NZS 4404:2004

STANDARDS NEW ZEALAND
PAEREWA AOTEAROA

New Zealand Standard

Land Development and Subdivision Engineering

Superseding NZS 4404:1981

NZS 4404:2004

COMMITTEE REPRESENTATION

This Standard was prepared by Technical Committee P 4404 for the Standards Council established under the Standards Act 1988.

The committee consisted of representatives of the following:

Association of Consulting Engineers New Zealand
Cement and Concrete Association of New Zealand
INGENIUM (Formerly Association of Local Government Engineers)
Local Government New Zealand
New Zealand Institute of Surveyors
New Zealand Planning Institute
New Zealand Water and Wastes Association
Ministry for the Environment
Resource Management Law Association of New Zealand
Transfund New Zealand
Transit New Zealand

Published by Standards New Zealand, the trading arm of the Standards Council, Private Bag 2439, Wellington 6140.
Telephone: (04) 498 5990, Fax: (04) 498 5994.
Website: www.standards.co.nz

AMENDMENTS

No.	*Date of issue*	*Description*	*Entered by, and date*

New Zealand Standard

Land Development and Subdivision Engineering

NOTES

CONTENTS

PART 5: WASTEWATER

PART 6: WATER SUPPLY

PART 7: LANDSCAPE DESIGN AND PRACTICE

PART 8: RESERVES

PART 9: POWER, TELECOMMUNICATIONS, GAS

Appendix

Figure

Table

Schedule

REFERENCED DOCUMENTS

Reference is made in this document to the following:

NEW ZEALAND STANDARDS

NZS 3109:1997	Concrete construction
NZS 3114:1987	Specification for concrete surface finishes
NZS 3116:2002	Concrete segmental paving
NZS 3604:1999	Timber framed buildings
NZS 4121:2001	Design for access and mobility – Buildings and associated facilities
NZS 4402:- - - -	Methods of testing soils for civil engineering purposes
Part 6:1986	Soil strength tests
NZS 4405:1986	Helical lock-seam corrugated steel pipes
NZS 4406:1986	Helical lock-seam corrugated steel pipes – Design and installation
NZS 4431:1989	Code of practice for earth fill for residential development
NZS 4442:1988	Welded steel pipes and fittings for water, sewage and medium pressure gas
NZS 4501:1972	Code of practice for the location marking of fire hydrants
NZS 5828:xxxx	Playground equipment and surfacing (in preparation)
Part 2:1986	Materials and labelling requirements
Part 3:1986	Design and construction – Safety aspects
NZS 7643:1979	Code of practice for the installation of unplasticized PVC pipe systems
NZS 7649:1988	Unplasticized PVC sewer and drain pipe and fittings
SNZ HB 44:2001	Subdivision for people and the environment
SNZ HB 2002:2003	Code of practice for working in the road
SNZ PAS 4509:2003	New Zealand Fire Service fire fighting water supplies code of practice

JOINT AUSTRALIAN/NEW ZEALAND STANDARDS

AS/NZS 1158:- – - -	Road lighting
Part 0:1997	Introduction
Part 1.1:1997	Vehicular traffic (category V) lighting – Performance and installation design requirements
Part 1.3:1997	Vehicular traffic (category V) lighting – Guide to design, installation, operation and maintenance
Part 3.1:1999	Pedestrian area (category P) lighting – Performance and installation design requirements
AS/NZS 1260:2002	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 1477:1999	PVC pipes and fittings for pressure applications
AS/NZS 2041:1998	Buried corrugated metal structures
AS/NZS 2280:1999	Ductile iron pressure pipes and fittings
AS/NZS 2544:1995	Grey iron pressure fittings
AS/NZS 2566:- – - -	Buried flexible pipelines
Part 1:1998	Structural design
Supp 1:1998	Buried flexible pipelines – Structural design – Commentary (Supplement to AS/NZS 2566.1:1998)
Part 2:2002	Installation

➤

AS/NZS 3500:- – - -	National plumbing and drainage
Part 2.2:1996	Sanitary plumbing and drainage – Acceptable solutions
AS/NZS 4020:2002	Testing of products for use in contact with drinking water
AS/NZS 4130:2003	Polyethylene (PE) pipes for pressure applications
AS/NZS 4158:2003	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4256:- – - -	Plastic roof and wall cladding materials
Part 3:1994	Glass fibre reinforced polyester (GRP)
AS/NZS 4360:1999	Risk management
AS/NZS 4765(Int):2000	Modified PVC (PVC-M) pipes for pressure applications
NZS/AS 1657:1992	Fixed platforms, walkways, stairways and ladders. Design, construction and installation
NZS/AS 2033:1980	Installation of polyethylene pipe systems

AUSTRALIAN STANDARDS

AS 1579:2001	Arc-welded steel pipes and fittings for water and waste-water
AS 1741:1991	Vitrified clay pipes and fittings with flexible joints – Sewer quality
AS 1906:- – - -	Retroreflective materials and devices for road traffic control purposes
Part 3:1992	Raised pavement markers (retroreflective and non-retroreflective)
AS 2032:1977	Code of practice for installation of UPVC pipe systems
AS 2033:1980	Installation of polyethylene pipe systems
AS 2200:1978	Design charts for water supply and sewerage
AS 2700:1996	Colour Standards for general purposes
AS 3518:- – - -	Acrylonitrile butadiene styrene (ABS) pipes and fittings for pressure applications
Part 1:1988	Pipes
Part 2:1988	Solvent cement fittings
AS 3681:1989	Guidelines for the application of polyethylene sleeving to ductile iron pipelines and fittings
AS 3996:1992	Metal access covers, road grates and frames
AS 4060:1992	Loads on buried vitrified clay pipes

OTHER DOCUMENTS

Accident Compensation Corporation (ACC):

IP – Chalmers and Langley 5 (1): 72

Jambor T, Chalmers D, O'Neill D. The New Zealand playground safety manual. Wellington: Accident Rehabilitation and Compensation Insurance Corporation (1994)

Auckland Regional Council:

Technical Publication No. 10 Stormwater treatment devices

Technical Publication No. 90 Erosion and sediment control: guidelines for land disturbing activities in the Auckland Region (1999)

Technical Publication No. 124 Low impact design manual for the Auckland region

Austroads:

AP-1/89	Rural Road Design – Guide to the geometric design of rural roads
AP-11:- – - -	Guide to Traffic Engineering Practice
AP-11.5/91	Part 5: Intersections at grade
AP-11.6/93	Part 6: Roundabouts
AP-11.10/88	Part 10: Local area traffic management
AP-11.11/88	Part 11: Parking
AP-11.14/99	Part 14: Bicycles
AP-17/92	Pavement Design – A guide to the structural design of road pavements
AP-40/95	Austroads Strategy for Ecologically Sustainable Development

Building Industry Authority:
The New Zealand Building Code and Approved Documents

Hicks, D.M. & Mason, P.D., Roughness Characteristics of New Zealand Rivers (1991)

Institution of Engineers, Australia:
Australian Rainfall and Runoff (Volumes 1 and 2)

Land Information New Zealand:
NZGD2000 New Zealand Geodetic Datum (2000)

Land Transport Safety Authority:
Light Vehicle sizes and dimensions: Street survey results and parking space requirements – Road and traffic standards information No. 35 (June 1994)
RTS 11 Urban Roadside Barriers and Alternative Treatments

Ministry of Health:
Drinking-Water Standards for New Zealand (2000)

Ministry for the Environment:
Guidelines for Subdivision (1991)
The Resource Management Act and You: Getting in on the Act (2001)
Your Guide to the Resource Management Act (1999)

Shigo, Alex: Modern Arboriculture, Touch Trees (1991)

Transit New Zealand:

SP/M/020	Guidelines for Highway Landscaping
SP/M/022	Bridge Manual 2003
MOTSAM	Manual of Traffic Signs and Markings
Part 1	Traffic Signs, September 1998
Part 2	Markings, February 1997
TNZ B/2:1997	Construction of unbound granular pavement layers
TNZ M/1:1995	Specification for roading bitumens

➤

TNZ M/4:2003	Specification for crushed basecourse aggregate
TNZ M/10:2002	Specification for asphaltic concrete
TNZ P/3:1995	Specification for first coat sealing
TNZ P/4:1995	Specification for resealing
TNZ P/9:1975	Construction of asphaltic concrete paving
TNZ T/10:2002	Skid resistance deficiency investigation and treatment selection
SHGDM	State Highway Geometric Design Manual, December 2000
	NZ Supplement to the Austroads Pavement Design Guide, May 2002

Water Services Association of Australia (WSAA):

WSA 01	Polyethylene Pipeline Code
WSA 02	Sewerage Code of Australia
WSA 03	Water Reticulation Code of Australia
WSA 04	Sewage Pumping Station Code of Australia

NEW ZEALAND LEGISLATION

Building Act 1991
Health and Safety in Employment Act 1992
Land Transfer Act 1952
Local Government Acts 1974 and 2002
Resource Management Act 1991
Transport Act 1962
Transport Management Act 2003

LATEST REVISIONS

The users of this Standard should ensure that their copies of the above-mentioned New Zealand Standards and referenced overseas Standards are the latest revisions or include the latest amendments. Such amendments are listed in the annual Standards New Zealand Catalogue which is supplemented by lists contained in the monthly magazine *Standards Update* issued free of charge to committee and subscribing members of Standards New Zealand.

REVIEW OF STANDARD

Suggestions for improvement of this Standard will be welcomed. They should be sent to the Chief Executive, Standards New Zealand, Private Bag 2439, Wellington 6020.

FOREWORD

This Standard is a revision of NZS 4404:1981 *Code of Practice for Urban Land Subdivision.*

The 1981 document was developed at a time when subdivision was governed by the Local Government Act 1974, including a statutory requirement for local authorities to have a Code of Urban Subdivision that set out the minimum requirements for the subdivision of land. With the repeal of the subdivision provisions of the Local Government Act 1974 by the Resource Management Act 1991 many of the requirements of NZS 4404:1981 became outdated and were no longer applicable.

In the early days of working under the Resource Management Act 1991 there was a perception that prescriptive codes or standards were not required because of the "effects-based" nature of district planning under the new legislation. However, a survey of territorial authorities carried out at the commencement of this revision confirmed that there was a continuing need for guidance to achieve effective engineering design and construction in relation to the subdivision of land.

While a number of the larger authorities advised that they had adopted their own codes of practice setting out what is required of a subdivider to meet the approval of the authority, the survey revealed that small to medium-sized authorities would welcome a revised standard that could be adopted, in whole or in part, to meet their needs. Therefore, for those authorities choosing to adopt it, this Standard offers a convenient way of providing good practice guidelines and a means of compliance for the various types of infrastructure.

The Standard recognizes and provides for alternative designs that will result in development equivalent or superior in performance to that complying with the Standard. This flexibility can be used to meet circumstances peculiar to a site or local authority, or to meet the principle of life cycle costing, particularly for major projects.

The scope of the Standard has been widened by including provisions for rural subdivision, for landscape design and practice, and for the development of reserves that are to be vested in local authorities. Procedures for the approval, design and construction of land developments have been updated. Modern materials for water reticulation and drainage have been included and the use of some older materials such as asbestos cement has been removed. Outdated National Roads Board specifications have now been superseded by Transit New Zealand specifications for the design and construction of roads.

As a result of submissions received on the Public Comment Draft, the chapters on water supply and wastewater were substantially re-written and modelled on the Water Services Association of Australia (WSAA) documents for those infrastructures. The Committee would like to thank both North Shore City Council and WSAA for allowing the use of their material in the preparation of this Standard.

The Committee would also like to thank Western Bay of Plenty District Council for allowing the use of its material in Part 7 on Landscape Design and Practice, and New Zealand Institute of Landscape Architects for reviewing this material.

The new name for the Standard LAND DEVELOPMENT AND SUBDIVISION ENGINEERING recognizes that it is the activity of land development that is being addressed through the application of subdivision and engineering activities.

NOTES

PART 1: GENERAL REQUIREMENTS AND PROCEDURES

NEW ZEALAND STANDARD

LAND DEVELOPMENT AND SUBDIVISION ENGINEERING

PART 1: GENERAL REQUIREMENTS AND PROCEDURES

1.1 Scope

This Standard, if adopted by territorial authorities (TAs), serves as a basis for technical compliance for the subdivision and development of land where these activities are subject to the Resource Management Act 1991.

Part 1 of this Standard concerns matters of general application and general requirements to be observed.

Parts 2 to 9 of this Standard provide good practice guidelines relating to particular types of infrastructures to be provided.

C1.1

This Standard does not include a statement of all minimum requirements for land subdivision and development engineering. TAs may specify their own minimum requirements, citing this Standard or their own bylaws or district plan as appropriate.

This Standard does not deal with the processes of compliance with the requirements of a district plan in respect of subdivision and/or development activities or obtaining a resource consent for such activities. For these purposes reference can be made to the following publications of the Ministry for the Environment:

"Your Guide to the Resource Management Act – An essential reference for people affected by or interested in the Act" – Ministry for the Environment: Wellington, January 1999 – ISBN 0 478 09053 6

"Guidelines for Subdivision" – Ministry for the Environment: Wellington, October 1991 – ISBN 0-447-05868-X

"The Resource Management Act and You: Getting in on the Act" – Ministry for the Environment, June 2001 – ISBN 0 478 24017 1.

1.2 Interpretation

1.2.1 *General*

1.2.1.1 Where any other Standard named in this Standard has been declared or endorsed in terms of the Standards Act 1988, then:

(a) Reference to the named Standard shall be taken to include any current amendments declared or endorsed in terms of the Standards Act 1988; or

(b) Reference to the named Standard shall be read as reference to any Standard currently declared or endorsed in terms of the Standards Act 1988 as superseding the named Standard, including any current amendments to the superseding Standard declared or endorsed in terms of the Standards Act 1988.

NOTE – The date at which an amendment or superseding Standard is regarded as "current" is a matter of law depending upon the particular method by which this Standard becomes legally enforceable in the case concerned. In general, if this is by contract the relevant date is the date on which the contract is created, but if it is by Act, regulation, or bylaw then the relevant date is that on which the Act, regulation, or bylaw is promulgated, or comes into effect.

1.2.1.2 The full titles of reference documents cited in this Standard are given in the list of referenced documents.

1.2.1.3 The word "shall" or the imperative mood refers to practices which are mandatory for compliance with the Standard. The words "should" or "may" indicate a recommended practice.

1.2.1.4 Clauses prefixed by "C" and printed in italic type are intended as comments on the corresponding mandatory clauses. They are not to be taken as the only or complete interpretation of the corresponding clause. The Standard can be complied with if the comment is ignored.

1.2.1.5 The terms "informative" and "normative" have been used in this Standard to define the application of the Appendix to which they apply. A "normative" Appendix is an integral part of a Standard, whereas an "informative" Appendix is only for information and guidance. Informative provisions do not form part of the mandatory requirements of this Standard.

1.2.2 *Statutory requirements*

The provisions of this Standard shall be read subject to the provisions of the district plan and to any applicable statutes, regulations and bylaws and any subsequent amendments, including (but not limited to):

Building Act 1991

Electricity Act 1992

Health and Safety in Employment Act 1992

Land Transfer Act 1952

Local Government Acts 1974 and 2002

Plumbers, Gasfitters, and Drainlayers Act 1976

Public Works Act 1981

Resource Management Act 1991

Telecommunications Act 2001

Transit New Zealand Act 1989

Transport Management Act 2003

Water Supplies Protection Regulations 1961

1.2.3 *Definitions*

In this Standard, unless inconsistent with the context, the following definitions apply:

ANNUAL EXCEEDANCE PROBABILITY (AEP) means the probability of exceedance of a given occurrence, generally a storm, within a period of one year. (1 % AEP is equivalent to a 1 in 100 years storm.)

AUTHORIZED OFFICER means any person appointed or authorized by the territorial authority (TA) to act on its behalf and with its authority to control the engineering work of the territorial authority.

CYCLEWAY means so much of any road as is laid out or constructed by authority of the TA primarily for cyclists; and may include the edging, kerbing and channelling thereof.

DEVELOPER means an individual or organization having the financial responsibility for the development project and includes the owner.

DEVELOPER'S PROFESSIONAL ADVISOR means the person, appointed by the developer, who shall be responsible for:

(a) The investigation, design and obtaining of approvals for the works;

(b) Contract administration and supervision of the works;

(c) Certification upon completion of the works.

DRAINAGE means wastewater drainage or stormwater drainage, and "drain" has a corresponding meaning.

EARTHWORKS means any alteration to the contours, including the excavation and backfilling or recompaction of existing natural ground and the stripping of vegetation and topsoil.

FOOTPATH means so much of any road as is laid out or constructed by authority of the TA primarily for pedestrians; and may include the edging, kerbing and channelling thereof.

GEOTECHNICAL ENGINEER means a Chartered Professional Engineer (CPEng) or an engineering geologist with recognized qualifications and experience in geotechnical engineering, and experience related to the development.

GROUND is used to describe the material in the vicinity of the surface of the earth whether soil or rock.

HOUSEHOLD UNIT OR DWELLING UNIT means any building or group of buildings, or part thereof used, or intended to be used principally for residential purposes and occupied or intended to be occupied by not more than one household.

INDEPENDENT QUALIFIED PERSON (IQP) means a specialist approved by the TA and having the appropriate skills and qualification to carry out specific procedures.

LAND DRAINAGE SYSTEM refers to the flow of surface and ground water but concentrates mainly on peak surface discharges and their regulation under urban conditions.

LOW FLOW PATH refers to the path taken by run-off resulting from ground water discharge and light rainfall. The low flow path should be kept to the minimum size consistent with ease of maintenance and may be considered to be 2 % to 5 % of the primary design flow.

MEANS OF COMPLIANCE means a method by which the requirements of the Standard may be complied with. It implies that there may be other methods which may meet the requirement subject to specific consideration or approval.

NETWORK UTILITY OPERATOR has the same meaning given to it by section (s.) 166 of the Resource Management Act 1991.

OWNER in relation to any land or interest therein, includes an owner thereof, whether beneficially or as trustee, and their agent or attorney, and a mortgagee acting in exercise of power of sale; and also includes the Crown, the Public Trustee, and any person, local authority, board, or other body or authority however designated, constituted or appointed, having power to dispose of the land or interest therein by way of sale.

PRIMARY DESIGN FLOW is the estimated run-off selected to provide a reasonable degree of protection to the surrounding land and buildings. In most cases this flow will be piped or contained within relatively narrow confines under public control by reserve or easement.

PRIVATE ROAD means any roadway, place, or arcade laid out within a district on private land by the owner thereof intended for the use of the public generally.

PRIVATE WAY means any way or passage whatsoever over private land within a district, the right to use which is confined or intended to be confined to certain persons or classes of persons, and which is not thrown open or intended to be open to the use of the public generally and includes any shared access or right of way.

ROAD has the same meaning given to it by s. 315 of the Local Goverment Act 1974.

SECONDARY FLOW PATH refers to the path taken by run-off in excess of the primary design flow and should be capable of producing a reasonable degree of protection to the surrounding buildings.

A freeboard above the secondary flow level is normally considered advisable when determining allowable floor levels. This is to cater for inaccuracies in flow estimation methods and for possible failure of the primary system.

STORMWATER is rain water that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel, open watercourse or a constructed infiltration facility.

STREET has the same meaning as “road” as defined by s. 315 of the Local Government Act 1974.

SUBDIVIDING OWNER means the owner of the land to be subdivided, until allotments are sold.

SURFACE WATER means all naturally occurring water, other than sub-surface water, which results from rainfall on the site or water flowing onto the site, including that flowing from a drain, stream, river or sea.

SURVEY PLAN means a survey plan in terms of s. 2 of the Resource Management Act 1991.

SWALE means a constructed watercourse shaped or graded in earth materials and stabilized with site-suitable vegetation, for the safe conveyance and water-quality improvement of storm run-off.

TERRITORIAL AUTHORITY means a territorial authority (TA) defined in the Local Government Act 2002.

WATER SUPPLY AUTHORITY (WSA) is the operational unit of the TA responsible for the supply of water, including its authorized agents.

WASTEWATER is water that has been used and contains unwanted dissolved and/or suspended substances from communities, including homes, businesses and industries.

1.2.4 *Abbreviations*

The following abbreviations are used in this Standard.

ABS	Acrylonitrile Butadiene Styrene
AEV	annual event probability
AV	air valve
°C	degrees Celsius
CC(C)TV	closed circuit (colour) television
CLS	concrete lined steel
DI	ductile iron
DN	nominal diameter
DWSNZ	drinking water standards New Zealand
EP	equivalent population
FSL	finished surface level
GL	ground level
GPR	glass reinforced plastic
H	head (in metres)
h	hour
ha	hectare
HGL	hydraulic grade line
K	kilometre
kPa	kilopascal
L	litre(s)
m	metre
min	minute(s)
MDPE	medium density polyethylene
MH	manhole or maintenance hole
MPa	mega Pascals
MS	maintenance shaft
m/s	metres per second
m^3/s	cubic metres per second
mm	millimetres
NAASRA	National Association of Australian State Road Authorities
NZBC	New Zealand Building Code
OSH	occupational safety and health
p	person
PE	polyethylene
PF	peaking factor
ppm	parts per million
PRV	pressure reducing valve
PVC	polyvinylchloride
uPVC	unplasticized polyvinyl chloride

mPVC	modified polyvinyl chloride
RPZD	reduced pressure zone device
RRJ	rubber ring joint
RTU	remote telemetry unit
s	second
s.	section
SDR	standard dimension ratio
SIDS	safe intersection sight distance
SP	service pressure
WPS	wastewater pumping station
T	temperature
TA	territorial authority
TMS	terminal maintenance shaft
TNZ	Transit New Zealand
VC	vitrified clay
UV	ultraviolet
vpd	vehicles per day
0^o	degrees

1.3 Relationship with Resource Management Act 1991 and Building Act 1991

1.3.1 *Resource Management Act*

The Resource Management Act 1991 is the principal statute under which the development and subdivision of land is controlled.

The district plans of TAs are resource management instruments with the purpose of achieving the promotion of sustainable management of natural and physical resources, which is the overarching purpose of the Resource Management Act 1991.

Standards unless incorporated into a district plan or bylaw do not have a binding effect. It is not practical or justifiable in resource management terms to include all the technical and construction compliance requirements for development and subdivision in a district plan.

This Standard therefore can serve as a technical compliance manual, and although outside the district plan, its provisions can be referred to by the district plan and given effect through conditions of resource consent.

> ***C1.3.1***
> *Under s. 313 of the former Part XX of the Local Government Act 1974 there was a separate requirement for TAs to prepare and publicly notify a code of urban subdivision setting out the minimum requirements and general advice for people undertaking subdivisions. There is no equivalent under the Resource Management Act 1991.*

1.3.2 *Building Act*

The Building Act 1991 provides a national focus for building control to ensure that buildings are safe and sanitary and have suitable means of escape from fire, and the Building

Regulations made under the Act provide the mandatory requirements for building control in the form of the New Zealand Building Code. The Building Code contains the objective, functional requirements and performance criteria that building work must achieve.

Where infrastructural development associated with subdivision or development of land involves the creation of structures with associated site works, the requirements of the Building Act must be observed. Nothing in this Standard shall detract from the requirements of the Building Act 1991 or the Building Code.

> ***C1.3.2***
> *Systems owned or operated by a network utility operator for the purpose of reticulation to other property are not included in the definition of building under the Building Act 1991.*

1.4 Requirements for design and construction

1.4.1 *Investigation and design*

All investigation, calculations, design, supervision and certification of the works outlined in this Standard shall be carried out by or under the control of persons who:

(a) Are experienced in the respective fields;

(b) Hold appropriate membership in the respective professional bodies;

(c) Have appropriate professional indemnity insurance.

The provisions of this Standard do not reduce the responsibility of those professionals to exercise their judgement and devise appropriate solutions for the particular circumstances of each development.

1.4.2 *Construction*

All works carried out in any development shall be done by persons who:

(a) Have the appropriate experience in the relevant areas;

(b) Have the appropriate equipment;

(c) Meet the requirements of the Health and Safety in Employment Act 1992.

1.5 Approval of design and construction

1.5.1 *Documents to be submitted for design approval*

1.5.1.1 Prior to or as a condition of granting a resource consent for subdivision and/or development of land, or as otherwise required by a district plan, or as otherwise considered necessary by the TA when considering applications to carry out such works, the TA may require documents to be submitted including the following:

(a) Engineering drawings, specifications and calculations concerning the following work to be carried out:

Earthworks

Roading and site access

Drainage (stormwater and wastewater)

Water supply

Landscaping

Reserves development

Network utility services;

(b) Geotechnical engineer's report on the suitability of the land for subdivision and/or development;

(c) Other reports as considered necessary by the TA in the circumstances of the proposed work in order to meet the requirements of this Standard;

(d) A design certificate in the form of the certificate in Schedule 1A.

1.5.2 *Drawings*

1.5.2.1 *General*

Design drawings shall be prepared in accordance with the TA's practices. Except where otherwise notified, the requirements are as set out in this section and Parts 2 to 9 of this Standard. Drawings shall be approved by the TA. All drawings shall be provided in paper form, and where required by the TA, in computer media compatible with the authority's computer system.

Engineering design drawings shall be to adequate detail to clearly illustrate the proposals and enable assessment of compliance with this Standard and enable accurate construction.

1.5.2.2 *Composition of drawings*

Design drawings generally include the following:

(a) A locality plan giving the overall layout and location of the works;

(b) Detailed plans, longitudinal sections, cross sections and diagrams of the proposed developments and/or works;

(c) Special details where the standard drawings are not sufficient;

(d) A north point and level datum, the scale or scales used, the date of preparation and the date of any amendments, the designer's name and contact details, and a unique number or identifier.

1.5.2.3 *Scale*

The scale for plans is generally 1:500 but other accepted engineering scales may be used to suit the level of details on the plans. Special details shall be to scales appropriate for clarity. Individual TAs may require other specific scales to be used.

1.5.2.4 *Content of drawings*

The following information shall be shown on the design drawings:

(a) The extent of the works showing existing and proposed roads, and the relationship of the works with adjacent works, services and/or property;

(b) Significant existing vegetation to be removed and any special or protected trees, and any areas of heritage significance that may be affected by the works;

(c) The extent of earthworks, including earthworks on proposed reserves, existing and proposed contours, areas of cut and fill, batter slopes, proposed stockpiles, subsoil drainage, silt control measures both temporary and permanent;

(d) The design of proposed roads (and their connections with existing roads), including plans longitudinal and cross sections, horizontal and vertical geometry and levels, typical cross sections, details of proposed pavement, kerbing, berms, footpaths, cycleways, tree planting, road marking and signals and all other proposed road furniture;

(e) The horizontal and vertical location and alignment, lengths, sizes, materials, minimum cover, position relative to other services of all proposed water, wastewater and stormwater mains and service connections, valves, hydrants, manholes, bends, tees, meters and backflow devices, and services that may be reconnected or plugged;

(f) Details and location of mechanically restrained portions of pipelines, pipeline bridges, pumping stations, reservoirs, intake and outlet structures and the location of surface obstructions, hazards, or other features that may be affected by the works;

(g) In respect of water mains - nominal static pressure head at the point of connection and at the lowest point of the works; design pressure and maximum design pressure;

(h) Details and location of existing and proposed telecommunications, electricity and gas supply and street lighting layout, including proposed underground and above ground junction boxes, transformers and similar equipment;

(i) Details of proposed landscaping of roads and allotments, and details of proposed reserve development including earthworks, landscaping features, landscaping structures (see 7.3.5), tree planting, hard and soft surface treatment, park furniture and playground equipment (see 8.3.5).

1.5.2.5 *Recording of work – as-built information*

The TA may require the design drawings to be in a certain format, suitable for later addition of as-built information and inclusion in the TA asset map base. In particular, electronic transfer of plans may be required.

1.5.3 *Design basis for documents submitted for approval*

1.5.3.1 *Standard design basis*

Proposals submitted on a standard design basis shall conform to this Standard and to whatever amendments are made.

1.5.3.2 *Alternative design basis*

Proposals submitted on an alternative design basis may differ from this Standard and shall apply specifically to a particular proposal. TA approval of an alternative design does not confer approval in general by the TA to any design criteria, construction technique or material forming part of the alternative design. An explanation of the design basis or construction method is to be submitted, for approval in principle, and will be considered on its merits in relation to the proposal, provided that the design results in infrastructural development equivalent or superior in performance to that complying with this Standard. Alternative designs will be permitted to provide flexibility for adoption of design to meet circumstances and requirements of the district plan, which may be peculiar to the site, or as a means of encouraging innovative design, or to meet the principle of life cycle costing.

1.5.3.3 *Cost benefit or life cycle costing*

Where appropriate, consideration shall be given to the cost and benefits of a proposal, both to the developer and the TA.

Life cycle costing may be used to consider options within a proposal or a proposal as a whole. In undertaking a life cycle costing, consideration shall be given to the initial costs borne by the developer and the maintenance and replacement costs borne by the future owners and/or the TA. A reasonable balance shall be maintained between these short-term and long-term costs.

C1.5.3.3

Consideration will normally only be necessary for a major proposal departing significantly from this Standard.

1.5.4 *Approval of design*

1.5.4.1 When it is satisfied that the design meets the requirements of this Standard, or in the case of an alternative design, that the design satisfies the requirements of 1.5.3.2 above, the TA shall notify the owner that the design has been approved and endorse the engineering plans, specifications and other documents accordingly. For the purpose of this approval the TA may require the owner to make amendments to any plans, specifications and/or other documentation and to submit further or other reports. In considering project design and giving its approval, the TA shall act without undue delay.

1.5.4.2 *Approval before commencing work.*

Work shall not commence on site unless and until:

(a) A resource consent for the work has commenced, except when no such consent is required; and

(b) The authorized officer has approved the engineering drawings, specifications and calculations for the specific work that is required in accordance with 1.5.4.1 above.

C1.5.4.2
S. 116 of the Resource Management Act 1991 sets out when a resource consent commences. Generally this will be when any appeals against the grant of the consent have been disposed of. Where any appeals are unresolved, approval to commence work will need to be obtained from the Environment Court.

1.5.5 *Notification of contracts and phases of work*

1.5.5.1 The developer shall notify the authorized officer, in writing, of the names and addresses of contractors to whom it is proposed to award the work, and the nature of the work to be awarded in each case.

1.5.5.2 Unless the TA requires otherwise, the developer shall notify the authorized officer when the following phases of the work are reached and such other phases as the TA may determine to enable inspection to be carried out:

- Commencement of works
- Prior to concrete works
- Prepared earthworks and subsoil drainage prior to filling
- Completed earthworks and prepared subgrade
- Drainage and water reticulation prior to backfilling
- Water and drainage reticulation during pressure testing
- Finished basecourse before the commencement of road sealing.

At least 24 hours notice shall be given by the developer. Inspection shall be carried out within 24 hours of notification if possible. Further work phases shall not proceed until inspection has been made.

C1.5.5.2
TAs may require the appointment of a "developer's professional advisor" or "independent qualified person (IQP)" in which case this requirement will be performed by that person.

1.5.6 *Supervision of work*

The level of supervision undertaken in connection with any work shall be agreed between the TA and the developer's professional advisor or the IQP as the case may be, and shall be appropriate to the circumstances of the work having regard to the size and importance of the project, the complexity of the construction works, and the experience and demonstrated skill in quality management of the person carrying out the work.

The TA may require completion certification as to construction and supervision be submitted to it upon completion of the work. Such certification may be required from the contractors undertaking the work, or the developer, or the developer's professional advisor (if any). The certificates shall be in the form given in Schedules 1B and 1C.

C1.5.6
An appropriate level of supervision can be selected by reference to the Construction Monitoring Services information published by the Institution of Professional Engineers of New Zealand (IPENZ) and the Association of Consulting Engineers New Zealand (ACENZ).

1.5.7 *Connecting to existing services*

1.5.7.1 Connection of water, drainage and other services to existing systems will normally be carried out by the appropriate network utility operator at the cost of the developer, except that at the discretion of the network utility operator connections may be made by the owner, or contractor employed by the owner, if appropriately qualified and under the network utility operator's supervision.

1.5.7.2 The developer shall give the network utility operator five working days notice of intention to connect to existing services. New services shall be tested and approved by the network utility operator prior to connection.

1.5.8 *Testing*

Any work required to be tested by the developer or in the presence of the authorized officer shall be pre-tested and proved satisfactory by the developer before test by the TA is requested.

1.5.9 *Maintenance*

The developer shall maintain the works until they are formally taken over by the TA or to a date specified in a bond for completion of uncompleted works. The developer shall not be responsible for damage caused by other activities such as building construction on completed sections or for fair wear and tear caused by public use of the roads.

1.5.10 *Completion documentation*

Upon completion of all subdivision and/or developments, the developer shall provide the TA with the following:

(a) The geotechnical reports and as-built plans required by 2.11 of this Standard;

(b) As-built plans of all infrastructure showing the information set out in Schedule 1D. As-built plans may be submitted as electronic data where a standard data format has been agreed between the TA and the developer;

(c) Evidence that all testing required by this Standard has been carried out and that the test results comply with the requirements of this Standard;

(d) Evidence that reticulation and plant to be taken over by network utility operators have been installed to their standards and will be taken over, operated and maintained by the network utility operator concerned;

(e) Completion certificates as per Schedules 1B and 1C;

(f) Other documentation required by the TA including, but not limited to, operation and maintenance manuals and warranties for new facilities involving electrical or mechanical plant and asset valuations for all infrastructures to be taken over by the TA.

1.5.11 *Approval of uncompleted work*

Where in the opinion of the TA it is desirable, the TA may approve uncompleted work, subject to satisfactory bonds being arranged.

1.6 Bonds and charges

1.6.1 *Uncompleted works bonds*

1.6.1.1 Bonds to cover uncompleted works, especially where a subdivision or development has been substantially completed, are recognized as an acceptable procedure and will be permitted at the discretion of the TA, except that acceptance of a bond for uncompleted works shall not be unreasonably withheld.

1.6.1.2 Bonds shall be secured by an appropriate guarantee or shall be in cash and lodged with the TA. Where necessary bonds shall be executed and registered.

1.6.1.3 The amount of the bond shall be the estimated value of the uncompleted work plus a margin to cover additional costs estimated to be incurred by the TA in the event of default.

C1.6.1
A satisfactory system of bonding uncompleted works is needed to overcome delays in obtaining the deposit of land transfer plans for subdivision. A major factor can be the practical difficulties of fully completing the construction of a subdivision caused by inclement weather, shortages of machinery, materials and labour and the difficulty of co-ordinating the many aspects required to achieve full completion of a substantially completed subdivision.

The authority to require bonds is given in s.108 (2) (b) and s. 108A of the Resource Management Act 1991, and s.109 of that Act deems bonds and covenants to be instruments registerable under the Land Transfer Act 1952, running with the land and binding subsequent owners. Section109 of the Resource Management Act 1991 also gives the TA the power to enter land to recover costs in respect of uncompleted work. Additional powers are given by s. 223 of the Resource Management Act 1991, in respect of subdivision, to allow the deposit of a survey plan notwithstanding uncompleted work.

SCHEDULE 1A

DESIGN CERTIFICATE – LAND DEVELOPMENT/SUBDIVISION WORK

ISSUED BY: ………………………………………………………………………
(Suitably qualified design professional)

TO: ………………………………………………………………………………..
(Owner)

TO BE SUPPLIED TO: ………………………………………………………….
(Territorial authority)

IN RESPECT OF: ……………………………………………………………….
(Description of land development/subdivision work)

AT: ………………………………………………………………………………

……………………………………………………………………………………
(Address)

.... has been engaged by ....
(Designer) *(Owner)*

to provide .... services in respect of the land development and/or subdivision work described above.

I ……………………………................ have the qualifications and experience relevant to this project as set out herein and have designed the subject works and confirm that the design is to current good engineering practice, and that it satisfies all relevant resource consent conditions, all relevant TA requirements, and applicable codes and standards. I / My practice holds professional indemnity insurance in the sum of

$……………………………...............

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)

Qualifications and experience:

………………………………………………………………...

……………………………………………………………………………………………...

…………………………………………………… Date:………………………
(Signature of designer)

SCHEDULE 1B

CONTRACTOR'S CERTIFICATE UPON COMPLETION OF LAND DEVELOPMENT/SUBDIVISION WORK

ISSUED BY:……………………………………………………………………………
(*Contractor)*

TO: ……………………………………………………………………………………..
(Principal)

TO BE SUPPLIED TO:………………………………………………………………….
(Territorial authority)

IN RESPECT OF: ………………………………………………………………………
(Description of land development/subdivision work)

AT:………………………………………………………………………………………

………………………………………………………………………………………….
(Address)

……………………………………….... has contracted to ………………………..
(Contractor) *(Principal)*

to carry out and complete certain land development and/or subdivision work in accordance with a contract,

titled Contract No....................... for …………………………………………………(“the contract”).

I ………………………………..... a duly authorized representative of ……………..
(Duly authorized agent) *(Contractor)*

hereby certify that ……………………………………………………………….. has carried out and completed
(Contractor)
the works, other than those outstanding works listed below, in accordance with the contract.

.... Date:……………………………
(Signature of authorized agent on behalf of)

....
(Contractor)

.... …………………………………………………
(Address)

Outstanding works

……

……

……

SCHEDULE 1C

CERTIFICATE UPON COMPLETION OF LAND DEVELOPMENT/SUBDIVISION WORK

ISSUED BY:……………………………………………………………………………
(Suitably qualified professional)

TO: ………………………………………………………………………………..
(Developer)

TO BE SUPPLIED TO: …………………………………………………………
(Territorial authority)

IN RESPECT OF: …………………………………………………………………
(Description of land development/subdivision work)

AT: ………………………………………………………………………………..

……………………………………………………………………………………….
(Address)

…………………………................ has been engaged by ………………………………….................
(Consultant) *(Developer)*

to provide construction observation, review and certification services in respect of the above work which is described in the specification and shown on the drawings numbered……………………………………………

approved by ………………………………………………….. on……………………………
(Territorial authority) *(Date)*

I have sighted the ....
(Territorial authority)

consent and conditions of consent to the works and the approved specifications and drawings.

As an independent professional, I or personnel under my control, have carried out periodic reviews of the land development work appropriate to the nature of the work and in my professional opinion, based upon reasonable enquiry, these reviews, information supplied by the contractor during the course of the works and the contractor's certification upon completion of the works (copy attached), the works, other than those outstanding works listed below, have been completed in accordance with the above consent and sound engineering practice.

……………………………………………………… Date…………………………….................
(Signature suitably qualified professional)

……………………………………………………… Member CSNZ NZIS ACENZ IPENZ
(Professional qualifications)

………………………………………………………
(Address)

Outstanding works

....

SCHEDULE 1D

AS-BUILT PLANS

Information given on as-built drawings, whether submitted electronically or as paper plans, shall include but shall not be limited to:

(a) Stormwater and wastewater reticulation – including the co-ordinated positions of manholes, manhole inverts, inverts of pipes and lid levels, measurements to house connections, and laterals and their length and position. Positions of connections and laterals shall be both co-ordinated and referenced to adjacent manhole lids and boundary pegs. All levels shall be in terms of datum approved by the TA;

(b) Flood and secondary flow information, flood water levels and the extent of any overland secondary flows shall be shown where these have been obtained or derived during the design;

(c) Water reticulation – including the position of mains, location of hydrants, valves, tees, reducers, connections, tobies, specials, etc. All features shall be accurately dimensioned, co-ordinated and referenced to boundary pegs so that they can be accurately relocated in the field;

(d) Ducts – measurements to ducts installed for utilities;

(e) Labelling of pipes and ducts to cover diameter, pipe material and class, year laid, jointing type;

(f) Road names – as approved by the TA;

(g) Co-ordinates of all utility surface features to be taken over by the TA, including tobies,

(h) The co-ordinates of at least two points on each plan in terms of an appropriate geodetic or cadastral datum and the origin of the plan level datum;

(i) Geotechnical completion report as detailed in 2.11 of this Standard. As-built surface contours covering all areas of undisturbed and cut/fill ground to indicate the finished ground and any deviation from approved design plan;

(j) Road construction, including location, structural details and details of road marking, signals, lighting, signs, landscape features, seating and other amenities and features;

(k) Road surfacing information – for sealed roads, information shall include binder type and application rate, cutter type and quantity, adhesion agent type and quantity, type and quantity of other additives, the width, length and area of each street sealed, chip size, the design basis for the binder application rate and a discussion on any reasons for differences between the design and applied rate.

Part 2: LAND STABILITY, FOUNDATIONS AND EARTHWORKS

PART 2: LAND STABILITY, FOUNDATIONS AND EARTHWORKS

2.1 Scope

This Part of the Standard draws attention to the need for the assessment of land stability and the design and control of earthworks to ensure a suitable platform for the construction of buildings, roads and other structures. Geotechnical assessment shall be undertaken by a geotechnical engineer as defined in 1.2.3 of this Standard because:

(a) The assessment of land stability requires specialist expertise;

(b) The construction of earthworks associated with any development requires initial planning and design to ensure that banks and batters remain stable and that fill material is placed in such a way that it can support the future loads imposed on it.

The New Zealand Standard, NZS 4431:1989 *Code of practice for earth fill for residential development* is applicable to the construction of earth fills for residential development including residential roading. NZS 4431 does not deal with historical fill which has not been undertaken in accordance with any Standard and does not cover natural slopes, banks and batters.

There is no Standard for earth fill for other than residential developments and in such places the requirements will be set by the designer to suit the proposed development;

(c) The assessment of ground for the foundations of buildings, roads, services and other works requires specialist expertise as weak ground may require special design;

(d) The wide range of soil types, physical conditions and environmental factors applying in different areas make it impossible to lay down precise requirements for land stability assessment or earthworks.

C2.1

This Part 2 is not a geotechnical standard but sets out some, but not necessarily all of the matters which need to be considered in planning and constructing a land development project. Its function is to provide information for professionals involved in designing and constructing a land development project and to require geotechnical expertise in projects where land stability could be an issue or where earthworks other than of a minor nature will occur.

The assessment of land stability to meet the provisions of the Resource Management Act and Building Act is the responsibility of the TA. The TA requires and relies on the assessment made by the geotechnical engineer.

The methods used and investigations undertaken are defined by the TA and the geotechnical engineer.

This Standard does not set those requirements or set standards for assessing geotechnical risk.

Special requirements apply when land is subject to erosion, avulsion, alluvium, falling debris, subsidence, inundation or slippage. In such situations reference needs to be made to s.106 of the Resource Management Act 1991, and for subsequent building work, s. 36 of the Building Act 1991.

2.2 General

The choice of final land form is dependent on many factors which may be specific to the development. These include the relationship with surrounding landscapes, the size of the development, the proposed and existing roading patterns, the preservation of natural features, the land stability, the function and purpose of the development and the potential for flooding, erosion and other natural events including earthquakes.

The order of importance of the above factors will vary from project to project.

2.3 Technical responsibilities

2.3.1 *Geotechnical works*

Where any proposed development involves the assessment of slope stability or the detailed evaluation of the suitability of natural ground for the foundations of buildings, roading and other structures, or the carrying out of bulk earthworks, then a geotechnical engineer shall be appointed by the developer to carry out the following functions:

(a) Prior to the detailed planning of any development, to undertake a site inspection and such investigations of sub-surface conditions as may be required, and to identify geotechnical hazards affecting the land, including any special conditions that may affect the design of any pipelines, underground structures and/or other utility services;

(b) Before work commences, to review the drawings and specifications defining any earthworks or other construction work and to submit a written report to the TA on the foundation and stability aspects of the project;

(c) Before work commences, and during construction, to determine the extent of further geotechnical engineering services required (including investigation and geological work);

(d) Before and during construction, to determine the methods and frequency of construction control tests to be carried out, determine the reliability of the testing, and to evaluate the significance of test results and field inspection reports in assessing the quality of the finished work;

(e) During construction, to undertake regular inspection consistent with the extent and geotechnical issues associated with the project;

(f) On completion, to submit a written report to the TA attesting to the compliance of the earthworks with the specifications and as to the suitability of the development for its proposed use. Where NZS 4431 is applicable, the reporting requirements of that Standard shall be used as a minimum requirement.

2.3.2 *Preliminary site evaluation*

During the preliminary site evaluation phase the developer's professional advisor shall engage a geotechnical engineer at an early stage to undertake a preliminary site evaluation and prepare a geotechnical assessment report where:

(a) There is doubt as to the stability or suitability of the ground for the proposed development; or

(b) There are any TA or local practice requirements for geotechnical involvement in the project.

C2.3.2

The preliminary evaluation should be carried out in the context of the total surroundings of the site, and should not be influenced by details of land tenure, territorial or other boundary considerations. Where the preliminary evaluation discloses the potential for slope instability, other geotechnical hazards or the need for major foundations or for earthworks, the geotechnical engineer should be involved at an early stage in the planning of the development.

In simple cases a visual appraisal may be sufficient, but in other cases, depending on the nature of the project, its locality, the scale of development proposed and individual site characteristics, particular attention may need to be given to the following matters which should normally be considered prior to preparing a proposal for development:

(a) Drainage:

Identify the existing natural drainage pattern of any area and locate any natural springs or seepage. Where any natural surface or subsurface drainage paths are interfered with or altered by earthworks, then appropriate measures should be taken to ensure that adequate alternative drainage facilities are provided;

(b) Slope stability:

Some natural slopes exist in a state of only marginal stability and relatively minor works such as trenching, excavation for streets or building platforms, removal of scrub and vegetation, or the erection of buildings, can lead to failure. Signs of instability include cracked or hummocky surfaces, crescent-shaped depressions, crooked fences, trees or power poles leaning uphill or downhill, uneven surfaces, swamps or wet ground in elevated positions, plants such as rushes growing down a slope and water seeping from the ground. (See references 1, 2 and 3. A sample checklist for geotechnical assessments is contained in reference 3);

(c) Foundation stability:

A study of the general topography of the site and its surroundings may indicate areas which have previously been built up as a result of natural ground movement or by the deliberate placing of fill material. Unless such fill has been placed and compacted under proper control, long-term differential settlement could occur causing damage to superimposed structures, roads, services or other structures;

(d) Local conditions:

A wide range of soil types exists throughout New Zealand which may need special consideration. Expansive soils, volcanic soils, soft alluvial sediments and compressible soils are examples of these. Liquefaction of saturated non-cohesive soils should also be considered. The TA may have information on the soil types in its area;

(e) Peer review:

Where risk for the land prior to development is assessed as being medium to very high risk, a peer review of the geotechnical assessment for the proposed development should be required and this should be carried out by an independent geotechnical engineer. (For guidance see reference 3 for risk classification and reference 4 for peer review).

2.3.3 *Construction control testing*

The construction control testing shall be carried out by a testing laboratory or competent person under the control of the geotechnical engineer.

The testing laboratory shall have recognized registration or quality assurance qualifications.

2.4 Planning and design

2.4.1 *Landform*

The final choice of landform shall represent the most desirable compromise between the development requirements and the preservation of natural features and the natural quality of the landscape including the retention of natural watercourses.

C2.4.1

1. *The choice of a suitable landform is dependent on many factors which may be specific to a particular site. In general, unnecessary earthworks should be avoided but considerations which may justify the carrying out of earthworks include:*
   - *(a) The minimization of the risk of damage to property occurring through ground movement in the form of slips, subsidence, creep, erosion or settlement;*
   - *(b) The minimization of the risk of damage to property occurring through flooding, or surface water run-off;*
   - *(c) The development of a more desirable roading pattern with improved accessibility to and within the site and the creation of a better sense of orientation and identity for the area as a whole;*
   - *(d) The efficiency of overall land utilization including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services, and the standard of roading and on-site vehicular access;*
   - *(e) The need to create suitably graded areas for playing fields and other community facilities; and*
   - *(f) The enhancement of the general environmental character of the area by softening the landscape or by artificially creating or emphasizing landforms of visual significance particularly on flat sites or on areas devoid of landscape features.*
2. *The general nature and shape of the ground should be studied and particular note taken of:*
   - *(a) The geological nature and distribution of soils and rock;*
   - *(b) Existing and proposed drainage conditions and the likely effects on ground water;*
   - *(c) Previous history of ground movements in similar soils in the area;*
   - *(d) Where earthworks are involved, performance of comparable cuts and fills (if any) in adjacent areas; and*
   - *(e) Air photography and other sources of information which should be reviewed and incorporated into any slope stability assessment.*

➤

3. Soil data should be obtained for areas which:

(a) Are intended to form in situ bases for fills;

(b) Are intended to yield material for construction of fills;

(c) Are intended to be exposed as permanent batters; and

(d) Are to remain as permanent slopes or cut areas.

4. Sufficient borings, probings, or open cuts should be made to:

(a) Classify the soil strata by field and visual methods;

(b) Evaluate the likely extent and variation in depths of the principal soil types; and

(c) Establish the natural ground water levels.

5. The soil information thus obtained should form the basis for:

(a) Further sampling and testing which may be required on representative soil types;

(b) Relating subsequent soil test properties to relevant strata over the site;

(c) Assessment of or calculations for slope stability;

(d) Assessment of or calculations for foundations suitable for the finished site; and

(e) Assessment of or calculations for road pavements.

The test data appropriate in different areas should be determined by the geotechnical engineer.

2.5 Stability criteria

In making an assessment of the stability of slopes and earth fills, the geotechnical engineer shall use accepted criteria and analysis methods.

C2.5

Stability criteria applicable to land development in New Zealand are published or recommended by the New Zealand Geotechnical Society. (See references 1 to 4.)

2.6 Special soil types

If special soils types are known to exist in a locality or are identified, then a geotechnical engineer shall be engaged to advise on appropriate measures for incorporation of these soils into a development.

Special soil types include, but are not limited to the following:

(a) Soils with high shrinkage and expansion;

(b) Compressible soils;

(c) Volcanic soils;

(d) Soils subject to liquefaction;

(e) Soils prone to dispersion (e.g. loess).

C2.6
The geotechnical engineer should refer to the TA or regional council for hazard maps or information on special soil types in the locality if unfamiliar with the area.

2.7 Compaction standards for fill material

The standard of compaction and method of determination shall be as set out in NZS 4431.

Where NZS 4431 is not applicable, the methods and standards of compaction shall be specified by the geotechnical engineer.

C2.7
Industrial and commercial development often have specialized requirements for fill materials and compaction. In these cases the requirements of NZS 4431 may not be applicable. The geotechnical engineer should set the fill standards and procedures for these developments, but may use NZS 4431 as a basis where appropriate.

2.8 Erosion, sediment and dust control

2.8.1 *Minimization of effects*

Earthworks shall be designed and constructed in such a way as to minimize soil erosion and sediment discharge. Where necessary, permanent provision shall be made to control erosion and sediment discharge from the area of the earthworks.

Generation of dust during and after the earthworks operation shall be considered during the planning and design phase. If necessary, specific measures shall be incorporated to control dust.

C2.8.1
Most territorial authorities and regional councils have requirements for erosion, sediment and dust control or these will be set in resource consents for the project. Such conditions must be referred to and taken into account in the early stages of planning a project.

2.8.2 *Protection measures*

Where surface water could cause batter erosion or internal instability through infiltration into the soil, open interceptor drains shall be constructed in permanent materials, and benches in batter faces should be sloped back and graded longitudinally and transversely to reduce spillage of stormwater over the batter.

Water from stormwater systems shall be prevented from flowing into a fill or into natural ground near the toe or sides of a fill.

No stormwater or wastewater soakage systems shall be constructed in a fill which could impair the stability of the fill.

C2.8.2

Protection measures may include:

(a) The surfaces of fills and cuts should be graded to prevent ponding;

(b) Temporary drains should be constructed at the toe of steep slopes to intercept surface run-off and to lead drainage away to a stable watercourse or pipe stormwater system;

(c) Surface water should be prevented from discharging over batter faces by drains formed to intercept surface run-off and discharge via stable channels or pipes, preferably into stable watercourses or piped stormwater systems;

(d) The upper surface of fills should be shaped and compacted with rubber-tyred or smooth-wheeled plant when rain is impending, or when the site is to be left unattended to minimize water infiltration;

(e) The completed battered surfaces of fills should be topsoiled and grassed to reduce run-off velocities;

(f) Sediment traps and retention ponds should be constructed where they are necessary. These should be cleaned out, as required, to ensure that adequate sediment storage is maintained;

(g) Temporary barriers or silt fences using silt control geotextiles, should be used to reduce flow velocities and to trap sediment;

(h) Sections of natural ground should be left unstripped to act as grass (or other vegetation) filters for run-off from adjacent areas;

(i) All earthwork areas should be re-topsoiled and grassed or hydroseeded as soon as possible after completion of the earthworks and drainage works;

(j) Permanent control of erosion and sediment discharge may require planting, environmental matting, hydroseeding, drainage channels or similar measures at an early stage in the earthworks construction phase;

(k) Dust control may require frequent watering during construction along with establishment of the permanent surface at an early stage in the construction phase;

(l) The effect of utility services laid within the fill should be taken into consideration.

2.9 Seismic considerations

The geotechnical engineer shall consider the seismic effects on earth fills, slopes and liquefiable ground and shall take these into account in design and construction of any development.

2.10 Lifeline systems

The developer's professional advisors and geotechnical engineer shall consider the risks to lifeline systems in the event of a major earthquake, flood, tsunami or slope failure.

C2.10

Normally, the TA will designate the lifeline systems through its district plan. The design and construction of any development should incorporate provisions to protect these systems during a major natural event.

2.11 Final documentation

2.11.1 *Geotechnical completion report*

For all developments where a geotechnical engineer is engaged the geotechnical engineer shall submit a geotechnical completion report to the developer and the TA accompanied by a statement of professional opinion as set out in Schedule 2A. The geotechnical report shall identify any specific design requirements which would necessitate building design to deviate from NZS 3604.

The report shall describe the extent of inspection, the results of testing and their professional opinion as to the compliance of the development with the standards set by the geotechnical engineer. The report shall also include the all geotechnical reports prepared for the development.

> ***C2.11.1*** *Documentation on the testing of the soils for compaction should be included in the geotechnical completion report. This documentation should clearly show the areas in which compaction met the required Standards, any areas requiring re-testing and areas which did not meet the Standards.*
>
> *For simple developments where there are no earthworks the geotechnical completion report will comprise the geotechnical assessment report. For large or more complex developments where there may have been several stages of geotechnical reporting, all reports shall be included in the geotechnical completion report. The aim is to have all relevant geotechnical information included within the one report.*

2.11.2 *As-built drawings for earthworks and drainage*

Where NZS 4431 is not applicable an as-built plan shall be prepared showing the extent and depth of fill in the form of lines joining all points of equal depth of fill at vertical intervals which adequately define the fill as appropriate. Alternative methods of representing the fill depths may also be acceptable. The as-built plans shall also record the position, type and size of all subsoil drains and their outlets. The plans shall also show areas of filling of low density and any fill areas which the geotechnical engineer considers do not comply with this Standard or areas where the standards have been varied from the original construction specification.

These plans shall be made available to the TA and the developer in conjunction with the geotechnical completion report.

REFERENCES:

1 BRANZ Study SR4, *Assessment of Slope Stability at Building Sites*, BRANZ & Worley Consultants Ltd (1987).

2 *Geotechnical Issues in Land Development*, Proceedings of NZ Geotechnical Society Symposium, Hamilton (1996).

3 Crawford, S.A. & Millar, P.J., "*The Design of Permanent Slopes for Residential Building Development* ", EQC Research Project 95/183, *NZ Geomechanics News* (June 1998).

4 Cook, D., Pickens, G.A., MacDonald, G., "*The Role of Peer Review*", Report by Crawford S.A., *NZ Geomechanics News* (Dec 1995).

SCHEDULE 2A

STATEMENT OF PROFESSIONAL OPINION AS TO SUITABILITY OF LAND FOR BUILDING CONSTRUCTION

Development ....

Developer ....

Location...

I .... of ....

(Full name) *(Name and address of firm)*

Hereby confirm that:

1. I am a geotechnical engineer as defined in section 1.2.3 of NZS 4404 and was retained by the developer as the geotechnical engineer on the above development.
2. The extent of my inspections during construction, and the results of all tests carried out are as described in my geotechnical completion report dated ....
3. In my professional opinion, not to be construed as a guarantee, I consider that (delete as appropriate):
   (a) The earth fills shown on the attached Plan No...................... have been placed in compliance with the requirements of the .... Council and my specification.

   (b) The completed works give due regard to land slope and foundation stability considerations.

   (c) The original ground not affected by filling is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

   (i) ....

   (ii) ....

   (d) The filled ground is suitable for the erection thereon of buildings designed according to NZS 3604 provided that:

   (i) ....

   (ii) ....

   (e) The original ground not affected by filling and the filled ground are not subject to erosion, subsidence or slippage in accordance with the provisions of section 106 of the Resource Management Act 1991 provided that:

   (i) ....

   (ii) ....

   NOTE – The sub-clauses in clause 3 may be deleted or added to as appropriate.
4. This professional opinion is furnished to the TA and the developer for their purposes alone on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.
5. This certificate shall be read in conjunction with my geotechnical report referred to in clause 2 above and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

Signed .... Date.......................................

....

(Professional Qualifications)

Part 3: ROADS

Table

Figure

PART 3: ROADS

3.1 Scope

This Part of the Standard sets out general requirements for the design and construction of roads associated with land development and improvement projects.

It provides for one means of compliance in terms of engineering design and construction but other means may be accepted subject to specific consideration or approval by the TA.

3.2 General

3.2.1 *Objective*

The objective is to provide safe roads with operating speeds appropriate to the surrounding environment. Roads should be capable of carrying all utility services underground and providing an aesthetically acceptable environment.

3.2.2 *Relevant standards and guideline documents*

Road designs shall incorporate all special requirements of the relevant TA and shall be designed by the most appropriate codes and guidelines applicable at the time. The following is a selection of currently available documents which provide an appropriate basis for road designs. These are not exclusive and other standards and guidelines accepted by the engineering profession at the time may be used where appropriate.

(a) All Transit New Zealand (TNZ) manuals and standards including Bridge Manual, Criteria and Guidelines and AUSTROADS Codes and Guides which at any time may be acceptable to the TA;

(b) All current Transit New Zealand/Transfund New Zealand specifications and notes for road construction, maintenance and material standards;

(c) All Land Transport Safety Authority (LTSA) guidelines (RTS series) and manuals;

(d) NZ Institute of Highway Technology approved pavement design techniques;

(e) New Zealand Transport Strategy (2002)

(f) *The Street Where You Live* – (Streetscape, Traffic Calming) M.L. Gadd 1995;

(g) *Concrete Segmental Pavements – Design Guide for Residential Access Ways and Roads* (Concrete Masonry Association of Australia);

(h) *Concrete Pavement Design for Residential Streets* (Cement and Concrete Association of Australia);

(i) *Concrete Roundabout Pavements – A Guide to their Design and Construction* (Road and Traffic Authority of Australia).

3.2.3 *Roading hierarchy and design*

Design of roads shall recognize the various components of a road as including the following:

(a) Road carriageway, including bridges and culverts;

(b) Pedestrian and cycle facilities (including paths and cycleways that may be at some distance from road carriageways);

(c) Road lighting;

(d) Berm and amenity provisions (including planting and seating);

(e) Vehicle parking and manoeuvring areas;

(f) Associated utility services.

Road designs shall meet all relevant standards and criteria of the district plan, road hierarchy and classification acceptable to territorial authorities and current at the time of the project. Over their lifetime, roads and associated facilities shall provide for safe, efficient use by all anticipated users, including persons with disabilities, based on the position of the subject road (and pedestrian/cycle links where applicable) in the TA's approved long term road hierarchy network plan. Roads shall be designed on the assumption that the land will be fully developed to the extent defined in the district plan.

Road design shall provide for safe pedestrian and cycle movement and streetscape enhancement to mitigate harsh formed surfaces. It shall include all associated detailing including road marking, signals, signs, lighting and all road furniture required for traffic, pedestrian safety and for landscaping (e.g. sealing, planting etc.).

The use of roads as secondary flow paths and also use of the road reserve as a significant part of the available flood storage area shall be taken into consideration during the design of roads.

3.2.4 *Traffic management plan*

When required by the nature of the development a traffic management plan shall be prepared and submitted with the consent application. This plan shall show the basis for selection of the roading dimensions and layout proposed and how it will cope with expected traffic needs over its lifetime. The plan shall cover the requirements of public transport and traffic calming where applicable as required under the following clauses of this Standard and or the relevant district plan.

In addition it shall evaluate the effects of the proposed development at its ultimate extent (and staged, where applicable) on the surrounding road network. Where the evaluation shows the changed traffic volumes and patterns to have detrimental impacts on the surrounding road network the consent process may require that either financial contribution be made or works carried out at the developer's expense to mitigate the detrimental impacts.

3.2.5 *Public transport*

Urban land development shall plan to maximize convenient access to all forms of public transport (e.g., trains and buses) or such potential public transport.

Where a plan to demonstrate public transport accessibility is required it shall address at least the following matters:

(a) The provision of a continuous through route classified as a collector road or higher for public transport to use. The gradient shall not be steeper than an average of 1 in 10 with localized maximum grades not exceeding 1 in 8;

(b) High transport intensity land uses (such as schools, tertiary institutions, hospitals, medical facilities, shopping areas, retirement villages and community facilities) should be located with frontages along the public transport route;

(c) Not less than 90 % of dwelling sites should be within 400 m of a proposed bus route or 500 m from an existing or planned bus stop;

(d) Pedestrian accessways and cycleways shall be provided where necessary to assist in compliance with 3.2.5(c).

3.2.6 *Classification of urban roads*

For the purposes of this Standard urban roads are classified into the following hierarchy in descending order.

3.2.6.1 *Primary arterial roads*

These provide interconnections between major sectors of a large area linked with external areas and distribute traffic from major intercity links. Access is at grade but may be limited. Traffic volumes are typically 7,000 to 10,000 vehicles per day (vpd) with a significant number of heavy vehicles.

3.2.6.2 *Secondary arterial roads*

Secondary arterial roads provide access to primary arterial roads. They have a dominant through vehicular movement and carry the major public transport routes. Access to property may be restricted and rear servicing facilities may be required.

3.2.6.3 *Collector roads – area residential/industrial/commercial*

These provide circulation between and within local areas and link to primary roads. They may service schools, intermittent or peak hour public transport. Their main feature is to service the local residential or industrial area. Vehicular movements and needs dominate.

3.2.6.4 *Local distributor roads – residential/industrial/commercial*

A road which has the primary function of providing access to adjacent residential/industrial/commercial lots.

3.2.6.5 *Local roads (residential and industrial) including cul-de-sacs*

A road which has the primary function of providing access to abutting properties and through which only traffic having origin or destination there will pass. Low speed vehicle movements, pedestrian and local amenity values predominate.

3.2.6.6 *Service lanes*

A road which has the primary function of providing rear access, generally in commercial and industrial areas. Heavy or commercial vehicle movements dominate along with low vehicle speeds. Public use may be limited.

> ***C3.2.6***
>
> *Motorways are not included in this Standard. They are subject to specific design standards to be agreed between the TA and Transit New Zealand.*

3.2.7 *Classification of rural roads*

In rural roads, where topography allows, berm or road shoulder facilities should be provided for pedestrian use and off carriageway emergency parking, horse riding etc. Stormwater drainage is generally carried by adjacent open drains. The classification of rural roads in this Standard is based on the terms defined below.

3.2.7.1 *Arterial roads (primary/secondary)*

Provide interconnections between major sectors of a large area and link with external areas and distribute traffic from motorways and major inter-city links. Access is at grade but may be limited. Traffic volumes are typically greater than 2,500 vpd with a significant number of heavy vehicles. Arterial roads carrying more than 4,000 vpd will require specific design standards to be agreed between the TA and the developer.

3.2.7.2 *Collector roads*

Provide circulation between and within local areas and link to primary roads. They may service schools, intermittent or peak hour public transport. Their main feature is to service the local residential or farming area.

3.2.7.3 *Local roads*

A road which has the primary function of providing access to adjacent residential/ rural lots.

3.2.7.4 *Minor local roads – including cul-de-sacs*

A road which has the primary function of providing access to abutting properties and through which only traffic having origin or destination there will pass. Low speed vehicle movements, pedestrian and local amenity values predominate.

C3.2.7

The district plan of each TA defines the road hierarchy classification and may vary. The classification in this Standard is given as a model which can be adapted by TAs.

3.3 Design

3.3.1 *Minimum requirements*

Unless approved otherwise by the TA, road standards as defined in table 3.1 (urban) and table 3.2 (rural) shall be used as the basis for road design. Traffic calming measures may be used in conjunction with these road dimensions to enhance streetscape and community amenity and control vehicle speeds.

Urban roads shall be provided with kerbs and channels and be adequately drained unless the TA approves an alternative. Subsoil drains under pavement/kerb edges shall be provided in terms of good engineering practice.

Road reserve widths shall be selected to ensure that adequate carriageway, footpaths, berms and batters can be provided to retain amenity values (including landscaping) and enable services to be provided safely and in economically accessible locations. They shall be planned to cope with estimated long-term community needs even though construction may be carried out only to shorter term requirements.

Footpaths shall generally be provided on both sides of all urban roads of local residential class and above and on not less than one side of the road for cul-de-sacs. Pedestrian accessways and cycleways shall be provided where necessary to provide continuity of access to specially identified amenities.

In rural roads side drains shall be provided to carry stormwater and keep potential groundwater below structural pavement layers.

C3.3.1

In soils of reasonable permeability the use of soakage systems may be able to provide benefits of attenuating peak flows or improving run-off quality. It is generally unlikely that soakage systems will dispose of peak flows for more than about a 10-year return period and thus overflow systems will generally be necessary.

The ground soakage used in soakage systems should be conservatively set as such systems generally deteriorate with time due to clogging up of the soakage surface with silts, grease etc. Systems should be designed and located so as to be maintainable.

3.3.2 *Road geometric design*

3.3.2.1 *Design parameters*

Primary and collector roads shall be designed to accepted standards (generally satisfied by the use of the Austroads *Guide to Traffic Engineering Practice*) and shall incorporate horizontal transition curves. Other urban roads within speed limit zones below 70 km/h or with adequate bend widening may satisfy the geometric standards incorporated in table 3.1 of this Standard or other standards set from time to time by the TA and horizontal geometry may generally use wholly circular curves.

Rural roads shall be designed in general compliance with the TNZ *State Highway Geometric Design Manual or Austroads Guide to the Geometric Design of Rural Roads* except as modified by the design parameters given in table 3.2 for the applicable road class. Rural roads in steep hill country where speed limits do not exceed 70 km/h may utilize circular curves without horizontal transition curves.

Combination of carriageway widening and off-street parking shall be used to provide extra and/or safe parking in the vicinity of shopping centres or community facilities (e.g. schools, community centres, hospitals etc.).

For design speeds, carriageway width, road reserve width, berms, maximum and minimum gradients, camber and super-elevation refer to tables 3.1 and 3.2.

Horizontal and vertical curve design aids suitable for urban roads without horizontal transition curves are given in tables 3.3 to 3.6 inclusive.

3.3.2.2 *Sight distance*

Sight distance criteria at intersections as well as for stopping, overtaking, curves and obstructions shall be applied in accordance with the Austroads *Guide to Traffic Engineering Practice Part 5: Intersections* and *Part 6: Roundabouts*.

Table 3.1 – Road design standards – Urban (speed limit ≤ 70 km/h)

Class	Type	Area served	Traffic volumes vpd[1]	Design speed, (km/h)		Road reserve width, m	Minimum carriageway width (m)				Footpath (m)	Berm (m)	Max/min gradient	Normal camber	Max super-elevation	Notes
				Flat or rolling	Hilly		Parking[2]	Traffic	Cycles[3]	Total						
Local roads	Private way	1-3 lots 1-6 du[1]	NA	NA	NA	3.6[4]	–	1 x 2.75	–	2.75[4]	–	0.5+0.35	16 % max. 0.4 % min.	3 %	NA	Not public street[4]
	Private way	4-6 lots 7-12 du	NA	NA	NA	6.0[4]	–	1 x 5.0	–	5.0[4]	–	2 x 0.5	16 % max. 0.4 % min.	3 %	NA	
	Cul de sac	up to 20 du	NA	NA	NA	11.0	1 x 2.5	1 x 3.5	–	6.0	1.4	0.5 + 3.1	12.5 % max. 0.4 % min.	3 %	6 %	No stopping on one side
	Residential	21-150 du	Up to 750	30	30	20	2 x 2.5	2 x 3.0	–	11.0	2 x 1.4	2 x 3.1	12.5 % max. 0.4 % min.	3 %	6 %	(5)
	Industrial	Up to 20 units	> 300	30	30	15.5	1 x 2.5	2 x 3.5	–	9.5	2 x 3.0	–	10 % max. 0.4 % min.	3 %	6 %	No stopping on one side
	Industrial/ Commercial service lane	–	NA	NA	NA	8.0	–	2 x 3.5	–	7.0	–	2 x 0.5	10 % max. 0.4 % min.	3 %	NA	(6)
	Commercial (Park precinct)	–	<2000	30	30	(7)	(7)	2 x 3.5	–	7.0	2 x 3.0	–	10 % max. 0.4 % min.	2 %	NA	(7)
Local distributor roads	Residential	<150 du	200 – 1000	40	40	21.0	2 x 2.5	2 x 3.5	–	12.0	2 x 1.4	2 x 3.1	12.5 % max. 0.4 % min.	3 %	8 %	
	Industrial/ Commerical	20 – 40 units	300 – 1000	40	40	18.0	2 x 2.5	2 x 3.5	–	12.0	2 x 3.0	–	10% max. 0.4% min.	3 %	6 %	(7)
Collector roads	Residential	150 – 450 du	1000 – 3000	50	40	23.0	2 x 2.5	2 x 3.5	2 x 1.0	14.0	2 x 1.4	2 x 3.1	10 % max. 0.4 % min.	3 %	8 %	
	Industrial/ Commercial	>40 units	>1000	50	40	20.0	2 x 2.5	2 x 3.5	2 x 1.0	14.0	2 x 3.0	–	10 % max. 0.4 % min.	3 %	6 %	(7)
Secondary (District) arterial		>450 du	3000 – 7000	50	50	24	2 x 2.5	2 x 3.5	2 x 1.5	15.0	2 x 1.4	2 x3.1	10 % max. 0.4 % min.	3 %	8 %	
Primary (Regional) arterial		–	>7000	70	60	27	2 x 3.0	2 x 3.5 1 x 2.0	2 x 1.5	18.0	2 x 1.4	2 x 3.1	10 % max. 0.4 % min.	3 %	8 %	Painted median occupies 2 m traffic lane

NOTE –

(1) du = dwelling units, vpd = vehicles per day

(2) Parking lane width allows for limited cycle space.

(3) Where the TA gives approval to remove cycle lanes each traffic lane shall be increased to 4.0 m.

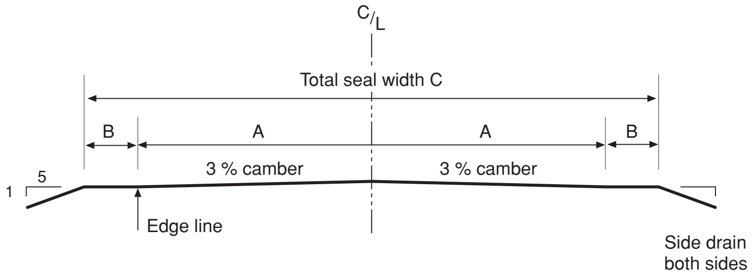
(4) Where a private way adjoins a local distributor road or higher, it shall have a 5 m traffic width and 6 m road reserve width for a minimum of 6 m from road boundary.

(5) Parking bays set into berm footpath zones.

(6) No parking both sides.

(7) Width dictated by parking provisions. Parking (including angle parking) shall be provided on both sides of street and maximized taking into account traffic considerations.

Table 3.2 – Road design standards – Rural (speed limit up to 100 km/h)



Typical cross section

(a) Road standards – Rural

Classification	**Traffic volumes vehicles per day**	**Lane width** (m) **A**[1]	**Shoulder width**[2] (m)		**Minimum total seal width** (m) **C**	**Design speed** [3] (km/h)		**Maximum/ minimum gradient** [4]	**Minimum road reserve** [5] (m)	**Normal camber**
			Total width B	**Sealed part**		**Flat or rolling**	**Hilly**			
Minor local	0 – 300	2.5	0.5	0.5	6.0	Up to 70	50	12.5 % 0.4 %	15.0	3 %
Sub-collector	300 – 700	3.0	1.0	0.5	7.0	70	50	12.5 % 0.4 %	15.0	3 %
Minor collector	700 – 1000	3.5	1.0	0.5	8.0	70	50	10 % 0.4 %	15.0	3 %
Major collector	1000 – 2500	3.5	1.0	0.5	8.0	Up to 100	70	10 % 0.4 %	20.0	3 %
Arterial [6]	> 2500	3.5	1.5	1.0	9.0	100	70	10 % 0.4 %	20.0	3 %

(b) Recommended values for curve widening for two traffic lanes

Curve radius (m)	**Total amount of widening in metres where normal width of two traffic lanes is:**			
	6.0 m	**6.5 m**	**7.0 m**	**7.5 m**
30 – 50	2.0	1.5	1.5	1.0
50 – 100	1.5	1.0	1.0	0.5
100 – 250	1.0	1.0	0.5	–
250 – 750	1.0	0.5	–	–
over 750	0.5	–	–	–

NOTE –

(1) **Lane widths**
Curve widening on rural roads should be as outlined in table 3.2 (b).

(2) **Shoulder width**
The shoulder width needs to be assessed for each project based on the speed environment of the area and the terrain. For high speed environments or where high cycle use is expected, shoulder widths may need to be increased to optimize overall road safety.

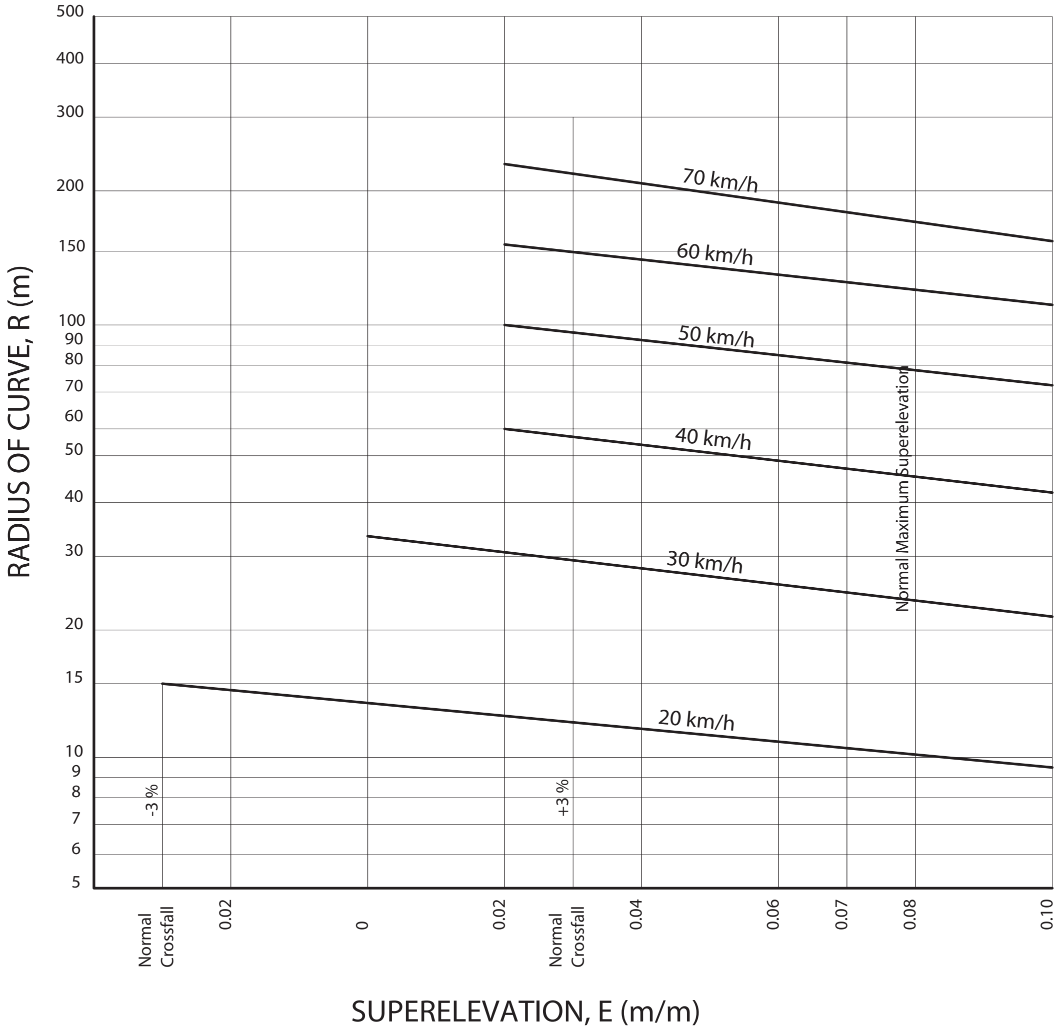
(3) **Design speed**
The design speed indicated generally assumes a "Rural/residential" level of frontage onto the road. Where frontage access is minimal and terrain reasonable, higher design speeds may be appropriate. This may also impact on shoulder widths. (Refer to Note (2)).

(4) **Maximum/minimum grades**
Gradients of 10 % are generally considered suitable for trucks and public transport. Steeper gradients may be acceptable for shorter lengths of road in hilly country with low overall speed environments.

(5) **Road reserve**
In some circumstances a reduced road reserve width may be acceptable (not less than 12.5 m).

(6) **Arterial**
The TNZ State Highway Geometric Design Manual may be used as an acceptable solution for any rural road design provided road reserve widths are of adequate width to serve the purposes required by NZS 4404.

Table 3.3 – Safe speeds on horizontal curves



Radius of Curve, $R = \dfrac{V^2}{127(e + f)}$

Where: R = radius of curve (m)
V = speed (km/h)
e = superelevation
f = friction factor (dimensionless).

Negative crossfall should not be used where this is avoidable.

Speed, V (km/h)	Friction factor
10	0.26
20	0.24
30	0.22
40	0.20
50	0.18
60	0.16
70	0.15

For circular curves used without transitions:
Use 60 % to 66 % of the maximum superelevation at the tangent points,
90 % of the maximum superelevation at the 1/4 and 3/4 points, and
the maximum superelevation at the 1/2 point.

NOTE – Intended for use in urban roads. For higher speeds use TNZ guidelines which can be used for any design speed.

Table 3.4 – Superelevation run-off

$$\text{Runoff length, } L = \frac{100\,We}{G} \text{ metres}$$

Where: L = runoff length (m)
W = pavement width (m)
e = superelevation rate (m/m)
G = percentage difference in longitudinal grade between the pavement edges.

Speed km/h	20	30	40	50	60	70
Suitable Values of G %	1.95	1.80	1.65	1.50	1.35	1.20

FOR PAVEMENT WIDTH W = 7 m

SUPERELEVATION RATE em/m	MINIMUM RUNOFF LENGTH, L (metres) FOR SPEED (km/h) OF:					
	20	30	40	50	60	70
.06	22	23	25	28	31	35
.07	25	27	30	33	36	41
.08	29	31	34	37	42	47
.09	32	35	38	42	47	53
.10	36	39	42	47	52	58
.12	43	47	51	56	62	70
ABSOLUTE MINIMUM	20	20	25	25	30	30

FOR PAVEMENT WIDTHS UP TO 7 m USE THE ABOVE RUNOFF LENGTHS.
FOR PAVEMENT WIDTHS 7 m TO 10 m MULTIPLY THE ABOVE RUNOFF LENGTHS BY 1.2.
FOR PAVEMENT WIDTHS 10 m TO 14 m MULTIPLY THE ABOVE RUNOFF LENGTHS BY 1.5.

NOTE – INTENDED FOR USE WITH CIRCULAR CURVES IN URBAN ENVIRONMENTS. TRANSIT NEW ZEALAND STATE HIGHWAY GEOMETRIC DESIGN MANUAL ALSO PROVIDES ACCEPTABLE SOLUTIONS.

Table 3.5 – Widening of curves for urban kerbed streets

NOTE –
The amount of widening required on curves depends on the lane width, the radius of curvature, the dimensions of the design vehicle and the design speed. The values in table 3.5 (a) and (b) are suitable for use in urban areas at all normal urban speeds.

(a) PRIMARY, COLLECTOR AND SUB-COLLECTOR STREETS OF UP TO 60 km/h DESIGN SPEED

WIDENING ON HORIZONTAL CURVES						
Radius (metres)	Two lane carriageway width (metres)					
	6.0	6.5	7.0	7.5	8.0	8.5
	Metres widening					
Up to 40	1.75	1.50	1.25	1.00	0.75	0.50
40 to 50	1.50	1.25	1.00	0.75	0.50	-
50 to 80	1.25	1.00	0.75	0.50	-	-
80 to 150	1.00	0.75	0.50	-	-	-
150 to 250	0.75	0.50	-	-	-	-

(b) FOR LOCAL ROADS DESIGNED FOR 40 km/h OR LESSER DESIGN SPEED

WIDENING ON HORIZONTAL CURVES	
Radius (metres)	Two lane carriageway width (metres)
	5.5 to 6.5
	Metres widening
15 - 20	2.00
20 - 25	1.60
25 - 30	1.30
30 - 40	1.10
40 - 50	0.80
50 - 60	0.70
60 - 80	0.60
80 - 100	0.40
100 - 200	0.20

Table 3.6 – Vertical curve lengths

For urban roads where lighting provides illumination and topography is such that full vertical curve length is difficult to attain, comfort and appearance of sag vertical curves are more relevant features than that of safe stopping distance by vehicle headlights.

To ensure reasonable standards of comfort and appearance and to secure appropriate visibility, vertical curves shall not be shorter than:

Curve length L = K x A

where:
L = the curve length in metres
A = the algebraic difference in grade (expressed as percentage)
K = value not less than in the table below.

Design Speed V (km/h)	**Sag curves Minimum K value**		**Crest curves Minimum K value**			**General Min. vertical curve length** (m)
	Comfort	**Headlight**	**Comfort**	**Over-taking**	**Stopping**	
30	2	–	2	4	3	25
40	3	11	3	7	4	40
50	4	20	4	14	7	60
60	6	38	6	26	13	75
70	8	60	8	41	21	95
80	10	88	10	60	31	120
90	(1)	(1)	(1)	(1)	(1)	(1)
100	(1)	(1)	(1)	(1)	(1)	(1)

NOTE –

1. TNZ guidelines should be used for speed values greater than 80 km/hr.

2. Minimum curve lengths also need to meet the various K value requirements.

3. Where K values over 40 are used, gradients at summits and valleys will be flatter than 4 % for more than 30 metres and surface water drainage may require special attention. Storm drainage in sag curves should be specifically controlled by local steepening of the channel gradient to 1 % at the sump.

4. Where the consequences of ponding or scour are serious, or where the potential catchment area may become large due to blocking of adjacent sumps then double sumps within sag vertical curves should be provided.

5. Headlight controls on sag curves may not be necessary for lightly trafficked, non through streets with good street lighting (urban situations only).

3.3.3 *Pavement structural design*

Generally pavements shall be flexible designs with the use of other types of pavements needing TA approval prior to detail design being carried out. Pavements shall be designed in accordance with the following manuals with a design life of 25 years:

(a) Austroads: *Pavement Design – A guide to the structural design of road pavements*;

(b) TNZ: *NZ Supplement to the Austroads Pavement Design Guide*: May 2002.

> ***C3.3.3***
> *For roads of collector class or above structural design should be undertaken by mechanistic design methods. For other roads, mechanistic or other industry standard chart based methods may be used.*

3.3.3.1 *CBR design method for rigid and flexible pavements*

Soaked CBR (California Bearing Ratio) values of the pavement subgrade shall be used and the pavement designed for the estimated number of EDA (Equivalent Design Axle) loadings over a 25-year design life.

3.3.3.2 *CBR tests*

CBR values shall generally be determined in the laboratory according to section 1 of Part 6 of NZS 4402.

For local roads an alternative method of determining subgrade CBR in non-granular materials by Scala Penetrometer may be acceptable for clay and colluvial materials.

NOTE – Figure 3.1 shows a correlation between Scala penetration and CBR values. This should be used conservatively.

The CBR value used in the design shall be the 10th percentile value of the CBR tests taken on the subgrade material. A selection of tests shall be taken at 150, 300 and 450 mm below final subgrade level.

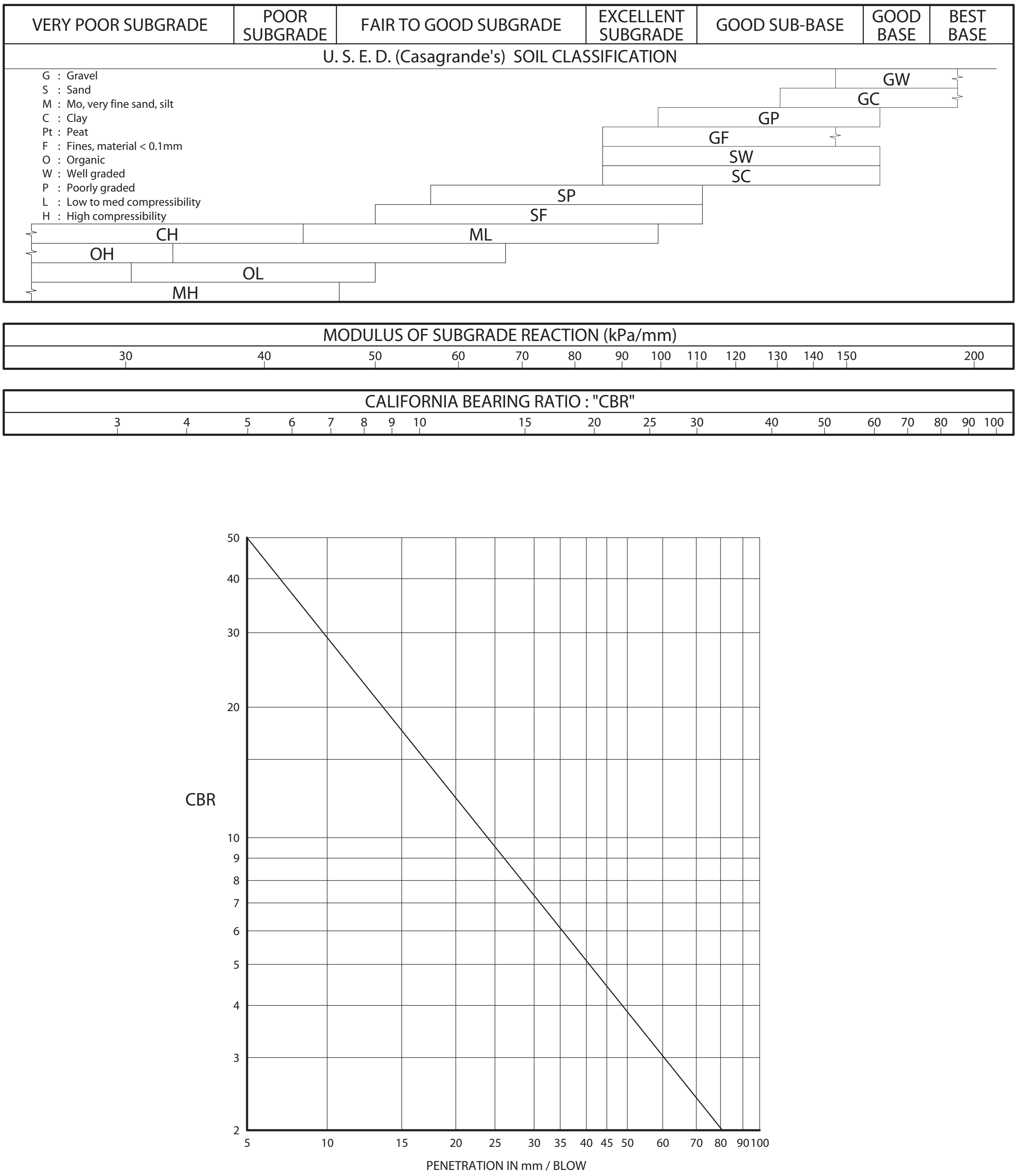
Where CBR values are required for aggregates these shall be based on laboratory tests prepared on the fraction passing the 19 mm sieve but a CBR of more than 30 shall never be used. The use of CBR on metal layers shall only be in conjunction with consideration of the CBR and stiffness of lower layers.

3.3.4 *Safety provision on hills*

Where roads, private ways or other vehicular or pedestrian access, whether public or private, run parallel with land which drops away on one or more sides, the sides shall be provided with safety barriers to protect pedestrian and vehicular traffic.

Safety barriers for pedestrian access shall comply with the design requirements of the Approved Document D1 of the NZBC.

> ***C3.3.4***
> *Refer to LTSA RTS 11 Urban Roadside Barriers and Alternative Treatments for suitable design of safety barriers for vehicular traffic.*



CORRELATION OF DYNAMIC CONE BLOWS PER mm AND CALIFORNIAN BEARING RATIO (SCALA PENETROMETER)

NOTE –

1. May not apply to all soils.
2. Use conservatively with local knowledge.
3. Some TAs may only accept direct field or laboratory CBR testing for pavement design.

Figure 3.1 – Parameter relationship

3.3.5 *Traffic calming in residential streets*

In residential streets, traffic calming measures may be required to ensure that the design speed regime cannot be significantly exceeded and that through traffic is discouraged from residential roads of category "Local residential" and lower.

Traffic calming where used should be based on relevant current practice but may incorporate such measures as providing horizontal bends of significant deviation (45° or more) at distances of not more than 100 m between tangent points; provision of speed humps; traffic islands; raised pedestrian crossings; lane deflections; local lane narrowing etc.

> ***C3.3.5***
> *Refer to Austroads Guide to Traffic Engineering Practice Part 10: Local Area Traffic Management for more information.*

3.3.6 *Parking*

All developments shall provide sufficient on and off road parking to satisfy the district plan and to ensure that the roading network is able to operate efficiently and without obstruction.

> ***C3.3.6***
> *Acceptable car park dimensions may be taken from figure 3.2 or the NZ Building Code – Approved Document D1.*
>
> *Austroads Guide to Traffic Engineering Practice Part 11: Parking may be used for design of parking and traffic facilities incorporated into any roading or parking area layouts.*

3.3.7 *Intersection design*

The preferred angle of intersection is 90° although for secondary roads a minimum angle of 70° may be justified by other constraints. Carriageway alignment may be offset within the street reserve to improve the intersection. Sight lines shall satisfy the minimum standards shown in figure 3.3.

All residential road intersections of collector/collector class and below shall have a minimum kerb radius at intersections of 9 m. Such intersections shall also have the lot corners splayed by a minimum of 6 m along both boundaries.

All road intersections above collector/collector class as well as any intersection within commercial/industrial zoning shall have a minimum kerb radius of 13.5 m and shall have corner splays of 6 m. Heavy industrial intersections shall be the subject of special design.

The separation between any two roads intersecting a road of local distributor class or higher than this class shall be a minimum distance of 150 m centreline to centreline. Two local roads intersecting a local road shall be offset at least 40 m centreline to centreline.

Except for the above minimum specific requirements, intersections shall be detailed to satisfy Austroads *Guide to Traffic Engineering Practice Part 5: Intersections at Grade*.

3.3.8 *Roundabouts*

Design of roundabouts shall comply with the *TNZ Manual of Traffic Signs and Markings Part 2* and *Austroads Guide to Traffic Engineering Practice Part 6: Roundabouts* as amended for New Zealand conditions.

NOTE –

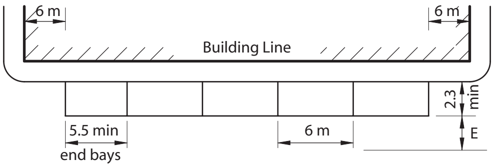
(1) WHEN VEHICLES OVERHANG THE END OF THE BAY (EG. OVER THE FOOTPATH) D MAY BE REDUCED TO Dx.

(2) TAIL-IN PARKING BAYS SLOPE IN OPPOSITE DIRECTION.

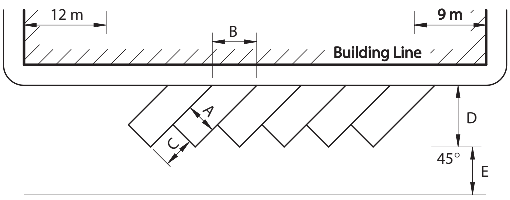
(3) E = MIN AISLE WIDTH FOR REGULAR USERS.

(4) E1 = MIN AISLE WIDTH FOR CASUAL USERS.

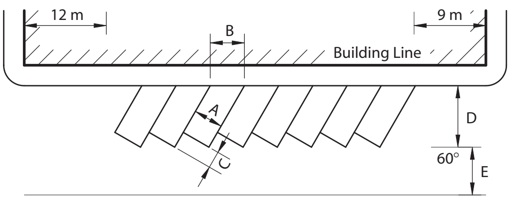
(5) NZ BUILDING CODE DI/ASI ALSO PROVIDES AN ACCEPTABLE SOLUTION.



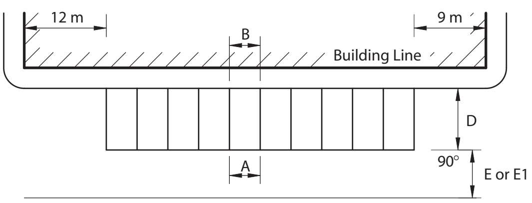
E = 3.5 ONE WAY AISLE
= 5.5 TWO WAY AISLE



A	B	C	D	Dx	E	E1
2.4	3.4	2.4	5.5	5.0	4.0	–
2.5	3.5	2.5	5.6	5.1	3.8	–
2.6	3.7	2.6	5.65	5.15	3.5	–
2.7	3.8	2.7	5.75	5.25	3.5	–

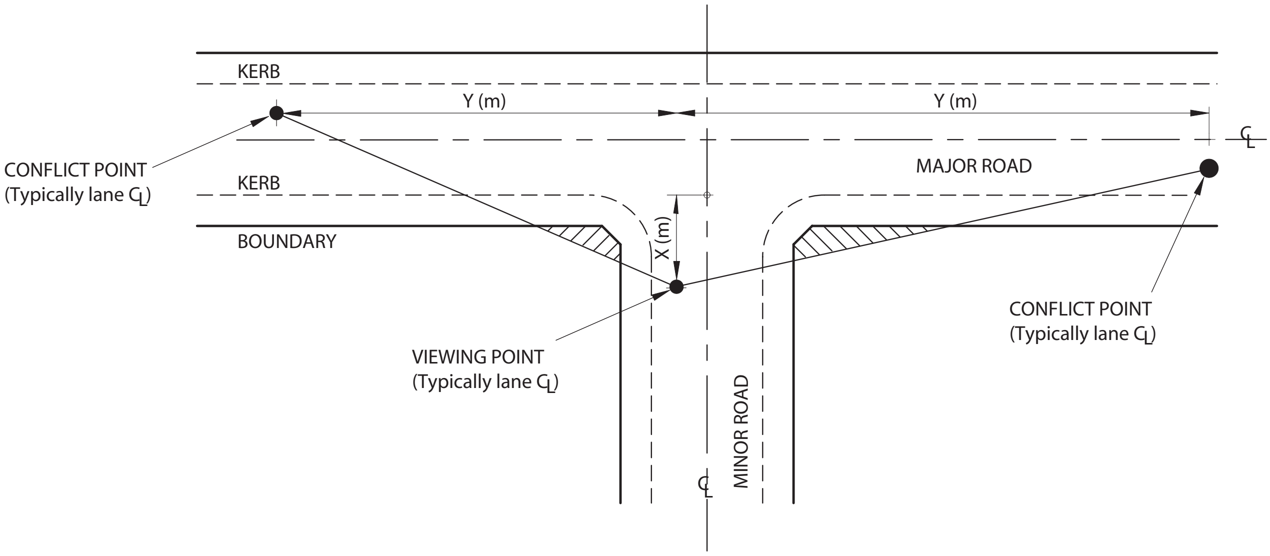


A	B	C	D	Dx	E	E1
2.4	2.75	1.4	5.9	5.25	4.8	–
2.5	2.9	1.45	5.95	5.3	4.5	–
2.6	3.0	1.5	5.95	5.35	4.3	–
2.7	3.1	1.55	6.0	5.4	4.0	–



	A	B	C	D	Dx	E	E1
	2.4	2.4	-	5.4	5.0	7.5	–
	2.5	2.5	-	5.4	5.0	7.0	8.0
	2.6	2.6	-	5.4	5.0	6.6	7.0
	2.7	2.7	-	5.4	5.0	6.2	6.8
DISABILITY PARK	3.6	3.6	-	5.4	5.0	8.0	8.0

Figure 3.2 – Car park dimensions



Major road		**Side road distance X** (m)		
Design speed (km/h)	**Distance Y** (m)	**Principal to sub-collector road**	**Local road Cul-de-sac Major private-way**	**Service lane Minor private-way**
>70	Refer TNZ Guidelines			
70	95	7	5	3
50	65	7	5	3
40	50	7	5	3
30	40	7	5	3
20	25	7	5	3

NOTE –

(1) Within the areas represented by the visibility splays, full visibility will be needed above a level of one metre above the level of the adjacent carriageway. For one-way roads and dual carriageways visibility will only be required in the direction of approaching traffic.

(2) These are minimum distances in an urban environment. For rural situations or primary or collection streets, use SISD (Safe Intersection Stopping Distance) as derived by TNZ Guidelines such as Austroads "Intersections at Grade".

Figure 3.3 – Minimum traffic sight lines at non-signalized intersections

3.3.9 *Cul-de-sac heads*

Typical heads are shown in figures 3.4 and 3.5. Subject to design a central area may be provided for parking or beautification in a cul-de-sac head. The minimum kerb gradient around cul-de-sac heads shall be 0.5 %. Where the head of a cul-de-sac is also a low point it shall be provided with a double sump with individual leads from each sump.

3.3.10 *Bus bays*

Local widening of the road may be provided at bus stops on all roads carrying public transport. Figure 3.6 shows an acceptable standard.

3.3.11 *Special road and footpath provisions near places of assembly*

Adjacent to places of public assembly including schools, hospitals, shopping areas, public halls etc., designs shall incorporate special provisions such as extra parking spaces, stopping lay-bys, widened footpaths, bus and taxi stops, pedestrian crossings, loading zones and any associated facilities desirable to ensure the safety of concentrations of vehicles and pedestrians.

3.3.12 *Footpaths, pedestrian accessways, cycleways, berms*

3.3.12.1 *Urban*

Footpaths shall be provided to adequately service all urban developments.

Their dimensions, strength, durability and finish shall be appropriate to their use and expected loadings. Footpaths shall be a minimum of 1.4 m wide surfaced over their full width. Wider footpaths or areas of local widening will often be required by the TA where higher use or other needs dictate such widening.

Grassed berms shall be provided over the widths between path and kerb and between path and road boundary. The berm shall incorporate not less than 100 mm compacted thickness of loam topsoil placed over a base material capable of allowing root penetration and sustaining growth.

In all cases the combined berm and footpath width shall be adequate to enable landscaping and all current and expected services to be installed.

Berm crossfall shall, where possible, be 1 in 25.

Grassed areas for tree planting which are additional to the minimum berm width shall be specifically designed, and in these areas steeper gradients may be permitted to a maximum of 1 in 5 providing the area can be mown.

Where a berm crossfall greater than 1 in 12.5 is proposed, the designer shall produce a cross section along suitable individual property access locations to show that the sag or summit curves at crossings can be satisfactorily negotiated by a 90th percentile car.

Pedestrian accessways shall be a minimum of 2.2 m wide and be designed for user safety. They should:

(a) Be direct and as short as possible;

(b) Have good sight lines for casual surveillance;

(c) Be sited to ensure high levels of community use.

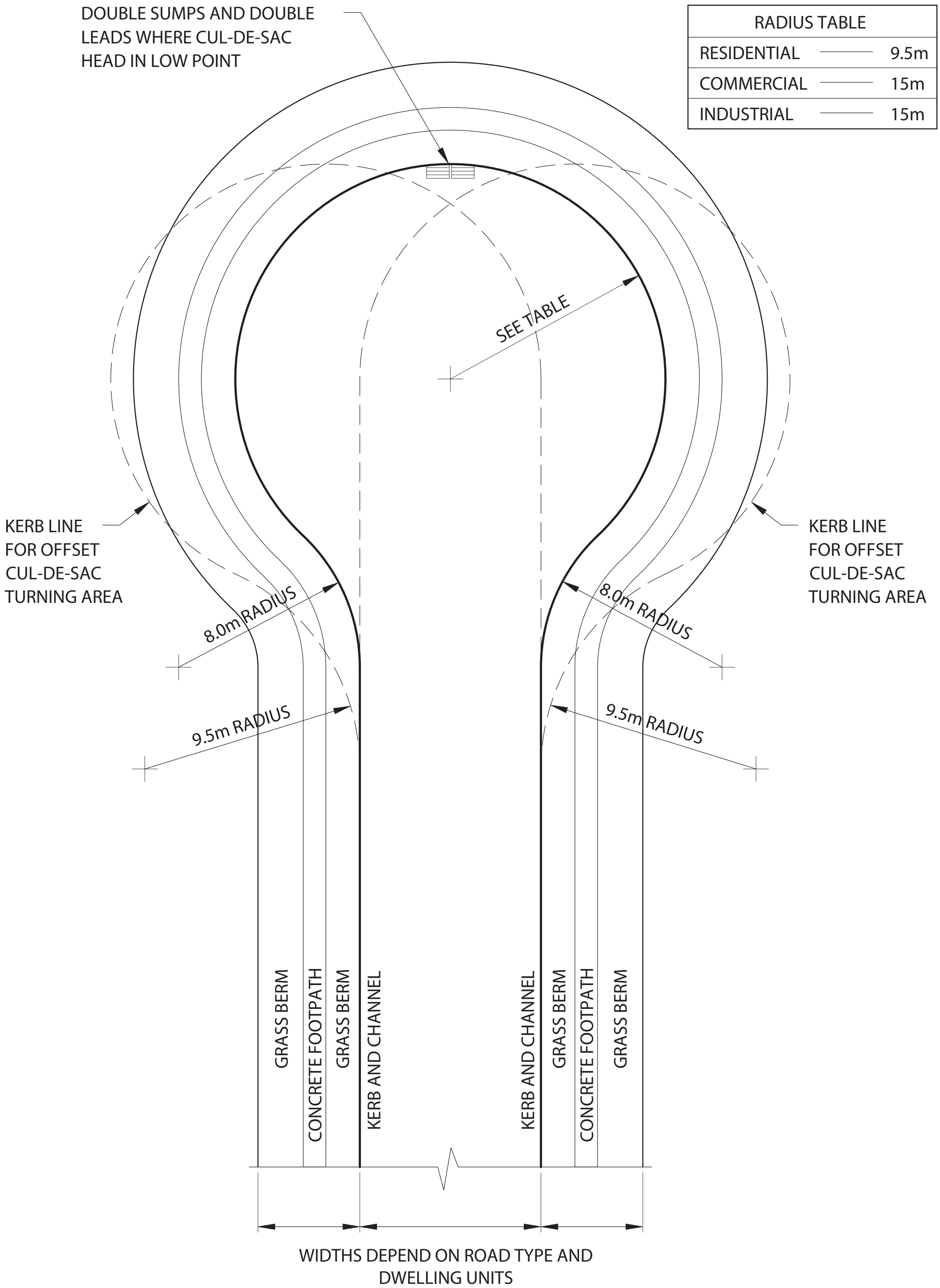


Figure 3.4 – Dimensions of cul-de-sac turning areas

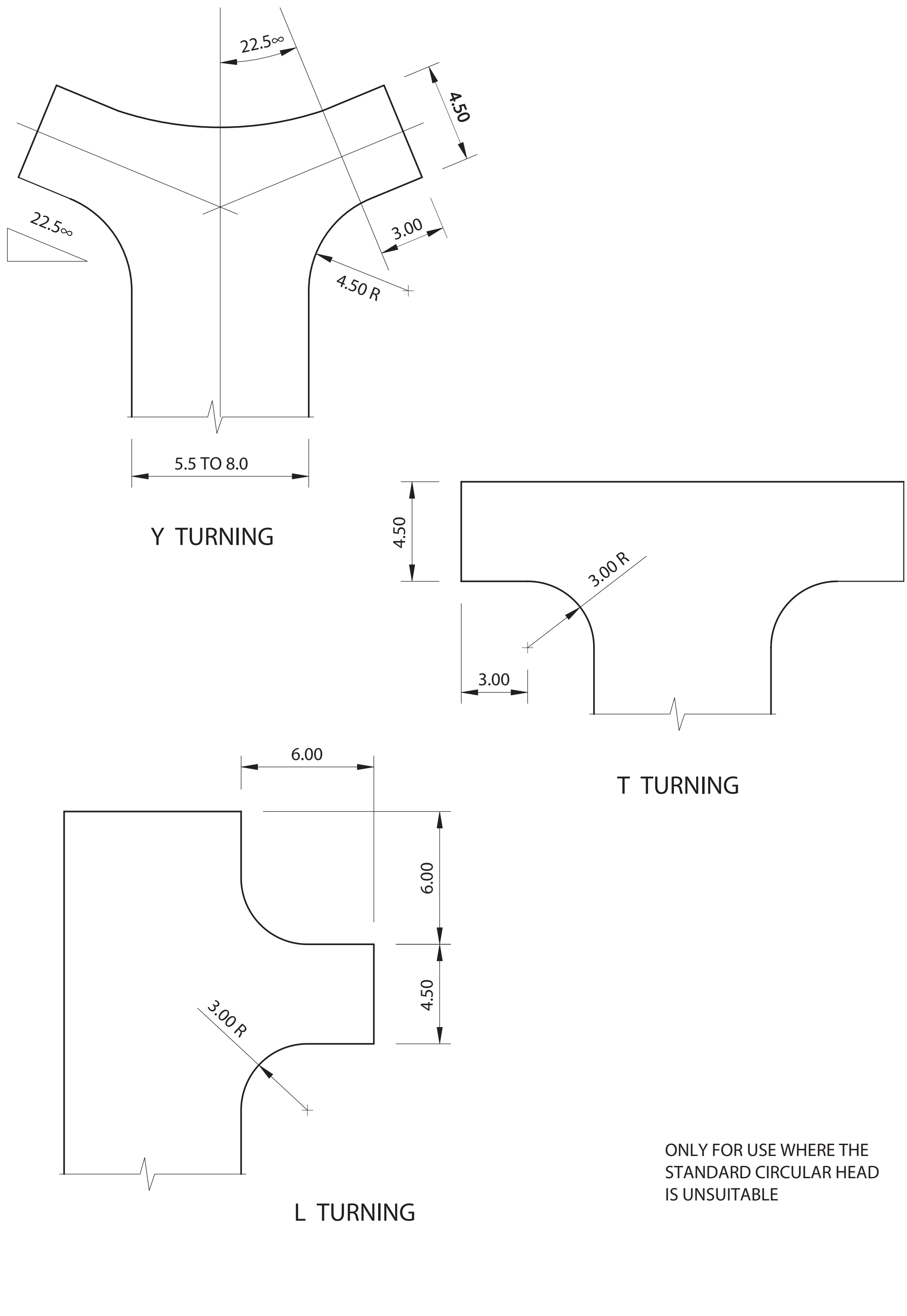


Figure 3.5 – Turning areas for cul-de-sacs

Pedestrian accessways shall be surfaced over their full width and provision shall be made for the collection and disposal of stormwater. Both sides of the accessway shall be fenced with solid fencing at least 1.2 m high and provided with mowing strips to all sides of the fence base. The palings or approved fence facing shall face the accessway or reserve as applicable. Cycle barriers shall be provided at both ends of pedestrian accessways suitable for disabled access including wheelchairs.

Acceptable details for pedestrian accessway cycle barriers are shown in figure 3.7. For fencing details refer to figure 8.1 of this Standard.

Stormwater disposal and lighting shall be provided to all pedestrian accessways.

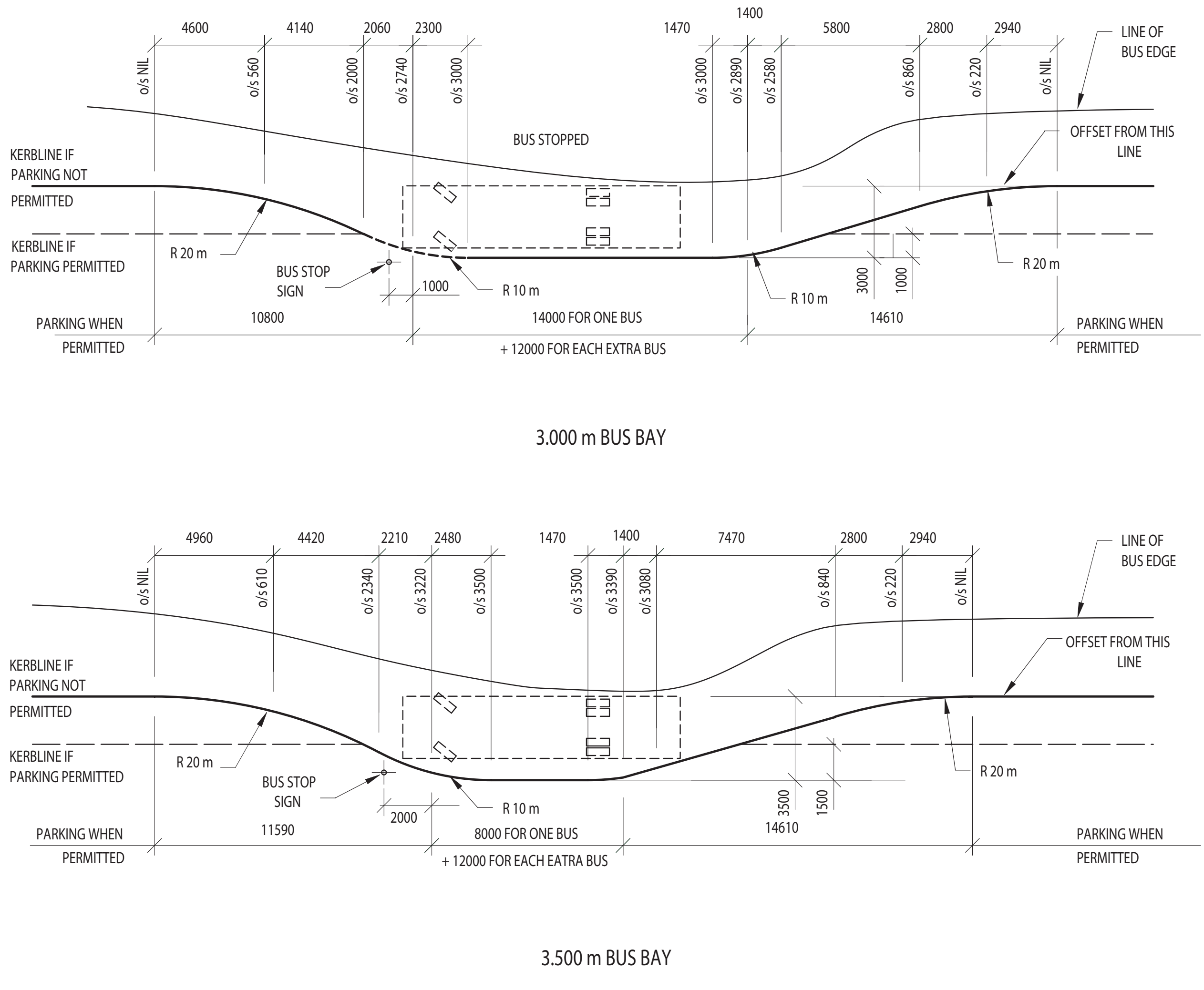


Figure 3.6 – Bus bays: 3.0 m and 3.5 m

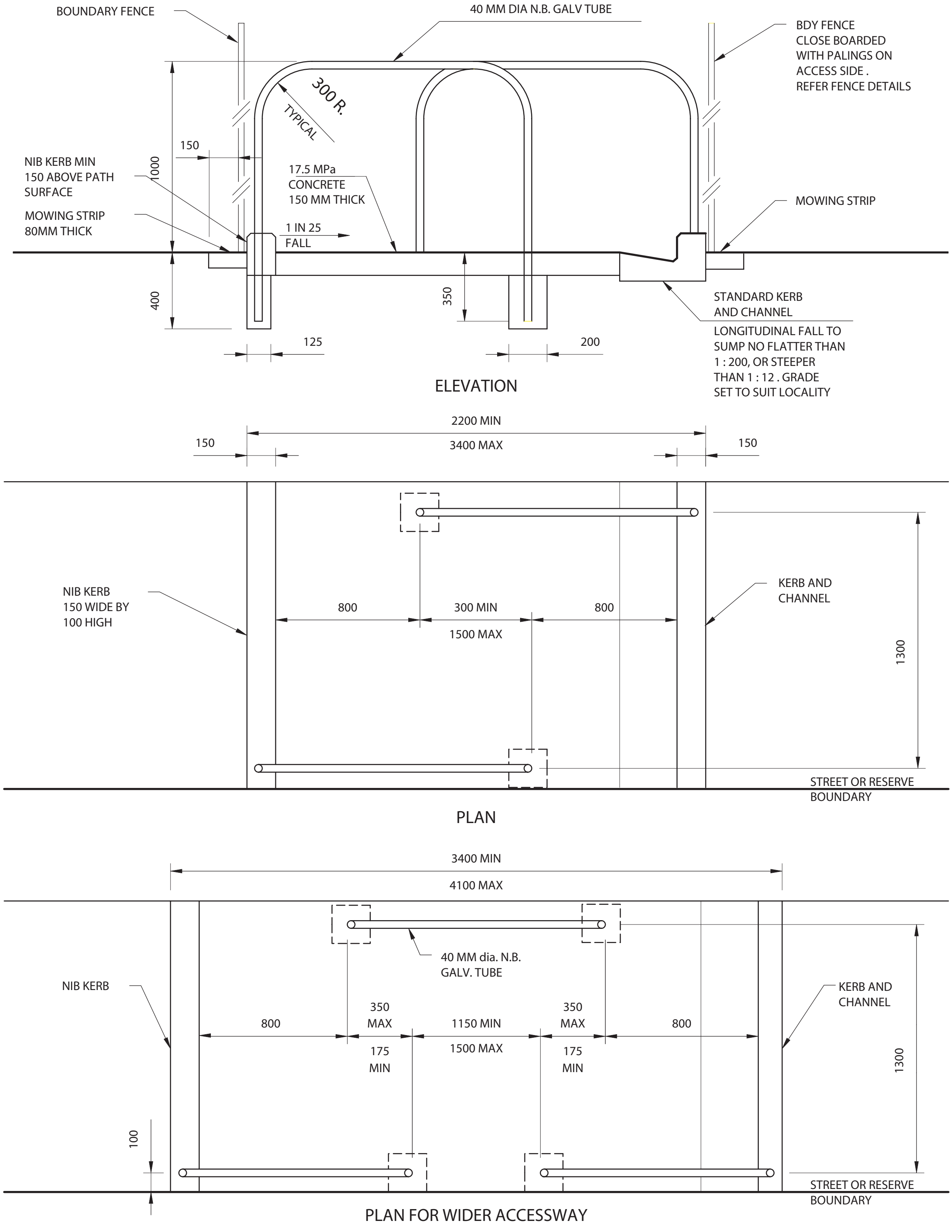


Figure 3.7 – Pedestrian accessway cycle barriers

3.3.12.2 *Rural*

In rural areas, the combination of carriageways and shoulders shall be of adequate width to allow safe passage and stopping of bicycles, pedestrians and motorized traffic.

Rural berms shall be of adequate width to:

(a) Achieve safe clearances between the carriageway edge and any obstacle;

(b) Allow running of utility services and placing of power poles within the berm unless approved otherwise by the utility provider or the TA;

(c) Provide adequate space between the road reserve boundary and the carriageway edge to enable residents to safely enter the road traffic;

(d) Allow room for efficient road edge and edge drain maintenance.

In no case shall berms provide less than 2 m width between the road side channel and road reserve boundary.

Rural berms shall be topsoiled to the same standards as urban berms unless they make use of already grassed undisturbed ground.

Pedestrian accessways where required shall be of the same minimum dimensions as for the urban case. They shall be formed and surfaced full width with provision made for disposal of surface water. They shall be fenced each side with fencing at least 1.2 m high and of a style in keeping with the surrounds.

3.3.12.3 *Cycleways*

Allowance for cycles shall be made in road design (both urban and rural) in general compliance with Austroads guides.

Separate bicycle tracks shall be provided where good design requires separation from the carriageway or a different route to be selected.

Stormwater disposal and lighting shall be provided to all off-road cycleways.

Cycle tracks shall be designed to the standards as set out in *Austroads Guide to Traffic Engineering Practice Part 14: Bicycles.*

3.3.12.4 *Footpath and cycleway surfacing*

All footpaths and cycleways shall be surfaced with a permanent surfacing layer appropriate to the surrounding environment and level of use expected.

Acceptable surfacings are:

(a) Concrete;

(b) Concrete pavers;

(c) Asphaltic concrete (a minimum of 25 mm compacted thickness).

In all cases the surfacing shall be placed over compacted basecourse which in turn shall be placed over a firm subgrade with all organic soft material removed.

Typical details are shown in figure 3.8.

C3.3.12.4

Stone pavers may be approved in areas of high aesthetic value. Chipseal (grade 6) in areas of very low pedestrian traffic may be accepted.

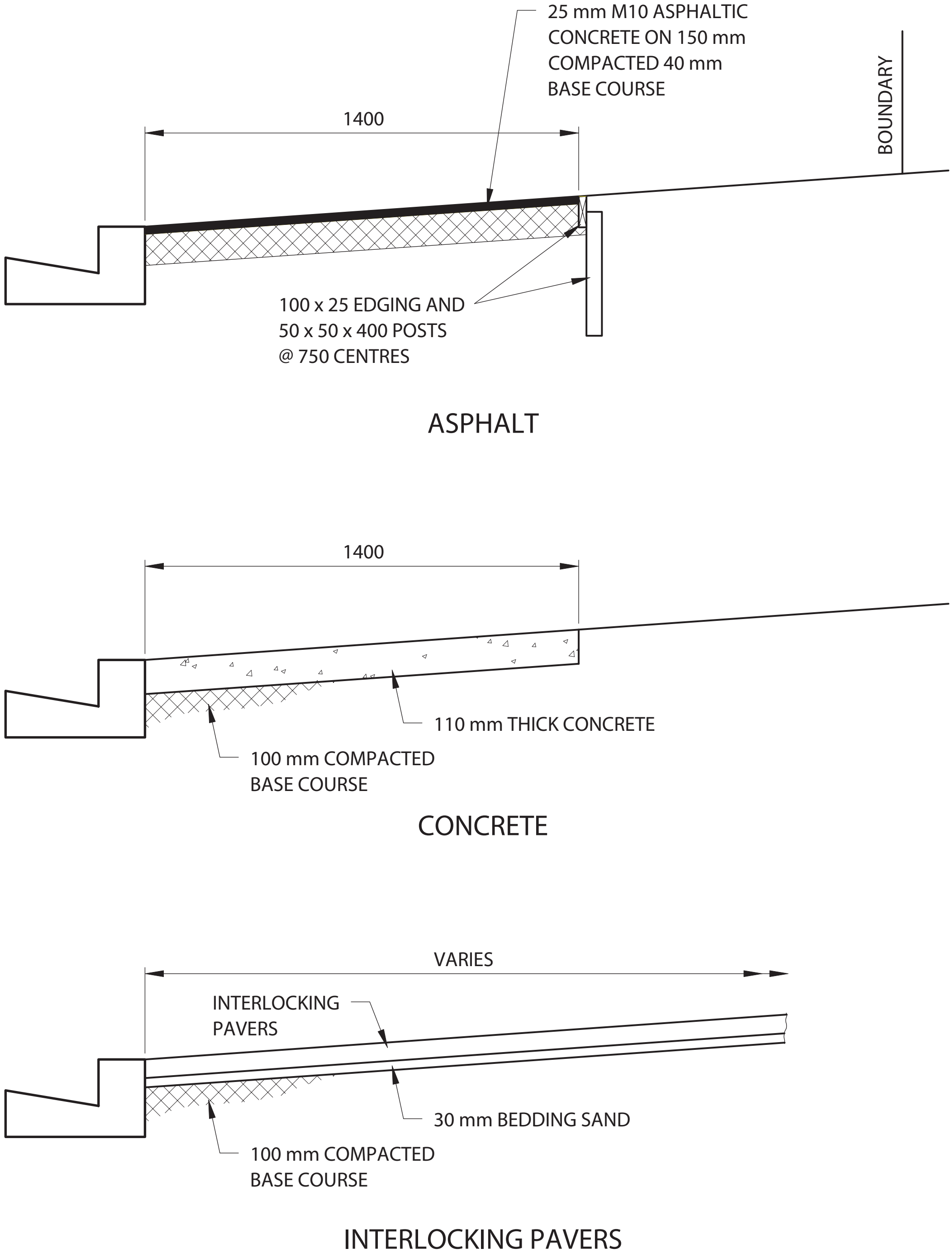


Figure 3.8 – Footpath construction – typical sections

3.3.13 *Traffic services, signage and road furniture*

The design shall incorporate all road marking, including traffic and utility services as appropriate, road traffic and road signs, edge markers and other facilities appropriate to the road type and its position in the road hierarchy.

Design shall satisfy relevant TNZ, LTSA and Austroads guidelines and manuals adopted by or acceptable to the TA.

All road markings and traffic signs shall comply with the TNZ *Manual of Traffic Signs and Markings* and be approved by the TA.

In addition all fire hydrants shall be marked in accordance with NZS 4501.

Road name signs shall comply with the TA's current sign writing standards and their mounting shall be provided by the developer to the TA's requirements.

Seats, signs and other street furniture shall be designed and placed in accordance with the TA's standards but shall not be positioned such that they may cause impediment or sight obstructions to pedestrian and vehicular traffic. Furniture used shall unless expressly approved otherwise be compatible with a TA's existing street furniture.

3.3.14 *Trees and landscaping*

Refer to Part 7 of this Standard for information.

3.3.15 *Road lighting*

All road lighting shall be designed and installed in compliance with the recommendations of AS/NZS 1158 and the guidelines adopted by the TA at that time.

Pedestrian accessways and cycleways separate from the roads shall be to the standard of illumination recommended in AS/NZS 1158.

> ***C3.3.15***
> *The TA may have other requirements for lighting e.g., installation methods, that will need to be satisfied.*

3.3.16 *Bridges and culverts*

The design shall ensure all appropriate resource consents are obtained for bridges and culverts.

All bridges shall be designed in accordance with the Transit New Zealand *Bridge Manual*.

For hydraulic and bridge waterway design, refer to Part 4 of this Standard.

Particular features to be considered/covered include:

(a) Widths/lengths:

All bridges and culverts shall be designed to carry the roadway width including berms and any batter slopes created;

(b) Roadside barriers:

Standard galvanized steel W section guardrails or concrete barriers shall be used on all bridges and culverts. (Refer to LTSA RTS 11 *Urban Roadside Barriers and Alternative Treatments*);

(c) Batter slope protection:

All culverts shall have a wingwall and anti-scour structure to protect batter slopes, berms and carriageway;

(d) Clearance over traffic lanes:

Where passing above traffic lanes, bridges shall have the full clearance for the passing of all vehicles permitted to operate on public roads under the Transport Act 1962. Clearances to all bridges shall be signposted with warning signs on the approach to the bridge and clearance signs shall be posted on each side of the bridge structure;

(e) Foundations:

All bridges and culverts shall be founded to resist settlement or scour. Abutments shall be designed to ensure bank stability and provide erosion or scour protection as applicable.

3.3.17 *Non public accesses (urban and rural)*

Non public accesses include all access types that remain in private ownership after completion of a development. They include:

(a) Private drives – individual or shared;

(b) Private ways – shared;

(c) Formed accessways – shared.

In all cases in urban and rural situations an access shall be formed at the time of subdivision/development where it is to be used or shared by more than a single lot. For rear lots or multi-unit or comprehensive developments the provisions of 3.3.18 apply. For individual lots, whether urban, rural, or rural residential, the designer shall show that it is possible to form an access to each lot, that can be safely traversed by normal road going vehicles. The maximum grade for the 5 m of any non public access immediately abutting a carriageway or back of footpath shall not exceed 1 in 8.

NOTE – Exceptions to the above requirements will need to be justified and specifically designed to incorporate suitable vertical transitions and adequate safety at the point where the access meets the footpath or road.

Accesses sloping up from the road shall have a stormwater collection system at the road reserve boundary so as to avoid stormwater run-off and debris migration onto the public road.

Accesses required to slope down from the road shall be designed to ensure that road stormwater is not able to pass down the access. Side drainage such as kerbs or side ditches (rural) shall be provided to stop the concentration and discharge of stormwater and debris onto adjacent properties or any land which could be at risk of instability or erosion.

A turning head in the common area shall be provided at the end of all accesses serving three or more rear lots or dwelling units and on all commercial/industrial accessways.

For accesses serving fewer than three residential lots or potential dwelling units, turning heads in the common area are not required where it can be shown that adequate turning area is available within each lot or private area.

All non public accesses (rural/urban) shall be surfaced with permanent impermeable surfacing for at least the first 5 m from the road carriageway or up to the road boundary, whichever is less, to prevent debris being carried onto roads.

3.3.18 *Multi-unit non public accesses (urban and rural)*

Minimum formed and legal widths and other relevant standards shall be as detailed in table 3.1.

Except as detailed below geometric standards for accesses shall be the same as for roads. Requirements include:

(a) Changes in alignment shall utilize circular curves. Minimum kerb radii shall be:

  (i) Residential urban/rural – 8 m or that required for the 99th percentile single unit truck

  (ii) Commercial industrial – set to allow free movement of a B train vehicle;

(b) Corner splays shall be provided along both inner and outer boundaries at changes of alignment.

  Splays shall be not less than:

  (i) Residential urban/rural – 3 m

  (ii) Commercial industrial – 5.5 m;

(c) Where turning heads are required, circular, L, T, or Y shaped heads are acceptable. Suitable dimensions are shown in figures 3.4 and 3.5;

(d) Centreline grades shall be:

  (i) Not steeper than 1 in 5 except that grades of 1 in 4.5 may be used on straight lengths of access over distances of up to 20 m. However the first 5 m of any access shall be not steeper than 1 in 8. A greater length of transition shall be provided where necessary on commercial/industrial lots.

  (ii) Not less than 1 in 250;

    NOTE – Exceptions to the above requirements will need to be justified and specifically designed to incorporate suitable vertical transitions and adequate safety at the point where the access meets footpath or road.

(e) All accesses shall be shaped with either crown or crossfall of not less than 2 %;

(f) To allow cars to pass, urban residential accesses of longer than 50 m and less than 4.5 m wide shall have widening to not less than 6.0 m to allow the passing of a 90th percentile car at not more than 50 m spacings. Rural accesses may have passing bays at up to 100 m distances where visibility is available from bay to bay;

(g) All shared urban accesses shall be surfaced and have their edges defined by concrete edging capable of collecting and directing stormwater to suitably designed stormwater collection and disposal systems. For accesses being shared by no more than three lots suitably robust and treated timber edging may be acceptable on one edge where it is not required to serve a stormwater control purpose;

(h) Rural accesses shall have a formation width wider than the sealed widths with safe water tables/edge drains along but adequately clear of each side of the access;

(i) All accesses sloping towards the road shall drain to sumps (urban) or side drain (rural) on the private side of the public road. For urban residential accesses the sumps shall discharge via a single appropriately sized connection to a stormwater main where available. Where a main is unavailable, disposal options shall be agreed with the TA (refer to figure 3.13 for a suitable example);

(j) Rural side drains may discharge directly to the road side drain or where accesses pass over storm ditches they shall be provided with a culvert of size appropriate for the design flow but not less than 300 mm diameter;

(k) Industrial commercial accesses shall drain from their sumps via a lead directly to a public stormwater main;

(l) Private pavements shall be designed as for public roads but no residential or rural pavement shall have a minimum formation thickness of less than 150 mm for flexible pavements or 100 mm for concrete pavements;

(m) Industrial/commercial pavement shall be provided with adequate supporting design to ensure that it will have a life of 20 years;

(n) Acceptable surfacing for accessways includes asphaltic concrete (25 mm minimum thickness), chipseals, *in situ* concrete or concrete pavers.

3.3.19 *Crossings*

3.3.19.1 *Urban*

Vehicle crossings shall be provided between the kerb line or carriageway edge and the road boundary at the entrance to all private ways and service lanes and to any lots, front or rear where access points are clearly identifiable at the subdivisional or development stage.

Where access points are not clearly identifiable at the subdivisional or development stage, crossings shall be constructed at the building consent stage.

Vehicle crossings shall be designed to enable the 90^{th} percentile car to use them without grounding of any part of the vehicle. Figure 3.9 shows details satisfying this requirement. Structural design shall be adequate to carry the loads to be expected over its design life. All crossings shall be surfaced with asphalt or concrete or paving stone as approved by the TA. Figure 3.10 shows an acceptable detail of vehicle crossing.

Where kerb and channel is not provided, and stormwater drainage is provided by open drain rather than piped system, crossings shall be provided as for rural locations as specified in 3.3.19.2.

Pram and wheelchair crossings shall be provided at all road intersections and pedestrian crossings. The crossings shall be sited to facilitate normal pedestrian movements in the road and where possible sumps shall be sited so as to reduce the flow of stormwater in the channel at the crossing entrance. Pram and wheelchair crossings shall satisfy NZS 4121 for disabled persons access and shall incorporate tactile tiles.

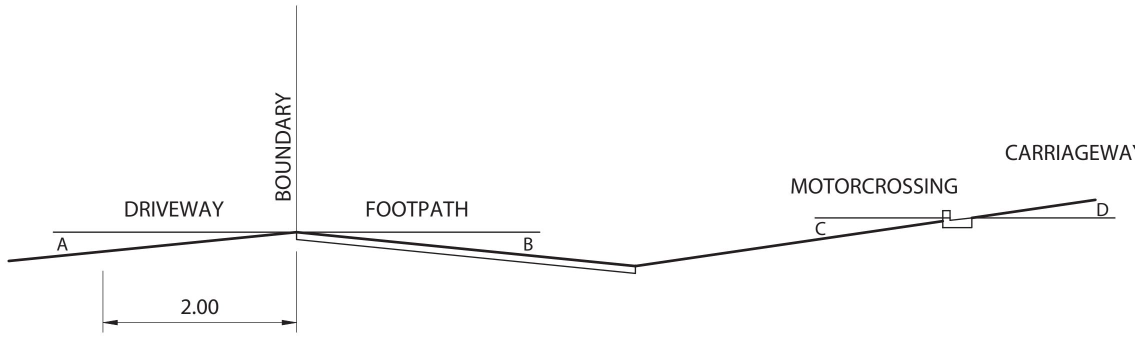
3.3.19.2 *Rural*

All shared crossings and any where the location is obvious at the design stage shall be installed at the development stage. Other crossings shall be provided at the building consent stage.

Crossings shall be provided between the surfaced road edge and the lot boundary at a defined and formed access point to every rural lot. The crossing shall be sealed to not less than the standard of the road, from at least the road reserve boundary to the road carriageway edge.

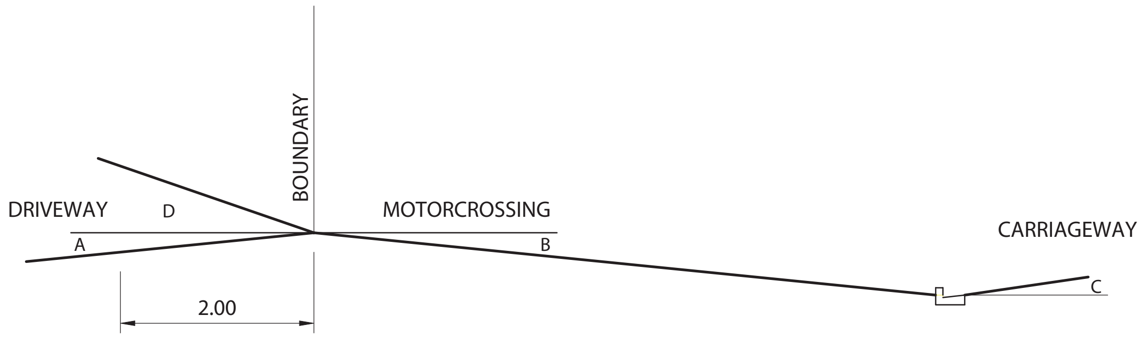
The crossing shall not obstruct the side drain. Where the side drain is shallow and only carries small flows during rain, the crossing may pass through the side drain. Where the side drain is of an unsuitable shape or carries flows for significant parts of the year the side drain shall be culverted under the crossing. Culverts and end treatments shall be sized appropriately for the catchment intercepted but shall be a minimum of 300 mm diameter.

Rural crossings shall be designed so that vertical curvature transitions are suitable for the passage of the 90^{th} percentile car and control of stormwater and debris run-off.



MAXIMUM CHANGE OF GRADE: A + B ≤ 10% (or 5.7°)
C – D ≤ 10% (or 5.7°)
B + C ≤ 17% (or 9.6°)

LOW LEVEL FOOTPATH



MAXIMUM CHANGE OF GRADE: A + B ≤ 10% (or 5.7°)
D – B ≤ 17% (or 9.6°)
B + C ≤ 17% (or 9.6°)

STANDARD FOOTPATH

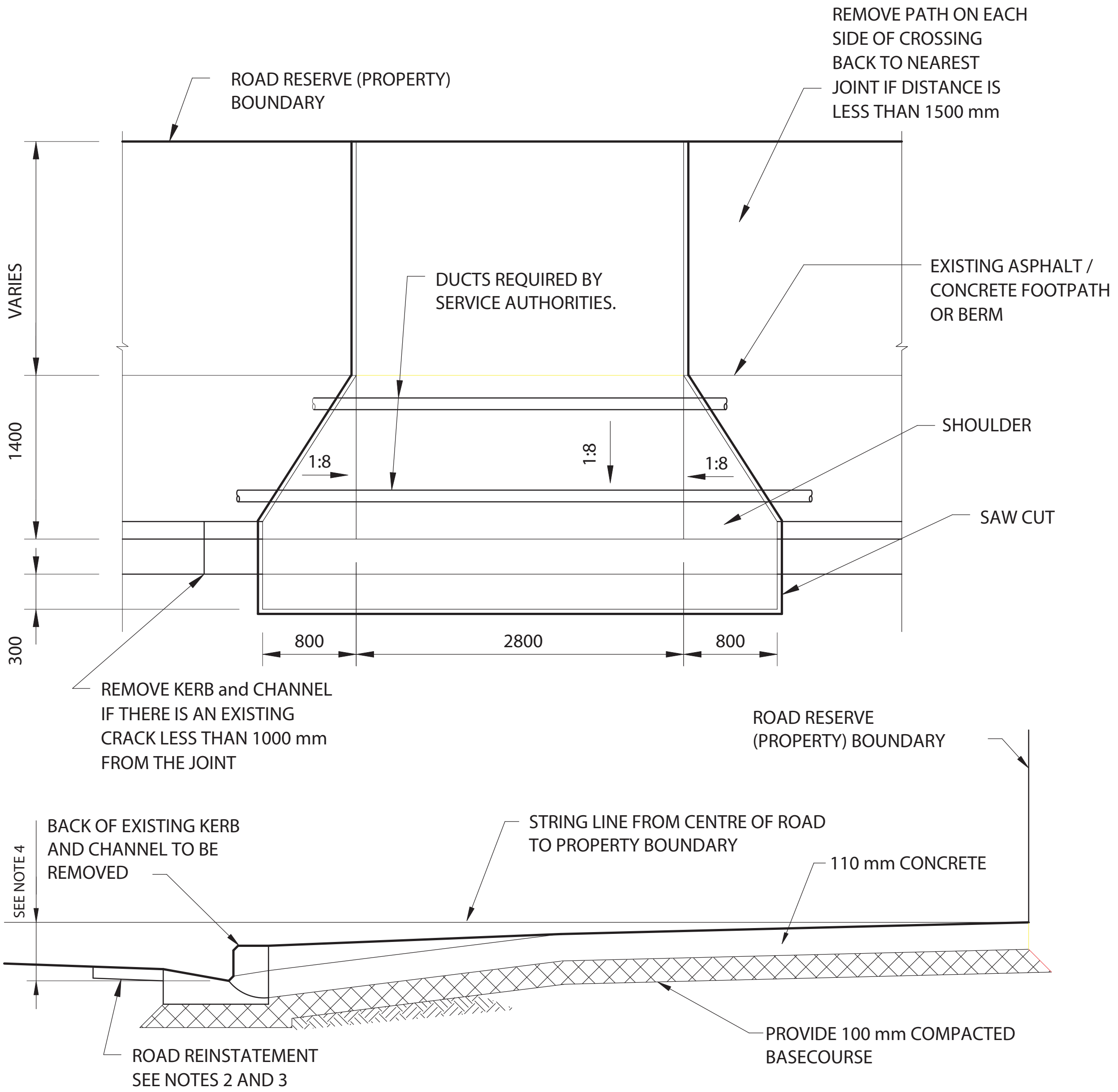
NOTE –

1. A, B, C, & D refer to the gradients expressed either as a percentage or in degrees.
2. Low slung cars with ground effect features may not meet the criteria assumed in this design guide.
3. LTSA document *Light Vehicle Sizes and Dimensions: Street Survey Results and Parking Space Requirements – Road and Traffic Standards Information No. 35* (June 1994) contains more information about the 90th and 99th percentile vehicles.
4. Buses are permitted lower clearance value of (A+B) of 6 % or 3.4°.

BASED ON 90th PERCENTILE CAR AS AT 1990.

GUIDE FOR MAXIMUM BREAKOVER ANGLES FOR VEHICLE CROSSINGS

Figure 3.9 – Maximum breakover angles for vehicular access to property



NOTE –

1. All concrete shall comply with NZS 3109, and be 30MPa crushing strength after 28 days minimum. All surfaces to have a broom finish.

2. A full bitumen coat completely covering the surface and extending up the sides of the reinstatement, is to be applied prior to the laying of the M10 asphaltic concrete.

3. Any damaged road surface shall be sealed with M10 asphaltic concrete, 300 mm in front of kerb and channel or as required. Asphalt thickness to match existing road, but not less than 30 mm.

4. Height from channel invert to string line to be between 150 mm and 250 mm.

Figure 3.10 – Standard light duty vehicle crossing detail

3.3.20 *Fencing*

Fencing shall be provided along the road reserve boundaries of all rural and rural residential subdivisions unless agreed otherwise by the TA. Standards and requirements shall be in accordance with the TA's fencing policy at the time.

For fencing of pedestrian, cycle and reserve accesses refer to 3.3.12 and figure 3.7 in this Standard.

3.3.21 *Road drainage*

3.3.21.1 *Calculations and design*

For stormwater run-off calculations and design refer to Part 4 of this Standard.

3.3.21.2 *Subsurface drains*

Where considered necessary by the TA or the geotechnical engineer, piped subsurface drainage shall be provided to protect road formations from deterioration or loss of strength caused by a high water table.

Piped subsurface drains shall be provided on each side of all urban roads where the natural subsoils have inadequate permeability or unacceptably high water table to enable long term strength of the new pavement to be maintained. They shall be provided on the upslope side of all urban roads in hill areas and on the downslope side also where the downslope side is in cut.

All piped subsurface drains shall discharge by gravity into a suitable component of the public stormwater drainage system.

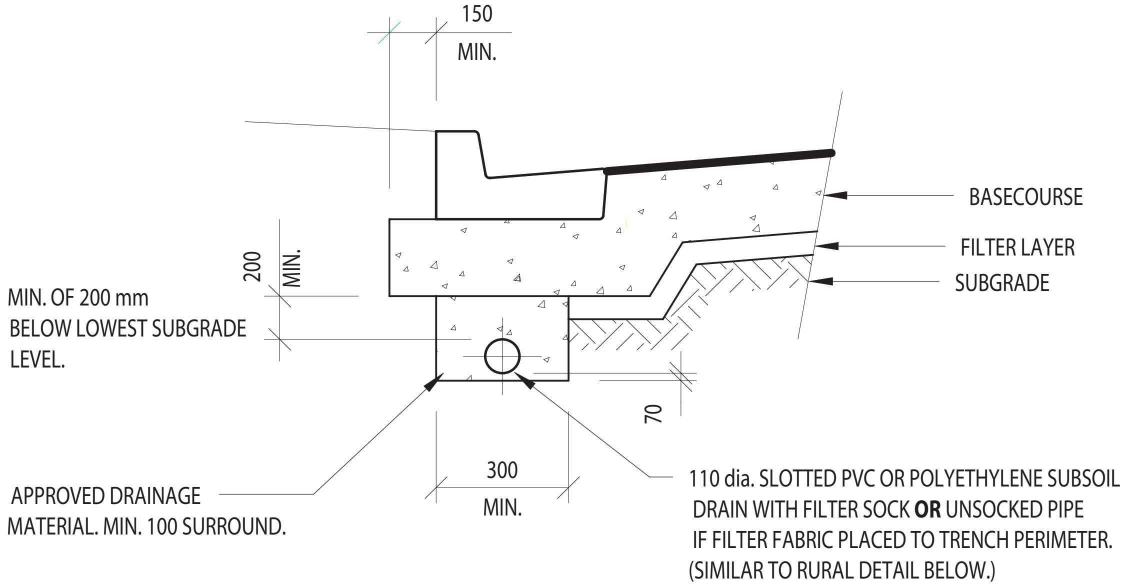
For typical under kerb drainage and rural subsoil drainage refer to figure 3.11.

3.3.21.3 *Side drains/water tables*

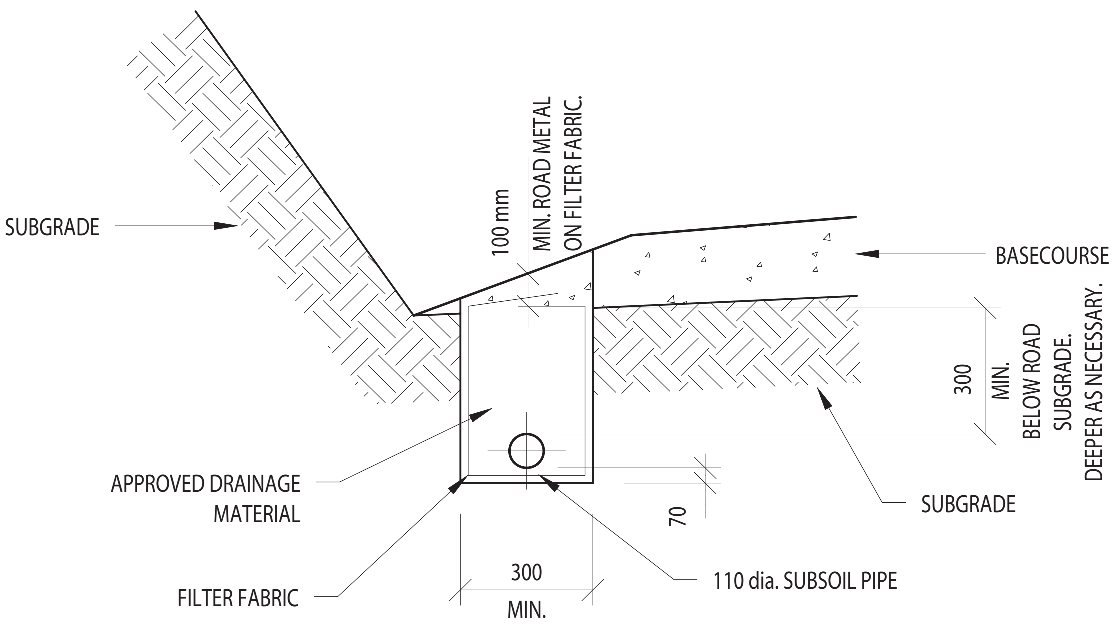
All rural roads shall have crossfall (see table 3.2) to side drains/water tables formed on each side of the carriageway except where the road is on embankment above adjacent land without available channelled drains. In such cases the road may be designed so as to provide for sheet run-off to the adjacent land surface provided natural pre-existing drainage patterns are not altered.

For all situations where side drains are required they shall be sized to suit the flows discharging to them. Side drains shall be intercepted at regular intervals and discharge via ditches or pipes to the nearest available watercourse, gully or natural drainage path. All discharge points shall have outlets protected from scour and shall be located to minimize the risk of slope instability.

Such discharges shall be subject to the approval of affected property owners and be shown to be neither diverting catchments nor significantly changing peak flows or flow patterns.



UNDER KERB DRAINAGE



RURAL SUBSOIL DRAINAGE

Figure 3.11 – Under kerb drainage and rural subsoil drainage

3.3.21.4 *Kerbs and channels*

Where kerbs and channels are to be provided on carriageways they should comply with figure 3.12. Mountable kerbs or their slip-formed equivalent may be used subject to the approval of the TA.

In private ways and accessways where crossfall is such that stormwater control is required on one side only of the carriageway, the kerb and channel may be replaced by a nib kerb on the higher side.

> ***C3.3.21.4***
> *For more information on drainage in urban streets refer to Part 4 of this Standard.*

3.3.21.5 *Sumps*

Sumps used in all public places shall comply with the TA's current standard details.

On footpaths and accessways, kerb or driveway or right of way type sumps shall be used. Figure 3.13 shows an acceptable detail for a driveway or right of way sump. A flat channel or yard sump and various styles of hillside sump are shown in figures 3.14, 3.15, 3.16, 3.17 and 3.18.

A double back-entry sump for road low points is shown in figure 3.19.

Trapped sumps shall be used where discharge to a soakpit is permitted.

3.3.21.5.1 *Sump location*

Sumps shall be located:

(a) To ensure that the total system design flow can enter the pipe system and that surface flows across intersections are minimized. In hill areas the total system design flow will include run-off from any upslope hillsides that are not specifically drained. In many cases this will mean the use of closely spaced or specially designed sumps to ensure that the flow to which the piped system is designed can actually get into the system.

Unless specific capacity of a sump intake is known or derived from first principles, the design capacity of a single back entry sump with standard grating shall be limited to about 28 L/s;

(b) At all points in a channel where a change in gradient is liable to result in ponding due to changes in flow velocity or on bends where there may be a tendency for water to leave the kerb and channel. Sumps discharging into soakpits shall provide for sediment trapping. The sump grating area provided shall be designed conservatively to pass design flow with partial blockage of the grate;

(c) Not further apart than 90 m along any kerb line. At all low points double sumps shall be used as a minimum.

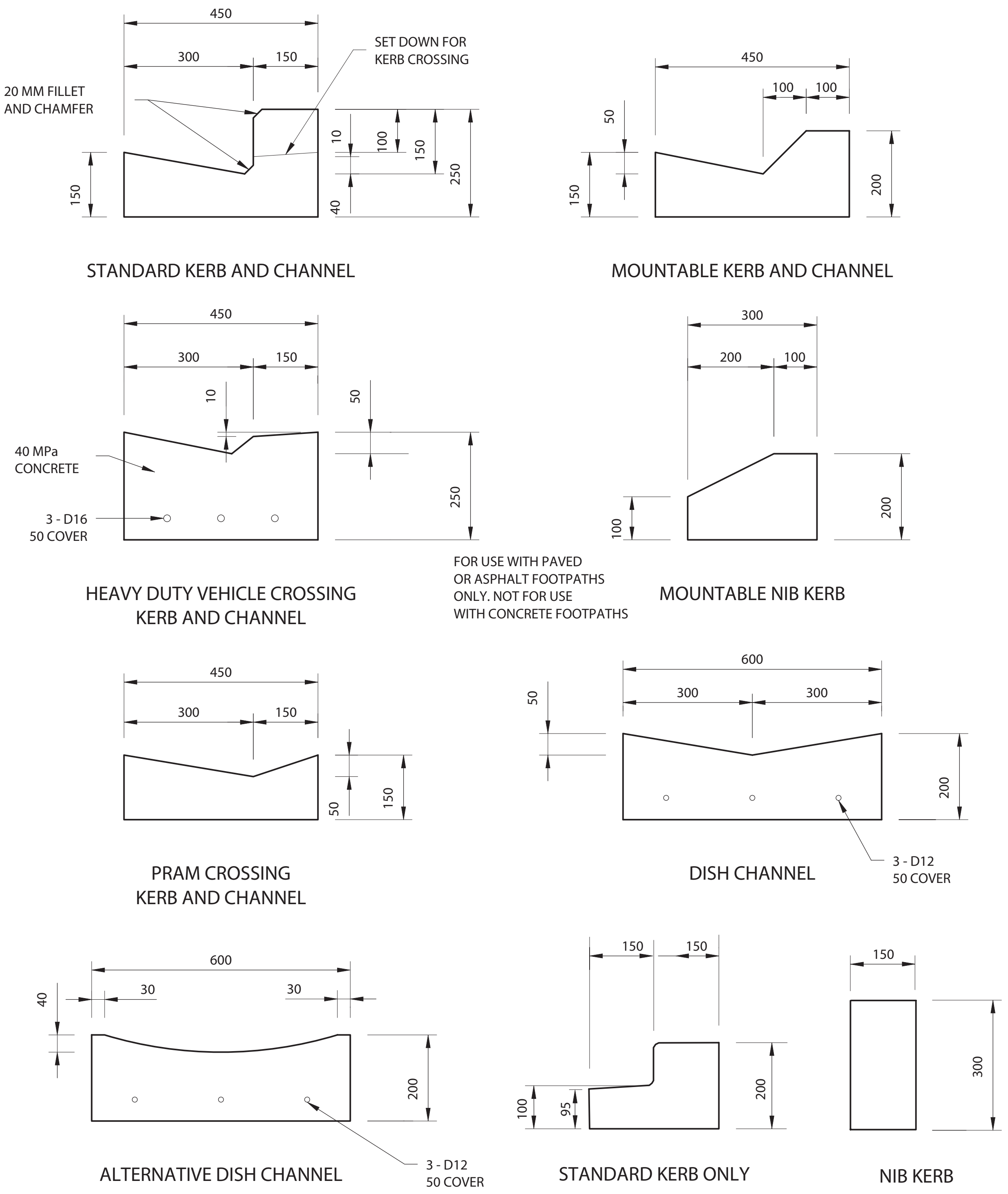


Figure 3.12 – Kerbs and dished channels

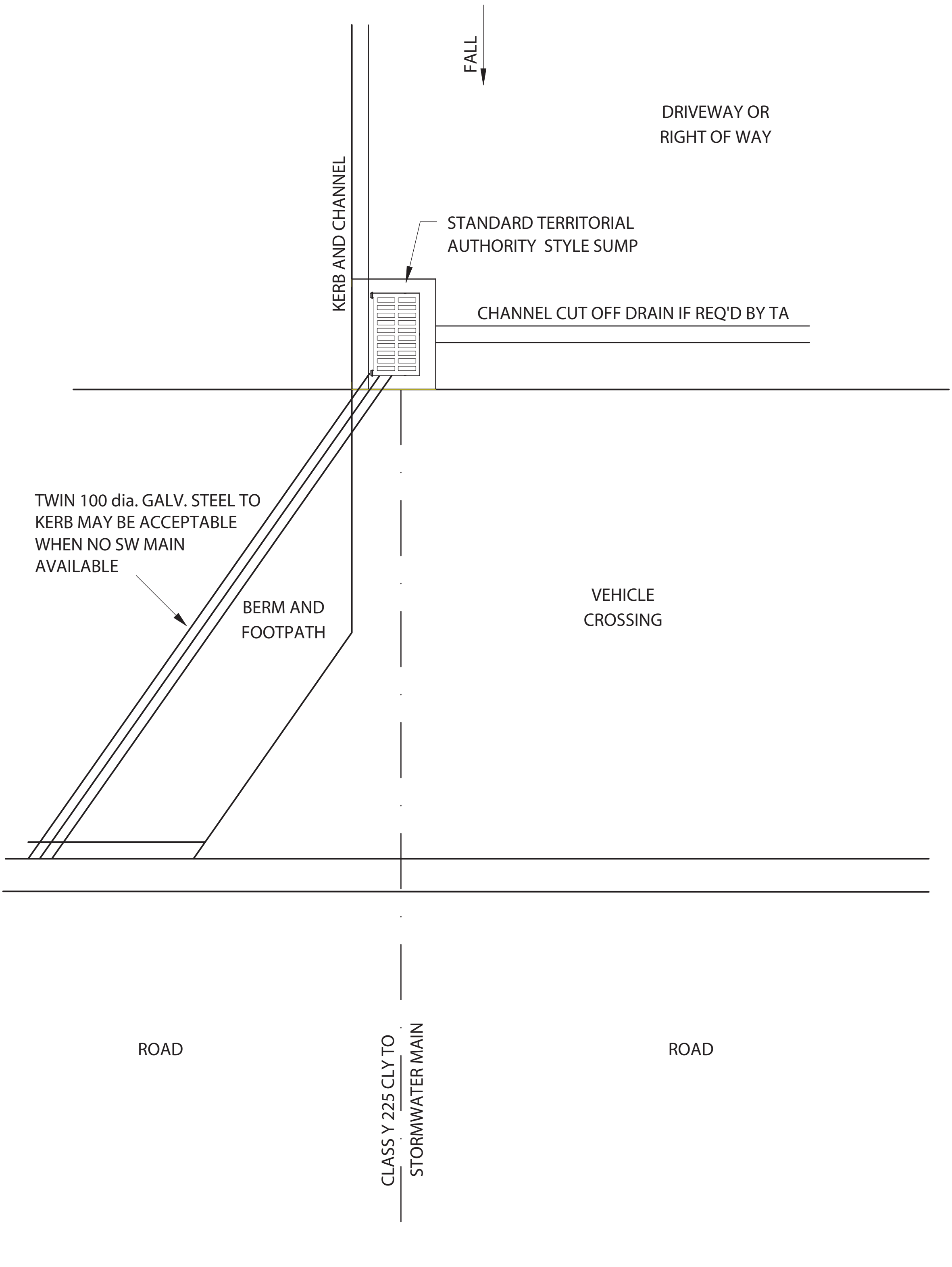


Figure 3.13 – Typical sump to driveway or right of way

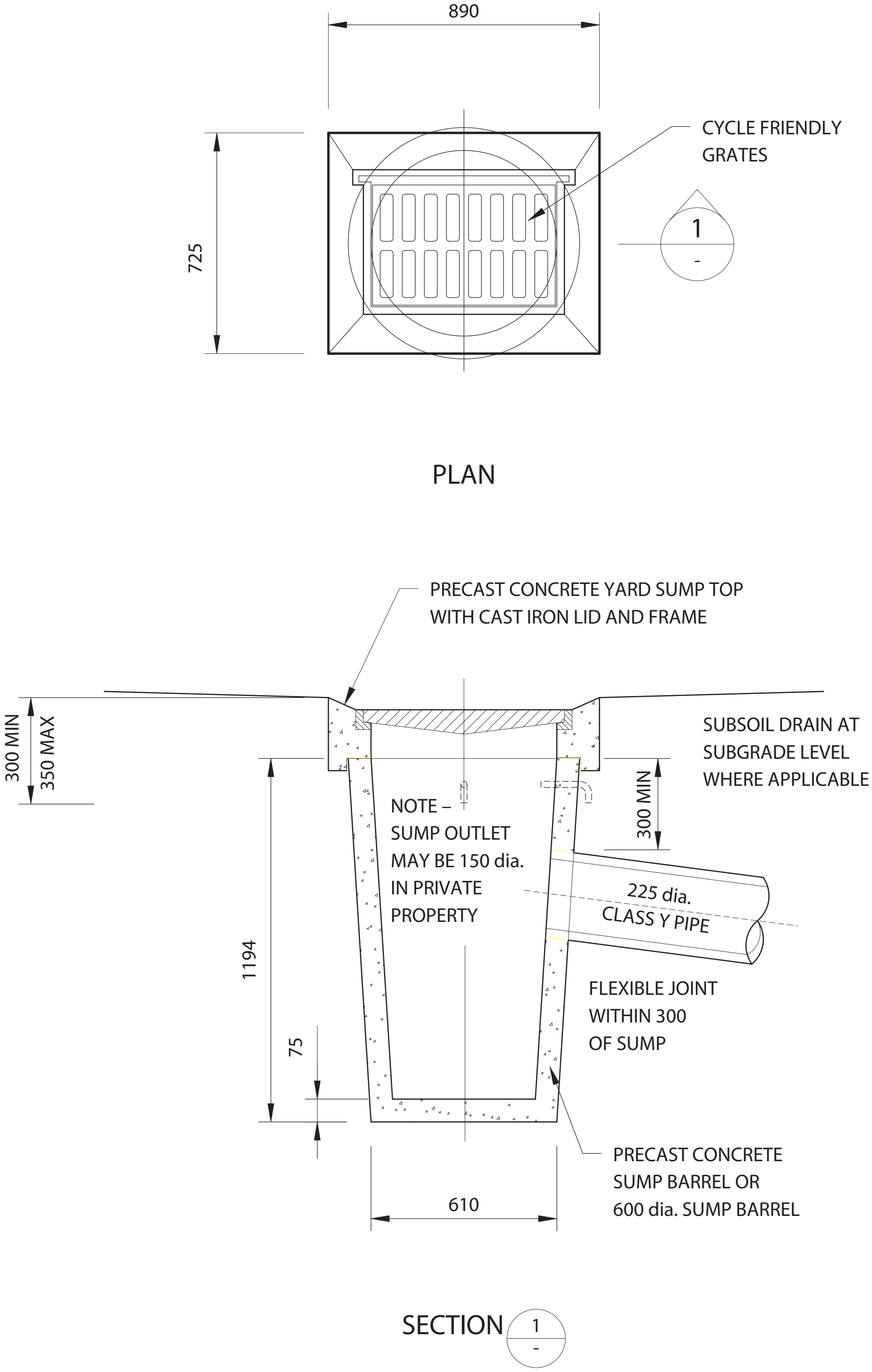


Figure 3.14 – Flat channel or yard sump

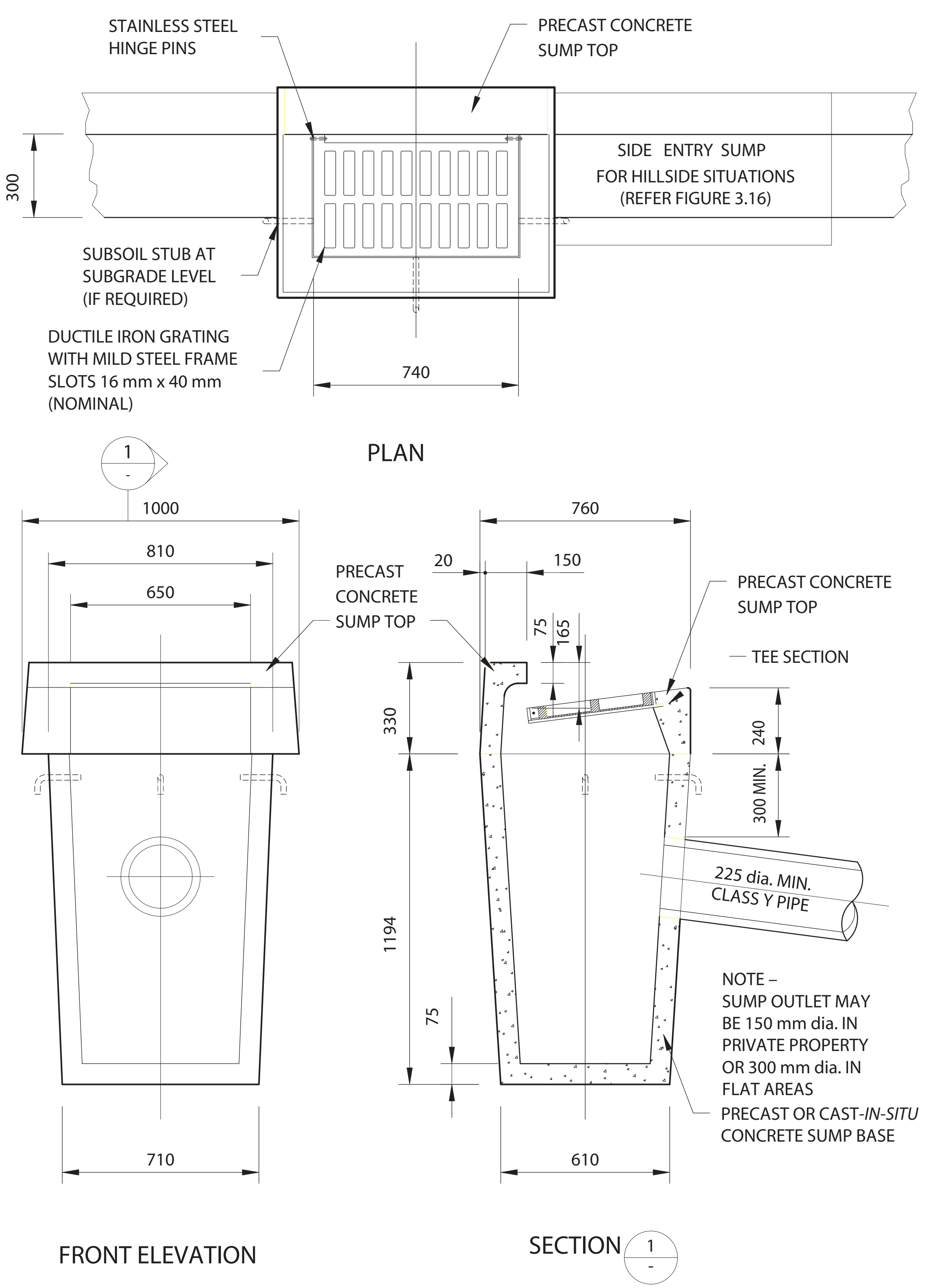


Figure 3.15 – Hillside sump

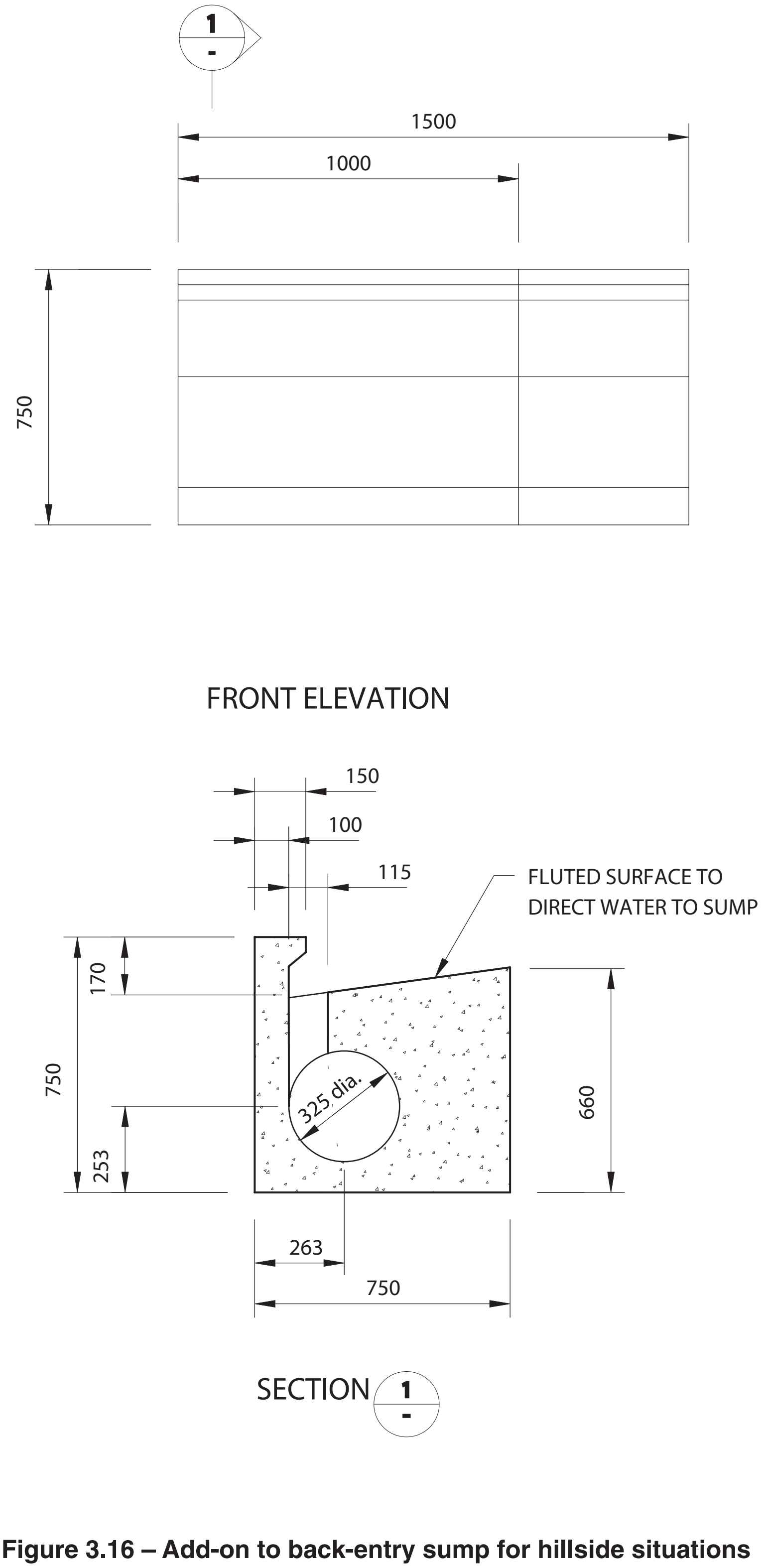


Figure 3.16 – Add-on to back-entry sump for hillside situations

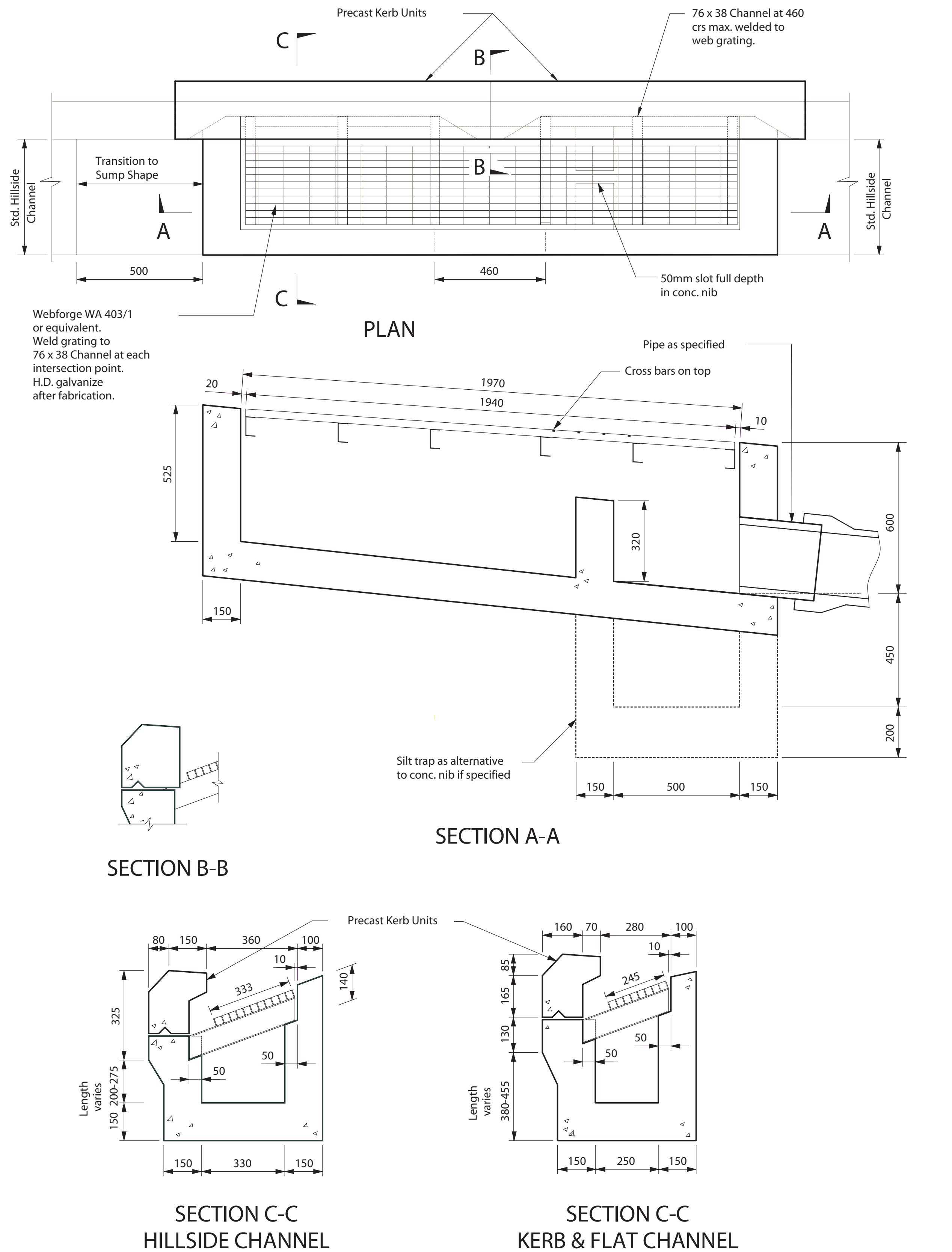


Figure 3.17 – An alternative sump for hillside situations

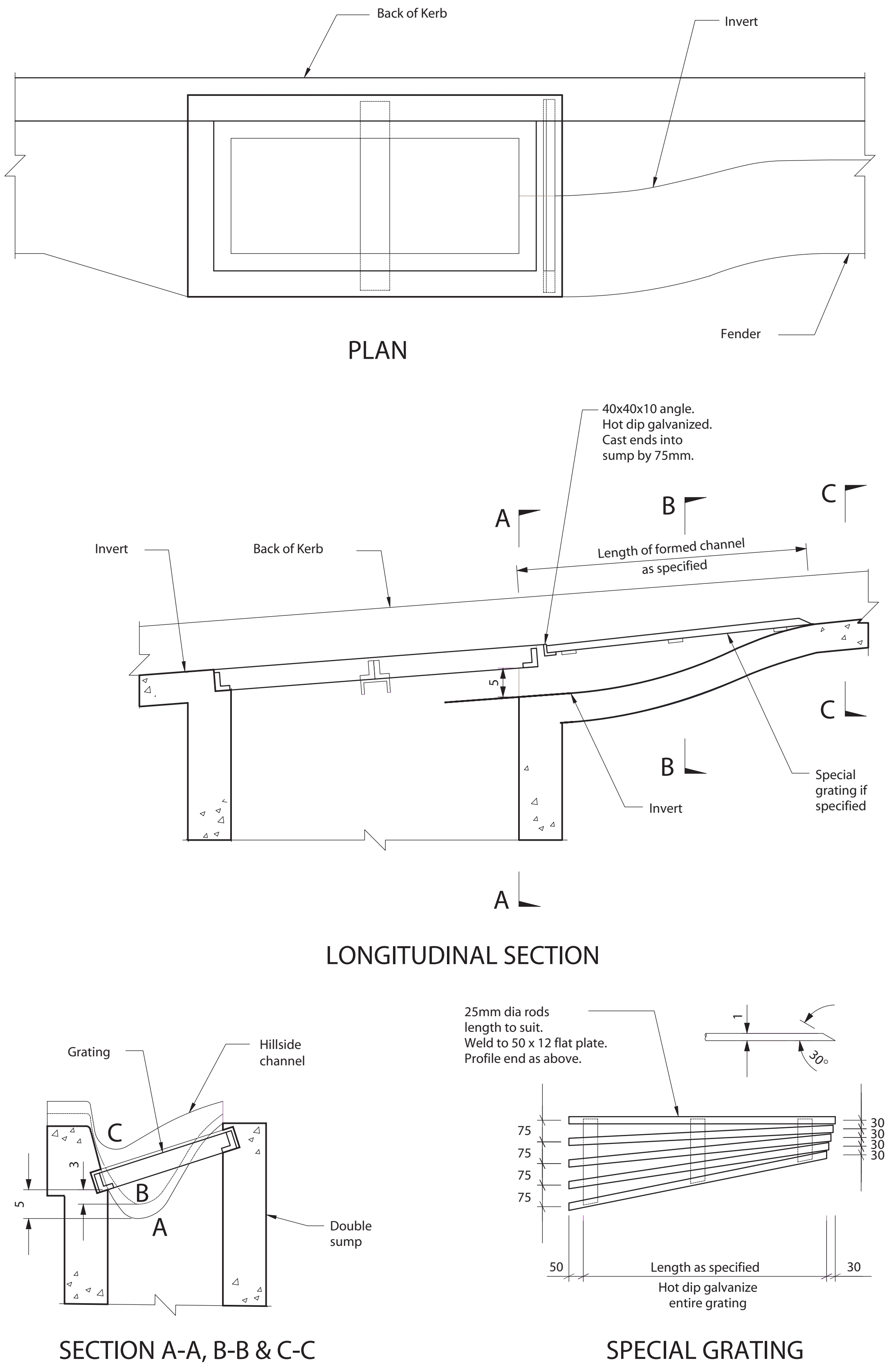


Figure 3.18 – Special entry to double sump in hillside channel

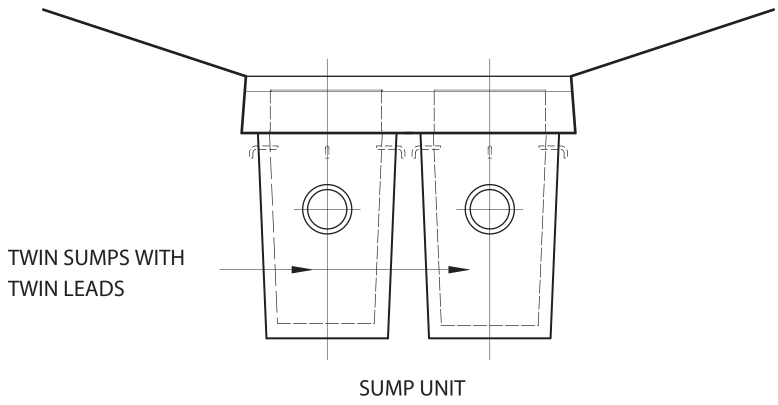


Figure 3.19 – Double back-entry sump for road low points

3.3.21.5.2 *Side-entry sumps*

Side-entry systems associated with traditional grated sumps significantly improve sump intake as they are less prone to blockage from debris. They are the preferred type of sumps for normal use. They should generally be detailed to provide a trap to limit the ability of solid or floatable debris entering the stormwater systems.

They shall not be used without debris control in commercial or industrial areas or in areas where long lengths of set down kerb may compromise the side entry.

3.3.21.5.3 *Sump gratings*

Sump grating area shall be sized generously to allow for partial blockage to ensure that side-channel water does not bypass sumps when velocities are high.

Cycle friendly sump grates shall be used where required by the TA. These gratings may be built either with bars transverse to the side-channel direction or closely spaced bars in a wavy pattern in a longitudinal direction.

3.3.21.5.4 *Sump leads*

The minimum size of a sump lead shall be 225 mm diameter but 300 mm diameter is desirable to minimize inlet losses and blockage risk.

3.3.21.5.5 *Secondary flow provisions*

At all points where sump blockage or undercapacity could lead to overflow into private property, the provision of designed secondary flow paths protected by public ownership or easement should be made. Refer also to Part 4 of this Standard.

3.4 Construction

3.4.1 *Introduction*

These requirements apply to flexible pavements. For rigid pavements, such as concrete pavements refer to Austroads, and the Cement and Concrete Association publication as listed in 3.2.2.

Road construction shall be carried out to the alignments and standards detailed in the approved drawings and with the specified materials so as to provide the intended design life.

The road construction includes all associated work required to complete adjacent footpaths, berms and road reserve areas.

3.4.2 *Materials for flexible pavements*

3.4.2.1 *Transition layer*

A transition layer may be required for traffic loading in excess of 1 x10^5 EDA (Equivalent Design Axle) where pavements are placed over silt, clay or weathered greywacke subgrades. The transition layer may be filter metal complying with appropriate TNZ specifications or an approved geotextile filter fabric. The transition layer shall be compatible between grading of adjacent layers and be regarded as part of the total depth of the sub-base layer.

3.4.2.2 *Sub-base*

The sub-base layer immediately beneath the basecourse shall have a permeability of at least 10^{-4} m/s for a depth of at least 100 mm.

The material used as sub-base shall be hard rock material with the largest aggregate size not larger than 60 % of the depth of the layer or 65 mm. The material shall be sufficiently free draining so as not to be susceptible to undue weakening at highest in-service moisture content.

3.4.2.3 *Basecourse*

The thickness of the basecourse layer when used with other metal aggregate layers shall not be less than 100 mm.

Acceptable basecourse specifications are:

(a) TNZ M/4, (all passing 40 mm – AP40)

This is a high quality material to be used for all roads of arterial class;

or

(b) TNZ approved regional basecourse

This is a slightly lower quality material than TNZ M/4. It may be used for roads of collector class;

or

(c) Local basecourses acceptable to the TA and TNZ

They may be used for non industrial/commercial roads of local class and footpaths, kerb crossings, shared accessways etc.

3.4.3 *Road surfacing*

All roads shall be provided with a permanent, hard wearing surfacing layer, which shall be either impermeable or formed over an impermeable base. The surfacing shall be capable of carrying all stresses expected during its lifetime. The skid resistance and surface texture of roads of collector class and higher, where design speeds exceed 70 km/h, shall comply with TNZ specification TNZ T/10 and its accompanying notes.

Acceptable road surfacing options include:

(a) Hot laid asphaltic concrete of minimum compacted thickness 30 mm, laid over a waterproofing sealcoat;

(b) Other asphaltic concrete mixes such as friction course or macadam wearing mix laid over a waterproofing coat;

(c) Chip seals of various types, providing the equivalent of 2 bound chip coatings;

(d) Concrete block pavers; and

(e) Stone block surfacing where designed for aesthetic effects.

To resist scuffing and local load effects minimum surfacing standards as given in table 3.7 shall apply to the named facilities.

Table 3.7 – Minimum surfacing standards

Facility	Minimum surfacing
Residential cul-de-sac head	Segmental concrete pavers, concrete, 30 mm asphaltic concrete
Public carparks (excl. parallel parks)	Segmental concrete pavers, concrete, 30 mm asphaltic concrete
Industrial/commercial cul de sac head	Segmental concrete pavers, concrete, 50 mm asphaltic concrete
Traffic islands and bus stops	Segmental concrete pavers, concrete, 50 mm asphaltic concrete

C3.4.3

In the cases of tight traffic islands and bus stops, where loading is concentrated, the use of stabilized base course is also desirable.

3.4.4 *Road surfacing materials*

All materials used in road surfacing shall comply with the appropriate Transit New Zealand specifications.

The following surfacing options will be acceptable for most subdivisional streets:

3.4.4.1 *First and second coat chip seals*

For first coat seals the chip size shall generally be grade 3 on all roads.

For second coat seals the chip size shall be grade 4. Cycle and/or parking lanes shall be grade 6.

3.4.4.2 *Double wet lock coat*

First and second seals may be constructed in one operation with asphaltic cutback to TNZ M/1 and P/3 specifications.

The binder application rate for the seals shall be designed to suit the conditions and chip size.

Acceptable and compatible chip sizes are:

Local roads	First coat: grade 4, second coat: grade 6
Other roads	First coat: grade 3, second coat: grade 5 or 6.

3.4.4.3 *Hot laid asphaltic concrete surfacing*

Hot laid asphaltic concrete surfacing shall comply with TNZ specification M/10. The mix used shall be appropriate to the end use and thickness being placed.

A waterproofing seal coat, using asphaltic binder or emulsion, and grade 5 chip, with the requirement that the seal coat comprises a minimum of 1.0 L/m^2 of residual penetration grade bitumen, shall be laid prior to surfacing with asphaltic concrete of 50 mm or lesser thickness. No cut back shall be used in such coats as it can cause flushing of the asphalt overlay.

When using TNZ Specification M/10 compliant mixes on roads of collector class and higher, TNZ guidelines on skid resistance and surface texture shall be incorporated in the mix design.

3.4.4.4 *Other asphaltic mixes*

For special uses other asphalt based hot mixes may be used such as friction course or macadam wearing mix. When used they shall be placed over a waterproof under layer and shall be designed according to current specifications and guides. In no case shall the laid thickness be less than 25 mm.

3.4.4.5 *Concrete*

All concrete for roads shall come from a special grade plant as defined in NZS 3109. Concrete of not less than 30 MPa 28-day strength shall be used for any road or crossing slabs.

Concrete for kerbs and channel shall be of not less than 20 MPa, 28-day strength.

3.4.4.6 *Concrete pavers*

Design and material standards shall be in compliance with NZS 3116. Paver thickness shall be as defined in NZS 3116 for the appropriate traffic loading classification.

When used in roads the basecourse underlayer shall be given a waterproofing seal coat before the sand and pavers are laid.

When used for bus stops or at raised crossings the basecourse shall be cement stabilized under the raised zone and for at least 3 m on either side of the raised zone.

Pavers shall be laid to 5 mm above the lips of channels and other draining features.

3.4.5 *Subgrade checking*

Where the extent of cut or fill for the project is too great to make subgrade CBR testing feasible at the design stage, it may be done on completion of earthworks when subgrade levels have been exposed. Even in cases where the subgrade has been tested as part of the design its condition shall be reviewed on exposure during construction and pavement thicknesses adjusted accordingly.

The results of such testing and/or review along with any consequent adjustments to pavement layer thicknesses shall be advised to the authorized officer before placing of pavement layers commences.

Any identified wet spots in the subgrade shall be drained to the under-channel drainage system. Where the wet area is below the level of the under-channel drain, it shall be drained using approved filter drainpipes connected to the nearest stormwater system.

Between the date the subgrade is completed and the application of the first metal-course aggregate, the subgrade shall be maintained true to grade and cross section. Should pot-holes or ravelling develop in the subgrade, the area so affected shall be scarified and clean metal added and recompacted.

3.4.6 *Spreading and compaction of metal course aggregates*

The metal course aggregates shall be placed on the prepared subgrade in layers. The aggregate layers shall be of adequate thickness and stiffness to ensure that with adequate compaction the minimum required deflections are achieved.

3.4.7 *Sub-base*

The subgrade shall be inspected by the designer to assess the suitability of the exposed subgrade for the proposed design. Where necessary the design shall be modified and soft spots removed before sub-base placement is commenced.

Sub-base material shall be placed in layers thin enough to ensure requisite compaction and CBR standards are achieved. Sub-base shall be compacted to not less than 98 % relative density and tested for compliance in terms of NZS 4402.

The layers shall be so placed that when compacted they will be true to the grades and levels required. The laying procedure shall be arranged to minimize segregation. Grader use shall be restricted to essential shaping and final trimming, with minimum working of the final surface.

The sub-base layer shall not be used by construction traffic.

3.4.8 *Basecourse*

Basecourse shall be placed in layers not exceeding 150 mm. It shall be placed and compacted in terms of TNZ Specification B/2 and shall be compacted to not less than 100 % relative density and tested for compliance in terms of NZS 4402.

To assist compaction, water may be added as a fine mist spray. Particular care shall be taken to avoid excess water reaching the formation or sub-base course.

Fine aggregate may be hand spread in a comparatively dry state over any open textured portion of the final compacted aggregate surface. The fine aggregate shall be vibrated or rolled into the interstices of the basecourse. The use of such surface choking material shall be kept to a minimum. Special attention shall be paid to the consolidation of the edges of the basecourse.

The construction of the basecourse shall be carried out in a manner that will ensure the production of a stone mosaic surface after sweeping.

3.4.9 *Maintenance of basecourse*

The finished aggregate surface shall be maintained at all times true to grade and cross section by placement of a "running course" watering as required, trimming, planing, rolling and taking appropriate measures to ensure the even distribution of traffic.

Every precaution shall be taken to ensure that the surface of the basecourse does not pot-hole, ravel, rut or become uneven, but should any of these conditions become apparent, the surface shall be patched with suitable aggregate and completely scarified and recompacted. The basecourse shall be maintained to the specified standards until covered with an impermeable surfacing layer.

3.4.10 *Basecourse preparation for surfacing*

Any loose or caked material shall be removed from the surface without disturbing the compacted base, and the material so removed shall be disposed of. The surface shall then be swept clean of any dust, dirt, animal deposits, or other deleterious matter. The surface of the road at the time of surfacing shall be clean, dry, uniform, tightly compacted and shall present a stone mosaic appearance. Immediately prior to any form of surfacing a strip 600 mm wide contiguous to each channel or seal edge shall be sprayed with an approved ground sterilizing weed killer at the manufacturer's recommended rate of application.

For second coat sealing, repairs shall be carried out prior to sealing. Areas to be patched shall be cleaned and loose material removed before application of an emulsion tack coat and asphaltic patching material. The repairs shall provide a finished surface flush with the levels and grades of the surround pavement, and shall not hold water.

Prior to commencement of sealing the surface preparation shall be inspected by the TA.

3.4.11 *Deflection testing prior to surfacing*

Where required by the TA prior to placing the surfacing layer (except for cast-*in-situ* concrete roads) deflections shall be tested by the Benkelman beam method. At least 95 % of all tests shall comply with the standards appropriate to the road type. Where the TA does not have its own deflection standards table 3.8 shall be considered as a minimum standard. In addition no test shall give deflections greater than 25 % above the specified maximum.

Table 3.8 – Benkelman beam standards

Residential	Deflections	Other	Deflections
		Industrial road	1.2 mm
Cul-de-sac	2.0 mm	Industrial service lane	1.2 mm
Minor residential	2.0 mm	Collector road	1.2 mm
Sub-collector	1.6 mm	Arterial road	1.0 mm

Readings shall be taken in the wheel path in both lanes and at a maximum interval of 10 m.

3.4.12 *Surfacing specification*

Chipsealing construction standards shall comply with TNZ Specifications P/3 and P/4.

Asphaltic concrete construction standards shall comply with TNZ Specification P/9.

3.4.13 *Bitumen application rate*

Bitumen application rate for chipseals and tack coats shall be assessed based on current TNZ design methods and ambient weather conditions at the time of construction.

3.4.14 *Footpaths*

3.4.14.1 *Concrete*

Concrete footpaths shall be formed over not less than 100 mm of compacted metal. The formation is to be thoroughly compacted by rolling before any concrete is placed. Porous areas shall be blinded with sand prior to placing concrete.

The foundation shall be evenly trimmed to a crossfall of 1 in 50. If the foundation is dry, it shall be moistened in advance of placing concrete.

The concrete paths shall be laid with construction joints at intervals of not greater than 3 m. If paths are constructed by continuous pour techniques, clean, true, well-oiled 5 mm thick steel strips at least 40 mm deep shall be inserted at 3 m intervals to facilitate controlled cracking. These shall be carefully removed after the concrete has set. Alternatively, the joints may be cut by means of a concrete cutting saw. In this case the cutting shall be carried out not more than 48 hours after pouring and shall be to a depth of 40 mm. These joints may also be typically tooled into the concrete when the concrete is still plastic.

Concrete in both footpaths and kerb and channel shall be cured for at least 7 days during dry weather.

Concrete used in footpaths shall be of at least 20 MPa, 28-day strength. Concrete for crossings shall be 30 MPa, 28-day strength as detailed in 3.4.4.5.

Where required, vehicle and pedestrian crossings shall be constructed in accordance with the TA standard details. Tactile pads may be required at pedestrian kerb crossings.

3.4.14.2 *Asphaltic concrete*

Asphaltic concrete footpaths shall be placed over not less than 100 mm of compacted basecourse after removal of all organic and soft subgrade. Asphalt concrete paths shall not puddle water and shall be edged with either concrete or ground treated timber where abutting berms or other grassed areas.

3.4.14.3 *Concrete pavers*

Concrete pavers shall be placed over not less than 100 mm of compacted basecourse after removal of all organic and soft subgrade. Laying shall be in accordance with NZS 3116. Pavers shall be laid to 5 mm above tops of channels and other drainage features.

3.4.14.4 *Surface finish, tolerances*

Surface finish and tolerances on footpaths shall comply with the appropriate design requirements.

3.4.15 *Kerb and channel*

Kerb and channel may be either cast *in situ* or extruded.

For cast-*in-situ* kerb and channel, formwork shall be clean dressed timber or steel sections adequately oiled or otherwise treated to allow ease of striking without staining or damaging of the stripped concrete surface.

No formwork shall be stripped until at least two days have elapsed from time of pouring concrete.

For extruded kerb and channel, concrete used shall be of such consistency that after extrusion it will maintain the kerb shape without support. The extrusion machine shall be operated to produce a well compacted mass of concrete free from surface pitting.

Finished tolerances and standards shall satisfy the design standards.

3.4.16 *Berms and landscaping*

Berms shall be formed after all other works have been completed. The topsoil shall be free of weeds, stones and other foreign matter and shall be graded to footpath edge and shall finish 15 mm above footpath level to allow for settlement.

After topsoiling, the berm shall be sown with grass seed that conforms with the following mix proportions unless the TA specifies an alternative seed mixture:

4 parts by weight Perennial Ryegrass;

2 parts by weight Chewing's Fescue;

1 part by weight Browntop;

1 part by weight Crested Dog's-tail.

Berms shall be sown and maintained mown free of weeds for the contract maintenance period.

A sward coverage of not less than 90 % shall be achieved within one month of sowing and before completion documentation will be accepted for processing by the TA.

Any landscaping within the road reserve shall be in accordance with Part 7 of this Standard.

3.4.17 *Road surface tolerances and texture*

The finished surface of new roads shall have a NAASRA roughness satisfying the TA's standards at the time of the work. No abrupt or abnormal deviations shall occur and no areas shall pond water. The surface shall be of uniform texture expected by best trade practice and satisfy density standards applicable to the surfacing being used. The skid resistance and surface texture of roads of collector class and higher, where design speeds exceed 70 km/h, shall comply with TNZ specification TNZ T/10 and its accompanying notes.

3.4.18 *Surface finish and tolerances on kerbs, paths and accessways*

3.4.18.1 *Kerbs and channel*

All curves both horizontal and vertical shall be tangential to straights and the lines and levels of kerbs shall be such as to give the finished kerbs smooth lines free of kinks and angles. Construction joints shall be placed in all unreinforced kerb and channel at 10 m centres.

Workmanship standards shall be such that, on straights, kerbing shall not deviate from a straight line by more than 6 mm in any length of 3 m. Similar standards shall apply to the gradient line. No visible ponding in new channels shall occur. ➤

The exposed faces of the kerb and channel shall present smooth, uniform appearance free from honey-combing or other blemishes to at least U3 standard in terms of NZS 3114.

3.4.18.2 *Paths, accessways*

Concrete paths and accessways shall be laid with construction joints at not more than 3 m centres. The paths shall be finished with a crossfall to shed water and an even non-skid brush surface to finish U5 in terms of NZS 3114.

Concrete shall be at least 20 MPa, 28-day strength.

The surface of other paths/accessways shall be of uniform texture as would be expected from best trade standards for the surfacing used. Crossfalls of 3 % to 4 % shall be provided.

The surface of all paths/accessways shall not deviate by more than 6 mm from a 3 m straight edge at any point and no abrupt changes in line or level shall occur. No path/accessway shall pond water.

3.4.19 *Progress inspections*

The contractor shall give notice to the TA as appropriate to allow the conduct of all inspections required to facilitate eventual acceptance of the project by the TA.

3.4.20 *Installation of traffic services, road furniture, benchmarks*

Traffic lines and utility services shall be painted and marked after initial surfacing and sweeping has been completed. Road furniture shall be installed, benchmarks surveyed, prior to final inspections being made by the TA.

3.4.21 *As-built and completion documentation*

On completion of construction, information and documents as required by the TA shall be provided by the developers' professional advisor. (See Schedule 1D for further information).

PART 4: STORMWATER DRAINAGE

Table

Figure

PART 4: STORMWATER DRAINAGE

4.1 Scope

This Part of the Standard covers the design and construction requirements of stormwater drainage works for land development and subdivision. While the emphasis in this Standard is on piped stormwater drainage networks, unlike other infrastructural networks such as water supply and wastewater, opportunities exist with stormwater drainage design to utilize or replicate the natural drainage system. Grassed swales, natural or artificial waterways, ponds and wetlands, for example, may in certain circumstances be not only part of the stormwater drainage system, but also a preferred solution especially if low impact on receiving waters downstream is critical.

The stormwater drainage system serves two purposes: the conveyance of storm surface run-off with minimal flood damage and groundwater control. Both aspects need to be considered in design and achieved with minimal adverse effects on the environment.

4.2 General

4.2.1 *Objectives*

The objective of a stormwater drainage system is to regulate storm surface run-off and groundwater levels to the extent that agreed levels of service are maintained and any adverse effects on the environment are not more than minor. To satisfy the latter, remedial or mitigation works will often need to be incorporated within the stormwater drainage system.

Potential adverse effects include flood damage, surface and channel erosion and sedimentation, water pollution, and damage to aquatic ecosystems.

4.2.2 *Legislation*

The principal statute which controls land development including stormwater drainage aspects is the Resource Management Act 1991.

Other relevant legislation is listed in 1.2.2 of this Standard.

4.2.3 *Local authorities' requirements*

The requirements of relevant regional and district plans relating to stormwater drainage shall be met. Regional plan requirements will generally be limited to effects on the natural environment. Relevant bylaws, if any, shall also be met.

> ***C4.2.3***
> *The division of responsibilities between territorial authorities and regional councils is set out in the Resource Management Act. The TA exercises control over works including drainage works associated with land development and subdivision. Approval of drainage works is required from the TA. Natural water quantity and quality, damming and diversion, and natural hazard risk management are controlled by the regional council.*
>
> *Authorization of the effects of drainage activities is required from the regional council. Activities with minor effects may be permitted by a rule in the regional plan (for example, the discharge of clean stormwater to natural water is sometimes permitted subject to conditions). Other activities require specific resource consent from the regional council.*

4.2.3.1 *Authorization from the regional council*

Authorization will be required from the regional council for the discharge of stormwater unless the discharge is to an existing stormwater drainage system and meets any conditions which apply to the existing system. However, territorial authorities have a responsibility to manage land and adverse effects under s. 31 of the Resource Management Act.

Other activities often associated with stormwater drainage works which must be authorized by the regional council include: the diversion of natural water during construction work, the permanent diversion of natural water as a consequence of the development, activities in the bed or on the banks of a natural waterway, and damming waterways.

The discharge of clean stormwater and other activities where effects are considered minor may be authorized as a permitted activity subject to certain conditions in the regional plan. Authorization may also be by way of a comprehensive consent held for a large area or entire catchment.

In other circumstances site specific discharge permits and water permits must be obtained. Resource consent issues can be complex and the consent process long. The advice of the regional council should be sought from consent officers at the earliest stage of planning for stormwater drainage works.

4.2.3.2 *Exercising permits*

Discharge and temporary water permits required during construction shall be applied for by the developer and exercised in the name of the developer.

Other discharge and water permits for works to be transferred to the TA upon completion will be applied for and exercised in the name of the TA. It will be a matter of negotiation and agreement between the developer and the TA who will make the application and at what point the operational responsibility for meeting the conditions of any permits issued will be transferred from the developer to the TA.

4.2.4 *Catchment management planning*

Stormwater planning should be carried out on a co-ordinated and comprehensive catchment-wide basis. Although this is primarily the responsibility of local authorities, consideration should be given to catchment-wide issues by designers at the concept design stage.

The implications of future development upstream on the site and the cumulative effects of land development on water quality and flooding downstream are important considerations. The larger the scale of the development the more significant the catchment management planning issues are likely to be.

Any catchment management planning issues should be discussed with local authorities at an early stage.

4.2.5 *Effects of land use on receiving waters*

Impervious surfaces and piped stormwater drainage systems associated with urban development have a major effect on catchment hydrology. Faster run-off of polluted storm flows, reduction in base flows and accelerated channel erosion and depositions alter the hydrology and adversely affect the quality of receiving waters. This in turn reduces the diversity of the aquatic biological community.

➤

The effects of rural development on receiving waters are generally less significant. The modification to stream hydrology is generally minor. However, any reduction in riparian vegetation increases sediment loads and nutrient concentrations are likely to reduce aquatic biodiversity.

Regional councils should be consulted at an early stage to identify likely adverse effects of land use on receiving waters.

4.2.6 *System components*

The stormwater drainage system conveys storm surface run-off and shallow groundwater from the point of interception to soakage areas or the point of discharge to receiving waters. Components of the conventional primary drainage system include road side channels and sumps, stormwater pipelines, subsoil drains, and outlet structures. Secondary surface flow paths to convey primary system overflows must also be provided.

For small rural developments a stormwater drainage network may not be necessary. Piped stormwater discharge from individual lots to soak pits, swales or natural waterways may be acceptable.

4.2.7 *Alternative stormwater systems*

Stormwater systems incorporating swales, soakage devices, waterways and wetlands, and water quantity and quality control structures can provide an alternative means of stormwater conveyance and disposal. Well-designed and well-maintained alternative systems which replicate the pre-development hydrological regime can not only mitigate adverse environmental effects but also enhance local amenity and ecological values.

Refer to Auckland Regional Council (ARC) Technical Publication No. 124 *Low impact design manual for the Auckland region*, SNZ HB 44:2001 *Subdivision for people and the environment*, and ARC Technical Publication No. 10 Design guideline manual *Stormwater treatment devices* for guidance.

Alternative stormwater systems will require the specific approval of the TA and should be discussed with authorized officers at an early stage.

4.2.8 *Catchments and off-site effects*

All stormwater systems shall provide for the collection and controlled disposal of stormwater from within the land being developed together with any run-off from upstream catchments. In designing downstream facilities the upstream catchment shall be considered to be fully developed to the extent defined in the current district plan.

For all land development works (including projects involving changes in land use or coverage) the design of the stormwater disposal system shall include the evaluation of stormwater run-off changes on upstream and downstream properties. This evaluation will generally be required at the resource consent stage.

Upstream flood levels shall not be increased by any downstream development unless any increase is negligible and can be shown to have no detrimental effects on the upstream properties.

Downstream impacts investigated shall include (but are not limited to) changes in flow peaks and patterns, flood water levels, contamination levels and erosion or silting effects, and effects on the existing stormwater drainage system. Where such impacts are considered detrimental mitigation measures (e.g. peak flow attenuation, velocity control, contamination reduction facilities) on or around the development site, or the upgrading of downstream stormwater disposal systems at the developer’s expense are likely to be required.

The maintenance of fish passage shall be investigated. This is likely to be a requirement of any authorization from the regional council.

4.2.9 *Stormwater pipelines and waterways*

Unless otherwise approved by the TA new stormwater drainage systems or existing systems undergoing major improvement shall provide:

(a) Piped reticulation and/or storage or alternative low impact solutions through residential, commercial and industrial areas; and

(b) Retention and enhancement of existing natural waterways through open space areas including parks, reserves and conservation areas.

4.2.9.1 *Stormwater pumping*

Stormwater pumping should be avoided.

> ***C4.2.9.1***
> *In special circumstances (e.g. a stormwater outfall through an existing stopbank, or an isolated building located on erosion prone land below the road) stormwater pumping may be unavoidable. The consequences and risk of pump malfunction and power outages should be considered carefully.*

4.2.9.2 *Materials*

All materials used for stormwater drainage works shall be new or in as new condition when placed.

4.2.9.3 *Rural areas*

Levels of service can sometimes be relaxed in rural areas. Any proposed reduction in levels of service shall be discussed with authorized local authority officers at an early stage.

4.3 Design

4.3.1 *Approval of proposed works*

The approval process for land development and subdivision design and construction and documents and supporting information on stormwater drainage works to be provided at each stage of the process shall be in accordance with Part 1 of this Standard.

4.3.1.1 *Approval process for stormwater drainage works*

New stormwater drainage systems generally require approval from the TA and authorization from the regional council. Authorization may be by way of a permitted activity or rule in a regional plan or discharge permit. A discharge permit is generally required for medium to large subdivisions (e.g., 50 lots or more) and when significant water quantity and quality issues need to be addressed.

In these circumstances it is good practice:

(a) To consult with authorizing officers from both the regional and district councils prior to consent application;

(b) For regional and district councils to process subdivision and water-related resource consents simultaneously and deal with land and water issues at a joint hearing pursuant to s.102 of the RMA.

4.3.1.2 *Information to be provided*

Specific information to be provided on any concept plans or scheme plans for development or subdivision incorporating stormwater drainage works shall include:

(a) The location of any natural waterways or wetlands within the site or in close proximity to a boundary. The location in plan and level of the water's edge and shoulder of the banks shall be indicated;

(b) Typical pre-existing and post development cross sections through any natural waterways or wetlands;

(c) The proposed proximity of buildings to the water's edge and/or shoulder of the banks;

(d) Clear identification of the extent of any river or coastal floodplains on or in close proximity to the site and overland flow paths within the site; and

(e) The level datum.

Applications for design approval shall include the information outlined in 1.5 of this Standard. In addition the following information shall be provided:

(a) A plan showing the proposed location of existing and proposed stormwater works and flow paths;

(b) Detailed long sections showing the levels and grades of proposed stormwater drains in terms of datum;

(c) Details and calculations prepared by persons experienced in catchment analysis which demonstrate that agreed levels of service will be maintained. All applications to build within a flood plain must be supported by detailed calculations and plans which determine the floodplain boundaries and levels relative to building floor levels;

(d) Details and calculations prepared by persons experienced in catchment analysis which clearly indicate any impact on adjacent area or catchment that the proposed works may have; and

(e) Operations and maintenance guidelines for any water quantity and or quality control structures shall be submitted to the TA for design approval along with other documents (see 4.3.6).

4.3.2 *System design*

4.3.2.1 *The designer*

The design shall be undertaken by a person with experience in the design of stormwater reticulation systems.

The designer shall undertake the necessary design and prepare design drawings compatible with the TA's high level structure plan and the design parameters included in this Standard. Designers shall ensure the following aspects have been considered and where appropriate included in the design:

(a) The size (or sizes) of pipework throughout the proposed reticulation system;

(b) Selection of appropriate pipeline material type(s) and class;

(c) Mains layouts and alignments including:

(i) Route selection (refer to 4.3.3.1, 5.3.2.2 (except that stormwater mains within the 1 in 100 year flood area are acceptable), 5.3.2.3 and 5.3.2.4)

(ii) Topographical and environmental aspects (refer to 5.3.1.4)

(iii) Easements (refer to 4.3.9)

(iv) Foundation and geotechnical aspects (refer to 4.3.3.12).

(v) Clearances and shared trenching requirements (refer to 5.3.3)

(vi) Provision for future extensions, etc.

(d) Hydraulic adequacy including:

(i) Acceptable flow velocities (refer to 4.3.3.7) and

(ii) Other requirements where applicable to satisfy 4.3.12.3;

(e) Property service connection locations and sizes (refer to 4.3.7.1 and Appendix A drawing WS-003);

(f) Preparation of final design drawings, plans (and specifications if applicable).

If the TA does not provide a high level structure plan, the designer shall liaise with the TA, prior to commencement of design, to ensure that sufficient prerequisite information is available to undertake the design.

4.3.2.2 *Separate system*

The stormwater drainage system shall be designed as a separate system (i.e. with no inter-connections whatsoever with the wastewater system).

4.3.2.3 *Primary and secondary systems*

Stormwater drainage shall be considered as the total system protecting people, land, infrastructure and improvements against flooding. It shall consist of a primary drainage system of pipes and waterways and a secondary system consisting of open channels, controlled flood plains and flow paths utilized in conjunction with the setting of building levels to ensure that buildings remain free of inundation up to the appropriate minimum protection standard.

The primary system shall cater for the more frequent rainfall events and the secondary system shall cater for higher intensity rainfall events and occasions when there are blockages in the primary drainage system.

4.3.2.4 *Secondary flow paths*

Lots shall generally be shaped such that they fall towards roadways which may be used as secondary flow paths.

Where secondary flow paths cannot, with good design, be kept on roads they should be kept on public land such as accessways, parks, and reserves or designated by legal easements where over private land. The location of the secondary flow paths shall be clearly delineated on plans held by the asset owner to ensure that their effectiveness is maintained.

Secondary flow paths shall be designed so that erosion or land instability caused by the secondary flows will not occur. Where necessary the design shall incorporate special measures to protect the land against such events.

Ponding or secondary flow on roads shall be limited in height and velocity such that the carriageway is passable.

The secondary flow path sizing and location shall be supported by adequate analysis to show:

(a) That it is of adequate capacity to cope with the design volumes;

(b) That it discharges to a location that does not detrimentally affect others and can safely dissipate via a controlled disposal system as the storm peak passes.

At critical culverts and at other critical structures the secondary flow path under conditions of total inlet blockage shall be considered in design.

The regional council should be consulted to confirm the required design standards.

C4.3.2.4
The standard recommended for ponding or secondary flow on roads is that they are passable to light vehicles in the 2 % annual exceedance probability (AEP) event (i.e., 50-year flood) and to 4WD vehicles in the 1 % AEP event.

4.3.2.5 *Minimum protection standards*

The minimum protection standards following apply to new "greenfields" development. Infill development may be at the same level as existing development with specific approval of the TA.

4.3.2.5.1 *Design storms*

All new stormwater systems shall be designed to cope with design storms of at least the AEP set out in table 4.1 unless specific approval has been obtained from the TA to adopt a lower standard.

A lower standard should be adopted only after a flood damage risk analysis has been carried out.

Table 4.1 – Minimum AEP for design storms

Function	**AEP** (%)	**Return period** (years)
Primary protection – satisfied by an appropriate sized pipe or waterway network.		
Rural and rural residential areas	20	5
Residential areas	20	5
Commercial and industrial areas	20	5
All areas where no secondary flow path is available	1	100
Secondary protection – satisfied by a combination of the primary protection system and appropriately designed secondary flow paths, controlled flood plains and setting of appropriate building levels.	1	100

C4.3.2.5.1
Consultation with the TA on protection standards is essential.

The TA may not require secondary protection for sports grounds or children's playgrounds, for example.

The New Zealand Building Code (NZBC) specifies that surface water resulting from a 2 % AEP storm event shall not enter buildings. This clause applies to new housing, communal residential and communal non-residential buildings.

Development levels may be set higher than NZBC requirements. Some regional councils interpret "inundation" under the Resource Management Act as set by the 1 % event. TAs should consider setting development levels appropriate to their district's circumstances through the district plan process.

4.3.2.5.2 *Freeboard*

The minimum freeboard height additional to the computed flood protection level shall be as follows or as specified in the TA's district plan:

Freeboard	**Minimum height**
Habitable building floors	0.5 m
Commercial and industrial buildings	0.3 m

C4.3.2.5.2
Freeboard is a provision for flood level design estimate imprecision, construction tolerances and natural phenomena (e.g. waves, debris, aggradations, channel transition and bend effects) not explicitly included in the calculations.

Freeboard requirements are related to local conditions. The TA should be consulted on appropriate freeboard for accessory buildings, sports grounds and children's playgrounds.

A minimum freeboard height of 0.5 m is generally applicable but should be increased for sites adjoining steep, rough channels and may be reduced for sites adjoining tranquil ponds.

4.3.2.5.3 *Tidal areas*

In tidal areas, protection standards should be discussed with the regional and territorial authorities at an early stage. Storm surge and tsunami hazards, climate change and sea level rise should be considered. Requirements must be met for building floor levels and if necessary, building platform levels also. In considering protection standards and tidal outfall structures a precautionary design approach is recommended.

4.3.2.5.4 *Bridges and culverts*

Refer to the Transit New Zealand Bridge Manual for waterway design at bridges and culverts.

4.3.3 *Pipelines and culverts*

4.3.3.1 *Location and alignment of stormwater mains*

The preferred location for stormwater pipeline mains shall be within the road reserve (but not under the crown of the carriageway) or within other public land.

A straight alignment between manholes (MHs) is preferred, but curvature on the pipeline is acceptable provided that pipe curvature and joint deflections are within the limits of the manufacturer's recommendations and a reverse gradient does not occur at any point along the invert of the pipe.

Refer to 5.3.2.5 and 5.3.2.6 of this Standard for further guidance on curved alignments for stormwater pipelines.

4.3.3.2 *Pipe materials*

Table 4.2 sets out acceptable system uses for various pipe materials. Stormwater pipe types as listed, or as amended may be used for stormwater drainage work.

> ***C4.3.3.2***
> *For modern materials for which no New Zealand or Australian Standard has been adopted check with the manufacturer on their suitability for the purpose intended.*

4.3.3.3 *Building over pipelines*

Building over pipelines is not recommended practice. Approval to build over pipelines shall be obtained from the TA which may set special conditions. Alternative options such as relocating the building or diverting the pipeline around the building should always be considered.

> **C4.3.3.3**
> *Typical TA special conditions could include:*
>
> *(a) MHs are to be provided either side of the building on the stormwater pipeline;*
>
> *(b) The pipeline is to be on an even vertical grade and in a straight horizontal alignment;*
>
> *(c) There shall be no entry points or junctions to the line under the building;*
>
> *(d) The provision of concrete surround to concrete type pipes or sleeving of flexible pipes.*
>
> *(e) The existing pipeline should be checked by closed circuit television (CCTV) before work commences. If the condition of the existing pipeline is unsatisfactory, it should be replaced;*
>
> *(f) A memorandum of encumbrance shall be drawn up at the applicant's expense to protect the TA.*

Table 4.2 – Acceptable pipe materials

Pipe materials	Standard applicable	Stormwater	Wastewater	Water supply	Comments
VC	AS 1741	✔	✔	–	Has benefits for particularly aggressive wastes or ground conditions
uPVC to (Class SN8 or 16 as required by TA)	AS/NZS 1260	✔	✔	–	For gravity pipes
PE	AS/NZS 4130	✔	✔	✔	
uPVC	AS/NZS 1477	–	✔	✔	For pressure pipes
mPVC	AS/NZS 4765	–	✔	✔	Generally pressure pipes
GRP	AS/NZS 4256.3	–	✔	✔	Lightweight. Resists many aggressive wastes in wastewater applications
RRJ reinforced concrete	NZS 7649	✔	–	–	Sometimes used for waste water pressure lines but subject to hydrogen sulphide attack
Spiral welded steel	NZS 4442	✔	✔	✔	Internal linings include concrete, epoxy, bitumen and galvanizing
Ductile iron pipe	AS/NZS 2280	✔	✔	✔	Generally suspended pipes and high structural loadings
Corrugated aluminium pipe	AS/NZS 2041	✔	–	–	Not acceptable to some TAs. Generally of short length (culverts etc.). Joints need consideration in fine soils with high water tables. Invert may need lining.
Corrugated steel pipe	AS/NZS 2041 NZS 4405 NZS 4406	✔	–	–	Not acceptable to some TAs. Generally only for short length (culverts etc.). Joints need consideration in fine soils & high water tables. Invert may need lining to extend life.
Grey iron	AS/NZS 2544	–	✔	✔	Generally special fittings pump stations etc.
ABS	AS 3518.1 AS 3518.2	–	✔	✔	Generally limited to pump stations, manifolds etc.

4.3.3.4 *Pipeline connections*

Minor pipelines are generally connected to major pipelines through MHs. Modern pipe materials, however, facilitate the efficient jointing and laying of pipelines. Direct connection of minor pipelines to major pipelines is acceptable provided it is either through a suitable junction (i.e. a prefabricated and welded junction for large PVC diameter); or through a saddle provided the diameter of the minor pipeline is not greater than half the diameter of the major pipeline and the distance from the connection to the closest inspection point is not greater than 11 m. (Refer to 4.3.7.2 for further guidance).

Factors to consider are hydraulic efficiency, ease of access for maintenance, and pipeline strength and durability in determining the appropriate method of connection.

4.3.3.5 *Minimum pipe sizes*

Minimum pipe sizes unless otherwise specified shall be:

Sump outlets – 200 mm internal diameter

Stormwater mains – 300 mm internal diameter.

4.3.3.6 *Minimum cover*

Pipelines shall have minimum cover in accordance with the TA or utility owner's requirements, taking into account factors such as the need to access the utility for future connection, surface loading, foreseeable changes to surface levels, any required resistance to physical damage, relationship to other underground assets, future access to the asset, any excessive loadings, any need for casings or slabbing etc. Where the TA does not have specific requirements, the minimum covers as described in AS/NZS 2566 may be used.

> ***C4.3.3.6***
> *AS/NZS 2566 allows covers which would not be acceptable to many New Zealand TAs.*

4.3.3.7 *Gradients and acceptable flow velocities*

In flat areas, gradients should be kept as steep as possible to control silt deposition. The designer should aim to achieve a velocity of at least 0.6 m/s at a flow of half the 2-year storm flow.

When pipe gradients are steeper than 1 in 3 for lengths greater than 3 m, the problem of erosion of concrete and ceramic pipes by high velocity waterborne grit shall be considered.

4.3.3.8 *Backflow effects*

Backflow effects shall be taken into account in design. Outlet design and water level conditions shall be considered in the design of discharges to existing stormwater systems and waterways and incorporate backflow prevention if necessary.

4.3.3.9 *Culverts*

In designing culverts the effects of inlet and tailwater controls shall be considered. Refer to E1/VM1 of the Approved Document for Clause E1 of the NZBC for guidance.

Culverts under fills shall be of suitable capacity to cope with the design storm with no surcharge at the inlet. All culverts shall be provided with adequate wingwalls, headwalls, aprons, scour protection, removable debris traps and/or pits to prevent scouring or blocking. Special consideration shall be given to the effects of surcharging or blocking of culverts under fill.

Fish passage through culverts should always be considered.

Refer to the Transit New Zealand *Bridge Manual* for waterway design at culverts.

> ***C4.3.3.9***
> *In many instances, especially in steep channels, it is recommended that an oversized culvert (in terms of design capacity) partially buried below channel inlet level be provided to reduce inlet/outlet discontinuity and susceptibility to blockage.*

4.3.3.10 *Inlets and outlets*

Where an open waterway discharges into a pipeline, or vice versa, consideration shall be given to erosion control, fill retention around the pipeline, structural support of the pipeline, energy losses and energy dissipation. This is often achieved by a headwall structure.

Where inlets and outlets are located on or near natural waterways their appearance in the riparian landscape and likely effect on in-stream values shall be considered carefully.

> ***C4.3.3.10***
> *Methods include cutting off the pipe end at an oblique angle to match soil slope, constructing a headwall from local materials such as rock or boulders, planting close to the structure, and locating outlets well back from the water's edge.*

4.3.3.11 *Subsoil drains*

Subsoil drains are installed to control groundwater levels. Perforated or slotted pipes with a smooth internal surface are preferred to lightweight corrugated pipes to reduce blockage and facilitate cleaning. High quality slotted pipe shall be used under all areas subject to vehicular traffic loads. It is good practice to provide regular inspection points.

Bedding and backfill material around a subsoil drain pipe shall be more free-draining than the *in situ* soil. If filter fabrics are used their susceptibility to clogging, thereby reducing the through flow, should be considered.

Groundwater control must always be considered when an open drain is piped.

4.3.3.12 *Seismic design*

All structures shall be designed with adequate flexibility and special provisions to minimize risk of damage during earthquake. Specially designed flexible joints shall be provided at all junctions between rigid structures (e.g. reservoirs, pump stations, bridges, buildings, MHs etc.) and natural or made ground.

4.3.3.13 *Geotechnical investigations*

The designer shall take into account any geotechnical requirements determined under Part 2 of this Standard.

4.3.3.14 *Bulkheads*

Bulkheads shall be detailed on the design drawings and shall be in accordance with Appendix A drawing CM-003. Spacing of bulkheads shall be:

Grade %	**Requirement**	**Spacing (S)** (m)
15 – 35	Concrete bulkhead	S = 100/Grade (%)
>35	Special design	Refer to TA

NOTE – On flat grades where scour is a problem, sand bags are often used to stabilize the trench backfill.

Where the natural transfer of water from the trench into the surrounding ground will not provide sufficient drainage, trench drainage shall be provided to divert the water.

4.3.4 *Manholes*

4.3.4.1 *Standard manholes*

Access chambers or MHs shall be provided at all changes of direction, gradient and pipe size, at branching lines and terminations and at a distance apart not exceeding 120 m unless approved otherwise. They shall be easily accessible and located clear of any boundary. All mains shall terminate with a MH at the upstream end.

Refer to 5.3.2.7 and 5.3.6 of this Standard for further guidance on the location of MHs.

On stormwater pipelines equal to or greater than 1 m diameter, the spacing of MHs may be extended with the approval of the TA.

Appendix A drawings CM-004, CM-005 and CM-006 for manholes may be adopted for stormwater systems.

4.3.4.2 *Manhole materials*

Standard MHs shall be manufactured in reinforced concrete. However, if aggressive groundwater or other special conditions exist, alternative materials such as fibreglass, polyethylene, PVC or polypropylene may be more appropriate as access chambers or MHs.

For alternative materials check with the manufacturer on their suitability for the purpose intended.

4.3.4.3 *Size of manholes*

The standard internal diameter of circular MHs is 1050 mm and preferred nominal internal diameters are 1050 mm, 1200 mm and 1500 mm. However, for shallow systems a 600 mm minimum diameter may be permitted. (See 4.3.4.4.)

When considering the appropriate MH diameter, consideration shall be given by the designer to the base layout to ensure hydraulic efficiency and adequate working space in the chamber. Where the effective working space is reduced by internal drop pipes, a larger diameter may be required. Where there are several inlets, the designer may require guidance as to the best layout of the chamber.

The minimum inside dimension for rectangular MHs shall be:

(a) The outside diameter of a pipe connecting at right angles; and

(b) Not less than 900 mm x 900 mm for MHs greater than 1 m in depth (to provide for access).

Additional MH width is required when pipes are not connected at right angles.

The base layout of MHs shall comply with 5.3.6.4 of this Standard and Appendix A drawings CM-004 and CM-005.

4.3.4.4 *Shallow manholes*

For shallow systems (less than 1.2 m to invert) a 600 mm minimum diameter MH may be permitted subject to approval by the TA. Such small diameter MHs shall be classified as maintenance shafts (MSs) for the purposes of the spacing covered under this Standard. See Appendix A drawing CM-005.

4.3.4.5 *Manhole connections*

Open cascade is permitted into MHs over 2.0 m in depth and for pipes up to and including 300 mm diameter providing the steps are clear of any cascade. Other situations may be considered and require TA approval.

The bases of all MHs shall be benched and haunched with concrete to a plaster finish to accommodate the inlet and outlet pipe.

New inlet pipes shall be cut back to the inside face of the MH and plaster provided to a smooth finish. All chambers are to be made watertight with concrete mortar around all openings.

4.3.4.6 *Access*

All TAs shall have a well-documented procedure for entry into MHs. Where MH steps are provided they shall comply with Appendix A drawings CM-004 and CM-005.

4.3.5 *Waterways*

4.3.5.1 *Constructed waterways*

Constructed waterways shall be designed to meet the aesthetic and amenity criteria of the TA.

Access shall be provided along at least one side of any waterway to provide for maintenance, taking into account the “reach” of cleaning machinery. Berms and banks shall be vegetated and laid at slopes that are stable, not prone to scour in flood flows and are able to be maintained by the TA. Constructed waterways, which will be maintained by the TA, shall be protected by easement or be in public ownership.

4.3.5.2 *Natural waterways*

The piping or filling in of natural waterways should be avoided. The natural features and amenity values of highly modified natural waterways should be restored and enhanced respectively. Authorization will be required from local authorities.

Public reserves should be created around significant natural waterways.

4.3.6 *Water quantity and quality control*

Operations and maintenance guidelines shall be provided for any water quantity and/or quality control structures and formed features such as ponds. The guidelines should describe the design objectives of the structure, describe all major features, explain operations such as recommended means of sediment removal and disposal, identify key design criteria, and identify on-going management and maintenance requirements such as plant establishment, vegetation control and nuisance control.

4.3.7 *Connection to the public system*

4.3.7.1 *Individual lots and developments*

The connection of individual lots and developments to the public system shall meet the following requirements:

(a) Connection shall be by gravity flow via laterals to mains or waterways, or to a roadside kerb or swale or rain tanks;

(b) All new urban lots shall be provided with individual service laterals;

(c) Each connection shall be capable of serving the entire building area of the lot (unless specific approval is obtained from the TA to do otherwise);

(d) Stormwater connections shall be provided at such depth at the boundary of urban lots that a drain is able to be extended from the connection, at grades and cover complying with the Building Act, to the farthest point on the lot;

(e) The minimum internal diameter of connections shall be:

  (i) 100 mm for internal lots

  (ii) 150 mm for commercial/industrial lots

  (iii) 200 mm for connections serving three or more dwellings or premises (unless otherwise approved by the TA);

(f) The connection shall be of a type capable of taking the spigot end of an approved drain pipe;

(g) Where the stormwater pipeline is outside the lot to be served, a connection pipeline shall be extended to the boundary of the lot;

(h) Connection to an alternative stormwater disposal system such as vegetated swales, soakpits, or soakage basins is acceptable provided the system is authorized by the regional council and adverse effects and potential nuisances are addressed;

(i) All connections to pipelines or MHs shall be sealed by removable caps until such time as they are required;

(j) Connections shall be indicated accurately on as-built plans. Location relative to boundaries, depth to invert and ground level shall be given as a minimum.

4.3.7.2 *Connection of lateral pipelines to mains*

Factory made fittings shall be used for all connections to stormwater mains up to 300 mm diameter. Connections to larger mains up to 750 mm diameter shall use properly manufactured saddles. Concrete bondage to the exterior of the main pipe is required.

A hole may be made in a 900 mm diameter and larger main to effect a connection. The connection shall be properly dressed and plastered from inside the main to ensure that no protrusions exist.

When the lateral being connected is larger than 300 mm in diameter it shall be connected at a MH.

Connections shall not be made directly to drains more than 3 m deep to the invert of the pipe. A shallow branch drain discharging into the deep drain through a drop MH will be required.

4.3.8 *Stormwater disposal*

4.3.8.1 *Approved outfall*

The approved outfall for stormwater drainage from development and subdivision shall be the public stormwater drainage system or an approved alternative stormwater disposal system. If a connection or capacity is not available, direct discharge to a waterway or the sea may be approved subject to the following conditions:

(a) A suitable outfall and dissipating structure shall be constructed at the outlet to ensure no erosion occurs in the immediate vicinity of the waterway;

(b) No obstruction which will impede the natural flow shall be placed in the channel;

(c) The discharge is authorized by the regional council.

4.3.8.2 *Soak pits*

Stormwater soakpits may be used for developments in rural areas or for residential developments in urban areas if connection to the public system is not feasible and soil conditions are suitable for soakage. For guidance on disposal of soak pits refer to E1/VM1 of the Approved Document for Clause E1 of the NZBC. Soakpits shall be designed to allow easy access for maintenance and located so that access by maintenance machinery is available.

A geotechnical assessment shall be carried out when large-scale use of soak pits is under consideration.

A discharge permit may be required from the regional council for discharge to soakage.

4.3.9 *Easements*

Easements are required for constructed waterways and secondary flow paths through private property.

Where required by the TA, easements shall be provided for public pipelines and subsoil drains through private property.

Easements are necessary where private pipelines serving one property cross another.

4.3.10 *Fencing and safety*

4.3.10.1 *Fencing*

There is no statutory requirement to fence waterways. The fencing off of natural urban waterways is not generally recommended. Where a site-specific risk to health and safety exists the TA may require a fence to be erected.

Fencing may be a condition of easements for constructed waterways or drainage structures. An open, see-through type rather than a solid fence is recommended.

Fences shall not significantly impede flood flows up to the minimum protection standards.

C4.3.10.1
Open, see-through fences allow not only the aesthetic and amenity aspects of sensitively designed drainage features to be appreciated but also informal surveillance of the site improving public safety.

4.3.10.2 *Health and safety*

The design and construction of stormwater drainage works shall be in accordance with the health and safety requirements of the Building Act and the Health and Safety in Employment Act.

Vertical drops of 1 m or more onto hard surfaces such as concrete shall be avoided or screened off by barriers in the design and construction of stormwater drainage works.

4.3.11 *Developer contributions*

Where further subdivision, upstream of the one under consideration, is provided for in the district or regional plan, the TA may require stormwater infrastructure to be constructed to the upper limits of the subdivision.

Additionally, the TA may require additional capacity to be provided in the stormwater drainage system to cater for existing or future development upstream.

Formal cost sharing schemes pursuant to the Local Government Act, rules in the district plan, or direct negotiations with the TA should be pursued to achieve an equitable sharing of costs.

4.3.12 *Means of compliance*

4.3.12.1 *Surface water*

Refer to Approved Document for Clause E1 of the NZBC: Surface Water which comprises Verification Method E1/VM1 and Acceptable Solution E1/AS1. E1/VM1 includes design details for stormwater hydrology, drainage system hydraulics, drain leakage tests, and disposal to soak pits.

E1/VM1 shall be an acceptable means of compliance for the design of stormwater drainage works.

Although E1/AS1 is limited to small sites (no more than 0.25 ha) the drain bedding and backfilling clauses shall be an acceptable means of compliance for the design and construction of stormwater drainage works.

4.3.12.2 *Estimation of surface water run-off*

Refer to E1/VM1 of the Approved Document for Clause E1 of the NZBC.

Another useful text is *Australian Rainfall and Run-off* published by the Institution of Engineers, Australia.

4.3.12.2.1 *Large catchments*

For catchment areas greater than 100 ha or smaller catchments with significant storage elements (e.g., ponds, wetlands, and basins) surface water run-off shall be determined by unsteady flow modelling.

4.3.12.2.2 *Rainfall intensity and time of concentration*

Local rainfall intensity data shall be used if available. (The New Zealand-wide rainfall intensity maps in Acceptable Solution E1/AS1 Appendix A are appropriate for a 10 % AEP 10-minute duration design storm only.)

> ***C4.3.13.2.2***
> *The appropriate rainfall intensity is for the time of concentration at the design point. The increase in the time of concentration further downstream in the stormwater drainage system should be taken into account in design to avoid over conservative system capacity.*

4.3.12.3 *Sizing of the stormwater drainage system*

Refer to E1/VM1 for pipe, culvert, and open channel hydraulics.

> ***C4.3.12.3***
> *Pipe diameters are specified differently for different purposes. Nominal (DN), inside (ID) or outside diameters (OD) are all in common usage. Care must be taken to use ID for all flow calculations. It is good practice to indicate in all situations whether DN, ID or OD size is intended.*

4.3.12.3.1 *Pipe flow*

The pipe flow relationship graph in E1/VM1 is based on Manning's formula and applies to full pipe flow.

Part full pipe flow relationships can be determined from figure 4.1.

4.3.12.3.2 *Energy loss through structures*

Refer to E1/VM1 for guidance on energy loss through structures.

Energy loss is expressed in terms of velocity head:

Energy loss $H_e = kV^2/2\,g$

where k is the energy loss coefficient and V is velocity.

The entrance loss coefficient table and energy loss coefficient graph in E1/VM1 provide k values for flow through inlets and access chambers respectively.

For bends, refer to table 4.3.

4.3.12.3.3 *Determination of water surface profiles*

Stormwater drainage systems shall be designed by calculating or computer modelling backwater profiles from an appropriate outfall water level. On steep gradients both inlet control and hydraulic grade line analysis shall be used and the more severe relevant condition adopted for design purposes. For pipe networks at MHs and other nodes, water levels computed at design flow shall not exceed finished ground level while allowing existing and future connections to function satisfactorily.

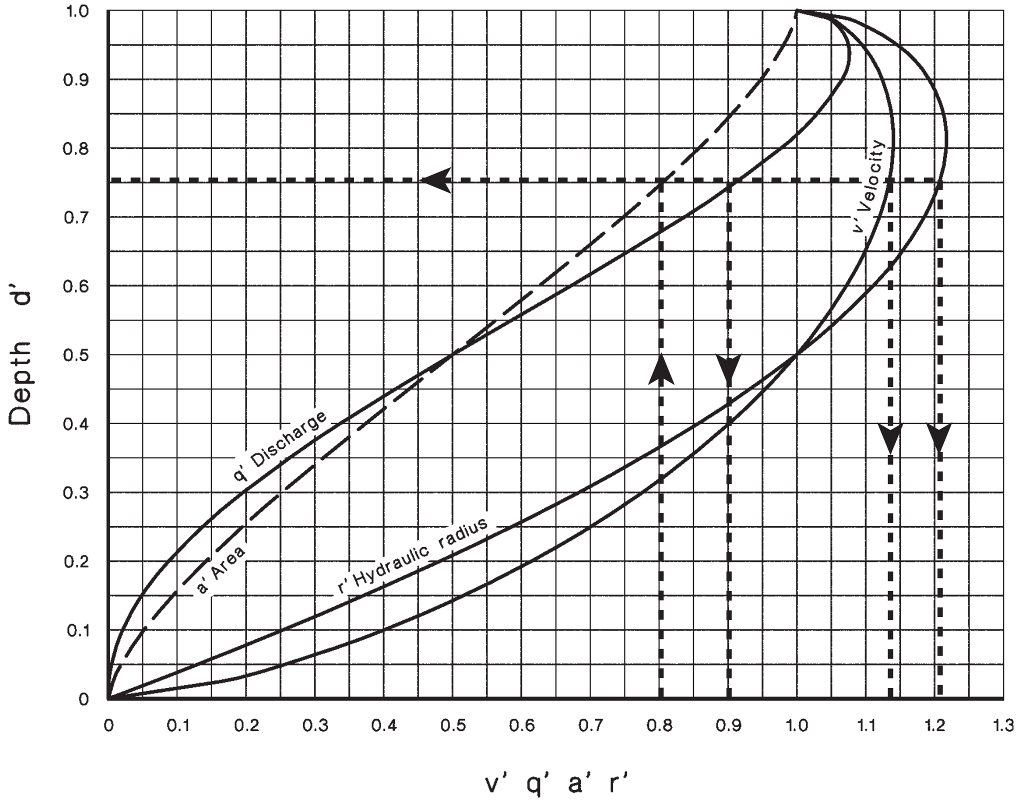
In principle, each step in the determination of a water surface profile involves calculating a water level upstream (h_2) for a given value of discharge and a given start water level downstream (h_1).

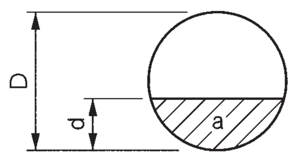
This can be represented as:

$$h_2 + V_2^2 / 2\,g = h_1 + V_1^2 / 2\,g + H_f + H_e$$

where V is velocity,

H_f is head loss due to boundary resistance within the reach (for pipes, unit head ➤





$$d' = \frac{d}{D} = \frac{\text{Actual depth}}{\text{Pipe diameter}}$$

$$v' = \frac{v}{V} = \frac{\text{Actual velocity}}{\text{Full pipe velocity}}$$

$$q' = \frac{q}{Q} = \frac{\text{Actual flow}}{\text{Full pipe flow}}$$

$$a' = \frac{a}{A} = \frac{\text{Area of liquid}}{\text{Area of pipe}}$$

$$r' = \frac{r}{R} = \frac{\text{Actual hydraulic radius}}{\text{Full pipe hydraulic radius}}$$

Example: With actual flow q known and pipe diameter D determine full pipe flow Q from pipe flow chart.

Say for	q′	=	0.80
Determine from graph	d′	=	0.75
	a′	=	0.90
	v′	=	1.13
	r′	=	1.21

Figure 4.1 – Part full pipe flow data

loss is read from Manning's flow charts, for example),

H_e is head loss within the reach due to changes in cross section and alignment (refer to table 4.3 for loss coefficients).

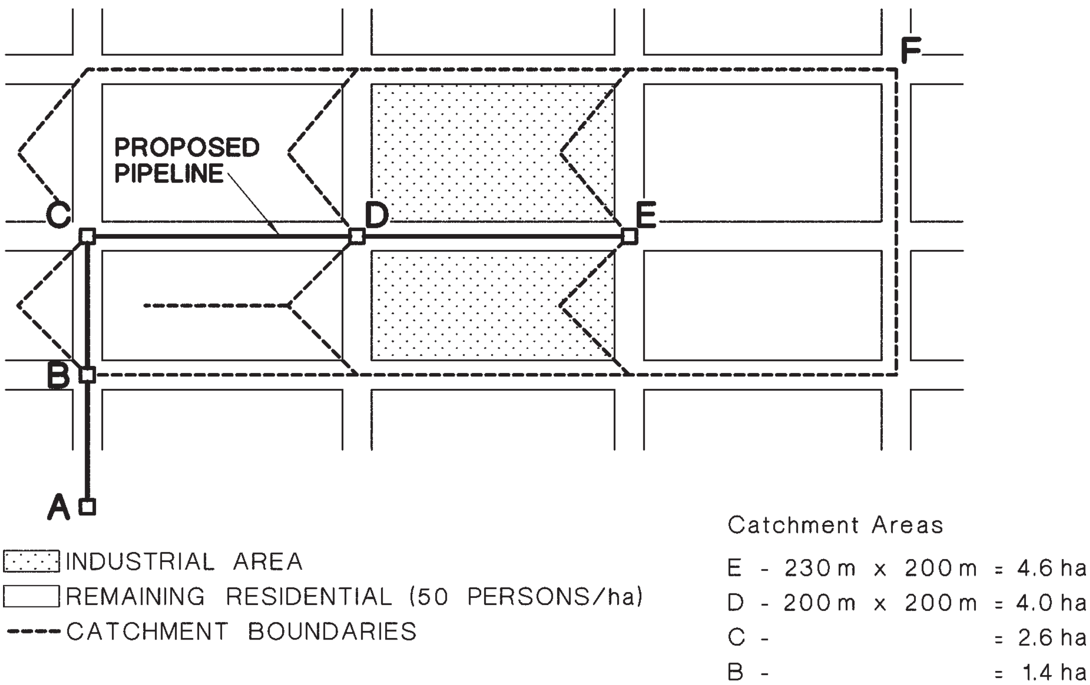
An example of stormwater system analysis including a backwater calculation is provided in figures 4.2, 4.3 and table 4.4.

C4.3.12.3.3

Note that stormwater pipelines generally operate in a surcharged condition at full design flow. Pipe diameters chosen on the basis of pipe flow graphs such as figure 4.1 of E1/VM1, using pipeline gradient rather than hydraulic grade line slope, are likely to be unnecessarily large for free outfall conditions.

Table 4.3 – Loss coefficients for bends

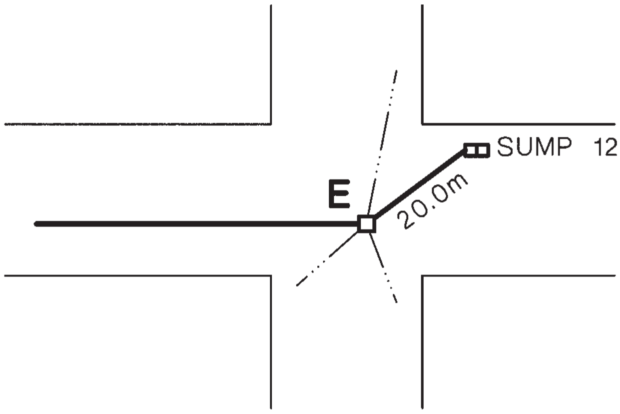
Bends	k
MH properly benched with radius of bend	
1.5 x pipe diameter	0.5 to 1.0
Bend angle	
90°	0.90
45°	0.60
22.5°	0.25



Time of concentration for the design storm T_c = 25 minutes

Rainfall intensity for the 5-year return period design storm i_5 = 32 mm/h

Figure 4.2 – Typical stormwater catchment



Assume Sump 12 serves 1.0 ha of total catchment E in figure 4.2

Check Sump 12 connection

$Q = 2.78\ C\ i\ A = 2.78 \times 0.25 \times 32 \times 1.0 = 22.2$ L/s

Where Q = runoff (L/s)
C = runoff coefficient
i = rainfall intensity (mm/hr)
A = catchment area (ha)

Try 225mm diameter pipe

Water level at Manhole E (table 4.4)	= 50.622 m
Friction head hf = 20 m x 1/260	= 0.077
Velocity generation head hv = $v^2/2g$	= 0.016
Pipe entry loss = $0.5\ v^2 / 2g$	= 0.008
Grating loss = $Q^2/30,000$	= 0.016
Total losses	= 0.117
Water level in side channel if sump drowned	= 50.622 m + 0.117
	= 50.739

Figure 4.3 – Sump to manhole connection

Table 4.4 – Backwater calculation for surcharged stormwater systems

(a) Node name	(b) Dist (m)	(c) Area (ha)	(d) Run-off coeft	(e) C.A (ha)	(f) ∑C.A (ha)	(g) Time of conc (min)	(h) Rainfall intensity (mm/h)	(i) Design flow (l/s)	(j) Pipe size (mm)	(k) Full pipe vel (m/s)	(l) Vel head (m)	(m) Lgth (m)	(n) Pipe slope (m/m)	(o) Loss coeft k	(p) Friction head loss (m)	(q) Node head loss (m)	(r) Water level (m)	(s) Total energy (m)	(t) Ground level (m)	(u) Remarks
F	900					15														
						+10						300								
MH E	600	4.6	0.25	1.15		25	32.0										50.622	50.643		
					1.15	+4		102	450	0.64	0.021	200	1/910		0.220					
MH D	400	4.0	0.40	1.60		29	29.5										50.402 50.390	50.423 50.423		Accelerating
					2.75	+3		226	600	0.80	0.033	200	1/900		0.222					
MH C	200	2.6	0.25	0.65		32	27.9							0.9		0.030	50.168 50.138	50.201 50.166		Decelerating 90° bend
					3.40	+1.5		264	675	0.74	0.028	100	1/1200		0.083					
MH B	100	1.4	0.25	0.35		33.5	27.2										50.055 50.055	50.083 50.076		Decelerating
					3.75			284	750	0.64	0.021	100	1/1800		0.055					
MH A	0																50.000	50.021		

Area sum **12.6**

Start water level 50.000

NOTE –

(1) k = entry, grating, bend or exit loss.

(2) Node head loss = $kV^2/2g$.

(3) See notes following on the use of this table.

Design storm return period: 5 years

Project name: Dead End Street

File: DES 007

Eng: GMW

Date: 8/04

Notes to table 4.4

(1) This method can be used to design pipelines which are submerged or surcharged or pipelines with some surcharged sections and some sections flowing part full, provided that appropriate losses are accounted for at the MHs. It is based on the principle of conservation of energy and the Bernoulii Equation. For the underlying theory, see any text book on Fluid Mechanics.

(2) Columns (b) to (i) are used to calculate the pipe flow using the Rational Method (see Verification Method E1/VM1).

Proceed downstream from F to MH A.

(3) Determine pipe size, velocity and pipe slope (hydraulic gradient) for columns (j), (k), and (n).

NOTE – This is an iterative process. Estimate pipe diameter and use a pipe flow nomograph such as figure 3 of E1/VM1 to determine velocity and gradient. Hint: Select Initial Pipe Diameter to give a velocity of around 1.0 m/s and a moderate gradient.

(4) Calculate the Friction Head Loss in metres over each pipeline length from the pipeline length column (m) and the pipe slope. Include these losses in column (p).

NOTE – The hydraulic gradient or pipe gradient determined from any pipe flow nomograph is the gradient required to drive the water through the pipeline at the given velocity and pipe diameter. Where the pipeline is submerged, this is approximately the gradient of the water surface between the upstream and downstream MHs.

(5) Determine a downstream water level. This could be a pond or river water level or, in the absence of any information on water levels in downstream systems, the soffit of the existing pipeline.

Where the new outfall discharges as a free outfall above any downstream water levels, use the soffit of the new pipe at the outfall. In this case a static water level of 50.00 m has been used at MH A with the pipe soffit below the water level.

(6) In column (u), note whether the flow is accelerating or decelerating downstream.

For properly benched, straight-through MHs:

(a) Where flow is accelerating, assume the total energy is constant across the MH (i.e. no energy loss);

(b) Where flow is decelerating, assume the water level is constant across the MH (i.e. energy loss equals the difference in upstream and downstream velocity heads).

NOTE – For poorly benched MHs, an additional allowance based on a loss factor K of between 0.5 and 1.0 should be made. An additional allowance should also be made for bends in a MH (see table 4.3).

(7) Calculate water levels and total energy levels at the inlet and outlet to each manhole. See examples in columns (r) and (s). Proceed upstream from MH A to MH E.

(8) Check that the water levels at all MHs are below ground level and sufficiently low to enable branch lines to function. If the levels require adjustment, re-work the calculation by selecting a more appropriate pipe diameter.

(9) Calculate the pipe invert levels. The pipe gradients do not need to be the same as the hydraulic gradients. Under peak flow conditions with a submerged (surcharged) pipeline, the flow velocities can be below self-cleansing velocities provided the pipe has a gradient sufficient to give a velocity of about 0.6 m/s when the pipe is flowing partly full in minor storms.

4.3.12.3.4 *Outfall water levels*

The TA will provide the start water level at the point of connection to the public stormwater system.

When a tributary drain or a waterway flows into a much larger drain or a much larger waterway, the peak flows generally do not coincide. Backwater profiles should produce satisfactory water levels when assessed as follows:

(a) Set the tributary AEP;

(b) Determine the tributary design duration D;

(c) For duration D and AEP determine tributary catchment run-off Q_{trib};

(d) Determine receiving waterway peak water level at AEP in (a) above;

(e) Starting with the level from (d) above determine the tributary water profile at a flow of 75 % of Q_{trib};

(f) Determine the receiving waterway mean annual flood water level;

(g) Starting with the level from (f) above determine tributary water profile at flow Q_{trib};

(h) Select the higher of the two profiles determined for design purposes.

Similarly, for tidal outfalls, peak flow may or may not coincide with extreme high tide levels. A full dynamic analysis and probability assessment may be necessary.

Alternatively, consideration of the following two scenarios may be sufficient:

(i) An outfall water level of mean high water for peak design flow conditions; and/or

(ii) A 10 % AEP extreme high tide outfall water level for half peak design flow conditions.

In addition, sea level rise should be considered and a precautionary design approach adopted.

4.3.12.4 *Manholes*

4.3.12.4.1 *Hydraulic flow in manholes*

In addition to the normal pipeline gradient all MHs shall have a minimum drop of 30 mm within the MH. MHs on pipelines greater than 1000 mm diameter shall have the drop through the MH designed to compensate for the energy lost due to the flow through the MH.

Refer to 5.3.6.4.4 of this Standard for further guidance.

4.3.12.4.2 *Angle of connection*

Minor pipelines connecting to a MH at or below design water level in the MH shall do so at an angle of not greater than 90^{o} to the main pipeline direction of inflow.

Minor pipelines connecting at above design water level may do so at any angle.

4.3.12.5 *Waterways*

4.3.12.5.1 *Manning's ‘n’*

Waterway capacity shall be determined from Manning’s formula (refer to E1/VM1). Conservatively high values of Manning’s ‘n’ should be selected from table 3, E1/VM1 reproduced as table 4.5 to provide a generous cross section area which allows for the flow resistance effects of margin and bank plants retained or provided for amenity and ecological benefits.

C4.3.12.5.1

Refer to “Roughness Characteristics of New Zealand Rivers” by D.M. Hicks and P.D. Mason (1991) for further guidance on the selection of Manning’s ‘n’ values. This handbook emphasizes that the Manning’s ‘n’ values can vary significantly with flow and the selected value should be based on the graphs of Manning’s ‘n’ versus discharge presented for each site.

4.3.12.6 *Outlets*

Where pipes discharge onto land or into a waterway outlet, structures shall be designed to dissipate energy and minimize erosion or land instability. The design shall ensure non-scouring velocities at the point of discharge. Acceptable outlet velocities will depend on soil conditions, but should not exceed 2 m/s without specific provision for energy dissipation and velocity reduction.

4.3.12.7 *Stormwater quality control*

A 75 % contaminant removal efficiency is recommended as a best practicable option (BPO) for stormwater treatment devices.

For small, impervious catchments (e.g., supermarket car parks) a high proportion of contaminant accumulated between storms is discharged early in the run-off hydrograph (i.e. the first flush).

Stormwater treatment devices which capture at least the first 10 mm to 15 mm of run-off (depending on local climate) are acceptable as a BPO.

Design in accordance with ARC Technical Publication No. 10 *Stormwater treatment devices* is recommended.

4.3.12.8 *Subsoil drains*

In the absence of any other more appropriate criterion the design flow for subsoil drainage systems shall be based on a drainage standard of 1 mm/ h (2.78 L/s / ha).

Refer to manufacturer's literature for information on pipe materials, filter fabrics, bedding and filter design.

4.4 Construction

4.4.1 *Construction standard specifications*

Many TAs have their own construction standard specifications which shall be referred to.

4.4.2 *Pipeline construction*

The construction of pipelines shall be carried out in accordance with the requirements of NZS 7643 and NZS/AS 2033.

Table 4.5 – Manning's 'n'

Description	Value of 'n'
Circular pipes	
HDPE and PVC	0.011
Ceramic and concrete	0.013
Culverts	
Cast *in situ* concrete	0.015
Corrugated metal	0.025
Open stream	
Straight uniform channel in earth and gravel in good condition	0.0225
Unlined channel in earth and gravel with some bends and in fair condition	0.025
Channel with rough stoney bed or with weeds on earth bank and natural streams with clean straight banks	0.030
Winding natural streams with generally clean bed but with some pools and shoals	0.035
Winding natural streams with irregular cross section and some obstruction with vegetation and debris	0.045
Irregular natural stream with obstruction from vegetation and debris	0.060
Very weedy irregular winding stream obstructed with significant overgrown vegetation and debris	0.100

4.4.3 *Trenching*

Refer to E1/AS1 "Bedding and backfilling" and Appendix A drawings CM-001 and CM-002 for guidance.

Where a pipeline is to be constructed through areas with unsuitable foundations such material shall be removed and replaced with other approved material or alternatively, other methods of construction shall be carried out to the approval of the TA to provide an adequate foundation for the pipeline.

4.4.4 *Reinstatement*

Areas where works have taken place shall be reinstated to a condition not worse than before the works commenced. Developers affected by the works shall give written approval of their satisfaction with the reinstatement works.

4.4.5 *Earthworks, erosion and sediment control*

Refer to 2.5 and 2.6 in Part 2 of this Standard.

Guidance is also provided in ARC Technical Publication No. 90 *Erosion and sediment control: guidelines for land disturbing activities in the Auckland Region* (1999).

Earthworks shall not be carried out during the winter months without specific TA approval.

4.4.6 *Testing*

Stormwater pipelines should be tested for leaks and pass one of the three drain leakage tests described in E1/VM1. The low pressure air test is the preferred test.

Pipeline inspection and recording by CCTV is recommended.

Part 5: WASTEWATER

Table

Figure

5 WASTEWATER

5.1 Scope

Based on WSA 02 – Sewerage Code of Australia, this Part of the Standard sets out requirements for the design of wastewater systems up to and including DN 300 (nominal diameter 300 mm) or DN 355 mm for PE (polyethylene). This Standard covers wastewater services for both new developments and re-development areas. For pipes larger than DN 300 refer to WSA 02 or the requirements of the TA.

If the scope of the development is sufficiently large to include its own pumping station, then reference should be made to WSA 04 – Sewage Pumping Station Code of Australia.

5.2 General

5.2.1 *Objectives*

The objectives of the design are to ensure that the wastewater system is functional and complies with the requirements of the TA's wastewater systems.

In principle the wastewater system shall provide:

(a) A single gravity connection for each property;

(b) A level of service to the TA's customers in accordance with the authority's policies;

(c) Minimal adverse environmental and community impact;

(d) Compliance with environmental requirements;

(e) Compliance with statutory OSH requirements;

(f) Adequate hydraulic capacity to service the full catchment;

(g) Long service life with minimal maintenance and least life cycle cost;

(h) Zero level of pipeline infiltration on commissioning of pipes;

(i) Low level of pipeline infiltration/exfiltration over the life of the system;

(j) Resistance to entry of tree roots;

(k) Resistance to internal and external corrosion and chemical degradation;

(l) Structural strength to resist applied loads; and

(m) "Whole of life" costs that are acceptable to the TA.

5.2.2 *Referenced documents and relevant guidelines*

Wastewater designs shall incorporate all the special requirements of the TA and shall be in accordance with the most appropriate Standards, Codes and Guidelines including those set out in Referenced Documents and in Appendix D.

5.3 Design

All wastewater systems shall be designed for an asset life of at least 100 years. Some components such as pumps, valves and control equipment may require earlier renovation or replacement. Refer to WSA 02 for the classification of life expectancy for various components.

5.3.1 *Design responsibilities*

5.3.1.1 *High level structure plan*

The TA may provide a high level structure plan setting out certain information to be used in design, such as flows, sizing, upstream controls, recommended pipe layout, or particular requirements of the TA. Where a high level structure plan is not provided, the designer shall determine this information by investigation using this Standard and engineering principles.

5.3.1.2 *Catchment design*

Pipes within any project area shall be designed to be consistent with the optimum design for the entire catchment area and any future extension of the system shall be accommodated. This may affect the pipe location, diameter, depth and maintenance structure location and layout. Designers shall particularly assess the depth of the proposed works, adopting the best design practice to ensure a system with lowest life cycle cost.

Pipes shall be designed with sufficient depth and capacity to cater for all existing and possible development of the catchment. Where future extension of the pipe is possible, it may be necessary to carry out preliminary designs for large areas of subdivided and unsubdivided land. This design shall use safety factors defined by the TA for hypothetical subdivision and service for layouts to determine the necessary depth and diameter for an extension.

5.3.1.3 *Extent of works*

Where pipes are to be extended in the future, the ends of pipes shall extend past the far boundary of the development by a distance equivalent to the depth to invert and be capped off, unless otherwise agreed to by the TA. This ensures that a future extension of the pipe does not require unnecessary excavation within lots or streetscapes already developed.

5.3.1.4 *Topographical considerations*

In steep terrain the location of pipes is governed by topography. Gravity pipelines operating against natural fall create a need for deep installations which can be very expensive. The pipe layout shall conform to natural fall as far as possible.

5.3.1.5 *Geotechnical investigations*

The designer shall take into account any geotechnical requirements determined under Part 2 of this Standard.

5.3.2 *Design of the wastewater system*

5.3.2.1 *Prime considerations*

The pipe shall be designed to:

(a) Have adequate capacity, grades and diameters;

(b) Have adequate grade for self-cleaning;

(c) Be deep enough to provide gravity service to all lots;

(d) Comply with minimum depth requirements to ensure mechanical protection and safety from excavation;

(e) Avoid all underground services, whilst maintaining all the necessary clearances; and

(f) Allow for various drops and losses through MHs.

Pipes within private property shall be laid at sufficient depth to avoid interference with land drains and gardening activities.

5.3.2.2 *Scheme layout*

The preferred layout/location of pipes within roads, public reserves and private property may vary and will be dictated by the requirements of each TA.

Pipes should be positioned as follows:

(a) Within the street according to the locally applicable utilities allocation code. In the absence of a code, a location clear of carriageways is preferred;

(b) Within public land with the permission of the controlling authority;

(c) Within drainage reserves outside the 1 in 100 year flood area;

(d) Within private property parallel to front, rear and/or side boundaries.

5.3.2.3 *Pipes in road and drainage reserves and public open space*

Pipes in road and drainage reserves and public open space shall be located in accordance with the TA's requirements.

Crossings of roads, railway lines, creeks, drains and underground services shall, as far as practicable, be at right angles.

5.3.2.4 *Pipes in private property*

Where pipes are designed to traverse any vacant or occupied public or private properties, the design shall as far as practicable allow for possible future building plans, preclude maintenance structures and specify physical protection of the pipe within or adjacent to the normal building areas and all engineering features (existing or likely) on the site e.g. retaining walls.

The design shall allow access for all equipment required for construction and future maintenance. Except where obstructions and/or topography dictate otherwise, pipes shall run parallel to boundaries at minimum offsets of 1.0 m.

Where pipes are designed to traverse properties containing existing structures e.g. retaining walls, buildings and swimming pools, the current and future stability of the structure shall be considered. Pipes adjacent to existing buildings and structures shall be located clear of the "zone of influence" of the foundations. If this is not possible, protection of the pipe and associated structures shall be specified for evaluation and approval by the TA.

5.3.2.5 *Horizontal curves*

The term "curved pipes" is used to describe either cold bending of flexible pipe during installation and/or small deflections at joints for rubber ring jointed flexible and rigid pipes. Curved alignments are used in curved streets to conform with other services and to negotiate obstructions, particularly in easements. The use of curves in locations other than curved street alignments shall be justified by significant savings in life cycle cost. The straight line pipe is usually preferred as it is easier and cheaper to set out, construct, locate and maintain in the future.

Curved pipes shall only be used where allowed by the TA. Acceptable design standards for curved pipes can be found in WSA 02.

5.3.2.6 *Vertical curves*

Vertical curves may be specified where circumstances provide a significant saving or where maintenance structures would be unsuitable or inconvenient. The curvature limitations for vertical curves are the same as those for horizontal curves in 5.3.2.5.

5.3.2.7 *Maintenance structure location*

Maintenance structures include:

(a) Manholes (or maintenance holes) (MH);

(b) Maintenance shafts (MS); and

(c) Terminal maintenance shafts (TMS).

The selection of a suitable location for maintenance structures may influence the pipe alignment. Generally, a minimum clearance of 1.0 m should be provided around maintenance structures clear of the opening to facilitate maintenance and rescue. The TA may determine other specific requirements subject to the individual site characteristics.

Maintenance structures shall be located:

(i) Where long term, safe access is available;

(ii) Clear of floodways, stormwater detention areas, stormwater secondary flow paths and inter-tidal regions.

5.3.2.8 *Underground services*

The location of underground services affecting the proposed pipe alignment shall be determined. Where pipes will cross other services, the depth of those services shall be investigated, and exposed where necessary. Services upstream of the project area may affect the design. A future extension of the pipe that will cross existing and proposed upstream services may determine the level for the current project infrastructure.

5.3.3 *Clearances*

5.3.3.1 *Clearance from underground services*

Where a pipe is designed to be located in a road which contains other services, the clearance between the pipe and the other services shall comply with SNZ HB 2002, unless the TA has its own specific requirements.

For normal trenching and trenchless technology installation, clearance from other service utility assets shall not be less than the minimum vertical and horizontal clearances shown in table 5.1. Written agreement on reduced clearances and clearances for shared trenching shall be obtained from the TA and the relevant service owner.

5.3.3.2 *Clearance from structures*

Pipes adjacent to existing buildings and structures shall be located clear of the "zone of influence" of the building foundations. If this is not possible, a specific design shall be undertaken to cover the following:

(a) Protection of the pipeline;

(b) Long term maintenance access for the pipeline; and

(c) Protection of the existing structure or building.

The protection shall be specified by the designer for evaluation and acceptance by the TA.

5.3.4 *Easements*

Refer to 4.3.9 for requirements relating to easements.

Table 5.1 – Clearances between wastewater pipes and other underground services

Utility (Existing service)	Minimum horizontal clearance for new pipe size $\leq$DN 300	Minimum vertical clearance$^{(1)}$ (mm)
Gas mains	300$^{(2)}$	150
Telecommunication conduits and cables	300$^{(2)}$	150
Electricity conduits and cables	500	225
Drains	300$^{(2)}$	150
Water mains	1000$^{(3)}$/600	500

NOTE –

(1) Vertical clearances apply when wastewater pipes cross one another, except in the case of water mains when a vertical separation shall always be maintained, even when the wastewater pipe and water main are parallel. The wastewater pipe should always be located below the water main to minimize the possibility of backflow contamination in the event of a main break.

(2) Clearances can be further reduced to 150 mm for distances up to 2 m when passing installations such as poles, pits and small structures, providing the structure is not destabilized in the process.

(3) When the wastewater pipe is at the minimum vertical clearance below the water main (500 mm) maintain a minimum horizontal clearance of 1000 mm. This minimum horizontal clearance can be progressively reduced to 600 mm as the vertical clearance increases to 750 mm.

5.3.5 *Pipe size and gradient*

Pipe size shall be based on the need to transport the design flow without surcharging.

5.3.5.1 *Design flow*

The design flow comprises domestic wastewater, industrial wastewater, infiltration and direct ingress of stormwater.

The design flow shall be calculated by the method nominated by the TA. In the absence of information from the TA the following design parameters are recommended:

(a) Residential flows

(i) Average dry weather flow of 180 to 250 litres per day per person

(ii) Dry weather diurnal PF of 2.5

(iii) Dilution/infiltration factor of 2 for wet weather

(iv) Number of people per dwelling 2.5 to 3.5.

> ***C5.3.5.1(a)***
> *For small contributing catchments, PFs can be significantly higher but, due to the requirement for a minimum pipe size of DN150, such flows will not govern the design.*

(b) Industrial/commercial flows

Where flows from a particular industry or commercial development are known they should be used as the basis of design.

Where there is no specific flow information available and the TA has no design guide, table 5.2 is recommended as a design basis.

These flows include both sanitary wastewater and trade wastes and include peaking factors.

5.3.5.2 *Hydraulic design of pipelines*

The hydraulic design of wastewater pipes should be based on either the Colebrook-White formula or the Manning formula.

The coefficients to be applied to the various materials are shown in table 5.3.

5.3.5.3 *Minimum pipe sizes*

Irrespective of other requirements, the minimum sizes of property connection and reticulation pipes shall be not less than those shown in table 5.4.

> ***C5.3.5.3***
> *For infill situations, particularly where upgrading of existing DN 100 connections in sound condition and at reasonable grades would be impractical, it is common practice for up to six dwelling units to utilize the existing connection. However, such connections would not normally be taken over as public pipes by the TA.*

Table 5.2 – Industrial/commercial flows

Industry type (Water usage)	Design flow (Litre/second/hectare)
Light	0.4
Medium	0.7
Heavy	1.3

Table 5.3 – Coefficients for gravity lines

Material	Colebrook-White coefficient K(mm)	Manning roughness coefficient (n)
VC	1.5	0.013
PVC	0.6	0.011
PE	0.6	0.011
GRP	0.6	0.011
Cement lining	1.5	0.012
PE or epoxy lining	0.6	0.011

NOTE –

(1) These values take into account possible effects of rubber ring joints, slime, debris etc.

(2) The n and K values apply for pipes up to DN 300.

Table 5.4 – Minimum pipe sizes for wastewater reticulation and property connections

Pipe	Minimum size DN
Connection servicing 1 dwelling unit	100
Connection servicing more than 1 dwelling unit	150
Connection servicing commercial and industrial lots	150
Reticulation servicing residential lots	150

5.3.5.4 *Limitation on pipe size reduction*

In no circumstances shall the pipe size be reduced on any downstream section.

5.3.5.5 *Minimum grades for self-cleaning*

Self-cleaning of grit and debris shall be achieved by providing minimum grades specified in tables 5.5 and 5.6.

C5.3.5.5

In practical terms, in a catchment not exceeding 250 dwelling units, and where no pumping station is involved, DN 150 pipes laid within the limits of table 5.4 will be adequate without specific hydraulic design.

Table 5.5 – Minimum grades for wastewater pipes

Pipe size DN	Absolute minimum grade (%)
150	0.55
225	0.33
300	0.25

Table 5.6 – Minimum grades for property connections and permanent ends

Situation	Minimum grade (%)
DN 100 property connections	1.65
DN 150 property connections	1.20
Permanent upstream ends of DN 150, 225 and 300 pipes in residential areas with population ≤20 persons	1.00

5.3.5.6 *Maximum velocity*

The preferred maximum velocity for peak wet weather flow is 3.0 m/s. Where a steep grade that will cause a velocity greater than 3.0 m/s is unavoidable see WSA 02 for precautions and design procedures.

5.3.5.7 *Minimum cover*

Refer to 4.3.3.6.

5.3.6 *Maintenance structures*

5.3.6.1 *General*

This section describes the requirements for structures which permit access to the wastewater system for maintenance. These are categorized as:

(a) MHs;

(b) MSs; and

(c) TMSs (also known as inspection shafts or rodding points).

5.3.6.2 *Location of maintenance structures*

The design shall include maintenance structures at the following locations:

(a) Intersection of pipes except for junctions between mains and property connections;

(b) Changes of pipe size;

(c) Changes of pipe direction, except where horizontal curves are used;

(d) Changes of pipe grade, except where vertical curves are used;

(e) Combined changes of pipe direction and grade, except where compound curves are used;

(f) Changes of pipe invert level;

(g) Changes of pipe material, except for repair/maintenance locations;

(h) Permanent or temporary ends of a pipe;

(i) Discharge of a pressure main into a gravity pipe.

Table 5.7 summarizes maintenance structure options for wastewater reticulation.

Table 5.7 – Acceptable MH, MS and TMS options for wastewater reticulation

Application	**Acceptable options**[1]		
	MH	MS	TMS
Intersection of pipes[2]	YES	NO	NO
Change of pipe grade at same level	YES	YES for DN 150 pipe only and using vertical bend	NO
Change of grade at different level	YES MH with internal/external drops	NO	NO
Change in pipe size	YES MH is the only option	NO	NO
Change in horizontal direction	YES within permissible deflection at MH	YES MS prefabricated units or MS used with horizontal bends of max 33^{o} deflection	YES for DN 150 pipe only
Change of pipe material	YES	NO	NO
Permanent end of a main[3]	YES	YES	YES
Pressure main discharge point	YES MH is the only option and must include a vent	NO	NO

NOTE –

(1) Where personnel entry is required down to the level of the pipe, a MH is the only option.

(2) This table refers to reticulation mains. DN 100 connections can be made to any maintenance structure or, using a proprietary junction, at any point along the main.

(3) Some TAs permit the use of London Junction or Rodding Eye at the end of the main, but it is recommended that TMSs are used.

5.3.6.3 *Maintenance structure spacing*

For reticulation pipes, the maximum distance between any two consecutive maintenance structures shall be 120 m.

At the permanent end of a wastewater main, the distance from the end maintenance structure to the nearest downstream MH shall not exceed 240 m (see figure 5.1).

Where a combination of MHs and MSs is used along the same pipe, the maximum spacing between any two consecutive MHs shall not exceed 400 m irrespective of how many MSs are used between the two MHs (see figure 5.2).

5.3.6.4 *Manholes*

5.3.6.4.1 *Base layout*

Each MH base shall have:

(a) One minimum standing area of 350 mm x 350 mm or of 350 mm diameter (where the ladder or step irons are located), and a second minimum width standing area of 250 mm x 250 mm or of 250 mm in diameter, as shown in Appendix A drawing CM-004;

(b) A minimum working space of 750 mm clear of drop pipes, ladders, step irons, etc; and

(c) Channels with a minimum inside channel wall radius of 300 mm (in plan).

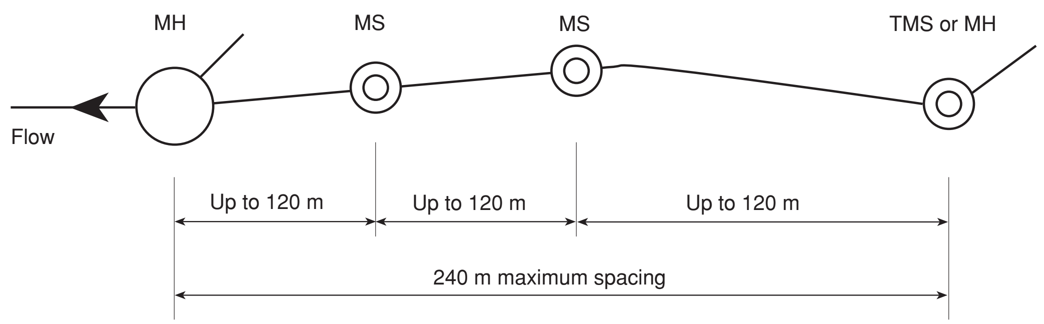


Figure 5.1 – Multiple MSs between MH and "last" MH/TMS

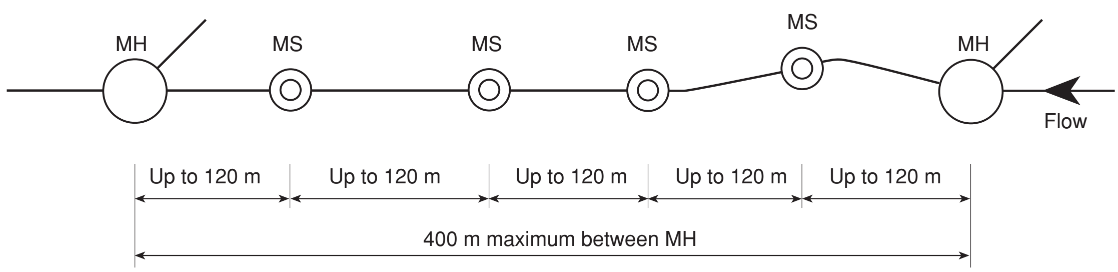


Figure 5.2 – Multiple MSs between consecutive MHs

5.3.6.4.2 *Allowable deflection through MHs*

A maximum allowable deflection through a MH shall comply with table 5.8.

5.3.6.4.3 *Internal falls through MHs*

The minimum internal fall through a MH shall comply with table 5.9.

Where the outlet diameter at a MH is greater than the inlet diameter, the minimum fall through the MH shall be not less than the difference in diameter of the two pipes, in which case the pipes shall be aligned soffit to soffit.

On pipes where the internal fall across the base of the MH is not achievable due to a large difference between the levels of incoming and outgoing pipes (see Appendix A drawing CM-005), then internal or external drops shall be provided.

Table 5.8 – Maximum allowable deflections through MHs

Pipe size DN	**Maximum deflection** Degrees (°)
150 – 300	Up to 120° for internal fall along MH channel – Refer to table 5.9
150 – 300	Up to 150° where there is a large fall at MH using an internal or external drop structure

Table 5.9 – Minimum internal fall through MH joining pipes of same diameter

Deflection angle at MH Degrees (°)	**Minimum internal fall** (mm)
0 to 30	30
>30 to 60	50
>60 to 120	80

5.3.6.4.4 *Effect of steep grades on MHs*

Where a pipe of grade >7 % drains to a MH, the following precautions shall be taken:

(a) No change of grade is permitted at inlet to a MH;

(b) Steep grades are to be continuous through the MH at the same grade;

(c) Depth of MH is to exceed 1.5 m to invert for DN 150 and DN 225 pipes;

(d) Depth of MH is to exceed 2.0 m deep for DN 300 pipes;

(e) Change of direction at the MH is not to exceed 45°;

(f) No drop junctions or verticals are to be incorporated in the MH;

(g) Inside radius of channel inside the MH is to be greater than 6 times the pipe diameter; and

(h) Benching is to be taken 150 mm above the top of the inlet pipe.

To avoid excessively deep channels within MHs, steep grades (>7 %) shall be "graded-out" at the design phase where practicable.

Grading the channel of the MH shall be limited to falls through MHs of up to 0.15 m. Where the depth of the channel within the MH would be greater than 2 x pipe diameter, then an internal or external drop structure shall be provided.

> ***C5.3.6.4.4***
> *For further guidance on handling steep grades, see WSA 02.*

5.3.6.4.5 *Flotation*

In areas of high water table, all MHs shall be designed to provide a factor of safety against flotation of 1.25.

5.3.6.4.6 *Access*

See 4.3.4.6.

5.3.6.4.7 *Covers*

Watertight MH covers with a minimum clear opening of 600 mm in diameter, complying with AS 3996, shall be used, unless the TA has an alternative standard. AS 3996 gives direction for the class of cover for particular locations and applications. (See Appendix A drawing CM-004.)

> ***C5.3.6.4.7***
> *For OSH reasons the 600 mm diameter MH cover is recommended.*

5.3.6.4.8 *Bolt-down covers*

Where required by the TA, bolt-down metal access covers (watertight type) shall be specified on MHs:

(a) In systems where the possibility of surcharge exists; and

(b) Along creeks subject to flooding above the level of the cover, in tidal areas, or in any location where surface waters could inundate the top of a MH.

The top of MHs in areas subject to flooding shall be 300 mm above the 1 in 100 year flood level or as specified by the TA. Where this is not practicable, bolt-down access covers shall be specified. It will also be necessary to specify the tying together of MH components where bolt-down covers are specified and precast components are used.

5.3.6.5 *Maintenance shafts (MSs)*

Where MSs have been approved by the TA, and where it is expected that human access below ground will not be required, MSs can be used on DN 150 and DN 225 pipes as an alternative to MHs, providing 5.3.6.5.1 and 5.3.6.5.2 are satisfied. Refer to Appendix A drawings WW-001, WW-003 and WW-004.

Typical MS configurations are:

(a) Straight through MSs; and

(b) Angled MSs – see 5.3.6.5.2 (a).

MSs can also be used in conjunction with a TMS (see 5.3.6.6).

5.3.6.5.1 *Limiting conditions*

The following conditions apply to the use of MSs:

(a) MSs shall only be used on DN 150 and DN 225 pipes;

(b) MSs shall not be used instead of MHs at junctions;

(c) Depth of MSs shall:

- (i) Be within the allowable depth limit for the particular pipeline system
- (ii) Not exceed the MS manufacturer's stated allowable depth limit and
- (iii) Be within the depth limit imposed by the TA;

(d) MSs shall be restricted to pipeline gradients and depths where the deviation from vertical of the MS riser shaft (i.e. projected centreline of base to centreline at surface) is a maximum of 0.3 m measured at the surface;

(e) MSs shall not be used at discharge points of pumping mains.

5.3.6.5.2 *Design parameters*

MSs shall only be used at the design locations detailed in figures 5.1 and 5.2.

(a) Directional and gradient changes at MSs shall be achieved by using either:

- (i) Close-coupled horizontal and/or vertical manufactured bends immediately adjacent to the MS (maximum horizontal deviation of 33^o), or

- (ii) MS units specially manufactured with internal horizontal and/or vertical angles to suit design requirements. Maximum horizontal deviation of 90^o;

(b) MSs at changes of grade shall be located on the pipe with the lesser of the two gradients to minimize the deviation from the vertical of the riser shaft;

(c) Straight through type and angled MSs can incorporate up to two higher level property connections discharging directly into the riser shaft.

For construction details refer to Appendix A drawings WW-003 and WW-004.

5.3.6.6 *Terminal maintenance shafts (TMSs)*

Where TMSs have been authorized by the TA and where it is expected that human access below ground will not be required, TMSs may be used on DN 150 and DN 225 pipes as an alternative to MHs, providing the conditions detailed in this Standard are satisfied.

For construction details refer to Appendix A drawing WW-005.

5.3.6.6.1 *Design parameters*

A TMS may only be used as a terminating structure under the following conditions:

(a) At the permanent end of a wastewater pipe;

(b) On DN 150 and DN 225 pipes;

(c) After the last MH (with no intermediate MS) provided it is spaced no further than 150 m from that MH, as shown in figure 5.1;

(d) After an intermediate MS, as shown in figure 5.2;

(e) Subject to the limiting conditions detailed in 5.3.6.5.1.

5.3.6.6.2 *Property connections into a permanent end*

TMSs may incorporate a maximum of two higher level property connection branches discharging directly into the riser shaft. Where a property connection is required directly ahead of the permanent end of the pipe (e.g. connection at the end of a cul de sac), a MS may be used in lieu of a TMS to accommodate the straight through connection. In such a case, a DN 100 connection will require a reducer immediately adjacent to the MS.

5.3.6.6.3 *Dead ends*

Pipes need not terminate at a MH, MS or TMS if the pipe is to be extended in the future (see 5.3.1.3).

5.3.7 *Venting*

In urban developments, pipes will normally be adequately ventilated within private property drainage. However, there are some situations where vent shafts will be required such as:

(a) At pumping stations; and

(b) At MHs where pumping stations discharge to a gravity pipe.

In such situations vent shafts shall be installed as per the requirements of WSA 02 and WSA 04.

5.3.8 *Structural design*

5.3.8.1 *Pipeline materials*

Pipeline materials and jointing methods shall be selected and specified for the location to ensure:

(a) Structural adequacy;

(b) Compatibility with potentially chemically aggressive flows in the wastewater or contaminated ground (if applicable); and

(c) Suitability for the geological conditions.

All materials used in the construction of wastewater systems shall be approved by the TA.

The pipe materials commonly used by TAs for gravity reticulation systems (up to DN 300) are set out in 4.3.3.2.

5.3.8.2 *Structural computations*

Pipeline structures shall be designed to resist structural failure under service conditions that are outside the conditions on the Standard Drawings. The selection of the appropriate pipe, type, class and embedment, combined with correct installation practice, is necessary to achieve this.

For flexible pipelines, failure includes excessive short term or long term deflection as defined by AS/NZS 2566.1 and AS/NZS 2566.2.

Structural computations shall be performed in accordance with AS/NZS 2566.1 (flexible pipe material) or AS 4060 (vitrified clay pipe).

5.3.8.3 *Foundation design and groundwater control*

The designer shall consider whether special precautions are necessary against difficult geological and foundation conditions.

If the predicted foundation conditions and/or the predicted groundwater conditions (present or likely to occur) do not call for special design details or construction practices, then the designer shall state this on the design drawings. However, if foundation treatments are necessary, and/or groundwater conditions affect either the design or construction of the wastewater system, then the designer shall indicate the following on the design drawings:

(a) The extent, and all design details of, any special foundation treatments required for the pipes and other structures;

(b) The extent, and all design details of, any special methods necessary to control groundwater flow along the pipe embedment and/or trench backfill material e.g. bulkheads;

(c) All sections of the wastewater system where the constructor will need to pay particular attention to controlling groundwater prior to excavation to prevent heave or loss of density in the trench floor material (e.g. “boiling” sand);

(d) Areas subject to subsidence;

(e) Other geotechnical considerations, e.g. “zone of influence” near structures.

5.3.8.4 *Near-horizontal bores*

Near-horizontal boreholes may be used to facilitate the economic installation of pipes, usually in difficult areas such as under railway lines or highways or to avoid environmentally sensitive areas. Boreholes may also be suitable for applications such as catchment consolidation and wastewater pumping station elimination.

For design guidelines and tolerances, refer to WSA 02.

5.3.8.5 *Bulkheads*

See 4.3.3.14.

5.3.9 *Connections*

Connections link private drainage to the public main or other approved outlet point. Private drainage extends through to the public system, except where the TA accepts responsibility for that part of the pipe outside private property.

5.3.9.1 *General considerations*

The property connection should be designed to suit the existing situation and any future development.

> ***C5.3.9.1***
> *Where practicable, pipes shall be designed to provide a service for the whole of the property they serve. Where, for physical reasons, it is not practical to fully service a property, a partial service may be acceptable to the TA.*

5.3.9.2 *Requirements of design*

The design shall specify the requirements for the property connections including:

(a) Plan location and lot contours;

(b) Invert level at property boundary or junction with the main as applicable.

5.3.9.3 *Number of connections*

It is normal practice to provide one connection per lot. Provision of additional connections shall be subject to justification by the developer and approval by the TA.

For multiple occupancies (unit title, cross lease or company lease), service of the whole property is normally achieved by providing a single point of connection to a TA system. Connection of the individual units is by joint service pipes owned and maintained by the body corporate, tenants in common or the company as the case may require. In this instance the whole of the multiple occupancy shall be regarded as a single lot.

Alternatively, if authorized by the TA, developers have the option of providing wastewater facilities to the individual titles or tenements in new developments by:

(a) Constructing individual connections which shall be owned and maintained by the body corporate, tenants in common or the company; or

(b) Extending the public line into the lot and providing a separate connection to each unit.

5.3.9.4 *Location of connection*

The connection shall be located to service the lowest practical point on the property and where possible:

(a) Be clear of obstructions, e.g. tree, tree roots, paved areas;

(b) Be easily accessible for future maintenance;

(c) Be clear of any known future developments, e.g. swimming pools or driveways;

(d) Avoid unnecessarily deep excavation >1.5 m where practicable.

5.3.9.5 *Connection depth*

Connection depths shall be set to drain the whole serviced area recognizing the following factors:

(a) Surface level at plumbing fixtures of buildings (existing or proposed);

(b) Depth to invert of pipe at plumbing fixture or intermediate points;

(c) Minimum depth of cover over connection for mechanical protection;

(d) Invert of public main at junction point;

(e) Allowance for crossing other services (for clearances see 5.3.3);

(f) Provision for basements;

(g) Allowance for head loss in traps and fittings;

(h) Allowance for any soffit depth set by the TA.

The designed invert level at the end of the connection shall be not higher than the lowest calculated level consistent with these factors.

5.3.10 *Pumping stations and pressure mains*

Where pumping stations and pressure mains are required to service a development they shall be designed and installed in accordance with the standards of the TA. If the TA has no applicable standards, then they shall be designed in accordance with WSA 04.

5.4 Construction

Refer to 4.4.1, 4.4.2, 4.4.3 and 4.4.4 for construction requirements for wastewater pipelines.

PART 6: WATER SUPPLY

Table

Figure

PART 6: WATER SUPPLY

6.1 Scope

This Part of the Standard is based on WSA 03 – *Water Reticulation Code of Australia* and sets out the requirements for the design of water systems up to and including DN 375. It is applicable for servicing new developments and re-development areas. It covers the design of both the localized reticulation system and the larger distribution network. For pipes larger than DN 375 refer to WSA 03 or the requirements of the TA.

This part describes water reticulation design generally in “performance based” terms combined with “deemed to comply” solutions. Individual TAs may specify additional or varying requirements.

The designer is responsible for all aspects of the water system design, excepting those aspects nominated and provided to the designer by the TA.

If the scope of the development is large and includes its own water source, treatment and/or reservoirs, reference should be made to WSA 03.

Detailed plans and design calculations (where appropriate) shall be submitted to the TA. In addition the requirements outlined in Part 1 of this Standard shall be met.

6.2 General requirements

6.2.1 *Objectives*

The objectives are to ensure that the water reticulation system is functional, the required quality and quantity of water is supplied to all customers within the TA’s designated water supply area and the TA’s requirements are satisfied.

The design shall ensure an acceptable water supply for each property including fire flows, depending on TA policies by providing either:

(a) A water main allowing an appropriate point of supply to each property; or

(b) A service connection from the main for each property.

The designer shall consider:

(i) The TA’s policies, customer charters and contracts;

(ii) The hydraulic adequacy of the system;

(iii) The ability of the water system to maintain acceptable water quality;

(iv) The structural strength of water system components to resist applied loads;

(v) The requirements of SNZ PAS 4509;

(vi) OSH requirements;

(vii) Environmental requirements;

(viii) The environmental and community impact of the works;

(ix) The “fit-for-purpose” service life for the system;

(x) Optimizing the “whole-of-life” cost; and

(xi) Each component’s resistance to internal and external corrosion or degradation.

6.2.2 *Referenced documents and relevant guidelines*

Water designs shall incorporate all the special requirements of the TA and shall be in accordance with the most appropriate Standards, Codes and Guidelines including those set out in Referenced Documents and in Appendix D.

6.3 Design

6.3.1 *Design life*

All water supply systems shall be designed for an asset life of at least 100 years without rehabilitation. Some components such as pumps, metering, control valves and control equipment may require earlier renovation or replacement.

6.3.2 *Design tolerance*

The location and levels of water mains shall be specified:

(a) In m to one decimal place for horizontal alignment;

(b) In m to two decimal places for level.

Horizontal alignment shall be referenced to NZGD2000 co-ordinates, or, where this is not possible, to local property boundaries. Levels shall be referenced to a datum approved by the TA.

6.3.3 *Impact of consequential damage*

An assessment and risk analysis shall be conducted to evaluate and address the impact of environmental and property damage in the event of a major water main failure. AS/NZS 4360 can be used as a guide for this process.

The following aspects should be considered:

(a) Failure mode of the selected pipeline material;

(b) Failure mode of the selected pipeline jointing system;

(c) The topography of the area adjacent to the water main and how it affects the natural flow of surface water;

(d) The capacity of the local drainage system to cater for a water main failure;

(e) The type of property development adjacent to the water main and the impact of a water main failure on below ground developments such as basements, below ground car parks or terraced development;

(f) Impact on community infrastructure;

(g) Clearance from other services and structures to reduce the likelihood of consequential damage; and

(h) The provision for future access for operational purposes.

6.3.4 *Future system expansion*

Water mains shall be designed with sufficient capacity to cater for all existing and predicted development within the area to be served. The designer shall make allowance for areas of subdivided or unsubdivided land capable of future development.

The water demand allowance in the design for large tracts of vacant land may be determined on the basis of:

(a) Population targets; or

➤

(b) The area to be serviced; or

(c) Individual properties proposed by the developer.

Adjustment may be required to cater for the known performance (demand-based flows) of the existing parts of the water system.

Future demands are estimated on the basis of:

(i) Growth forecasts from planning authorities;

(ii) The rate of development in recent years;

(iii) The current district plan; and

(iv) Discussion with the TA on development expectations.

6.3.5 *Electrical earthing of water services*

Where a metallic water main is to be replaced with a plastic main, a licensed electrician shall make an assessment of potentially affected property earthing systems. Work shall not commence until the electrician declares in writing that it is safe to proceed.

> ***C6.3.5***
> *Properties in some areas with older reticulation systems have electrical earthing systems that make use of the metallic water service line as the main earthing conductor. In some cases the metallic water main can form part of the electrical earthing system. Removal of the earthing conductor by replacement of either the main or services with a non-conducting material can render the electrical earthing unsafe.*

6.3.6 *Design responsibilities*

6.3.6.1 *Territorial authority*

The TA may provide a concept plan setting out certain information to be used in the design. The ability of existing water infrastructure to service the development proposal, may have been verified by the TA, or the TA may require the assessment to be undertaken by the designer.

The TA may provide the designer with some or all of the following information:

(a) Details of acceptable connection point(s);

(b) Details of available flow (Q) at the connection point;

(c) Details of available pressure / head (H) at the connection point;

(d) Minimum allowable operating (working) pressure;

(e) Maximum allowable operating (working) pressure;

(f) Details of any larger through mains required for future expansion; and

(g) A concept plan which would identify any other special requirements of the TA including provision for future expansion of the system.

6.3.6.2 *The designer*

The design shall be undertaken by a person with experience in the design of water reticulation systems.

The designer shall undertake the necessary design and prepare design drawings compatible with the TA's concept plan and the design parameters included in this Standard. Designers shall ensure the following aspects have been considered and where appropriate included in the design:

(a) The size (or sizes) of pipework throughout the proposed reticulation system;

(b) Selection of appropriate pipeline material type/s and class;

(c) Mains layouts and alignments including:

  (i) Route selection (see 6.3.10)

  (ii) Topographical and environmental aspects (see 6.3.10)

  (iii) Easements (see 6.3.10.3)

  (iv) Foundation and geotechnical aspects (see 6.3.11.3)

  (v) Clearances, shared trenching requirements (see 6.3.13)

  (vi) Provision for future extensions (see 6.3.4);

(d) Hydraulic adequacy including:

  (i) Compliance with the required maximum and minimum operating (working) pressure

  (ii) Acceptable flow velocities (see 6.3.9.7), and

  (iii) Compliance with the estimated water demand, including fire fighting;

(e) Property service connection locations and sizes (see 6.6.2 and Appendix A drawings WS-001 and WS-002);

(f) Types and locations of appurtenances, including:

  (i) Stop valves (see 6.4.2)

  (ii) Pressure reducing valves (PRVs) (see 6.4.2.4)

  (iii) Hydrants and fire services (see 6.5)

  (iv) Scours and pump-out branches (see 6.4.2.6) and

  (v) Termination details (see 6.7);

(g) Locations and details of thrust blocks and anchors. (See Appendix A drawings WS-004 and WS-005);

(h) Preparation of final design drawings, plans (and specifications if applicable).

If the TA does not provide a concept plan, the designer shall liaise with the TA, prior to commencement of design, to ensure that sufficient prerequisite information is available to undertake the design.

6.3.7 *Pipe selection*

The selection of the appropriate pipe material, sizes and classes shall be based on system demands.

6.3.7.1 *Sizing of mains*

Mains shall be the minimum size necessary to ensure that residual pressures due to peak demands are not less than the minimum specified by the TA (see 6.3.9.6, 6.3.9.7 and 6.3.9.8.2 for pressure limits and flow velocities allowable in the design). See also SNZ PAS 4509.

6.3.7.2 *Pipe class*

Pipe class is established on the basis of the design pressure (head) calculated for the various sections of the reticulation network. This may be varied by specific operational requirements specified by the TA.

6.3.7.2.1 *Design pressure (head) – maximum*

The maximum design pressure (head) for the mains to be installed shall be based on the following:

Design Pressure, (m) = Maximum Supply Pressure, (m)
+ Surge Allowance, (m) (see 6.3.9.8)
– Lowest Ground Level (GL) of the proposed main, (m).

The design pressure (head) shall be used for:

(a) Selection of pipe materials and classes;

(b) Selection of pipe fitting types and classes;

(c) Design of thrust and anchor blocks.

6.3.7.2.2 *Minimum pipe class*

The minimum pipe and fittings class to be used for reticulation mains shall be Class 9 (see AS/NZS 1477, AS/NZS 2280, AS/NZS 2566.1 Supp 1, AS/NZS 4130 and AS 1579). Designers shall verify the TA's minimum requirement before specifying the required pipe class.

6.3.7.2.3 *Nominated pipe class*

Some TAs may nominate a pipe class (e.g. Class 16) for pressure pipes and fittings to allow future operational flexibility within their system and/or to cater for inconsistency in as-constructed pipeline performance. Where this is the case, the design pressure used as the basis for system design, anchorage and pressure testing shall not exceed the TA's specified operating pressure limit associated with the pipe class.

> ***C6.3.7.2.3***
> *Nominated pipe classes may be used by the TA to standardize on a limited number of pipe classes.*

6.3.7.2.4 *Pumped mains*

For water mains in pumped systems, a detailed surge analysis shall be conducted unless otherwise directed by the TA to ensure:

(a) The appropriate surge pressure is included in the calculated design head;

(b) Surge control devices are included in the system design, where identified by the detailed analysis, to protect the network and/or control pressure fluctuations in the supply to customers.

NOTE – Surge can also be managed by soft starts on pump motors, variable speed drives, speed controls on valve closures, etc.

6.3.7.3 *Pipe material*

See table 4.2 in Part 4.

6.3.8 *Fire flow*

The water reticulation system shall be designed to comply with SNZ PAS 4509.

6.3.8.1 *Fire protection services*

Many industrial and commercial developments require installation of special fire protection services. Whilst it is the responsibility of the site owner to provide these fire services, the developer shall design the water infrastructure to meet the required demands, where these are known in advance.

6.3.8.2 *Allowable operating pressures (heads)*

The designer shall ensure that pressures within the system are always contained within the allowable maximum and minimum limits. Refer to TA or if it has no specific requirements, use the values set out in 6.11.3.

6.3.9 *Hydraulic design*

6.3.9.1 *General*

The diameter of the water main shall be selected to ensure that:

(a) The main has sufficient capacity to meet peak demands;

(b) All consumers connected to the main receive at all times an adequate water supply; and

(c) The appropriate fire demand is met.

6.3.9.2 *Network analysis*

Where required by the TA, a network analysis of the system shall be undertaken. The system shall be analysed using a mathematical model of the network to ensure adequate water supply is available to all consumers connected to the system for all defined modes of operation. The analysis shall include all elements within the system and shall address all demand periods including peak demand, low demand flows and fire flows.

6.3.9.3 *Peak flows*

Water demands vary on a regional basis depending on a variety of climatic conditions and consumer usage patterns. The TA should be able to provide historically based demand information appropriate for design. Where peak demands are required for the design of a distribution system, the value shall be calculated from the following formulae:

Peak Day Demand (over a 12-month period) = Average Day Demand x PF

Unless specified otherwise by the TA:

(a) PF = 1.5 for populations over 10,000;

(b) PF = 2 for populations below 2,000.

Peak Hourly Demand = Average Hourly Demand (on peak day) x PF (over a 24-hour period)

Unless specified otherwise by the TA:

(a) PF = 2 for populations over 10,000;

(b) PF = 5 for populations below 2,000.

6.3.9.4 *Head losses*

The head loss through pipe and fittings shall be less than:

(a) 5 m/km for DN ≤150

(b) 3 m/km for DN ≥200.

Head loss can be calculated using one of a number of standard hydraulic formulae. Some TAs have a preferred procedure and, where appropriate, this procedure should be used.

6.3.9.4.1 *Hydraulic roughness values*

The hydraulic roughness values considered in the analysis shall take account of the pipe material proposed, all fittings and other secondary head losses and the expected increase in roughness over the life of the pipe. The designer should check with the TA to ascertain if it has any requirements to use a specific formula and or roughness coefficients. If there are no specific requirements then it is recommended that the Colebrook White formula is used. If the designer uses Manning or Hazen-Williams the coefficients in table 6.1 are recommended.

Table 6.1 – Hydraulic roughness values

	Pipe types	PVC/MDPE		CLS/DI	
Formula	**Use type**	**Trunk**	**Reticulation**	**Trunk**	**Reticulation**
Manning (n)		0.011	0.013	0.013	0.014
Colebrook White (ks)		0.06	0.15	0.15	0.6
Hazen-Williams (c)		145	135	135	130

NOTE –

(1) The roughness of poorly lined (or unlined) DI or steel pipes can deteriorate significantly with time if linings get damaged. For modelling or back analysis of existing systems obtain pipe samples where possible and calibrate assumptions against measured flows and heads.

(2) Manufacturers' design charts may be based on smoother pipe assumptions than these (e.g. K = .003) but such charts usually assume "as-new" laboratory conditions and ignore such effects as tappings, tees, valves etc.

(3) The designer must judge when it is appropriate to analyse all bends and fittings specifically.

6.3.9.5 *Pressure zones*

TAs will have maximum acceptable pressure requirements in any pressure zone. Where the height variation of the total system extends beyond the allowable operating pressure range, e.g. over 55-60 m in elevation, the system should be divided into zones, each with its own service reservoir or tank and reticulation network. In some cases, a "PRV zone" may be used to control the pressure delivered to an area. These zones are developed to provide operational bands of supply that vary approximately 60 m in height to meet minimum and maximum allowable operating pressure requirements (see 6.3.8.2). Each zone is locked off from the other zones to prevent higher pressure loadings from one zone being accidentally imposed on a lower zone system. The ability to vary the interface point between zones may be required to optimize the operational performance of adjacent zones.

The restriction of diurnal pressure variations may be specified within a set percentage of the normal operating head of the system.

> ***C6.3.9.5***
> *Pressure variation may be reduced by measures such as:*
>
> *(a) Supplying a sufficiently large number of connections from an interlinked network to reduce the effect of demand peaks and/or;*
>
> *(b) Limiting the range of elevations served from each pipeline.*

6.3.9.6 *Design (head) requirements*

The pressure within a pipeline system arises from the combination of static head of supply source, pumping and surges arising from pumping and valve operation. Pressure varies with location (static head and hydraulic losses) and time (intermittent surges and rise and fall of supply head). Pressure definitions are summarized in figure 6.1.

➤

An output of the hydraulic design of a pipeline is the specification of the maximum pressure that may be imposed on the pipeline during operation.

Inputs to the design process include:

(a) Static head of supply;

(b) The range of pressure required to provide an acceptable level of service to the end-user (minimum pressure) and to avoid water leakage (maximum pressure);

The outputs of water main hydraulic design shall include:

(i) Size of mains;

(ii) Maximum and minimum design pressure;

(iii) The pressure class / rating of pipeline system components;

(iv) Surge analysis results;

(v) Hydraulic loss functions;

(vi) Specification of the maximum allowable operating pressure.

C6.3.9.6
For a comprehensive discussion of surge and fatigue and the derating of thermoplastic pipes see WSA 03.

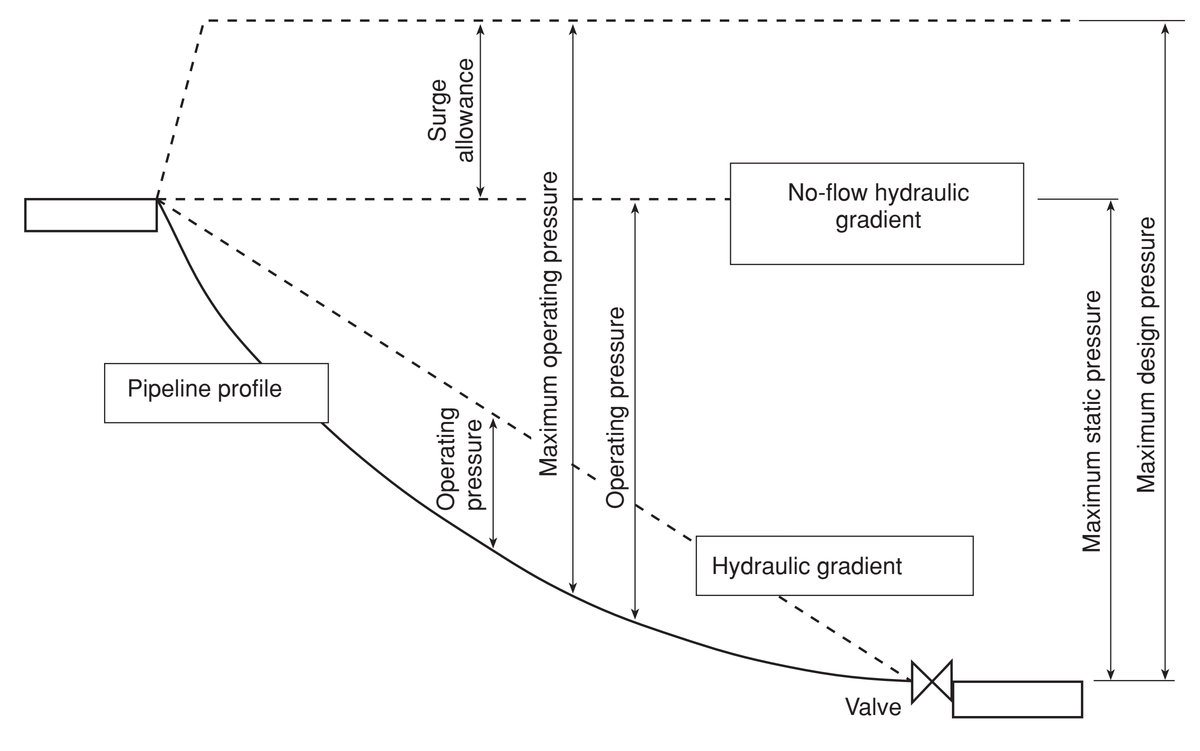


Figure 6.1 – Conceptual hydraulic operation of a gravity main

6.3.9.6.1 *Design pressure*

The design pressures are the limiting pressures for operation of a pipeline system including any allowance for variation of usage in the future. They are the documented output of the design process and specify the maximum and minimum internal pressure to which any location in the system may be exposed.

The maximum design pressure includes pressure arising from the static head, pumping pressures and an allowance for surge. During operation, any location of the pipeline system shall not be exposed to steady state or transient pressure in excess of the maximum design pressure for that location. The pressure rating/class of a component in the pipeline system (e.g. pipe, valve, flange etc.) at a defined location shall not be less than the maximum design pressure for the location. The TA may specify the minimum class/rating of pipeline components for distribution and/or reticulation systems. The maximum design pressure may be exceeded during pressure testing of the system.

The minimum design pressure is either the minimum pressure defined by the TA or some higher pressure selected to control (minimize) the range of pressures experienced over the normal diurnal variation in the system.

6.3.9.6.2 *Operating pressure/working pressure*

The terms operating pressure and working pressure may be used interchangeably.

Operating pressure is the actual pressure within a system during its operation. It includes the combined pressures of static head, pumping and surges.

The operating pressure will vary within the system and over time under the influence of hydraulic losses and transient surges. Operating pressure is dependent on system variables such as the preceding length of pipe, the number and geometry of fittings, the actual flow rate, pumping starts and stops and valve closures. The operating pressure at any location of the pipeline shall not exceed the design pressure for that location.

The operating pressure shall not exceed the rerated pressure class/rating or the operating pressure limit of the pipeline components at that location.

6.3.9.6.3 *Service pressure*

Service pressure (SP) is location and flow-rate dependent. At any point in the system, SP is dependent on the available static head, steady state pumping pressure or demand flows, less hydraulic losses. SP is typically measured by a pressure gauge at a tapping point.

An upper limit on SP is generally imposed to prevent wastage of water and to minimize the risk to household appliances.

6.3.9.7 *Flow velocities*

In practice it is desirable to avoid unduly high or low flow velocities. Pipelines shall be designed for flow velocities within the range of 0.5 to 2.0 m/s. In special circumstances, velocities of up to 3.5 m/s may be acceptable.

For pumping mains an economic appraisal may be required to determine the most economical diameter of pumping main to minimize the combined capital and discounted pumping cost. The resulting velocity will normally lie in the range 0.8 m/s to 1.4 m/s.

➤

The following factors shall be considered in determining flow velocity:

(a) Stagnation;

(b) Turbidity (large fluctuations in flow rates can dislodge the biological slime or stir up settled solids in pipelines);

(c) Pressure;

(d) Surge;

(e) Pumping facilities;

(f) Pressure reducing devices;

(g) Pipe lining materials.

6.3.9.8 *Surge analysis*

A surge analysis shall be undertaken for any pipeline within a pumped system or system containing automated valves. The source of any significant pressure surges or high-pressure areas shall be identified and remedial measures designed and specified.

> ***C6.3.9.8***
> *Surges can be considerably amplified where there is air in the pipeline causing damage to the pipe as well as to other components such as pumps and valves. Excessive surges can reduce the life of materials and increase customer complaints due to pressure variations, noise or air entrainment and water quality problems associated with column separation caused by the disturbance of deposits within the pipeline. Fatigue is a problem with plastic pipes which deteriorate with repeated surge pressures. For a more comprehensive discussion on fatigue and pressure rerating of plastic pipes refer to WSA 03.*

6.3.9.8.1 *Maximum allowable operating pressure – trunk mains*

Trunk mains and those distribution mains not supplying directly to consumers may operate at higher pressures than reticulation mains [e.g.1200 kPa (120 m) up to 3500 kPa (350 m)] subject to use of appropriate pipeline materials. An operating pressure limit for the pipeline material may be specified by the TA.

6.3.9.8.2 *Minimum allowable operating pressure*

The TA may specify a minimum net positive head value [e.g. 30 kPa (3 m)] to be used in pipeline design. During operations, it is possible for the minimum pressure (head) in the distribution mains to fall below zero (particularly during surge conditions). If this is determined during design, the TA shall be advised and a suitable pipe material selected. Where a distribution main is supplying water directly to consumers, the minimum operating pressure shall be not less than that set by the TA.

6.3.9.9 *System test pressure*

The system test pressure is the pressure of hydrostatic testing (static), applied to test the integrity of a pipeline system. The system test pressure generally exceeds the actual design pressure of the system (typically by 25 %). The excess pressure is accommodated by the inherent design safety factor.

6.3.9.10 *Temperature rerating of plastic pipes*

The pipe class of plastic pipes is determined at 20 °C. Where the temperature of water within the distribution system exceeds 20 °C for part of the year, the pipe class shall be rerated in accordance with WSA 03.

6.3.10 *Layout of water mains*

6.3.10.1 *General*

Water mains are usually located in the street. The location shall be specified by the TA, within the street or space allocation nominated by the road controlling authority. Where approved by the TA water mains may be located in private property or public reserve. Easements may be required. Trees and structures should not be positioned where they will interfere with the standard alignment of water mains.

Water mains should:

(a) Be aligned parallel to property boundaries;

(b) Should not traverse steep gradients; and

(c) Should be located to maintain adequate clearance from structures and other infrastructure.

6.3.10.2 *Mains layout*

In determining the general layout of mains, the following factors shall be considered:

(a) Main location to allow easy access for repairs and maintenance;

(b) Whether system security, maintenance of water quality and ability to clean mains meet operational requirements;

(c) Location of valves for shut-off areas and zone boundaries (see 6.4.2);

(d) Avoidance of dead ends by use of looped mains or rider mains;

(e) Provision of dual or alternate feeds to minimize service risk.

6.3.10.3 *Water mains in easements*

Subject to the approval of the TA, water mains may be located within an appropriately sized and registered easement in accordance with the TA's requirements.

C6.3.10.3

For some TAs, an easement over private property is not the preferred option and may only be used as a temporary solution for landlocked subdivisions pending future permanent supply within a street. A typical situation where the TA may approve water mains in easements is a fire main in a right of way. Specific requirements for the use of an easement shall be obtained from the TA, but may include:

(a) The zone-of-influence of the trench for the water main. It should be noted that the pressurized nature of water mains means that failures can do much more damage than gravity mains, hence locating them close to buildings needs to be carefully considered;

➤

(b) Sufficient width and drainage capacity to minimize the risk of consequential damage in the event of a mains failure;

(c) Sufficient width for machinery access for construction/maintenance;

(d) Additional access to allow for future upsizing, if appropriate;

(e) Valves should be provided to facilitate isolation of the easement.

6.3.10.4 *Types of system configuration*

Networks layouts shall be established in accordance with TA practice. Interconnected ring systems should be provided when feasible. See WSA 03 for further information.

6.3.10.5 *Water mains near trees*

Special consideration shall be given to the location of water mains adjacent to mature trees.

6.3.10.6 *Shared trenching*

Where shared trenching is approved by the TA and utility service owners, a detailed design shall be submitted for approval by those parties and shall include:

(a) Relative location of services (horizontal and vertical) in the trench;

(b) Clearances from other services;

(c) Pipe support and trenchfill material specifications;

(d) Embedment and trenchfill compactions;

(e) Trench markings;

(f) Services location with respect to property boundaries; and

(g) Any limitations on future maintenance.

Where approved by the TA and utility service owners, shared trenching may also be used for property service connections.

6.3.10.7 *Rider mains and duplicate mains*

A rider main shall be laid along the street frontage of all lots not fronted by a principal main.

Duplicate mains are required to provide adequate fire protection in the following cases:

(a) Major roads or roads with a central dividing island;

(b) Roads with split elevation;

(c) Roads with rail or tram lines;

(d) CBDs;

(e) Parallel to large distribution mains that are not available for service connections;

(f) Industrial/commercial areas nominated by the TA;

(g) Where required by SNZ PAS 4509.

6.3.10.8 *Contaminated sites*

Contaminated sites should be avoided. Where a contaminated site cannot be avoided, written approval to proceed shall be obtained from the TA. The TA will require at least confirmation of the following issues:

(a) Compliance with statutory requirements;

(b) Options to de-contaminate the area;

(c) Selection of appropriate pipeline materials and jointing techniques to maintain water quality;

(d) Selection of pipeline materials to achieve the required life expectancy of the pipeline;

(e) Safety of construction and maintenance personnel;

(f) Special pipeline maintenance considerations.

6.3.10.9 *Crossings*

Water main crossings of roads, railway lines and underground services shall, as far as practicable, be at right angles. Mains should be located and designed to minimize maintenance and crossing restoration. The TA may require extra mechanical protection for the pipes and/or different pipe materials to minimize the need for future maintenance.

6.3.10.10 *Crossings of creeks or drainage reserves*

All crossings of creeks or drainage reserves shall be specific designs to suit the TA's requirement.

Crossings shall be made as close as practicable to 90^{o} to the creek or drainage reserve. Reference should be made to the TA to establish whether it prefers elevated crossings or below waterway invert crossings. When the pipeline is placed under the invert level of a waterway it may require mechanical protection by concrete encasement. Different pipeline materials may need to be used for the crossing.

6.3.10.11 *Location marking of valves and hydrants*

The location marking of valves and fire hydrants shall be to NZS 4501 and Appendix A drawing WS-006.

6.3.11 *Structural design*

6.3.11.1 *General*

For installation conditions beyond those shown on the drawings, the pipeline installation shall be specifically designed to resist structural failure. The design shall be in accordance with AS/NZS 2566.1 including the structural design commentary AS/NZS 2566.1 Supplement 1. Details of the final design requirements shall be shown on the drawings.

6.3.11.2 *Structural consideration*

Pipelines shall be designed to withstand all the forces and load combinations to which they may be exposed including internal forces, external forces, temperature effects, settlement and combined stresses. The water main design shall include the selection of the pipeline material, the pipe class and selection of appropriate bedding material to suit site conditions.

6.3.11.2.1 *Internal forces*

Pipelines shall be designed for the range of expected pressures, including transient conditions (surge and fatigue) and maximum static head conditions. In the case of transient conditions the amplitude and frequency shall be estimated. The allowance for surge included in the maximum design pressure shall not be less than 200 kPa. Transfer and distribution mains subject to negative pressure shall be designed to withstand a transient pressure of at least 80 kPa below atmospheric pressure. A safety factor of 2 shall be used.

6.3.11.2.2 *External forces*

The external forces to be taken into account shall include:

(a) Trench fill loadings (vertical and horizontal forces due to earth loadings);

(b) Surcharge;

(c) Groundwater;

(d) Dead weight of the pipe and the contained water;

(e) Other forces arising during installation;

(f) Traffic loads;

(g) Temperature (expansion/contraction).

The consequences of external forces on local supports of pipelines shall also be considered.

6.3.11.3 *Geotechnical investigations*

The designer should take into account any geotechnical requirements determined under Part 2 of this Standard.

Where required, standard special foundation conditions shall be referenced on the drawings.

6.3.11.4 *Pipe selection for special conditions*

Pipeline materials and jointing systems shall be selected and specified to ensure:

(a) Structural adequacy with respect to ground conditions and water temperature;

(b) Water quality with respect to lining material;

(c) Compatibility with aggressive or contaminated ground;

(d) Suitability for the geotechnical conditions;

(e) Compliance with the TA's requirements.

6.3.11.5 *Above-ground water mains*

The design of above-ground water mains shall include the design of pipeline supports, loading protection, maintenance and access requirements, and shall address exposure conditions, such as corrosion protection, UV protection, freezing of water mains and temperature derating.

In such situations the pipe materials, support and restraint for the pipes and fittings shall be detailed on the drawings.

6.3.11.6 *Trenchless technology*

Trenchless technology may be required by the TA as appropriate for alignments passing through or under:

(a) Environmentally sensitive areas;

(b) Built-up or congested areas to minimize disruption and reinstatement;

(c) Railway and major road crossings;

(d) Significant vegetation;

(e) Vehicle crossings.

The following details including location of access pits and exit points shall be submitted to the TA for approval:

(i) Clearances from services and obstructions;

(ii) The depth at which the pipeline is to be laid to ensure minimum cover is maintained;

(iii) The pipe support and ground compaction;

(iv) How pipes will be protected from damage during the work;

(v) Any assessed risk to abutting surface and underground structures.

> ***C6.3.11.6***
> *Damage is a particular risk for plastic pipes or coated pipes in areas where the soils are known to be abrasive.*

6.3.11.7 *Embedment*

6.3.11.7.1 *Pipe cover*

Pipe cover shall meet the requirements of 4.3.3.6 and any special requirements to suit the height dimensions of water fittings such as valves and hydrants.

The minimum depth of cover for each section of pipeline shall be shown on the drawings. The maximum depth of the trench shall not exceed 1.5 m without the approval of the TA.

> ***C6.3.11.7.1***
> *It is good practice to have a consistent cover along the length of the main as a minimum that allows future valves to be cut in without lowering sections of the main in the future.*

6.3.11.7.2 *Trench width*

Pipe trench width design considerations shall be based on the minimum side clearances detailed in Appendix A drawing CM-003.

6.3.11.8 *Pipeline restraint*

Anchorage shall be provided at bends, tees, reducers, valves and dead ends where necessary.

> ***C6.3.11.8***
> *In-line valves, especially those larger than DN 200, should be anchored to ensure stability under operational conditions.*

6.3.11.8.1 *Thrust blocks*

Thrust blocks shall be designed to resist the total unbalanced thrust and transmit all load to the adjacent ground. Calculation of the unbalanced thrust shall be based on the maximum design pressure, or as otherwise specified by the TA.

Typical contact areas for selected soil conditions and pipe sizes are shown in Appendix A drawings WS-004 and WS-005.

Thrust blocks for temporary works shall be designed to the requirements for permanent thrust blocks.

For pipelines with design pressures exceeding 1.3 MPa, and pipelines > DN 375, see WSA 03.

6.3.11.8.2 *Anchor blocks*

Anchor blocks are designed to prevent movement of pipe bends in a vertical direction. They consist of sufficient mass concrete to prevent pipe movement (see Appendix A drawing WS-005).

6.3.11.8.3 *Restrained joint water mains*

Commercial mechanical restrained joint systems may be used subject to the approval of the TA.

> ***C6.3.11.8.3***
> *Many TAs will still require the use of thrust and anchor blocks due to operational and maintenance requirements.*

6.3.11.9 *Bulkheads*

See 4.3.3.14.

6.3.12 *Reservoirs and pumping stations*

Where reservoirs or pumping stations are required, reference shall be made to the TA for its specific requirements.

> ***C6.3.12***
> *WSA 03 contains design criteria for pumping stations.*

6.3.13 *Obstructions and clearances*

6.3.13.1 *Underground services*

The location of underground services affecting the proposed pipe alignment shall be determined. Where pipes will cross other services, the depth of those services shall be investigated, and exposed where necessary.

6.3.13.2 *Clearance from underground services*

Where a pipe is designed in a road the location of the pipe with respect to other services shall comply with SNZ HB 2002, unless the TA has its own requirements.

For normal trenching and trenchless technology installation, clearance from other service utility assets shall not be less than the minimum vertical and horizontal clearances shown in table 6.2. Written agreement on reduced clearances and clearances for shared trenching shall be obtained from the TA and the relevant service owner prior to the commencement of any work.

Table 6.2 – Clearances between water mains and underground services

Utility (Existing service)	**Minimum horizontal clearance** (mm)		**Minimum vertical clearance**[1] (mm)
	New main size		
	DN ≤200	**DN >200**	
Water mains DN >375	600	600	500
Water mains ≤DN 375	300[2]	600	150
Gas mains	300[2]	600	150
Telecommunications conduits and cables	300[2]	600	150
Electricity conduits and cables	500	1000	225
Stormwater mains	300[2]	600	150[3]
Wastewater pipes	1000/600[4]	1000/600[4]	500[3]
Kerbs	150	600[5]	150 (where possible)

NOTE –

(1) Vertical clearances apply when water mains cross another utility service, except in the case of wastewater when a vertical separation shall always be maintained, even when the main and wastewater pipe are parallel. The main should always be located above the wastewater pipe to minimize the possibility of backflow contamination in the event of a main break.

(2) Clearances can be further reduced to 150 mm for distances up to 2 m when passing installations such as poles, pits and small structures, providing the structure is not destabilized in the process.

(3) Water mains should always cross over wastewater and stormwater drains.

(4) When the wastewater pipe is at the minimum vertical clearance below the water main (500 mm), maintain a minimum horizontal clearance of 1000 mm. This minimum horizontal clearance can be progressively reduced to 600 mm as the vertical clearance is increased to 750 mm.

(5) Clearance from kerb and channel shall be measured from the nearest edge of the concrete. For water mains ≤375 clearances can be progressively reduced until the minimum of 150 mm is reached for mains DN ≤200.

(6) Where a main crosses other services, it shall cross at an angle as near as possible to 90°.

6.3.13.3 *Clearance from structures*

Pipes adjacent to existing buildings and structures shall be located clear of the "zone of influence" of the building foundations. If this is not possible, a specific design shall be undertaken to cover the following:

(a) Protection of the pipeline;

(b) Long term maintenance access for the pipeline; and

(c) Protection of the existing structure or building.

➤

The protection shall be specified by the designer for evaluation and acceptance by the TA.

Sufficient clearance for laying and access for maintenance is also required. Table 6.3 may be used as a guide for minimum clearances for mains laid in public streets.

Table 6.3 – Minimum clearance from structures

Pipe diameter **DN**	**Clearance to wall or building** (mm)
<100	600
100 – 150	1000
200 – 300	1500
375	2000

NOTE – These clearances should be increased for mains in private property (even with easements) as access is often more difficult and damage risk greater.

6.3.13.4 *Clearance from high voltage transmission facilities*

Water mains constructed from metallic materials shall generally not be located close to high voltage transmission lines and other facilities. Special design shall be undertaken if it is necessary to locate such mains close to such facilities.

6.3.13.5 *Deviation of mains around structures*

Deviation of a pipeline around an obstruction can be achieved by deflection at pipe joints and with bends. Plastic pipes, with the exception of polyethylene shall not be bent. The maximum deflection angle permitted at a flexible joint shall be in accordance with AS/NZS 2280 and AS/NZS 1477. Multiple joint deflections shall not be more than 80 % of the manufacturer's recommendation.

6.3.14 *Water quality*

A number of factors in a network can adversely affect the quality of the water in the system. The network design shall ensure that the water quality at each property complies with the DWSNZ.

6.3.14.1 *Materials*

All parts of the water supply system in contact with drinking water shall be designed using components and materials that comply with AS/NZS 4020. The pipe material selected should ensure minimal impact on water quality within the system.

6.3.14.2 *Prevention of back siphonage*

Drinking water supply systems shall be designed and equipped to prevent back siphonage. The location and operation of hydrants, air valves and scours shall ensure no external water enters the system.

NOTE – Some TAs require appropriate backflow at the point of supply for all connections.

6.3.14.3 *Water age*

Drinking water supply systems shall be designed to minimize water age to ensure no unacceptable deterioration of water quality.

(a) Mains with dead ends shall be avoided by the provision of linked mains or looped mains. Particular care shall be taken at the boundaries between supply zones where dead ends shall be minimized.

(b) Mains for short runs shall be reduced in size or looped e.g. cul-de-sacs (see figure 6.6);

(c) Provision of large diameter main capacity shall be staged by the initial provision of a smaller main, followed by additional mains as the demand increases.

6.4 Valves

6.4.1 *General*

The siting of valves shall take a holistic view of the existing infrastructure and proposed additions. General principles to be considered shall include:

(a) Valves shall be sited to provide the control (flow, pressure, isolation, diversion, etc.) required by the TA;

(b) Ready access to valves to enable their safe operation. Account shall be taken of traffic and other site peculiarities;

(c) Minimization of inconvenience to the public by avoiding clustering of surface fittings in the footpath at intersections;

(d) Optimization of the number and location of valves and hydrants to meet the TA's operation and maintenance requirements, safe working and to minimize the effect of a shut down on the TA's customers.

Typical valve installation and chamber details are shown in figure 6.3 and figure 6.4.

6.4.2 *Valve types*

6.4.2.1 *Gate valves*

Valves shall have anti-clockwise rotation of the input spindle for closure, unless otherwise specified by the TA. Gate valves DN ≤50 (commonly called peat valves) shall be clockwise closing unless otherwise specified by the TA.

Buried gate valves shall be operated from above ground and shall be designed to facilitate the use of a standard key and bar. An extension spindle shall be incorporated as necessary to ensure the top of the spindle is 350 mm below the FSL.

6.4.2.2 *Butterfly valves*

Butterfly valves shall only be used with the approval of the TA.

> ***C6.4.2.2***
> *Butterfly valves are not normally used in reticulation mains as they hinder swabbing operations.*

6.4.2.3 *Stop valves for reticulation mains*

In the reticulation network, stop valves are used to limit the size of the shut-off area when a main is taken out of service for operational purposes.

Stop valves DN ≥80 shall be gate valves. In-line stop valves shall be the same diameter as the reticulation main.

6.4.2.3.1 *Stop valves – location and arrangements*

6.4.2.3.1.1 *General*

Stop valves shall be located at street intersections and along the line of the main as required, and, where practicable, in line with the inner splay corner of the property boundary as shown in figure 6.2.

The location of stop valves shall take into consideration:

(a) The operational needs of the system so that continuity of supply can be maximized;

(b) Operation and maintenance requirements;

(c) Safety of operation and maintenance personnel.

C6.4.2.3.1.1

Stop valves are used to:

- *Isolate reticulation mains from distribution mains;*
- *Isolate smaller reticulation mains from larger reticulation mains;*
- *Isolate planning zone boundaries, for example, industrial, residential or commercial;*
- *Provide valves each side of freeways, arterial roads, and railway and tram crossings;*
- *Provide valves adjacent to street intersections (for ease of location);*
- *Provide valves in the footway, clear of roadway, where possible.*

Subject to the above considerations, valve numbers shall be minimized.

The TA should be consulted to establish the local requirement for connection type (flange or socket), as well as any other issues such as valve anchoring requirements for specific applications (see figure 6.2 to figure 6.4 and 6.3.11.8).

6.4.2.3.1.2 *Branch mains*

Stop valves shall be located on branch mains adjacent to the through water main. The type of joint to be used (Soc-Soc, FI-Soc or FI-FI) shall be based on the required security of the water mains. For transfer mains or reticulation mains (DN 250, a tee with a flanged branch and a flanged valve shall be used (see figure 6.2 and Appendix A drawings WS-001 and WS-002).

Where a road crossing is necessary immediately after the tee branch and there is no space available adjacent to the tee, a stop valve shall be installed on the opposite side of the road. In this instance, the TA may specify restrained joints for the main from tee to valve (see figure 6.2 and Appendix A drawings WS-001 and WS-002).

6.4.2.3.1.3 *Pressure zone dividing valves*

Pressure zone dividing valves and hydrants shall be installed in one of the following arrangements (see figure 6.3).

(a) Valves in a paired configuration with a standard fire hydrant located between them. Installation in this manner permits the valves to be checked for leakage. The valve on the low pressure side of the pair will normally be closed in order for the fire hydrant to be used for fire fighting purposes with the supply from the higher pressure zone.

(b) A valve with a standard fire hydrant on each side.

6.4.2.3.1.4 *Secure service connections*

Additional stop valves may be provided at a service connection to a customer requiring a greater security of supply such as hospitals and large industrial or commercial developments. Figure 6.4 illustrates typical arrangements to facilitate partial isolation of the main while maintaining supply to the customer.

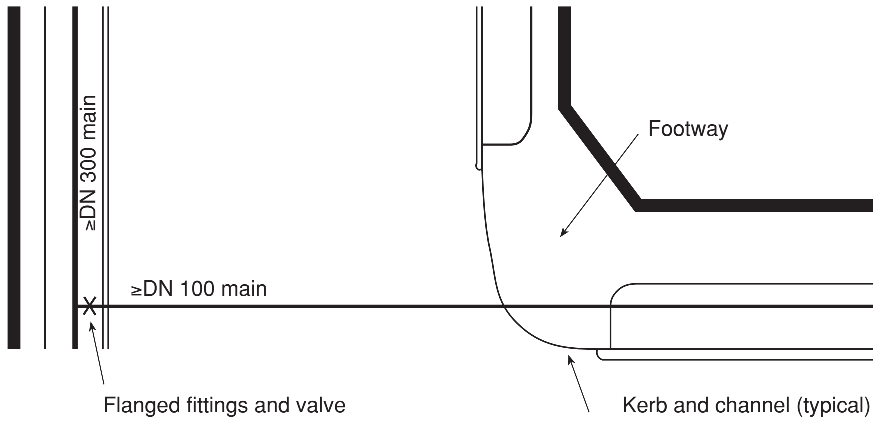


Figure 6.2 – Branch valve adjacent to main

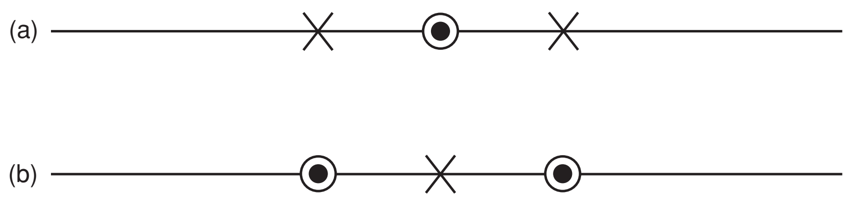
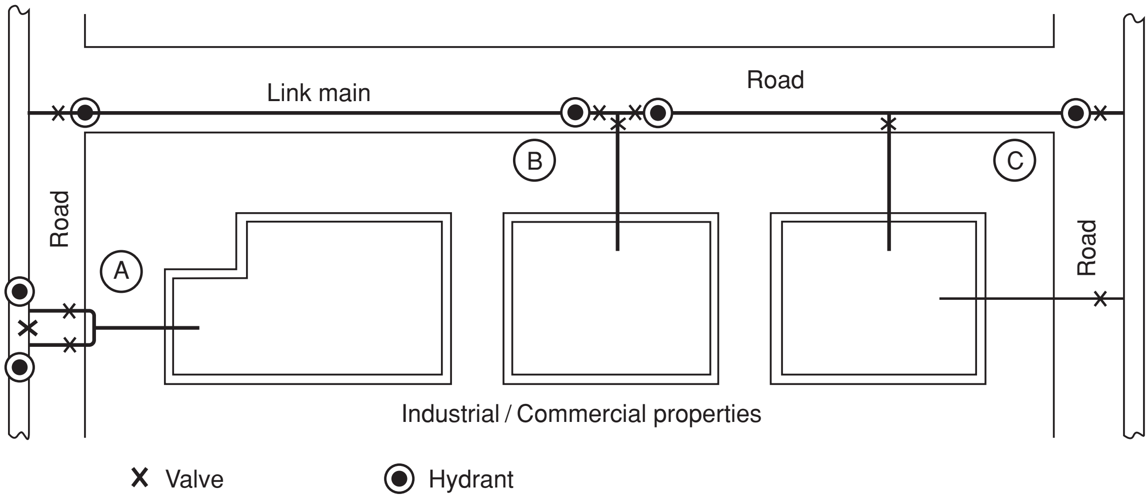


Figure 6.3 – Valve and hydrant combinations for pressure zone dividing valves



NOTE –

(1) Example A – feed from two directions off a large diameter water main. The arrangement is more complicated than example B, but is justified by the cost of an additional large diameter stop valve which would be required if using example B.

(2) Example B – feed from two directions off a smaller diameter main. This is a simpler arrangement than example A, but requires two valves on the main.

(3) Example C – feed from two separate mains.

Figure 6.4 – Secure connection

6.4.2.4 *Pressure reducing valves (PRV)*

Pressure reducing valves are outside the scope of this Standard. See WSA 03.

> ***C6.4.2.4***
> *A PRV is used to reduce the pressure upstream of the PRV to a desired lower downstream pressure. The PRV works automatically to maintain the desired downstream pressure. See WSA 03 for design criteria.*

6.4.2.5 *Air valves (AV)*

6.4.2.5.1 *Installation design criteria*

Investigation into the need for AVs shall be made for all high points on mains, particularly at points more than 2 m higher than the lower end of the section of water main and particularly if the main has a steep downward slope on the downstream side.

Where the hydraulic head is less than 10 m, special consideration shall be given to the type of AV to prevent water leakage from the valve.

AVs shall be installed with an isolating valve to permit servicing or replacement without having to shut down the main.

Combination AVs i.e. (dual) AVs incorporating an AV (large orifice) and an air release valve (small orifice) in a single unit, are generally the preferred type for distribution and transfer mains, and where required on reticulation mains.

The nominal size of the large orifice of air valves shall be DN 80 for installation on mains. This size has an exhaust capacity of approximately 0.3 m^3/s.

> ***C6.4.2.5.1***
> *Water mains with only a few service connections or a configuration that leads to air accumulation may require combination air valves to automatically remove accumulated air that may otherwise cause operational problems in the water system.*
>
> *The configuration of the distribution network in terms of both the change in elevation and the slope of the water main governs the number and location of air valves required.*

6.4.2.5.2 *Air valves location*

Air valves shall not be located in major roadways or in areas subject to flooding.

When required, air valves shall be located:

(a) At summits (high points);

(b) At intervals of not more than 800 m on long horizontal, ascending and descending sectors;

(c) At every increase in downward slope;

(d) At every reduction in upward slope;

(e) On the downstream side of PRVs;

(f) On the downhill side of major isolating valves;

(g) At blank ends.

Where the air valve is in a valve chamber, the design shall ensure adequate venting for effective operation and drainage to prevent backflow contamination.

6.4.2.6 *Scours and pump-out branches*

Scours and pump-out branches are provided in the distribution network for maintenance purposes. They are designed to allow draining of water from the mains by gravity or use of a mobile pump.

Hydrants may be used for scouring on water mains DN <300.

> ***C6.4.2.6***
> *On mains DN ≥300, scours are more effective in draining and provide greater flushing velocities than hydrants.*

Scours and pump-out branches shall incorporate appropriate measures to prevent back siphonage into the water supply system.

There shall be adequate drainage facilities to receive the flow resulting from scouring operations.

Scours shall:

(a) Drain the water main by gravity and/or have provision for pump-out within a period of one hour;

(b) Have a diffuser fitted at the discharge point if there is a likelihood of environmental or asset damage; and

(c) Not be subject to inundation.

6.4.2.6.1 *Scour sizes*

Scours shall be sized in accordance with table 6.4.

Table 6.4 – Minimum scour size

Main size DN	**Scour size** DN
DN ≤200	80
DN >200 – DN ≤300	100
DN >300 – DN ≤375	150

6.4.2.6.2 *Scour locations*

Scours shall be located at:

(a) Low points at the ends of water mains; and

(b) Low points between in-line stop valves.

Scours shall drain to a point where the discharge is readily visible to prevent the scour valve inadvertently being left open.

Typical discharge locations include:

(i) An approved pit that is to be pumped out each time the scour is operated (called a pump scour);

(ii) A kerb and channel;

(iii) An open-grated street drainage sump;

(iv) A natural water course (with energy dissipater).

Scours shall not:

(A) Cause damage when operated;

(B) Discharge to closed stormwater structures;

(C) Discharge across roadways;

(D) Discharge directly to waterways, unless in compliance with the appropriate consent requirements.

6.4.2.6.3 *Flushing points*

Flushing points shall be installed at the end of DN 65 rider mains (see Appendix A drawing WS-002).

6.5 Hydrants

6.5.1 *General*

Hydrants are installed on reticulation mains for fire fighting and/or operational purposes. Operational purposes include mains flushing, chlorination and to allow the escape of air during charging and the release of water during dewatering of the water main, where air valves and scours are not installed.

6.5.2 *Hydrants for fire fighting*

The spacing of hydrants for fire fighting shall be in accordance with SNZ PAS 4509.

6.5.3 *Hydrant installation*

Fire hydrants shall not be fitted to reticulation mains DN <100 or to distribution or transfer mains without the prior written approval of the TA.

6.5.4 *Hydrants for reticulation system operational requirements*

Additional to fire fighting requirements, hydrants shall be provided at:

(a) High points on reticulation mains to release air during charging, to allow air to enter the main when dewatering and for manual release of any build up of air, as required, where automatic combination AVs are not installed (see 6.4.2.5);

(b) Localized low points on water mains to drain the water main where scours are not installed.

Adequate drainage facilities shall be provided to receive the hydrant flows from dewatering and flushing operations.

> ***C6.5.4***
> *AVs are not normally required on reticulation mains in residential areas where the configuration of mains and service connections will usually eliminate small amounts of air accumulated during operation;*
>
> *Hydrants should be placed as close as possible to stop valves to facilitate maintenance activities such as cleaning of water mains.*

6.5.5 *Hydrants at ends of mains*

If a scour is not provided, a hydrant shall be installed as close as possible to the end of every main DN ≥100.

> ***C6.5.5***
> *Apart from the fire fighting function, a hydrant also allows the section of dead end main to be flushed regularly to ensure acceptable on-going water quality. This is particularly important in new subdivisions where only a small number of properties may be connected initially and where the main has been laid in a larger than required size with the expectation that it will be extended at a future date.*

6.6 Connections

6.6.1 *Connection of new mains to existing mains*

In specifying connection detail the designer shall consider:

(a) Pipe materials, especially potential for corrosion;

(b) Relative depth of mains;

(c) Standard fittings;

(d) Pipe restraint and anchorage;

(e) Limitations on shutting down major mains to enable connections; and

(f) Existing cathodic protection systems.

Connections from the end of an existing main shall be designed to address any differing requirements for the pipes being connected, particularly restraint, spigot/socket joint limitations and corrosion protection. The designer shall consider the potential for insufficiently restrained/ anchored stop valves near the connection.

All connections to the existing reticulation shall be made by a contractor approved the TA.

6.6.2 *Property service connections*

Property service connections shall conform with the sizes permitted by the TA.

The method of connection (including tapping) is dependent upon both the reticulation main and service connection pipe materials. The method adopted shall conform to:

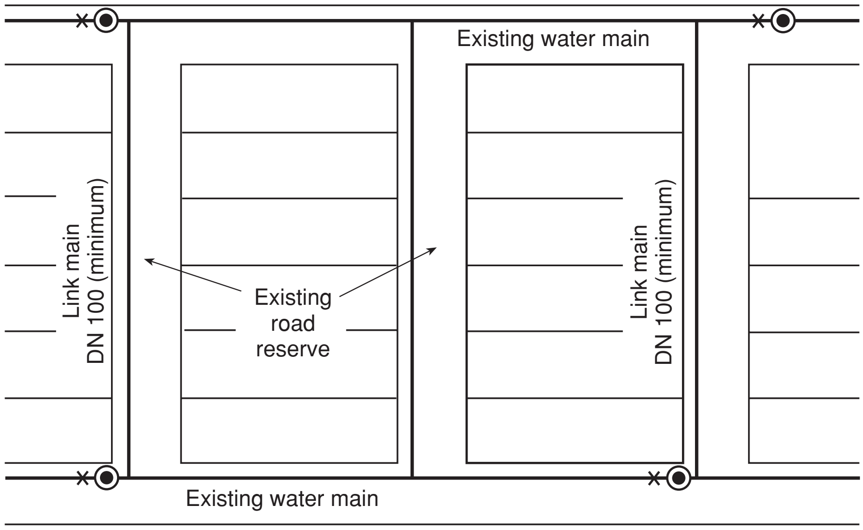
(a) Appendix A drawing WS-003;

(b) The requirements of the TA.

The position of the property connection toby valve, meter and backflow device shall conform with the requirements of the TA.

6.7 Termination points

Termination points or dead ends should be avoided to prevent poor water quality. Alternative configurations such as a continuous network, link mains, looped mains and use of reticulation mains smaller than DN 100, particularly in cul-de-sacs, should be considered (see figures 6.5 and 6.6).



NOTE – Rider mains are not shown.

Figure 6.5 – Elimination of termination points

NOTE– Rider mains are not shown.

Figure 6.6 – Looped and link principal mains

6.7.1 *Permanent ends of water mains*

Rider mains, DN <100, may be used to supply the furthest properties beyond the water main. The DN 100 main shall be laid to a point where all properties are provided with the fire protection required by SNZ PAS 4509.

A method of flushing shall be provided at the end of the rider main and water main, which shall be suitably anchored (see Appendix A drawing WS-002).

6.7.2 *Temporary ends of water mains*

Water mains shall be laid to within 1 m of the boundary of a subdivision where the main is to be extended in the future.

Temporary dead-end mains shall terminate with a hydrant followed by a gate valve. The valve and hydrant shall be suitably anchored so that the future extension can be carried out without the need to disrupt services to existing customers.

Where a development is staged mains shall be constructed to terminate approximately 2 m beyond the finished road works to ensure that future works do not cause disruption to finished installations.

6.8 Bends and tees

At street intersections where PVC pipes are used 90° tees and 90° bends are preferable to 45° bends separated with a short length of pipe. When the degree of curvature cannot be obtained within normal joint tolerances, bends not sharper than 45° shall be used.

6.9 System review

The designer shall undertake a system review to ensure compliance with the requirements of the TA and this Standard. Compliance shall cover at least the following issues:

(a) Minimum allowable operating (working) pressure can be maintained at all property connections. This may require zoning;

(b) Maximum allowable operating (working) pressure will not be exceeded anywhere in the system;

(c) Pipe class is suitable for the pipeline application (including operating temperature, surge and fatigue);

(d) Maximum and minimum flow velocities meet TA requirements;

(e) Pipe and fittings materials are suitable for the particular application and environment;

(f) Minimal likelihood of water quality problems or water stagnation;

(g) Valve spacing and positioning allow isolation of required areas;

(h) Mains layout and alignment meet TA requirements;

(i) Minimum fire fighting demands.

Control valves and scour systems where required are positioned to give required control of the system.

6.10 Construction of pipelines

6.10.1 *Excavation*

Excavation of existing carriageways shall conform to the TA's road opening procedures where these exist. Excavation in existing carriageways shall be carried out in a safe manner with the minimum disruption to traffic and/or pedestrians.

6.10.2 *Bedding*

Pipes and fitting shall be surrounded with a suitable bedding material (see Appendix A drawings CM-001 and CM-002).

6.10.3 *Backfilling and reinstatement*

6.10.3.1 *Carriageways*

Backfilling shall be in accordance with the requirements of the TA.

Pipe trenches within a carriageway shall be backfilled using an approved hardfill placed immediately above the pipe surround and compacted in layers not exceeding 200 mm in depth, as per Appendix A drawing CM-002.

In existing sealed streets, the top section of the trench shall be backfilled as specified by TNZ M/4. The depth of base course and type of finishing coat seal shall conform to the standard of the existing road construction.

6.10.3.2 *Berms*

Pipe trenches under grass berms and footpaths shall be backfilled in accordance with the requirements of Appendix A drawing CM-002.

6.10.3.3 *Detector tape*

Open trenching – backfill shall be placed to 100 mm below existing ground level. At this point, where required by the TA, the contractor shall provide and lay metallic 'detector' tape coloured blue, stipulating "Danger – Water Main Below" (or similar). See Appendix A drawing CM-001.

6.10.3.4 *Tracer wire*

When a pipe is installed by a directional drilling technique or bored through the ground for a distance exceeding 20 m, the pipe shall have a 'tracer wire' attached. This wire shall take the form of a continuous 2.5 mm^2 multi strand (polythene-sleeved) cable, strapped to the pipe wall by means of a minimum of two complete wraps of heavy duty adhesive tape, at a maximum of 3.0 m intervals.

6.10.4 *Pressure testing of water mains*

Before a new water main is connected to the existing reticulation, a successful pressure test shall be completed. The test shall be carried out as specified in Appendix B, in the presence, and to the satisfaction, of the authorized officer.

6.10.5 *Discharge of testing water from pipelines*

Discharge of testing water from pipelines may require a resource consent.

6.10.6 *Disinfection of water mains*

Disinfection of the water mains shall be carried out following successful pressure testing and backfilling as specified in Appendix C. The disinfection solution shall be collected and disposed of in an appropriate manner.

6.10.7 *Discharge of water containing chlorine from pipelines*

Reference should be made to the relevant regional council to ascertain the conditions for discharging chlorinated water.

6.11 Means of compliance with this Standard

Unless the TA has its own specific levels of service and or specific design criteria the following may be used as a means of compliance with this Standard.

6.11.1 *Standard pipe sizes*

The principal main shall be standardized as DN 100, 150, 200, 250, 300, 375, 450, 525 and 575 mm nominal diameter only. When larger pipes are required the exact diameter will be determined by the TA.

6.11.2 *Minimum pipe sizes*

Minimum pipe diameters shall be as follows:

(a) DN 50 for rider mains in residential zones;

(b) DN 100 for residential zones;

(c) DN 150 for industrial or commercial zones.

The TA may also specify minimum pipe diameters for other identified areas such as CBDs.

6.11.3 *Allowable operating pressures (heads)*

The operating pressures (see 6.3.9.6) shall be as per table 6.5.

Table 6.5 – Operating pressure limits

Allowable operating pressure (Head)	**Residential pressure (Head)**		**Industrial/commercial pressure (Head)**	
Maximum	800 kPa	(80 m)	800 kPa	(80 m)
Minimum	200 kPa	(20 m)	250 kPa	(25 m)

The minimum pressures shall be measured at the building platform on the site.

6.11.4 *Minimum flows*

The minimum flow shall be:

(a) 25 L/min for normal residential sites;

(b) As specified in SNZ PAS 4509.

6.11.5 *Minimum water demand*

The minimum peak domestic demand shall be based on:

(a) Daily consumption of 250 L/p/day;

(b) Peak factor of 5.

6.11.6 *Sizing of mains*

Tables 6.6 and 6.7 may be used as a guide for sizing mains.

Table 6.6 – Empirical guide for principal main sizing

Nominal diameter of main DN	Capacity of main (single direction feed only)			
	Residential (lots)	Rural residential (lots)	General/light industrial (ha)	High usage industrial (ha)
100	40	10		
150	160	125	23	
200	400	290	52	10
225	550	370	66	18
250	650	470	84	24
300	1000	670	120	35
375	1600	1070	195	55

Table 6.7 – Empirical guide for sizing rider mains

DN 50 Rider mains		
Pressure	Max no. of dwelling units	
	One end supply	Two end supply
High > 600 kPa	20	40
Medium 400-600 kPa	15	30
Low < 400 kPa	7	15

6.11.7 *Reticulation layout*

A water main of not less than DN 100, the principal main, fitted with fire hydrants shall be laid on one side of all public roads and cul-de-sacs in every residential development. A DN 50 rider main shall be laid along the road frontage of all lots not fronted by the principal main. A DN 50 rider main shall also be provided for service connections where the principal main is DN 250 or larger. The principal mains serving industrial and commercial areas shall be at least DN 150 laid on both sides of the street. This requirement may be relaxed in short cul-de-sacs as long as adequate fire fighting coverage is available.

6.11.8 *Stop valve spacing criteria*

The number of property service connections in a shut-off area shall be in accordance with table 6.8. When assessing property service numbers, unit title and strata title properties such as apartment buildings and multi-unit developments shall be counted as multiple connections. All connections having an alternative supply may be excluded when assessing property service numbers. The overriding maximum spacing between in-line valves shall be in accordance with table 6.8.

Table 6.8 – Stop valve spacing criteria

Water main size DN	**Number of property service connections (nominal)**	**Maximum spacing** (m)
≤150	40	300*
200-300	100	750
375	150	1000

* In rural areas, the maximum spacing is 500 m.

Part 7: LANDSCAPE DESIGN AND PRACTICE

Figure

PART 7: LANDSCAPE DESIGN AND PRACTICE

7.1 Scope

This Part primarily applies to landscaping, whether in road reserves, recreation reserves or other public reserves. Each TA may have specified landscape guidelines which will be detailed in district plans or codes of practice and some areas may be subject to special landscape requirements which will need assessment through a resource consent process.

7.2 General

7.2.1 *Concept stage*

Landscape design has application at all levels of the subdivision and development process. At the initial concept stage it may be important to establish objectives for overall landscape design including open space connections, access to and location of watercourses, protection of remnant vegetation, and provision of reserves and streetscape to provide a framework of coherence and amenity. At a more detailed level landscape plantings may need to be located to minimize effects on vehicle sight lines.

7.2.2 *Compatibility with engineering design*

Landscape design should be considered in the early stages of a development to ensure that any landscape conditions and objectives are compatible with subsequent engineering design and works. Landscape design is intended to enhance the character and environment of a development, to strengthen existing neighbourhood character and unify those areas into an integrated district. Landscape design is not, however, compulsory for all developments and must be assessed in accordance with the scale of the development, identification of positive effects that landscaping may provide and local conditions.

7.2.3 *Long-term public benefit*

Any landscaping shall provide maximum long-term public benefit with minimum ongoing maintenance costs, while giving due regard to the safe use of public assets.

7.2.4 *Recreation reserves*

Recreation reserves to be vested in the TA shall also comply with Part 8 of this Standard.

7.2.5 *Functional and aesthetic opportunities*

Landscaping provides a range of functional and aesthetic opportunities for environmental enhancement:

(a) Functional:

- (i) Defines space
- (ii) Provides shade, shelter and privacy
- (iii) Screens unsightly outlooks
- (iv) Ameliorates noise and pollution
- (v) Assists driver recognition of road bends, junctions and roading hierarchy
- (vi) Reduces glare and reflection
- (vii) Assists in the control of erosion
- (viii) Creates physical barriers
- (ix) Provides recreation and amenity value.

(b) Aesthetic:

- (i) Frames views
- (ii) Emphasizes landform and landscape features
- (iii) Provides visual unity in the environment
- (iv) Reduces the visual impact of the roadway
- (v) Softens hard surfaces and bleak areas
- (vi) Provides colour, form and texture
- (vii) Provides visual lineage within and between regions
- (viii) Provides identity and environment.

7.2.6 *Street landscaping*

Opportunities for street landscaping are diverse, ranging from specimen tree planting within the standard road berm (see figure 7.1) to planting associated with traffic calming devices and specific landscape features within the development.

7.3 Design

7.3.1 *Location*

7.3.1.1

Trees and garden plantings shall be located so as not to compromise the integrity and efficient operation of infrastructural services. As such if particular landscape conditions or objectives are required for a subdivision or development then these will need to be taken into account prior to undertaking detailed engineering design.

7.3.1.2

The minimum separation and site distances referred to in figures 7.1 and 7.2 should be observed for tree and shrub planting. These distances are guidelines and may have to be increased depending on the road geometry.

7.3.1.3

Alternative location and design proposals will also be considered, such as provision of trees in a dedicated “non-services” berm, either side of a footpath. “Curved” footpaths allow for tree planting in groups and can help accentuate road perception particularly at intersections. Strategically placed, grouped plantings of trees are often of greater benefit and impact than individual trees placed outside each house.

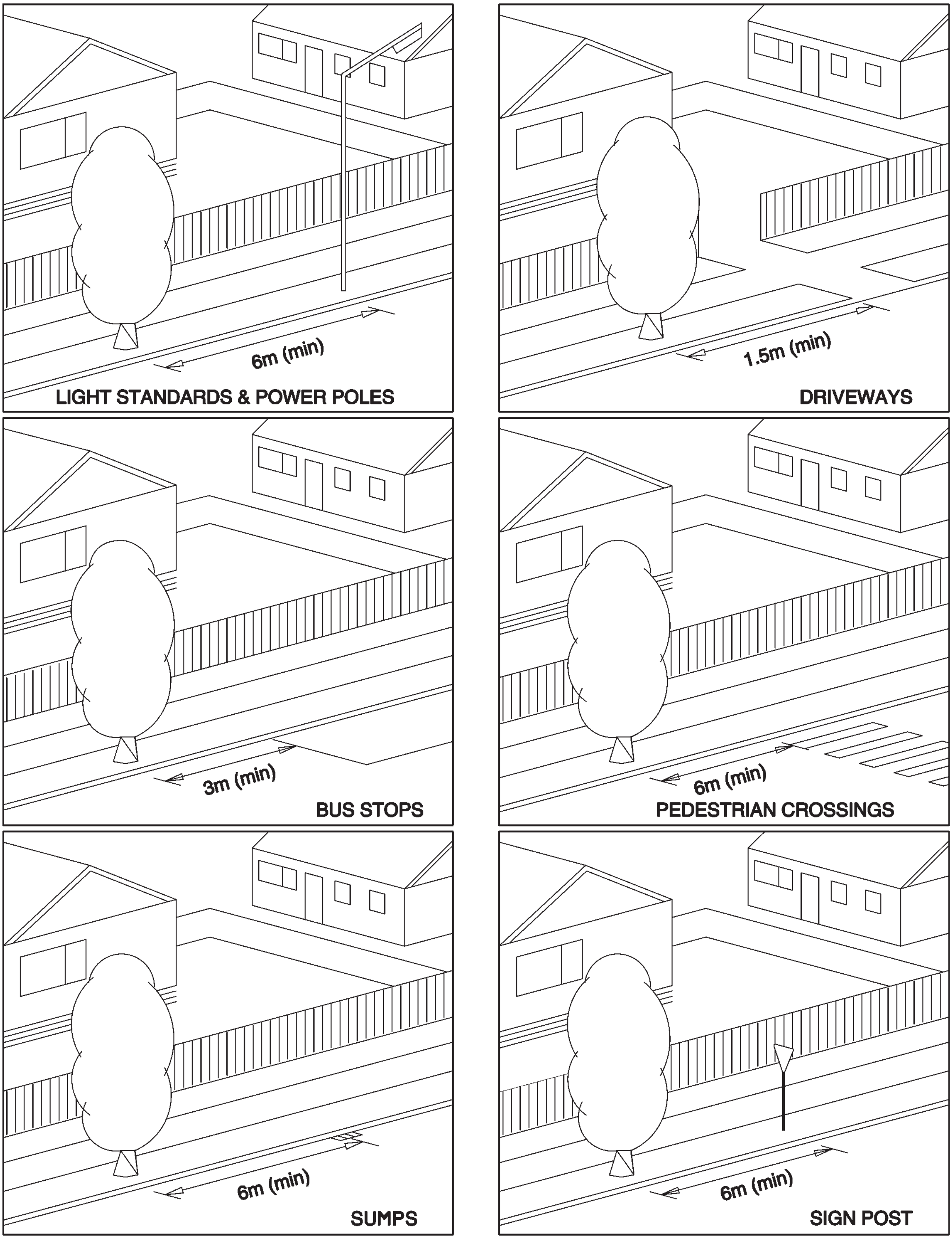
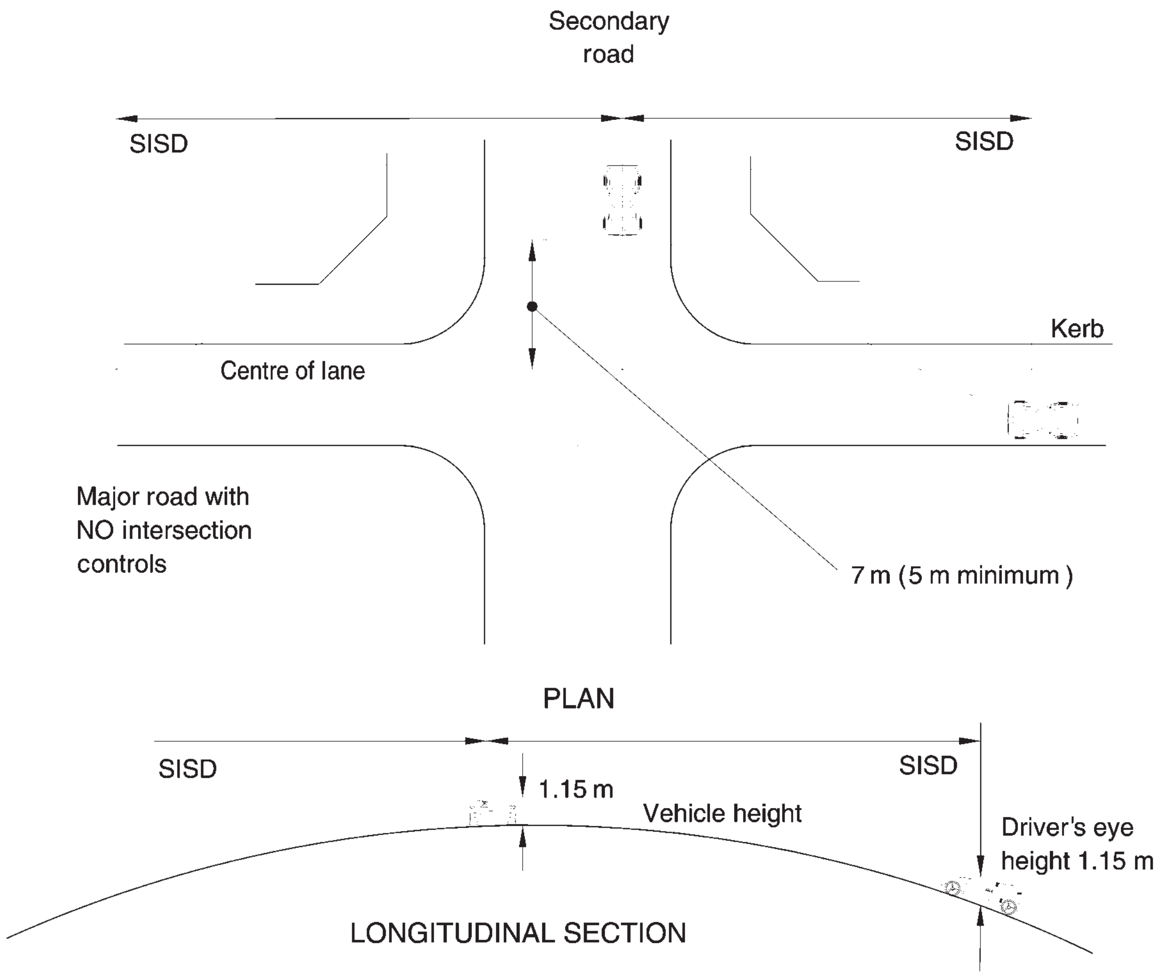


Figure 7.1 – Street tree planting clearances



Speed Value (km/h)	Safe Intersection Sight Distance (SISD) Rural	Urban
40	70	60
50	90	80
60	115	105
70	140	130
80	175	165
90	210	-
100	250	-
110	290	-
120	330	-

NOTE –

1. It is desirable that plants are placed far enough back from the intersection so that even when mature the SISD is maintained

2. See Transit New Zealand's guidelines for planting for road safety for more details.

Figure 7.2 – Intersection sight distances for clear sight lines for landscaping

7.3.2 *Tree/plant size*

7.3.2.1 The mature size of any tree or garden planting is to be assessed for each planting location and is to be in scale with the surrounding street environment. Plants should not exceed 450 mm in height in the sight triangle of intersections, or other traffic or vehicle/pedestrian conflict areas, unless tree planting provides for eventual clear trunking to a high canopy, or planting does not interfere with sight lines.

7.3.2.2 The minimum planting size of a landscape tree is 1.5 m tall at the time of planting unless the local conditions of a site require consideration of alternatives, e.g., an exposed site may require small, well-hardened trees.

7.3.3 *Species selection*

7.3.3.1 Species are to be selected with regard to overall composition, low maintenance and longevity and should comply with the TA's planting policies. The TA should maintain a register of suitable species for local conditions.

7.3.3.2 The number of species used should ensure a unified result and species choice in street gardens to complement street planting, environment, and scale of surroundings. The following matters are to be considered for correct species selection:

(a) Suitability to environmental conditions e.g. ground moisture, wind, etc.;

(b) Tolerance to amenity situation;

(c) Pest and disease resistance;

(d) Non-suckering habit;

(e) Longevity;

(f) Shading consistent with location;

(g) Minimum maintenance requirements;

(h) Toxicity of leaves, flowers, seeds and bark in areas likely to be used by young children.

7.3.4 *Quality control*

7.3.4.1 All plants shall be sound, healthy, vigorous and free of any defects which may be detrimental to plant growth and development. In addition plants should have vigorous root and branch systems and plants supplied in pots must not be root bound. Defects may include but are not limited to the following:

Pests	Denuded bark
Diseases	Form not consistent with species
Sun scalds	Multileaders
Abrasions	Dead wood
Cankers	Girdling roots
Cracks	Weed and parasites
Excess dead leaf material	Breakages
Plants not hardened off	Spent flowerheads
Tree proportion (i.e. trunk calliper/tree size)	Frost damage

7.3.4.2 Generally only species adapted to the site conditions shall be planted.

7.3.5 *Landscaping structures*

7.3.5.1 Landscaping structures include (but are not limited to) sculptures, walls, fences, screens, bollards, entranceways, posts, etc., and could be made from materials such as concrete, brick, stone, rock and timber. The design of the landscape must be considered as an integral part of the development and surroundings to fulfil both functional and aesthetic requirements. Durability and maintenance requirements must be considered.

7.3.5.2 Structures must be located so that they do not obstruct the sight lines for intersections, pedestrian crossings and signs. The separation distances must be considered together with trees and other landscaping features.

7.3.5.3 Structures must be designed to safely withstand appropriate loadings and must not be a hazard to traffic.

7.3.5.4 Entranceway wall structures must be located fully on private land. Any other immovable landscape structure (e.g. boulders) is not to be located so as to prevent access to underground services.

7.3.5.5 The developer is responsible for gaining any necessary building consents in respect of proposed structures, including retaining walls. All retaining walls including those not requiring a building consent should be constructed to resist lateral earth pressures and those from any surcharge loading that may be present.

7.3.6 *Irrigation*

7.3.6.1 The TA may require provision for permanent irrigation of street gardens.

7.3.6.2 Provision for irrigation during the establishment of plants is acceptable for gardens that are not otherwise irrigated.

7.3.7 *Grassing of berms*
Grassing of berms shall be in accordance with 3.4.16.

7.4 Construction

7.4.1 *Introduction*
This section outlines minimum construction and maintenance standards required and recommended procedures to be followed to ensure that all landscape works are at an acceptable standard prior to final inspection and release of the bond if a bond is required.

7.4.1.1 It is the developer's responsibility to ensure that the landscape works meet the required standards at the termination of the maintenance period.

7.4.1.2 The developer is responsible (and may be bonded) for the routine maintenance and replacement of the planting including dead wooding, weed control, mulching, replacing dead trees, shrubs and plants and watering for a period of 18 months from the time of acceptance of as-built landscape plans by the TA or issue of a s. 224 certificate under the Resource Management Act 1991, whichever is later.

7.4.2 *Soil and fertility*

7.4.2.1 The developer shall be responsible for the supply and spreading of fertilizer. A proprietary fertilizer suited to the species shall be applied where plants are showing signs of lack of fertility, or to ensure maximum health and vigour.

7.4.2.2 Application rates and type of fertilizer should vary according to species.

7.4.3 *Weeds*

7.4.3.1 At the end of the maintenance period there shall generally be no weeds within 2 m of any tree planting.

7.4.3.2 It is preferable that weeds are controlled manually. When hoeing/pulling weeds care shall be taken to avoid damage to plants and their roots. The soil shall not be mixed with mulch when removing weeds.

7.4.4 *Mulch*

7.4.4.1 Mulch shall be cambium grade bark mulch. Bark mulch must be clean, free of sawdust and dirt and with individual pieces no larger than 100 mm. Mulch for gardens and shrubberies shall be a uniform 100 mm in final depth. Edges shall hold mulch without spillage.

7.4.4.2 Before mulching soil should be damp to a depth of 300 mm. Mulching should be carried out on an ongoing basis to all shrubberies and juvenile trees to maintain specified depth at end of maintenance period.

7.4.4.3 Mulch shall only be spread after the soil surface is levelled off to remove bumps and hollows. Weeds and grass are to be removed prior to mulching. Plants must not be damaged or buried during the mulching process.

7.4.4.4 Where it is known that bark mulch affects certain species or will be lost due to wind, slope of the land or for some other reason, alternative mulches shall be considered and used.

7.4.5 *Juvenile tree planting*

7.4.5.1 Juvenile trees are defined as trees with a trunk diameter of less than 100 mm when measured at 1400 mm above ground level.

7.4.5.2 Those contractors involved in juvenile tree planting and maintenance are expected to be competent horticultural/ arboricultural practitioners and therefore follow accepted industry standard procedures for tree planting.
Establishment and initial maintenance are critical to the long-term viability of the street tree.

7.4.5.3 Juvenile trees are to be a minimum of PB 95 (planter bag of 95 pint capacity approximately 54 L) grade when planted.

7.4.5.4 Given the generally modified nature of soil within the subdivisional environment it is essential that a suitable tree planting pit be prepared. The approach outlined in figure 7.3 shall be followed including:

(a) Area shall be free from debris and rubbish;

(b) Ground shall be cultivated to a depth of 1 m to break up any compaction and fracture subsoil and afford drainage to hard rock areas;

(c) Sides of planting holes shall be crumbled and not smooth;

(d) Topsoil shall be incorporated into the upper level of planting holes;

(e) Each tree shall be fertilized with 15 g of slow release fertilizer;

(f) Each tree shall be secured with specified stakes and expandable ties. Two untreated 50 mm x 50 mm stakes per tree shall be driven into the ground 1/3 of their length before planting. Trees are to be secured with expandable ties at approximately 1/3 of their height;

(g) Soil shall be firmed sufficiently to force any air pockets from planting holes; and

(h) Trees shall be watered immediately following planting.

7.4.5.5 The onus is on the developer to ensure that trees are protected during the further development of the subdivision (i.e. construction of dwellings/buildings) during the 18-month maintenance period.

7.4.5.6 In accordance with 7.3.4.1 juvenile trees must be sound, healthy, vigorous, and free of any defects (relative to the species).

7.4.5.7 Final planted depth is to be consistent with finished ground level.

7.4.5.8 Ties are to be expandable (refer to figure 7.4 for suggested tree tie configuration).

7.4.5.9 Staking is to be uniformly low and visually consistent throughout the subdivision stage. Ground treated timber stakes should only be used if the stakes are to be removed once the trees are stable, i.e. at the end of a maintenance period.

7.4.5.10 Mulch type and depth shall be in accordance with 7.4.4. Trees are to be radially mulched to a distance of 500 mm or to drip line, whichever is the greater area.

7.4.6 *General planting*

7.4.6.1 Before topsoil is added all stripped and graded ground intended for planting should be cultivated to a depth of 500 mm to break up any compaction.

7.4.6.2 There should be 300 mm of friable topsoil.

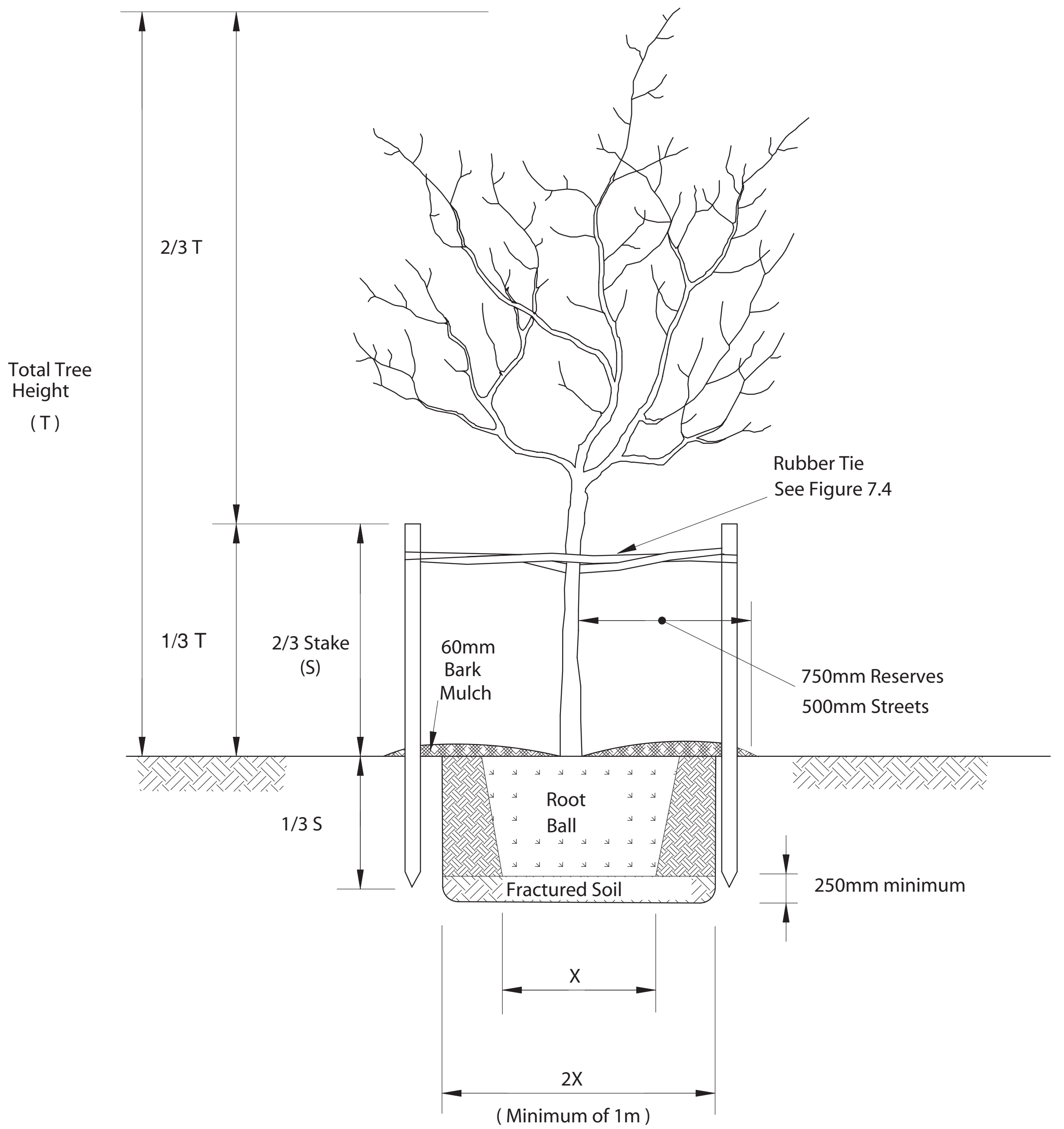


Figure 7.3 – Juvenile tree planting

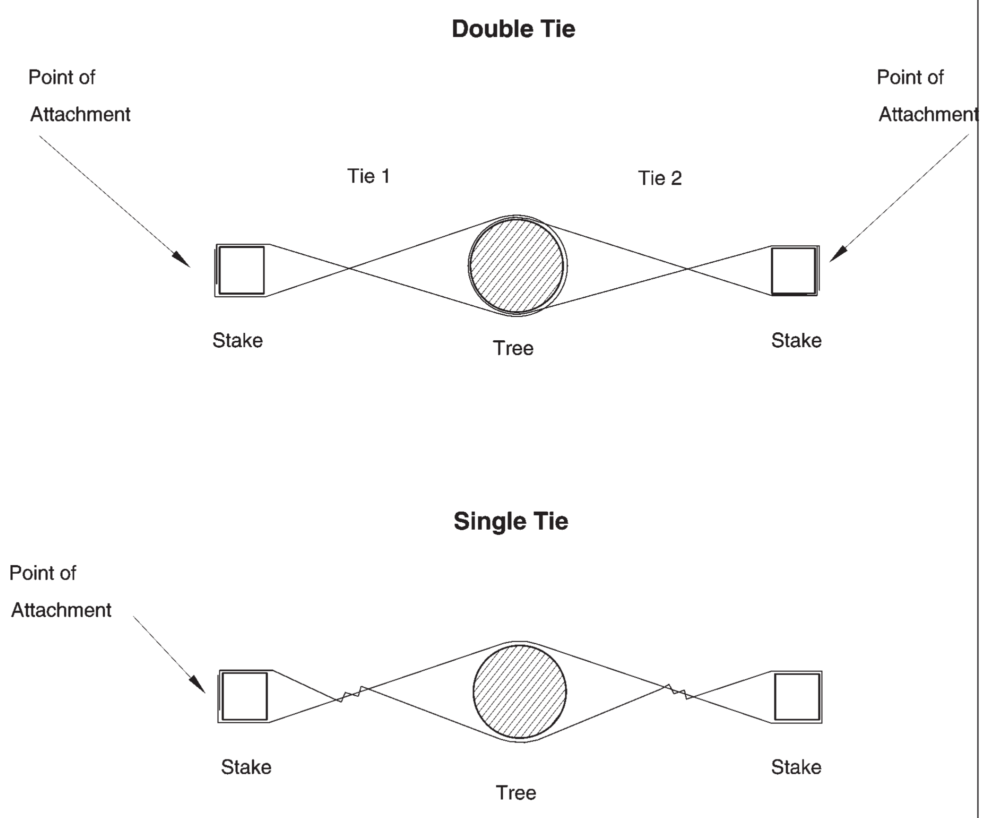


Figure 7.4 – Recommended tree tie configurations

7.4.7 *Pruning*

7.4.7.1 Trees should be selected and located to minimize ongoing pruning costs and requirements. Pruning should be carried out on shrubs to maintain a high standard of presentation, display, and plant vigour. Paths, roads and all other accessways should be kept clear of excess growth. Pruning is also necessary to ensure signs are not obscured.

7.4.7.2 All weak, dead, diseased and damaged growth should be removed, and pruning carried out to maintain the desired shape and size.

7.4.7.3 Pruning should not be carried out during leaf burst or leaf fall.

7.4.7.4 The following pruning techniques (for shrubs only) should be employed where appropriate:

(a) Tips to be pinched or purged as appropriate for species to give desired shape and size;

(b) Form pruning of young plants to ensure compact form and shape;

(c) Undercutting of groundcovers at edges generally;

(d) Plants are to be pruned so that they do not smother neighbouring plants.

7.4.7.5 Pruning to provide adequate sight visibility at intersections and driveways is required. This is to ensure the safety of pedestrians and motorists (see figure 7.2).

7.4.7.6 Spent flower heads should be removed including but not limited to the following species: Agapanthus, flax, grass species and Arthropodium.

7.4.7.7 All future pruning of street trees, once planted, shall be undertaken by a suitably qualified arborist/horticulturist. All pruning shall be undertaken to recognized arboricultural practices.

> ***C7.4.7.7***
> *For recommended arboricultural practices refer to "Modern Arboriculture" by Alex Shigo, and for guidelines to promote the natural form and habit of individual species refer to "Sunset Pruning Handbook", published by Sunset Books.*

7.4.8 *Restoration and tidy up*

7.4.8.1 The developer shall remove all temporary services, machinery and surplus materials that have been used for the work from the area and leave the site in a tidy condition.

7.4.8.2 The developer shall clean all paths and surrounding areas. All plant labels shall be removed. Channels shall be cleared and weeded. All damage shall be made good to the satisfaction of the TA.

7.4.8.3 The developer shall ensure that plants are picked over to remove prunings, dead or damaged leaves and any other object or material, including retail attachments such as labels. The edges of the beds shall be left evenly shaped and sloped.

7.4.8.4 For high maintenance areas such as roses, annual bedding and perennial areas, the developer shall ensure that footprints are removed by lightly raking over the bed with a fork or hoe and that all surrounding areas are swept clean. Grass restoration where re-sowing is involved shall be included as a requirement under the maintenance period.

PART 8: RESERVES

Figure

PART 8: RESERVES

8.1 Scope

This Part of the Standard sets out the requirements for the development of reserves (recreation, drainage, vegetation, earthworks, presentation and fencing) to be vested in the TA as provided by a resource consent.

8.2 General

8.2.1 Landscaping planting is to be carried out in accordance with Part 7 of this Standard.

8.2.2 Development plans for all reserves showing the proposed work shall be submitted with application for engineering approval, and no work is to be carried out on site before the TA approval is issued.

8.2.3 All reserves are to be presented so as to be economically maintained, for example by tractor-mounted mowing equipment, and with established landscape plantings.

8.2.4 All reserves are to be fenced to surveyed and pegged boundaries.

8.3 Design and construction

8.3.1 *Activity*

No activity shall take place on proposed reserves prior to vesting without the approval of the TA.

Such activity includes but is not limited to:

(a) Clearing works;

(b) Removal of topsoil and cut to fill operations;

(c) Dumping of soil materials;

(d) Stockpile of materials, or contractor maintenance/parking areas.

8.3.2 *Earthworks on reserves*

8.3.2.1 Earthworks, subject to prior approval by the TA as required in 8.3.1, may be carried out on reserves to remove such items as tree stumps, buildings and foundations, farm tracks, cattle yards, roading aggregate etc., and to provide maximum finished gradients of 1 vertical to 4 horizontal for mowable areas. Profiles should be obtained which do not excessively pond water during 20 % AEP storms, and drain sufficiently to allow year round mowing by tractor-mounted equipment.

8.3.2.2 All earthworks on reserves are to be carried out to avoid erosion or dust nuisance in accordance with a consent from the regional council or the TA, to be obtained by the developer.

8.3.3 *Stormwater drainage for reserves*

Sufficient piped drainage reticulation shall be installed from the lowest point of the reserve to ensure that water does not pond excessively on reserves. Stormwater drainage shall comply with Part 4 of this Standard. Internal reserve drains may be by dry swales or open drains for reserves with large upstream catchments.

8.3.4 *Existing trees*

All existing trees on the reserves shall be inspected by an experienced arborist, prior to development plans being prepared and suitable healthy trees retained where practical. Prior to vesting any required arboricultural maintenance shall be undertaken by an approved arborist.

Existing trees to be retained are to be protected during earthworks and reserve development by temporary fencing 1 m beyond the drip line of the tree.

8.3.5 *Park furniture/structures*

Proposed park furniture or structures shall be shown on the reserve development plan for approval. All park furniture or structures shall be robust, maintenance free, able to be safely used by the public and treated with an approved graffiti guard.

Structures, including but not limited to seats, pergolas, sculptures, walls, fences, screens, bollards entrance posts etc., could be constructed from materials such as concrete, bricks, stone, rock and treated timber. The design of any landscape features must be considered as an integral part of the reserve and its surroundings to fulfil both functional and aesthetic requirements.

Structures not exempt under the Building Act 1991 shall only be constructed on receipt of a building consent.

Playground equipment shall comply with NZS 5828 *Specification for Playground and Playground Equipment* and the *New Zealand Playground Safety Manual*.

8.3.6 *Pedestrian accessways*

Pedestrian accessways shall have permanent surfacing to the widths and gradients detailed in 3.3.12.

All walkways less than 2.5 m wide shall be fenced on both sides to the minimum of the standard shown in figures 8.1 and 8.2, with a fence constructed within the reserve.

The TA may also require fencing of any walkways over 2.5 m wide subject to individual requirements.

8.3.7 *Presentation of reserves*

Land to be vested for reserves purposes shall as a minimum meet the following general requirements:

(a) The land is to be free of noxious weeds, tree stumps (above ground) and other specified vegetation;

(b) All previous fences, farm utilities etc., building remains, and rubbish are to be removed or disposed of to the satisfaction of the TA;

(c) Land is to be accessible for tractor-mounted mowing equipment, and is to have an established turf type seed grass cover;

(d) All boundaries are to be surveyed and clearly pegged;

(e) Any rights of way or easements are to be formalized at no cost to the TA;

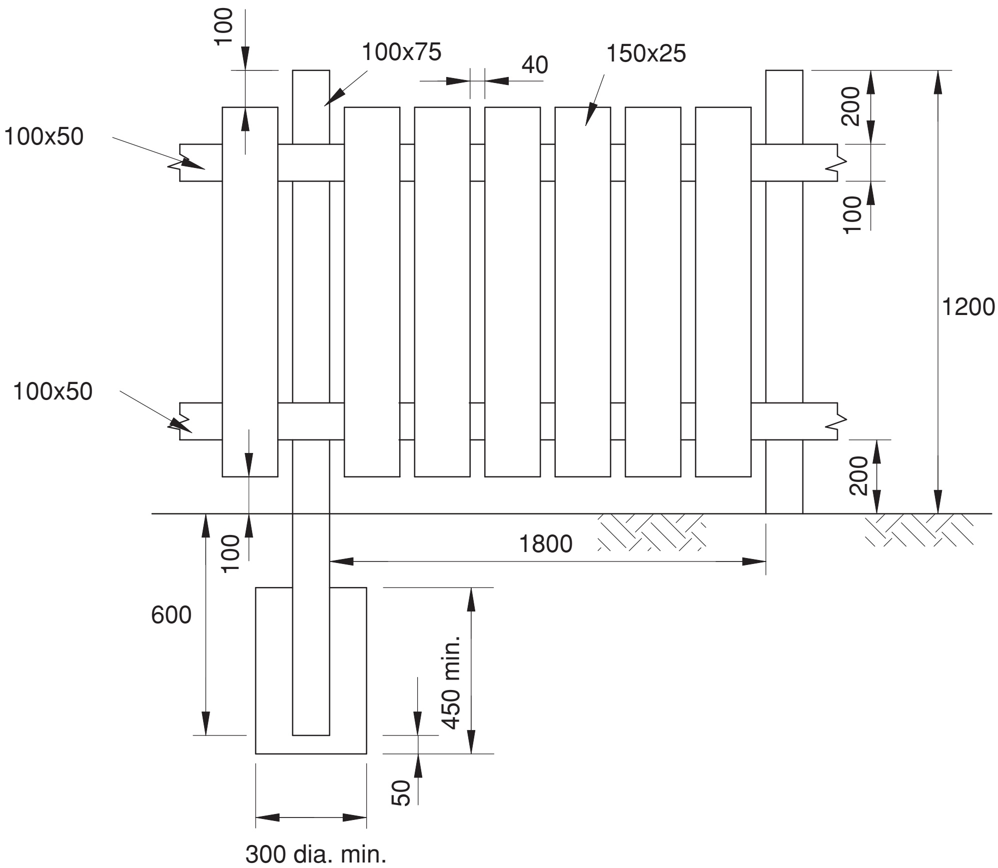
(f) Any proposed landscape planting or furniture/structures shall be completed.

8.3.8 *Fencing of reserves*

The permanent fencing of common boundaries of any reserve including esplanade and accessway reserves, may be required. The TA may specify that one of the following options apply:

(a) A fencing covenant be registered on all titles of properties with a common boundary to reserve land, indemnifying the TA against all costs of erection and maintenance of fences on common boundaries; or

(b) A fence be erected in accordance with figure 8.1, or in the case of reserves in a rural area, in accordance with figure 8.2.

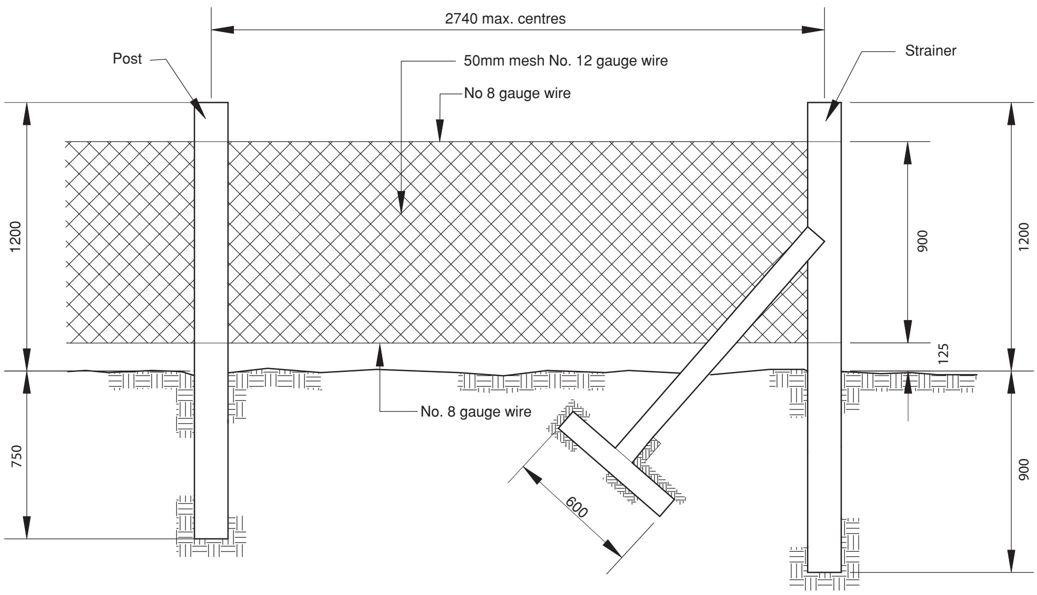


CLOSE BOARDED TIMBER PALING FENCE

NOTES –

1. Alternative fence types to that shown may be approved by the Authorized Officer.
2. All timber is to be ground treated.
3. Posts not to be greater than 1.8 m apart and are to be set in concrete or approved by the Authorized Officer.
4. Vertical timber palings to be on Reserve side.
5. All joins are to be by way of galvanized bolts or nails and are to be firmly secured.
6. All construction to be in accordance with recognized trade practice.
7. Concrete mowing strip is required on both sides of the fence and to extend 150 mm on each side.
8. Pedestrian accessways shall generally be concreted full width.

Figure 8.1 – Standard urban fencing for reserves

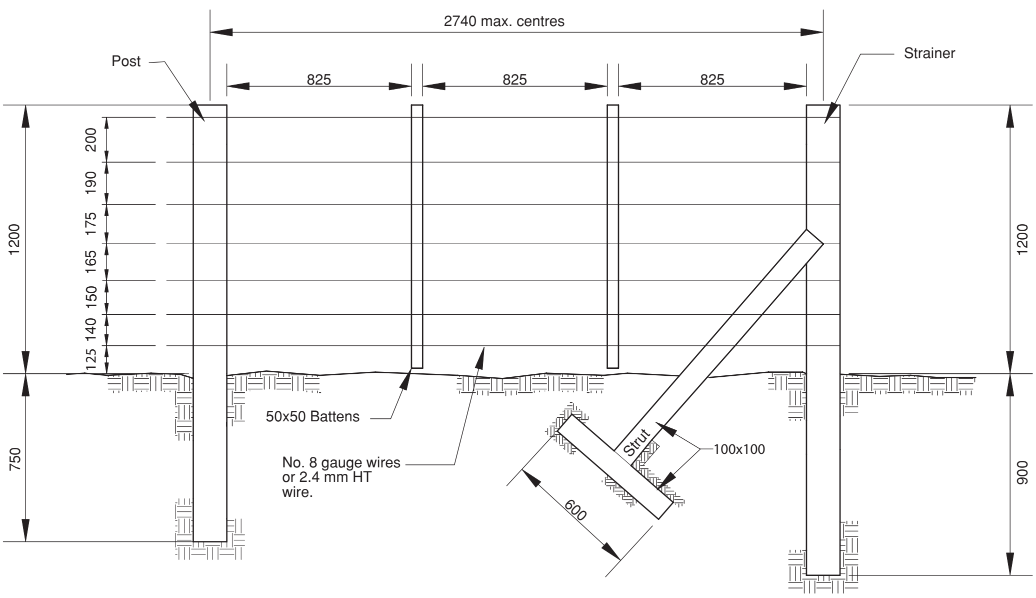


STANDARD WIRE-MESH FENCE

Minimum Sizes: Timber posts and struts - 100 x 100 mm or 150 mm Ø

Timber strainer posts - 150 x 150 mm or 225 mm Ø

Reinforced Concrete Posts: Size and design to be approved.



STANDARD WIRE FENCE

Minimum Sizes: Timber posts and struts - 100 x 100 mm or 150 mm Ø

Timber strainer posts - 150 x 150 mm or 225 mm Ø

Figure 8.2 – Standard rural fencing for reserves

PART 9: POWER, TELECOMMUNICATIONS, GAS

PART 9: POWER, TELECOMMUNICATIONS, GAS

9.1 Scope

This Part of the Standard sets out the requirements for the provision of power, telecommunications and gas and their locations in the street.

9.2 General

The developer is required to make all arrangements with the appropriate network utility operators for the supply and installation of electric power and to the extent applicable for the provision of telecommunication and gas reticulation.

The developer shall provide satisfactory evidence to the TA that the network utility operator is prepared to reticulate the subdivision and that agreement on the financial arrangements for the installation of the supply has been reached.

(a) Electric power. The supply of electric power shall generally be by means of an underground system. Ducts shall be installed at the time of road construction to the requirements of the electrical supply authority.

(b) Telecommunications. Arrangements shall be made with the telecommunication supplier for the reticulation of telecommunication facilities. Where only part of this reticulation is being supplied initially the arrangements shall include the requisite space being maintained for the installation of the remainder of the reticulation at a later date. Ducts will be supplied to the subdividing developer at the time of road construction for installation in the carriageway formation at locations where cables may be required at a later date.

(c) Gas. Where an existing gas supply is available or likely to be available to serve a subdivision, the developer may make appropriate arrangements with the gas supply authority, and at the time of road construction, install such duct pipes as may be required.

9.3 Design

9.3.1 *Plans*

Copies of the plans of the development/subdivision shall be forwarded by the developer to the network utility operators at an early date to facilitate the design of the reticulation.

> ***C9.3.1***
> *It is important that the network utility operators be advised by the developer of any amendments to the development plan. Information when available on the type of dwellings and likelihood of more than one dwelling on any lot, will be valuable for design purposes.*

9.3.1.1 In preparing the engineering plans due regard shall be given to the requirements of the network utility operators as to:

(a) Minimum cover to cables and pipes;

(b) The network utility operator's desired position for the cable/piping/mains within the street berm;

(c) The minimum separation distances between power or telecommunication cables, and gas or water mains;

(d) The width of berm which must be clear of other services and obstructions to enable efficient cable laying operations.

> ***C9.3.1.1***
> *Reference should be made to each network utility operator for their specific requirements.*
>
> *Refer to SNZ HB 2002 for further information.*

9.3.2 *Utilities above ground*

These should preferably be sited within the street berm or on land which will legally become part of the street but which is set back outside the normal street line. Alternatively separate lots (public utility reserves) or easements over private property may be used.

9.4 Construction

9.4.1 *Underground cabling*

Underground cable laying shall be achieved by the most appropriate method having regard to the nature of subsoil and potential damage to infrastructures and must be to the approval of the TA.

> ***C9.4.1***
> *The trenchless method is preferred in urban areas for underground cabling. Refer to SNZ HB 2002 for further information.*

9.4.2 *Materials*

Materials for ducting and the sizes of ducts shall comply with the requirements of the network utility operators.

9.4.3 *Conversion to underground on existing streets*

Where a proposed subdivision fronts on to an existing street, the conversion of overhead reticulation to underground will in some instances be desirable. Agreement on the feasibility and benefit will first be agreed between the network utility operator and the TA.

9.4.4 *Industrial and commercial subdivisions*

The servicing requirements for industrial and commercial areas are often indeterminate. Close liaison between the developer and the network utility operator is advisable, particularly immediately before cabling is installed so that changes can be incorporated to accommodate extra sites or the requirements of a particular industry.

9.4.5 *Location of services*

9.4.5.1 Position in the street

The position of services in the street shall conform to the established local practice, as agreed between the TA and the various network utility operators and as prescribed by the TA.

9.4.5.2 *Recording of underground services*

TAs should maintain a procedure for recording the location of underground services on plans which are readily available to the public at the TA office. It is unlikely that the TA will be able to provide a full service, and will be able to record only the services for which it is immediately responsible. These will usually be water, sewerage and stormwater drainage. Other authorities or network utility operators should be required to maintain similar records of the existence and detailed location of their services for ready reference.

9.4.5.3 *Accuracy and tolerance*

It is essential that all services be laid to predictable lines if there is to be a reasonable opportunity of laying new services within existing systems. In addition to specifying the location of any service in the street berm, there should also be a tolerance which must on no account be exceeded without proper measurement and recording on the detailed record plan. Tolerance of ±100 mm is recommended.

9.4.6 *Trenches*

9.4.6.1 When new subdivision work is undertaken the backfilling and compaction of trenches to a state of stability consistent with the future of the surface shall be carried out to the satisfaction of the TA.

9.4.6.2 Where underground services are laid after the initial engineering work of the subdivision or where they are extended from an existing area into a new one, special attention shall be given to the opening and reinstatement of trenches to the satisfaction of the TA.

> ***C9.4.6***
>
> *TAs are recommended to prepare standard specifications for the opening of trenches and the restoration of surfaces. Network utility operators are in turn recommended to comply with the requirements of such specifications.*
>
> *Refer to SNZ HB 2002 for further guidance.*

APPENDIX A
STANDARD CONSTRUCTION DRAWINGS
(Informative)

The following drawings are sourced with permission from the Water Services Association of Australia and modified for New Zealand conditions.

COMMON DETAILS

CM–001	Embedment and trenchfill – typical arrangement
CM-002	Standard embedment – flexible and rigid pipes
CM-003	Bulkheads and trenchstop – standard details
CM-004	Manhole – standard details
CM-005	Manholes – mini and drop manhole details
CM-006	Manholes – stormwater or wastewater DN 375 to DN 750

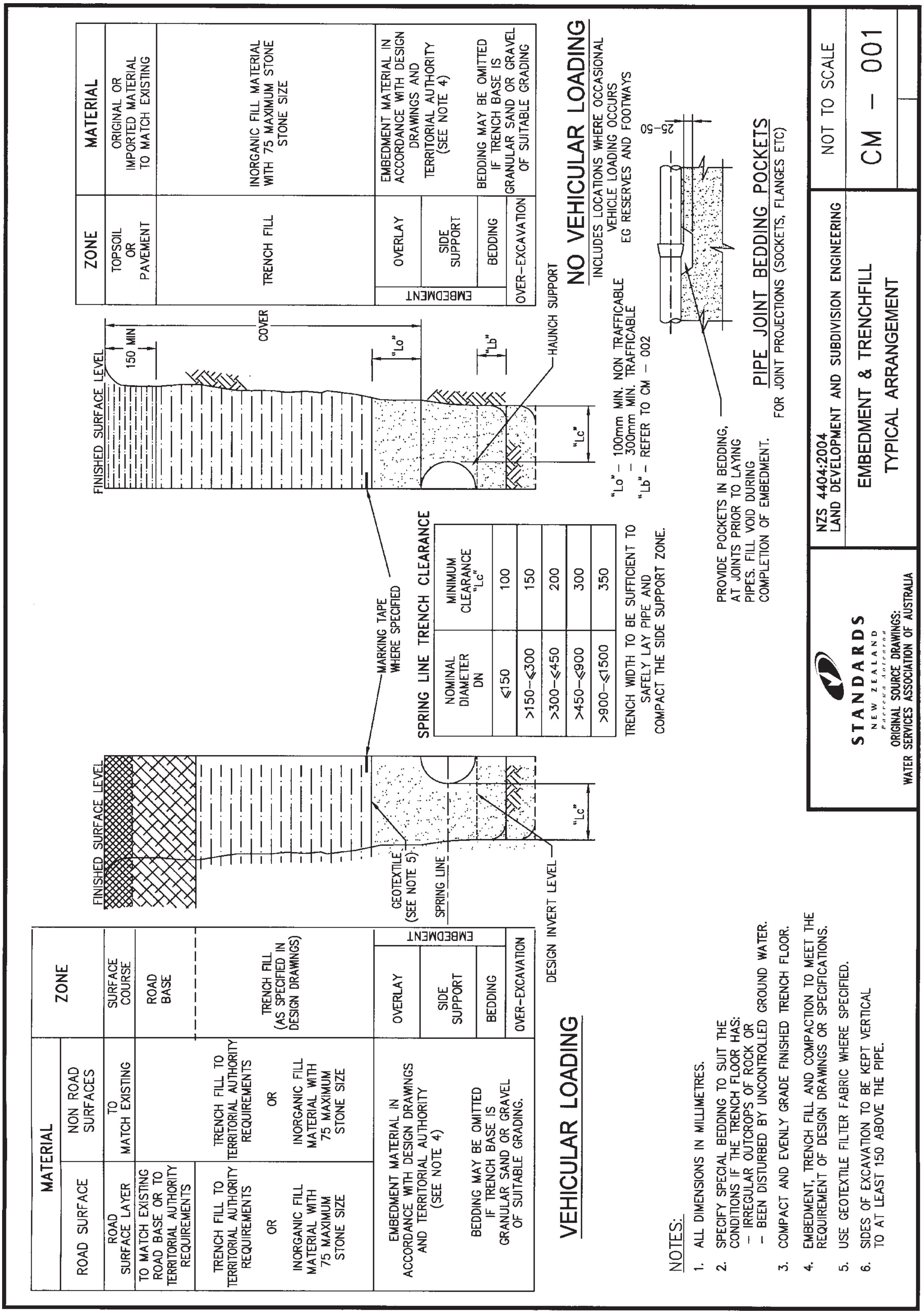
WATER SUPPLY

WS-001	Typical mains construction – reticulation main arrangements
WS-002	Typical mains construction – distribution and transfer mains
WS-003	Property services – connection to main
WS-004	Thrust blocks – concrete block details
WS-005	Thrust and anchor blocks – gate valves and vertical bends
WS-006	Valve and hydrant identification – identification markers and marker posts

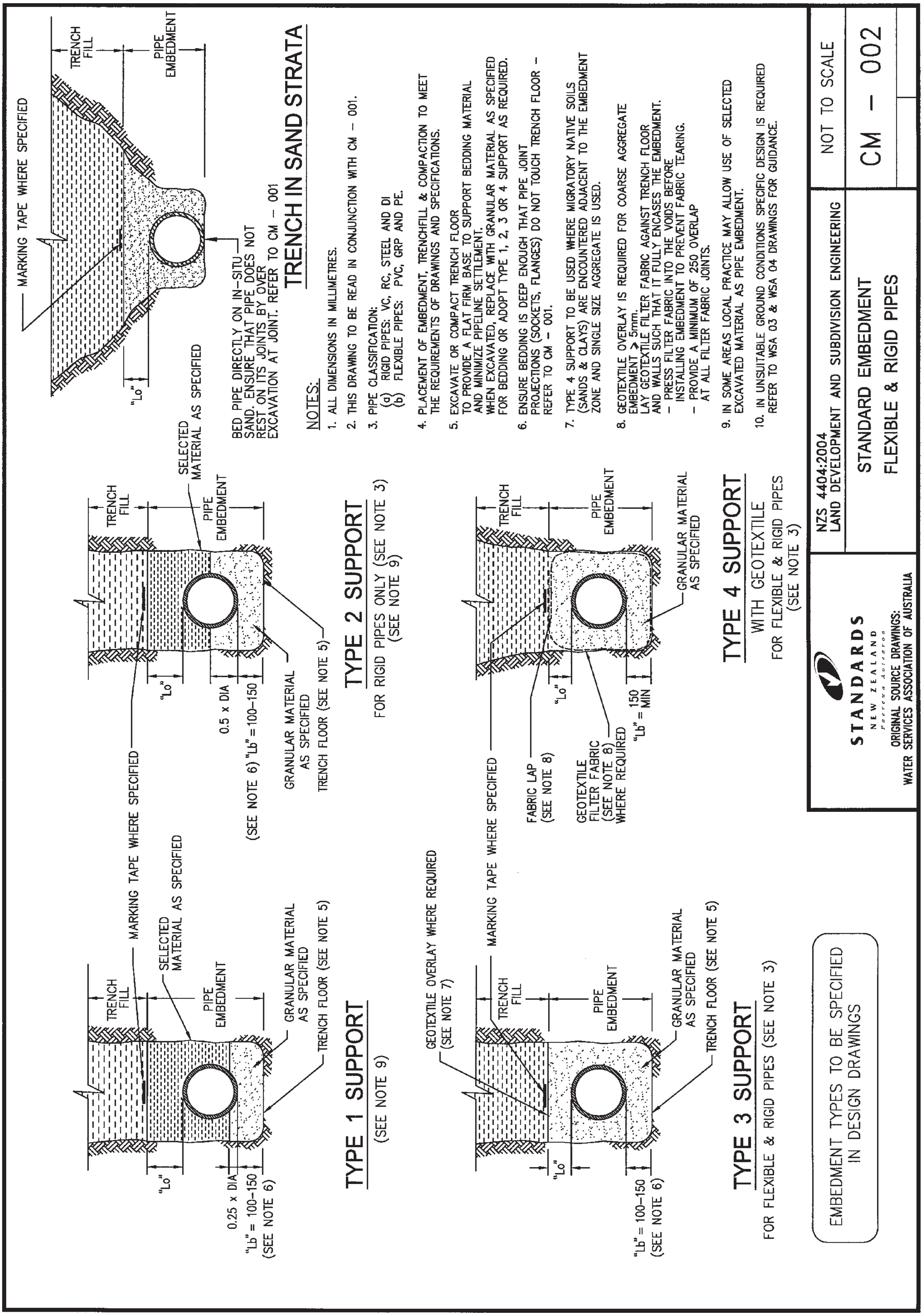
WASTE WATER

WW-001	Pipelaying – typical arrangements
WW-002	Property connections – buried interface method
WW-003	Maintenance shafts – typical installation
WW-004	Maintenance shafts – MS and variable bend installations
WW-005	Maintenance shafts – TMS and connection installations
WW-006	Maintenance shafts – typical MS cover arrangements

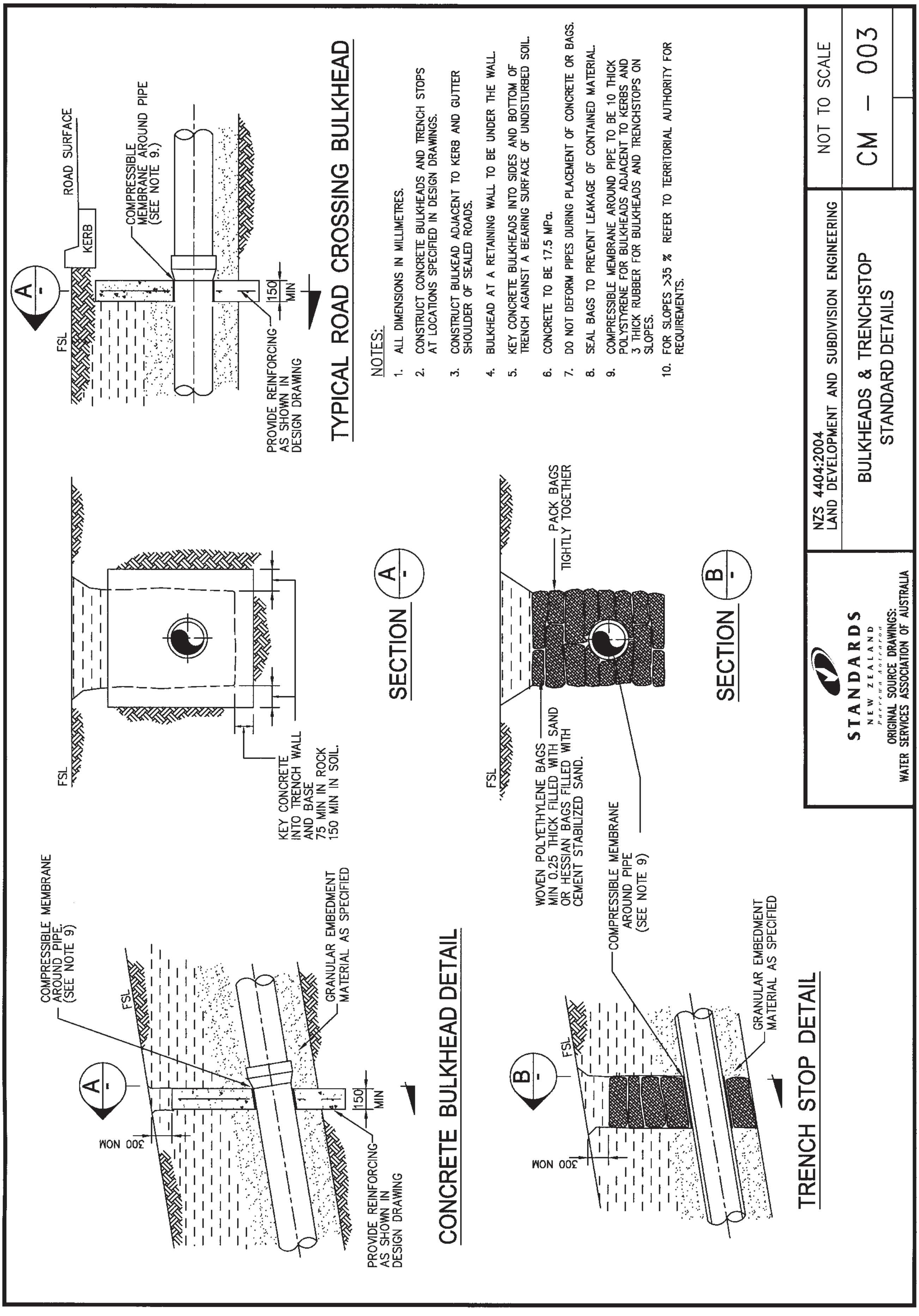
These drawings are available in standard CAD and .pdf formats as free downloads from the Standards New Zealand web shop (www.standards.co.nz). Purchasers of this Standard will be able to adapt the CAD drawings for incorporation into their specific design without breaching copyright.



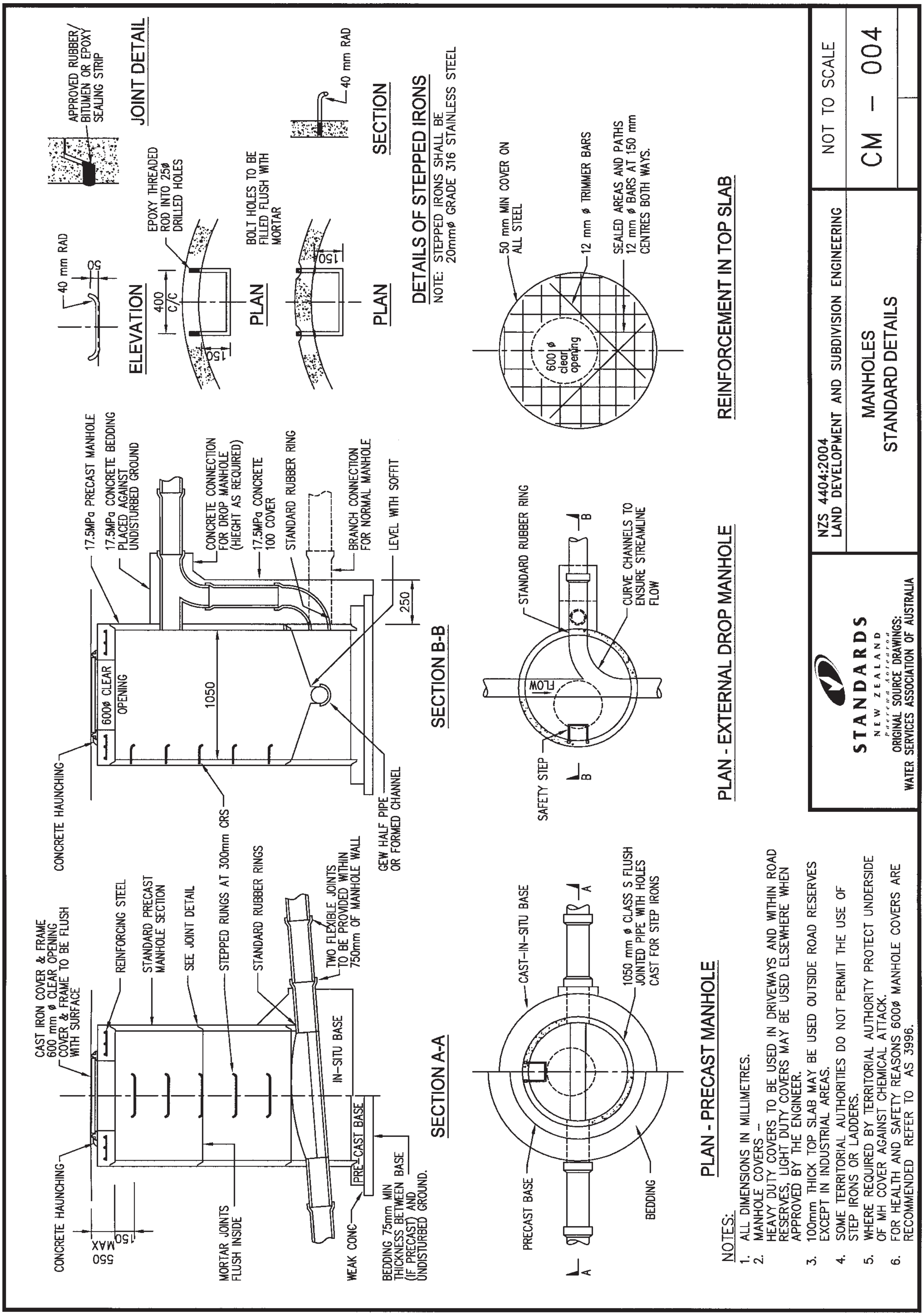
CM - 001 Embedment and trenchfill – typical arrangement



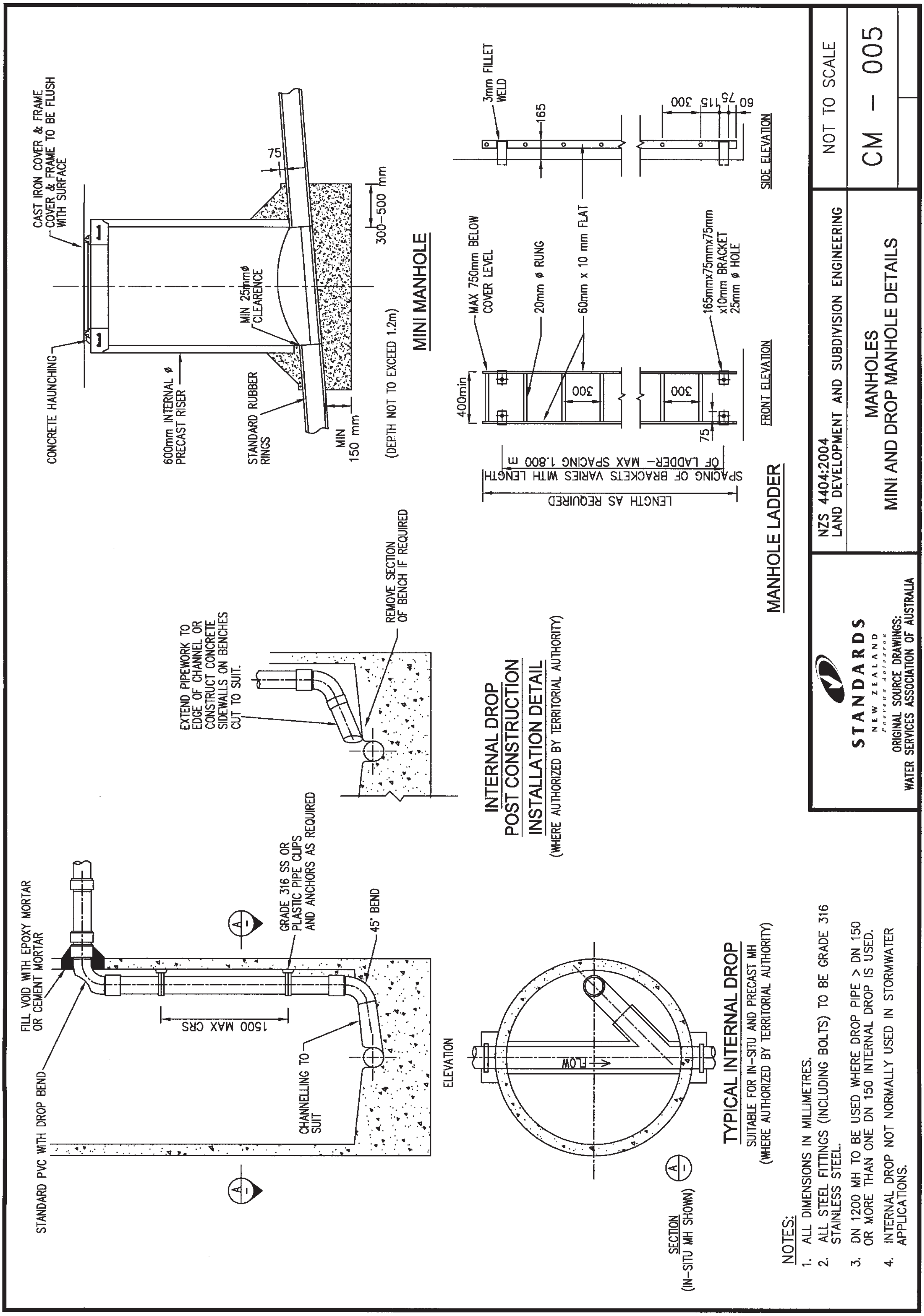
CM - 002 Standard embedment – flexible and rigid pipes



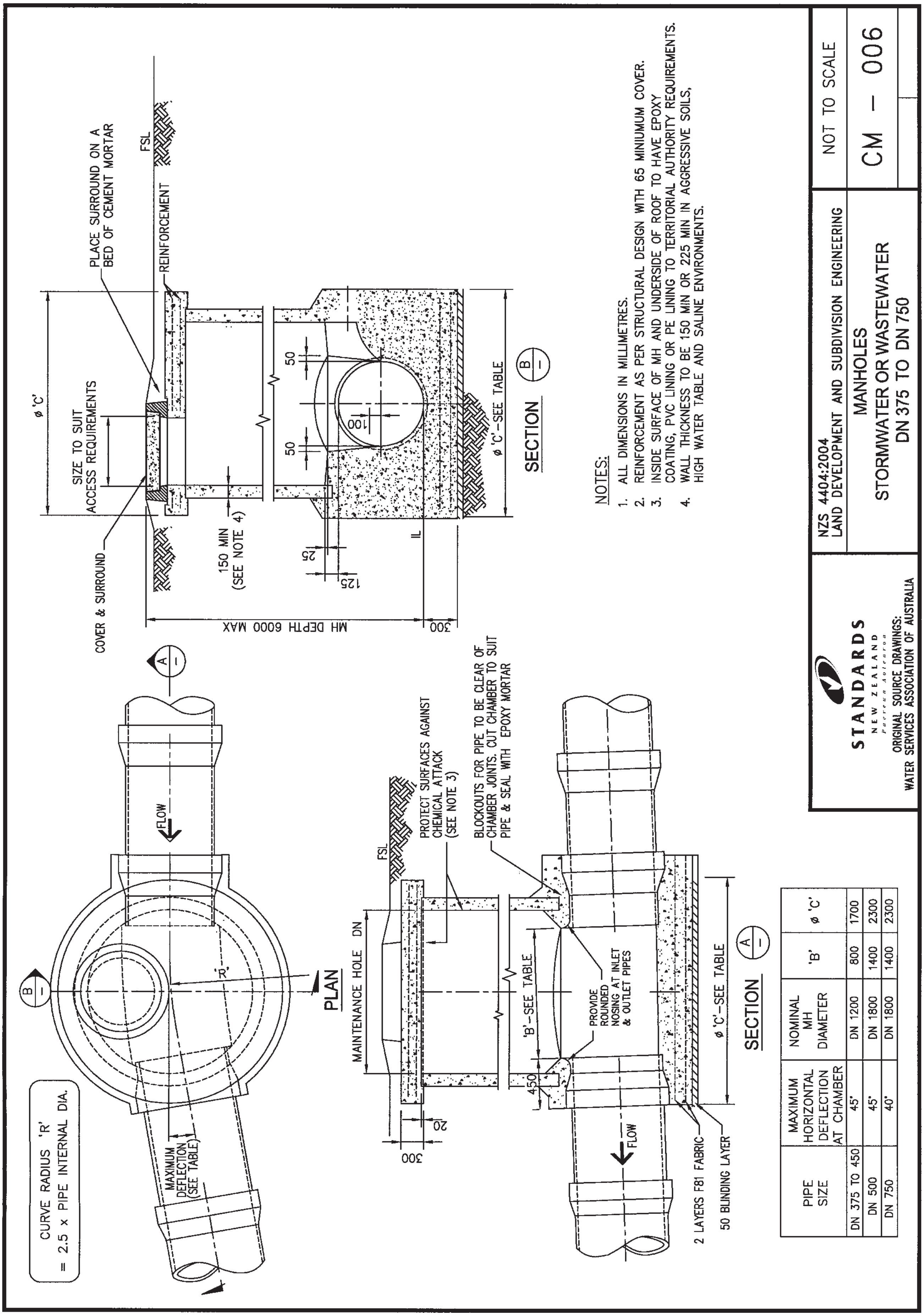
CM - 003 Bulkheads and trenchstop – standard details



CM - 004 Manhole – standard details

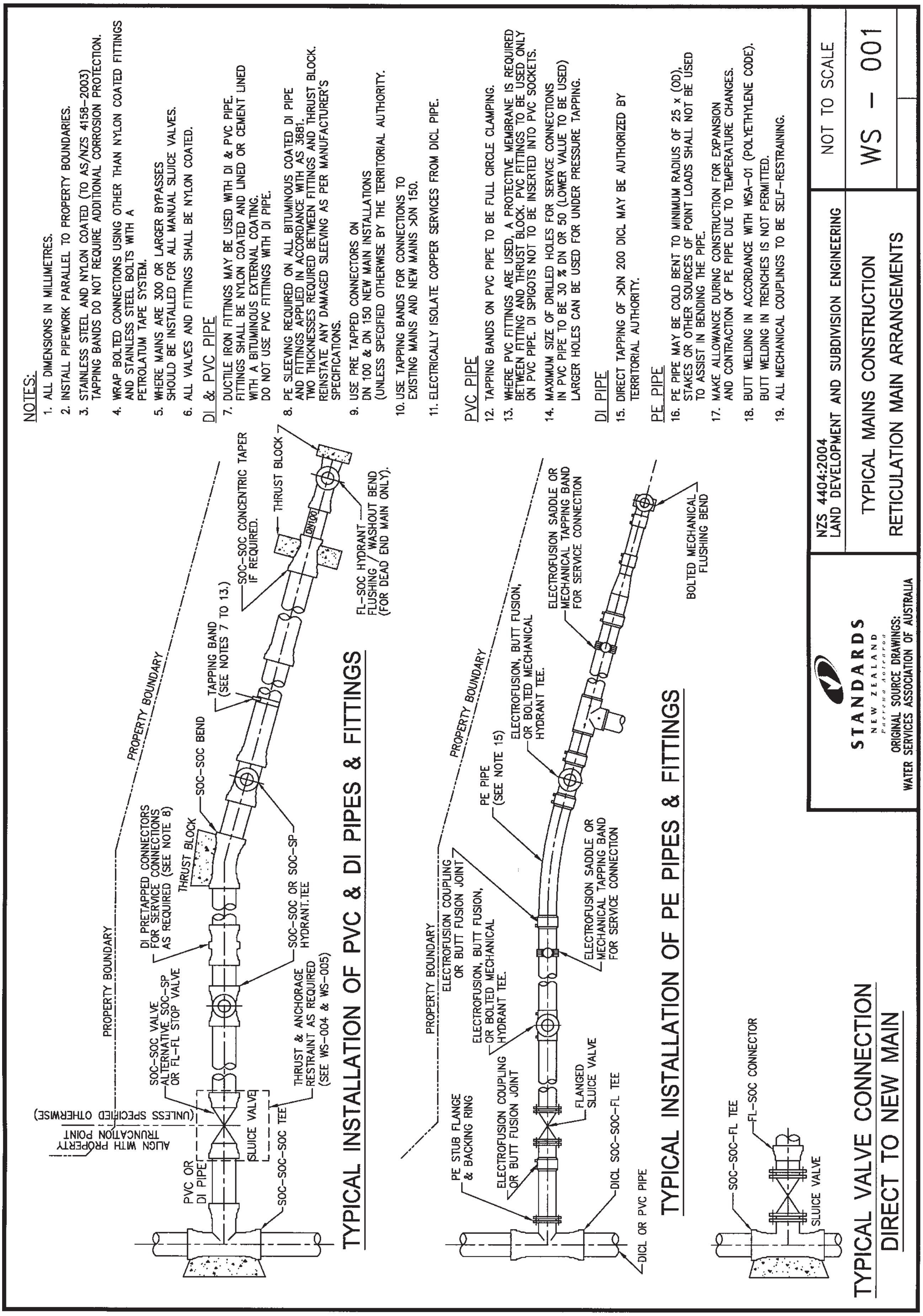


CM - 005 Manholes – mini and drop manhole details

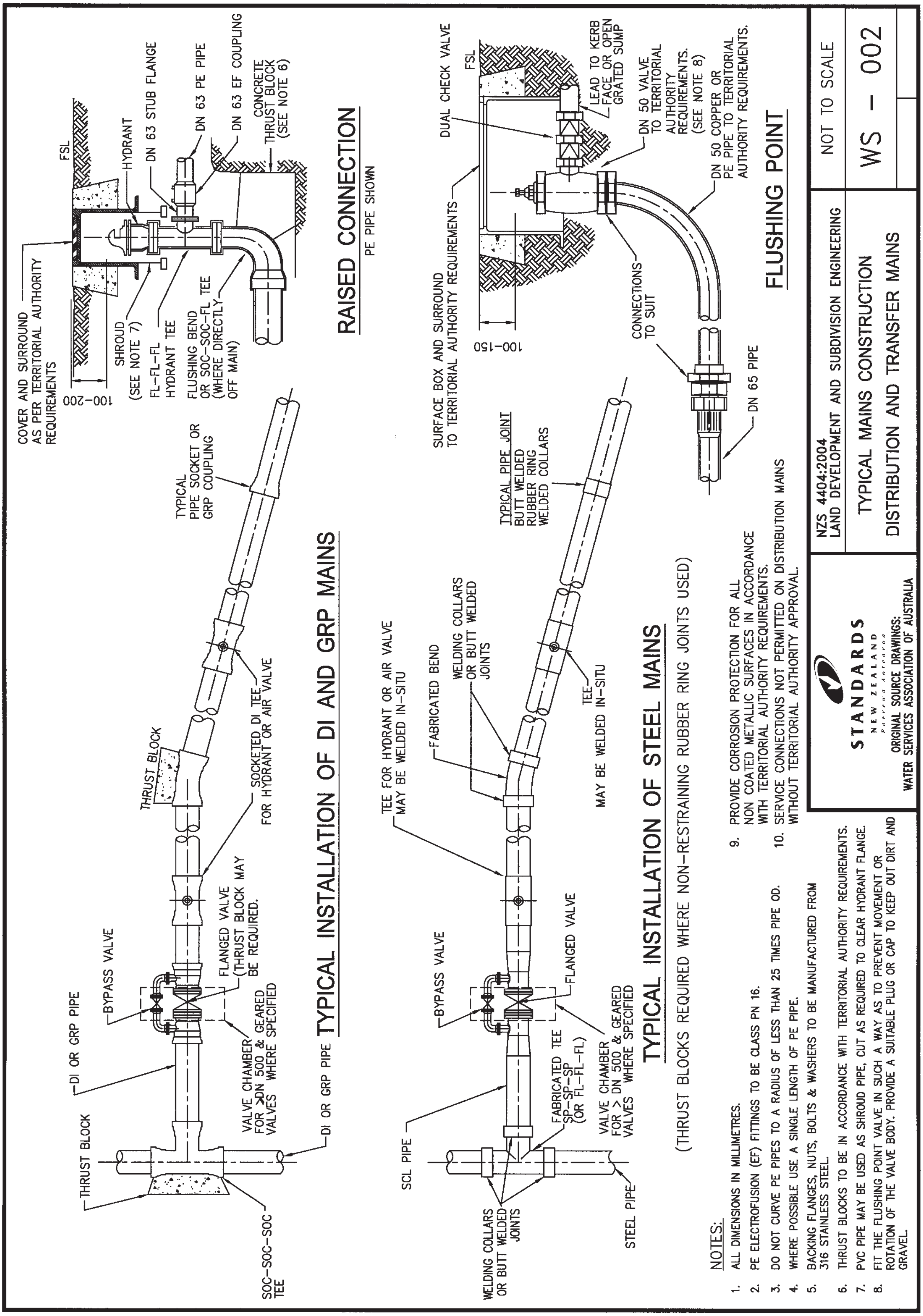


PIPE SIZE	MAXIMUM HORIZONTAL DEFLECTION AT CHAMBER	NOMINAL MH DIAMETER	'B'	ø 'C'
DN 375 TO 450	45°	DN 1200	800	1700
DN 500	45°	DN 1800	1400	2300
DN 750	40°	DN 1800	1400	2300

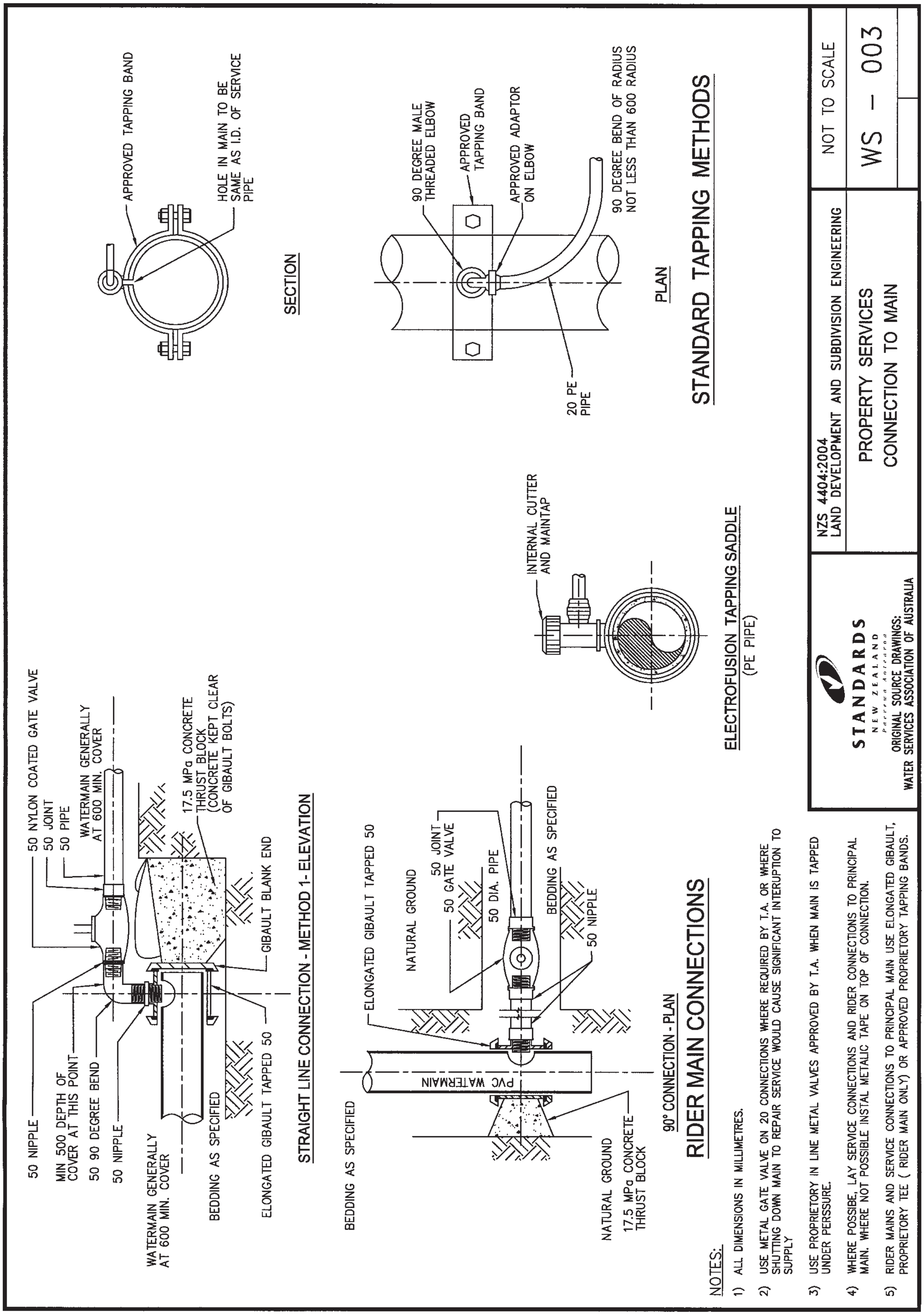
CM - 006 Manholes – stormwater or wastewater DN 375 to DN 750



WS - 001 Typical mains construction – reticulation main arrangements



WS - 002 Typical mains construction – distribution and transfer mains



WS - 003 Property services – connection to main

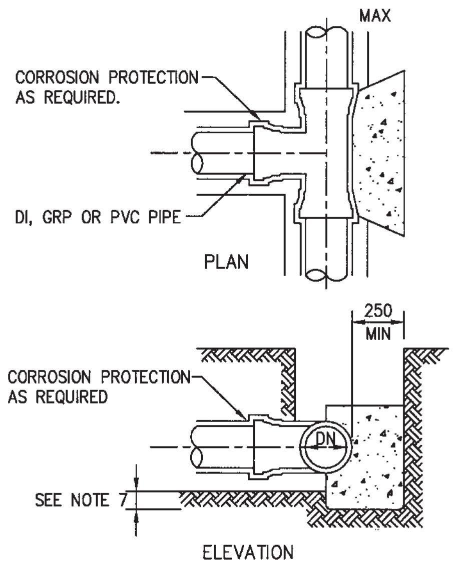
MINIMUM THRUST AREA FOR BLOCKS IN SQUARE METRES (m^2)
DESIGN PRESSURE 1000 kPa (NOM. 100 m HEAD)

SOIL CLASSIFICATION AND ALLOWABLE HORIZONTAL BEARING PRESSURE OF GROUND. (SEE NOTE 3)

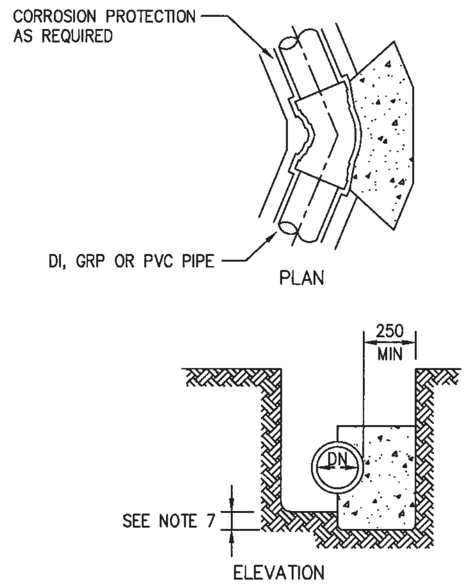
FOR HORIZONTAL THRUST ON TRENCH WALLS WHERE THE COVER OVER PIPES IS 450 OR GREATER	90° & 60° HORIZONTAL BENDS			45° & 30° HORIZONTAL BENDS			22.5° HORIZONTAL BENDS			11.25° HORIZONTAL BENDS			TEES AND DEAD ENDS		
	STIFF CLAY MEDIUM DENSE CLEAN SAND	VERY STIFF CLAY DENSE SAND/GRAVEL DECOMPOSED ROCK	HARD CLAY SOUND ROCK	STIFF CLAY MEDIUM-DENSE CLEAN SAND	VERY STIFF CLAY DENSE SAND/GRAVEL DECOMPOSED ROCK	HARD CLAY SOUND ROCK	STIFF CLAY MEDIUM-DENSE CLEAN SAND	VERY STIFF CLAY DENSE SAND/GRAVEL DECOMPOSED ROCK	HARD CLAY SOUND ROCK	STIFF CLAY MEDIUM-DENSE CLEAN SAND	VERY STIFF CLAY DENSE SAND/GRAVEL DECOMPOSED ROCK	HARD CLAY SOUND ROCK	STIFF CLAY MEDIUM-DENSE CLEAN SAND	VERY STIFF CLAY DENSE SAND/GRAVEL DECOMPOSED ROCK	HARD CLAY SOUND ROCK
PBH kPa	50	100	200	50	100	200	50	100	200	50	100	200	50	100	200
100	0.34	0.17	N	0.18	N	N	N	N	N	N	N	N	0.24	0.12	N
150	0.70	0.35	0.18	0.38	0.19	N	0.20	N	N	N	N	N	0.50	0.25	0.12
200	1.20	0.60	0.30	0.64	0.32	0.16	0.34	0.17	N	0.16	N	N	0.84	0.42	0.21
225	1.52	0.75	0.38	0.81	0.41	0.21	0.42	0.22	0.11	0.22	N	N	1.06	0.53	0.27
250	1.80	0.91	0.45	0.98	0.49	0.25	0.50	0.25	0.12	0.26	0.13	N	1.28	0.64	0.32
300	2.66	1.33	0.66	1.44	0.72	0.36	0.74	0.37	0.18	0.36	0.18	N	1.88	0.94	0.47
375	4.04	2.02	1.01	2.18	1.09	0.55	1.12	0.56	0.28	0.56	0.28	0.14	2.86	1.43	0.72
225	5.71	2.86	0.73	3.09	1.55	0.40	1.58	0.79	0.20	1.58	0.79	0.20	4.04	2.02	0.52
250	6.98	3.49	0.89	3.78	1.89	0.49	1.93	0.98	0.25	1.93	0.98	0.25	4.93	2.37	0.63
300	9.89	4.95	1.27	5.36	2.68	0.68	2.73	1.36	0.35	2.73	1.36	0.35	6.90	3.50	0.89
375	15.16	7.58	1.94	8.21	4.10	1.05	4.19	2.10	0.53	4.19	2.10	0.53	10.72	5.36	1.37

NOMINAL DIAMETER OF FITTING (DN)

'N' DENOTES NOMINAL THRUST AREA – (SEE NOTES 4 & 5)
PBH – ALLOWABLE HORIZONTAL BEARING PRESSURE



THRUST BLOCK FOR TEES
(FOR HORIZONTAL THRUST)

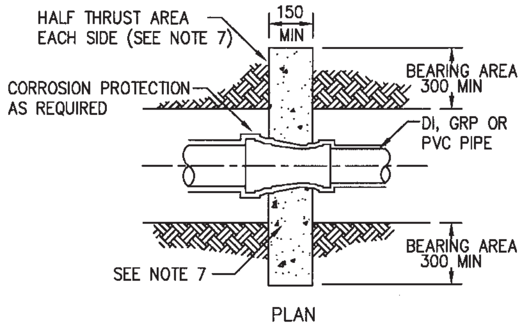


THRUST BLOCK FOR BENDS
(FOR HORIZONTAL THRUST)

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. CAST THE THRUST AREA OF ALL THRUST BLOCKS AGAINST A CLEAN FACE OF UNDISTURBED NATURAL SOIL. THRUST BLOCKS NOT TO INTERFERE WITH OTHER SERVICES.
3. DO NOT USE STANDARD THRUST BLOCKS AS SPECIFIED IN THIS DRAWING IN:
   - VERY SOFT, SOFT OR FIRM CLAY.
   - LOOSE CLEAN SAND.
   - UNCOMPACTED FILL OR REFUSE.

   A GEOTECHNICAL ASSESSMENT AND INDIVIDUAL DESIGN IS REQUIRED FOR THESE SOILS.
4. THE NOMINAL THRUST AREA 'N' TO BE ACHIEVED BY POURING CONCRETE THE FULL LENGTH OF THE FITTING AND EXTENDING FROM THE FLOOR OF THE TRENCH TO ABOVE THE FITTING (SEE ALSO NOTE 7).
5. DESIGN PRESSURES OTHER THAN 1000 kPa REDUCE OR INCREASE THE MINIMUM THRUST AREA BY THE RATIO OF THE DESIGN PRESSURES EXCEPT WHERE:
   - MIN THRUST AREA IS <0.1 m^2, AND
   - 'N' APPEARS IN THE TABLE AND DESIGN PRESSURE IS ABOVE 1000 kPa. CALCULATE THE AREA.
6. FINISH THRUST BLOCKS APPROXIMATELY 100 ABOVE THE TOP OF THE FITTING OR BEARING PAD AND EXTEND TO THE FLOOR OF THE TRENCH OR DEEPER IF NECESSARY TO ACHIEVE THE REQUIRED THRUST AREA. MAXIMUM ENCASEMENT TO BE 180°
7. THE MINIMUM THRUST AREA FOR TAPER THRUST BLOCKS TO BE EQUAL TO THE DIFFERENCE BETWEEN THE THRUST AREAS FOR DEAD ENDS OF EQUIVALENT DIAMETER TO THOSE EACH SIDE OF TAPER.
8. FOR DOWNWARD VERTICAL THRUST, THE ALLOWABLE BEARING PRESSURES FOR VARIOUS SOILS MAY BE TAKEN AS TWICE THAT FOR HORIZONTAL THRUST SHOWN.
9. WHEN POURING CONCRETE AGAINST FITTINGS PLACE A MEMBRANE OF POLYETHYLENE, PVC OR FELT BETWEEN THE FITTING AND CONCRETE TO PREVENT DAMAGE TO THE FITTING. JOINTS TO BE CLEAR OF CONCRETE.
10. CONCRETE TO BE KEPT CLEAR OF BOLTS & FLANGES OR GIBAULT JOINTS TO ALLOW FITTINGS TO BE REMOVED WITHOUT INTERFERING WITH ANCHOR BLOCK.



TAPER THRUST BLOCK
(FOR HORIZONTAL THRUST)

STANDARDS NEW ZEALAND
Paerewa Aotearoa
ORIGINAL SOURCE DRAWINGS:
WATER SERVICES ASSOCIATION OF AUSTRALIA

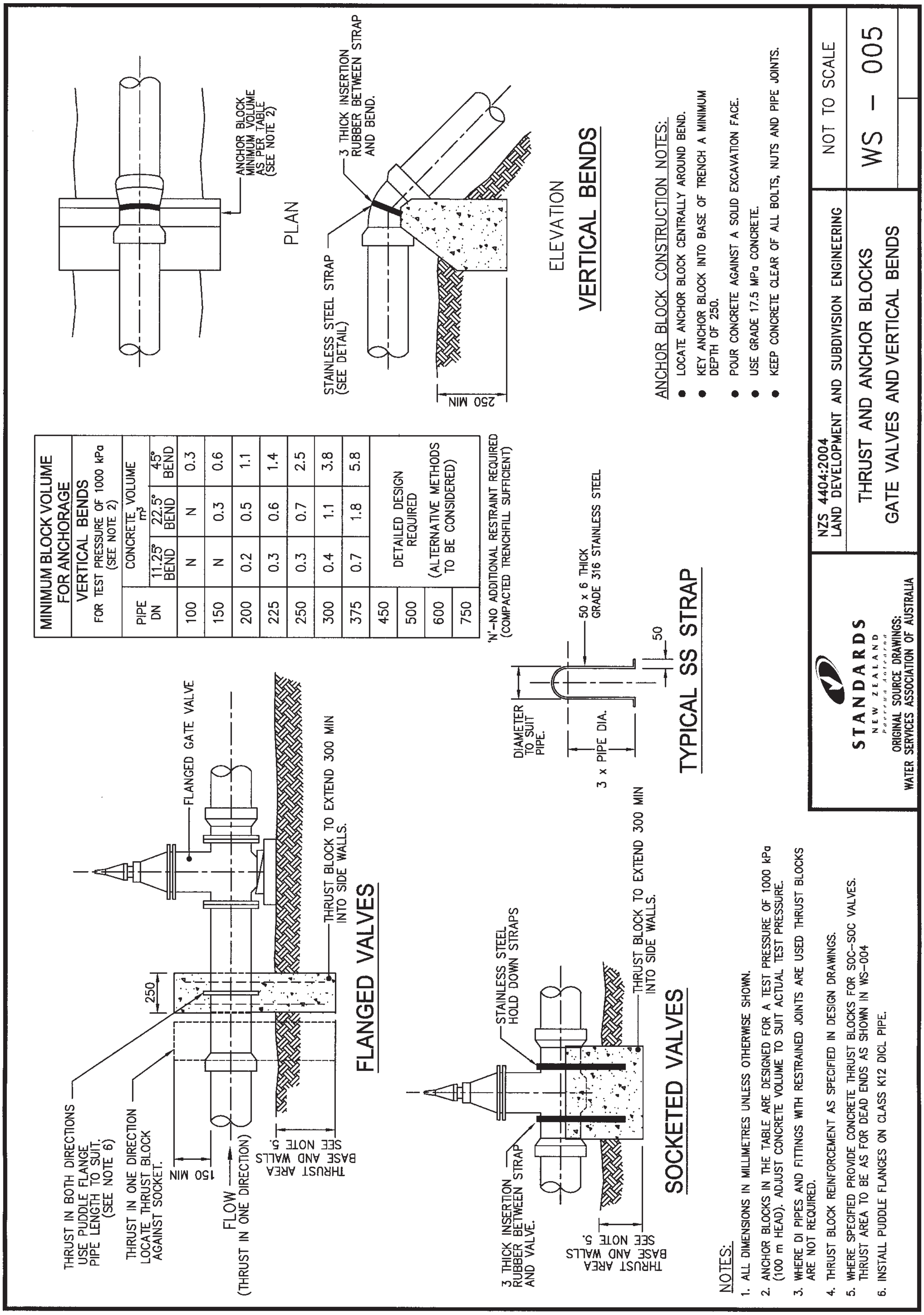
NZS 4404:2004
LAND DEVELOPMENT AND SUBDIVISION ENGINEERING

THRUST BLOCKS
CONCRETE BLOCK DETAILS

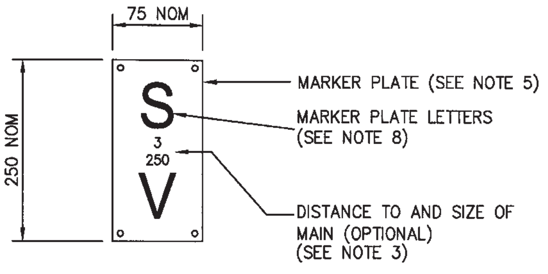
NOT TO SCALE

WS – 004

WS - 004 Thrust block – concrete block details

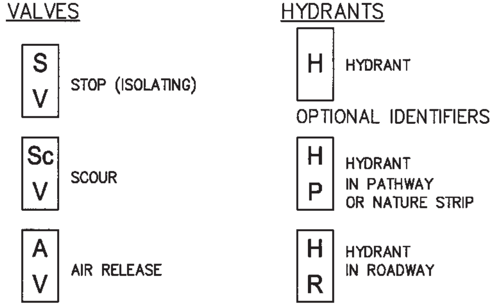


WS - 005 Thrust and anchor blocks – gate valves and vertical bends

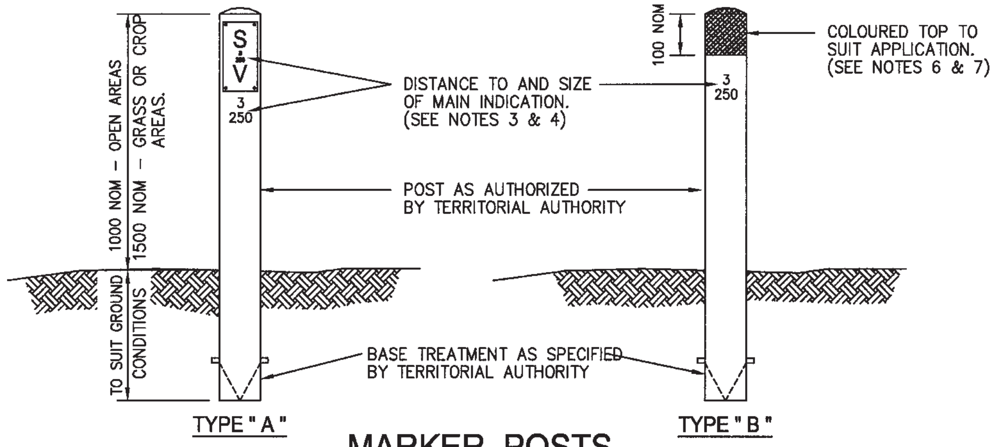


TYPICAL PLATE ARRANGEMENT

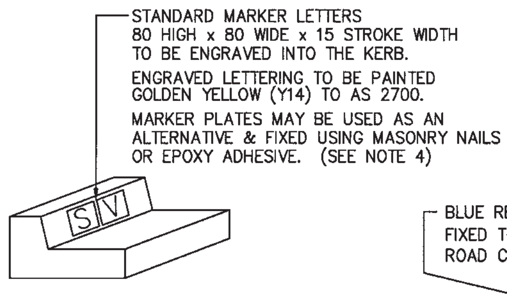
MAY BE FIXED TO POST, KERB OR BUILDING



MARKER PLATES

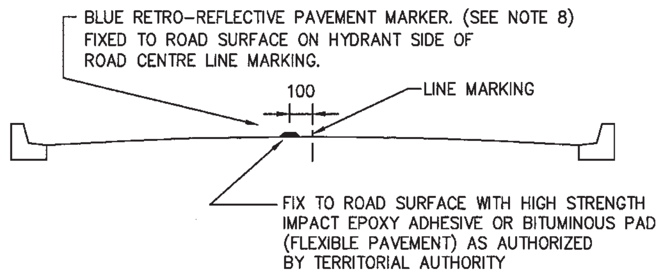


MARKER POSTS



KERB MARKING

(OPTIONAL)



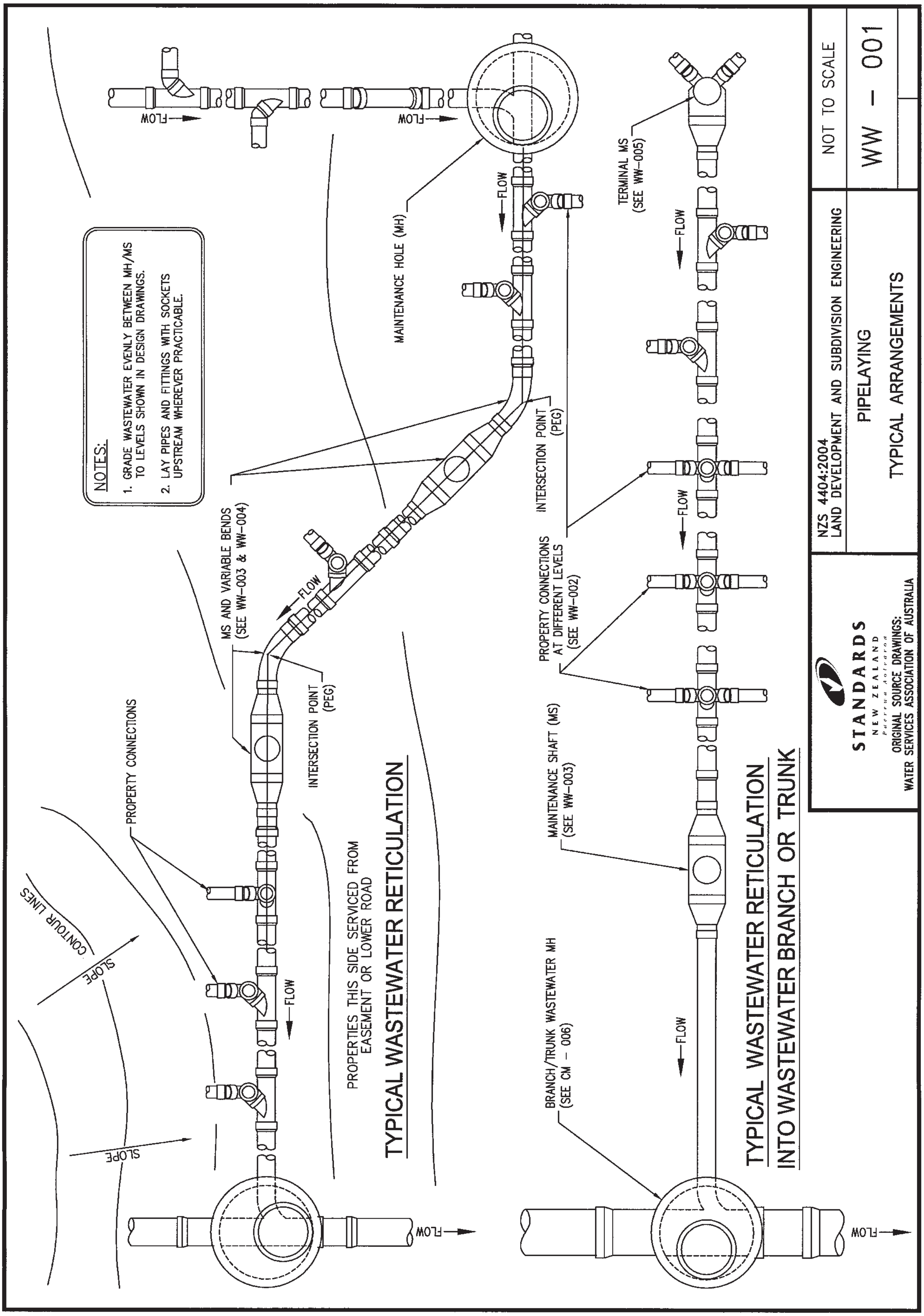
HYDRANT RETRO-REFLECTIVE PAVEMENT MARKER

NOTES:

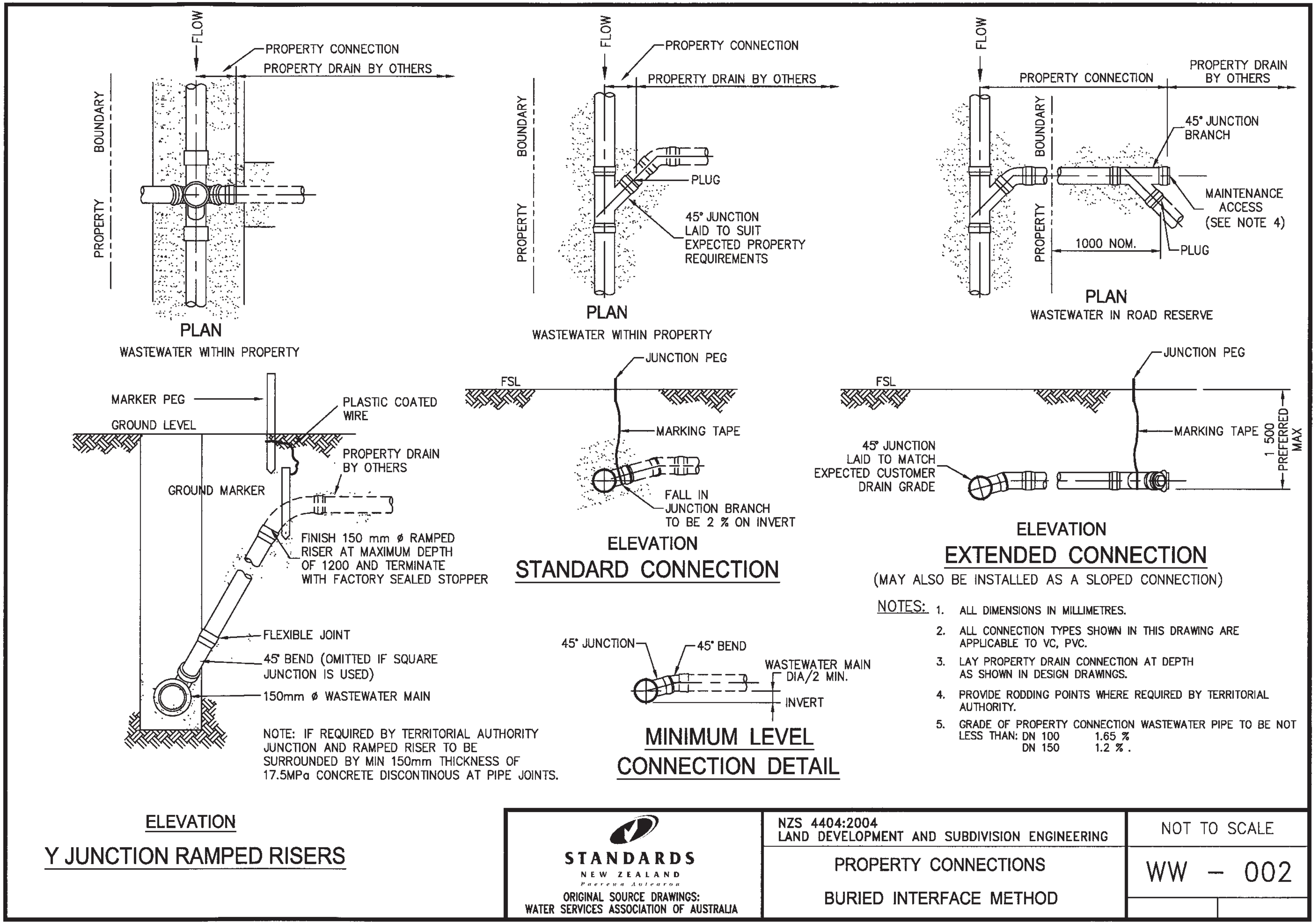
1. ALL DIMENSIONS IN MILLIMETRES.
2. TYPE, LOCATION AND ORIENTATION OF MARKERS TO BE IN ACCORDANCE WITH RELEVANT TERRITORIAL AUTHORITY REQUIREMENTS.
3. DISTANCE TO AND SIZE OF MAIN/FITTING TO BE MARKED ON POST OR MARKER PLATE:
   - NUMBERS TO BE 12 (MIN) HIGH.
   - NUMBERS TO BE PAINTED OR PUNCHED TO CREATE A PERMANENT IDENTIFICATION.
   - TOP NUMBER TO BE DISTANCE TO MAIN (m).
   - BOTTOM NUMBER TO BE DN OF MAIN (mm).
4. LOCATE MARKERS AT RIGHT ANGLES TO THE MAIN WITH MARKINGS FACING TOWARDS THE VALVE OR HYDRANT.
5. METALLIC MARKER PLATES TO BE REFLECTIVE WHITE WITH NON–REFLECTIVE LETTERING. LETTERING COLOUR TO BE HOMEBUSH RED (R22), LILAC (P23) OR OTHER COLOURS TO AS 2700 AS APPROPRIATE TO USAGE. MARKER PLATE LETTERS TO BE 80 HIGH x 40 WIDE x 10 STROKE WIDTH.
6. COLOURED MARKER TOPS ON TYPE "B" POSTS TO BE:
   - WATER (GENERAL) – BLUEBELL (B41).
   - HYDRANTS – HOMEBUSH RED (R22).
7. INSTALL TYPE "A" AND TYPE "B" MARKER POSTS AS SPECIFIED BY TERRITORIAL AUTHORITY.
8. RAISED PAVEMENT RETROREFLECTIVE MARKERS TO COMPLY WITH AS 1906.3.

STANDARDS NEW ZEALAND Paerewa Aotearoa ORIGINAL SOURCE DRAWINGS: WATER SERVICES ASSOCIATION OF AUSTRALIA	NZS 4404:2004 LAND DEVELOPMENT AND SUBDIVISION ENGINEERING	NOT TO SCALE
	VALVE AND HYDRANT IDENTIFICATION IDENTIFICATION MARKERS & MARKER POSTS	WS – 006

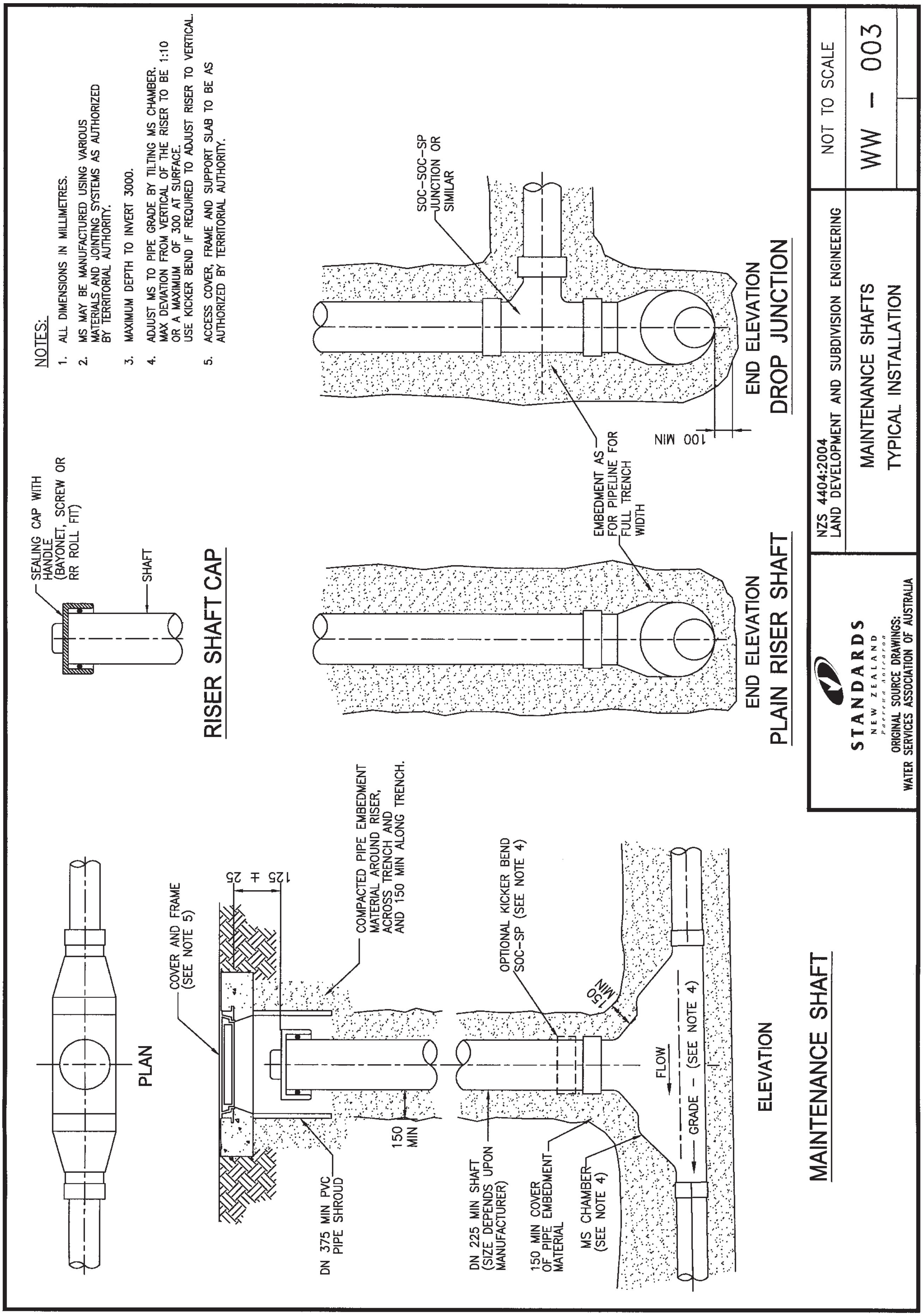
WS - 006 Valve and hydrant identification – identification markers and marker posts



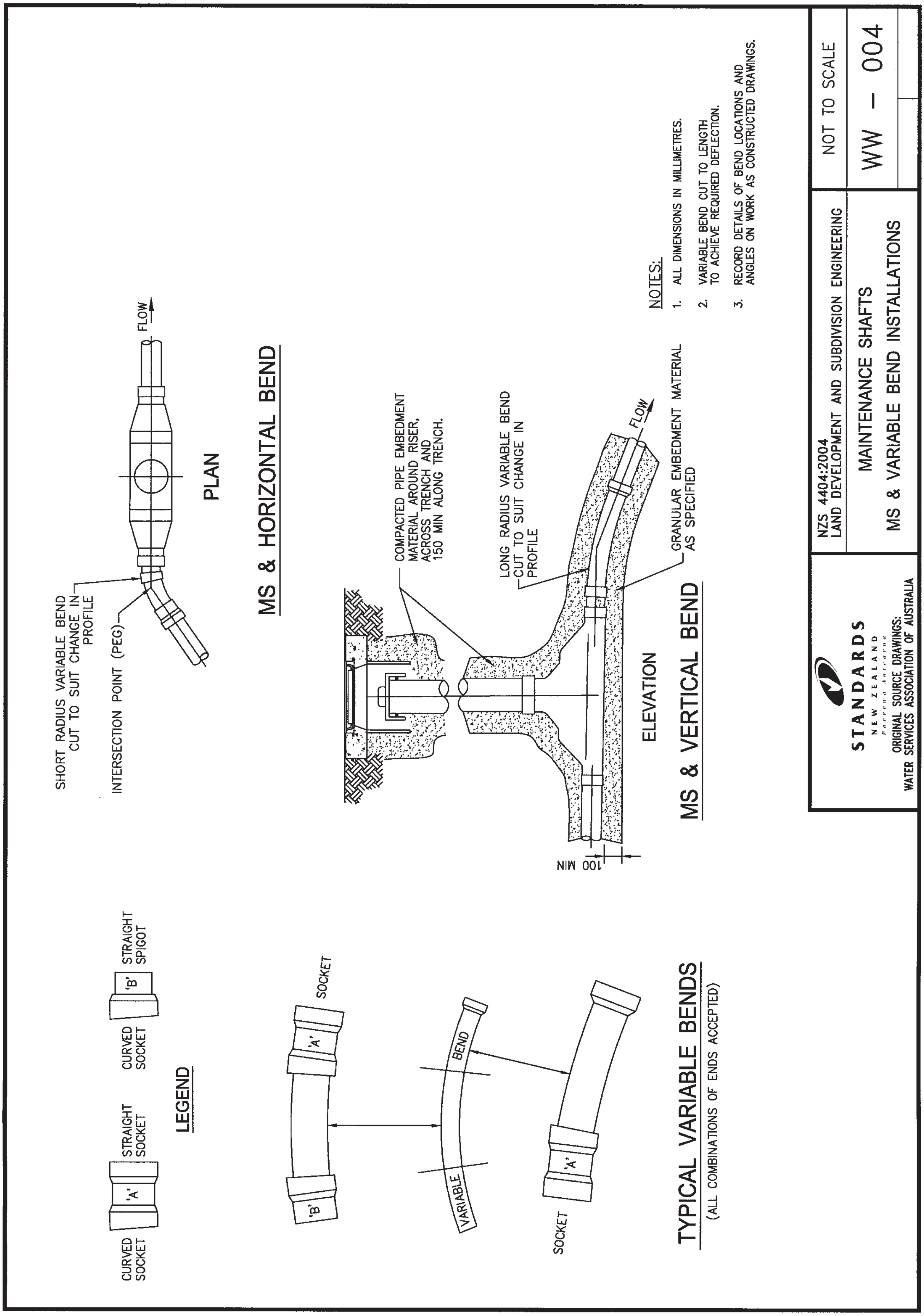
WW - 001 Pipelaying – typical arrangements



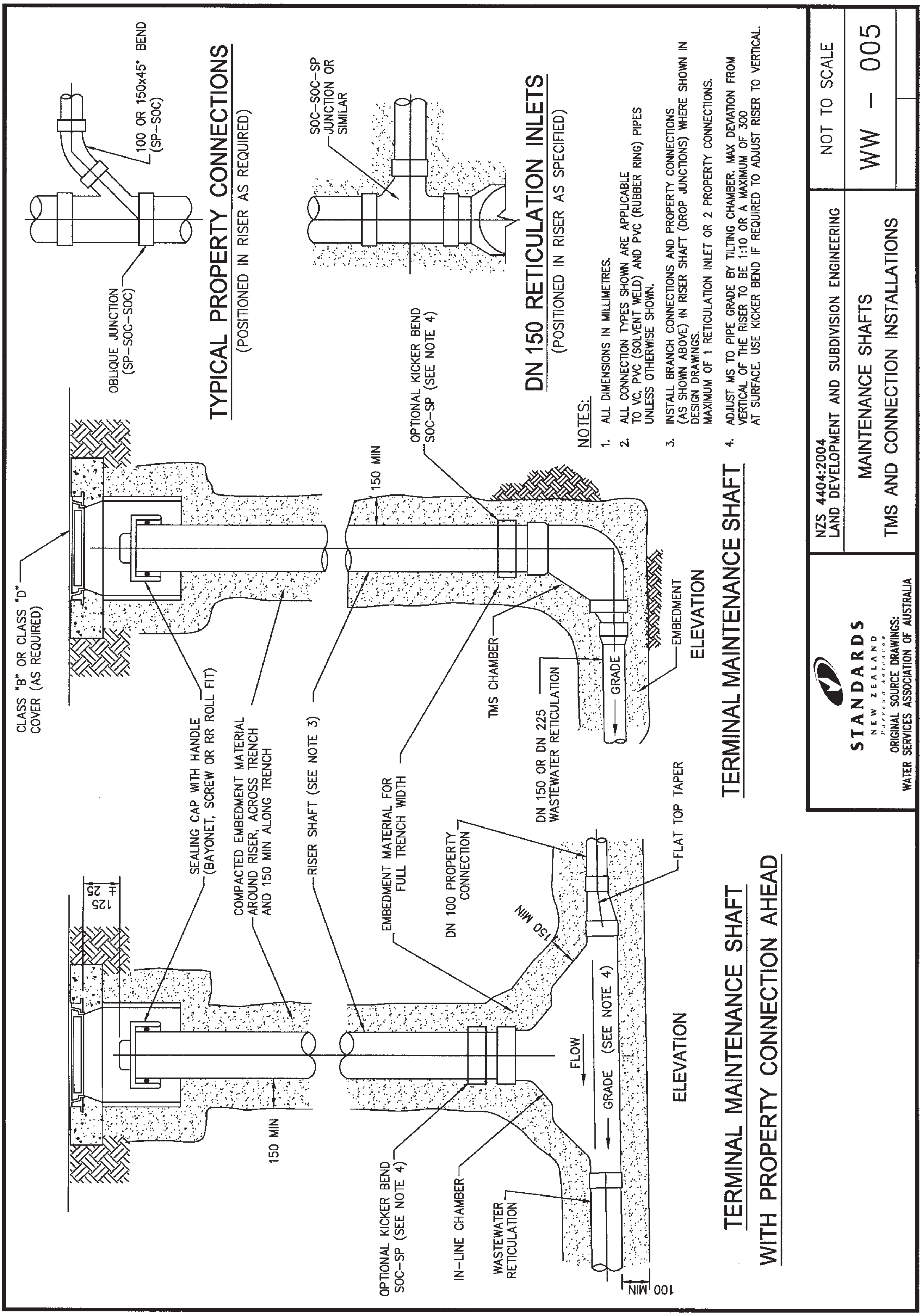
WW - 002 Property connection – buried interface method



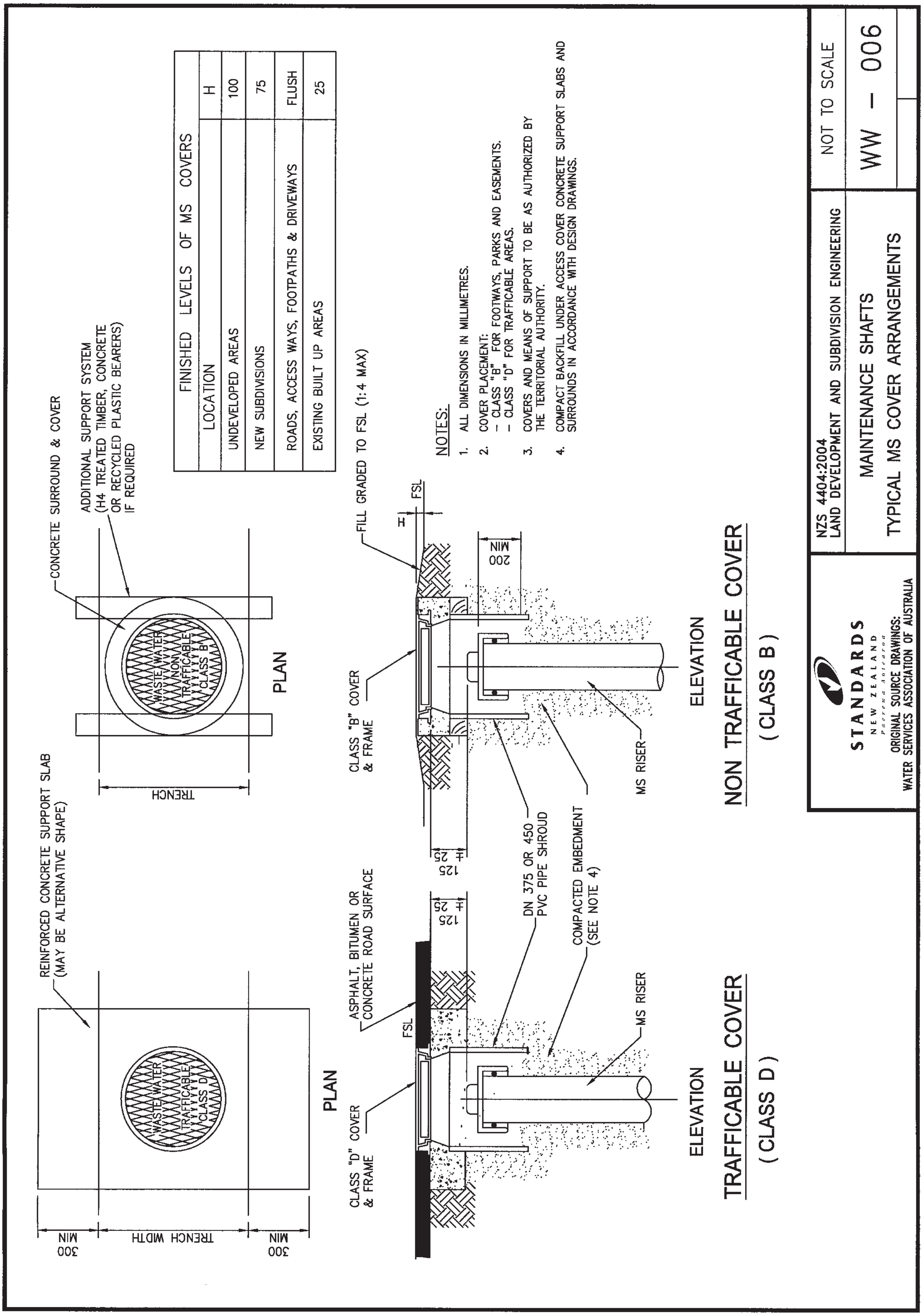
WW - 003 Maintenance shafts – typical installation



WW - 004 Maintenance shafts – MS and variable bend installations



WW - 005 Maintenance shafts – TMS and connection installations



WW - 006 Maintenance shafts – typical MS cover arrangements

APPENDIX B
WATER MAIN PRESSURE TESTING PROCEDURE

(Informative)

B1 Testing of steel and PVC pipes

A successful pressure test is required prior to the water main being allowed to be connected to the existing water supply system.

Before joints are covered, but after anchor blocks are completed, each section of the reticulation, together with all specials and fittings connected thereto including service connections shall be tested by the developer or contractor in the presence of the authorized officer or his representative. The test shall be carried out, and all necessary apparatus supplied, by the subdividing owner or contractor. The reticulation shall withstand a pressure of 1400 kPa measured at the lowest point of the section under test, or 1.5 times the working pressure at any point in the system, whichever is the greater. The pressure shall be maintained for a period of 15 min, and during which time, the leakage shall not exceed one litre per 10 mm of pipe diameter per k length of pipe under test per hour.

Before arranging a connection to the existing reticulation, the authorized officer may require a similar test after completion of backfilling to any other adjoining works which may affect the existing water reticulation.

The contractor shall make arrangements for bleeding air during the charging of the mains, and for flushing after chlorinating.

B2 Testing of PE pipes

The following procedure may be used only for the testing of polyethylene pipelines. Whilst the normal procedures followed and precautions taken for hydrostatic pressure testing of completed pipework apply equally to polyethylene systems, some variations are necessary because of the mechanical properties of polyethylene (PE).

Test pressures must be limited to 1.5 times the rated pressure and reduced accordingly if the test water temperature is above 20 ^{o}C.

B2.1 *Test method 1*

This simple test is a useful method of checking relatively short, small diameter mains. It is essential that all air is vented.

(a) Apply a selected test pressure, not exceeding the limits given above.

(b) Maintain this pressure for 30 min (additional pumping may be required to compensate).

(c) Check for any obvious leaks.

(d) After 30 min reduce this pressure rapidly by bleeding water from the system to a nominal pressure of approximately 2 bars (200 kPa) at the test gauge.

(e) Record pressure gauge readings at convenient times for up to an hour after the pressure has been reduced (say 5-min intervals).

In a leak-free system, the gauge pressure would be expected to rise from its reduced setting when the polyethylene attempts to contract to its original diameter. The system should then retain this slightly higher pressure.

If the pressure does not rise, or falls after an initial rise, then a leak must be suspected.

This test is a simple pass/fail test, the degree to which the response of the polyethylene affects the gauge pressure being dependent on several system parameters (e.g. pipe diameter, length of test section, etc.).

B2.2 *Test method 2*

Test method 2 involves calculating the rate at which the test pressure decays and used for large diameter or long lengths of pipes.

The duration of the test should be limited to 1 hour.

(a) When the main is fully charged and all air vented the system should be allowed to stabilise before the test procedure begins.

(b) Pressure should be applied at a constant rate and the time t_L taken from the start of pressurisation to attainment of test pressure must be recorded.

(c) Readings of pressure decay at time intervals in minutes must be taken and recorded.

(d) The first such reading P_1 is taken at a decay time t_1 equal to or greater than t_L.

(e) The second reading P_2 is taken at a decay time t_2 equal to or greater than 5 x t_L.

(f) Calculate $N_1 = \dfrac{\log_e P_1 - \log_e P_2}{\log_e t_2 - \log_e t_1}$

which should be between 0.04 and 0.12. If $N_1 > 0.25$ an unacceptable leak is indicated.

(g) A third reading P_3 is taken at a decay time t_3 equal or greater than 15 x t_L.

(h) Calculate $N_2 = \dfrac{\log_e P_2 - \log_e P_3}{\log_e t_3 - \log_e t_2}$

If $N_2 > 0.25$ an unacceptable leak is indicated.

If the ratio is less than 0.8 an unacceptable leak is indicated.

Any test carried out on replacement water mains, shall include all service lines up to the gate valve at the metering point or toby; and the contractor shall include in his/her rate for testing, any plugs or stoppers necessary to overcome leakage at gate valves, if this occurs.

APPENDIX C
WATER SUPPLY DISINFECTION SPECIFICATION

(Normative)

C1 Disinfection of pipelines and fittings

After flushing the main to remove all debris and air, the main shall be filled with water containing a free available chlorine concentration of 15 g/m^3 (5 g/m^3 and allowed to stand for a minimum of 12 hours for all new mains. At the end of the disinfection period, the free available chlorine (FAC) concentration shall be at least 5 g/m^3. If the FAC is less than 5 g/m^3 at the completion of the period, the disinfection shall be repeated until a satisfactory result is obtained. Note that the main must not be drained after flushing unless all high points are 'vented' to allow for complete removal of air.

Under no circumstances will the use of handfuls of hypochlorite powder or chlorine tablets dumped into the pipe and hydrant tees be an acceptable practice.

The sterilizing solution should be fed by gravity or pumped into one end of the main and the 'flushing' water in the pipe displaced out of the opposite end of the main until tests carried out show that the water being displaced contains the full FAC concentration. The authorized officer will arrange for testing of the FAC concentration and, to this end, the contractor must give 24-hours notice of intention to sterilize.

The contractor shall provide all temporary fittings necessary to allow for the introduction of the sterilising solution to and its removal from the main.

See also C3 below.

C2 Methods of introducing the sterilizing solution

This will depend on the volume of solution required for the particular main and the availability of appropriate equipment.

In general, wherever the pipe volume is less than 10 m^3, the most practical method is to add sufficient calcium or sodium hypochlorite (powder or solution) to a potable water tanker suitable for carrying potable water to achieve the desired 15 g/m^3 FAC concentration. (This may require two tankers full.)

For greater quantities, the sterilizing solution may be injected into the main using a portable gas chlorinator or a hypochlorinator. An approved backflow preventer must be installed if either of these options is used.

C3 Disposal of sterilizing solution

After the satisfactory completion of the sterilizing process, the chlorine solution shall be flushed into the sanitary wastewater pipe or, alternatively, retained in a temporary surface storage pond until the authorized officer is satisfied that the FAC has reduced to a satisfactory concentration before being allowed to flow down the stormwater drainage system or into a natural watercourse.

C4 Acceptable method for sterilizing mains

(a) Use sodium hypochlorite solution. This solution usually has 10 % or 15 % free available chlorine (FAC);

(b) Obtain a clean water tanker, as used for potable drinking water. The tanker must have a known water capacity;

(c) Measure the required amount of sodium hypochlorite solution into a beaker and pour it into the empty tanker;

NOTE – The final strength of the chlorine to water is to be 15 ppm ±5 ppm.

(d) Fill the tanker to the appropriate volume and ensure the solution is well mixed;

(e) Charge the new main with the chlorinated water from the tanker at one end of the main or into a new hydrant through a standpipe. All service pipes and hydrants shall be left open and allowed to run for a couple of minutes. The services and hydrants shall then be closed to allow the highest end of the main to fill completely;

NOTE – The main should ideally be charged from the highest point. This will allow the water to be gravity fed into the main. If this is not possible the water tanker shall have a truck mounted pump to pump the chlorinated water in.

(f) Seal off the main and leave it charged with the chlorinated water for 24 hours.

(g) Take samples and test for residual chlorine.

(h) After 24 hours flush the main well until the chlorine smell is gone. Once the main is connected into the reticulation system it should be flushed thoroughly before the services are connected up.

NOTE – For large mains, a water tanker may not have the required capacity so a dose pump system must be used and approved by the authorized officer.

Example:

A. Calculate the volume of the mains to be chlorinated,

i.e., 85 m of 100 mm dia. main

$$\text{Vol.} = \frac{85 \times \pi \times 0.1^2}{4} = 0.67\ \text{m}^3$$

= 667.6 litres

Plus 110 m of 150 mm dia. main

$$\text{Vol.} = \frac{110 \times \pi \times 0.15^2}{4} = 1.944\ \text{m}^3$$

= 1.944 litres

Total volume = 1,944 + 667.6 = 2,611.6 litres

B. The total volume of 2,611.6 litres is less than the volume of the water tanker (say 5,000 litres) so calculate how many millilitres of sodium hypochlorite is required for the 5,000 litre tanker to give a final solution of 15 ppm.

$$v = \frac{V \times c}{s \times 10}$$

v = volume of sodium hypochlorite in ml

V = volume of water tanker

c = concentration of final solution in ppm

s = strength of concentrated hypochlorite in % FAC

$$v = \frac{5000 \times 15}{15 \times 10} = 500\ \text{ml}$$

APPENDIX D
RELATED DOCUMENTS

(Informative)

This Appendix lists Standards and specifications that may be used in addition to this Standard. The users of this Standard should ensure that their copies of the documents listed below are the latest revisions and include the latest amendments.

NEW ZEALAND STANDARD

NZS/BS 750:1984	Specification for underground fire hydrants and surface box frames and covers

AUSTRALIAN STANDARDS

AS 3571:1989	Glass filament reinforced plastics (GRP) pipes – Polyester based – Water supply, sewerage and drainage applications
AS 4087:1996	Metallic flanges for waterworks purposes

OTHER DOCUMENTS

Gadd,M.L., The street where you live – Streetscape, traffic calming (1995)

Concrete Masonry Association of Australia:

Concrete segmental pavements – Design guide for residential access ways and roads

Cement and Concrete Association of Australia:

Concrete pavement design for residential streets

New Zealand Transport Strategy (2002)

Road and Traffic Authority of Australia:

Concrete roundabout pavements – A guide to their design and construction

Sunset Books: Sunset Pruning Handbook

NEW ZEALAND LEGISLATION

Electricity Act 1992

Plumbers, Gasfitters, and Drainlayers Act 1976

Public Works Act 1981

Telecommunications Act 2001

Transit New Zealand Act 1989

Water Supplies Protection Regulations 1961

Approved by the Standards Council on 23 February 2004 to be a New Zealand Standard pursuant to the provisions of section 10 of the Standards Act 1988.

First published: 3 March 2004
Reprinted: July 2006

The following SNZ references relate to this Standard:
Project No. P 4404
Draft for comment No. DZ 4404
Typeset by: Standards New Zealand
Printed by: The Colour Guy