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Approved By:	**Lee Goddard**
Signature:	

Design Manual

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Recipients of this manual should note:

The information contained in this document is of a general nature and no warranty is given as to the correctness of the information contained herein. Furthermore, neither Waipa Networks Limited nor its Agents are liable for any loss suffered by any entity relying directly or indirectly upon this document.

Any queries pertaining to this document should be directed to WNL's planning team.

i. Preface

Waipa Networks Ltd (WNL) design manual has been developed to ensure that the Company's network is designed and built using best industry practices and proven materials which will;

- Facilitate the operational effectiveness of the network, and
- Reduce the inherent risks of electricity distribution for anyone who works on or interacts with the Company's assets.

The design manual will be reviewed and updated by the Operations Committee and approved by the Network Asset Manager, as necessary and at least every year in March.

Any new version will be identified by the footer text which will show the version number and the month of issue. All previous versions will be withdrawn and destroyed.

ii. External Distribution List

This controlled document has been distributed to the following companies who are authorised to work on WNL's network:

Currently, there are no companies authorised to work on the WNL's network.

Table of Contents

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Section 1 - General

1 Introduction

The purpose of this design manual is to facilitate operational effectiveness and efficiency of the network and to ensure it is designed and built to reduce the inherent risks of electricity distribution for anyone who works on or interacts with the Company's assets.

The manual details standards which will ensure that:

- WNL achieves a high degree of consistency within its network;
- WNL's internal work processes are clearly documented, and
- All designs reflect WNL's strategic intent for the state of its network.

This manual is intentionally conservative. It reflects current best practice and uses proven asset materials.

It is not intended to be a substitute for site-specific work procedures, qualified electrical engineering knowledge, experience, or judgment.

The guidelines in this manual must be adhered to for all works on WNL's network unless a formal exception has been granted by WNL's Network Asset Manager.

2 Associated Documents

This document is to be read in conjunction with:

- Appendix 1, WNL Overhead Construction Drawings
- Appendix 2, WNL Underground Construction Drawings

3 Network Extensions

Contractors carrying out network extensions on the WNL network must adhere to the following:

3.1 Design / Planning Phase

During the planning phase, a copy of the proposed design (electrical / physical), material listings, scrap value (if applicable), and volt drop calculations must be submitted to the WNL's design team for approval. A voltage drop calculator is available from:
http://www.generalcable.co.nz/newzealand/NZDownloads/Gencalc.aspx
Submitted documentation will include site-specific work procedures and assurance that proposals meet the requirements of the local territorial authorities' district plans.
WNL will review the design and provide written feedback within 21 working days.

3.1.1 PROCESSING FEES

WNL's processing fees are:

- Transformer processing fee: $500.
- Design processing fee: $300.
- As-built bond: $700.

All fees exclude GST.

3.1.2 CAPITAL CONTRIBUTION

WNL planning team will determine the magnitude of capital contribution payable by the developer (if applicable).

4 New Service Mains

New service main connections (not a WNL asset) will be treated in the same manner as network extensions.

The procedure for connecting a new service main is:

1. The client will submit a WNL or Energy Trader System Connection Form which includes the total load demand and intended connection point.
2. WNL will then determine the location of the network connection point.
3. A fuse pillar will be installed on the property boundary as a demarcation point. The conductor size and number of phases will be determined by the WNL planning team.
4. All costs associated with the connection will be paid for by the client.

It is the client's service provider's responsibility to trench / install the service main to the base of the relevant network service pole / pillar.

For pole connections, the service provider will allow 8m of cable to run to the termination point on the pole. The cable must be installed in a 6m white UV stabilised duct which is temporarily tied in a safe manner to the pole.

4.1 Design / Planning Phase

During the planning phase, a copy of the proposed design (electrical / physical), and volt drop calculation must be submitted to WNL's planning team for approval.

A voltage drop calculator is available from:
http://www.generalcable.co.nz/newzealand/NZDownloads/Gencalc.aspx

Submitted documentation will include site-specific work procedures and an assurance that proposals meet the requirements of the local territorial authorities' district plans.

WNL will review the design and provide written feedback within 21 working days.

4.1.1 PROCESSING FEES

WNL's equipment processing fee is $500, excluding GST

4.1.2 CONSTRUCTION COSTS

All construction costs shall be met by the client.

5 Easements

Easements (in WNL favor) are required for network extensions in private property.

Private easements may be required when installations cross boundary lines. Easements are not required for portions of service mains contained within a road reserve (or land that will become a road reserve upon deposit of a Plan of Division).

The easement process is described as follows and is shown in the Figure 1 below.

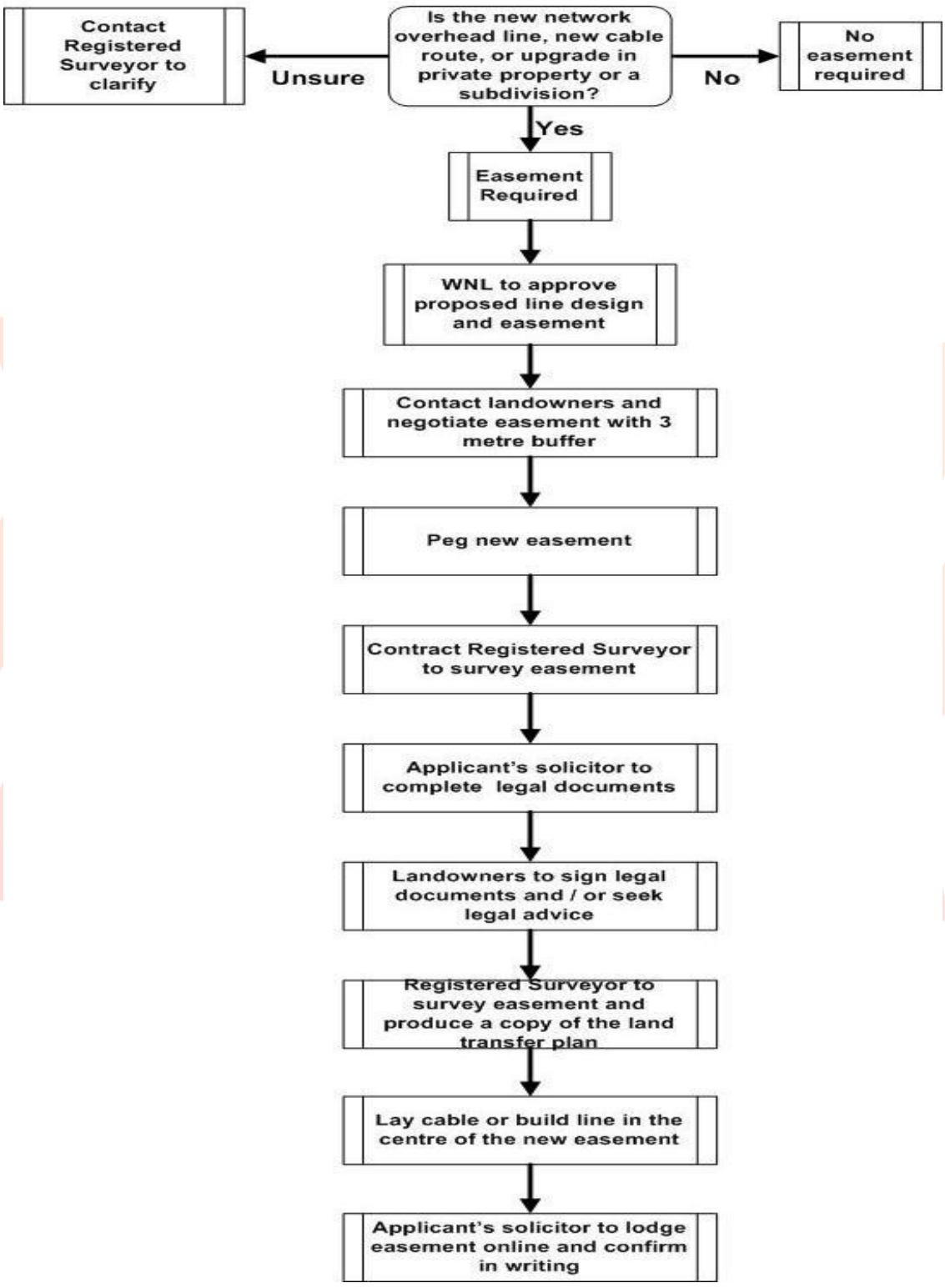
- When an applicant is lodging a survey plan in conjunction with a development, the applicant will fund and be responsible for creating an easement in gross favour of WNL.

- The applicant must liaise with WNL to ensure that the proposed design and the preferred easement meet WNL's requirements.

- Unless otherwise agreed, all easements are to be surveyed by a registered surveyor and pegs placed in position before the work commences. The pegs must delineate the easement and the boundaries of blocks before, during and after the electricity distribution assets are installed.

- All easements must be surveyed and a copy of the land transfer plan showing easements in place must be lodges with WNL's planning team

Figure 1 – Easement Process – Clients Responsibility



6 Utility Separation

6.1 Telco

- **U/G Cables: -** The Power cables must not be installed above Telecom cables and the minimum separation between the Power cable and Telecom cables complies with the following table.

Power Cable Voltage	Power Cable Type	Crossing or Parallel	Special Protection	Minimum Separation
Low Voltage Exceeding 32v ac or 115v dc but not exceeding 1000v ac or 1500v dc.	Neutral screened or armoured	Crossing	No	150
			Yes	50
		Parallel	No	150
			Yes	50
	Un-armoured or un-screened	Crossing	No	450
			Yes	50
		Parallel	No	450
			Yes	450
High Voltage Any voltage exceeding 1000v ac or 1500 dc	Single or multi core	Crossing	No	450
			Yes	150
		Parallel	No	450
			Yes	450

- **Transformers, Airbreak switches and arresters:** - If the work involves installing new Transformers, Airbreak switches or Arresters on existing poles supporting Telecom Service leads, the service leads must be removed from the pole. Please contact Telecom local contractor.

- **Earth systems: -** Your earth systems /concrete pole will not, under any condition, cause an earth potential rise hazard to Telecom plant in the vicinity. (See E.S.R. 33) If you have not determined the earth potential rise gradient, the following tables of separations for worst case scenarios can be used as a guide.

Type of Telecom Plant	Minimum Horizontal Separation to Steel or Concrete Poles (metres)				
	11kV	22kV	33kV	50/66kV	110kV
Exchanges, cabinets, jointing manholes	17	25	25	180	300
Ready-access points e.g. pedestals, pillars, pits	1.9	5	8	20	40
Cables	0.8	4	5	14	24

Type of Telecom Plant	Minimum Horizontal Separation to Earth systems		
	With small MEN	With extensive bonded MEN	Other earth system
Cabinets, jointing manholes excl. powered exchanges and cabinets.	65	48	65
Ready-access points e.g. pedestals, pillars, pits	3,5	31	3,5
Cables	0,5	0,5	0,5

- **O/H lines: -** If your proposal includes any HV lines which cross over a Telecom overhead line in span, the termination of the Telecom line will need to be improved on each side of the crossing to minimise the possibility of the Telecom line "flicking" up into the HV line. If this is the case, please contact 120 or Telecoms local contractor as soon as possible to arrange a quote for this work, which will need to be effected prior to enlivenment.

  Clearance between your lines and the Telecoms above ground plant must comply with ECP 34.

6.2 Other Utilities

	WNL LV Cable		WNL HV Cable	
	Crossing	**Parallel**	**Crossing**	**Parallel**
Gas Pipe	300 mm	300 mm	300 mm	300 mm
Sewer Pipe	300 mm	300 mm	300 mm	300 mm
Water Pipe	300 mm	300 mm	300 mm	300 mm

Note 1.

WNL earthing systems must comply with ER 58

Note 2

The above clearances are indicative only and contractors should refer to the relevant regulations for further guidance.

Note 3

Generally, WNL network cables run within the road reserve and parallel with the property boundary (except at road crossings) and private cables run within private property. However, if in doubt, contractors should contact WNL for further clarification

7 Construction Phase

When WNL has approved the design and the client has paid the appropriate fees, the contractor is authorised to carry out the work provided they comply with all relevant legislation and industry guidelines including but not limited to:

- NZ Electrical Code of Practice and the Health and Safety in Employment Act 1992 and its subsequent amendments.
- Resource Management Act 1991.
- Guide for Safety with Underground Services (Department of Labour, 2002).

- Telecom Guidelines – see Appendix A.
- Safety Manual – Electricity Industry (SMEI) – Parts 1, 2, &3 (EEA).
- The Land Code, Section CB6 (Electricity and Gas Complaints Commission, 2006).
- Roading Authority and Territorial Council Requirements.
- The “best practice” guidelines set out on the Electrical Engineers’ Association’s website (http://www.eea.co.nz/) and The Line Mechanics Handbook (EEA, 2006).
- Code of Practice for Temporary Traffic Management (Transit New Zealand).
- Portable site earths used on WNL’s network must be a minimum of 13.1kA rating for 1 second.

8 Quality Assurance Phase

The contractor will ensure through their own quality assurance procedures when work is completed that:

1. All network assets are labelled with WNL’s unique identification numbers, i.e. pole numbers, site numbers, dropout fuse numbers, ring-main unit numbers.
2. WNL’s equipment record sheets have been submitted.
3. WNL is notified that the new works are ready to be connected to the network at less four working days before livening is required.

WNL retain the option to quality assure contractor’s work to ensure that:

- All materials are new, undamaged and suitable for their intended purpose.
- The workmanship is of a high standard and in accordance with this design manual.

WNL will advise the contractor of any defects that need to be repaired before the works are connected to the network by WNL. The contractor will repair any defects in a timely manner.

9 Pre Connection Phase

1. WNL will authorise a connection to take place once satisfied that any defects have been repaired.

2. The contractor will provide a warranty to cover their workmanship and materials for a period of 3 years from the commissioning date. The warranty must state that:

    a. Should the Contractor's services, goods or supplies prove to be defective within the warranty period, the Contractor agrees to promptly (within 7 days) replace or repair the goods or supplies or correct such services to WNL's satisfaction without cost to WNL.

    b. Notwithstanding, the contractor will pay for any time and material expenses incurred by WNL if the Company needs to repair any of the contractor's defective workmanship under fault conditions.

3. All new connections must be made using live line techniques (including low voltage) under WNL's permit system unless otherwise agreed.

10 Post Connection Phase

The contactor has 21 working days to submit detailed "as-built" drawings to the WNL's planning team.

11 Pre Commissioning and Commissioning Tests

The contractor will submit pre-commissioning and commissioning plans as part of the contractor's quality assurance programme.

11.1 Pre-Commissioning

The contractor will carry out all checks, inspections, and tests necessary to prove the adequacy and safety of the lines before they are put into service. The documented tests will include:

- Earth tests;
- Insulator inspections for cracking and chipping;
- Pole arm fixings;
- Binder and/or armour rod fixings;
- Pole accessories (stays, switches etc);
- Conductor sagging; and
- Site reinstatement.

12 Commissioning

12.1 Orange Folder

The Project File (orange folder) used by WNL shall be house all test & information sheets.

A single copy of the following tests are printed on the WNL Project File

- Tailgate session
- Polarity & Loop Impedance Test Sheet
- Works Quality Audit

12.2 WNL Equipment Record Sheets

All tests are to be recorded on, or attached the Equipment Record Sheet. Ensure all relevant sections are completed and any other test results are attached to the sheet.

Each piece of equipment is to have a separate Equipment Record Sheet.

12.3 WNL Works Quality Audit Sheet

Each finished job is to be submitted to the Planning Office with a “Works Quality Audit” form completed by the foreman.

12.4 Pre- livening Tests

The following tests will be carried out prior to livening of any newly installed underground plant:

- Meggar test with a 5kV meggar (11kV cables only).
- Phase identification.
- Earth bank test.

12.5 Pre-Livening Asset Labelling

All high and low voltage equipment will be labelled with the appropriate code.

The labelling includes:

- All equipment identification plates / labels to be affixed to the relevant assets; and
- LV circuit labels, single line diagrams, and fuse sizes will be clearly displayed in the relevant cubical.

12.6 Post Livening Tests

The following tests will be carried out as soon as the plant has been livened:

- Phasing check (with LV isolators removed)
    - Polarity testing.
    - Voltage rotation.
    - Phasing out of 11kV if required.
- Voltage checks.

13 Site Reinstatement

The standard of reinstatement must comply with the relevant council or authority's code of practice (i.e., Excavation and Shafts for Foundations, Department of Labour, 1995).

In summary:

- Kerbing, pavements, vegetation, and other objects will be reinstated to a standard at least equivalent to that which existed prior to construction activity. In all cases, the site will be left in a safe, clean, and tidy condition.

- Drainage will be reinstated to its pre construction condition (or better) to ensure ground stability.

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Section 2 – Overhead Construction

14 Introduction

The following outlines WNL's objectives for its overhead network.

The overhead lines within WNL's network must:

- Be safe to construct and maintain, and should not introduce any hazards to the general public.
- Be designed with aesthetic consideration in mind.
- Adequately serve the purpose for which they have been designed.
- Safely carry any peak loads without creating problems associated with unacceptable voltage drop.
- Meet the requirements set out in the relevant regulations and codes of practice.

15 Strength of Materials

Overhead line must be designed and constructed in accordance with the following Acts, Regulations and standards;

- Resource Management Act 1991 (RMA)
- Health and Safety in Employment Act 1992 (HSE Act).
- Electricity Act 1992 and amendments
- The Electricity (Safety) Regulations 2010
- New Zealand Electrical Codes of Practice (NZECP)
- Overhead line design-Detailed procedures AS/NZ 7000:2010

WNL has chosen to build its lines to security level 1 and return period of a 50year working life. This was determined from a risk/feasibility assessment.

Refer to AS/NZS 7000:2010; Australian/New Zealand Standard, Overhead line design-Detailed procedures, section 6, Basis Of Structural Design.

Conductor sags and tensions will be determined in accordance with the following parameters:

- Maximum conductor tension determined at the higher of either 0^{o} with wind loading of 900 Pascal's or -7 ^{o} C with no wind.
- Maximum conductor sag determined at 50^{o} C with no wind.
- Constant conductor tension occurs at defined normal everyday temperature of 15^{o} C. This is the assumed average temperature at which conductor stringing will occur.
- Everyday stress limited to 18% of conductor calculated breaking load (CBL).
- Maximum allowable stress with wind and low temperature limited to 70% CBL in accordance with the Electrical Supply Regulations.

Maximum wind speeds were recorded at Te Rauamoa with a wind monitoring mast over a five year period (the maximum was 38m/s). All future calculations are to use a wind speed of <u>39m/s.</u>

The following formula should be used when designing an aerial line over 60m. *Note,* for spans up to 600m and where spans are level only.

$$\frac{wL^2}{8T} = \text{Sag}$$

L = Span length (meters)
w = mass/unit length of conductor (N/M)
T = Horizontal tensions (N)

16 Materials Used

In order to achieve consistency within our electrical network, all materials used to build new lines or maintain existing lines must comply with WNL standards and be readily available from WNL's store.

17 Poles

17.1 General

The general rules for poles are:

- All new or maintenance overhead construction on WNL's 11kV and LV network will be supported by pre-stressed concrete poles.
- All poles (and other plant) installed on the WNL network will be new.
- Poles will be selected such that the static (permanent) and dynamic (wind) load combination is within safe limits.

As a general guide, WNL's nominal standard pole sizes are:

- 9m (LV);
- 10m (Rural 11kV);
- 11m (HV transformer structures, 11kV cable termination poles etc).

17.2 Pole Numbering

These numbers are shown on WNL drawings.

Numbers starting with 3, are private poles. No number has been attached to the pole.

Numbers starting with 4, are Telecom poles, being used by WNL. No number has been attached to the pole.

Numbers starting with 6, are locations of ground mounted transformers. No number has been attached to the ground mounted equipment.

Numbers starting with 7, are in NCS only and are used for administration. The numbers in NCS, are not shown on the drawings, no pole number has been attached to the pole.

Numbers starting with 8, are WNL poles. This number has been attached to the pole.

Numbers starting with 9, are WNL poles. No NCS . No number has been attached to the pole. Ideally when these poles are visited, a number starting with an 8 sould be attached and the Network Information Officer advised.

17.3 Pole Ownership

There are two types of 11kV line:

Network (owned by WNL) and Service Main (Privately Owned).

Network Lines consist of:

a) Lines in road reserve
b) When multiple properties are serviced, the line to the last service.

c) When a property is feed by crossing another property, the network line is to the first crossing of the last boundary.
d) The line across a road, this may or may not lead to a service main

Service Mains consist of:

a) The line within one property (may have one or more ICP's).
b) The line between adjacent properties when the properties are owned by the same owners

17.4 Design Information

Poles are commonly described by the duty they perform. They can be termed inline, angle, termination, stay, and transformer poles. Each individual pole must be examined in relation to its duty to determine that a pole of adequate strength in strong and weak directions is used without the use of guy wires.

The poles must be buried to the ground-line mark on the pole and the number of poles in any street will be kept to a minimum.

17.5 Position of Poles in Urban / Residential Areas

Pole spacing in residential areas is governed by the layout of the area.

Poles will be placed:

- At a distance from the property boundary which has been negotiated with the appropriate Council and / or Authorities.

- On an alignment parallel to the property boundary.

Poles will be placed on the extension of the fence line dividing two properties when:

- There will be driveways on both properties that will be adjoining the dividing fence.

- Neither property will have a driveway adjoining the dividing fence.

- The position of the driveways on either property is not known.

When there will be only one driveway adjoining the fence-line, poles will be located as near as practicable to 0.6m for road crossing poles, or 1.5m for parallel construction, from the extension of the fence line dividing the two properties and on the side of the property in which there will not be a driveway adjoining the dividing fence.

Where no land subdivision has taken place, poles will be located in the most suitable positions for local and technical considerations.

When a customer requests that a pole be relocated in a position other than those set out above, it will be placed in an agreed position in front of that customer's property. Network alterations requested by the customer will be at the customer's expense. The customer will also provide any necessary easements.

See example below

The owners of 32 Laurina Ave have requested the existing pole '3' is moved to position 'X to allow for a new driveway.

The rules that will apply are:

a) the pole must be in an agreed position in front of the customer's property.

b) the move will be at the customer's expense.

c) the customer will be accountable for any new easements

17.6 Position of Transformer Poles

In addition to the above, transformer poles are to be located to minimise the visual impact where practical. Also, the location must ensure that access to two sides of the pole is maintained to replace the transformer. Poles are to be 11.6m pre-stressed concrete unless otherwise stated and agreed.

17.7 Position of Poles at Street Intersections

The location of poles erected at street intersections will be determined by the above requirements and:

- Giving due consideration to traffic requirements.
- Considering the needs of the property owner adjacent to the pole.
- Consideration of public lighting requirements.

17.8 Position of Road Crossing Poles

The location of road crossing poles will be determined by the above requirements. They will be erected so that the strong direction of the pole will be at right angles to the route of the roadway.

17.9 Position of Poles in Rural Areas

The position of poles in rural areas will be determined by their height, the route profile, and by fiscal considerations.

17.10 Safety Distances / Clearances

The safety distances / clearances on all WNL lines must adhere to the guidelines set out in the current New Zealand Electrical Codes of Practice and Electrical Supply Regulations.

17.11 Minimum Breaking Load

Calculated Minimum Breaking Load	
New Conductor	
AAAC Fluorine (49mm)	11.8 kN
AAAC Helium (77mm)	17.6 kN
AAAC Hydrogen (111mm)	24.3 kN
AAAC Krypton (158 mm)	37.4 kN
ASC Squirrel (25mm)	7.75 kN
ABC 35mm	19.6 kN
ABC 50mm	28 kN
ABC 95mm	53.2 kN

AAAC: All Aluminium Alloy Conductor
ABC: Aerial Bundle 4 Core Conductor

Source: www.generalcable.co.nz

17.11.1 VARIATIONS TO THE ABOVE TABLE

Variations to the above table may be submitted for approval if the above conductors cannot be used for specific applications.

17.12 Cable Current Capacities

Cable current capacities will be determined in accordance with the following parameters:

Conductor Name & Nominal Area	Current Rating @ 75°C – Summer Noon **
Krypton (158 mm^2)	490 Amps
Hydrogen (111 mm^2)	418 Amps
Helium (77 mm^2)	333 Amps
Fluorine (49 mm^2)	251 Amps

** Wind Speed 1m/sec, emissivity 0.5, absorptance 0.5., 25°C for summer noon. Intensity of solar radiation 1000 W/m^2 for summer noon. Angle of wind to conductor axis is 60°.

Source: www.generalcable.co.nz

17.13 Pole Alignment & Raking

Overhead lines will be designed to ensure that:

- Poles are set vertical except at corners where they will be raked against the load so that the pole top will be in line after the load is applied.
- Backfill will be compacted under all circumstances.
- Termination poles are vertical and in-line after the load is applied.

Blocking

Blocking may be necessary for termination and angle poles where a guy / stay wire is not practicable (note: prior network design approval is required in these

situations).

Where it is necessary to fit breast blocks, a toe block must also be bolted to the bottom of the pole. In all cases the blocks will be reinforced concrete and to WNL standards.

18 Guy / Stays

All angle (>15^{o}) and termination poles must be stayed and stays on H-Pole structures must be WNL approved.

Any guy/stay wires will be to WNL's standard (see Overhead Construction Drawings) and fitted with stay-guards.

19 Crossarms

In general, crossarm length within the WNL network will be influenced by the likely impact of:

- Adverse weather conditions (i.e., strong wind / squalls);
- Vehicles or wildlife (birds) hitting the poles or conductors;
- Short circuit conditions (i.e., conductors clashing under fault conditions); and
- Conductor swing.

19.1 Standard Crossarm Sizes

WNL's standard crossarm sizes are:

11kV Span Length	Required Crossarm Length
Greater than 165m	Design review
100m to 165m	3m at both ends
90m to 100m	2m one end and 3m at the other end
Up to 80m	2m

Note that:

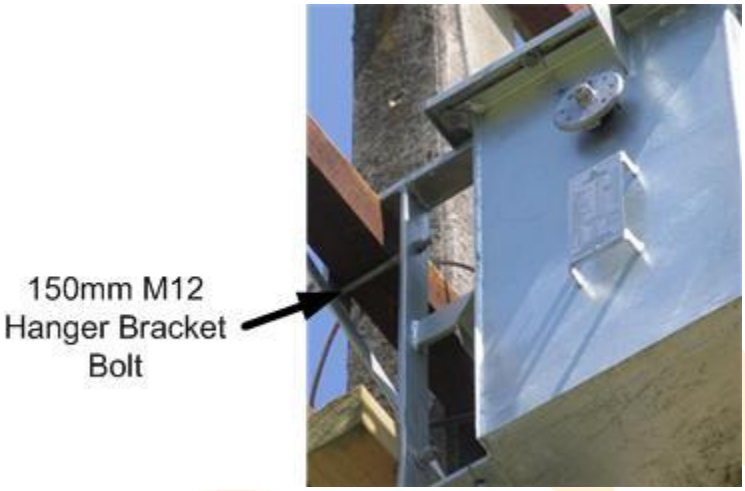
- 3m 100mm x 100mm crossarms are to be used on spans greater than 165m in length.
- Delta construction will be considered as an alternative to longer cross-arms.
- Vibration dampeners are to be fitted where appropriate.

20 Equipment Mounting Bolts

All bolts used during construction will be appropriately sized and fitted with square washers. Note that:

- All bolts will be long enough to fully engage the nut and washer(s) but will not extend more than 10 threads beyond the nut when fully tightened.

Note that transformer hanger brackets are to be fitted with an M12 bolt:



21 Stringing Conductors

The work procedures submitted during the design phase will include the methodology to be used for:

- Running the conductors
  - Snatch blocks / rollers to be used.
  - Cable stockings / grips to be used.
- Sagging (note: dynamometers must be used).

22 Lineguards and Preformed Deadends

Lineguards are to be used on all aluminium construction (HV & LV).

Aluminium deadends are to be used for terminating aluminium conductors and copper deadends are to be used for terminating copper conductors. Galvanised deadends are not be used on overhead conductors.

23 Joints and Connectors

23.1 Full Tension Joints

The appropriate compression sleeves must be used on all full-tension joints.

The rules for using compression sleeves are:

- Mid-span joints will not be used on new construction.
- Compression sleeves must be crimped with the correct size dies.
- Once crimped, the sleeve must have less than a 3mm bend. Any bends over 3mm must be rejected.

23.2 Tap Off Connectors

The following connectors will be used for tap-off connections:

All 11kV connections are to be Ampac

LV Connections:

- ACSR and AAA and AAA/Cu: Ampac
- Copper: Bowthorpe Line Taps
- ABC: IPC.
- EPs can be used on aluminium and copper LV connections.

24 Fusing

24.1 Fusing 11kV Transformers

Protection and isolation for 11kV distribution transformers is provided by crossarm mounted dropout (cutout) fuse switches.

24.2 Dropout Fuses (cutout type)

25kV S&C Type XS Fuse Dropouts (cutout - pole-top style) are to be used in the WNL network.

These dropouts are not to be used on:

- An 11kV line that can be paralleled with another line; or
- 11kV ring circuits.

24.3 Fusing of Service Mains

The rules for fusing all spur lines are:

1. Where practical, 25kV dropout fuses should be attached to the take-off pole;
2. Where possible, the rating of the fuse links should be 10% of the transformer's kVA rating; for example, a 30kVA transformer would have 3amp fuse links. Note that this rule is not always possible, for example, 50kVA transformers require a 6 amp fuse.
3. Refer to the Line Mechanics Handbook (EEA, 2004, p. 218) for ratings.

24.4 Fuse Maintenance

When a transformer is upgraded, the dropouts / fuse links should be checked in the field to ensure that they can function under the new load requirements.

25 11kV Transformers

25.1 General

WNL will supply all transformers to be used on its network. Contact WNL Planning Office for further information.

25.2 Mounting

WNL requires all 100kV and larger transformers to be ground mounted. Transformers less then 100kVA may be pole mounted.

25.3 Tappings

Tappings will be determined after installation during the contractors “no load” voltage tests.

Contractors will ensure that the secondary (LV) “no load voltage” ranges between 237 volts and 242 volts per phase at the time of testing.

26 11kV Switches

26.1 Choice of Overhead Switch

WNL have predetermined locations for overhead switch types.
The spread sheet can be found at the address below. Insert the existing switch number and the new switch type will be given

N:/EPS1 vs. G&W locations

26.2 Switch Types

The following hot-stick operated switches shall be used at the discretion of WNL:

SF_6	*Photo to be added.*
ESP1 Electropar Switch	 
Britech	Photo to be added
S & C	Photo to be added

27 Surge Arrestors

ABB MWK 10 surge arrestors will be provided for all 11kV cable connections and on transformers in lightning prone areas.

28 Earthing

28.1 Earthing Systems

Whilst acknowledging the standards set out in AS/NZS 3000:2000, all earthing systems in the WNL network will be to the following standard:

- All transformer star point earths will not exceed 10 ohms.
- Lightning arrestor will not exceed 30 ohms.
- ABS or reclosers will not exceed 30 ohms.

The earth wire diameter will be:

Earth Wire Diameters	
Equipment	**Earth Wire Diameter (copper)**
Reclosers	70mm^2
Regulators	70mm^2
Lightning Arrestors (out to first recloser)	70mm^2
Air Break Switches (out to first recloser)	70mm^2
Lightning Arrestors (beyond first recloser)	25mm^2
Air Break Switches (beyond first recloser)	25mm^2
Transformers up to 75kVA (urban and rural)	25mm^2
Transformers over 75kVA (urban and rural)	70mm^2

PVC covered earth wire will be used in all circumstances.

28.2 Dual Earth Labels

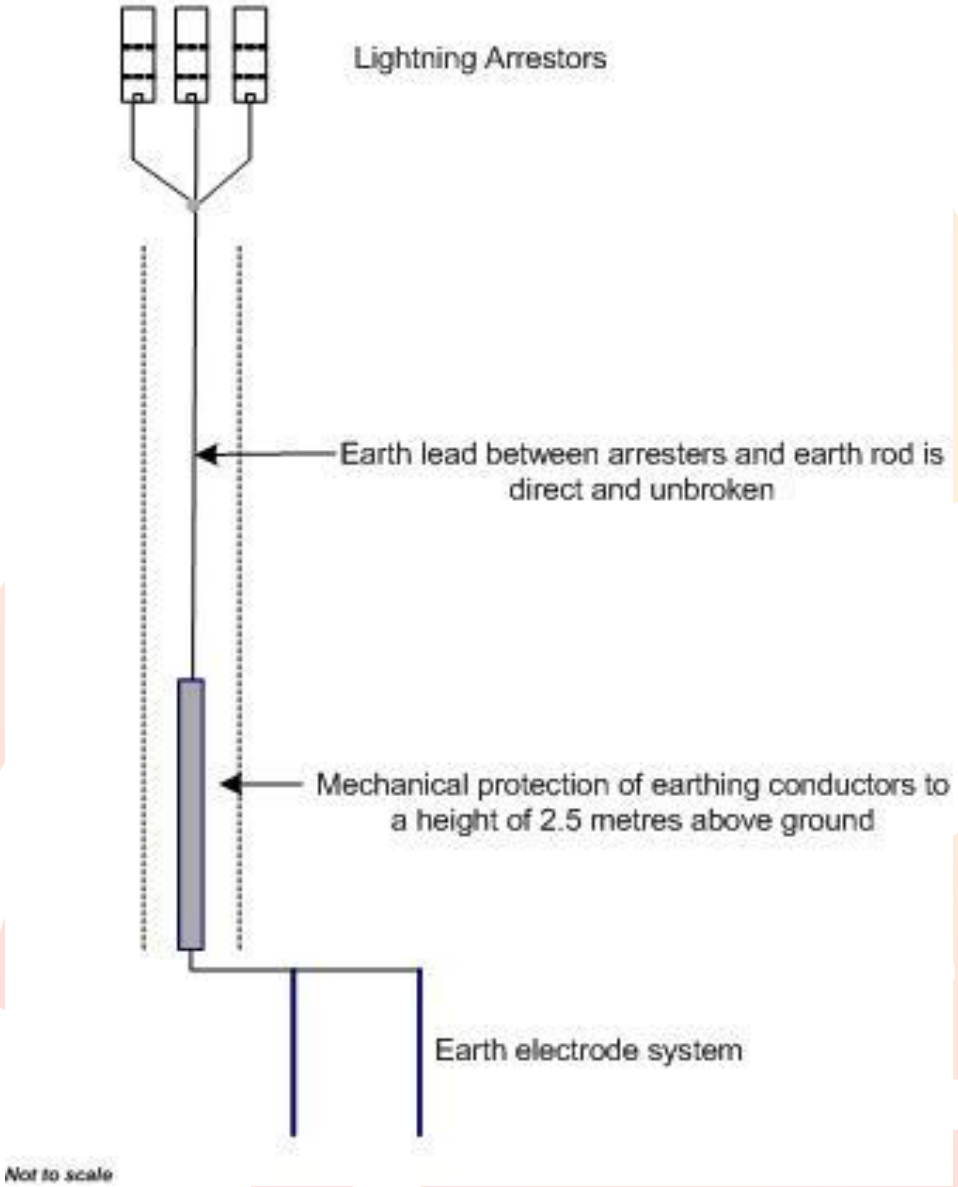
“Bank 1” and “Bank 2” labels are to be fitted to each earth conductor below the test link.

28.3 Earth Pins

All below ground earthing will be connected via cadweld and use 1.8m x 13mm2 copper plated pins.

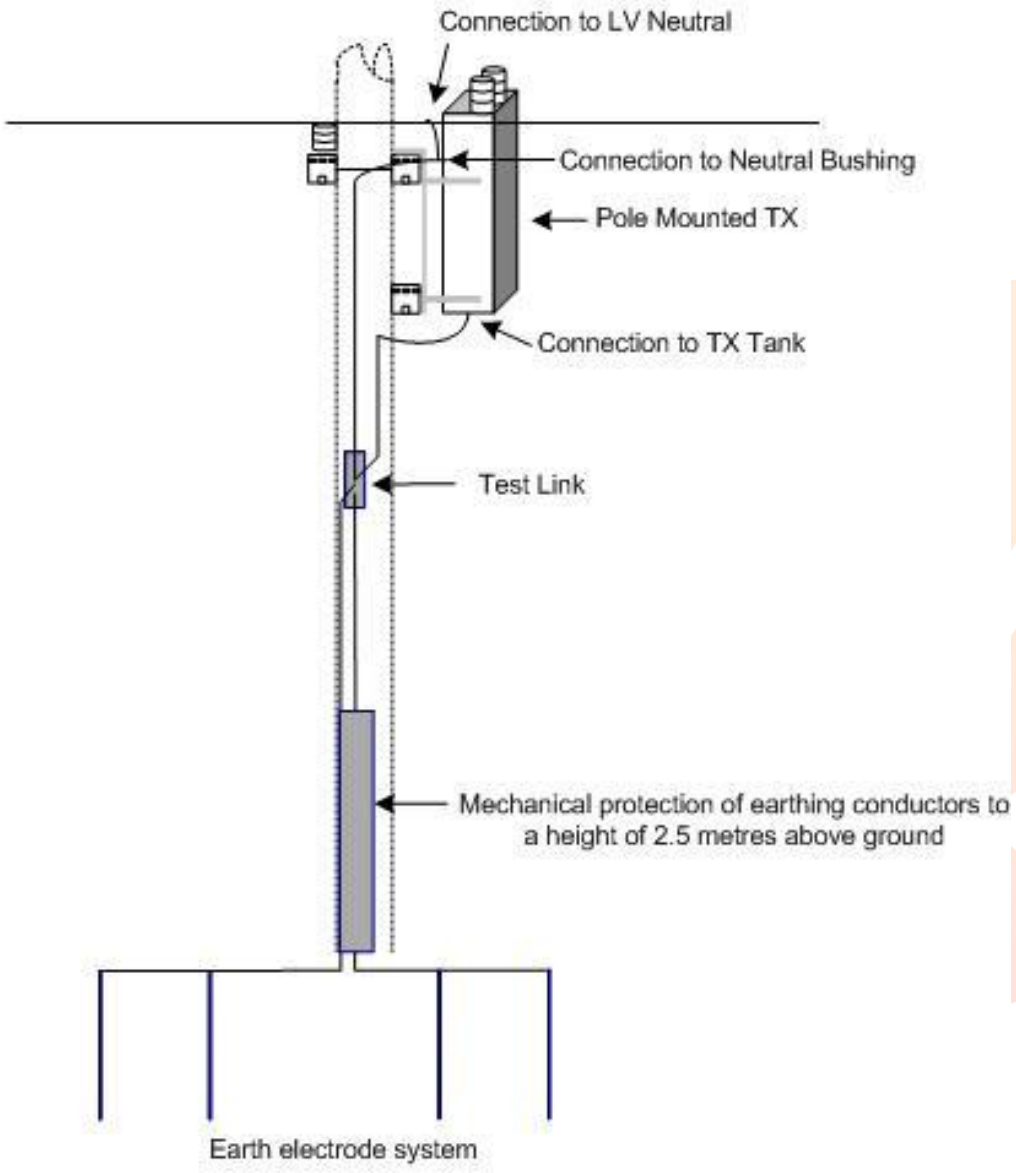
28.4 Lightning Arrestor Earthing Arrangement

WNL Earthing Arrangement for Lightning Arrestors



28.5 Pole Mounted Transformer Structure Earthing Arrangement

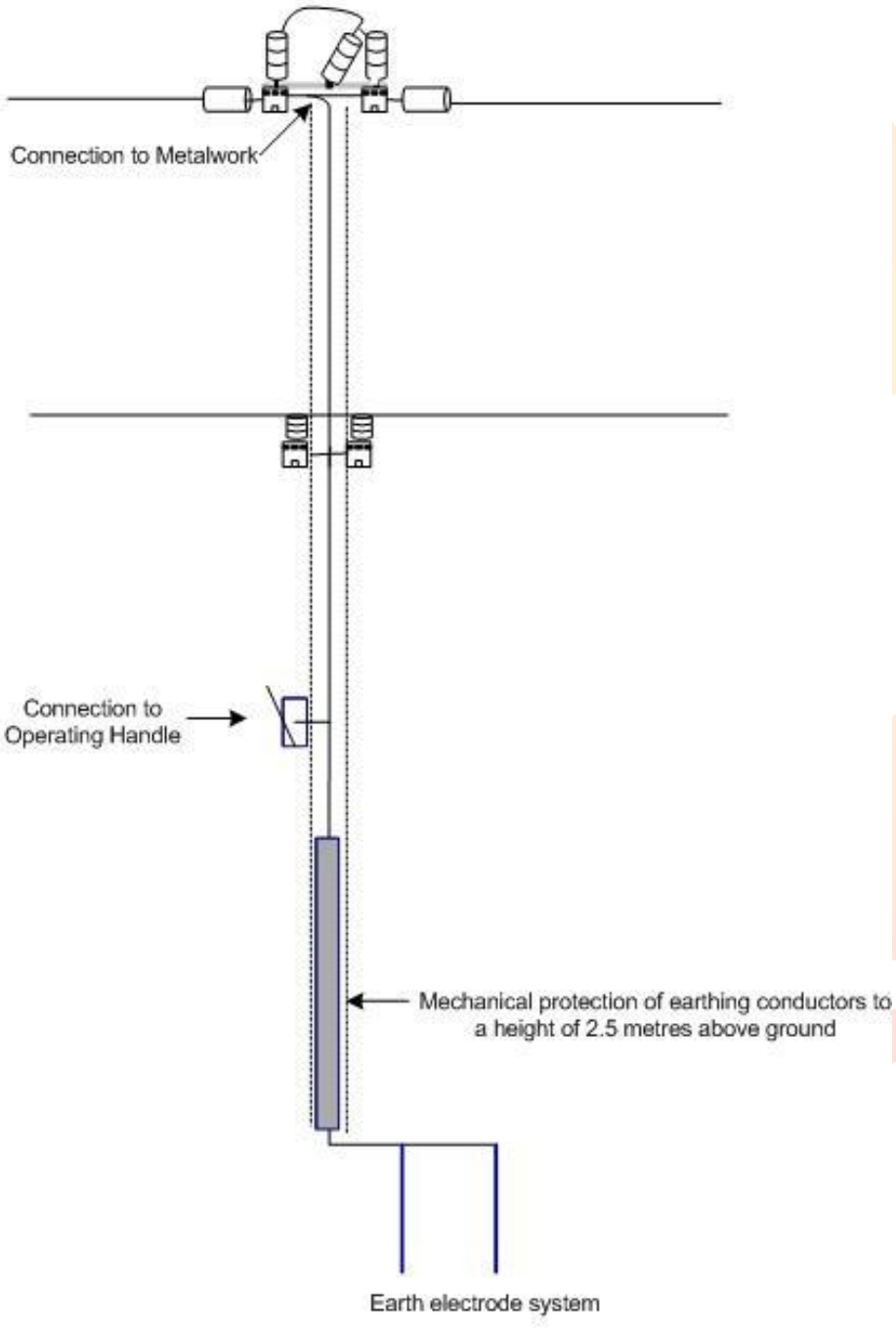
WNL Earthing Arrangement for Pole Mounted Transformers



Not to scale

28.6 ABS Earthing Arrangement (Non Hotstick Operated Only)

WNL Earthing Arrangement for Air Break Switch



Not to scale

29 Guards/Clamps

29.1 Opossum Guards

All 11kV poles will be fitted with opossum guards.

- The guards will have a minimum width of 600mm and will encapsulate any accessories.

The cable guard must be secured with bandit tape.

29.2 Cable Guards

WNL's rules for installing cable guards on poles are:

- All network cables are to be protected by the appropriate length of ABS recycled cable guard; if necessary a white duct can be installed on the cable and covered by the above.

The cable guard must be secured with bandit tape.

29.3 Cable Clamps

When the cable needs supporting on the pole (e.g. the cable guard is adequate for the length of cable) a clamp shall be used to hold the cable to the pole.

Section 3 – Underground Reticulation

30 Open Trenching

Underground Network Reticulation General rules:

- All cables laid in a common trench must be on the boundary side of the trench.
- When ducts (conduits) or cables are to be installed, the trench will be as straight as possible with a firm and smooth base.
- There will be a minimum separation of 750mm (centre to centre) between direct laid WNL 11kV multi circuits (see Figure 1 below).
- In order to reduce any damage to WNL's electrical infrastructure, the distance between the trench wall and WNL infrastructure will be a minimum of 50mm.
- The maximum depth of any length of open trench should not be greater than 1.5 metres.
- Cables installed under all non-Transit roads must have 1.2m of cover. Cables under Transit roads require 1.5m cover.
- A cover of 100 mm of compacted good quality fill is to be placed on top of the bedding sand.

  The appropriate magslab or warning tape will then be laid on top of the fill.

The requirements are:

- All cables in common trenches: 150mm magslab.
- Cables using chain trencher and LV: 100mm magslab.
- Neutral screen: hazard warning tape.

Note: Magslab is a polymeric cable cover strip that complies with AS 4702.

- The trench will then be backfilled and compacted using suitable materials.

31 Thrusting

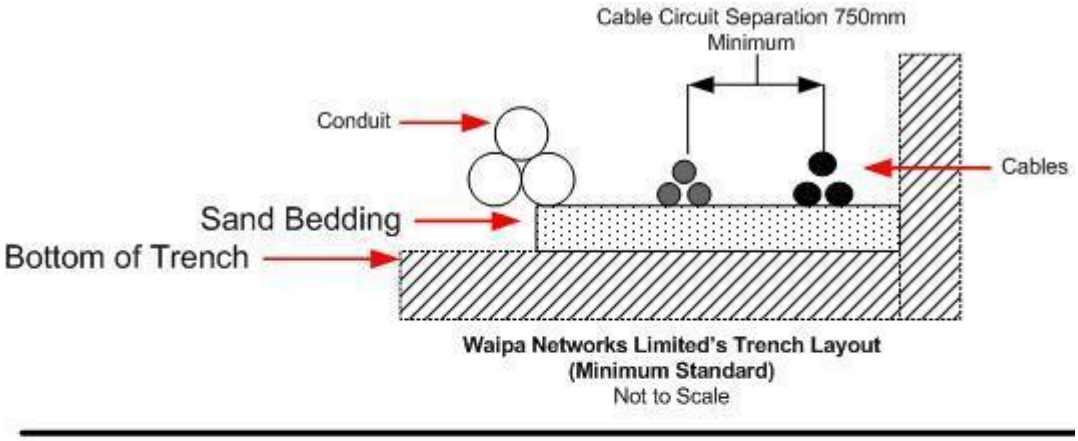
The general thrusting rules are:

- All road crossings must be thrusted.
- Continuous ducting must be used for all thrusting.
- The continuous ducting sizes (inner dimensions) to be used are:

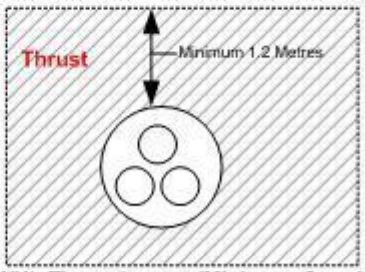
Cable Type	Duct Size (inner dimensions)
300mm^2 cable	140mm
185mm^2 cable	110mm
Street lighting	40mm
All other cables	90mm

- Multiple ducts can be passed through a single bore or tunnel.
- The minimum depth of a thrust will generally be 1.2 metres (Transit roads – 1.5m) to minimise ground swell. Final depths are to be determined in conjunction with the boring contractor with the minimum depth to be achieved wherever possible (see Figure 1 below).

Figure 1



Waipa Networks Limited's Trench Layout
(Minimum Standard)
Not to Scale



WNL Thrust Layout (Minimum Standard)
Not to Scale

32 Ducts

Cables will be installed in ducts:

- Under all road crossings; and
- Where ground conditions determine that duct is required.

Note that:

- Earth cables do not need to be installed in ducts.
- 11kV cables must not be installed in the same duct as low voltage cables.
- Cables running under all roads must be installed in continuous ducting.

Ducts and couplings used for direct burying will:

- Be orange in colour.
- Meet the standards set out in AS/NZS 2053 (Parts 1 and 2) for Rigid Plain designation.

- Meet the standards set out in AS/NZS 1477 (1996) for the test impact Test for Impact at 20 degrees C.

Ducts used for thrusting will:

- Be orange in colour.
- Meet the standards set out in AS/NZS4130.
- Be able to withstand the forces involved in the directional boring process.
- Be of size and characteristics to allow the cable to achieve its current rating.

All ducts/conduits to be installed on poles must be white in colour and UV stabilised.

Draw wires will be installed in all ducts.

32.1 Duct Size

The following duct sizes are to be used:

Cable Size	Duct Size	
	Outer Dimension	Inner Dimension
2 phase 6mm streetlight	36.2mm – 36.4mm	32mm
LV service or > 6mm streetlight	55.8mm – 56mm	50mm
LV reticulation	82.3mm – 82.7mm	80mm
Up to 95mm 11kV (</= 45 metres)	82.3mm – 82.7mm	80mm
Up to 95mm 11kV (> 45 metres)	110mm – 110.4mm	100mm
185mm 11kV	110mm – 110.4mm	100mm
300mm 11kV	160mm – 160.5mm	150mm

33 Cable Installation

33.1 General

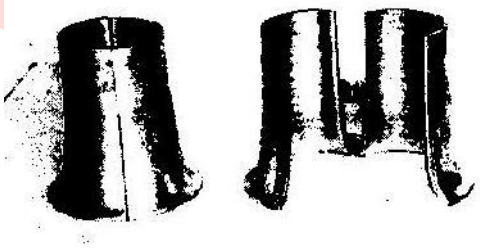
Cable drums will not be transported in any other position than vertical. During the installation and jointing, cables must not be stood on.

Cables should be visually and manually inspected for defects during the installation process.

33.2 Cable Drum Operations

The cable may be laid by mounting the cable drum on jacks or trailer or suitable stand, at the end of the trench, fitting a cable stocking grip to the end of the cable and drawing it off the drum into the trench.

When cables are pulled into ducts the cable drum will be positioned so that the cable is drawn from the bottom of the drum in an even curve into the required duct without undue pressure on the mouth of the duct. A split bell-mouth will be used in all circumstances.



SPLIT BELL MOUTH

At no time must any loose turns on the under side of the cable drum be permitted to come in contact with the surface upon which the cable drum support has been mounted.

33.3 Cable Pulling

When installed in ducts, the cables will be lubricated with cable pulling lubricant to facilitate drawing in. In ducts greater than 200m, the duct must be opened every 100m to facilitate re-greasing of the cable.

During installation operations, cables, both 11 kV and low voltage, must not be bent to a radius of less than 12 times the overall diameter of the cable. These conditions will be strictly adhered to, particularly where cables turn into road crossings, duct entry, etc.

Sharp objects and all stones will be removed from the trench before the cable is laid. If the sharp stones or objects cannot be removed:

- 100mm of sand must be applied to the trench floor before the cable is laid and a further 100mm of sand is to cover the cable once it has been laid; or
- The cable must be installed in duct.

Stones & Sharp Objects to be Removed

Where required, rollers will be used where cables are installed in an open trench using a pulling rope and eye. Cable rollers are to be used at frequent intervals to support the cables and must never be more than 3 metres apart. Care must be taken to ensure that the cable does not enter or leave the rollers at an angle that exceeds the bending radius of the cable.

The rollers are to be placed securely to prevent movement. Before driving any spikes to secure the rollers, care must be taken to avoid other utilities' equipment, which may exist below. The pulling rope must be equipped with a swivel and be attached to the cable by a stocking grip with pulling eye.

The plant used to pull cable will be firmly anchored, before the pull commences, to stop the winch from moving with subsequent uneven pulling of the cable. The cable will be drawn into the trench smoothly with a minimum of stops and at an average speed of between 9-12 metres per minute, to avoid irregular movement.

All cable ends must be temporarily sealed by the use of heat shrink caps. This requirement applies to 11kV cable and LV cable at all service pit positions. Caution: Cables must not be energised with this method of cable end seal.

At the conclusion of a cable pull, all cable ends will be sealed prior to those ends being secured to the inner and outer drum flange. The sealing of cable ends must be via heat shrink as a minimum.

34 High Voltage Cable Designs

34.1 High Voltage Cables Sizes

a) The following cross-linked polyethylene (XLPE) insulated 11kV cable sizes are used:

- 11 kV substation feeder exits to the first switching cubicle: 300mm^2 AL.
- Main feeders: 300mm^2 AL.
- Load transfer ties between radial main feeders: 185mm^2 AL.
- Laterals and radials: 95mm^2 AL.
- Laterals and radials with no prospect of future ties: 35mm^2 AL or 25mm^2 copper.

34.2 Cable current capacities

Cable current capacities will be determined in accordance with the following parameters:

Nominal Area	Direct Buried	Buried in Ducts
300mm^2	476 amps	417 amps
185mm^2	367 amps	320 amps
95mm^2	253 amps	219 amps
35mm^2	148 amps	127 amps

Note: The above information is based on 30^{o}C ambient air temperature and where applicable, burial depth of 0.8m, soil temperature of 15^{o}C and thermal resistivity of 1.2^o Cm/W.

34.3 Avoiding Ferro-resonance

Underground cables of a length greater than those shown in the table below, shall be connected to the network via a three phase switch to avoid ferro-resonance occurring upon livening an unloaded transformer.

Transformer Size	Cable 35mm ^{2}	Cable 25mm ^{2}	Cable 16mm ^{2}
750kVA	800m	870m	960m
500kVA	400m	550m	610m
300kVA	300m	330m	360m
200kVA	200m	220m	240m
100kVA	100m	115m	125m
75kVA	75m	95m	105m
50kVA	50m	60m	65m

Note: Distance shown is total length of cable

35 Pad Mounted Transformers

Transformers will be capable of supplying the maximum customer demand. A looped high voltage network is required for any development with more than three transformers.

Pads must be to WNL standards and equi-potential bonded.

The location of a transformer is dependent on a satisfactory risk assessment. Transformers should be sited in the road reserve and in the centre of the low voltage feeder network that it supplies.

The HV and LV ends of the transformer must be clearly identified.

35.1 Transformer Mounting Pads

Concrete pads for padmount transformers and switching cubicles will be precast (Refer WNL Underground Construction Drawings).

35.2 Earthquake Restraint

All transformers must be dyna bolted (minimum of four dyna bolts) to the pad and meet seismic regulations

35.3 Locking Facilities

Padmount transformer and switching cubicle doors at both ends will be locked with an “X Key” padlock and hex screws will be inserted at both ends. Doors must be locked when the equipment is not being worked on.

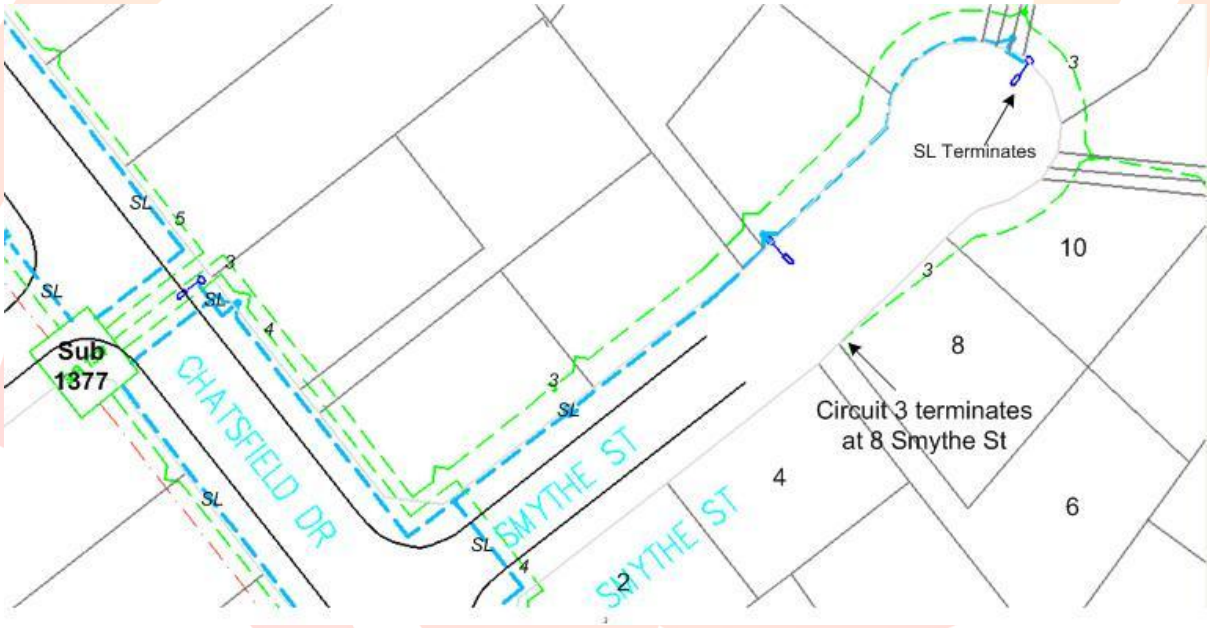
35.4 Labels on Cable Circuits

At transformers, labels are required on all LV cable ends to indicate circuit names or destinations. Labels must be durable, permanent and weatherproof. The labels should be checked to determine whether they are in the correct position and all cable ends are correctly designated.

Laminated single line diagrams of all circuit are also to be attached to the LV door of the transformer.

For example, the following diagram outlines that Circuit 3 from Sub 1377 ends at 8 Smythe Street.

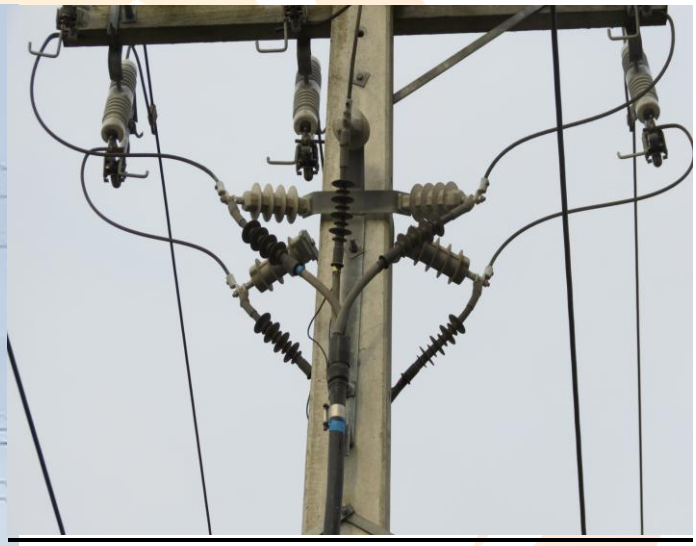
Service cables must be labeled with the house number and ICP (with permanent marker) inside service pillars.



36 Overhead to Underground Connection

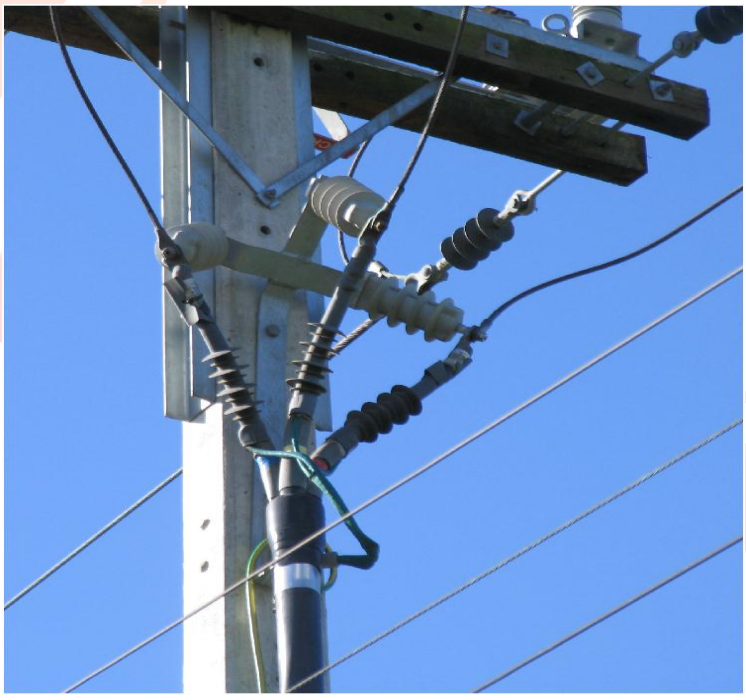
From time to time it will be necessary to install two 11kV cables back to back on the same pole. Slack spans shall be used on termination poles in lieu of heal and breast blocks.

The following photos are examples of back to back 11kV on the same pole.



37 11kV Surge Arrestors

Appropriate surge / lightning arrestors will be fitted to all 11kV underground cables at the point where the cable connects to overhead line.



Cable Termination with Lightning Arrestors

38 Ring Main Units

ABB SF_6 Safelink ring main units are to be used in the WNL network. The location of a RMU is dependent on a satisfactory risk assessment. These switches should be sited in the road reserve.

39 SF_6 RMU HV Fusing

Where HV fuses are required, they will be of a rating outlined in the following table:

100% 630A	Transformer Rating (kVA)													
	50	100	125	160	200	250	315	400	500	630	800	1000	1250	1500
Un (kV)	Fuse Link Rating In (A)													
11	16	16	16	25	25	25	40	40	50	50	80	80	160	

The table is based on using fuse types ABB CEF (alt. SIBA)
Fuse barrel length = 292mm
Normal operating conditions with no transformer overload
Ambient temperature -25°C + 40°C

Source: BASED ON SF_6 Insulated RMU Installation and Operating Instructions, www.abb.co.nz

40 Low Voltage Cable Designs

40.1 Low Voltage Cable Sizes

The following 0.6/1.0kV cables will be used for the low voltage network:

Mains Cables:

- 185mm^2 AL 4C XLPE/PVC 6/1kV.
- 120mm^2 AL 4C XLPE/PVC 6/1kV.

- 70mm^2 AL 4C XLPE/PVC 6/1kV. Note: 70mm^2 is only to be used for laterals (up to six connections up each R.O.W.) and radials with no prospect of future ties.

Streetlights:

- 2 core x 6mm ANN NS (10085).
- 2 core 2.5mm TPS (1007) Twin + E (only used in streetlight columns).

40.2 Cable current capacities

Cable current capacities will be determined in accordance with the following parameters:

Nominal Area	Direct Buried	Buried in Ducts
70mm^2	203 amps	176 amps
120mm^2	276 amps	239 amps
185mm^2	349 amps	309 amps

Note: The above information is based on 30^{o}C ambient air temperature and where applicable, burial depth of 0.8m, soil temperature of 15^{o}C and thermal resistivity of 1.2^o Cm/W.

40.3 Voltage Drop

The voltage drop at any network connection point off a feeder will not exceed 6% (see Electricity (Safety) Regulations 2010, Part 3, Systems of Supply, and Regulation 28).

A suitable voltage drop calculator is available from:

http://www.generalcable.co.nz/newzealand/NZDownloads/Gencalc.aspx

41 Balanced Loads

Single-phase customers must be evenly connected across all three phases. Three phase customers are assumed to have their load evenly balanced across all three phases.

42 Pit and Pillar Types

In most cases, WNL service points will be in the form of an above ground pillar. However, in certain circumstances (e.g., when there are design issues) WNL will allow the use of underground pits.
Pits and pillars will be selected to suit the terrain and electrical supply requirements.

All fuse pillars must be livened (i.e. line side) from the bottom side so that ICP tags can be fitted in a convenient visual position.

The following pillar selection priorities will be applied:

Description	Photo	Fuse Range	Typical Application
Pillar Gyro E3000		63 amp to 100 amp	Residential or Commercial Distribution
Pillar Gyro Medium		63 amp to 100 amp Where more than 6 fuses are required	Residential or Commercial Distribution
Pit – Dulmison 300D & Lid with Michaud Fuse		60 to 100 amp Where required.	Residential or Commercial Distribution

43 Provision for Future Development

When a development is staged and indicative future requirements are known, provision should be made for extending HV and LV feeders. Such provision can include installing additional ducts and coiling buried cables in a marked location.

Where a low voltage cable is installed in one stage to ultimately feed a future stage the cable is to be clearly marked on the “as built” design.

Appendices

1 WNL Overhead Construction Drawings

2 WNL Underground Construction Drawings