## CONTENTS

**PREFACE** 6  
**INTRODUCTION** 9  
**PART 0: GLOSSARY OF TERMS AND ABBREVIATIONS**  
I Glossary of Terms 14  
II Abbreviations 27  
III Referenced Documents 31  
**PART 1: PLANNING AND DESIGN** 36  
Contents 36  
1 General 46  
2 System Planning 57  
3 Flow Estimation 66  
4 Products and Materials 68  
5 Detail Design 80  
6 Property Connection 114  
7 Maintenance Structures 122  
8 Ancillary Structures 158  
9 Structural Design 178  
10 Design Review and Drawings 203  
**PART 2: CONSTRUCTION** 210  
Contents 210  
11 General 216  
12 General Construction 218  
13 Products and Materials 226  
14 Excavation 230  
15 Bedding for Pipes and Maintenance Structures 235  
16 Pipe Laying and Jointing 237  
17 Maintenance Holes (MHs) 247  
18 Maintenance Shafts (MS and TMS), Maintenance Chambers (MC and Inspection Openings (IO) or Inspection Shafts (IS) 250  
19 Pipe Embedment and Support 251  
20 Fill 254  
21 Acceptance Testing 257  
22 Tolerances on As-Constructed Work 271  
23 Connections to Existing Sewers 273  
24 Restoration 274  
25 Work As Constructed Details 276
APPENDICES

Appendix A  Generic Infrastructure Protection Guidance
Appendix B  Estimation of Equivalent Population
Appendix C  Flow Estimation for Undeveloped Population
Appendix D  Protection Against Degradation
Appendix E  Ventilation of Reticulation Sewers Guidelines
Appendix F  Trenchless Technologies
Appendix G  Use of Bends, Fittings and Maintenance Shafts/Chambers
Appendix H  Property Connection Types
Appendix I  Maximum Depth to Invert for Standard Support Types
Appendix J  Pipelines in Slip and Potentially Unstable Areas
Appendix K  Ovality Testing of Gravity Sewers
Appendix L  Specification for Internal Inspection
Gravity Sewerage Code of Australia

Part 1: Planning and Design

Third Edition
Version 3.1
3.3.2 Traditional design flow estimation method
3.3.3 Design flow estimation incorporating existing systems
3.3.4 Design flow estimation—Partially pumped systems
3.3.5 Flow schedule

4 PRODUCTS AND MATERIALS

4.1 GENERAL
4.2 IDENTIFICATION OF SEWER SYSTEMS
4.3 SERVICABILITY OF SEWER SYSTEMS
4.4 PROTECTION AGAINST DEGRADATION
4.5 DUCTILE IRON GRAVITY SEWERS
  4.5.1 Product Specifications
  4.5.2 Sizes and configurations
  4.5.3 Cement mortar lining
  4.5.4 Sleeveing
4.6 PVC GRAVITY SEWERS
  4.6.1 Product Specifications
  4.6.2 Sizes and configurations
4.7 POLYETHYLENE GRAVITY SEWERS
  4.7.1 Product Specifications
  4.7.2 Sizes and configurations
4.8 POLYPROPYLENE GRAVITY SEWERS
  4.8.1 Product Specifications
  4.8.2 Sizes and configurations
4.9 GRP GRAVITY SEWERS
  4.9.1 Product Specifications
  4.9.2 Sizes and configurations
4.10 PLASTICS-LINED CONCRETE GRAVITY SEWERS
  4.10.1 Product Specifications
  4.10.2 Sizes and configurations
4.11 VITRIFIED CLAY SEWERS
  4.11.1 Product Specifications
  4.11.2 Sizes and configurations
4.12 STEEL GRAVITY SEWERS
  4.12.1 Product Specifications
  4.12.2 Sizes and configurations
  4.12.3 Joints
  4.12.4 Field welding
  4.12.5 Flanged joints
4.13 MAINTENANCE STRUCTURES
  4.13.1 Product Specifications
  4.13.2 Classification and application
  4.13.3 Sizes and configurations
4.14 MARKING TAPES
  4.14.1 Product Specifications
  4.14.2 Application
4.15 ACCESS COVERS AND FRAMES
  4.15.1 Product Specifications
  4.15.2 Application
  4.15.3 Cast iron access covers and frames
  4.15.4 Macro-composite access covers and frames
  4.15.5 Thermoplastic access covers and frames
  4.15.6 Size and configuration
  4.15.7 Marking of access covers and frames
4.16 VENT SHAFTS
  4.16.1 Product Specifications
  4.16.2 Application
5 DETAIL DESIGN

5.1 DETAIL DESIGN PROCESS

5.2 DETAIL DESIGN CONSIDERATIONS

5.2.1 Catchment design
5.2.2 Design accuracy
5.2.3 Sewer layout
5.2.4 Location of sewers
  5.2.4.1 General
  5.2.4.2 Sewers located along side boundaries
  5.2.4.3 Sewers located along rear boundaries
  5.2.4.4 Sewers located in small lots (lot area ≤450 m²)
  5.2.4.5 Sewers servicing industrial/commercial lots
  5.2.4.6 Branch and trunk sewers
5.2.5 Trenchless techniques for pipe installation
5.2.6 Near-horizontal boreholes and tunnels
  5.2.6.1 General
  5.2.6.2 Design requirements
  5.2.6.3 Silt traps
5.2.7 Environmental, cultural and heritage considerations
  5.2.7.1 General
  5.2.7.2 Urban salinity
  5.2.7.3 Acid sulphate soils
  5.2.7.4 Vegetation
  5.2.7.5 Coastal zones
  5.2.8 Easements
  5.2.9 Disused sewers
  5.2.10 Special design considerations

5.3 HORIZONTAL ALIGNMENT OF SEWERS

5.3.1 General
5.3.2 Roads, reserves and open space
5.3.3 Railway reserves
5.3.4 Waterways
5.3.5 Maintenance structures and vent shafts
5.3.6 Changes in direction using an MH
5.3.7 Changes in direction using an MS or MC
5.3.8 Horizontal curves in sewers
  5.3.8.1 General
  5.3.8.2 Use of manufactured and variable bends in reticulation sewers
  5.3.8.3 Cumulative deflection using pipe joints

5.4 OBSTRUCTIONS AND CLEARANCES

5.4.1 General
5.4.2 Surface obstructions
5.4.3 Clearance from transmission towers and power lines
5.4.4 Clearance from structures
5.4.5 Underground obstructions and services
  5.4.5.1 General
  5.4.5.2 Clearance requirements
5.4.6 Marker posts

5.5 PIPE SIZING AND GRADING

5.5.1 General
5.5.2 Environmental protection requirements
5.5.3 Minimum air space
5.5.4 Minimum pipe sizes for maintenance purposes
5.5.5 Maximum ET for reticulation sewers
  5.5.5.1 General
  5.5.5.2 Design assumptions
5.5.6 Limitation on sewer size reduction
5.5.7 Minimum grades for self-cleansing
  5.5.7.1 General
  5.5.7.2 Reticulation sewers
  5.5.7.3 Property connection sewers and end-of-line sewers
5.5.8 Minimum grades for slime control
5.5.9 Maximum grades
  5.5.9.1 Branch and trunk sewers
  5.5.9.2 Reticulation sewers

5.6 VERTICAL ALIGNMENT OF SEWERS
  5.6.1 General
  5.6.2 Long section design plan
  5.6.3 Minimum cover over sewers
  5.6.4 Lot servicing requirements
    5.6.4.1 General
    5.6.4.2 Serviced area requirements for residential lots
    5.6.4.3 Serviced area requirements for industrial and commercial lots
    5.6.4.4 Partial lot service
    5.6.4.5 Servicing of basements
    5.6.4.6 Servicing of developed lots
  5.6.5 Minimum depth of sewer connection point
    5.6.5.1 General
    5.6.5.2 Soffit requirement
    5.6.5.3 Physical losses in customer sanitary drains
    5.6.5.4 Depth of connection point
  5.6.6 Grading through MHs
    5.6.6.1 General
    5.6.6.2 Internal fall through MHs joining sewers of same diameter
    5.6.6.3 Internal falls through MHs joining sewers of different diameters
    5.6.6.4 Major sewer junctions
    5.6.6.5 Large falls at MHs
    5.6.6.6 Avoiding hydraulic jumps due to steep grades
    5.6.6.7 Avoiding deep channels in MHs due to steep grades
  5.6.7 Vertical curves in sewers
  5.6.8 Compound curves

6 PROPERTY CONNECTION
  6.1 GENERAL
  6.2 LIMITATIONS OF CONNECTION TO SEWERS
  6.3 METHODS OF THE PROPERTY CONNECTION
    6.3.1 General
    6.3.2 IO interface method
    6.3.3 Buried interface method
    6.3.4 Typical layouts of sewers and general arrangements for property connection sewers
    6.3.5 Maximum depth of property connection point
  6.4 NUMBER OF PROPERTY CONNECTION POINTS
    6.4.1 Single occupancy lots
    6.4.2 Multiple occupancy lots
  6.5 LOCATION OF PROPERTY CONNECTION POINTS
    6.5.1 General
    6.5.2 Vacant lots
    6.5.3 Lots with existing buildings
  6.6 PROPERTY CONNECTION SEWERS
    6.6.1 General
    6.6.2 ‘Type 7 spur’ or ‘Y’ property sewer connections
  6.7 LENGTH OF PROPERTY CONNECTION SEWERS

7 MAINTENANCE STRUCTURES
  7.1 TYPES OF MAINTENANCE STRUCTURES
7.2 LOCATIONS OF MAINTENANCE STRUCTURES
7.3 SPACING OF MAINTENANCE STRUCTURES
   7.3.1 General
   7.3.2 Maintenance structure spacing—Reticulation sewers
   7.3.3 Maintenance structure spacing—Branch and trunk sewers
7.4 SPECIAL CONSIDERATIONS FOR LOCATION OF MAINTENANCE STRUCTURES
7.5 SPECIAL CONSIDERATIONS FOR CONNECTION OF NEW SEWERS TO EXISTING SEWERS

7.6 MAINTENANCE HOLES (MHS)
   7.6.1 General
   7.6.2 Types of MH construction
   7.6.3 Design parameters for MHs
   7.6.4 Design requirements for connection of sewers to MHs
      7.6.4.1 Pre-cast concrete MH base units
      7.6.4.2 Cast in-situ concrete MH base units
      7.6.4.3 Rocker pipes
   7.6.5 Connection of property connection sewers into MHs
   7.6.6 MH drops
   7.6.7 Diameters of MHs
   7.6.8 MH base layout
   7.6.9 Ladders, step irons and landings

7.7 MAINTENANCE SHAFTS (MSS) / MAINTENANCE CHAMBERS (MCS)
   7.7.1 General
   7.7.2 Design parameters for MCs, MSs and TMSs
   7.7.3 Connections to MCs, MSs and TMSs
      7.7.3.1 Connections to PE MSs and TMSs
      7.7.3.2 Connections to pre-cast concrete MC base units
      7.7.3.3 Connections to PP MCs and MSs
   7.7.4 High-level connections to MCs, MSs and TMSs
      7.7.4.1 High-level connections into a pre-cast concrete MC
      7.7.4.2 High-level connections into a PE MC and MS
      7.7.4.3 High-level connections into a PVC-U MS
      7.7.4.4 High-level connections into a PP MC and MS

7.8 INSPECTION SHAFTS (ISS)
   7.8.1 General
   7.8.2 Terminal inspection shaft (Type A)
   7.8.3 Vertical drop inspection shaft (Type B)
   7.8.4 Intermediate inspection shaft (Type C)
   7.8.5 Ends of pipe
      7.8.5.1 Temporary ends of pipe
      7.8.5.2 Permanent ends of pipe

7.9 MAINTENANCE STRUCTURE COVERS
   7.9.1 General
   7.9.2 Cross-fall on MH covers
   7.9.3 Modifications to existing maintenance holes

7.10 SEWERS FROM JUNCTIONS
7.11 OTHER MAINTENANCE STRUCTURES AT INTERFACE OF PROPERTY CONNECTION SEWERS AND SANITARY DRAINS

8 ANCILLIARY STRUCTURES
8.1 GENERAL
8.2 WATER SEALS, BOUNDARY TRAPS, WATER-SEALED MHS AND GAS CHECK MHS
   8.2.1 Boundary traps on sanitary drains
      8.2.1.1 General
      8.2.1.2 Responsibility for installation of boundary traps
   8.2.2 Water seals, water-sealed MHs and gas check MHs
      8.2.2.1 General
8.2.2.2 Water seals on reticulation sewers entering branch or trunk sewers
8.2.2.3 Water seals on branch sewers entering trunk sewers
8.2.3 Water-sealed MHs and gas check MHs
  8.2.3.1 General
  8.2.3.2 Water-sealed MHs
  8.2.3.3 Gas check MHs
8.3 VERTICAL AND NEAR VERTICAL SEWERS
  8.3.1 General
  8.3.2 Design parameters for bored, exposed and encased vertical and near vertical sewers
8.4 VENTILATION
  8.4.1 General
  8.4.2 Design parameters for ventilation and location of vent shafts
  8.4.3 Design details for ventilation lines, vent shafts and cowls
8.5 VORTEX INLETS AND WATER CUSHIONS
8.6 INVERTED SYPHONS
  8.6.1 General
  8.6.2 Design parameters for inverted syphons
8.7 EMERGENCY RELIEF STRUCTURES
  8.7.1 General
  8.7.2 Design parameters for ERSs
    8.7.2.1 General
    8.7.2.2 Configuration
    8.7.2.3 Overflow pipe
    8.7.2.4 Overflow level
8.8 FLOW MEASURING DEVICES
  8.8.1 General
  8.8.2 Within the sewer system
  8.8.3 At a sewage pumping station
8.9 WET WEATHER STORAGE
  8.9.1 General
  8.9.2 Design considerations
9 STRUCTURAL DESIGN
  9.1 GENERAL
  9.2 PRODUCTS AND MATERIALS
  9.3 STRUCTURAL CONSIDERATIONS
    9.3.1 Pipes
    9.3.2 Design factors affecting buried flexible and rigid pipes
    9.3.3 Maintenance structures
  9.4 LOADINGS
    9.4.1 External forces
    9.4.2 Native soil strength
    9.4.3 Embedment zone dimensions
    9.4.4 Pipe embedment
    9.4.5 Buoyancy
    9.4.6 Flotation
  9.5 FOUNDATION DESIGN AND GROUNDWATER CONTROL
    9.5.1 Migration of fines
  9.6 GEOTECHNICAL CONSIDERATIONS
    9.6.1 General
    9.6.2 Pipelines in engineered or controlled fill
    9.6.3 Pipelines in non-engineered fill
    9.6.4 Filling along route of pipeline
    9.6.5 Mine subsidence
    9.6.6 Slip areas
    9.6.7 Water-charged ground
  9.7 SPECIAL EMBEDMENT CONCRETE AND STABILISED SUPPORTS
9.7.1 General
9.7.2 Requirements
9.8 ABOVE GROUND CROSSINGS
9.9 PIPE COVER
9.10 BULKHEADS AND TRENCHSTOPS
9.11 TRENCH DRAINAGE

10 DESIGN REVIEW AND DRAWINGS
10.1 DESIGN REVIEW
10.2 DESIGN DRAWINGS
  10.2.1 General
  10.2.2 Composition of Design Drawings
  10.2.3 Scale
  10.2.4 Real property information
  10.2.5 Sewers
  10.2.6 Structures
  10.2.7 Longitudinal sections (profiles)
  10.2.8 Title block notation and standard notes
  10.2.9 Other
10.3 SEWER SYSTEM ACRONYMS
10.4 SPECIFICATIONS
10.5 RECORDING OF WORK AS CONSTRUCTED INFORMATION

TABLES
Table 1.1  Asset Categories
Table 1.2  Typical Asset Design Life
Table 1.3  Planning and Design Approach
Table 4.1  Colour Identification of Components in Reticulation Sewer Systems
Table 4.2  Limitations of Sewage Chemistry Constituents for Use of Different Types of Cement
Table 5.1  Maximum Limit of Deviation in Level and Line of Boreholes and Tunnels
Table 5.2  Maximum Allowable Deflections Through an MH
Table 5.3  Methods of Achieving Curved Sewers
Table 5.4  Clearances Between Sewers and Other Underground Services
Table 5.5  Minimum Pipe Sizes for Reticulation and Property Connection Sewers
Table 5.6  Maximum Capacities for Gravity Sewers for Various Locations
Table 5.7  Manning Coefficient
Table 5.8  Design Minimum Grades
Table 5.9  Minimum Grades for Property Connection Sewers
Table 5.10 Minimum Grades for End-of-line Sewers
Table 5.11 Minimum Cover over Sewers
Table 5.12 Minimum Internal Fall Through an MH Joining Reticulation Sewers of Same Diameter
Table 5.13 Limitations on Large Falls at MHs Using Internal and External Drops
Table 5.14 Steep Sewers Requiring Special Treatment
Table 7.1 Acceptable Maintenance Structure Options for Reticulation and Property Connection Sewers
Table 7.2 External MH Drop Pipe Structure
Table 7.3  Rocker Pipe Dimensions
Table 7.4  Minimum Drop Height Details for PP
Table 7.5  Guide to Selection of Maintenance Structure Access Covers, Class and Finished Surface Levels
Table 8.1  Requirements for Vortex Inlets and Water Cushions
Table 8.2  ERS Structure Components
Table 9.1  Requirements for Bulkheads and Trenchstops

FIGURES
Figure 2.1  Disaggregation Model for Transportation Subsystems
Figure 3.1  Flow Components in a Gravity System
Figure 5.1  Physical Losses in Customer Sanitary Drains
Figure 5.2  Depth of Point of Connection and Use of Risers
Figure 5.3  Excessively Deep Channels Caused By Steep Grades
Figure 5.4  Incoming Level Adjusted to Prevent Deep Channel
Figure 6.1  Typical Raised Inspection Opening Interface Method
Figure 6.2  Typical Buried Interface Method – Variation (A)
Figure 6.3  Typical Buried Interface Method – Variation (B)
Figure 6.4  Property Connection Points for Sewers in Road Reserves – IO Interface Method
Figure 6.5  Property Connection Points for Sewers in Easements and Private Lots – Buried Interface Method
Figure 6.6  Typical Connection to Deep Sewers in Private Property
Figure 6.7  ‘Type 7 ‘Spur’ or ‘Y’ Property Sewer Connections – Buried Interface Method
Figure 7.1  Single MS or MC Between Consecutive MHs
Figure 7.2  Multiple MS or MC Between Consecutive MHs
Figure 7.3  No MS or MC Between Last MH and IS, TMS or MC
Figure 7.4  Single MS/MC Between Last MH and IS, TMS or MC
Figure 7.5  Typical Pre-Cast MH Base with Pre-Formed Benching
Figure 7.6  Typical Pre-Cast Concrete MH Base with Conical Benching
Figure 7.7  Typical Cast In-Situ Concrete MH Base for VC, RC and DI RRJ Sewers
Figure 7.8  Typical Cast In-Situ Concrete MH Base for PVC RRJ Sewers
Figure 7.9  Typical Cast In-Situ Concrete MH Base for PVC-U SCJ
Figure 7.10  Typical Cast In-Situ Concrete MH Base for VC and GRP Sleeved Coupled Sewers
Figure 7.11  Typical Cast In-Situ Concrete MH Base for Profile Wall PP Sewers
Figure 7.12  Typical Cast In-Situ Concrete MH Base for Solid Wall PE Sewers
Figure 7.13  Typical Cast In-Situ Concrete MH with External Drop Pipe (PVC-U DWV RRJ Sewer Pipe Shown)
Figure 7.14  Typical Pre-Cast Concrete MH with External Drop Pipe (PVC-U DWV RRJ Sewer Pipe Shown)
Figure 7.15  Typical Cast In-Situ Concrete MH with Internal Drop Pipe (PVC-U
Figure 7.16 Typical MH Base Design
Figure 7.17 Typical Arrangements for the Connection of PE Sewers
Figure 7.18 Typical Arrangements for the Connection of a PE MS to PE Sewers
Figure 7.19 Typical PVC-U Cap Assembly and Fittings
Figure 7.20 Typical Arrangement for the Connection to a Pre-Cast Concrete MC
Figure 7.21 Typical PP MC and MS Connection Details
Figure 7.22 Typical TMS with Property Connection Ahead
Figure 7.23 Typical Pre-Cast MC with High-Level Connection
Figure 7.24 Typical PE MC or MS Drop Detail Dimensions
Figure 7.25 Typical PVC-U MS Drop Detail Dimensions
Figure 7.26 Typical PP MC/MS With High-Level Connection
Figure 7.27 Typical External Sewer Drop Structure Type A - 45° Slope Junction
Figure 7.28 Typical External Sewer Drop Structure Type B – 90° Slope Junction
Figure 7.29 Terminal Inspection Shaft – Type A
Figure 7.30 Vertical Drop Inspection Shaft – Type B
Figure 7.31 Intermediate Inspection Shaft – Type C
Figure 7.32 Access Requirements for Sewers from Junctions
Figure 8.1 Application of Water Seal Arrangements
Figure 8.2 Typical Boundary Trap and Shaft
Figure 8.3 Typical Water Seal on Inlet Sewer
Figure 8.4 Typical Water-Sealed MH with External Drop – Plan View
Figure 8.5 Typical Water-Sealed MH with External Drop – Elevation
Figure 8.6 Typical Water-Sealed MH with Minimum Drop – Plan View
Figure 8.7 Typical Water-Sealed MH with Minimum Drop – Elevation
Figure 8.8 Typical Gas Check MH – Sectional Plan
Figure 8.9 Typical Gas Check MH – Section Elevation
Figure 8.10 Typical Gas Check MH – Internal Drop Arrangement Section Elevation
Figure 8.11 Typical Syphon Creek Crossing
Figure 8.12 Typical PE Pipe Section
Figure 8.13 Typical ERS Arrangement – Plan
Figure 8.14 Typical ERS Arrangement – Elevation
Figure 8.15 Typical Headwall Arrangement - Elevation
Figure 9.1 Typical Arrangement for Buried Flexible Pipelines
Figure 9.2 Type 1 Support for Rigid Pipes Only
Figure 9.3 Type 2 Support for Rigid Pipes Only
Figure 9.4 Type 3 Support for Flexible And Rigid Pipes
Figure 9.5 Type 4 Embedment Support with Geotextile Filter Fabric for Flexible and Rigid Pipes
Figure 9.6 Type 5 and 6 Support Utilising Concrete Foundation
Figure 9.7 Type 7 Support Utilising Geotextile Pillow Foundation for Rigid and Flexible Pipes
Figure 9.8 Type 8 Support Utilising Cement Stabilised Foundation for Rigid and Flexible Pipes
Figure 9.9 Type 9 Embedment Support
Figure 9.10 Type 10 Embedment Support
Figure 9.11 Type 11 Embedment Support
Figure 9.12 Type 12R Support Concrete Encasement
Figure 9.13 Type 12U Support Concrete Embedment
Figure 9.14 Type 13 Support Utilising Cement Stabilised Embedment
Figure 9.15 Typical Concrete Bulkhead Detail
Figure 9.16 Typical Road Crossing Bulkhead
Figure 9.17 Typical Trenchstop Detail
Figure 9.18 Typical Trench Drainage Detail at Bulkhead
Figure 9.19 Typical Trench Drainage Discharge
Figure 9.20 Typical Trench Drainage Detail at Low Point in Trench
Figure 9.21 Typical Trench Drainage Detail at Concrete Encased Sections
Figure 9.22 Typical Trench Drainage Around MHs
CONTENTS

11 GENERAL
  11.1 SCOPE
    11.1.1 Resolution of complaints
  11.2 INTERPRETATION

12 GENERAL CONSTRUCTION
  12.1 GENERAL
  12.2 ORDER OF CONSTRUCTION, TESTING AND COMMISSIONING
  12.3 CONTRACT INTERFACES
  12.4 CUSTOMER FOCUS
    12.4.1 General
    12.4.2 Resolution of complaints
  12.5 PROTECTION OF PROPERTY AND ENVIRONMENT
    12.5.1 Protection of other services
    12.5.2 Road reserves or other thoroughfares
      12.5.2.1 Road opening permits
      12.5.2.2 Treatment of pavements and other surfaces
      12.5.2.3 Cleanliness of roads, paths, accesses and drainage paths
      12.5.2.4 Storage of products, materials, equipment and excavated material
      12.5.2.5 Obstruction of street drainage
    12.5.3 Private and public lands
    12.5.4 Protection of the environment and heritage areas
      12.5.4.1 General
      12.5.4.2 Collection and disposal of wastes
      12.5.4.3 Protection of adjacent lands and vegetation
      12.5.4.4 Control of water pollution
      12.5.4.5 Contaminated soils
      12.5.4.6 Control of noise and atmospheric pollution
      12.5.4.7 Equipment and machinery use in bush fire prone areas
  12.6 DISUSED SEWERS
  12.7 OPERATION OF WATER SUPPLY NETWORK
  12.8 ALTERATION OF EXISTING SERVICES
  12.9 SURVEY MARKS
  12.10 CONSTRUCTION TOLERANCES
  12.11 LATENT CONDITIONS

13 PRODUCTS AND MATERIALS
  13.1 APPROVED PRODUCTS AND MATERIALS
  13.2 DELIVERY INSPECTION OF PRODUCTS AND MATERIALS
  13.3 TRANSPORTATION, HANDLING AND STORAGE OF PRODUCTS AND MATERIALS
    13.3.1 General
    13.3.2 Transportation
    13.3.3 Unloading and handling
    13.3.4 On-site storage
    13.3.5 Plastics-lined concrete products
    13.3.6 Coiled plastics pipe
  13.4 CONCRETE WORKS
  13.5 SUPPLY OF WATER TO THE WORKS

14 EXCAVATION
  14.1 PRECAUTIONS
  14.2 LIMITS OF CLEARING AND EXCAVATION
  14.3 PROTECTION OF TREES
    14.3.1 General precautions
    14.3.2 Protection of roots
  14.4 BLASTING
14.5 SUPPORT OF EXCAVATIONS
14.6 DRAINAGE AND DEWATERING
14.7 EXCAVATION ACROSS IMPROVED SURFACES
14.8 TRENCH EXCAVATION
  14.8.1 General
  14.8.2 Construction of embankment
  14.8.3 Clearances for on-site works
14.9 REFILL OF EXCESSIVE EXCAVATION
14.10 FOUNDATIONS AND FOUNDATION STABILISATION
14.11 SURPLUS EXCAVATED MATERIAL
14.12 EXCAVATION AND PIPELAYING USING TRENCHLESS TECHNIQUES

15 BEDDING FOR PIPES AND MAINTENANCE STRUCTURES
15.1 TRENCH FLOOR PREPARATION
15.2 BEDDING MATERIALS
  15.2.1 Placement of bedding
15.3 SPECIAL PIPE SUPPORT FOR NON-SUPPORTIVE SOILS
15.4 BEDDING FOR MAINTENANCE CHAMBERS, MAINTENANCE SHAFTS, INSPECTION SHAFTS AND BENDS
15.5 BEDDING FOR MAINTENANCE HOLES

16 PIPE LAYING AND JOINTING
16.1 INSTALLATION OF PIPES
  16.1.1 General
  16.1.2 Cleaning, inspection and joint preparation
  16.1.3 Coiled plastics pipes
  16.1.4 Laying
16.2 HORIZONTAL AND VERTICAL DEFLECTION OF SEWERS
  16.2.1 General
  16.2.2 Methods of deflection
  16.2.3 Horizontal curves
  16.2.4 Vertical curves
  16.2.5 Compound curves
16.3 HORIZONTAL AND VERTICAL SEPARATION OF CROSSING PIPELINES
16.4 FLOTATION CONTROL
16.5 TRENCH STOPS
16.6 BULKHEADS
16.7 PROPERTY CONNECTION SEWERS
16.8 DEAD ENDS
16.9 MARKING OF PROPERTY CONNECTION SEWERS AND DEAD ENDS
16.10 CORROSION PROTECTION OF CAST IRON
16.11 MARKERS
  16.11.1 Non-detectable marking tape
  16.11.2 Detectable marking tape
16.12 BORED PIPES UNDER ROADS, DRIVEWAYS AND ELSEWHERE
16.13 AQUEDUCTS
16.14 BRIDGE CROSSINGS
16.15 PLASTICS-LINED RC PIPE JOINTING
  16.15.1 General
  16.15.2 Plastics lining work protection
  16.15.3 Field jointing
  16.15.4 Plastics lining ancillary work
    16.15.4.1 Alignment of lining keys
    16.15.4.2 Provision of seepage channels
    16.15.4.3 Use of jointing accessories and adhesives
16.16 WELDING OF STEEL PIPELINES
  16.16.1 General
  16.16.2 Field welding of flanges
  16.16.3 Reinstatement of cement mortar lining
16.16.4 Reinstatement of external corrosion protection at joints using a tape system
   16.16.4.1 Surface preparation
   16.16.4.2 Priming surfaces
   16.16.4.3 Mastic filler
   16.16.4.4 Tape application
16.16.5 Reinstatement of external corrosion protection at joints using a heat-shrinkable sleeve system
   16.16.5.1 Surface preparation
   16.16.5.2 Preheat pipe
   16.16.5.3 Priming surfaces
   16.16.5.4 Mastic filler
   16.16.5.5 Heat-shrinkable sleeve preparation
   16.16.5.6 Heat-shrinkable sleeve application
16.17 WELDING OF PE PIPELINES
   16.17.1 General
   16.17.2 Welder qualifications
   16.17.3 Connections to pipes of other materials

17 MAINTENANCE HOLES (MHS)
   17.1 GENERAL
   17.2 CONCRETE MHS
      17.2.1 Concrete MH base
      17.2.2 Pre-cast concrete MH systems
      17.2.3 Cast in-situ concrete MH
      17.2.4 Benching and channels
      17.2.5 Concreting for thermoplastics-lined works
         17.2.5.1 Concrete work planning
         17.2.5.2 Fixing of thermoplastics lining for concrete work
         17.2.5.3 Concrete placement and formwork removal
      17.2.6 Internal coating of concrete MHs
   17.3 GLASS REINFORCED PLASTICS (GRP) MHS
   17.4 POLYETHYLENE (PE) MHS
   17.5 POLYPROPYLENE (PP) MHS
   17.6 TRENCH DRAINAGE AROUND MHS
   17.7 COVERS
   17.8 CONNECTIONS TO MHS
   17.9 MH DROPS
   17.10 LADDERS, STEP IRONS AND LANDINGS

18 MAINTENANCE CHAMBERS (MC), MAINTENANCE SHAFTS (MS AND TMS) AND INSPECTION OPENINGS (IO) OR INSPECTION SHAFTS (IS)
   18.1 GENERAL
   18.2 SEALING CAPS
   18.3 COVERS
   18.4 CONNECTIONS TO MCS, MSS AND TMSS

19 PIPE EMBEDMENT AND SUPPORT
   19.1 GENERAL
   19.2 EMBEDMENT MATERIALS
   19.3 COMPACTION OF EMBEDMENT
      19.3.1 Methods
      19.3.2 Compaction trials / Pre-qualification of embedment compaction method
         19.3.2.1 General
         19.3.2.2 Test method
         19.3.2.3 Interpretation and applicability
      19.3.3 Compaction control
   19.4 SPECIAL BEDDING AND EMBEDMENTS / GEOTEXTILE SURROUND AND PILLOW
   19.5 REMOVAL OF TRENCH SUPPORTS
   19.6 CONCRETE EMBEDMENT AND ENCASEMENT
20 FILL
20.1 TRENCH FILL
  20.1.1 General
  20.1.2 Material requirements
    20.1.2.1 Trafficable areas
    20.1.2.2 Non-trafficable areas
  20.1.3 Placement
  20.1.4 Compaction of trench fill
20.2 EMBANKMENT FILL
20.3 DRIVES AND TUNNEL FILL

21 ACCEPTANCE TESTING
21.1 GENERAL
21.2 VISUAL INSPECTION—ABOVE-GROUND
21.3 COMPACTION TESTING
  21.3.1 General
  21.3.2 Compaction testing requirements
    21.3.2.1 General
  21.3.3 Embedment compaction testing
    21.3.3.1 Applicable pipe sizes
    21.3.3.2 Frequency and location of embedment tests
    21.3.3.3 Retesting
  21.3.4 Trench fill compaction testing
    21.3.4.1 Trafficable test zone
    21.3.4.2 Non-trafficable test zone
    21.3.4.3 Test method
    21.3.4.4 Frequency and location of tests
    21.3.4.5 Retesting
  21.3.5 Other fill compaction testing
    21.3.5.1 General
    21.3.5.2 Trafficable test zone
    21.3.5.3 Non-trafficable test zone
    21.3.5.4 Frequency and location of tests
    21.3.5.5 Retesting
21.4 AIR PRESSURE AND VACUUM TESTING OF SEWERS
  21.4.1 General
  21.4.2 Air testing methods for sewers
    21.4.2.1 Vacuum testing
    21.4.2.2 Low pressure air testing
  21.4.3 Testing of sewers >DN 1500
    21.4.3.1 General
    21.4.3.2 Method of test
  21.4.4 Testing of non-pressure PE sewers
  21.4.5 Testing of concrete MHs
    21.4.5.1 General
    21.4.5.2 Test method
21.5 INFILTRATION TESTING
21.6 DEFLECTION (OVALLITY) TESTING OF FLEXIBLE SEWERS
  21.6.1 General
  21.6.2 Ovality proving tools
  21.6.3 Flexible sewers ≤DN 300
  21.6.4 Flexible sewers >DN 300
    21.6.4.1 General
    21.6.4.2 Flexible sewers >DN 300 and <DN 750
    21.6.4.3 Flexible sewers ≥DN 750
21.7 MEASUREMENT OF SEWER GRADE
21.8 INTERNAL INSPECTION
21.9 INSPECTION AND TESTING OF THERMOPLASTICS LINED CONCRETE SEWERS AND MHS
   21.9.1 Visual inspection
   21.9.2 Spark testing
   21.9.3 Locking key pull-out tests
21.10 PRESSURE TESTING OF INVERTED SYPHONS
   21.10.1 General
   21.10.2 Hydrostatic system test pressure
   21.10.3 Satisfactory pressure test

22 TOLERANCES ON AS-CONSTRUCTED WORK
22.1 HORIZONTAL TOLERANCES
   22.1.1 Sewers and on-line structures
   22.1.2 Property connection sewers
22.2 VERTICAL TOLERANCES
   22.2.1 Sewers and structures
   22.2.2 Property connection risers and inspection openings
   22.2.3 Grade
   22.2.4 Verticality ("plumb")
22.3 TOLERANCES ON FINISHED SURFACE STRUCTURES AND FITTINGS
22.4 TOLERANCES ON CAST IN-SITU CONCRETE STRUCTURES AND SLABS

23 CONNECTION TO EXISTING SEWERS

24 RESTORATION
24.1 GENERAL
24.2 PAVEMENTS
24.3 LAWNS
24.4 GRASSED AREAS
24.5 BUSHLAND
24.6 PROVISION FOR AND RECTIFICATION OF SETTLEMENT
24.7 MAINTENANCE OF RESTORED SURFACES

25 WORK AS CONSTRUCTED DETAILS

TABLES
Table 21.1 Flexible Pipes – Minimum Compaction Embedment, Trench Fill And Embankment Of Flexible Pipes
Table 21.2 Rigid Pipes – Minimum Compaction Embedment, Trench Fill And Embankment
Table 21.3 Pressure And Vacuum Air Testing Acceptance Times For 7 kPa Pressure Change
Table 21.4 Concrete MH Testing Frequency
Table 21.5 Minimum Test Times For Concrete MHs
Table 21.6 Maximum Allowable Short-Term Pipe Deflections
Table 22.1 Sewer Grade Tolerances
Table 22.2 Property Connection Sewer Grade Tolerances

FIGURES
Figure 16.1 Ball and Socket Joint
Figure 16.2 Slip-In Welded Joint
Figure 16.3 Plain End Welded Collar Joint
Figure 16.4 Plain End Butt Welded Joint