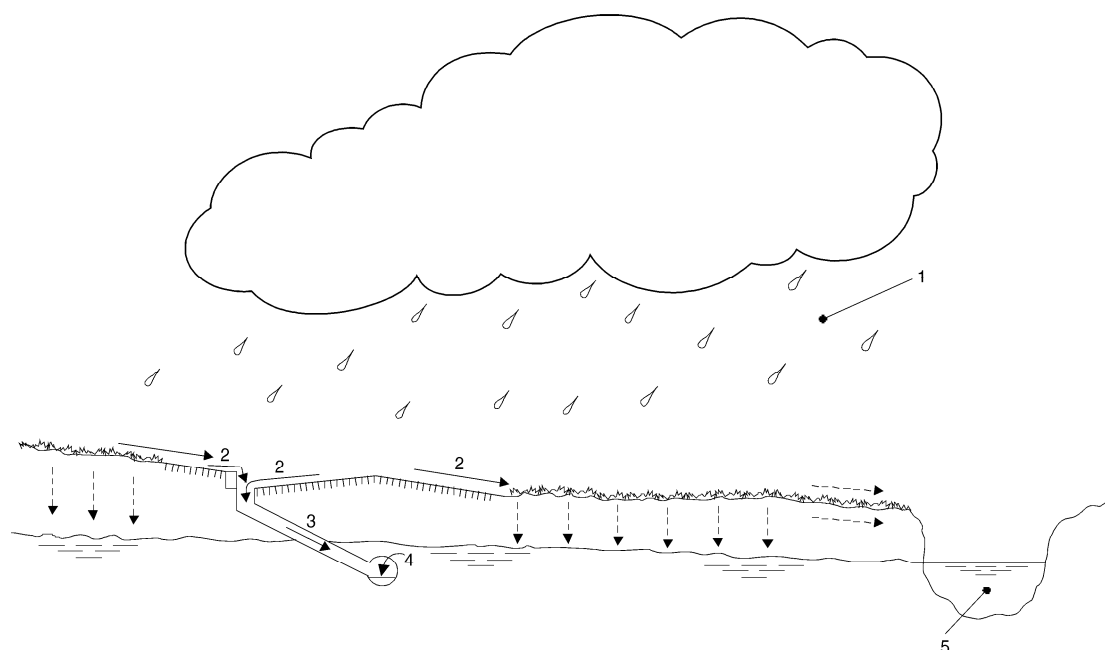
wastewater discharge resulting from any industrial or commercial activity

[EN 1085:2007, definition 2040]

3.77

urban drainage system

systems used for the collection and transport of wastewater and other rain water runoff in an urban area



Key

- 1 Rain Water (see 3.48)
- 2 Runoff (see 3.59)
- 3 Surface Water (see 3.73)
- 4 Infiltration (see 3.32)
- 5 Surface Receiving Water (see 3.72)

Figure 2 — Terminology for flows derived from rain water

3.78

utility services

services provided to customers and industry such as gas, electricity, telephone, cable TV and water

3.79

vortex manhole

circular manhole within which a large difference in level is accommodated by the wastewater entering tangentially and descending helically

3.80

wastewater

water composed of any combination of water discharged from domestic, industrial or commercial premises, surface run-off and accidentally any sewer infiltration water

[EN 1085:2007, definition 1010]

3.81

wastewater treatment plant

facility for the physical, biological and/or chemical treatment of wastewater

[EN 1085:2007, definition 4500]

3.82

wet well

chamber forming a part of a wastewater pumping station into which wastewater discharges prior to pumping. It can include submersible pumping equipment and pipework

3.83

whole life cost

aggregate cost of a scheme over its design life, being the sum of the construction, operating and maintenance costs all calculated at the same time base

3.84

winching

use of a bucket or other device pulled through a drain or sewer to facilitate removal of sediments (or obstructions)

4 Objectives

4.1 General

The four objectives of drain and sewer systems are:

- Public health and safety;
- Occupational health and safety;
- Environmental protection;
- Sustainable development.

A number of European Union Directives (e.g. the Urban Wastewater Treatment Directive (91/271/EEC)) make requirements for drain and sewer systems which relate to these objectives. For further information see Annex A (informative).

Drain and sewer systems are part of the urban drainage system (see Figure 3). Urban drainage systems comprise all infrastructures for the management of wastewater and rain water in the built environment. The extent and role of the drain and sewer system within the urban drainage system will depend on local circumstances for each system.

Urban drainage systems are part of a wider system of water management (see Figure 3). The Water Framework Directive (2000/60/EC) provides the basis for integrated management of the whole water management system through the river basin management plan.

Integrated sewer system management includes a consideration of the interactions of the drain and sewer system with the urban drainage system as a whole, and the wider water environment.

4.2 Public Health and Safety

Drain and Sewer systems are provided in order to:

- prevent spread of disease by contact with faecal and other waterborne waste;
- protect drinking water sources from contamination by waterborne waste;
- carry runoff and surface water away while minimising hazards to the public.

Poorly designed, constructed or maintained systems can cause health or safety hazards to the public.

The objective is to design, construct, operate, maintain and rehabilitate the system in order to minimise the health and safety risks associated with the conveyance of wastewater.

4.3 Occupational Health and Safety

All work associated with the installation, operation, maintenance and rehabilitation of drain and sewer systems presents a range of occupational health and safety hazards.

The objective is to minimise the occupational health and safety risks likely to arise during installation, operation, maintenance, and rehabilitation.

4.4 Environmental Protection

The objective is to design, construct, operate and maintain the system to minimise the impact on the environment.

The impact of drain and sewer systems on the receiving waters shall meet the requirements of any national or local regulations or the relevant authority. Other environmental requirements specified by any national or local regulations or the relevant authority shall also be met.

4.5 Sustainable Development

The objective is to design, construct, operate, maintain and rehabilitate the system at the best environmental, social and economical costs so that it:

- a) uses materials that minimise the depletion of finite resources;
- b) can be operated with the minimum practicable use of energy; and,
- c) can be constructed, operated and, at the end of their life, decommissioned with the minimum practicable impact on the environment.

5 Requirements

5.1 Functional Requirements

5.1.1 Introduction

Functional requirements cover the drain and sewer systems, together with combined sewer overflows, pumping installations and other components, including the effects of their discharges on receiving waters and the receiving wastewater treatment plant. The requirements shall be considered in respect of the whole system to ensure that additions or modifications to the system do not result in failure to meet the target standards.

Requirements shall be established that, whilst taking into account sustainable development and whole life costs including indirect costs (e.g. cost of social disruption), ensure that drain and sewer systems convey and discharge their contents without causing unacceptable environmental nuisance, risk to public health, or risk to personnel working therein.

Each functional requirement can relate to more than one objective. An indication of the relevance of each of the functional requirements to achieving the objectives is shown in Table 1.

Table 1 — Relationship between objectives and functional requirements

Clause No	Public Health and Safety	Occupational Health and Safety	Environmental Protection	Sustainable development
5.1.2 Protection from flooding	XXX	XX	XXX	—
5.1.3 Maintainability	XX	XXX	XX	XX
5.1.4 Protection of surface receiving waters	XXX	X	XXX	XX
5.1.5 Protection of groundwater	XXX	—	XXX	XXX
5.1.6 Prevention of odours and toxic, explosive and corrosive gases	XXX	XXX	XXX	XXX
5.1.7 Prevention of noise and vibration	XX	XXX	X	X
5.1.8 Sustainable use of products and materials	—	—	XX	XXX
5.1.9 Sustainable use of energy	—	—	XX	XXX
5.1.10 Structural integrity and design life	XXX	XXX	XXX	XXX
5.1.11 Maintaining the flow	XXX	—	XXX	X
5.1.12 Watertightness	XXX	X	XXX	XX
5.1.13 Not endangering adjacent structures and utility services	XXX	XXX	X	XX
5.1.14 Inputs quality	XX	XXX	XXX	XX
NOTE XXX is High; X is Low and; — is not related.				

5.1.2 Protection from flooding

Flooding from drains and sewers can have a major impact on the health of people affected. The economic impact can be high and depends on the type of location flooded.

Flooding shall be limited to nationally or locally prescribed frequencies taking into account the:

- health and safety effects of the flooding;
- costs of the flooding;
- extent to which any surface flooding can be controlled without causing damage;
- whether surcharge is likely to lead to flooding of basements.

NOTE In some jurisdictions it is the responsibility of the property owner to provide protection to prevent flooding of basements due to surcharge.

The hydraulic capacity shall limit flooding to nationally or locally prescribed levels and frequencies taking into account backwater levels. The hydraulic capacity shall allow for foreseeable increases in flow over the design life of the system. The effects of flows discharged into downstream sewers or receiving waters shall be considered. Further details are included in clause 8.

Where there are components in the system, which have a high risk of failure, measures should be taken to avoid or minimise the risk of flooding in the event of failure of those components.

5.1.3 Maintainability

The system shall be planned, designed, constructed and rehabilitated to allow appropriate maintenance activities to be carried out safely and without risks to the health of personnel.

Adequate access and working space shall be provided for maintenance purposes.

5.1.4 Protection of surface receiving waters

Surface receiving waters shall be protected from pollution within nationally or locally prescribed limits.

The impact of drain and sewer systems on the surface receiving waters shall meet the requirements of any national or local regulations or the relevant authority. Other environmental requirements specified by any national or local regulations or the relevant authority shall also be met.

The measures to achieve the standards required under Water Framework Directive (2000/60/EC) will be summarised in the Water Framework River Basin Plan.

5.1.5 Protection of groundwater

Groundwater shall be protected from pollution within nationally or locally prescribed limits. The effect of the drain and sewer system on the local recharge of aquifers shall be considered.

The impact of drain and sewer systems on the receiving groundwater shall meet the requirements of any national or local regulations or the relevant authority. Other environmental requirements specified by any national or local regulations or the relevant authority shall also be met.

The measures to achieve the standards required under Water Framework Directive will be summarised in the Water Framework River Basin Plan.

5.1.6 Prevention of odours and toxic, explosive and corrosive gases

Sewer systems shall be designed, constructed, maintained and operated to avoid odour nuisance, or toxic, explosive or corrosive gases.

5.1.7 Prevention of noise and vibration

The system shall be designed, constructed, maintained and operated so that noise and vibration are minimised.

5.1.8 Sustainable use of products and materials

Products, materials, and their construction methods shall be selected that minimise depletion of finite resources having regard to the design life of the component and the potential for re-use or recycling, for example minimising the volume of excavated material and the reuse of excavated material.

5.1.9 Sustainable use of energy

The design and operation of the drain and sewer system shall, so far as is practical, minimise the use of energy over the life of the system.

5.1.10 Structural integrity and design life

Drains, sewers and other components shall be designed, constructed, maintained and operated to ensure structural integrity over the design life.

5.1.11 Maintaining the flow

The system shall be designed, constructed, maintained and operated to reliably convey all design flows that can legally be discharged into the system to the point of discharge, ensuring that the operation of the system is safe, environmentally acceptable and economically efficient.

5.1.12 Watertightness

New drains, sewers and ancillary structures shall be watertight in accordance with the testing requirements of EN 1610. Existing drains, sewers and ancillary structures shall be watertight in accordance with national or local testing requirements.

5.1.13 Not endangering adjacent structures and utility services

The design, construction, maintenance and operation of drains and sewers shall not endanger existing adjacent structures and utility services.

5.1.14 Inputs quality

The drain and sewer system can be designed to receive both domestic and non-domestic wastewater inputs. The quality of the non-domestic inputs shall be controlled so that they do not compromise the integrity of the fabric of the system or its function or constitute a danger for the environment. National or local regulations can give requirements for inputs quality.

5.2 Determination of performance requirements for the drain and sewer system

In order to evaluate the performance of the system and to allow development of design standards, measurable performance requirements shall be determined from each functional requirement. The process for determining performance requirements is illustrated in Figure 4.

For each functional requirement there can be legal requirements, public expectations and financial constraints which will influence the performance requirements.

For each aspect of performance different levels could be required for example:

- trigger levels which justify early upgrading action according to priority;
- target levels to aim for in upgrading, which shall be equal to the requirements for new construction, but which sometimes can only be achievable or necessary in the longer term.

Examples of performance requirements in use in different countries can be obtained from the organisations listed in Annex B.

Performance requirements shall be reviewed periodically and updated if necessary. The performance requirements for the system should be updated after major extension, maintenance or rehabilitation.

In principle the performance requirements for a rehabilitated system shall be the same as those for a new system.

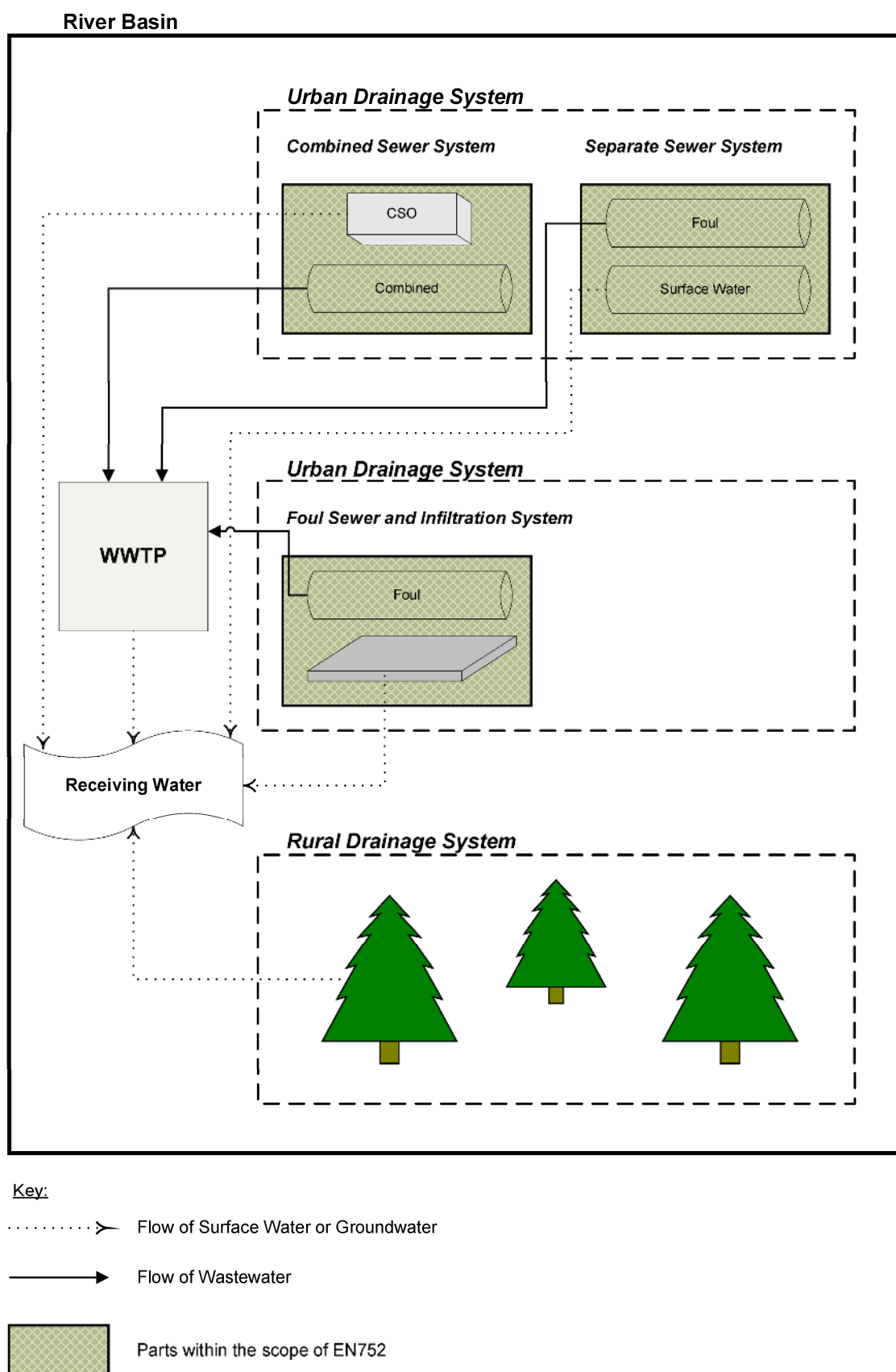


Figure 3 — Drain and sewer systems in the river basin

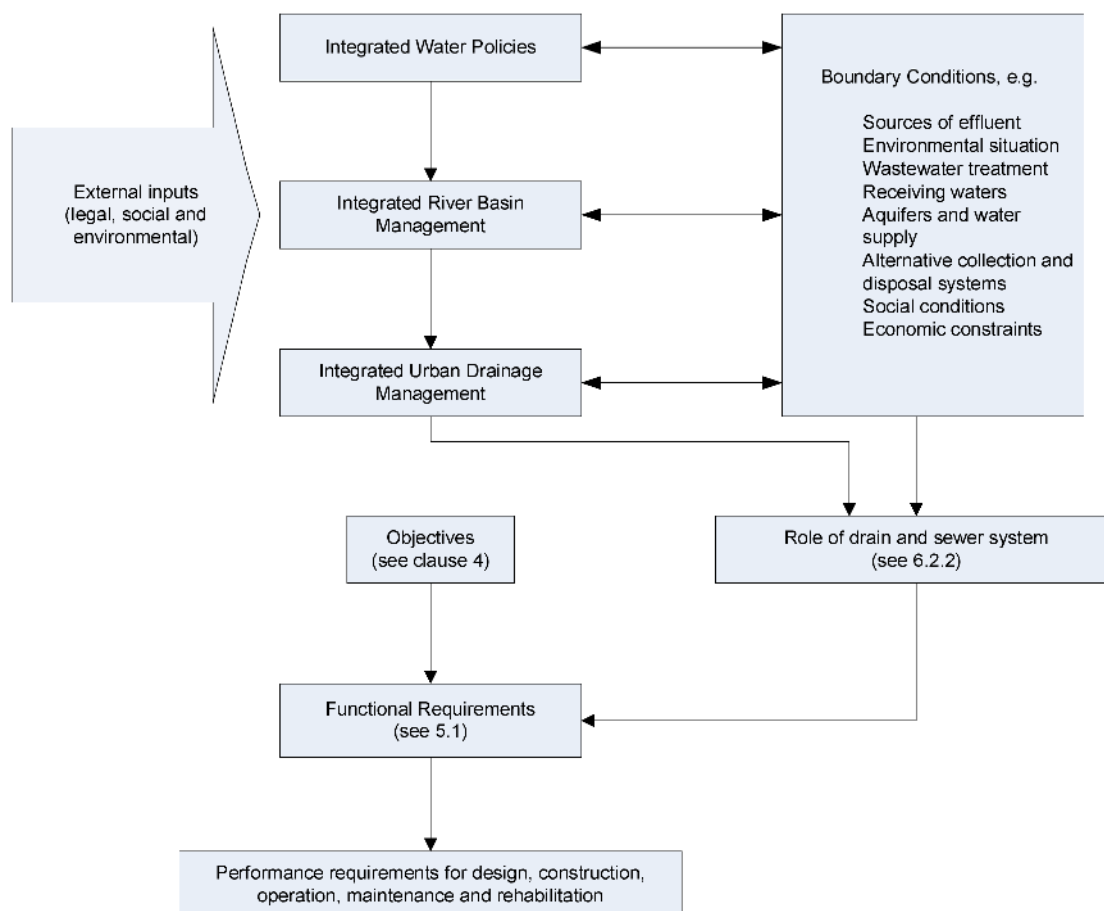


Figure 4 — Process for determining performance requirements

6 Integrated Sewer System Management

6.1 Introduction

Integrated sewer system management is the process of achieving an understanding of existing and proposed drain and sewer systems, and using this information to develop strategies to ensure that the hydraulic, environmental, structural and operational performance meets the specified performance requirements taking into account future conditions and economic efficiency.

The integrated sewer system management process is illustrated in Figure 5.

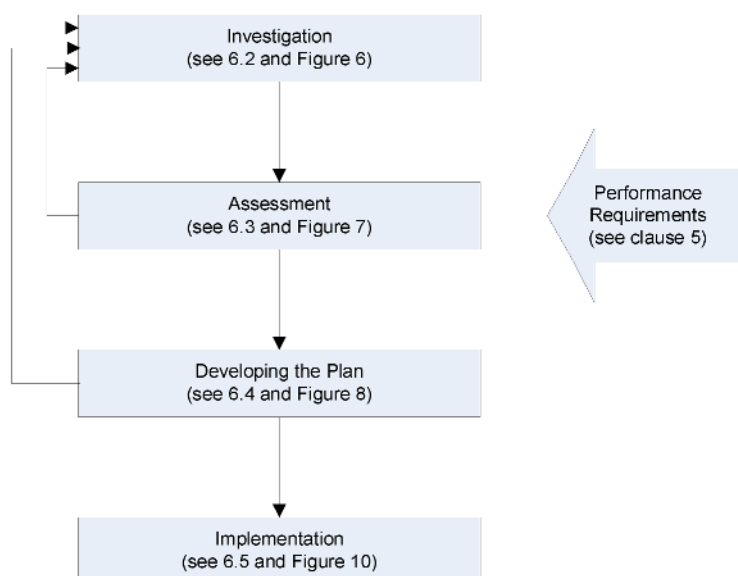


Figure 5 — Integrated Sewer System Management Process

The integrated sewer system management process has four principal activities.

- Appropriate level of investigation of all aspects of the performance of the drain and sewers system;
- Assessment of the performance by comparison with the performance requirements including identification of the reasons for the performance failures;
- Developing the plan of measures to be taken;
- Implementation of the plan.

The need for further investigation can become apparent either during the performance assessment or the development of the plan.

Integrated sewer system management forms the basis for the operation and rehabilitation of the drain and sewer system. The information is regularly updated for the future management of the drain and sewer system.

The role of the drain and sewer system should be determined within the context of the whole river basin catchment and the other elements of the urban drainage system. To determine this role account should be taken of integrated water policies set by any national or local regulations or the relevant authority together with any requirements of the integrated river basin management plan. Account should also be taken of any policies resulting from integrated urban drainage management.

The boundary conditions should also be considered.

6.2 Investigation

6.2.1 Introduction

The investigation is the first stage in the Integrated Sewer System Management as described in 6.1 (see Figure 5). The process for investigation is outlined in Figure 6.

Damaged, defective or hydraulically overloaded drains and sewers represent a potential hazard through flooding and collapses, and through pollution of surface receiving waters, groundwater and soil. The problems found in existing drain and sewer systems are frequently interrelated and upgrading works will often be

designed to overcome a number of problems at the same time. The investigation and planning of rehabilitation work should be carried out on complete catchment areas so that all problems and their causes can be considered together. In large sewer systems it could be necessary to start by investigating appropriate parts of the system. The procedures described in this Standard can be applied in any drain and sewer system, but detailed application should take account of the age, location and type of system, the materials used in its construction, together with functional and climatic factors.

6.2.2 Purpose of investigation

The investigation is carried out in order to make an assessment of the performance of the drain and sewer system and its components. This can include:

- investigation aimed at strategic planning;
- investigation aimed at operational planning.

The purpose of the investigation influences the way in which it will be carried out (e.g. choice of method, degree of detail, desired accuracy) and the way in which the results will be assessed.

The components of the drain and sewer system included in the investigation shall be those that are necessary to fulfil the purpose of the investigation. Examples include; drains, surface water and foul sewers, combined sewers, gravity sewers, pressure/vacuum sewers, manholes, inspection chambers and other access facilities, pumping stations, rising mains, storage and retention tanks, combined sewer overflows, monitoring facilities, control facilities, outfalls, gravel and sand traps, flushing facilities, ventilation, sedimentation tanks, light liquid/grease separators. EN 13508-1 gives guidance on establishing the condition of drain and sewer systems.

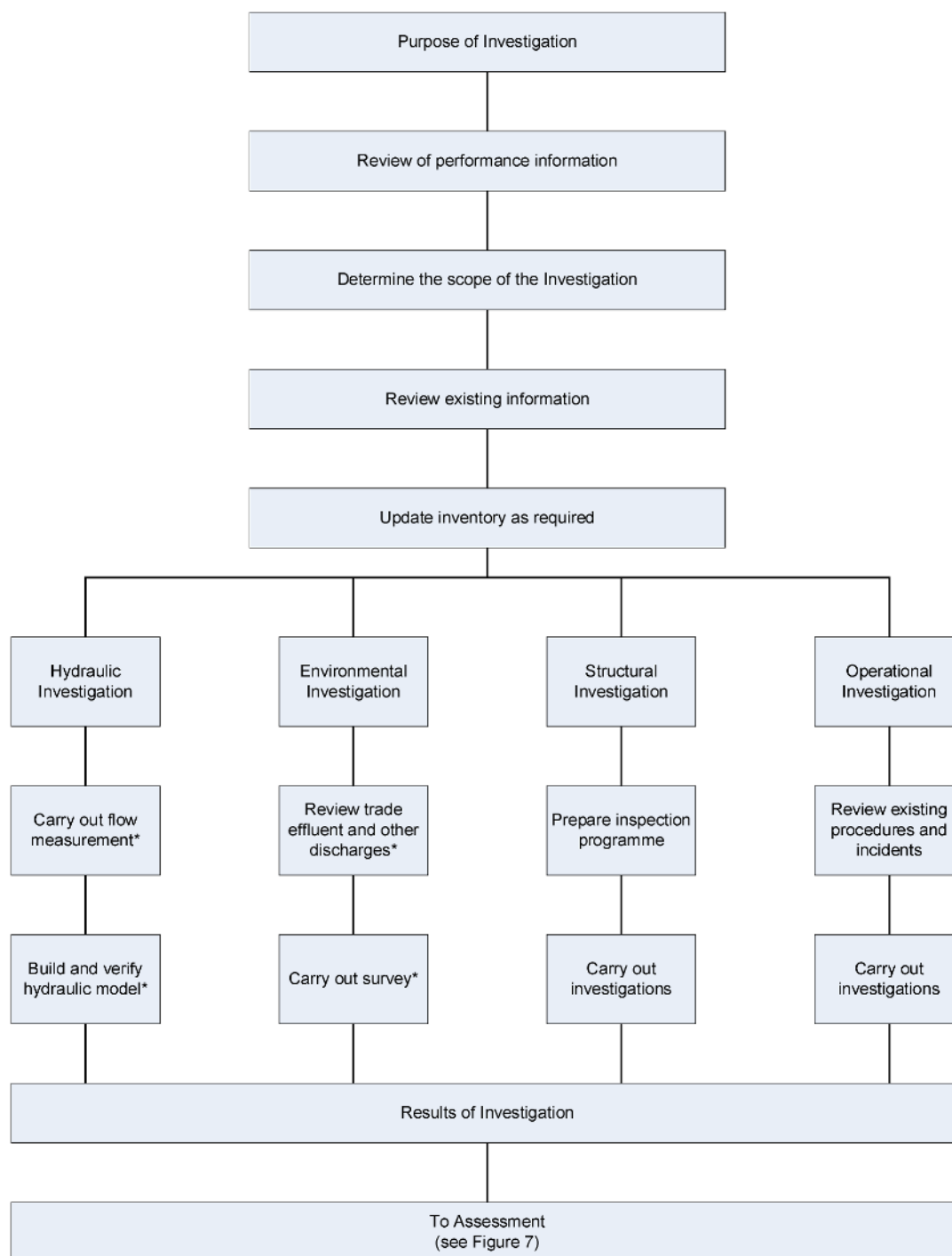
6.2.3 Review of performance information

An indication of the type of performance problems, if any, on existing systems is likely to be known through reports of incidents such as sewer collapses, flooding or polluted watercourses and from previous investigations. 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.

Examples are; records of flooding incidents, pipe blockage incidents, sewer collapse incidents, rising mains failures, disease, injury or fatal incidents to operators, disease, injury or fatal incidents to members of the public, sewer damage incidents, compliance with discharge consents into and out of the system, closed circuit television (CCTV) survey and visual inspection data, wastewater related odour complaint incidents, hydraulic performance analysis, performance of mechanical/electrical equipment, results of monitoring, performance and condition of flow control structures, sewer surcharge incidents.

The relevant authorities will be the source of many of the records listed above. All appropriate records should be retained.

Where large numbers of complete or partial catchments are in need of investigation, the existing information collected may also be used to assign priorities to the investigation of the perceived problems in each catchment (for example by comparing the cost of the investigation with the benefit that might be achieved). These can then be used to draw up a comprehensive programme so that the catchments with the most serious problems are investigated first.



*Other types of investigations/monitoring are also possible

Figure 6 — Process for investigation

6.2.4 Determine the scope of the investigation

Following the review of the current performance information it will be possible to decide whether to carry out an investigation and whether the extent of the problems justifies an investigation of the entire catchment area. The extent and detail of the subsequent investigation of the hydraulic, environmental, structural and operational aspects shall be determined. Further guidance on the type of investigations can be found in EN 13508-1.

6.2.5 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 activities are subsequently planned. This information should include historical records. In addition to the performance information listed in 6.2.3, examples are:

- inventory including:
 - location, dimensions, shape and type of material of all drains and sewers;
 - position depth and levels of manholes and the levels of connections to the manholes;
 - positions of connections to drains and sewers;
 - layout of ancillary structures such as combined sewer overflows, outfalls and pumping installations, including details of any special plant (e.g. pumps or screens).
- relevant permits and legal requirements;
- previous operational, maintenance, structural and safety measures to overcome the problems;
- nature and quantities of trade effluent;
- previous inspections;
- previous hydraulic calculations or hydraulic models;
- previous assessments of environmental impact;
- existing drain and sewer condition data;
- receiving water quality and use;
- groundwater levels and velocities;
- ground conditions including infiltration capacity;
- groundwater protection zones;
- previous test information;
- characterisation of wastewater;
- information on proposed new development or redevelopment within the catchment area.

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.

6.2.6 Inventory update

Where the inventory is incomplete it shall be updated so that a sufficient record of the sewer system is available to carry out the investigation.

NOTE The update of the other information is included in the hydraulic, environmental, structural and operational investigations.

6.2.7 Hydraulic investigation

Testing and inspection procedures can be required in order to ensure an adequate evaluation of flows (wet and dry weather, infiltration, flow through gaps in manhole tops (between the cover and frame), exfiltration and wrong connections). Surveys can include precipitation and flow measurements, identification of wrong connections and groundwater measurements.

In some cases it is not possible to understand the hydraulics of the system without using a hydraulic model. This sewer flow simulation model should be based on an as-built report updated after onsite investigation of the main works. However a model is not usually recommended where:

- there are no known hydraulic problems (particularly where the sewer system takes only foul wastewater flows); and,
- there are no combined sewer overflows; and,
- structural problems are to be solved using techniques which do not reduce the hydraulic capacity of the sewer.

Information on the use of computer based sewer flow simulation programs is given in 8.4.3.

Calibration and/or verification of the models shall be carried out whenever sufficient information is available. The procedures used depend on the sewer flow simulation program.

If suitable agreement 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.

6.2.8 Environmental investigation

The environmental impact will depend on the nature of the wastewater and its potential to escape from the system. In particular 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.

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

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 quality of surface receiving waters shall be ascertained to see whether they meet the requirements and if not, whether the sewer system is a significant factor.

Consideration should be given to other environmental factors such as noise, odour, visual intrusion and potential soil contamination.

6.2.9 Structural investigation

It is important to ensure that investigation of the system is selective in order to avoid duplication of previous work. The structural investigations may include either a complete survey of the drain and sewer system or a more selective approach. Consideration should be given to the age and location of existing infrastructure, geotechnical data including the pipe bedding and surround, and the vulnerability of existing buildings and other utility services.

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 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. 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.

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:

- unacceptable fissures;
- deformation;
- displaced joints;
- defective connections;
- roots, infiltration, settled deposits, attached deposits, other obstacles;
- subsidence;
- defects in manholes and inspection chambers;
- mechanical damage or chemical attack.

Where appropriate, other qualitative and quantitative investigation techniques may be used. These include sonar (for pipes that are filled with water) and ground probing radar or other geophysical techniques (e.g. for detecting voids behind the wall of the sewer pipe) or mechanical techniques (e.g. internal jacking to measure the stiffness of the side wall support). Investigation of the chemical composition of the groundwater and the soil should be carried out where this could affect the structural integrity.

The results of the structural investigations can also be relevant to the assessments of the hydraulic performance and environmental impact.

6.2.10 Operational Investigation

Existing operational procedures, inspection schedules and maintenance plans shall be identified and documented.

The frequency and location of recorded operational incidents (e.g. blockages, pumping station failures, sewer collapses etc.) shall be reviewed.

The impact of operational problems on the hydraulic, environmental and structural performance of the system should be determined from incident records.

The causes of significant recurrent operational incidents shall be investigated.

To deal with operational problems in the most cost effective way, it is necessary to investigate and understand the causes. Further information can be found in 11.4.

6.3 Assessment

6.3.1 Introduction

The performance of the system shall be assessed against the performance requirements.

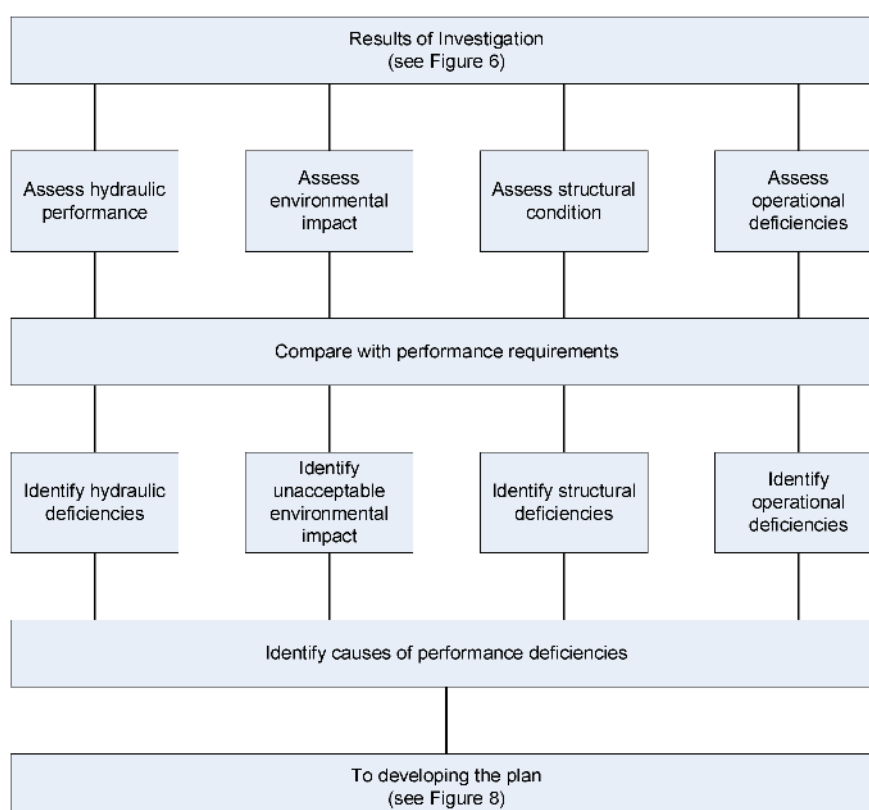


Figure 7 — Process for assessment

EN 13508-1 gives guidance on evaluating the condition of the drain and sewer systems.

6.3.2 Assessment of the hydraulic performance

The results of the hydraulic surveys and/or the verified flow simulation model shall be used to assess the hydraulic performance of the system for a range of rainfall conditions related to the performance requirements (see 8.4.3).

6.3.3 Assessment of environmental impact

The results of the investigations shall be considered together with information on the frequency, duration and volume of discharges to receiving waters, determined using a verified flow simulation model (see 6.2.7) where

this is available or from site measurements. This information shall then be used to assess the environmental impact (including impact on soil and groundwater) of the drain and sewer system (see 8.5).

The results of the structural investigation (see 6.2.9), the trade effluent survey and other relevant investigations shall be examined to identify:

- sources of hazardous effluents;
- exceedence of permissible concentrations and discharges;
- other deviations from permits.

6.3.4 Assess structural condition

Once the system has been inspected, the next stage is to examine the results to identify those areas requiring action. A number of methods have been developed to assist in this process. Details of these can be obtained from the organisations listed in Annex B.

6.3.5 Assess operational performance

The operational performance of the system as measured by the number of operational incidents or failures should be assessed.

6.3.6 Compare with performance requirements

The results of the assessment of the hydraulic, environmental, structural and operational performance should be brought together so that the overall performance of the system and its components can be compared to the performance requirements (see 5.2).

Performance indicators are one method of comparing the overall performance of a system with performance requirements. Any performance indicators used should be:

- clearly defined, concise and unambiguous;
- verifiable;
- simple and easy to use.

6.3.7 Identify unacceptable impacts

Details of those parts of the system where the hydraulic, environmental, structural or operational performance of the system or its components does not meet the performance requirements should be recorded.

6.3.8 Identify causes of performance deficiencies

Based upon the results of the hydraulic, environmental, structural and operational investigations, the causes of performance deficiencies shall be determined. The relative impact of each cause should be assessed in order to develop appropriate solutions and to set the priority for action.

6.4 Developing the Plan

6.4.1 Introduction

The process of producing the plan to fulfil the performance requirements is outlined in Figure 8.

6.4.2 Develop integrated solutions

6.4.2.1 Introduction

Integrated solutions shall be developed that fulfil the performance requirements, taking into account future conditions.

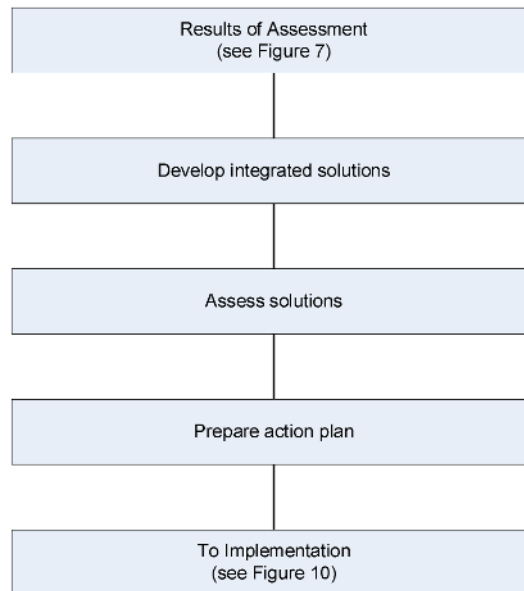


Figure 8 — Process for developing the plan

6.4.2.2 Hydraulic solutions

Hydraulic options include:

- a) Maximise use of existing flow capacity by:
 - removal of constrictions;
 - cleansing.
- b) Source control – Reducing the hydraulic input to the sewer system by:
 - diversion of surface water flows to infiltration drainage systems or pervious areas;
 - use of porous pavements;
 - diversion of flows to another system;
 - reduction of infiltration and inflow of extraneous water.
- c) Attenuate peak flows by:
 - mobilisation of existing storage potential within the system (strategically placed flow controls);
 - mobilisation of surface storage (including storage within the property boundary);
 - provision of additional storage (tank sewer or detention tank).

- d) Increase sewer system flow capacity by:
- replacement with larger pipe;
 - construction of additional pipeline;
 - renovation of the existing drain or sewer.

6.4.2.3 Environmental solutions

Environmental options include:

- a) Reduce pollutant inputs to system by:
- sediment basins and grit separators;
 - use of vegetation to absorb pollutants from runoff before entering the system;
 - controlling inputs (e.g. trade effluents).
- b) Decrease planned pollutant discharges to receiving waters by:
- increase of flows to treatment (see hydraulic solutions above);
 - treatment of surface water discharges (e.g. by separators, retention ponds etc.);
 - improve solids retention and hydraulic performance of combined sewer overflows;
 - real time control.
- c) Decrease impact by relocation of points of discharge.
- d) Reduce exfiltration by rehabilitation measures such as:
- repair techniques (e.g. sealing leaks);
 - renovation techniques (e.g. provision of watertight lining);
 - replacement of pipeline using open-cut or trench-less techniques.

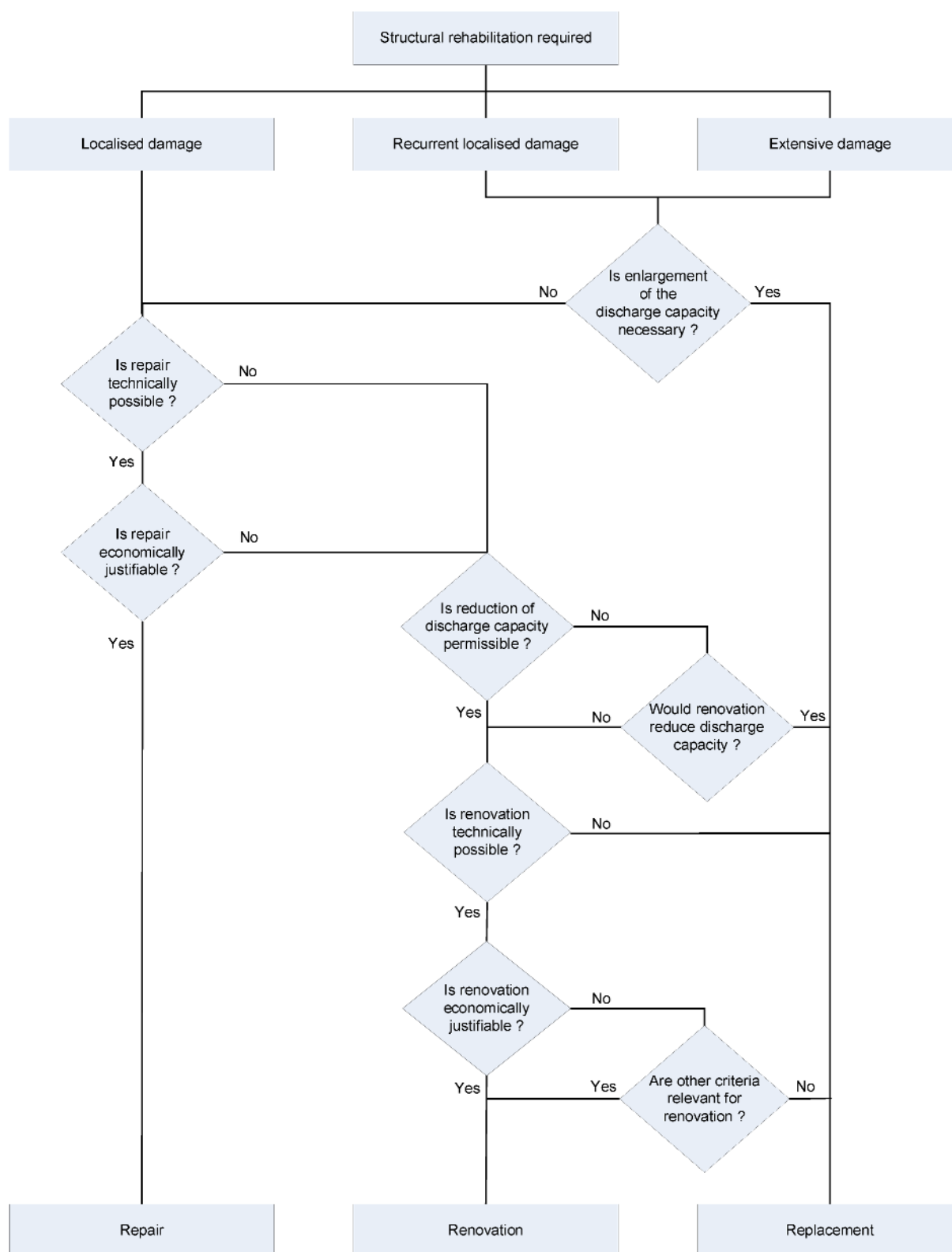


Figure 9 — Decision process for selection of structural solutions

6.4.2.4 Structural solutions

Structural options include:

- a) Protect fabric of sewer by provision of appropriate linings or internal coatings.
- b) Rehabilitate fabric of sewer by:
 - repair;
 - renovation;
 - replacement.

The decision process necessary to select the appropriate structural solution is given in Figure 9.

6.4.2.5 Operational solutions

In some cases an operational solution can be appropriate. Examples of possible operational solutions include:

- planned inspection and cleaning of a drain or sewer (see EN 14654-1);
- increased frequency of maintenance of pumps or pumping stations.

6.4.3 Assess Solutions

Solutions shall be assessed and the optimal solution selected having regard to the basic performance requirements (see clause 5) and factors such as:

- a) **Safety in construction and operation** - The minimisation of risks to health and safety during construction and subsequent operation of the system.
- b) **Social disruption** - The disruption to local residents and other members of the public due to traffic delays, dust, noise and other social factors shall be considered.
- c) **Sustainable use of resources** - The use of energy and other finite resources in the construction and operation of the system shall be taken into account. The ability to recycle materials used in the upgrading works and any waste produced shall be considered.
- d) **Phasing of the works** - The possibility of integrating the solution into a staged programme of works shall be considered. This shall take into account the priorities of the works and the benefits in terms of improved performance associated with each identified phase of the works, and the cost savings associated with deferral of the later stages.
- e) **Relationship to other infrastructure works** - The benefits of phasing the works with other infrastructure works shall be considered.
- f) **Capacity and resource constraints** - Account should be taken of the resource constraints (e.g. personnel, supply chain and financial) in the selection and phasing of the options.
- g) **Future maintenance liabilities** - The cost of future maintenance works and other operational costs of the system should be taken into account. The environmental impact of disposal of maintenance residues (see 8.5.1) shall also be considered.

- h) **Economic appraisal** - The costs and benefits shall be considered to determine whether the additional benefits of one solution over another, for example increased asset life, are justified.
- i) **Whole life cost** - The whole life cost of the solutions including temporary works, diversion of other utility services and all design, investigation and operational costs shall be taken into account as well as the indirect costs (e.g. cost of social disruption).

6.4.4 Prepare action plan

The selected integrated solution shall be documented to give a single plan for the drain and sewer system. The documentation should include:

- detailed objectives;
- legal requirements and permits, including any timescales for improvement;
- performance criteria;
- priorities;
- proposed works including costs and phasing;
- relationship to other construction or planned development;
- consequences for operations and maintenance.

Four types of plan can be prepared:

- a) **New development** – Information on drainage of new developments proposed. Where significant new development or redevelopment is proposed in the catchment, a plan should be produced showing:
 - 1) whether the foul and surface water from the new development should be drained by extension to an existing drain or sewer system or by an independent system or, for surface water, by an infiltration system;
 - 2) if the system is to be an extension of an existing system, the upgrading works to the existing system to accommodate the additional flows should be described in the rehabilitation plan for that system;
 - 3) outline of the main sewer systems to serve the development.
- b) **Rehabilitation plan** – Information on proposed rehabilitation works. The options to be considered will fall into one or more of the four categories: Hydraulic, Environmental, Structural and Operational performance. The works necessary to upgrade an existing drain and sewer system to meet the performance requirements should be incorporated into a rehabilitation plan. This should include:
 - 1) Details of the necessary upgrading works;
 - 2) Other options for upgrading the system;
 - 3) Any anticipated phasing of the work;
 - 4) Whether any of the items are conditional on any planned developments.
- c) **Operational plan** – Inspection schedules, operational procedures and contingency plans. The operations plan shall indicate the approach to be taken in a particular drain and sewer system. The plan shall include:

- 1) inspection routines (see C.2.1);
 - 2) procedures used in the operation of the elements of the system (see C.2.2);
 - 3) contingency and emergency plans (see C.2.3).
- d) **Maintenance plan** – Details of maintenance policies and schedules for each component of the system. The maintenance plan shall include:
- 1) type of maintenance strategy to be used in each component of the system and the monitoring requirements and frequencies. The strategies for maintaining drain and sewer systems are planned or reactive maintenance, or a combination of both.
 - i) Planned maintenance includes a programme of work to remedy the defects and problems identified during inspection. It is particularly required to reduce the incidence of failure where the consequences are severe.
 - ii) Reactive (or crisis) maintenance involves responding to failures and problems as they are identified. It is appropriate for those parts of the system that can function with little or no maintenance.
 - 2) risk assessment, taking into account the probability of failures and their consequences.

6.5 Implementation

6.5.1 Introduction

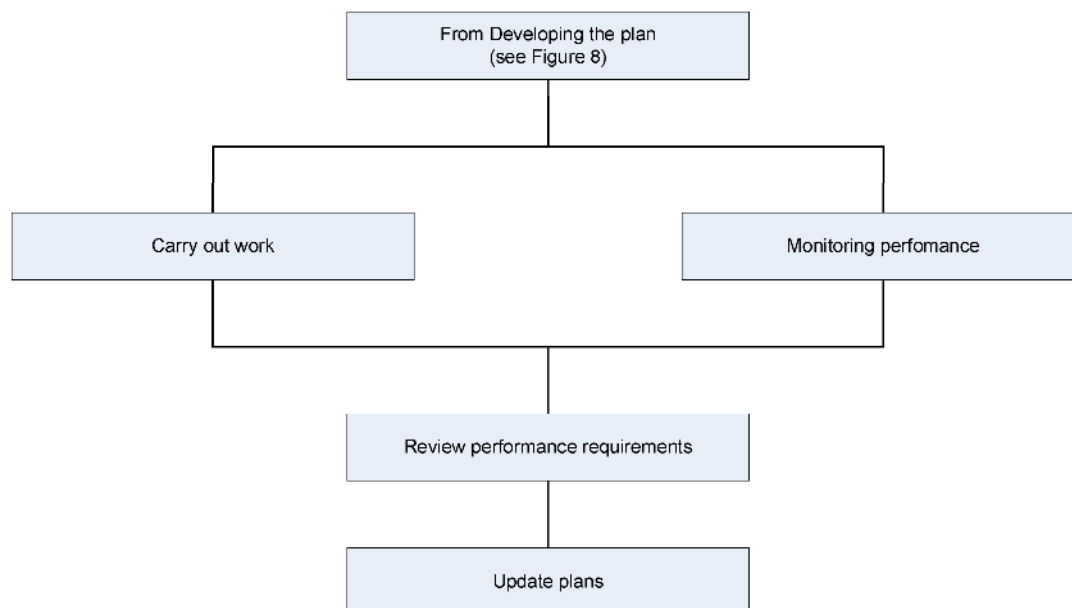


Figure 10 — Process for implementation

6.5.2 Carry out work

Where it is necessary to extend, reduce or rehabilitate the drain or sewer system these works should be designed in accordance with clause 8 and clause 9 and constructed in accordance with clause 10.

The operations and maintenance plans should be implemented in accordance with clause 11.

6.5.3 Monitoring performance

It is important to monitor the effectiveness of solutions and to update the plan, including the records (inventory) and the hydraulic model (see clause 12).

6.5.4 Review performance requirements and update plan

The performance requirements should be reviewed periodically and the whole planning process repeated so that all the plans remain up to date.

7 Health and Safety Principles

The fundamental strategy for occupational health and safety is laid down in the Framework Directive 89/391. This requires employers to avoid risks to health and safety, to assess the risks which cannot be avoided and to use the results of that assessment to mitigate the residual risks through combating these risks at source in preference to the application of protective measures and to ensure that preference is given to collective protective measures over those protecting the individual only. These are the principles of prevention. The directive also requires that employees are appropriately instructed in the risks to their health and safety.

The Temporary or Mobile Construction Sites Directive 92/57 sets out requirements relating both to the design and construction aspects of a project. With regard to design, Directive 92/57 requires that due account is taken of the principles of prevention set out in the Framework Directive 89/391, in the design and preparation stages of the project, that specific documentation regarding health and safety risk is drawn up and made available to parties to the project and that workers are consulted over and informed of the risks to their health and safety. Annex IV of Directive 92/57 sets out a range of specific health, safety and welfare requirements relating to work practices and to indoor and outdoor workplaces on site.

Accordingly drain and sewer systems shall be designed, constructed and operated so that the occupational health and safety risks to personnel undertaking work associated with the drain and sewer system are minimised. In addition welfare facilities shall be provided where appropriate.

Those who are responsible for work in drains and sewers, including the operator of the drain or sewer system shall ensure that the work does not present a risk to the health or safety of any person carrying out the work or any person who can be affected by their actions.

In addition it is the responsibility of employers to:

- provide safe systems of work including arrangements for safe access to and egress from the sewer system, and sufficient working space while in the sewer system;
- ensure that their employees are properly instructed, trained and supervised in the work being carried out and in the safe systems of work in use.

National or local regulations or the relevant authority can lay down requirements regarding the health, safety and welfare of the public and/or personnel. They can include more requirements than indicated in this standard.

The employer should define all tasks, competences and the ensuing responsibilities relating to the health and safety activities. Furthermore, the employer should provide a well-structured documentation of its hierarchy and organization of workflow [see EN ISO 9000 (all parts)]. Managers and supervisors responsible for safety should check all relevant regulations for their proper application. If they detect flaws in the hierarchical and workflow organization and/or the documented regulations, they should initiate immediate remedial action.

Further information on Health and Safety is found in Annex D.

8 Design Principles

8.1 General

The basis of the design stage should be the action plan (see clause 6). Design is the process of defining the project in sufficient detail so that instructions can be given to others for the system to be constructed or maintained.

The design process includes the following stages:

- conception;
- preliminary topographical, geotechnical and other investigations (see 9.3);
- preliminary calculations to check the feasibility of the proposed approach;
- refinement of the general concept;
- more detailed calculations;
- production of detailed drawings or specifications.

The design process is typically iterative.

Designers should take into account the practicability of safely constructing, operating and maintaining the system (see clause 7).

The design shall fulfil the objectives (see clause 4) and meet the functional requirements (see clause 5) and the action plan (see clause 6). Specific requirements shall be considered in case of rehabilitation.

Together with the functional requirements (see clause 5) the financial and economic aspects of the various options shall also be considered before reaching a decision as to the preferred solution. The above matters shall be considered in terms of their implications on the whole life cost.

8.2 Types of systems

There are two types of wastewater to be collected and transported by the system; foul wastewater and surface water. Two options are available as follows:

- Combined system – where both types of wastewater are mixed;
- Separate system – where each type of wastewater is collected and transported in a dedicated sewer (surface water in a surface water sewer and foul wastewater in a foul sewer).

Variants of these basic systems are also possible.

The selection of a system will mainly depend upon:

- national or local water management policies;
- type of system which presently exists and how it is expected to evolve;
- possible future changes in the catchment;
- capacity and quality of receiving waters;
- nature of influents to the system;

- need for prior treatment;
- topography;
- ground characteristics;
- treatment plant;
- economic considerations;
- other local conditions.

Adopting an integrated approach towards surface water drainage benefits both the quality and quantity impacts on receiving waters. Where a new system is being proposed, surface water should be kept separate from other wastewater. The discharge of surface water should be in accordance with the following hierarchy.

- a) To an adequate infiltration drainage system.
- b) Directly to a surface receiving water.
- c) To a drain or sewer system.

Storage should be provided to limit the peak discharges to acceptable flow rates.

National or local regulations or the relevant authority can specify the type of system to be used.

Permissible influents to the system are:

- Domestic wastewater.
- Authorised trade effluents. (In some cases pre-treatment of such trade effluents will be necessary before discharge to the system is permitted in order to achieve the quality required by national or local regulations or the relevant authority).
- Surface water and, where exceptionally permitted, groundwater.

The nature of the expected influents shall be assessed.

The design shall take into account the conveyance of wastewater, including trade effluents, which will neither damage the system and/or the wastewater treatment plant, nor impair their operation.

8.3 Layout and profile

The design of the system shall ensure that the layout and profile meets all relevant functional requirements including:

- Maintainability (see 5.1.3);
- Protection of occupational health and safety (see 4.3);
- Not endangering adjacent structures and utility services (see 5.1.13).

The layout and profile will be influenced by topography, the character of developments served, existing and future flows from the catchment, the suitability of receiving waters or receiving wastewater treatment plant and the adequacy of any existing system to accept the design flow.

Economical design is usually achieved when drains and sewers follow the natural falls of the ground. Where practicable they should be laid at such gradients as will prevent excessive accumulation of solid matter in the invert. The route shall be selected so as not to impair the stability of structures.

Access chambers should be sited in locations where they can be reached by operator personnel and equipment. Access should also be provided for excavation to repair a sewer, if this were to be necessary.

Circumstances can make the pumping of wastewater either necessary or advisable and should be considered alongside the long-term energy commitments and the whole life costs involved. Detailed design of pumping installations is considered in 9.2.6.

Positive and negative pressure systems are relatively independent of gradient and the depth of cover. In certain circumstances they are alternatives to, or can form part of, systems operating essentially under gravity. Long-term energy commitments and whole life costs including maintenance shall be considered for each option. Positive pressure systems should be designed in accordance with EN 1671. Vacuum sewer systems should be designed in accordance with EN 1091.

Where an appropriate sewer is not available and cannot immediately be provided, provision for local treatment of wastewater shall be provided.

The levels of the receiving waters at the outfalls shall be taken into account in the planning of the sewer system.

Detailed design of layout and profile is described in 9.2.

8.4 Hydraulic Design

8.4.1 General

The Hydraulic design of the system shall ensure that the design meets all relevant functional requirements including:

- Protection from flooding (see 5.1.2);
- Maintainability (see 5.1.3);
- Maintaining the flow (see 5.1.11).

8.4.2 Foul drains and sewers

The design flows for drains and sewers comprise:

- Domestic wastewater flows;
- Authorised trade effluent flows.

Extraneous water flows may be included in the calculation where these flows cannot be avoided.

Design flows should be calculated in accordance with 9.4.2.

The hydraulic capacity of the pipelines shall be calculated in accordance with Annex E. Surcharging is undesirable in foul gravity drain and sewer systems. Foul drains and sewers should therefore be designed to run at less than pipe full conditions.

Rising mains shall be designed to carry the required design flows in self-cleansing conditions without using excessive energy (see Annex F). The retention time should also be limited so that septicity does not occur (see 9.5.3).

Detailed design of the hydraulic design of foul drains and sewers is described in 9.4.2.

8.4.3 Surface water drains and sewers

8.4.3.1 General

Surface water drains and sewers collect and transport runoff generated within a catchment area during rainfall, for safe discharge into a receiving water or treatment plant. The magnitude of peak flows depends on the intensity and duration of rainfall, the size and configuration of impermeable areas and measures taken to reduce surface water. The topography, soil type and its permeability have also to be considered when estimating the flows emanating from other areas.

Surface water drains and sewers are dimensioned in order to limit flooding. It is usually impracticable to avoid flooding from very severe storms. A balance therefore has to be drawn between cost and the political choice of the level of protection provided.

The level of protection should be based on a risk assessment of the impact of flooding to persons and property. The level of protection should be specified in performance criteria for flooding frequencies or design storm events used in calculation. The design criteria shall be based on the performance criteria.

The hydraulic capacity of surface water drains and sewers shall limit surcharge to nationally or locally prescribed levels and frequencies taking into account backwater levels.

Surface water drains and sewers shall be designed so that the effect of any flooding caused by storms in excess of the nationally or locally prescribed flooding frequencies causes the minimum of impact to persons and property.

Storage should be provided (e.g. by use of detention tanks and ponds) to minimise the hydraulic impact on receiving waters.

Other techniques can be used to reduce the runoff entering the drain and sewer system either in addition to or as a substitute to the use of drains and sewers. These techniques are based on one or more of the following principles:

- infiltration systems;
- minimising the area of impermeable surfaces connected to the drain and sewer system;
- time lag and attenuation of the flow.

In setting hydraulic design performance criteria for surface water sewers, allowance shall be made for the design methods that are likely to be used. In all cases the scale of the consequences of flooding should be taken into account.

For surface water drains and sewers, design flows for the surface water pipelines will be runoff. No allowance shall be made for any other wastewater component.

8.4.3.2 Surface water inlets

Surface water inlets shall be designed in order to ensure an adequate transfer of runoff from impermeable areas into the surface water drains and sewers.

8.4.3.3 Design criteria

Design criteria shall take into account any changes in flows expected over the design life of the drain or sewer system if these changes are not otherwise taken into account in the design. The potential effects of climate

change should be considered. This is to ensure that the sewer continues to meet the performance criteria over the design life of the system.

The frequency of an event may be expressed either as a return period or a probability of occurrence in any one-year period.

Surcharge frequencies and depths in surface water drains and sewers shall be limited to any nationally or locally prescribed values having regard to:

- Whether there are any connected basements not protected by anti-flooding valves, effluent lifting stations or pumping stations;
- Whether the surcharge is likely to lead to flooding of basements.

Design flooding frequencies should be set in order to manage the risk of flooding, having regard to both the frequency and consequences of flooding.

National or local regulations or the relevant authority can specify design storm frequencies or design flooding frequencies or both. Different design criteria may be set for combined and separate systems.

The designer shall assess risk of flooding in events that exceed the design flood frequency, taking into account both the consequences of the flooding and the frequency. Flow routes for excess flows should be investigated to determine the consequences and where possible, the design should be changed to minimise the impact. Where the risk of flooding cannot be reduced by these means the design frequency should be decreased.

The nature of design criteria will depend on the type of design methods used.

a) Design Criteria for use with Simple design methods

In simple design methods the pipes are usually designed to run full, without surcharge, for relatively frequent storms in the knowledge that this provides protection against flooding from much larger storms.

In the absence of any design criteria specified in national or local regulations or by the relevant authority the "design storm frequency" for no surcharge criteria in Table 2 should be used for small schemes.

These approaches should be applied when an existing system is being considered for upgrading.

Both the storm frequency and the flood frequency may be expressed as a return period, which is the average period in years between events, or a probability that an event will occur in any year.

Table 2 — Recommended design frequencies for use with simple design methods

Location	Design storm frequency ^a	
	Return period (1 in "n" years)	Probability of exceeding in any 1 year
Rural areas.	1 in 1	100 %
Residential areas.	1 in 2	50 %
City centres/industrial/commercial areas.	1 in 5	20 %
Underground railway/underpasses.	1 in 10	10 %
^a For those design storms no surcharge shall occur.		

b) More complex methods

For larger developments and for schemes particularly where risks to public health or the environment are significant, time-varying design rainfall and computer based flow simulation models shall be used. Any model used shall be chosen in cooperation with the relevant authority. For any application it is necessary to select a method where the appropriate balance between cost complexity and required accuracy is achieved. Guidance on when they should be used and the type of method to select is given in normative Annex E.

In these cases design should be undertaken to limit frequency of surcharge following which the design should be checked to ensure that the design meets the design flood frequency criteria at specific sensitive locations. These design checks are particularly important on steeply sloping catchment areas.

In the absence of any design criteria specified in national or local regulations or by the relevant authority the design flooding frequency values given in Table 3 may be used.

Table 3 — Recommended design frequencies for use with complex design methods

Location	Design flooding frequency	
	Return period (1 in “n” years)	Probability of exceeding in any 1 year
Rural areas.	1 in 10	10 %
Residential areas.	1 in 20	5 %
City centres/industrial/commercial areas.	1 in 30	3 %
Underground railway/underpasses.	1 in 50	2 %

Detailed design of the hydraulic design of surface water drains and sewers is described in 9.4.3.

8.4.4 Combined drains and sewers

The hydraulic design of combined drain and sewers shall be undertaken in the same way as surface water drains and sewers with the design flows increased to include the dry weather flow. Since the dry weather flow is generally only a small proportion of the capacity of the sewer, less allowance is necessary for the peak dry weather flow rate.

Detailed design of the hydraulic design of combined drains and sewers is described in 9.4.4.

For combined drains and sewers, the design flowrate is made up of runoff, which is by far the predominant component, plus an allowance for foul wastewater flows. The runoff component should therefore be estimated using the methods outlined in 9.4.3. The foul wastewater component is estimated as described in 9.4.2. As the foul wastewater flows are usually considerably lower than the design flowrates, particular consideration should be given to self-cleansing velocities during dry weather conditions.

8.5 Environmental Considerations**8.5.1 General**

The environmental design of the system shall ensure that the design meets all relevant functional requirements including:

- Protection of surface receiving waters (see 5.1.4);

- Protection groundwater (see 5.1.5);
- Prevention of odours, toxic, explosive and corrosive gases (see 5.1.6);
- Prevention of noise and vibration (see 5.1.7);
- Minimising the use of finite resources (see 5.1.8 and 5.1.9).

Control of the sources of pollution from drain and sewer systems shall be considered as it can limit the environmental impact to levels acceptable to the relevant authority.

Consideration of impacts shall pay due regard both to short-term effects and to cumulative long-term effects.

Short-term effects can include fall in the concentration of dissolved oxygen, acute toxicity and hydro-biological stress. Cumulative long-term effects can include the build up, in aquatic biota and sediments, of persistent pollutants such as heavy metals and certain organic compounds.

Sources of environmental impact include:

- outfalls;
- combined sewer overflows;
- emergency overflows, for example from pumping installations or detention tanks;
- exfiltration to groundwater;
- infiltration of groundwater;
- untreatable non-domestic wastewater;
- disposal of residues produced during sewer cleaning (see EN 14654-1).

Any untreatable non-domestic wastewater can have an impact when subsequently discharged from a combined sewer overflow or the wastewater treatment plant.

Infiltration can also affect the frequency and volume of discharges from combined sewer overflows and the quality of discharges from wastewater treatment plants.

Consideration shall be given to the risk of spills of noxious substances within the catchment area, particularly on surface water systems. Where there is significant risk of spillage or discharge of significant quantities of fire fighting water containing harmful substances, appropriate measures shall be taken to avoid entry into or exit from the sewer system of these substances by, for example, the provision of separators (see 8.7.2) or retention tanks.

Pipelines shall be designed to avoid leakage that might cause pollution of groundwater.

To minimise odour nuisance gravity drains and sewers shall be sufficiently ventilated to atmosphere by allowing a free passage of air through the system. In very cold areas special precautions can be required.

Disused drains and sewers shall be removed or, where this is impracticable, they shall be filled with suitable material to prevent for example, structural deterioration, unauthorised use, ingress of groundwater and infestation by rodents.

Care should be taken in the design of systems to minimise the accumulation of deposits as residues from sewer cleaning activities can cause pollution.