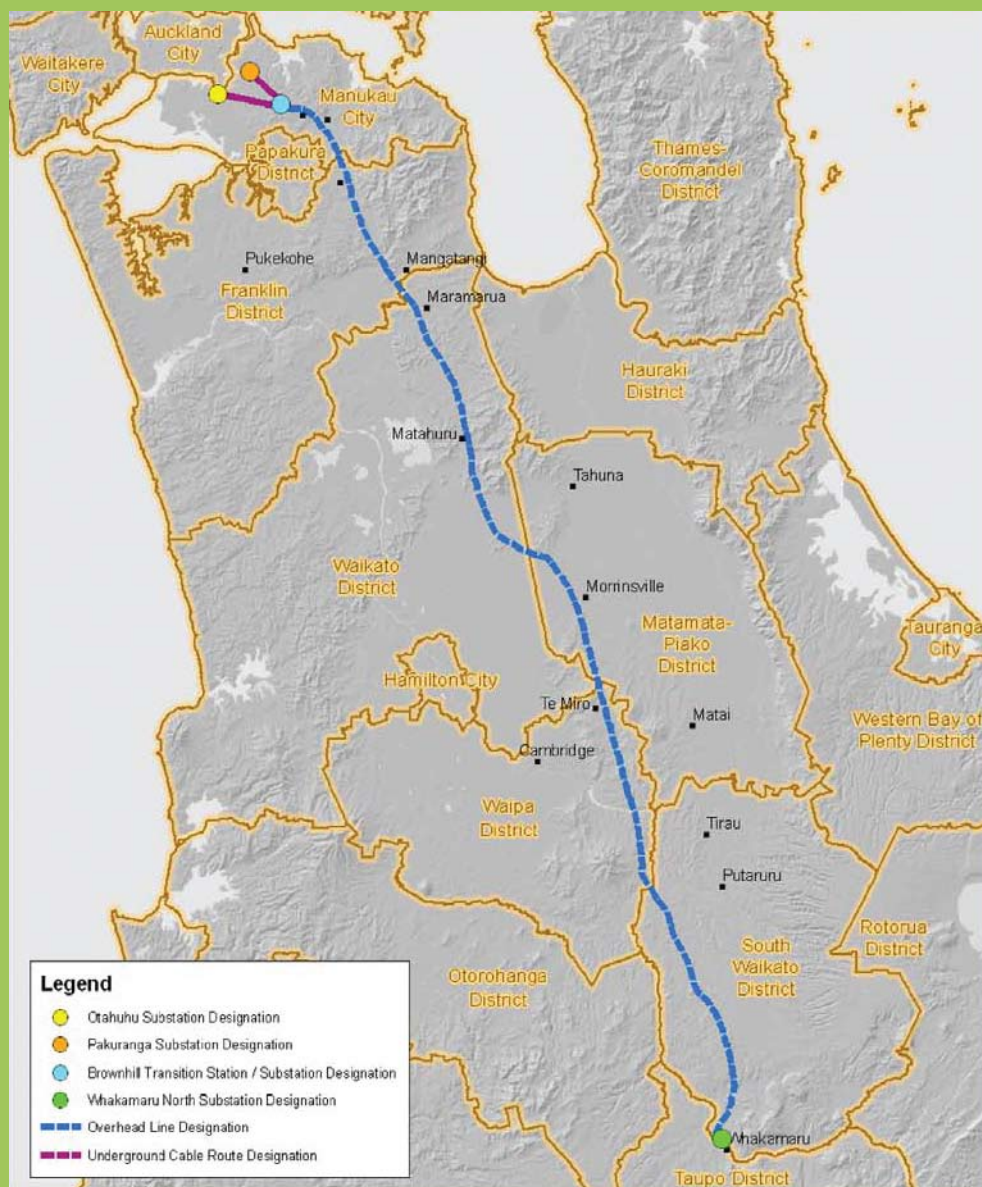


# Transpower New Zealand Ltd North Island Grid Upgrade Project

## Notices of Requirement Documentation

### Part VI



# **PART VI**

## **INFORMATION, DESCRIPTION AND ASSESSMENT OF EFFECTS ON THE ENVIRONMENT**

### **UNDERGROUND CABLE ROUTE PAKURANGA TO BROWNHILL**

Transpower NZ Ltd  
North Island Grid Upgrade Project  
Pakuranga to Brownhill Underground Cable

## Contents

1	Introduction .....	1
1.1	Purpose of this document .....	1
1.2	Designation .....	1
1.3	Route location.....	3
1.4	Transpower’s Objectives .....	3
2	Project Description.....	4
2.1	Cable system components .....	4
2.1.1	Overview .....	5
2.1.2	Power Cable Design .....	5
2.1.3	Joints and Ancillary Equipment .....	10
2.1.4	Water Cooling Pipes/Future Forced Cooling Provision .....	12
2.1.5	Design Constraints Affecting Cable Installation.....	12
2.1.6	Possible Cable Vault .....	16
2.2	Installation methodology .....	16
2.2.1	Initial Investigations.....	16
2.2.2	Site Preparation .....	17
2.2.3	Excavation .....	17
2.2.4	Flush Decking .....	18
2.2.5	Troughing.....	18
2.2.6	Joint Bay Construction .....	19
2.2.7	Cable Laying .....	19
2.2.8	Backfilling.....	20
2.2.9	Reinstatement and Rehabilitation .....	20
2.2.10	Jointing.....	20
2.2.11	Link Pit .....	21
2.2.12	Cable Vault .....	21
2.3	Cable locations with specific Design Requirements .....	21
2.3.1	Existing underground tunnel .....	21
2.3.2	Private Land (Dunvegan Rise to Point View Drive).....	22
2.3.3	Point View Drive.....	24
2.3.4	Caldwells Road (formed section) .....	24
2.3.5	Caldwells Road (unformed paper road section) .....	24
2.3.6	Redoubt Road and extension (Option 1).....	24
2.3.7	Private land between Redoubt Road and Brownhill Road (Option 1).....	25

2.3.8	Brownhill Road (Option 2) .....	25
2.3.9	Whitford Park Road/Sandstone Road (Option 2) .....	25
2.4	Construction Management .....	25
2.4.1	Workforce.....	25
2.4.2	Contractor's Facilities.....	26
2.4.3	Hours of Construction .....	26
2.4.4	Services .....	26
2.4.5	Refuelling.....	27
2.5	Construction Management Plan .....	27
2.6	Maintenance and Emergencies .....	27
2.6.1	Maintenance .....	28
2.6.2	Emergency Action .....	28
3	Statutory Context .....	30
3.1	Introduction.....	30
3.2	Relevant planning instruments .....	30
3.3	Manukau Operative District Plan 2002 .....	30
3.3.1	Network Utility Services .....	30
3.3.2	Earthworks .....	32
3.3.3	Other Relevant Rules.....	33
3.3.4	Plan Change 8 .....	34
3.4	Auckland Regional Policy Statement.....	35
3.5	Hauraki Gulf Marine Park Act.....	35
3.6	New Zealand Coastal Statement.....	36
3.7	Other Legislation and Relevant Guidelines .....	36
3.8	Resource Consents Required.....	38
4	Alternatives Considered .....	39
4.1	Introduction.....	39
4.2	Alternative Cable Types .....	39
4.3	Route alternatives.....	40
5	Description of the Environment.....	42
5.1	Roading network.....	42
5.2	Reserves and open space .....	42
5.3	Recreation .....	42
5.4	Stormwater Management Areas.....	43
5.5	Private land .....	43
5.6	Adjoining landuses .....	43

5.6.1	Sensitive land uses .....	43
5.6.2	Residential activities.....	43
5.6.3	Business activities.....	44
5.6.4	Rural / Rural Residential .....	44
5.6.5	Other Adjacent Landuses.....	44
5.7	Tangata Whenua Values .....	45
5.8	Heritage values.....	45
5.9	Water courses .....	46
5.10	Vegetation .....	48
5.11	Existing Utilities .....	48
<b>6</b>	<b>Assessment of Construction Effects .....</b>	<b>50</b>
6.1	Transportation network.....	50
6.2	Property access.....	51
6.3	Noise .....	52
6.4	Vibration .....	53
6.5	Dust.....	54
6.6	Existing utilities .....	55
6.7	Stormwater management areas .....	56
6.8	Land stability and erosion.....	57
6.9	Recreation .....	58
6.10	Tangata whenua.....	58
6.11	Ecology.....	59
6.11.1	Terrestrial Ecology .....	59
6.11.2	Aquatic Ecology .....	61
6.12	Heritage.....	65
6.13	Contaminated land .....	65
6.14	Clean Fill .....	66
6.15	Sediment Control.....	67
6.16	Landscape and Visual .....	67
6.17	Summary of mitigation measures .....	68
<b>7</b>	<b>Assessment of Operational Effects .....</b>	<b>69</b>
7.1	Electric and magnetic fields.....	69
7.2	Earth potential rise and induced voltage.....	70
7.3	Visual.....	71
7.4	Ground conditions and vegetation .....	71

7.5	Summary of mitigation measures .....	71
8	Other Effects .....	73
8.1	Cumulative effects .....	73
8.2	Positive effects .....	73
9	Consultation .....	73
10	Conclusion .....	74
11	Section 171(1) of the RMA .....	75
11.1	Relevant provisions of plans and policy statements .....	75
11.2	Consideration of alternatives .....	75
11.3	Work and designation reasonably necessary to achieve objectives .....	75
11.4	Other relevant matters .....	76
11.5	Part 2 of the RMA .....	76
12	Suggested conditions .....	77
12.1	Proposed restrictions .....	77
12.2	Other proposed conditions .....	77

# 1 Introduction

## 1.1 Purpose of this document

Part VI relates to the Notice of Requirement for the 220kV underground cable from the proposed Transition Station/Substation at Brownhill Road, Whitford to the Pakuranga Substation. These works are part of the North Island Grid Upgrade Project involving the construction of a new power line from Whakamaru, north of Taupo, via the transition station/substation at Brownhill Rd, to Otahuhu and Pakuranga.

This report has been prepared to support Transpower's Notice of Requirement to Manukau City Council (MCC) to designate the 220kV underground cable route between the proposed Brownhill Road transition station/substation site and Pakuranga Substation. The route extends from Brownhill Road through the suburbs of Whitford, Dannemora and Pakuranga to a proposed new substation at the existing Pakuranga Substation site. The location of the proposed underground cable route, including two options at the southern end of the route, is shown in Figure 1.1.

The proposed works involve the installation of 220kV underground double circuit consisting of cables with associated joints, link pits and ancillary structures. The designation is required to provide for the installation, operation, and maintenance of the proposed underground cable, and to provide for an efficient and secure electricity transmission connection between overhead transmission circuits terminating south of the existing urban boundary of Auckland, to South Auckland substation facilities.

This document has been prepared in accordance with section 168 of the Resource Management Act 1991 (RMA). It describes the proposed underground cable route and the works associated with its installation, sets out the statutory framework, and explains the alternatives considered. It describes the existing environment and the effects associated with the installation and operation of the underground cable, as well as any maintenance required. It also includes measures to avoid, remedy or mitigate adverse effects on the environment and outlines in preliminary terms, possible conditions and restrictions for the designation.

## 1.2 Designation

Part I contains detailed maps showing the extent of the designation. Where the proposed route is located on a road, the majority of the width of the legal road will be designated i.e. the carriageway and berm. Where the cable route is located outside legal road, the designation will be 25 metres in width. Such a width is required to accommodate not only the cable trench, but also the joint bays and link pits along with all the construction materials and machinery required.

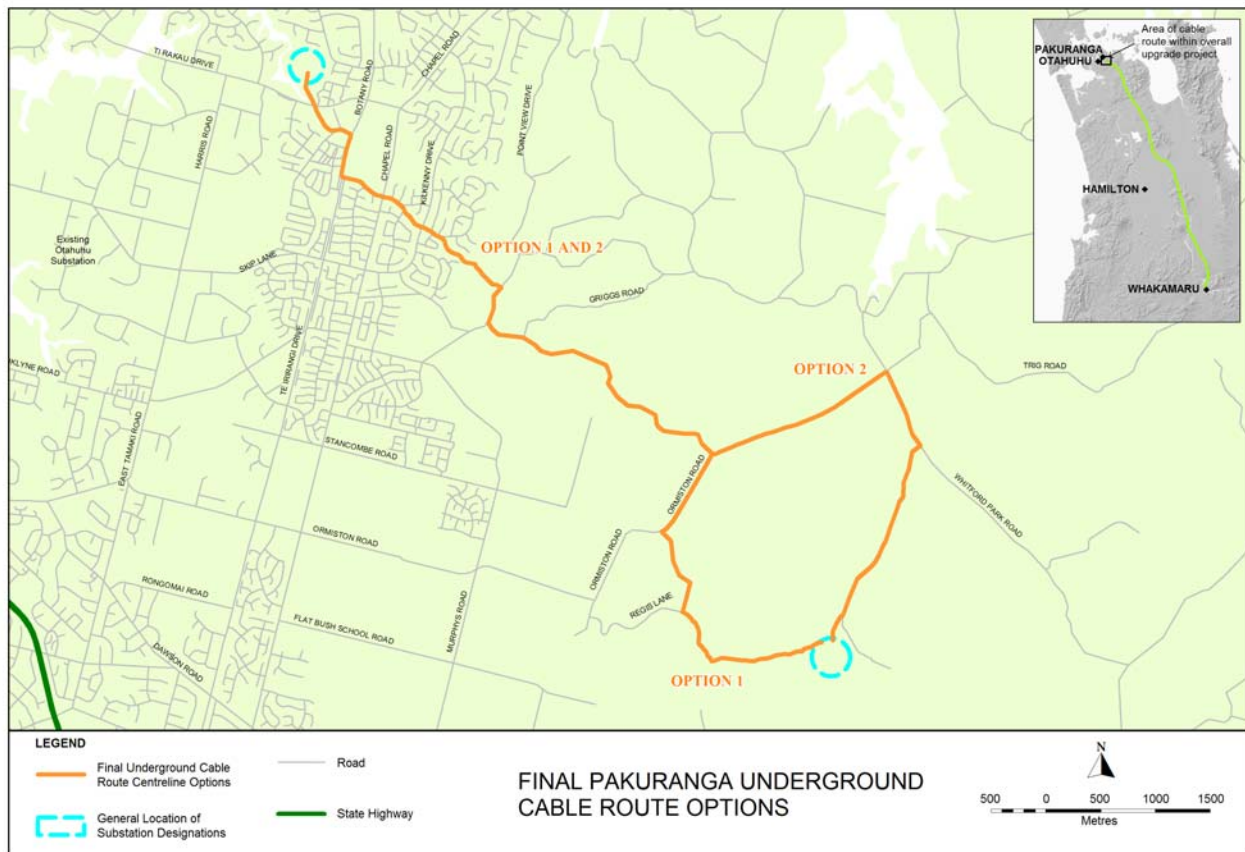


Figure 1.1 Locality Map

It is noted that the area sought for the designation is wider than will actually be physically required for the purpose of the cable. The larger area is needed to provide for the installation of the cable, and sufficient flexibility to ensure that the cable circuits are located in the most appropriate alignment. By having a wider designation initially, it allows for flexibility to avoid effects on other utilities, to reduce effects on traffic and private property access and to accommodate the construction machinery and equipment. The assessment of effects has been undertaken on the basis of the larger area. Once the cable has been installed, Transpower intends that the width of the designation will be reduced to only cover the extent of the physical works associated with the underground cable system and to provide a 1 metre clearance on either side of the circuit, joint bays and link pits.

It is also noted that there are two options at the southern end of the cable route from the Brownhill Road transition station/substation to the Pakuranga Substation. Two options have been identified between the end of Caldwell's Road and the Brownhill Road transition station/substation site due to there being some uncertainty as to the feasibility of fitting the two cable circuits to Pakuranga Substation, and two proposed circuits to the Otahuhu Substation along the same section of road, and on land with some stability issues. Transpower also has a general preference for grid security reasons that the cable circuits to Pakuranga and those to Otahuhu do not share a common route.

### 1.3 Route location

The underground portion of the route is located entirely within Manukau City. The underground section of the route is largely through an existing or planned intensively-developed urban environment. The preferred option that the route investigation and consultation processes identified exits the Brownhill Road transition station/substation site and follows a southern option along the Redoubt Road extension and Ormiston Road before joining Caldwell's Road. (Refer to Figure 1.1)

At a later stage, some issues were identified with this route, so option 2 was also progressed via consultation processes.

#### Route With Option 1 - via Redoubt Road and Regis Lane

From the south, this route exits Transpower owned land on Brownhill Road, Whitford, and follows a ridgeline up to Regis Lane and Redoubt Road which it follows for several hundred metres before it crosses private land (identified in the Manukau City District Plan as 'Future Road' – Redoubt Road extension, although not zoned or vested as paper road) up to Ormiston Road. From there it is located within road reserve all the way along Caldwell's Road (which is predominantly paper road<sup>1</sup>) before intersecting with Point View Drive. The route passes along the edge of Point View Reserve (which is accessed off Caldwell's Road then travels along Point View Drive and crosses private land before meeting the Transpower tunnel entrance at the urban edge of Dannemora in Dunvegan Rise (note that only one circuit will be in the tunnel and the other will closely follow the tunnel alignment). The existing tunnel<sup>2</sup> beginning in Dunvegan Rise is located underground all the way to a stormwater reserve adjacent to the existing Pakuranga Substation.

The areas of private land that the route crosses up to this point are mostly rural lifestyle blocks.

#### Route With Option 2 - via Brownhill Road

From the south, this route exits Transpower owned land on Brownhill Road, Whitford, via Brownhill Road onto Whitford Park Road. From there it heads north to the intersection of Whitford Road and Sandstone Road, then west along Sandstone Road to Caldwell's Road. From there it shares the same path into Pakuranga Substation as the previous option. The cable route is located within road reserve all the way along Caldwell's Road (which is predominantly paper road) before intersecting with Point View Drive. The route passes along the edge of Point View Reserve (which is accessed off Caldwell's Road) which contains some stands of native bush. The route travels along Point View Drive and then crosses private land before meeting the Transpower tunnel entrance at the urban edge of Dannemora in Dunvegan Rise. The existing tunnel beginning in Dunvegan Rise is located underground all the way to a stormwater reserve adjacent to the existing Pakuranga Substation.

The areas of private land that the route crosses up to this point are mostly rural lifestyle blocks.

### 1.4 Transpower's Objectives

The common objective for the North Island Grid Upgrade Project is as follows:

*To ensure the continued security and certainty of electricity supply to Auckland, Northland, and parts of the Coromandel and Waikato, by constructing and operating a new transmission link (including*

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<sup>1</sup> "Paper road" is a road that is legally established and recorded in survey plans, but has not been formed.

<sup>2</sup> Technically, this is a culvert structure, including joint bays and other components.

*substations and ancillary facilities) and to upgrade existing assets, in a manner that is safe, efficient, and consistent with maintaining current grid reliability standards and which provides flexibility to address future changes in supply.*

The specific objective for the Notice of Requirement for the two Underground Cable Sections is as follows:

*To provide for an efficient and secure electricity transmission connection to overhead transmission circuits, and its ongoing operation and maintenance, between the existing urban boundary of Auckland and substation facilities.*

These objectives are self-explanatory and cover the variety of activities existing or proposed to be undertaken along the underground cable route. The work and designation is considered by Transpower to be reasonably necessary for achieving its objectives, for the following reasons:

- The underground cable forms an integral part of the North Island Grid Upgrade project and cannot be considered in isolation from the remainder of the project, therefore meeting the common objective;
- The underground cable is reasonably necessary to provide a secure link between the existing urban boundary of Auckland, where the overhead line terminates, and the substation facilities;
- The use of the designation technique is reasonably necessary to ensure that Transpower has the flexibility to undertake the proposed works in a manner which ensures that the cable is located in a readily accessible location in case of the need for future maintenance;
- The use of the designation technique is reasonably necessary to ensure that security of the underground cable is maintained in respect of separation from other utilities and the potential actions of third parties on and within the roading network; and
- The designation is also reasonably necessary to ensure that Transpower has the legal ability to locate the cable across those parts of the route that are not within legal road or the coastal marine area.

## 2 Project Description

The underground cable section traverses approximately 9.35 kilometres (for Option 1) and 10.57 kilometres (for Option 2) between the Pakuranga Substation and the Brownhill Road transition station/substation. For system security reasons it comprises two cable circuits in parallel for the whole of the distance. The cable is supplied in lengths, and the construction process will involve a number of processes. Careful management will be needed during the construction stage.

### 2.1 Cable system components

This section explains the various components that will be included in the underground, high voltage, electricity cable system. The parts of the cable are described, along with joints and associated equipment installed along the cable route. An explanation is given of the limitations of the cable that determine how and where it can be placed.

### 2.1.1 Overview

Two cable circuits are to be installed in parallel a short distance apart along the same route. Each cable circuit will consist of three separate, single core power cables. At least two fibre optic cables will be installed with each cable circuit, one to monitor the temperature of the cables in service and the other to carry essential control and protection data as well as telecommunications, cable alarms and for other operational requirements.

Transpower has decided to install cross linked polythene (XLPE) insulated metal sheathed power cables. It is proposed to invite manufacturers of such power cables to tender for the detailed cable design, supply of the cables and cable installation.

Cables will be laid in existing roads, an existing tunnel and in open ground/open country. Figures 2.1 and 2.2 show typical installation cross sections of each area of ground that cables will be installed.

While the type of cable is known, the final details of the overall system will only be known after a contract has been let and the contractor has completed the detailed design based on the selected route and any imposed constraints. The investigation and design process to date has defined the cable system in sufficient detail for Transpower to fully understand the requirements for installing the cables.

The description of the cable system components and their installation is based on general requirements. Where the specific installation method depends on detailed design, options are described to cover the worst case anticipated environmental impact in this report.

The cable circuits will be designed to operate at a nominal voltage of 220,000 volts (phase to phase). Initially the cables will be naturally cooled by dissipation of heat into the surrounding ground and then to the atmosphere. This will be sufficient for the cables to meet the expected transmission load until approximately 2034 after which forced water cooling will be required. To allow for the later application of forced water cooling, polythene pipes will be laid alongside the cables for use in 2034 or whenever the load requires.

### 2.1.2 Power Cable Design

The three individual power cables of each circuit will have identical configurations. Each cable will have an overall diameter of between 130 and 160 mm and weigh approximately 30 to 40 kilograms per metre i.e. 90 to 120 kilograms per metre per circuit. The four main components to the power cable are the conductor, insulation, metallic shield and outer jacket. These are shown in Figures 2.3 and 2.4 and are described in further detail in the following sections.

#### Conductor

The electrical conductor is at the centre of the power cable. This is usually copper rather than aluminium for cables of such a high voltage and current. Strands of copper wire are bundled into segments and then spiralled around a central wire or hollow former.

The conductor will have a cross sectional area of 2000 to 3000 mm<sup>2</sup>. The final size will be selected at the detail design stage when full information on installation conditions is known.

#### Insulation

The high voltage conductor is insulated in a triple extrusion process which includes the conductor and semi-conducting insulation shields. The insulation material used is Cross Linked Polyethylene (XLPE) (refer to the cross section drawing shown in figure 2.5). The insulation and shields are cross linked immediately after

extrusion in a vulcanisation process using a combination of heat, pressure and cross bonding agents. During normal operation, the insulation and shields can function at temperatures up to 90 degrees Celsius. The corresponding temperature on the cable surface is up to 60 degrees Celsius. The main purpose of the semi-conducting shields is to prevent concentrations of electric stress at the insulation boundaries.

Figure 2.1 Typical installation configuration for cable circuit in road

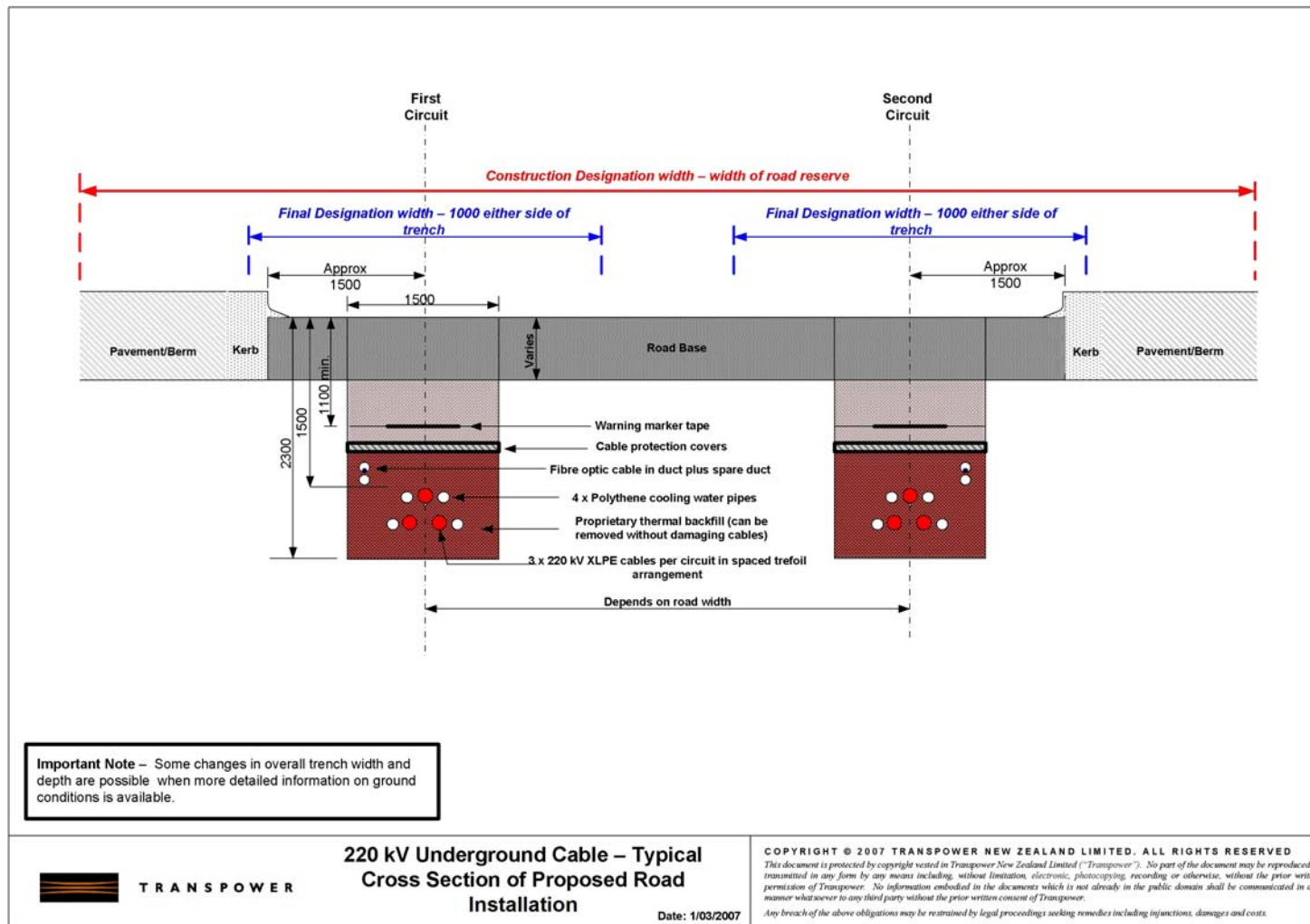
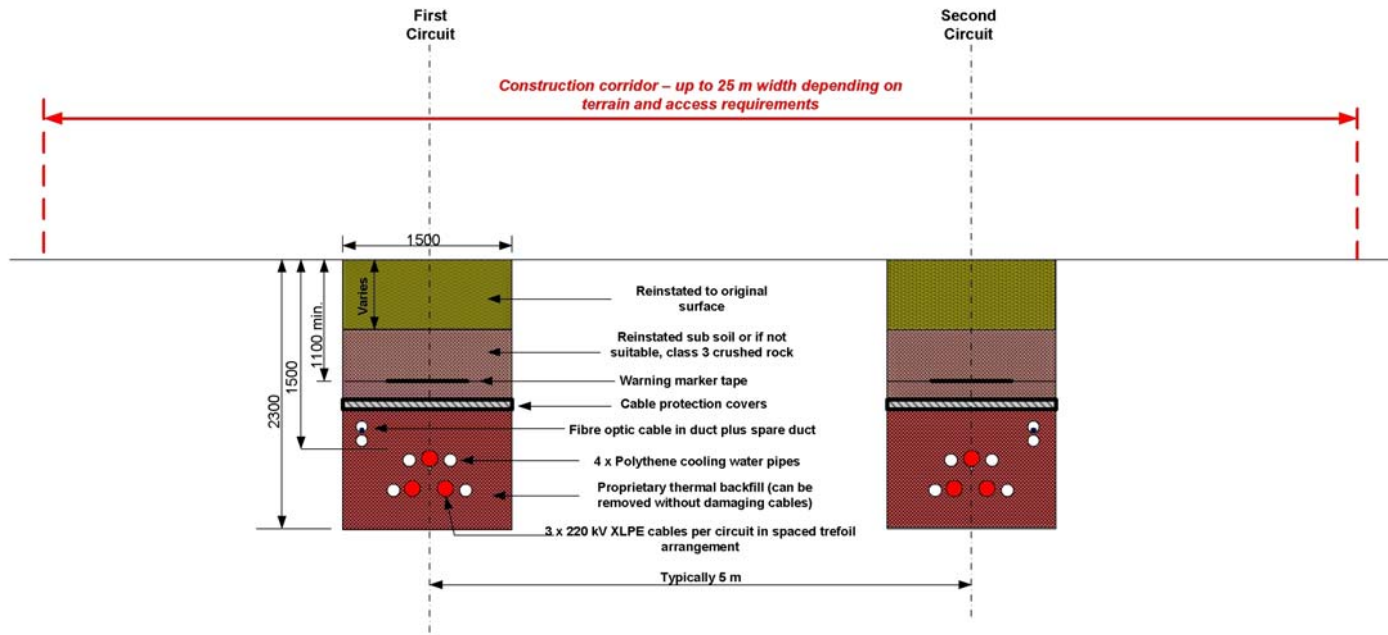


Figure 2.2 Typical installation configuration for cable circuit in open country



**Important Note** – Some changes in overall trench width and depth are possible when more detailed information on ground conditions is available.



**220 kV Underground Cable – Typical Cross Section of Open Ground Installation**

Date: 8/03/2007

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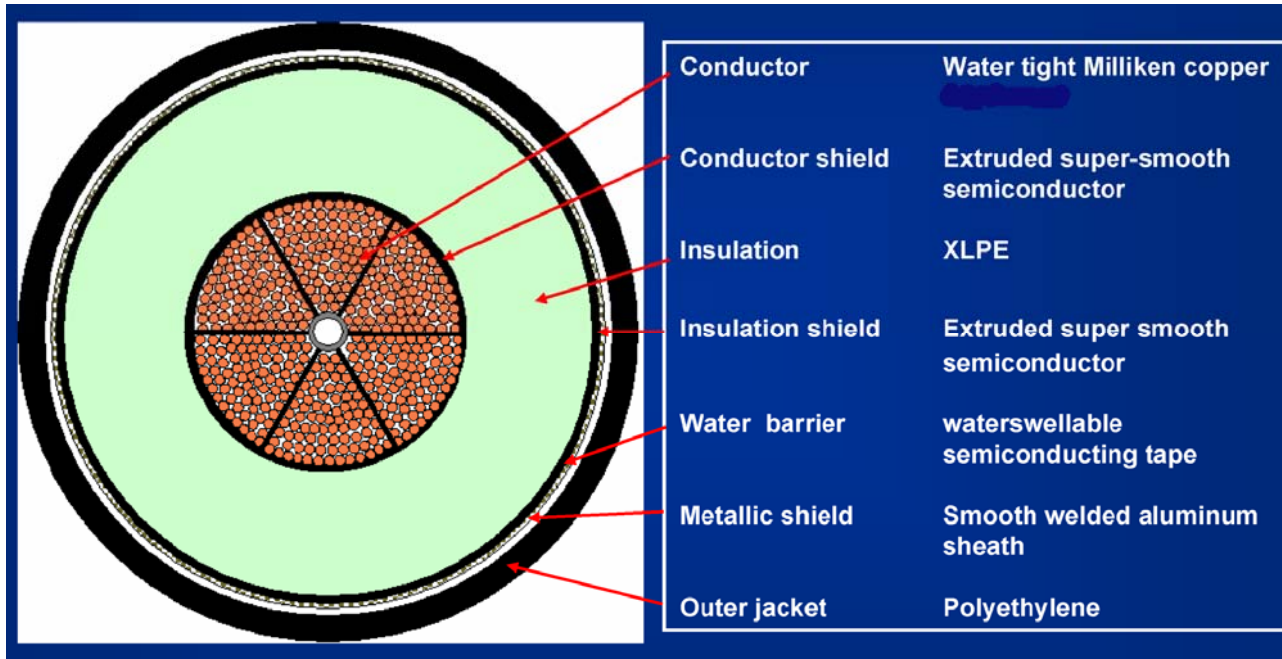


Figure 2.3 Typical 220kV XLPE Cable Cross section



Figure 2.4 Typical 220 kV XLPE Cable Cut Away View

### Metallic Shield

An aluminium tape is longitudinally applied as a metallic shield over the insulated conductor after the application of water swellable semi-conducting tape. The metallic shield is shaped around it and welded to form a sheath. Alternatively the aluminium may be extruded over the cable and the sheath then corrugated to improve its bending performance.

The sheath has the following functions:

- acts as an electric shield and ensures that there is no electric field outside the cable;
- provides mechanical strength to the cable;
- provides radial waterproofing by eliminating contact between the insulation and water; and
- provides a metallic path for capacitive and fault currents.

The water swellable tape is provided to limit the penetration of water under the aluminium sheath in the event of damage to the sheath.

### Outer Jacket

An outer jacket of polythene is extruded onto the aluminium sheath. The firm bond between the polythene and aluminium sheaths protects the aluminium from corrosion and provides excellent resistance to fatigue strain.

The outer jacket insulates the aluminium sheath from its surroundings and enables the sheath to be earthed at designated locations, which assists in testing and maintenance. The overall construction of the cable gives protection to any person accidentally contacting the cable surface.

## 2.1.3 Joints and Ancillary Equipment

### Cable Joints

The cable is manufactured in drum lengths, which are pulled into position and then jointed in situ. Joints in a 220 kV XLPE cable are approximately 700 mm in diameter and around 3 metres long, as shown in Figures 2.5 and 2.6. The joint consists of the following components:

- Conductor connection – copper conductors are joined by a compression ferrule while aluminium conductors are welded.
- Corona shield over the conductor connection - provides a smooth interface with the joint sleeve
- Joint sleeve – an ethylene-propylene rubber (EPR) premoulded sleeve that provides the full electrical insulation required together with conductor and insulation semi-conducting shields.
- Copper casing with insulation ring – the copper casing extends the cable's metallic shield over the joint and provides connection points for earthing and cross bonding of cables.
- Outer protection box – a plastic box filled with cold pouring resin to provide mechanical protection, water sealing and insulate the copper casing from earth.

Joints for all three power cables have to be located in the one position. The jointing operation is very precise and carried out in clean working conditions by technical experts specifically trained for the work.

### Link Pit

The metallic cable sheaths are cross-bonded at each joint bay location to reduce power losses. The sheaths are electrically earthed at every third jointing location. To enable technicians to gain access to the cross bond links and earthing connections, a link pit is installed beside each cable joint bay, with connections to the sheaths of each phase cable. The link box is installed in a concrete pit, accessed by removing a heavy steel and concrete cover. Where the cable is located in the roadway, the link pit will often be sited in the berm or footpath, to enable technicians to undertake routine testing work without disrupting traffic.

The link pit is evident only by the presence of the lid in the berm or carriageway.

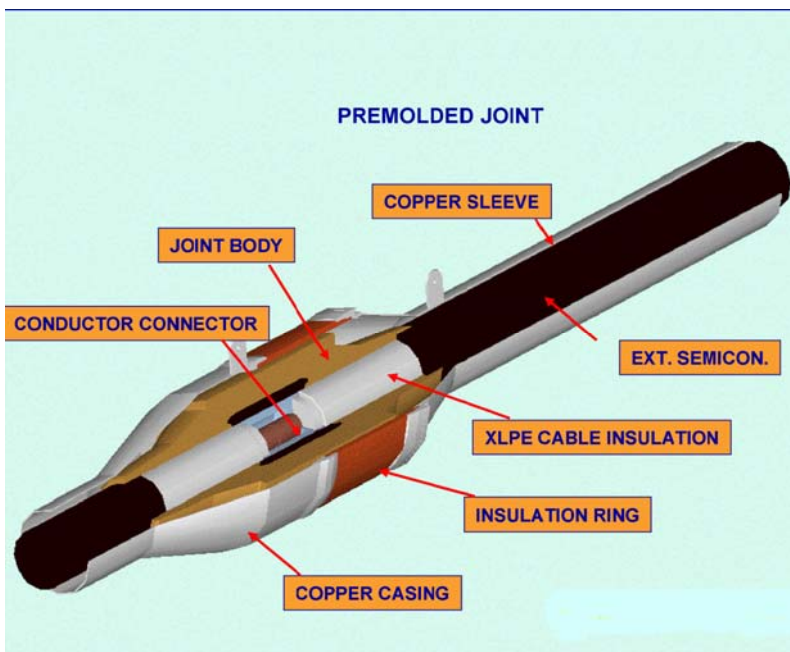


Figure 2.5 XLPE Cable Joint components



Figure 2.6 XLP Cable Jointing in Progress

### Fibre Optic Cables

To ensure the reliable operation of the power cables, it is necessary to install smaller fibre optic cables along the full length of the cable route.

One of these cables will form part of a distributed temperature sensing (DTS) system for the cable circuit. This allows the temperature of the cable to be continuously measured along the cable route in order to identify any hot spots and warn of overheating.

Another cable will provide a signalling path for protection relays provided at each end of the cable and at the far end of the 400kV-capable overhead line. In addition, the fibre optic cables will form part of the communication links between Pakuranga, Otahuhu and Whakamaru Substations, the Control Centre and other substations in Transpower's network.

The final design of the cable monitoring systems and associated communication cables will be the responsibility of the cable contractor.

#### 2.1.4 Water Cooling Pipes/Future Forced Cooling Provision

The water cooling pipes will be installed alongside the power cables but spaced approximately 50mm from them. At this stage, but subject to a design study, it is proposed to install four 100mm diameter polythene pipes with each cable circuit.

When load growth requires it, the cables would be uprated by the addition of forced water cooling. This would require the construction of water cooling stations at each end of the cable route and at intermediate positions approximately 3 to 4 kilometres apart. These would contain the plant to pump the water through the route pipe work and discharge the heat to the atmosphere. A cooling system design study would be carried out to confirm the size and number of pipes required and number of cooling stations required.

#### 2.1.5 Design Constraints Affecting Cable Installation

The design of the cable system places constraints on its installation, affecting both location and construction methods. These considerations also affect route selection – for example, changes in direction are limited by the flexibility of the cable. Such design constraints include:

- changes in direction;
- maximum pulling tension;
- drum size and weight;
- laying depth;
- maximum operating temperature;
- number of circuits;
- magnetic field;
- cable sheath bonding; and
- mechanical protection.

Each is discussed in greater detail below.

##### Changes in Direction

Where the cable needs to turn a horizontal or vertical corner along the route, the minimum bending radius is about 4.5 metres for direct buried cables. At intersections, the kerb line of roads may turn more tightly than this minimum radius, meaning that the cable cannot follow the kerb line around a corner.

Cable manufacturers recommend a minimum bending radius of around 15 to 18 times the cable diameter for EHV XLPE insulated cables.

##### Maximum Pulling Tension

The cable can be pulled into position by one of two methods:

- Direct or nose pulling: a pulling eye is attached to the cable end, gripping both the copper conductor and metal sheath.
- Bond pulling: a bond wire is attached to the cable by ties at about 1500 mm intervals so that the pulling load is evenly distributed along the length of the cable.

If excessive force is applied during direct pulling, the cable can be damaged by being stretched or subjected to excessive side wall pressure at bends. In accessible locations, pulling tension can be relieved with secondary pullers at intermediate locations.

### Drum Size and Weight

Cable joints are expensive to make and are less reliable than the cable itself. It is therefore desirable to minimise the number of joints by manufacturing the cable in the longest practicable lengths. It is expected that weight and handling limitations will restrict the cable length to about 600 to 800 metres, although some manufacturers may attempt longer runs. Once the cable lengths are ordered it can be quite expensive to make changes to the route or joint locations.

Full drums of cable could weigh up to 35 tonnes based on a cable weight of 40 kilograms per metre. Figure 2.7 shows how the cable drums are transported.



Figure 2.7 Cable Drum Transportation

### Laying Depth

It is proposed to install the cables so the top cable is at a depth of 1500 mm below ground. This slightly “deeper than normal” burial depth will facilitate crossing of the trench alignment by other underground services and increase the security of these important cables by reducing the likelihood of “dig ins” and damage caused by other service providers.

Wherever practicable, the 220kV cables will be installed beneath other network utility services. This is to minimise the risk of other network utility operators disturbing or damaging the cable when undertaking maintenance or other works on their services. It is intended that there will be no physical impact on the other utilities. When using trenches, the cables, pipes etc of other utility services will be supported by an appropriate site-specific method – for example see Figure 2.8. Where a greater depth of installation is needed, for example

to clear an existing utility service, this may require additional support of the trench during construction. Such circumstances will be identified and subject to specific design



Figure 2.8 Excavational Cable Trench with Existing Utility Service Structure

### Maximum Operating Temperature

The cable will generate heat during operation as a result of electrical losses, primarily in the copper conductor. The cable insulation is designed for a maximum operating temperature under normal conditions of 90 degrees Celsius. The cable is cooled by dissipating heat through its sheath and absorbing into the surrounding material.

Where the cable is buried in the ground, generated heat moves towards the surface to be dissipated in the atmosphere. If the cable is laid deeper in the ground, the emitted heat has further to travel to reach the atmosphere, decreasing the effectiveness of cooling. Soil properties are important in determining how quickly heat will move away from the cable, which is one reason why a special thermally stable backfill will be placed under and around the cables during installation.

Where it becomes necessary to lay the cables deeper than 1500mm in the ground, then cooling will be less effective. In such circumstances there are various options available to enable the cable to operate within its temperature parameters. These include the following:

- provide greater separation between the phase cables to reduce the mutual heating effect;
- improve the thermal environment by providing a thicker layer of thermally stable material around the cables

- install a section of cable with a larger copper conductor, which does not generate as much heat; or
- reduce the rated power carrying capacity of the entire cable installation so that the deeper section will not exceed temperature limits.

Under normal circumstances the preferred solution is a combination of placing the phase cables further apart and improving the thermal environment wherever it is necessary for the cable to be laid deeper than 1500 mm in the ground. The most appropriate solution for a particular circumstance will be determined by the cable supplier at the detail design stage.

Forced water cooling provides a parallel path of very much lower thermal resistance than that provided through the ground. In the system proposed, cooling water is passed down two of the pipes and returned via the other two to the cooling stations where the water temperature is reduced before being returned to the inlet pipes. Consequently the current rating of the cable can be increased by around 70% for the same maximum conductor temperature. However, to achieve this, the water pipes must be placed as close as practically possible to the 220kV cables. This requirement introduces constraints to the installation, the principal one being that it is impractical to run the 220kV cables in individual plastic pipes/pre-laid cable ducts.

#### Number of Circuits

The largest size of 220kV XLPE cable used for transmission cable circuits to date has a 2500mm<sup>2</sup> copper conductor, with 3000mm<sup>2</sup> available from some manufacturers. The size of the conductor will be determined by the cable supplier at the detail design stage and is expected to be in the range of 2000mm<sup>2</sup> to 3000mm<sup>2</sup>. Preliminary calculations indicate that, using 2500mm<sup>2</sup> cable, to install both circuits within a common trench would require significant separation between the circuits, with a double circuit trench requiring excavations nominally 3500mm wide by 2300mm deep.

Within the normal road pavement widths, trench dimensions such as these (especially when direct buried installations require complete minor section lengths being “open” for extended periods) can create major traffic management problems and increase the risk of trench collapse.

This, together with the fact that an increased spacing between circuits facilitated by separate single trenches inherently increases current rating and reduces the probability of both circuits suffering simultaneous third party damage, favours the use of single circuit trenches despite the increased excavation costs.

To provide the required cable ratings using 220kV 2500 sq mm XLPE cable, the nominal trench dimensions are 1500mm wide by 2300mm deep. The depth of thermally stabilised bedding/backfill materials will be dependent on the thermal resistivity of the surrounding ground.

The minimum separation between trench centrelines will be approximately 3500mm with a larger spacing being preferred (subject to available width).

#### Cable Sheath Bonding

If the metal sheath of a cable is connected to earth at both ends, then a current proportional to the load current will appear in the sheath. This will cause losses in the sheath that will significantly reduce the load current capacity.

To prevent currents in the metal sheath, the cable sheath can be connected to earth at one end only. This results in a voltage being induced between the sheath and earth which is proportional to the current and the cable length. This limits the length of cable that can be single-point bonded.

If a three phase cable circuit is split up into three equal length sections and the cable sheaths broken at the intermediate joints, then the sheaths can be 'cross-bonded' i.e. sheaths of different sections can be electrically connected together so that no sheath currents will appear. The length of the equal (minor) sections is limited by the induced voltage as in the single-point case.

The requirement to have three equal minor section lengths to make up each major section places a constraint on the location of joint bays, but this is generally manageable during the detailed design.

### Mechanical Protection

The cables have to be adequately protected against external damage. Apart from being buried at a depth that gives some protection, the cables are usually protected all along their length by a cover of durable and mechanically resistant materials that protect them against damage from excavation tools. The cover usually consists of slabs of reinforced concrete or other suitable material that extends on both sides above the cables.

Plastic warning tape indicating the voltage level and the name of the utility is placed above the covers.

In areas where enhanced protection is required, the cables can be placed in pre-formed reinforced concrete troughs which would be provided with robust reinforced concrete covers.

#### 2.1.6 Possible Cable Vault

A cable vault as part of the underground cable route may also be required adjacent to the Brownhill Road transition station/substation to allow for future minor movement of the structures. The cable vault is likely to be underground and have a greater area requirement than the cable joint bays in the underground line to allow for cable sag/looping or alternative methods to provide for movement and expansion. The exact location of the cable vault is not known. It may be fully or partly within the transition station designation, or fully or partly within the underground cable alignment. This is a matter for detailed design.

## 2.2 Installation methodology

It is proposed that Transpower will let a single contract for design, manufacture, installation and commissioning of the proposed underground cable system. The successful contractor is expected to engage various subcontractors to undertake particular aspects of the operations; examples may include, but not be limited to, earth works, directional drilling, cable transportation and heavy lifting.

Cable laying and jointing comprises a series of interconnected activities as follows.

### 2.2.1 Initial Investigations

Contracts, work procedures and designs will be prepared and implemented prior to the commencement of any site works.

In general, the cable will be laid in excavated trenches in discrete sections between the termination and/or intermediate joint locations, referred to as joint bays. Approximately 16 joint bays per circuit will be required. The designated cable route will be surveyed by the contractor with a view to locating the positions of the joint bays. In principle, it is normal to use as long a length of cable between joint bays as possible, i.e. to have the minimum number of joints practicable. In practice, the maximum section length (distance between consecutive joint bays) can be limited by one or more different constraints, including:

- Local restrictions on the length of continuous trench that can be opened;
- Maximum cable manufacturing length;
- Transportable length on one drum;
- Handling limitations at the site of installation; and
- Physical features constraining the positioning of joint bays.

Where deemed necessary, trial holes and/or trial trenches will be dug (usually by hand) to determine the feasibility of the proposed excavations. The line of the trench must have as few changes of line and direction as possible, all corners and vertical profile changes will be taken at a radius at or greater than the minimum installation radius of the cable.

### 2.2.2 Site Preparation

The perimeter and/or centre line of the trench will be suitably marked on the ground. In the case of rigid surfaces spray paint is used, and for other locations suitable marker posts will be utilised. The location of all existing services crossing and in the immediate vicinity of the trench will be identified prior to the commencement of construction. These locations will be indicated on the ground and personnel briefed appropriately. Before excavation commences, road paving and any other rigid surfaces will be cut along both sides of the proposed trench using a diamond-bladed saw.

### 2.2.3 Excavation

Rigid road surfaces will be broken using either an excavator mounted breaker or pneumatic hammer. For the most part, a mechanical excavator will be used to remove material down to the base of the trench. The two excavation options are as follows:

- Where space allows, the excavator will stand directly over the cable route and load material into dump trucks standing immediately to the side. Within roadways this operation will effectively occupy two lanes, although the obstruction in the second lane will be limited to about 20 to 40 metres in length. The major advantage to this approach is that disruption is contained within the installation area.
- If it is not possible to close the adjacent lane, the trucks will have to reverse into the work area and the excavator will have to turn through 180° to load the material into the truck. During these turning processes suitable mitigation measures will be implemented at each location to minimise effects on traffic and public safety.

Agreed traffic management measures will be implemented during excavation as appropriate.

Where rock is encountered which is unable to be removed by the excavator, the contractor may elect to loosen the material with a rock breaker, jackhammers or other specialist techniques as appropriate.

To minimise the risk of damage, the contractor may use hand methods to expose other buried services and guide the excavator operator.

An assessment will be made of the stability of the sides as the trench is excavated. Where appropriate and/ or stipulated by appropriate legislation, shoring will be installed as a precaution against slump or collapse.

The contractor will place barricades on both sides of the trench as a visual and physical barrier for the safety of motorists and pedestrians at all times. Flashing lights will be affixed to the barricades for night time warning. The same level of barricading will be used in grassed parkland areas used by the public. In the rural areas, where access by the public is difficult, the extent of barricading will be discussed with the land management agency/owners. The contractor will be required to monitor and maintain the barricades and lights daily, and on a more frequent basis during and following weather incidents, to ensure adequate protection is provided for the public.

In order to meet the overall construction program it will be necessary for the contractor to work in a number of locations simultaneously along the length of the route.

#### 2.2.4 Flush Decking

Trenching across roads, particularly at junction areas, is a significant issue. These junctions must usually be kept open and operational throughout the cable installation period. Consequentially the trench cannot simply continue across the junction and some special arrangements are needed.

Normal practice would be to excavate across the road junction, perhaps in stages, to lay ducts through which the cables could be pulled through later. This is not practical for water cooled cables as the water pipes must be laid in close proximity (25 to 50 mm) to the power cables. If ducts are used to cross road junctions adequate space must be left between the ducts (and the water pipes) such that the concrete used to surround these can flow to ensure that there are no air gaps introduced. This has the effect of increasing the actual distance from the cable when eventually installed (in the duct) and the water cooling pipes. The cooling process is extremely sensitive to this and becomes less efficient as it increases.

Therefore in these instances one method is the use of flush decking. Flush decking involves cutting the trenches and installing load supporting cross members in the top 0.3 metres of the trench. Steel plates with a non-skid surface are then placed over the trenches. This enables traffic to drive on the plates over the trench. Sufficient room must be left for the men to work under the flush decking.

The decking may be installed several weeks or even months in advance of cable installation (if required) to take advantage of favourable conditions such as low traffic periods.

#### 2.2.5 Troughing

Pre-cast sections of concrete troughing may be placed in the bottom of the cable trench at some selected locations. These concrete forms may be constructed from pre-cast elements or cast in-situ. The purpose of the trough is to provide stability for the cable in locations of poor soil conditions and enhanced protection from side impact from tree roots or accidental excavation.

## 2.2.6 Joint Bay Construction

Generally joint bays will be 10 to 15 metres in length, 2 metres wide and 2 metres deep. They will be excavated in line with the cable trench. Concrete sides will ensure stability of the excavation throughout the jointing period, assist to maintain clean conditions, which are essential during the jointing process, and provide ongoing mechanical protection for cable joints.

It is expected that the contractor will construct joint bays in advance of cable trench excavation so that cable installation can commence as soon as a section of trench is complete. If a joint bay is required in a difficult location, specific construction measures may be implemented, such as constructing the joint bay on a weekend and utilising steel plating or temporarily backfilling the excavation until the cable trench is ready and can be reopened. Figure 2.9 shows a joint bay under construction in a residential street.



Figure 2.9 A Joint Bay Enclosure During the Construction Stage

## 2.2.7 Cable Laying

Prior to cable laying, a bedding layer of sand/cement mix or similar thermally stable material is placed in the bottom of the open trench to provide a smooth base. The bedding material is delivered to the site in concrete mixers and poured directly in the trench for manual spreading and mechanical compaction. Cable rollers are then installed along the cable trench with vertical rollers and/or skid plates are positioned at bends.

Cable drums are held in a separate remote storage area until needed and then delivered to site by low loader and unloaded by crane. Each drum is lifted in turn onto an axle stand for cable laying. Each of the three power cables, communication cables and polythene pipes are then sequentially pulled into the trench and bedded into

their final position. In a difficult section, it may take a full day to set up the cable rollers etc and pull the first cable into position.

### 2.2.8 Backfilling

A further layer of the same material used for bedding mix will be placed around and over the power cables. The bedding material cures to a firm barrier preventing scouring by groundwater and ensuring good contact with the cable surface for heat conduction.

Concrete cable covers will be placed over the bedding mix for mechanical protection against accidental excavation. The covers will be marked with a warning that high voltage electricity cables lie below. The remainder of the trench will be backfilled with an aggregate mix depending on the location and will be compacted as it is placed into position to encourage rapid consolidation of the mix. An additional warning in the form of a yellow plastic warning tape is installed 100mm above the cable covers.

Backfilling is usually carried out immediately after cable laying is complete to minimise the possibility of damage to cables, enable the surface to be restored and to minimise the effects of subsequent rain. Backfilling could be undertaken at several locations along the same drum section of the cable route.

### 2.2.9 Reinstatement and Rehabilitation

Reinstatement involves placing the final surface over the cable trench and restoration of any other areas disturbed during the construction process. Such areas may include sections of grass berm, footpath or kerb and gutter. Where the cable is laid in the carriageway, the contractor will place a temporary reinstatement of bitumen over the backfilled trench. This will remain in place for up to several weeks while the backfill material consolidates under the weight of traffic.

In locations where the cable is laid in non-sealed locations, such as rural land and the stormwater management areas, the backfilled trench will be restored to a condition similar to or better than that existing prior to cable installation. Previously stripped and stockpiled topsoil will be spread over the backfilled trench.

### 2.2.10 Jointing

Jointing cannot start until cable laying has been completed for the cable sections on both sides of the joint. Jointing of cables of this voltage is a very critical and time consuming process that takes several days to complete. Therefore, it is essential to provide some form of weather and security protection in the form of an enclosure over the joint bay. The jointing process requires a clean environment and in some circumstances humidity controls may be required. This would involve the construction of air-conditioned enclosures within the external enclosure. In addition, joint bays require portable amenities for six or more staff, parking and materials storage and the erection of a security fence around the overall joint bay perimeter.

After jointing and testing work is complete, the joint bay will be either backfilled with cable bedding mix or left unfilled. Where bays are left unfilled, the chamber would be covered with a substantial roof and a man hole installed for future access.

### 2.2.11 Link Pit

A minor excavation is made near the joint bay and a concrete pit is poured in situ to contain the link box. For technical reasons, the link box must not be more than 15 metres from the joint bay. A manhole cover will be placed over the link box. Wherever possible the link box will not be located in the carriageway.

In some designs the link box is located in an unfilled joint bay and therefore a separate link box is not required.

### 2.2.12 Cable Vault

The cable vault, if one is required, involves a similar construction process to a joint bay, as described in 2.2.10 above.

## 2.3 Cable locations with specific Design Requirements

### 2.3.1 Existing underground tunnel

The existing underground tunnel is a 1.8metre diameter concrete pipe commencing in the stormwater reserve just north of Te Rakau Drive and adjacent to Pakuranga Substation and forms part of the proposed 220kV cable route to the end of Dunvegan Rise. It is approximately 2.27 kilometres long and is laid at invert depths that vary between 3 and 6.3 metres.

The pipe tunnel presently contains 110kV cables that connect the overhead Arapuni – Pakuranga (ARI-PAKA) 110kV line from the terminal tower at Dunvegan Rise to a short section of overhead line on the northern side of Te Rakau Drive into the Pakuranga Substation. The 110kV cables and the overhead line will be removed as part of the North Island Grid Upgrade Project.

One of the 220kV cable circuits with its cooling water pipe will be installed in the pipe tunnel while the other will be direct buried in the ground along the pipe tunnel route. The reason for installing only one cable circuit in the existing Pakuranga cable tunnel is to minimise the possibility that a single event will result in both circuits being out of service at the same time.

If both cable circuits were installed in the tunnel, such an event could occur for a number of reasons. Examples are as follows:

- An electrical fault in one cable could start a fire that destroyed both cable circuits. The possibility of this happening could be minimised by the provision of fire detection and suppression systems but cannot be completely eliminated.
- Repair work on one cable circuit, particularly replacing a section of cable between joint bays, could result in accidental damage to the other circuit. The small size of the tunnel (1.8 metres diameter) and the number of cables (6), water cooling pipes (8) and communications cables, together with fire suppression equipment and support brackets, etc, will make it a congested space.
- Personnel safety – additional to the hazards of entering a confined underground space, there are hazards provided by the close proximity of the cables, namely induced voltages on metal work and high magnetic fields. Assuming it is practical to design the cable installation in such a way that that

risks to personnel are mitigated to an apparently safe level, there remains the risk that a later review will determine it is not safe for personnel to enter the tunnel with a cable circuit in service.

Elsewhere along the cable route the cables are to be direct buried in cable trenches a minimum distance of 3.5 metres apart. In this situation and for one circuit laid outside the tunnel, the risk of both circuits being out of service at the same time is considered to be acceptable.

Generally where space permits there will be a horizontal separation of 4metres between the centreline of the tunnel and the direct buried cable circuit. This is to allow free access to the tunnel without risk of disturbing the buried cables. The tunnel is located along much of the route under extra wide berms rather than the roadway. The direct buried cables would normally be installed in the roadway but will be necessary to cross over the top of the tunnel in two places. The typical arrangement is shown below in Figure 2.10.

The pipe tunnel has three existing enlargements (8 metres long, 3.8 metres wide and 2 metres high) for use as jointing chambers at three positions along its route. It is likely that detail design of the cable circuits will require additional jointing chambers at other positions along the tunnel route.

### 2.3.2 Private Land (Dunvegan Rise to Point View Drive).

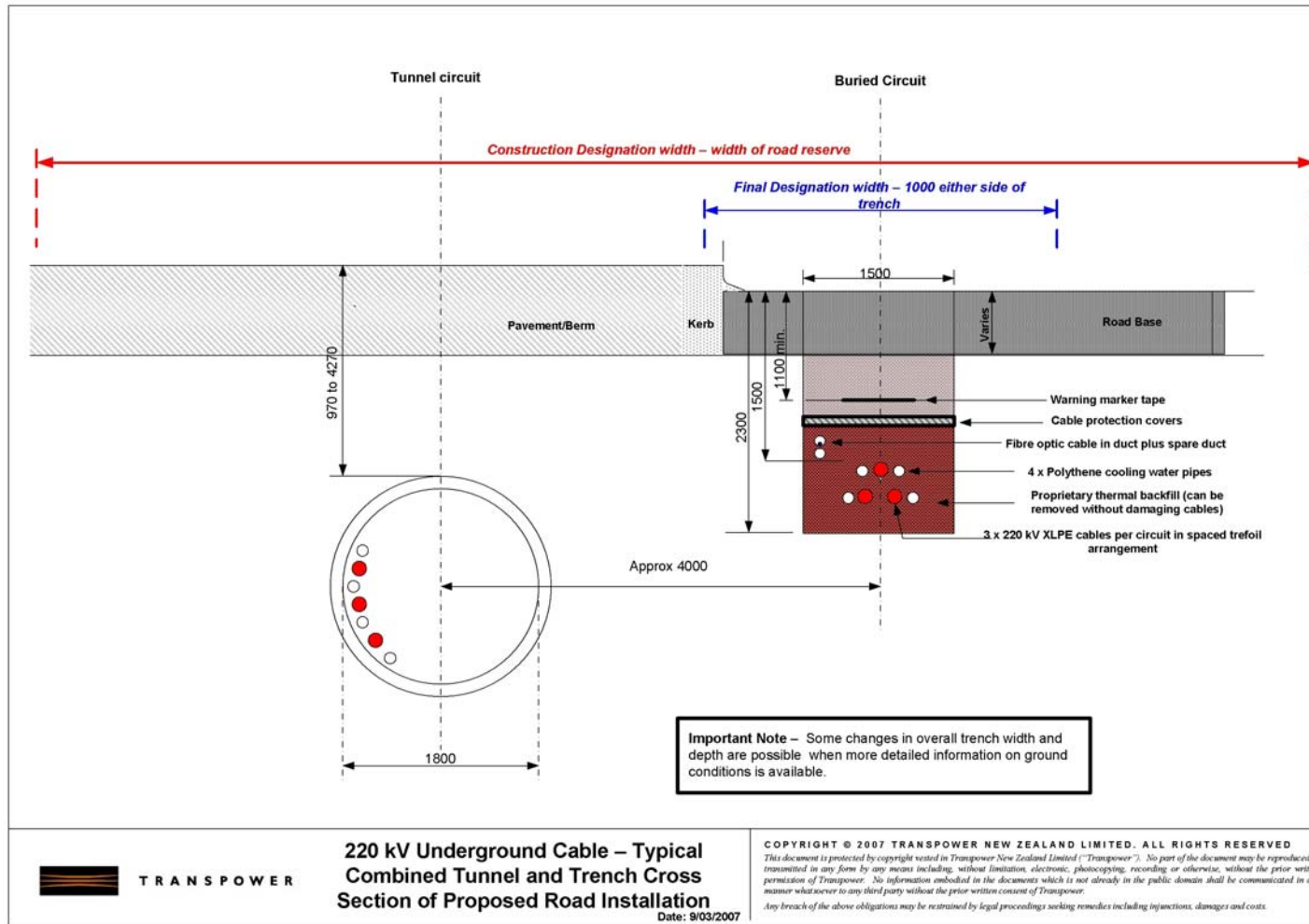
From north to south, the cable route ascends from Dunvegan Rise (where the directly buried circuit meets that installed within the tunnel) generally following the boundary with adjacent subdivided property to an existing stream before climbing a steep slope to Point View Drive.

It is anticipated that the stream will be crossed by extending the existing culvert, created as part of the adjacent subdivision process, with the cables then running along a spur past an existing pond used for stock watering. This option is considered to involve least geotechnical risk and does not involve construction in, or modification of, a watercourse. However, low retaining structures may be required along the gentle slope of the stream bank to create a corridor of sufficient width. This can only be confirmed after detailed design work has been undertaken. Another alternative, although not preferred, would be to excavate within the stream bed and then up the bank. If after investigation this is the selected option, work would be undertaken during a period of anticipated reduced water flow. A number of trees may have to be removed to accommodate the cable trenches.

The cable circuits then track into a relatively broad valley with a moderate to gently sloping valley floor. An ornamental pond has been created in this area, which would appear to be fed from the adjacent property, as upstream of the pond there is no defined watercourse and the broad valley floor is in pasture. Below this pond a channel is evident and the valley floor is narrow and heavily vegetated. Some vegetation will need to be removed. Drainage and minor reshaping is likely to be required for the valley floor section.

From the valley base the route then runs up a steep slope to Point View Drive. Whilst there is no evidence of geotechnical instability, it may prove necessary to clamp the cables to the base of the trench by the use of cleats.

Figure 2.10 Typical installation configuration for cable circuit in tunnel and road



### 2.3.3 Point View Drive

The sealed road long Point View Drive is only approximately 5metres wide in places with unformed and irregular edges. There is not sufficient space to lay both circuits in the sealed road, and to minimise disruption to traffic Transpower proposes installing the cables in the berms where possible alongside the roadway. Consequently as determined during the detail design stage, each cable circuit may run some distance in the berm and some in the roadway. This may require some levelling of ground by removal of banks and replacement of unsuitable material within road reserve. The circuits will always run on opposite sides of the road.

### 2.3.4 Caldwell's Road (formed section)

The existing sealed length of Caldwell's Road (northern end) is only approximately 4metres wide, with unformed and irregular edges. There is not sufficient room to excavate a cable trench without closing the road to all traffic. Therefore, widening of the road to at least 6metres will be required within the road reserve although the carriageway can remain in its existing width and position. Along some sections of the road, there is a steep bank rising one side and a steep bank dropping down the other. This will require removal of sections of bank up to approximately 3 metres high and the provision of batters/retaining walls for a distance of approximately 100 metres just south of the turn off for the Point View Reserve car park.

### 2.3.5 Caldwell's Road (unformed paper road section)

The unformed section of Caldwell's Road (from Point View Reserve) descends down a steep slope covered in vegetation with pine trees and areas of indigenous vegetation before crossing the Maungamaungaroa Stream and then crossing open farm land to Ormiston Road. Transpower will need to remove trees and scrub on the paper road section from Point View Drive to the Maungamaungaroa Stream.

As access for excavation of the cable trenches and installation of the cables will be along the cable route, a formed unsealed access track will be required for construction and maintenance purposes. This access track would be about 3 metres wide. Burial of the cables along this paper road will not preclude the forming of this section of paper road by either MCC or a private developer in the future.

### 2.3.6 Redoubt Road and extension (Option 1)

Redoubt Road and the proposed road extension (identified as 'Future Road' in the Manukau City District Plan) to Ormiston Road will be wide enough for only two cable circuits and other reticulated services that are anticipated to be required to service any adjacent developments. This is (in concept) set aside/reserved for future cables from the Brownhill Substation to Otahuhu Substation. Transpower is likely to install cables before the permanent road is built.

The underground cables to Pakuranga for Option 1 will therefore have to be laid in private land alongside the 'Future Road'. The land along some sections of the road slopes steeply down from the road and there are areas of instability. Engineering a secure cable route on these sections will require reasonably significant earthworks, drainage and retaining walls.

### 2.3.7 Private land between Redoubt Road and Brownhill Road (Option 1)

The cable route avoids steep and unstable land by following relatively narrow ridge spurs from the Brownhill Substation site up to Redoubt Road. This route is feasible for two cable circuits proposed to the Otahuhu Substation in the future with retaining structures 2 to 3 metres high and 100 metres long. However, to also fit the two cable circuits to Pakuranga along this route would mean significant additional earthworks and retaining will be required to construct the wider corridor. The corridor width required to fit four cables along this section of route is 30 to 40 metres wide compared to a 25 metre width if only the two cables to Otahuhu follow this route.

### 2.3.8 Brownhill Road (Option 2)

The sealed road along Brownhill Road is only approximately 3 to 7 metres wide with unformed and irregular edges. The existing road carriageway is generally suitable for the passage of the necessary construction machinery, and Transpower does not expect it will be necessary to realign or resurface Brownhill Road if it were to be a cable route. The Turanga Creek flows mostly in parallel with the road on its northern side. Transpower will lay both circuits within the road reserve. It would be necessary to lay one or both cables outside existing carriageway where this is less than 6 metres wide. Consequently, as determined by during the detailed design stage, each cable circuit may run some distance in the berm and some in the roadway. This may require levelling of ground by removal/retaining of uphill banks where they are close to the road, retaining of the banks of Turanga Creek where the roadway is close to the creek and replacement of unsuitable material inside the road reserve. Where necessary, culverts and bridges will be upgraded to cater for the expected vehicle weights. For example, the small bridge at the Brownhill Road fork near the entrance to Transpower's property may need to be replaced. The circuits will always run on opposite sides of the road.

### 2.3.9 Whitford Park Road/Sandstone Road (Option 2)

The Whitford Park Road / Sandstone Road intersection is a staggered T- arrangement. Whitford Park Road is the primary route with the minor intersection arm from Sandstone Road being controlled by Give Way signage. One circuit of the cable route will cross Whitford Park Road at the intersection. Whitford Park Road is in excess of 12m wide at this location and the active construction will be undertaken in a staged process with half the carriageway being completed at any time. Plates will be installed over the trenches for traffic to over run with final reinstatement will be required at a later date. The cable route in the western berm of Whitford Park Road will continue into the southern berm of Sandstone Road.

## 2.4 Construction Management

### 2.4.1 Workforce

The contractor and subcontractors will determine the optimum workforce for different sections of the project. A number of activities may be underway simultaneously at different parts of the cable route with varying numbers of personnel involved. Typical workforce numbers are as follows: -

- Trenching gang: 4 to 6;
- Backfilling gang: 8 to 12;
- Cable pulling: 20 to 40;

- Cable jointing: 4 to 6; and
- Special constructions/operations: 8 to 10.

Additional personnel on site at times could include delivery drivers, Transpower supervision staff and inspection personnel from other authorities.

#### 2.4.2 Contractor's Facilities

The contractor will require facilities for a site office, staff amenities and secure storage of equipment. Staff amenities will include a chemical toilet, caravan style office and lunchroom. These facilities will normally be positioned in a low traffic side street and relocated as often as required. These facilities will be needed at every joint bay. At any one time there could be several locations where these facilities are in use.

The cable installation contractor will be required to minimise material storage along the route by delivering needed items on an as-required basis. Such materials could include traffic barricades, heavy steel plates, shoring material cable rollers, cable drums, concrete covers, steel reinforcing, link pits and jointing equipment. As soon as the cable trench or joint bay is backfilled and the surface reinstated, the contractor will be required to remove all construction materials from that location.

It is anticipated that parking for vehicles used in the construction process will be provided by barricading a sufficiently large work area.

#### 2.4.3 Hours of Construction

Wherever works are being undertaken at or near the surface of the ground in the vicinity of residential areas, normal construction working times will apply. These are as follows:

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: No work

However, works may be undertaken outside these hours in the following circumstances:

- Special circumstances such as where work is planned to be carried out at low traffic times, for example, installation across busy roads. In these circumstances weekend work and night work may be necessary.
- Emergencies or contingencies that may require attention at any time. Some remedial work might be anticipated during or following heavy rain.
- Locations where the nature of the work is low impact and there are no nearby residences. An example might be cable jointing in a commercial/ industrial environment.

#### 2.4.4 Services

The contractor will be responsible for arranging all necessary construction services with the relevant service providers. Various services may be required for the site operations and may include electricity, water, sewer and telephones, waste collection, chemical toilets and fuel delivery.

### 2.4.5 Refuelling

On site refuelling will be required for mobile plant and static machinery such as tracked excavators, pumps, backhoes, rollers, vibrators. Refuelling will be carried out by mobile tanker, dispensing directly into the items of plant being refuelled, and thereby minimising the amount of volatile liquid stockpiled along the route at any one time.

## 2.5 Construction Management Plan

Mitigation of construction impacts will be achieved through a construction management plan. The construction management plan will be submitted to the MCC prior to the commencement of any physical works.

Transpower will include contractual requirements in the design/build construction contract for the contractor to manage construction impacts.

Construction management plans will be implemented by the contractor and will address such matters as:

- Storage and reuse of top soil
- On and off site disposal of spoil
- Silt and dust control during site levelling and earthwork stages
- Traffic management and property access management
- Temporary activities and equipment storage in specified areas
- Contractor car parking in specified areas
- Security and lighting during construction
- Contaminated land management procedures
- Construction noise, dust and vibration
- Hours of work
- Existing network utilities protocols and guidelines
- Cultural and archaeological protocols
- Land stability management
- Land stability management and water quality and sediment controls
- Community information and liaison

The contractor will be required to comply with all designation and resource consent conditions relevant to the scope of work.

## 2.6 Maintenance and Emergencies

The following section sets out Transpower's maintenance, monitoring and emergency response regime that will be set in place once the cable is installed and in operation.

## 2.6.1 Maintenance

### Patrols

The cable route will be routinely patrolled at a frequency determined by Transpower. Cable patrols will look for evidence of construction work being undertaken in the vicinity of the cable, check for any deterioration of the ground surface over or near the cable trench, and replace any missing or worn cable route markers. Patrol personnel will record any construction projects likely to affect the cable and make sure that the person in charge is aware of the location of the electricity cable.

### Standby

Where Transpower receives advice that an excavation is to take place in the vicinity of the proposed cable, a qualified person may be assigned to stand by while the excavation takes place. The standby person would have authority to issue directions to the excavator where this is necessary to ensure safety and the security of the cable.

### Routine Maintenance

Routine maintenance along the cable route will be limited to ensuring accessibility of pits associated with link boxes and communication cables. Every few years a maintenance team will ensure that pits can be found in the road, footpath or park, that lids remove and reseal as intended, and that the pit is not full of water or tree roots. Future accessibility is one of the factors considered when siting joint bays in off-road areas.

Maintenance crews will carry appropriate traffic warning devices when undertaking work at the roadside and erect barricades to restrict approaches by the public whenever link boxes are opened.

### Routine Testing

The cable will undergo routine testing from time to time to give advance notice of any deterioration. The cable will be taken out of service periodically so that technicians can test the cable sheath bonding system. Failure of these tests gives advance warning that the outer serving of the cable has been breached and is an indicator that the cable may have been struck by others or otherwise deteriorated, which if left unrepaired could lead to a cable fault.

### Adjustments

Over the life of the cable it may be necessary to make adjustments to enable other developments to proceed. Transpower will adjust or relocate any part of the cable installation if requested by another responsible authority at their cost. It is not unusual for future road works to require a link pit to be raised, lowered or relocated. Any works involving adjustment to the power cable itself would be very expensive and would need to be deferred until the cables could be taken out of service for the required time.

## 2.6.2 Emergency Action

Emergency action may be precipitated by a cable alarm, a poor result from a testing procedure or an electrical fault. Such conditions could arise in the following ways:

- Physical damage to the cable from an excavation, boring machine or failure of another nearby service in the ground;
- Ground movement around the cable such as in poor soil conditions impacted by traffic or water;
- Deterioration because of corrosive agents in the ground; or

- Internal failure from manufacturing defect, deterioration of the cable or damage sustained by prolonged operation outside its normal temperature range.

The response to an emergency condition will depend on the incident. Initially, further testing will be undertaken to determine the nature and location of the unusual condition. Where this reveals a fault, such as low sheath insulation resistance, the cable will have to be excavated at the nominated point and repairs carried out. If a section of cable has been damaged beyond repair, the damaged section will have to be cut out and a new section inserted. This may require two joint bays with work continuing for several weeks. In responding to an emergency situation it is common for crews to work 24 hours per day.

## 3 Statutory Context

### 3.1 Introduction

The statutory context of the Resource Management Act 1991 (RMA) is set out in Part II of the documentation for the Notices of Requirement. It includes consideration of the relevant section of the RMA, Transpower's objectives for the project and an explanation of the need for the project.

### 3.2 Relevant planning instruments

The operative Manukau District Plan (MDP) is the main planning instrument to be considered when assessing the Notice of Requirement for the designation for the underground cable. The other relevant planning instrument is the Auckland Regional Policy Statement (RPS). The objectives and policies contained in these documents that are considered relevant in assessing the Notices of Requirement are included in Volume X, section 4.

### 3.3 Manukau Operative District Plan 2002

While it is intended to provide for the installation, maintenance and other activities associated with the underground cable by way of the designation process, the provisions of the MDP provide useful guidelines and assist in providing a benchmark for assessing environmental effects and outcomes when considering the Notice of Requirement.

The MDP became operative in October 2002. The key provisions of the Plan that are considered relevant in assessing the Notice of Requirement are Chapter 7 – Network Utilities, and Chapter 9 – Land Modification, Development and Subdivision. Rules in both chapters apply on a city wide basis and over-ride the provisions of individual zones.

#### 3.3.1 Network Utility Services

The underground 220kV cable falls under the definition of “Network Utility Services” as these activities involve:

*(iii) Distribution or transmission of electricity;...*

*and include*

*(a) All structures necessary for the operation of the network utility service; and*

*(b) The operation and maintenance of the network utility service.*

Rule 7.8.2.1 – “Network Utility Services throughout the City” makes provision for underground electricity cables as a controlled activity where they are not located in legal road. The Rule states:

Activity	Classification in all Zones
Underground electric lines exceeding 110kV and a capacity exceeding 100MVA	Controlled

Where the proposed underground cable will be located beneath legal road, Rule 7.8.2.2 – “Network Utility Services beneath Roads” would classify the cable as a restricted discretionary activity. The relevant Rules are as follows:

Activity	Classification in all Zones
Installation, (including upgrading and renewals) of network utility services under the road carriageway at road intersections.	Restricted Discretionary
Installation, (including upgrading and renewals) of network utility services in urban roads which have not been built in accordance with the geometrical profile of Fig. 7.1. <sup>3</sup>	Restricted Discretionary
Transverse connections (including through pipes and ducts) under the road carriageway including those to serve individual properties.	Restricted Discretionary
Installation, (including upgrading and renewals) of network utility services in rural roads.	Restricted Discretionary

Chapter 7 of the MDP contains specific assessment criteria for Network Utilities considered to be controlled activities. These are set out in Rule 7.11.2. The criteria that are considered to be relevant in assessing the underground cable Notice of Requirement are summarised below. The summary also includes a cross reference to the relevant part of this report that addresses the matters raised.

- Extent to which any adverse effects on amenity values of an area from potential nuisance factors including noise, vibration, odour, dust, lighting and glare will be mitigated – refer to sections 6.3, 6.4, and 6.5
- Whether the operational efficiency and technical requirements of the network utility have been adequately taken into account in the assessment of the suitability of the site – refer to section 2
- Whether the impacts of vehicle trips, access, loading and parking generated by the proposal on the amenity values and safety of the area will be mitigated as far as practicable, including disruption to traffic from installation or maintenance works for network utility services located in the road – refer to sections 6.1, and 6.2.
- Whether the potential for contamination or hazards resulting from equipment failure, accidents or discharges have been considered when the suitability of the site was assessed. Whether the type and effects of adjoining activities have been taken into account and whether the risks of contamination of adjoining land will be minimal – refer to sections 2 and 5.
- Whether the effects on overland flowpaths and/or water courses are more than minor – refer sections 6.7 and 6.11.
- Whether the proposed site rehabilitation works will affect the safety, or functionality of other network utility services and amenity values – refer sections 6.6, 7.1 and 7.2
- Whether there are sensitive activities in the vicinity, including residential neighbourhoods and heritage areas, whose amenity values could be adversely affected, and location of the network utility service - refer section 5.
- Whether the proposal may affect road safety - refer sections 6.1 and 6.2.

<sup>3</sup> The installation of the proposed underground cable does not comply with Figure 7.1, because the cable will mainly be located in the carriageway.

Rule 7.13.2.1 sets out the assessment criteria for a restricted discretionary activity for Network Utility Services beneath roads. The criteria that are considered to be relevant in assessing the underground cable Notice of Requirement are summarised below. The summary also includes a cross reference to the relevant part of this report that addresses the matters raised.

- Whether the location of the proposed network utility service will ensure that the road space is used efficiently and safely with minimal inconvenience and disruption to road users and other utility services and provide ready access for maintenance purposes, and the extent of impacts of such effects - refer sections 6.1 and 6.2.
- Whether the proposed location of the network utility service is likely to adversely affect the functionality and safety of existing and probable future network utility services that are likely to use the road corridor, including the maintenance of adequate separation distances, and the extent or impact of such effects - refer sections 6.6, 7.1 and 7.2
- Whether the proposal will adversely affect the amenity values of the locality, and the extent of impacts of such effects - refer section 6.9 and 7.3
- Whether the proposal will adversely affect the road carriageway, vehicle crossings, footpaths, berms or planting in terms of their safety, structural integrity, design life, functionality and amenity values - refer sections 6.1 and 6.2
- Whether the construction methods and materials used in the installation and the maintenance of the network utility service in the road may effect the performance and safety of other network utility services - refer sections 6.6
- Whether alternative locations, technologies and techniques such as shared facilities have been adequately considered - refer section 4

The key objectives and policies contained in Chapter 7 of the MDP in respect of Network Utilities that are relevant in considering the Notices of Requirement are contained in Part X, section 5 of this documentation. It is considered that the proposal is generally consistent with the policy framework for network utilities.

### 3.3.2 Earthworks

Chapter 9 of the MDP contains rules relating to earthworks and land modification. *Land modification* refers to the activity of altering the landform through earthworks, construction (such as roads, utilities and services, and site works for buildings and other structures), and the removal or planting of vegetation. Land modification involving no more than a cumulative total of 200m<sup>3</sup> of earthworks in respect of any site is a permitted activity unless it is near the coast or waterways, within the floodplain or on a slope greater than 1:4. As the volume of earthworks involved in installing the cable will exceed this volume threshold and other criteria, and will traverse stormwater management areas, the proposed earthworks would be classified as a restricted discretionary activity.

Activity	City Wide <sup>4</sup>
Land Modification or Development (including that which involves earthworks) not otherwise permitted in this table.	Restricted Discretionary
Activity	Land in Stormwater Management

<sup>4</sup> Except for Explosives Zone and Whitford Landfill Zones

	Areas
Earthworks and fill	Restricted Discretionary

Rule 9.12.6 sets out the assessment criteria for controlled and restricted discretionary activities for Earthworks. The criteria that are considered to be relevant in assessing the underground cable Notice of Requirement are summarised below. The summary also includes a cross reference to the relevant part of this report that addresses the matters raised.

- Removal or alteration of existing vegetation, topography of the site, effect on existing natural features and the extent to which amenity values will be altered - refer section 6.11
- Proximity of earthworks to water bodies and the extent to which mitigation measures will minimise adverse effects on water bodies - refer sections 6.5, 6.7 and 6.8
- Effects of noise and dust nuisance and the effectiveness of mitigation measures - refer sections 6.3 and 6.5
- Whether traffic generation will have an adverse effect on amenity values and the carriageway of roads - refer section 6.1
- Whether earthworks and final levels will adversely affect existing utility services - refer section 6.6
- Impact on any feature of historic or cultural importance - refer sections 6.10 and 6.12
- The presence of pollutants and/or contamination that may be hazardous to the environment - refer section 6.13

Rule 9.12.10 sets out the assessment criteria for controlled and restricted discretionary activities for Earthworks located in Stormwater Management Areas. The criteria that are considered to be relevant in assessing the underground cable Notice of Requirement are summarised below. The summary also includes a cross reference to the relevant part of this report that addresses the matters raised.

- Effects on riparian vegetation, stream banks and flows – refer section 6.7, 6.8 and 6.11
- Extent to which the functionality of the stormwater management system is affected including effects on flooding and stormwater quality – refer section 6.7
- Whether the proposal will lower water quality and cause adverse effects on the biota of receiving environments – refer section 6.11
- Extent to which the earthworks will effect the installation and operation of utility services - refer sections 6.6 7.2 and 7.3

The key objectives and policies contained in Chapter 9 in respect of Earthworks that are considered relevant in assessing the Notices of Requirement are contained in Part X, section 5. It is considered that the proposal is generally consistent with the policy framework for earthworks.

### 3.3.3 Other Relevant Rules

The MDP contains a number of City-wide rules that are potentially relevant to the consideration of the underground cable Notice of Requirement. The key provisions that are considered relevant are summarised below. The summary also includes a cross reference to the relevant part of this report that addresses the matters raised.

### Construction Noise

Rule 5.18.3.6 requires that noise from construction work (including maintenance and demolition works) shall be measured, assessed and controlled in accordance with the procedures and limits set out in NZS 6803:1999 being the New Zealand Standard for Acoustics -Construction Noise - refer section 6.3.

### Vibration

To ensure that vibration from business activity does not cause a significant nuisance, Rule 5.18.4.1 requires that activities shall not create vibration exceeding specified performance standards. Section 6.4 of this report sets out the standards and how compliance with these standards will be achieved.

### Temporary Activities

It is anticipated that during the installation of the underground cable, it will be desirable to have temporary lay down areas for the storage of plant, equipment and materials associated with the installation of the underground cable. These activities are provided for under Rule 5.16 – Temporary Activities in the MDP. The following activities can be carried out as of right (permitted activities)

*(a) Temporary offices, storage sheds, builders' workshops, scaffolding and other similar buildings and activities which are:*

- (i) incidental to a building or construction project on the same site; and*
- (ii) limited to the duration of the project, or for a period not exceeding twelve months (whichever is the lesser)*

....

*(c) Any temporary storage, stacking of goods or materials for a period not exceeding six months.*

Any temporary activity that does not comply with the above requirements would be classified as a restricted discretionary activity.

Any construction activities associated with the installation of the underground activity such as storage areas and sheds, workshops and offices not located within the designation would comply with Rule 5.16 and would therefore be permitted activities.

### **3.3.4 Plan Change 8**

Plan change 8 covers rural areas of Whitford and part of both Option 1 and Option 2 fall within its boundaries. It was notified on 8 July 2005 with the decision notified on 19 December 2006. The 'Whitford Rural Area' covers approximately 3,735 hectares of rural land that lies entirely within Turanga, Waikopua, Te Puru and Beachlands stream catchments (collectively known as the Whitford Catchment). Because of its close proximity to the urban edge (Howick, Botany and Flat Bush) and the coastal edge (the Whitford embayment) the area has been identified as a desirable location for countryside living development. The purpose of the plan change is to provide for the establishment of countryside living development that maintains and enhances the landscape character, rural amenity values and environmental quality of the area. The Plan Change also includes seven Notices of Requirement by Manukau City Council to designate land for Proposed Road and Road Widening. One of those seven includes the intersection of Whitford Park Road and Sandstone Road which cable route Option 2 traverses.

Basically, the plan change manages future subdivisions and development through a series of rules relating to existing natural features and density requirements. The underground cable route, being for an underground infrastructure facility does, not directly relate to many of the rules.

However, the rule relating to Recreational Trails would be a relevant consideration, as a recreational trail is identified along Brownhill Road, adjacent to the Brownhill Substation site, and up to Regis Lane. It is considered that there will be no fundamental conflict of the development of the transition station/substation at Brownhill Road with the recreational trail rule.

#### Rule 12A.11.5 Recreational Trails

- (i) Where land through which recreational trails as shown on the Planning Maps are to pass is subdivided or developed, then provision for the trails shall be made as follows:
- (a) The route of the trail shall be generally in accordance with that indicated on the Planning Maps. Where practicable, the trail shall provide access to features of scenic, historic and ecological interest in the locality.
  - (b) Where practicable, the trail shall be independent of the road.
  - (c) Where it is necessary for the trail to be provided in conjunction with a road, the Council may require widened berms and other amenity features along the trail route.
  - (d) Where it is necessary to cross a major traffic route, the Council will consider the practicality of requiring traffic control devices to help ensure the safety of trail users.
  - (e) The trail route should be sited clear of the 1% annual exceedence probability flood path of any natural stream system.
  - (f) Where the trail route is provided by means of a pedestrian accessway, the width of the access way at any point shall not be less than 6 metres unless in the opinion of the Council a reduced width provides the required level of access.
  - (g) The trail shall be vested in the Council. Rule 15.15.2 – Reserve Contributions shall apply.

### **3.4 Auckland Regional Policy Statement**

The Auckland Regional Policy Statement (RPS) became operative in August 1999. It is a statement about managing the use, development and protection of the natural and physical resources of the Auckland Region. The key objectives and policies that are of relevance in assessing the Notices of Requirement are contained in Part X, section 4 of this documentation.

It is considered that the proposal is generally in accordance with the objectives and policies in the RPS, the most relevant being those that relate to the provision of national and regional infrastructure, in the interest of the economic and social wellbeing of people and communities in the regions.

### **3.5 Hauraki Gulf Marine Park Act**

The Hauraki Gulf Marine Park Act 2000 was developed to create the Hauraki Gulf Marine Park and achieve integrated management of the Gulf. The Hauraki Gulf and its catchments fall under the jurisdiction of a number of authorities including Auckland Regional Council and Manukau City Council. The Act applies not just to the waters and islands of the Gulf, but also to its catchment, hence the relevance to the underground cable.

Section 9(4) indicates the relevance of this Act to the 220kV underground Notice of Requirement as follows:

*A consent authority must, when considering an application for a resource consent for the Hauraki Gulf, its islands, and catchments, have regard to sections 7 and 8 of this Act in addition to the matters contained in the Resource Management Act 1991.*

Section 10 of the Act requires that for the coastal environment of the Hauraki Gulf, sections 7 (Recognition of National Significance of the Hauraki Gulf) and 8 (Management of Hauraki Gulf) of the Act must be treated as a New Zealand Coastal Policy Statement issued under the RMA and where there are any conflicts between the two, the New Zealand Coastal Policy Statement prevails.

Given the nature of the proposed works associated with the installation of the underground cable, as well as the existing environment and the mitigation measures proposed, it is considered that the Hauraki Gulf Marine Park Act has no particular relevance in terms of the designation.

### 3.6 New Zealand Coastal Statement

The New Zealand Coastal Policy Statement (NZCPS) became operative in May 1994. It was prepared and issued by the Minister for Conservation. The purpose of the NZCPS is to promote the sustainable management of natural and physical resources in relation to the coastal environment of New Zealand.

It focuses on preservation of natural character, and the integrity and functioning of the coastal environment. The policy places a certain amount of emphasis on the avoidance of adverse effects and where this is not practicable, the effects should be mitigated and/or provision made for remedying those effects.

Given the nature of the proposed works associated with the installation of the underground cable, as well as the existing environment and the mitigation measures proposed, it is considered that the NZCPS has no particular relevance in terms of this Notice of Requirement.

### 3.7 Other Legislation and Relevant Guidelines

Sections 24 and 25 of the Electricity Act 1992 provide the statutory basis for Transpower to locate the underground cable within roads. Section 24 (as recently amended) is set out below and provides:

- "(1) Except as provided in subsections (2) and (5) of this section, an electricity operator may from time to time construct and maintain works in, on, along, over, across, or under any road, and for any of these purposes may—*
- (a) Open or break up any road:*
  - (b) Alter the position of—*
    - (i) Any pipe (not being a main) for the supply of water or gas; or*
    - (ii) Any telecommunications line; or*
    - (iii) Any works—**that are constructed in, on, along, over, across, or under that road:*
  - (c) Alter, repair, or remove any works so constructed or maintained, or any part of any such works.*
- (2) No electricity operator shall exercise the powers contained in subsection (1) of this section otherwise than in accordance with such reasonable conditions as may be prescribed by—*
- (a) The local authority or other body or person having jurisdiction over the road; and*

- (b) *The owner of the pipe, telecommunications line, or works, as the case may require.*
- (3) *Without limiting the generality of subsection (2) of this section, a local authority or other body or person having jurisdiction over a road may impose under that subsection, in relation to any work undertaken by any electricity operator, a condition requiring the electricity operator to meet the reasonable costs and expenses of that local authority or other body or person—*
- (a) *In processing any notice given under section 25(1) of this Act by the electricity operator in relation to the work:*
- b) *In supervising the carrying out of the work, where such supervision is necessary in the circumstances of the case.*
- (4) *To avoid doubt, subsection (1) does not prevent the construction or maintenance of works that are undertaken under an agreement entered into by-*
- (a) *the electricity operator; and*
- (b) *the local authority or other body with jurisdiction over the road to which the works relate; and*
- c) *any owner referred to in section 25(1)(b).*
- (5) *Subsection (1) does not apply to the construction of works that are intended to convey, or are associated with, electricity at a voltage of more than 110 KV and a capacity of more than 100 MVA.*
- (6) *In subsection (5), works means works located at or above ground level in, on, along, over, or across a road, but does not include works suspended above a road."*

Before works are undertaken, section 25 of the Electricity Act requires appropriate notice to be given and provides:

- "(1) *Except as provided in subsection (5) of this section, before an electricity operator proceeds to undertake any work pursuant to the powers contained in section 24(1) of this Act, the electricity operator shall give notice of its intention to undertake the work to—*
- (a) *The local authority or other body or person having jurisdiction over the road to which the work relates; and*
- (b) *The owner of any pipe, telecommunications line, or works that are constructed in, on, along, over, across, or under that road and that will be affected, or are likely to be affected, by the work.*
- (2) *Every such notice shall be in writing, and shall specify the location of the proposed work, the nature of the work to be undertaken, and the reasons for it.*
- (3) *Within 15 working days after the receipt of the written notice of the intention to undertake work, the persons who are given a notice pursuant to subsection (1) of this section shall notify the electricity operator, in writing, of any conditions imposed pursuant to section 24(2) of this Act.*
- (4) *Where a person who is given a notice pursuant to subsection (1) of this section fails to notify the electricity operator of the conditions imposed pursuant to section 24(2) of this Act within the period referred to in subsection (3) of this section, no such conditions may be imposed, and the electricity operator may commence work.*
- (5) *Where any such work is rendered urgent and necessary by any defective equipment, or other emergency, the electricity operator shall be excused from complying with the requirements of subsection (1) of this section before commencing the work, but shall give the information required by subsection (2) of this section as soon as practicable thereafter."*

The above power does not equate to an RMA right and is subject to rules in district plans or to the conditions of a relevant designation.

### 3.8 Resource Consents Required

There will be a number of consents which will be required from the Auckland Regional Council in respect of the installation of the underground cable along the route and which will be sought separately. These are likely to include:

- Landuse consent for earthworks (including but not limited to trenching, excavation test pits, geotechnical drilling, backfilling or clean filling) to enable the installation of a 220kV underground transmission cable outside any sediment protection control area.
- Landuse consent for earthworks (including but not limited to trenching, excavation test pits, geotechnical drilling, backfilling or clean filling) to enable the installation of a 220kV underground transmission cable inside a sediment protection control area.
- Discharge permit to discharge contaminants to land from ancillary activities that produce wastewater or washwater, such as the washing of vehicles, plant or machinery, drilling activities, dust suppression, concrete or asphalt laying or reworking, associated with the installation of the underground cable.
- Landuse consent for works in the bed of a watercourse to trench through a watercourse and place a transmission cable structure under the bed of the unnamed watercourse, and to place a bridge or culvert over or within a watercourse.

Applications for the above consents will be sought prior to any construction works occurring.

## 4 Alternatives Considered

### 4.1 Introduction

Alternatives to the project as a whole have been considered and evaluated and are described in Part II. For the underground cable, two key alternatives that have been considered relate to transmission alternatives and route alternatives.

As part of its Amended Proposal for the North Island Grid Upgrade project, Transpower made a decision to underground the proposed 220kV transmission line between the Pakuranga Substation and the Brownhill Road transition station/substation. The underground section of the route runs in part through a densely populated urban environment that does not provide any buildable routes for an overhead transmission line without the removal of a significant number of houses and as a consequence, serious social disruption.

Installation of the underground cables within roads or other public land, wherever practicable, provides the further advantage of minimising potential disruption to landowners.

It is however, not practicable to underground the 220kV transmission line along the entire route (i.e. from Otahuhu to Whakamaru) primarily on account of the prohibitive cost of undergrounding when compared with overhead line.

### 4.2 Alternative Cable Types

There are three main types of cables used for voltages above 36kV, all of which were assessed by Transpower as possible cable alternatives. A basic description of each is given below: -

- Cross Linked Polyethylene (XLPE). This uses XLPE as a solid insulating material surrounding the copper conductor and encased by a metallic sheath.
- Self Contained Fluid Filled (SCFF). This uses either paper or paper-polyethylene laminated insulating tapes impregnated with insulating fluid and encased with a metallic sheath. The fluid pressure within cable sections is maintained slightly above atmospheric pressure (105 to 350 kPa) via fluid tanks which allows for fluid expansion and contraction with temperature.
- High Pressure Fluid Filled (HPFF). This uses paper laminated insulating tapes around individual conductor material. Three such insulated conductors are encased in a single steel pipe. The pipe is pressurised with insulating fluid to a high pressure (2,400 kPa) using oil pumps and oil storage tanks.

At the conclusion of this assessment process, a decision was reached by Transpower to use 220kV XLPE cable for the following reasons:

- Absence of insulating fluid, which eliminates potential for release of contaminants into the environment and reduces fire risk.

- Greater and increasing availability of technical support, spares and necessary skills as SCFF and HPFF technology world-wide is being superseded by XLPE (with the necessary maintenance skills and OEM support becoming increasingly scarce).
- Lower capacitance resulting in less shunt reactive compensation being required and a lower risk of high transient and temporary over voltages occurring during switching and faults.
- Simpler accessories require less specialised jointing and maintenance skills

### 4.3 Route alternatives

During the process of identifying a preferred underground route, a number of options were considered.

Initially seven possible route options were identified that utilised public roads and public land wherever practicable and provided the most direct routes between the Pakuranga Substation site and the transition station/substation location at Brownhill Road.<sup>5</sup>

The seven underground route options initially identified were:

Route – Northern – Brownhill and Whitford Park Roads

Route – Central 1 – Caldwell's Road (paper road), Point View Drive, existing tunnel to Pakuranga Substation

Route – Central 2 – Caldwell's Road (paper road), Te Irirangi Drive, then existing tunnel to Pakuranga Substation

Route – Central 3 – Caldwell's Road (paper road), eastern side of Greenmount landfill and Greenmount Drive

Route – Southern 1 – Stancombe Road, Te Irirangi Drive, then through part of the existing tunnel to Pakuranga Substation

Route – Southern 2 – Stancombe Road, Accent Drive, East Tamaki Road, eastern side of Greenmount landfill and Greenmount Drive

Route – Southern 3 – Stancombe Road, Accent Drive, Harris Road, and Greenmount Drive

The process followed in selecting the preferred underground route options for public consultation involved:

- Collection, analysis and mapping of information relating to the three route options and a number of alternative sub-options
- Development of a route choice methodology and route evaluation process
- Application of the methodology and evaluation process through a workshop involving relevant experts
- Discussion and meetings with senior officers of the Manukau City Council to generally discuss the route options being assessed.

This process resulted in a first-stage assessment, which led to the elimination from further consideration of four of the seven options.

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<sup>5</sup> The process of identifying, investigating and analysing the options is fully described in "North Island Grid Upgrade Project, Amended Proposal: Northern End Modifications Report", MWH NZ Ltd, October 2006.

The preferred route options that the selection process identified for further consideration and public consultation were the Central Routes 1, 2 and 3 referred to during the consultation that followed as the Eastern, Central and Western Routes.

The process followed in selecting the preferred underground route options from these three, included application of multi-criteria methodology and evaluation process through a workshop involving relevant experts including engineers, planners, ecologists and an archaeologist; scoring and weighting of options; and further analysis to determine a preferred option.

The analysis was also informed by further investigation in relation to environmental, engineering and property matters.

The outcome of the analysis was that the Eastern Route Option was clearly preferred for the underground cable route.<sup>6</sup> Transpower has, however, reconsidered the desirability for grid security reasons of not having a common section of route for the cable circuits to Otahuhu and Pakuranga and in the light of recent geotechnical advice on the common route section is considering the benefits of completely separate routes. An alternative route (Option 2 in this Notice of Requirement, described in section 2.3) has now been identified and is subject to additional consultation processes.

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<sup>6</sup> This process and its outcome is fully described in "North Island Grid Upgrade Project, Amended Proposal; Final Report on Northern End Modifications", MWHNZ Ltd, February 2007.

## 5 Description of the Environment

### 5.1 Roading network

The underground cable route passes through areas which are largely residential in nature, although there is a central section, which traverses a commercial/industrial area. The roads are all within Manukau City Council's jurisdiction and are a mixture of regional and district arterials and secondary local roads.

In undertaking the assessment of the traffic effects associated with the proposal, the route has been broken down into a number of sections where each section is relatively homogeneous in terms of land use and/or road type and has characteristics that distinguish it from adjacent sections (see Part X, section 17).

The route adjoins a number of road designations including road widening along the southern edge of East Tamaki Road, and road widening on the southern corner of Ormiston Road. With Option 1, once the route crosses Ormiston Road, it follows the proposed extension to Redoubt Road, which is identified as 'Future Road' in the MCC DP but is not as yet formed. Option 2 utilises the routes of Sandstone Road, Whitford Park Road and Brownhill Road.

### 5.2 Reserves and open space

There is very little public open space land that will be utilised for the underground route, as road corridors will mostly be used. The Pakuranga Substation at the northern end is bounded on the western and southern sides by a stormwater management area and public open space (local purpose reserve). The route then travels past and through small public open spaces within the Dannemora residential area at the end of cul-de-sacs that provide connectivity within the suburb and open space for residents.

The cable route also runs adjacent to Point View Reserve (along the formed section of Caldwell's Road) which contains car parking, open spaces and fenced native vegetation areas.

### 5.3 Recreation

There is minor informal recreational use of the open spaces areas within Dannemora and the Point View Reserve.

Brownhill Road currently has informal use by local residents for walking, jogging, cycling and horse-riding.

The Redoubt Road extension area has been promoted in the past as a "scenic drive", or recreational driving route.

There is an identified recreational trail within Plan Change 8 which runs along Brownhill Road and adjacent to the Brownhill Road transition station/substation and up to Regis Lane. The path provides connectivity within the Whitford Rural area for walking, running/jogging, cycling and horse riding. The path will be maintained on

private land through an applicant having to identify where on the land the trail can be accommodated when applying for subdivision consent and will be vested in the Council.

## 5.4 Stormwater Management Areas

Stormwater Management Areas are defined in the Manukau District Plan as “*land which is expected to be inundated or affected as a result of a 100 year flood, or by any other level of flood identified as part of a Comprehensive Discharge Permit or other approved discharge permit*”. They are designed primarily for the control and management of stormwater and no activities are to be undertaken on land in Stormwater Management Areas that will adversely affect their present or future functionality for stormwater management.

The proposed underground cable crosses adjacent to a Stormwater Management Area on the northern side of Ti Rakau Drive as it enters the Pakuranga Substation site. The route crosses a small stormwater management area at the end of Guys Road, East Tamaki before heading north through reserve area.

## 5.5 Private land

The route runs through several areas of private land in areas as follows:

- Dunvegan Rise to Point View Drive
- Caldwells Road (as paper road through private properties)
- Option 1 – Caldwells Road to Regis Lane (Where land is identified in the MCC DP as ‘Future Road’)
- Option 2 – via Brownhill Road to the Brownhill Substation site

The areas of private land are predominantly lifestyle blocks with some well developed outdoor landscaped garden areas including areas of vegetation fenced off from stock and subject to regeneration measures.

## 5.6 Adjoining landuses

### 5.6.1 Sensitive land uses

Sensitive land uses for the purposes of the project have been defined as schools, pre-schools and any other facility where people congregate for long periods of time. There are no known sensitive land uses on the route.

### 5.6.2 Residential activities

The surrounding environment at the northern end of the route near the Pakuranga Substation consists of residential dwellings, shops/commercial activities and small areas of public open space. The residential areas adjacent to the initial part of the route are zoned as Main Residential, which has a minimum lot size of 400 m<sup>2</sup> with mostly detached brick and tile privately owned residential housing.

There is also a small area of integrated and more intensive residential housing development (townhouse type living) within 200 metres of the Pakuranga Substation.

### 5.6.3 Business activities

At the northern end of the route commercial and retail business type activities are located in the general vicinity of the Pakuranga Substation along Ti Rakau Drive and towards Te Irirangi Drive. They include 'big box' type retail, vehicle part stockists, fast food services, an ice skating rink, Botany Town Centre, a vehicle testing station, supermarkets and service stations.

To the west of the cable route into the Substation site across the Stormwater Reserve is a Bunnings Warehouse. To the south of the site there is a bus park area and smaller commercial businesses, along with local café/bar and small restaurant type operations.

### 5.6.4 Rural / Rural Residential

The underground cable route runs through private properties within the rural and rural residential areas. The rural areas are used predominantly for pastoral grazing, along with the lifestyle blocks, pine forestry and some recently felled pine plantation. The smaller rural/residential type properties along Point View Drive, are used for grazing with many featuring landscaped gardens or areas of vegetation or small waterways/wetland areas fenced off from stock.

On crossing Ormiston Road, the route traverses a section of the formed road which remains in private ownership. Part of the route is shown on Manukau District Plan maps as an extension to Redoubt Road, and the route follows this before turning east to follow a ridge to the Transition Station. Although a compensation certificate is registered on the Certificate of Title, it does not appear that the land has been formally vested in Manukau City Council. This section of land is currently owned by Transpower.

The final area of private land is that from Redoubt Road to the Transition Station site in Brownhill Road. The Transition Station site is owned by Transpower.

Plan Change 8 comprises a number of zones based on landscape types, with several overlays intended to manage the location of development in order to protect rural character and amenity values.

Part of the underground route between the Redoubt Road extension and the Brownhill Road transition station/substation traverses land zoned proposed Whitford Rural A (average development capacity is one lot per 4 hectares) and is covered by the scenic amenity overlay which applies to all land in Whitford above the 80 metre contour. The primary purpose of this overlay is to maintain the balance between the built environment and the existing natural areas. Land above this contour is considered to be generally more visible, and any development is subject to evaluation in terms of specified criteria relating to rural character and amenity values. Further development of residential activities in the Plan Change 8 area is subject to discretionary control over location, density and design.

### 5.6.5 Other Adjacent Landuses

Because the route is predominantly located within road reserve in a rural or intensive residential area, there are limited other adjacent uses beyond those outlined in the sections above. The Whitford Park Country Club (Golf Course) is located on Whitford Park Road adjacent to Option 2.

## 5.7 Tangata Whenua Values

Historically the underground cable route area is located within what has been recognised in contemporary times as the wider Waikato-Tainui rohe and the iwi and hapu links associated with this part of Tamaki Makaurau reflect this.

Consultation has been undertaken with Te Aki Tai, Ngai Tai ki Tamaki, Ngai Tai ki Umupuia and Ngati Paoa all of whom have Tainui links. The nearest marae to the underground cable route is the Umupuia marae of Ngai Tai ki Umupuia located in Maraetai.

After an initial round of consultation (Consultation hui at Pukaki marae, 15 November 2006) with the Ngai Tai ki Umupuia Te Waka Totara Trust, Te Aki Tai, Ngai Tai ki Tamaki and Ngati Paoa, these iwi authorities agreed that the Te Waka Totara Trust would represent:

- Ngai Tai Umupuia, Umupuia Marae;
- Ngati Paoa, Kaiaua Marae;
- Te Aki Tai, Pukaki Marae; and
- Te Ahi Waru, Makaurau Marae.

There are no sites identified in the MDP as being of significance to tangata whenua directly located on the underground cable route. Ngai Tai ki Umupuia advised that Pointview Drive has two midden points, that they recognise it as a pa, and that Te Huarahi o Tara is a recognised track. They also noted that Option 2 (via Brownhill Road) was the preferred option for them. No sites of significance have been identified on or immediately adjacent to the subject site by Te Waka Totara Trust.

## 5.8 Heritage values

There are no heritage sites or landforms identified along the cable route within the MDP. An historic homestead "Guys Homestead" is located on land to the west of the alignment of the cable route as it approaches Ti Rakau Drive from the south.

An archaeological survey was undertaken along the three potential underground cable routes during the period of public consultation between October 2006 and January 2007.

No archaeological evidence was found in the Brownhill Road/Regis Lane area and the present landscape indicates there would be a low likelihood of any sites being found.

Survey of unformed parts of Caldwell's Road found no archaeological evidence, and it is thought that there is only a remote possibility that undetected archaeological evidence is present.

Adjacent to the formed part of Caldwell's Road within both road reserve and Point View Reserve terraces were discovered. The site is partly damaged and disturbed through previous road construction. Given the information on these terraces it is highly likely that they are an archaeological feature.

A survey was also conducted from Point View Drive to the tunnel entrance area at Dunvegan Rise. No archaeological evidence was found and it is considered unlikely that any would be found. There are no

concerns about the route along the length of the tunnel as it has already been earthwork and substantially disrupted previously.

## 5.9 Water courses

### Stormwater retention area between Ti Rakau Drive and the Pakuranga Substation

Between Ti Rakau Drive and the Pakuranga Substation site the cable route passes through a stormwater retention area (not designated) located immediately to the east of the designated Stormwater Management Area and Pakuranga Creek.

The stormwater retention area crossed by the cable route comprises a minor 'channel' within a larger basin. It is expected that flows would only occur from this area during or shortly after large or prolonged rain events, when the ponding stormwater reaches a depth sufficient to overtop the stand-pipe. The stormwater retention area collects stormwater from the surrounding residential and commercial developments. Flows from the area are discharged into the adjacent designated stormwater management area (to the west) which forms the upper extent of Pakuranga Creek.

Virtually none of original riparian vegetation remains in the vicinity of the cable crossing – only several mature mahoe (*Melicytus ramiflorus*) individuals are present. The banks of the stormwater basin have recently been planted in common indigenous plant species, such as cabbage trees (*Cordyline australis*), *Pittosporum* spp., *Coprosma* spp., *Leptospermum* sp. etc. None of these plantings exceed 1.5 metres in height. Rank grass and weeds common in highly disturbed (wet) conditions are also abundant.

### Unnamed Waterway and Stormwater Channel Crossing Between Point View Drive and Dunvegan Rise

Between Point View Drive and Dunvegan Rise the cable route passes, within a basin, along a minor unnamed waterway and across a formed stormwater channel. The basin below Point View Drive and above Dunvegan Rise comprises 'lifestyle' landuse, featuring several residential houses, limited areas of pasture, a block of fenced revegetation, and several farm dams. A waterway originates in the basin and flows through the block of revegetation before converging with a formed stormwater channel above Dunvegan Rise. The waterway is small in size (approximately 0.5 to 1.0 metres in width and <200mm deep). It is expected that the base flows of the stream are largely supported by overflows / seepage from the farm dams which are present in the basin. As the stream flows almost entirely within a block of revegetation, the waterway features a dense cover of riparian vegetation.

The formed stormwater channel which is intersected by the cable route above Dunvegan Rise carries stormwater from the vicinity of Point View Drive. The channel at this point of intersection undergoes a transition to culverts / piped reticulation under the recent residential development of Dunvegan Rise. The stormwater channel at the point of intersection with the cable route has a relatively steep gradient and is formed from coarse rock rip-rap. Riparian vegetation is limited to rank grasses, bracken and sedges.

### Mangemangeroa Stream Crossing on Caldwell's Road

The cable route crosses the Mangemangeroa Stream on the Caldwell's Road alignment (unformed road in this area).

The Maungamaungaroa Stream flows to the Mangemangeroa Creek which converges with the Turanga Creek and Waikopua Creek to form the ecologically significant Mangemangeroa Creek/Turanga Creek/Waikopua Creek estuary complex.

The area of the Maungamaungaroa Stream affected by the cable crossing has a margin of mature indigenous vegetation and is fenced to exclude stock.

The stream in this area has a width of approximately 1.5 to 3.0 metres and an approximate average depth of 0.3 to 0.6 metres. The reach of the stream contains a variety of aquatic habitats with pools and riffles present. Banded kokopu (*Galaxius fasciatus*) are noted as being present in the reach of the stream subject to the crossing with the cable<sup>7</sup>. This stream benefits from mature indigenous riparian vegetation, and is protected from stock by fencing.

### Two perennial stream crossings between the Brownhill Substation site and Regis Lane

Between the Brownhill Road transition station/substation and Regis Lane the cable route crosses two perennial streams recognised by the MDP as posing a “physical constraint” to development.

The full investigation of the western-most temporary stream has not been possible due to access restrictions. However it is anticipated that the stream characteristics would be of a similar value to that of the eastern-most stream.

The temporary streams crossed by the cable alignment are pastoral in nature. The eastern-most channel is formed by a ‘U’ shaped pastoral gully, featuring wet ‘boggy’ soils and no defined stream ‘channel’. A cascade of farm dams is positioned at intervals up the gully and stock have free access to the channel / gully. The watercourse is heavily modified and has retained little of its natural character. No significant riparian vegetation is present. The stream channel is dominated by pasture grass species and rushes and sedges typical of waterlogged pastoral conditions. In terms of species diversity, the stream is not considered to contribute significant ecological structural or functional components to the wider Turanga Catchment.

### Turanga Creek Crossing on Private Access Road

The cable route crosses the Turanga Creek in the vicinity of the alignment of the existing access road serving the Brownhill Substation site.

The Turanga Creek in the vicinity of the cable crossing at the existing road bridge has an approximate width of 2.0 to 3.0 metres and an approximate depth of 0.5 to 1.5 metres. The Creek has a ‘U’ shaped channel and has a soft bed, comprising of fine silts and clays. Limited quantities of macrophytes and algae are present. Several small unidentified bully species were noted as being present during a site visit. The Creek contains a variety of pool and riffle habitats and benefits from semi-continuous riparian vegetation cover, largely comprising crack willows and poplar trees.

It is anticipated that the Turanga Creek will be crossed in the area immediately upstream of the existing road access bridge serving the Brownhill Substation site. This area has crack willow trees, bracken and other

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<sup>7</sup> Bennett, K.V.; Don, G.L.; Mosen, M.A.; Smith, T.V. 1999: Ecological and Archaeological Features of the Sandstone Road Property. Auckland, Bioresearches. Pp 63.

herbaceous plants which are not considered to be of a high ecological benefit, and any ecological / riparian benefits they do contribute can be restored through site reinstatement on completion of cable installation works.

### **Encroachment beyond road reserve on Brownhill Road**

In one location on Brownhill Road, approximately 300 metres north east of the road bridge crossing over the Turanga Creek, the cable route designation extends beyond road reserve onto private land containing, in close proximity, the Turanga Creek.

Some riparian vegetation may be affected during the construction of a retaining structure to allow widening of the formed road. The composition and structure of this vegetation is highly disturbed already and it is considered to provide limited riparian benefits to the Turanga Creek. The Creek in the vicinity of the extension of the designation and onto private land is of a similar nature to that of the position of the road bridge crossing described above. Vegetation in the area is of a highly disturbed nature, typical of roadside environments.

### **Minor Perennial Stream Crossings in Brownhill Road Reserve**

Several very small perennial streams flow from the higher ground to the east of Brownhill Road to Turanga Creek, crossing under the formed road via culvert crossings.

No vegetation is present within road reserve in the vicinity of the perennial stream / culvert crossings of Brownhill Road.

## **5.10 Vegetation**

The alignment travels within the rural area from the Brownhill Road Substation to Caldwell's Road, with land predominantly used for agricultural grazing. However, the Option 1 route also passes through an area where production pine forestry has been clear-felled and a small patch of indigenous vegetation remains.

Patches of indigenous vegetation are also located in the wider vicinity of Caldwell's Road. However only limited amounts of indigenous vegetation are located within the proposed alignment. The alignment descends across privately owned land between Point View Drive and Dunvegan Rise. This area is in 'lifestyle' land use, and is a matrix of pasture and fenced revegetation.

Small reserve areas crossed by the tunnel sections are grassed and mown.

Vegetation in the vicinity of the alignment near the Pakuranga Substation site is predominantly an expanse of mown lawn.

Further detail of areas of value is given in section 6.11.1

## **5.11 Existing Utilities**

The road carriageway, berm and footpaths are occupied by telecommunication, gas, water/sewer and electricity network utilities. Best endeavours have been made in determining the location of the route to avoid existing

utilities wherever practicable. However, specific management techniques will be adopted to locate and protect utilities through all stages of the project implementation so as to avoid damage to these assets.

As a result of investigations and discussions with network utility operators, the following major transmission assets have been identified along the cable route. Due to the size and significance of these assets, specific mitigation measures will be required.

### **Water Pipelines**

The East Tamaki Howick feeder main's 700 mm diameter pipe crosses over the existing Pakuranga cable tunnel at the junction of Guys Road and Link Road and then runs parallel to the tunnel along Link Road. The water pipeline's depth of cover is only 800 mm at this point, so the direct buried cables will have to go under the pipeline.

### **Wastewater / Stormwater Pipelines**

The Watercare Botany Branch Sewer's 600mm diameter pipe crosses over the Pakuranga pipe tunnel in commercial land near Te Rakau Drive. The sewer pipe's depth of cover is 2.200 mm so the direct buried cables are expected to be able to pass above it.

## 6 Assessment of Construction Effects

### 6.1 Transportation network

#### *Description*

Typically, the construction methodology will involve excavation of the trench in lengths of up to between 600 to 800 metres with each section taking about 6 to 8 weeks. The nature of the construction will at certain times be 'active' with construction activity moving steadily along the trench line. Three "active" periods are likely to occur at each location once for excavation, once for cable-laying and temporary trench reinstatement and finally for surface reinstatement once the trench has had a chance to settle under normal vehicular loading. Each active period will last typically for a day. For the rest of the 6 to 8 week construction period, the construction will be 'passive' with the trench open, awaiting cable laying and/or reinstatement.

The road width required to safely accommodate plant, equipment and labour will typically be 6 metres during periods of active construction, although where space is constrained, techniques can be used to reduce this width. The trade-off is that the works will take longer. During passive construction periods a 3 metre width is required to safely accommodate the open trench.

#### *Potential Effects - Residential Roads*

Effects of trenching and cable laying are generally expected to be local with some impact on intersections with regional arterial roads such as Te Irirangi and Te Rakau Drive.

Through traffic may be affected in some areas where commuters use local roads rather than the main arterials to avoid signalled and/or major intersections at peak hour. Temporary road closures may also be required to all traffic except residential traffic on a section of Point View Drive and Caldwell's Road (formed road).

The works will disrupt some bus services, although these effects will be minimised through discussions with the service operator.

#### *Mitigation Measures*

Effects on through traffic can generally be managed through implementing the following measures:

- Local detours via adjacent roads to facilitate diversionary routes whilst some intersections are temporarily closed during active construction periods.
- Information boards providing advanced notification of the works start date and expected duration.
- Plating over the trench will facilitate access during passive construction periods.
- At all times during construction the contractor will be required to comply with the guidelines regarding traffic safety and safe management on the road in accordance with the Code of Practice for Temporary Traffic Management (COPTTM).

Effects on bus services can generally be managed through implementing the following measures:

- Plating over the trench to facilitate access during passive construction periods to accommodate traffic including the bus route.
- Temporary local re-routing of some bus stops and short sections of routes during the construction period. This will be undertaken in conjunction with the Bus Operator.

Effects on local residents due to a road closure can be alleviated through information signage and mail drops clearly identifying diversion routes. This will be part of the construction management plan.

#### *Potential Effects – Rural Roads*

Effects of trenching and cable laying are generally expected to be local with some impact on intersections with roads such as Whitford Park Road and Sandstone Road. Traffic effects will be localised but the temporary loss of the passing lane could result in minor delays as faster vehicles will not be able to overtake slower-moving heavy vehicles on the climbing sections of Sandstone road.

Temporary road closures may also be required to all traffic except residential traffic on part of the length of Brownhill Road. Heavy agricultural machinery and the movement of livestock may need to be accommodated.

#### *Mitigation Measures*

Weekend only working will be undertaken at these sites, as the weekend is the period with the lowest traffic flows.

Effects on through traffic can be managed through implementing the following measures:

- Local detours via adjacent roads to facilitate diversionary routes whilst the intersections are temporarily closed during construction periods.
- Information boards providing advanced notification of the works start date and expected duration.
- At both Springs Road intersection and Te Irirangi Drive, north and southbound traffic movements will be maintained through a temporary contraflow system.
- At all times during construction the contractor will be required to comply with the guidelines regarding traffic safety and safe management on the road in accordance with the Code of Practice for Temporary Traffic Management (COPTTM).

Effects on local residents due to a road closure can be alleviated through information signage and mail drops clearly identifying diversion routes. This will be part of the construction management plan.

## **6.2 Property access**

#### *Description*

The installation of the cable will involve trenching adjacent to property frontages and driveways.

#### *Potential Effects*

The installation of the cable has the potential to physically restrict access to residences and businesses due to the location of the cable trench in the road adjacent to a property and the use of equipment and machinery.

Point View Drive and Caldwell's Road may have to be closed to all traffic except residents during the construction along this length.

#### *Mitigation Measures*

In general, the effects of the trenching required for the placement of the underground cable will include measures such as:

- Scheduling work to minimise disruption to residents and business during active construction periods (i.e.: during excavation, cable laying etc).
- Liaison will be undertaken with local residents to minimise the effects on the community due to disrupted access.
- Plating over trenches will facilitate access during passive construction periods (i.e.: where no works are taking place but the trench is still open).
- At some locations temporary traffic control will be required. It is considered that stop/go controls or temporary traffic signals will be sufficient to accommodate traffic in most locations.
- Where traffic management outlined above is not appropriate, local deviations via adjacent roads will facilitate diversionary routes.
- Adjacent landowners and occupiers of properties affected by construction will be notified in advance to allow for alternative plans to be made

At all times during construction the contractor will be expected to comply with the guidelines regarding traffic safety and safe management on the road in accordance with the Code of Practice for Temporary Traffic Management (COPTTM).

## 6.3 Noise

#### *Description*

There will be noise associated with the machinery required to install the cable. Noise during installation will be primarily associated with excavation, heavy vehicles, and other traffic movements.

#### *Potential Effects*

The use of large machinery on the site may produce a noise nuisance effect on nearby properties if continued for long periods of time. Residential properties can be especially sensitive to prolonged or excessive noise. Because of the limited time at which construction will occur at each location, the controls upon construction noise set out in NZS 6803:1999 Acoustics – Construction Noise will ensure that any such noise nuisance is minor. It should be noted that the cable installation activities will be of a temporary nature.

#### *Mitigation Measures*

The effects of construction noise can be adequately mitigated through the implementation of the construction management plan. The measures proposed in the Plan will be designed and managed to ensure compliance with the procedures and limits set out in NZS 6803:1999 being the New Zealand Standard for Acoustics – Construction Noise and as required under Rule 5.18.3.6 of the Manukau District Plan (MDP).

The construction management plan will include such measures as:

- Limits on hours of potentially noisy operations
- Review requirements of NZS 6803:1999 Acoustics – Construction Noise and any other relevant noise performance standards.
- Identification of assessment locations where compliance with the noise limits is required.
- Review of the proposed noise sources.
- Design of noise mitigation treatment as may be required for locations and construction activities.
- Consultation with residents.
- Monitoring and reporting of construction noise levels.
- Investigation and mitigation of any specific activities or response to complaints.
- Establishment of a programme to inspect houses and measure vibration to address the issue of ground vibration (see 6.4 Vibration, below).

## 6.4 Vibration

### *Description*

Road opening and earthwork activities prior to the installation of the cable may result in some vibration.

Rule 5.18.4.1 of the Manukau District Plan states that activities should not create vibration that exceed specified levels and that measurements should be at the boundaries of residentially zoned land. However, these standards apply to permanent or on-going vibration levels and are significantly lower than vibration levels that can be tolerated for relatively short construction periods.

### *Potential Effects*

The use of large machinery may produce a vibration nuisance effect on nearby properties if continued for long periods of time. Vibration can cause complex sensations depending on the severity and location which may cause discomfort or annoyance.

### *Mitigation Measures*

Vibration effects will therefore be adequately mitigated through the implementation of a Construction Management Plan. The Plan will include such measures as:

- Limits on hours of operations where vibration causing machinery is used
- Identification of assessment locations where compliance with the vibration limits, discussed below, is required
- Review of the proposed vibration sources and avoidance of use of equipment that produces excessive or unnecessary vibration
- Consultation with residents, including advising residents of any upcoming periods of potential vibration effects.
- Monitoring and reporting of vibration levels at affected buildings.
- Investigation and mitigation of any specific activities or response to complaints.

- Establishment of a programme to inspect houses and measure vibration to address the issue of ground vibration.

In the absence of a specific requirement for construction vibration, it is appropriate to adopt the best practicable option to avoid, remedy or mitigate any adverse effect of vibration. For transient construction activities, vibration criteria should be based on the avoidance of damage to any buildings adjacent to the demolition and construction sites. In the absence of an appropriate New Zealand standard, it is recommended that the German Standard DIN 4150 be used. The structural damage criteria specified by DIN 4150 are presented in the following Table. The location of measurements is to be identified, in accordance with the Standard prior to commencement of construction, and measures will be incorporated in the Construction Management Plan.

Type of building	Vibration limit (PPV)
Industrial buildings, concrete buildings	20mm/s
Dwellings	5mm/s
Other buildings, including buildings of historical value	3mm/s

## 6.5 Dust

### *Description*

Earthworks associated with the excavation of the underground cable trench and the transportation of material to and from the working site have the potential to generate dust.

There are two effects that can potentially arise from the dust emissions generated by the proposed works. Firstly there is potential for public health issues from fine particulate matter which are small enough to be inhaled (<10 micrometers in diameter). Fine particulate is the term used to describe the dust that does not fall from the air at any significant rate. It can be breathed into the lungs and has the potential at high concentrations to cause pulmonary health effects.

Secondly, heavier particulate (>20 micrometers in diameter) falls from the air at an appreciable rate and can cause nuisance effects. Nuisance effects include settling on windows, cars and other flat surfaces.

### *Potential Effects*

Activities involved in breaking up the road surface and other hard material such as drilling, jack hammering, rock-breaking, diamond-blade saw, have the potential to generate dust which may effect the surrounding environment. There is the potential that dust may effect the operation of adjacent roads, and be an irritant to occupiers of adjacent properties.

### *Mitigation Measures*

Material excavated from the trench will be completely removed from the site. Apart from topsoil and surface rock, excavated material will not be reused on the project.

The roadway or ground adjoining the trench will be cleaned of any debris spillage as the excavation progresses. At the end of each working day all paved surfaces comprising the work site will be left in a swept state.

During construction, appropriate dust management measures will be put in place through the implementation of a construction management plan.

Following completion of the works, any exposed soil will be re-grassed to mitigate the effects of dust and runoff.

## 6.6 Existing utilities

### *Description*

The proposed underground cable route will be located in legal road for much of its length. Existing network utility services are already located within these roads. These services include gas, water, wastewater and stormwater lines and telecommunication cables. Although every attempt has been made to map the position of network utilities, the actual location of some utilities may vary from the information provided.

### *Potential Effects*

The installation of the underground cable has the potential to damage existing network utility services or interfere with or disrupt their operation. This would generally be the result of uncovering services in locations previously unknown.

### *Mitigation Measures*

Prior to excavation commencing, guidelines and protocols with regard to specific location of utilities and acceptable separations distances will be established with the network utility operators of existing services. These guidelines and protocols will be included in a construction management plan.

Also prior to any excavation works commencing (and this includes trial holing), the contractor shall contact the utility operators to obtain all the most up to date and relevant plans showing the location of existing services. The contractor will be responsible for locating all utilities detailed prior to trenching and instigate measures to protect any services exposed throughout the period of works.

Where existing services are encountered, the cables will be installed beneath these with a mutually agreed minimum separation where practicable. If this clearance cannot be achieved, further discussions will be initiated to identify and decide upon other protection measures.

Where the cable routes intersect with major assets of other utility operators, care will be taken when excavating around these and it is anticipated that these areas may be hand dug. Suitable measures will be taken to ensure that the services are adequately supported once exposed and undermined.

While every effort will be made to avoid damage to existing services, should accidental damage occur, the contractor would be required to expedite repairs in consultation with the owner of the service. In particular, should a supply to individual premises be accidentally damaged, the contractor will use their best endeavours to ensure that service is restored as a priority on the same day.

## 6.7 Stormwater management areas

### *Description*

The underground cable route to Pakuranga passes adjacent to a stormwater management area west of Te Irirangi Drive and south of “The Hub” commercial business area. In addition, the cable route passes through what appears to be a stormwater management area south of the Pakuranga Substation site, even though it is not identified as such in the MDP. Although not identified in Planning Maps, the area it appears to form part of the stormwater management area (identified in the Plan) to the south west of the cable route. The stormwater management area is a man-made area to detain stormwater flows within a modified gully/stream area. The method proposed by Transpower for cable installation adjacent to the stormwater management area is open trenching.

### *Potential Effects*

The Stormwater Management Area serves a large stormwater catchment and the amount of flow during a storm event is expected to be significant. The construction involving open trenching and cable installation in the south of “The Hub” area is not within the stormwater detention ponds but closer to the road/footpath area. However, the construction may potentially have an effect on the functionality of the area during a storm or heavy rainfall event. These potential effects can be summarised as follow:

- Obstruction of stormwater runoff during a heavy rainfall event causing flooding.
- Dewatering of trenches could result in the discharge of sediments into downstream watercourses.
- Any spillage of fuel and oil from machinery or storage tanks could contaminate downstream water courses if it reaches the stormwater ponds.

### *Mitigation Measures*

The potential effects of the proposed activities on the Stormwater Management Areas will be avoided, remedied or mitigated through the preparation and implementation of the construction management plan. The plan will include the following measures:

- Undertaking a comprehensive geotechnical investigation prior to construction to determine the ground conditions, the levels of underground water and identify any stability issues.
- Identifying the need for any dewatering activities and determine the discharge points and undertaking the necessary measure to mitigate erosion.
- Compliance with the conditions of resource consents required for working adjacent to and within stormwater management areas.
- Provide alternative and adequate channels that can accommodate the flows during a heavy rainfall event where there is the potential for existing channels or watercourses to be affected or blocked temporarily by any works.
- Carry out all erosion protection measures and sediment control in accordance with ARC Technical Paper (TP 90), and with any other conditions imposed by resource consents.
- Activities within the stormwater management area as far as practicable, will be carried out in the dry season to avoid any adverse impacts on these areas and their functionality.
- Works to be programmed to involve the minimum practicable duration.

- Proper and timely reinstatement procedures that include backfilling, compaction and plantation to help in minimising erosion.
- Environmental Emergency Response Plan to deal with fuel or oil spills from machinery. The provision of any storage facilities for fuel and oils within the stormwater management areas shall be avoided.
- Require that following completion of construction activities any temporary obstruction or structures that were installed during construction are removed and the site reinstated to its original condition.

## 6.8 Land stability and erosion

### *Description*

This issue applies only to Option 2 – Between the Brownhill Road transition station/substation and land up to, and along Regis Lane

Preliminary geotechnical investigations have been undertaken in respect of this area. The region is part of the South Auckland Landslide Zone and evidence of past instability is widespread on the moderate and steep slopes of the area. From the substation site a possible route that avoids steep and unstable slopes is an east/west spur. The spur is relatively narrow in places and flanked by instability with moderate to steep section near the crest at Regis Lane. Construction of a corridor capable of carrying the 220kV circuits is will be feasible only if there are earthworks and sufficient retaining structures to construct a corridor of suitable width.

The spur route for the 220kV circuits will require construction of a bench around a high point 300 metres east of Redoubt Road and the high point where the spur connects to the Redoubt Road ridge. The benches will most likely require retaining structures of heights of 2 metres to 3 metres and in the order of approximately 100 metres long. Retaining may also be required along short sections of the main ridge to where the Redoubt Road extension is planned, where the ridge is particularly narrow.

### *Potential Effects*

The installation of the underground cable in areas outside legal road could impact on the stability of land and result in the discharge of sediment into water courses. Retaining walls may have a visual impact.

### *Mitigation*

The implementation of the construction management plan will ensure that any impacts on land stability are avoided, remedied, or mitigated. Measures could include:

- Temporary slope cut support
- Permanent benches and retaining wall structures.
- Control of groundwater in the trenches (such as barriers) may be required to prevent water tracking along the trenches, and management of construction area runoff.

## 6.9 Recreation

### *Description*

The main part of the route of the proposed underground cable will be within legal road. However, the route does cross two small areas of public open space located between Pakuranga Substation and the end of Dunvegan Rise. This area is zoned Public Open Space 2 in the MDP and is intended to be used for passive outdoor informal recreation such as walking, resting, picnicking, enjoying nature or jogging. The cable is also proposed to be located along Caldwell's Road adjacent to Point View Reserve which is zoned Public Open MDP planning maps around the Guys Road area.

Brownhill Road has some informal and low-key recreational use.

### *Potential Effects*

Any disruption to recreational users of open space areas affected by the installation of the underground cable will be of a temporary nature. All areas will be appropriately re-instated, re-grassed and re-vegetated. Once the cable is installed, there will be no ongoing effects on recreation users.

Public information and liaison is an essential part of the construction management plan.

### *Mitigation*

The construction management plan will include a plan demonstrating how the open space areas on the entrance to the Pakuranga Substation, in the Dannemora residential area and at Point View Reserve will be re-vegetated. All affected car parks, fencing street furniture etc will be replaced, reformed and sealed to their original standard or better.

## 6.10 Tangata whenua

### *Description*

The route contains no sites of significance to Maori that have been identified in the MDP directly within the route alignment. The archaeological assessment of the proposed route identified that as the route is mostly within roads that have a number of services beneath them, it is unlikely that archaeological evidence either exists or would have survived the road construction process. However, the possibility of uncovering archaeological evidence can not be overlooked on open ground/undeveloped land.

### *Potential Effects*

During the works associated with the excavation of the cable trench, there is the possibility that some form of archaeological evidence may be uncovered. Appropriate procedures and protocols will be put in place through the construction management plan to ensure compliance with the Historic Places Act 1993 and any other necessary requirements.

### *Mitigation Measures*

Should any archaeological remains such as shell, middens, ovens, burials, or occupation evidence be uncovered during construction, an authority is required under the Historic Places Act to damage, modify or destroy any archaeological site. In cultural terms, any excavation work in the area will be undertaken in conjunction with the terms of the agreed project protocols, this is particularly so in respect of the possibility of uncovering koiwi or skeletal remains. The protocol requires the cessation of work in the vicinity of any such find and an archaeologist and identified Iwi representative will be contacted as soon as practicable so that the

remains can be examined, recorded and handled appropriately. Archaeological finds of any type also fall within the responsibility of the project archaeologist and iwi representative for recording and recovery purposes where appropriate.

## 6.11 Ecology

### 6.11.1 Terrestrial Ecology

#### *Description of the Environment*

The majority of the proposed cable alignments are within the highly modified environment of formed road reserve, in both urban and rural areas. The alignment does cross outside of road reserve in a number of locations. These environments outside of road reserve are described below:

The alignment climbs paddocks between Brown Hill Road and Regis Lane, which are currently managed in agricultural land use. This area is predominantly pastoral in nature, however the alignment also passes an area where production pine forestry has been clear-felled and a small patch of indigenous vegetation remains.

Another area of pasture is crossed between Regis Lane and Ormiston Road.

The alignment runs within the unformed section of Caldwell's Road, which is primarily pastoral land use and plantation pine forestry. Patches of indigenous vegetation are located in the wider vicinity, however only limited amounts of indigenous vegetation are located within the proposed alignment. The alignment also requires a crossing of the Maungamaungaroa Stream. The Maungamaungaroa Stream in the vicinity of the proposed crossing features a broad margin of mature indigenous riparian forest vegetation with an established structure of ground cover, understorey and canopy species present. This riparian vegetation is fenced to exclude stock.

The alignment descends across privately owned land between Point View Drive and Dunvegan Rise. This area is in 'lifestyle' land use, and is a matrix of pasture and fenced revegetation.

The alignment then passes within road reserve and within (and above) an underground tunnel, before emerging at the Pakuranga Substation site. Vegetation in the vicinity of the alignment at the Pakuranga Substation site is predominantly an expanse of mown lawn.

#### *Potential Effects*

The stretch of the alignment between Point View Drive and Dunvegan Rise is expected to involve the removal of approximately a 20 metre wide section of the revegetated area, disturbance to the small stream / wet area and alteration to the structure of the constructed stormwater channel, located in the lower extent of this area. The indigenous component of the revegetated area is predominantly broadleaf shrubs, but also features cabbage trees (*Cordyline australis*) tree fern spp. and toetoe (*Cortaderia sp.*) in relatively high numbers. The exotic component of this block is comprised of common adventive weed species such as blackberry and gorse. Mature crack willow (*Salix fragilis*) are also present on the margin of the stream / wet area.

The alignment climbs steeply from the Maungamaungaroa Stream to a plateau and hill-slope beyond and then ascends to the formed area of Caldwell's Road. While the proposed alignment passes predominantly within the pine plantation, fringes of indigenous vegetation fall within the alignment, particularly the stretch of the alignment on the upper slope near the formed portion of Caldwell's Road. It is expected that installation of the

cable in this stretch of the alignment will involve removal of up to a 20 metre wide section of *pinus radiata*, along with some indigenous vegetation which has colonised pine canopy gaps and the margin of the pine plantation with the adjacent Point View Reserve. A limited diversity of indigenous plant species are present such as several mid-aged totara trees (*Podocarpus totara*) and manuka (*Leptospermum ericoides*) and kanuka (*Leptospermum scoparium*) individuals. Understorey species include red matipo (*Myrsine australis*), mahoe (*Melicactus ramiflorus*) tree fern spp., and *Clematis* sp. Exotic understorey species within the alignment are dominated by an abundance of flannel weed (*Solanum mauritianum*) and mature gorse. The consequences of the vegetation disturbance at Caldwell's Road is expected to be localised changes in patch structure and function, and slight reduction of ecological connectivity at the landscape scale.

It is expected that the alignment in the vicinity of the formed area of Caldwell's Road (near the intersection with Point View Drive) will require the removal of some vegetation within Point View Reserve to the south side of Caldwell's Road. While this vegetation is mainly of indigenous composition, it is located at the margin of the reserve and involves relatively disturbed characteristics typical of a road-side environment.

Further to the north-west the alignment crosses the Maungamaungaroa Stream. Two methods of stream crossing are possible, and the actual method will be decided by the contractor responsible for the works and any resource consent limitations. It is likely that up to a 20 metres wide section of the riparian vegetation will be cleared, resulting in a reduction in the current riparian benefits in this discrete length of the stream.

The stretch of the alignment within the unformed area of Caldwell's Road, at a point approximately 50 metres to the east of the Maungamaungaroa Stream, crosses from pasture into an area of mixed indigenous / exotic vegetation. It is anticipated that an area of vegetation clearance 20 metres wide through this area will be required during the installation of the proposed underground cable. The indigenous component of the vegetation affected by the alignment comprises a single mature Totara tree (*Podocarpus Totara*) along with kanuka-broadleaf scrub in low densities. These indigenous species are in relatively low densities in comparison to the exotic species present, which are most notably gorse (*Ulex europaeus*) and blackberry (*Rubus fruticosus*) distributed amongst large grass clearings.

The alignment in this area also crosses in the vicinity of a small unfenced isolated patch of indigenous forest below the ridge line of Regis Lane which is identified in Figure 12A.2 of the MDP as "native bush to be protected". It is not clear at this stage how much (if any) of this small patch will be affected by the alignment. However any effects to the patch will be mitigated as described below.

#### *Mitigation Measures*

The following measures are proposed to reduce the extent of vegetation clearance and disturbance to terrestrial ecology:

- Defining all construction site boundaries clearly on the ground to limit any potential for unnecessary disturbance beyond the defined construction zone;
- Minimisation of (as far as practical) disturbance to the small patch of indigenous forest located below Regis Lane;
- Replanting of (as far as practical) any indigenous plant species removed from the small patch of indigenous forest below Regis Lane;
- Minimisation of (as far as practical) vegetation clearance in the areas of Caldwell's Road (formed and unformed sections) and the revegetated block located between Point View Drive and Dunvegan Rise;

- Replanting of (as far as practical) indigenous plant species removed from the areas of Caldwell's Road (formed and unformed sections, including the riparian vegetation at Maungamaungaroa Stream) and the revegetated block located between Point View Drive and Dunvegan Rise; and
- Ensuring that all areas of soil disturbed by works adjacent to streams are stabilised by planting with appropriate species on completion of the works.

The construction management plan will include these mitigation measures, along with a vegetation restoration plan and programme.

### 6.11.2 Aquatic Ecology

#### *Description of the environment*

Between Pakuranga Substation site and the Mangemangeroa Stream crossing the route crosses two minor watercourses (see section 5.9 of this report). Nothing is known of the values of these areas but they are expected to be low.

The Mangemangeroa Stream crossing on Caldwell's Road has higher values.

The stream in this area has a width of approximately 1.5 to 3.0 metres and an approximate average depth of 0.3 to 0.6 metres. The reach of the stream features a variety of aquatic habitats with pools and riffles present. Banded kokopu (*Galaxius fasciatus*) are noted as being present in the reach of the stream subject to the crossing with the cable. This stream environment benefits from its mature indigenous riparian vegetation.

Further south, the Turanga Creek Catchment originates on steep hill country in the south and flows in a general northern direction, eventually forming part of the ecologically significant Mangemangeroa Creek/Turanga Creek/Waikopua Creek estuary complex. The temporary streams crossed by the cable alignment above the Brownhill Road transition / substation site are pastoral in nature. The watercourses are heavily modified, are accessible to stock and have little natural character. No significant riparian vegetation is present.

In one location on Brownhill Road, approximately 300 metres north east of the road bridge crossing over the Turanga Creek, the designation is in close proximity to the Turanga Creek. The Creek is relatively modified habitat.

Further west the Turanga Creek in the vicinity of the cable crossing at the existing road bridge, has an approximate width of 2.0 to 3.0 metres and an approximate depth of 0.5 to 1.5 metres. The Creek has a 'U' shaped channel and has a soft bed, comprising of fine silts and clays. Limited quantities of macrophytes and algae are present. Several small unidentified bully spp. were noted as being present during a site visit. The Creek features a variety of pool and riffle habitats and benefits from semi-continuous riparian vegetation cover, largely comprising crack willows and poplar trees.

#### *Potential Effects*

There are basically three types of potential effects on aquatic habitat that can result in effects on aquatic ecology. Firstly, removal of riparian vegetation can expose waterways to direct sunlight, affecting temperature and the growth environment of plants, with a knock-on effect on habitat for aquatic fauna. Secondly, disturbance of the channel and banks of a stream causes sedimentation, with both short and longer term effects on habitat. Thirdly, structures affect the nature of the substrate and can affect fish passage. This latter effect will be avoided in the design of any structures in stream beds.

The main waterway crossings are now discussed in terms of the first two effects.

### 1. Pakuranga Creek Crossing Near Ti Rakau Drive

#### *Potential Adverse Effects on Riparian Vegetation*

The cable installation is likely to affect a small area of vegetation. Given the early stage of advancement of planted riparian vegetation, and the isolated position of the limited mature riparian vegetation affected, any adverse effects to riparian vegetation are expected to be minor.

#### *Potential Adverse Effects on Water Quality and Aquatic Ecology*

Trenching across the bed of the waterway will release sediments into the water column causing a reduction in water clarity within the ponding area. The stormwater retention area is significantly modified and is subject to periodic inundation during heavy rainfall when high suspended sediment concentrations are experienced and significant sediment deposition occurs on the waterway bed. Further, as trenching will not be carried out during high flows, when the stand pipe is overtopping, it is anticipated that no sediment laden discharge will migrate from the ponding area to downstream environments. Any aquatic biota present in this area will have adjusted to local conditions and can be expected to be relatively tolerant of short-term disturbances. Thus any potential adverse effects to water quality and aquatic ecology are expected to be minor.

### 2. Unnamed Waterway and Stormwater Channel Crossing Between Point View Drive and Dunvegan Rise

#### *Potential Adverse Effects on Riparian Vegetation*

There will be some vegetation removal along the alignment of the unnamed stream.

No significant riparian vegetation is present at the formed stormwater channel in the vicinity of the point of intersection with the cable route.

#### *Potential Adverse Effects on Water Quality and Aquatic Ecology*

Trenching along the bed of the waterway would release sediment into the water column, causing a reduction in water clarity and an increased rate of sediment deposition in aquatic environments downstream of the area of works. Given the position high in the catchment, the lack of diverse aquatic habitat due to the limited water body size and limited flows, the waterway is expected to support only a very minor diversity of aquatic species. Immediately downstream of the waterway flows enter a culverted / piped reticulation network, again reducing the ecological sensitivity of the waterway downstream of the site, thereby reducing the potential for adverse effects to aquatic ecology downstream of the site.

The crossing of the stormwater channel by the cable route is expected to result in short-term trenching within the channel. This may temporarily result in sediments entrained in flows entering downstream aquatic environments. The water body immediately downstream of the point of intersection undergoes transition into a culverted / piped reticulation network.

### 3. Mangemangeroa Stream Crossing on Caldwell's Road

#### *Potential Adverse Effects on Riparian Vegetation*

Both options of construction methodology will involve a degree of physical disturbance to riparian vegetation.

It is expected that up to a 20 metre wide area of riparian vegetation will be cleared for the installation of the cables.

#### *Potential Adverse Effects on Water Quality and Aquatic Ecology*

Both options of construction methods will involve a degree of physical disturbance to the stream bed. It is expected that a coffer dam (or similar dam structure) will be used, as appropriate, to isolate the trench from the stream flow during excavation and cable installation so that the excavations can be carried out in dry conditions, minimising the potential for sediments to enter the water column. It is expected that in-stream works will be of no more than 5 days in duration.

Trenching across the bed of the stream and on the stream banks may nevertheless potentially release sediment into the water column, causing a temporary reduction in water clarity and an increased rate of sediment deposition on the stream / creek bed downstream of the works. High sediment concentrations can potentially have a range of adverse effects on fish and other aquatic biota. The banded kokopu, which has been recorded in the Maungamaungaroa Stream / Creek, is particularly sensitive to suspended solids concentrations and its juvenile migratory stage fish, which migrates upstream mainly between September and November, is known to avoid high turbidity levels. Other fish species known in the Creek such as the eel spp are far less sensitive to suspended solids. It is not known which, if any, of these species are present in the reach of the stream in the vicinity of the proposed crossing.

### 4. Turanga Creek Catchment

#### *Potential Adverse Effects on Riparian Vegetation*

No significant riparian vegetation is present, and therefore none will be affected by the cable installation in the easternmost temporary stream cable crossing below Regis Lane. It is also anticipated that this would be the case with western-most stream.

It is anticipated that the Turanga Creek will be crossed in the area immediately upstream of the existing road access bridge serving the Brownhill Road transition / substation site. Current riparian vegetation is not of a high ecological benefit, and any minor benefits can be restored through site reinstatement on completion of cable installation works.

#### *Potential Adverse Effects on Water Quality and Aquatic Ecology*

Given the degraded nature of the temporary streams crossed by the cable routes, and the expectation that trenching works would be carried out in late summer when flows are at minimum levels, it is expected that the potential for adverse effects on water quality and aquatic environments in these streams arising from the cable installations will be minor.

The cable crossing of the Turanga Creek would be managed to minimise the potential for adverse effects as far as possible. Dewatering of the area of works will minimise the potential for adverse effects to occur from the

potential release of sediment into the water column, which would cause a reduction in water clarity and an increased rate of sediment deposition on the Creek bed downstream of the works.

Both options of construction methods will inherently involve a degree of physical disturbance to the stream bed, although the potential ecological impacts from the option involving installation of a new bridge and attachment of the cables to the bridge to achieve the stream crossing are likely to be limited to those effects associated with the construction of the bridge, such as removal and installation of bridge abutments.

The actual extent of disturbance to the benthic environment would depend on the design of the bridge. It is expected that a coffer dam (or similar dam structure) will be used, as appropriate, to isolate the area of works from the stream flow during construction. It is expected that the stream would only need to be partly dewatered, one abutment at a time, for these works.

If installation of the cable in a pipe embedded in the stream bed is the option used, it is also expected that a dam structure would be used, to isolate the trench from the stream flow during excavation and cable installation. Due to the narrow width of the stream, it is anticipated that the stream will need to be dammed and the stream flow diverted around the area of works to allow, as far as practical, the excavations to be carried out in dry conditions, minimising the potential for sediments to enter the water column. It is expected that in-stream works will be of no more than 5 days in duration.

The works may temporarily cause a reduction in water clarity and an increased rate of sediment deposition on the creek bed downstream of the works. As with disturbance to the Mangemangeroa Stream noted earlier, there is the potential to affect the banded kokopu, which has been recorded in the Turanga Creek. Other fish species such as eel species are far less sensitive to suspended solids and will not therefore be affected if they are present.

### *Mitigation*

The following measures are proposed to mitigate potential adverse effects on water quality and aquatic ecology:

- That the in-stream works are limited to a short period during late summer,
- That the in-stream works are limited to a duration of no more than 5 days,
- That stream diversion in the Turanga Creek and Mangemangeroa Stream is maintained to protect the aquatic environment downstream of the dam and the area works,
- That the need for machinery or vehicles to cross the water course is minimised,
- That stormwater is properly controlled so as to minimise the transport of suspended sediment from areas of disturbed soil into waterways,
- That sediment traps will be installed and maintained down stream of the area of in stream works to effectively control sediments potentially discharged to the water column, and
- That all areas of soil disturbed that are adjacent to waterways should be stabilised by planting with appropriate species on completion of the works.

The construction management plan will include these mitigation measures. The plan will also include a Vegetation Restoration Plan. These measures may also be incorporated as conditions of ARC consents.

## 6.12 Heritage

### *Description*

An archaeological and historical assessment of the proposed underground cable route was undertaken during consultation between October 2006 and January 2007. There are no heritage sites or landforms identified along the cable route within the MDP.

A description of the findings of the survey is included in section 5.8 of this report.

### *Potential Effects*

The archaeological assessment noted that the majority of the underground route is within formed roads that have a number of services already contained beneath them. It is unlikely that archaeological evidence remains beneath the formed roads. Should any have survived construction of the road, their values are likely to be compromised. Elsewhere the route proceeds across farmland which is likely to have no or low value archaeological sites in the vicinity (i.e. minor early farming evidence). It seems that the only area where archaeological evidence is likely is within the Point View Reserve area as outlined earlier.

Excavation in sensitive areas close to other archaeological finds may result in the finding and disturbance of unrecorded archaeological sites.

### *Mitigation*

Should any archaeological remains or occupation evidence be uncovered during construction, an authority is required under the HPTA to damage, modify or destroy any archaeological site. This would identify any specific requirements, such as observation and recording to mitigate potential loss of archaeological information.

## 6.13 Contaminated land

### *Description*

A search of the Auckland Regional Council's contaminated land database for private properties crossed by the underground cable to Pakuranga has provided a list of sites adjacent to the underground cable route that have historical pollution incidents tagged to them. No sites were identified as containing 'contaminated land'.

The fact that no sites were found on the database does not mean contamination will not be encountered. A Contaminated Site Management Plan that sets out the procedures and protocols to be followed should any contaminated soil be discovered will therefore be prepared.

### *Potential Effects*

Given that the area affected has recently been subject to significant development and major earthworks, it is unlikely that asbestos containing material is still present along the proposed cable route. However, if there are asbestos particles present, it is possible that earthworks excavations may disturb contaminated soils.

The type and degree of contamination could conceivably create effects on the operation or functionality of some equipment, the health and safety of on-site construction staff, and on nearby residents if the contamination is particulate and able to disperse in the air.

There is no known history of petroleum hydrocarbon contamination along the proposed underground cable route. It is not proposed therefore that soil samples should be obtained and analysed for hydrocarbons, unless indications such as hydrocarbon odour are detected.

#### *Mitigation*

Significant hydrocarbon contamination is typically indicated by a distinctive odour in the exposed soil. Should odorous material be uncovered during excavations will cease and representative samples obtained for analysis. Similarly, if foreign material suspected to contain asbestos (such as asbestos-cement board fragments) is uncovered, samples will be collected and tested in accordance with a method specified by a New Zealand accredited laboratory for the identification of asbestos.

A Contaminated Site Management Plan that sets out the procedures and protocols to be followed should any contaminated soil be discovered along the cable route will be included as part of the construction management plan and for any site remediation that may require ARC consents. The plan will include the following steps:

- Qualitatively assess excavated soils for contamination; indications can include visual observations such as staining or obvious foreign material (e.g. asbestos-cement), or odour.
- Cease excavation work, take samples as noted above and have these analysed by an accredited laboratory for the suspected contaminants.
- Retain and isolate exposed/excavated soil suspected of being contaminated until laboratory results are received.
- If the material is contaminated above Guideline levels, dispose of hazardous waste at approved landfills.
- Replace the excavated contaminated material with clean fill, as necessary.
- Groundwater or stormwater, which may be contaminated by contact with impacted soils, will be retained in a secured area, such as a lined pond. The retained water will be analysed for suspected contaminants; if concentrations are below relevant Guidelines (ANZECC) the water can be disposed to the stormwater system. If contaminants are at or above levels of concern the retained water shall be removed for off-site disposal by a liquid waste disposal contractor.
- At all times isolate site workers from the contaminated material by:
  - removing the material to a dedicated position on site
  - dampening down and/or covering the material until analytical results are received and off-site disposal can be arranged if required
  - ensuring that workers know about the potential risks posed by contact with the material
  - prohibiting eating, drinking or smoking except at designated site locations and following thorough washing of exposed skin.

## 6.14 Clean Fill

#### *Description*

Spoil from cut will be mostly or entirely removed from the site. Topsoil, consistent with MDP requirements, will be retained on or in the vicinity of the site and used for remediation.

#### *Potential Effects*

Spoil removal can involve the effects of dirt, noise, surface water and traffic.

Clean fill is a resource, which may be able to be reused in an appropriate approved off-site location, or disposed of in a cleanfill or landfill.

#### *Mitigation Measures*

Effects associated with the removal of spoil from the site will be avoided, remedied or mitigated through the implementation of the requirements of the construction management plan.

## 6.15 Sediment Control

#### *Description*

Excavation of the cable trench will result in significant lengths of earth being open at any one time and there is the potential for sediment to enter waterways, particularly through runoff.

#### *Potential Effects*

There is the potential for sediment runoff to enter waterways and stormwater networks. Management of such runoff is particularly important given the proximity to watercourses. Increase in sediment is undesirable because it reduces the amount of available oxygen for aquatic life, decreases clarity and results in deposition.

#### *Mitigation*

Appropriate sediment control measures will be put in place during construction through the implementation of the construction management plan. This plan will be prepared to address the effects of site works and demonstrate compliance with the various requirements of Auckland Regional Council with respect to sediment.

Following completion of the works any exposed soil will be re-grassed or otherwise finished to mitigate any effects of dust and runoff.

## 6.16 Landscape and Visual

#### *Description*

Option 1 between the Brownhill Road transition station/substation and Caldwells Road follows a relatively easy grade along road reserve or up a slope over private land to the Regis Lane ridge. The route itself is in pasture, with adjacent areas of pine plantation (including some felled in recent years) on side slopes. The landscape has a mixed use characteristic of lifestyle areas. However, the area around Regis Lane and Redoubt Road is being developed in a comprehensive way with residential development along the ridges and spurs, and restoration of natural vegetation in the intervening valleys. This pattern is likely to continue in the vicinity of the proposed cable route along the main ridge. A similar but less intensive approach has been proposed for the area east of the main ridge.

#### *Potential Effects*

Any landscape and visual effects associated with underground cables are likely to be very minor. The ridge and spur tops are the logical location for such works, reducing the extent of earthworks required, avoiding potentially prominent side cuts, and locating earthworks where there is least potential for erosion and sediment discharge to natural waterways. The width and undulating profiles of the ridges mean earthworks are unlikely to have any noticeable effect on landform. The cable will also follow likely routes for future road access, thereby confining infrastructure to an area likely to be modified.

The main ridge and higher spurs, including those followed by the cable route, are identified in the Manukau District Plan and partly in the proposed Plan Change 8 as sensitive ridgelines. The intention is to manage development on these areas in respect of visual impact. The underground cable will not affect this approach.

#### *Mitigation Measures*

It is not considered any specific mitigation is warranted apart from standard measures for silt control during construction and subsequent re-grassing of surfaces.

### **6.17 Summary of mitigation measures**

Mitigation measures adopted during construction will be dealt within the construction management plan which will include provisions to minimise temporary adverse effects on surrounding activities and the environment, including (but not limited to) dust, noise, traffic, property access, safety, ecological and recreational values, water courses and reserves.

Section 2.5 of this report lists the various aspects which will be included in the construction management plan. A draft Plan will be submitted to Manukau City Council for review. The construction management plan will also address aspects relating to resource consents required from the Auckland Regional Council.

## 7 Assessment of Operational Effects

### 7.1 Electric and magnetic fields

#### *Description*

As discussed in section 13 of Part II and in section 12 of Part X of the Notice of Requirement documentation, transmission conductors in service produce electric and magnetic fields (EMF). Electric fields are a function of the voltage on the conductors, whereas magnetic fields are a function of the current carried by the conductors.

The current is proportional to the load demand and will vary through the day, month and season, with an expected annual increase of maximum load demand of around 2-3%. Consequently the EMF levels will vary in accordance with the load. Daily cycling of this load demand means that under normal and exceptional conditions, peak power is transmitted for approximately 12 hours per day. Average power over a 24-hour cycle is about 80% of peak power of that load cycle.

#### *Potential Effects*

The strength of the electric field at the 220kV cable surface will be immeasurably small because the conductor will be totally enclosed within an earthed metal sheath. Consequently, electric fields are not discussed further in this section.

The magnitude of the magnetic field depends on the following factors:

- Current in the cable;
- The depth of the cable below the ground; and,
- The physical location of the cable with respect to each other (e.g. in flat horizontal formation or triangular, or trefoil, formation.)

Magnetic fields are difficult to screen as the field passes through most natural obstacles. The magnitude of the magnetic field is measured in microtesla and at any point is dependent on the distance from the cable and the amount of electrical current being carried. The magnetic field strength falls quickly as the distance from the cable increases.

#### *Mitigation*

The underground cable section will be designed to ensure that the magnetic fields will be within ICNIRP levels under all normal operating conditions over the life of the project. One measure identified to achieve this is the adoption of the trefoil (triangular) formation and burying the cables at the selected depth, which is deeper than that used for lower voltages. Additionally, its positioning under roads and through open space areas also has the effect of reducing exposure at residences.

## 7.2 Earth potential rise and induced voltage

### *Description*

As discussed in section 14 of Part II of this documentation, underground cables can result in potential effects associated with earth potential rise and induced voltages.

### *Potential Effects*

On extremely rare occasions (perhaps never in the life of the cable) the cable insulation may fail at some location resulting in an electrical fault. For a fraction of a second during the fault, until circuit breakers operate to cut electricity supply from the cable, the earth potential and induced voltage in parallel objects may be raised. The likelihood of this risk arising is greatly reduced by the presence of the cable sheath, which is earthed at selected joint bays and carries the majority of the unbalanced 'return' current under fault conditions. In summary, EPR and induced voltage involve events which are very rare or of low likelihood. In the remote chance that they do occur, the opportunity for any effects to become manifest is momentary (less than a second in duration). Accordingly, it is considered that the risk of effects associated with these phenomena is very low.

### *Mitigation*

The design phase will include a detailed engineering review, in accordance with industry recognised guidelines for infrastructure services located in close proximity to underground cables. In some situations, this work may involve assessment and review of areas of potential risk on land adjacent to the areas where the underground cables are to be installed.

Transpower has commenced a process of liaising with other utilities on this matter and will be providing calculations of possible induced voltages during cable fault conditions for any location of concern. If it is determined that an induced voltage could develop, which could in turn be potentially hazardous to the public or anyone working on another service, action will be taken to reduce the possible risk at that location to non-hazardous levels. Mitigation measures may include but are not limited to:

- Maintaining spatial separation limits between existing services and the 220kV underground cables.
- Providing asphalt or similar high electrical resistance surfaces at such locations.
- Modifications to telecommunications equipment and cables, including replacement of aged cables with modern high insulation strength cables and replacement with optical fibre cables.
- Modifications to gas pipeline access points, including installation of protective earthing conductors
- Modifications to cathodic protection systems.
- Provision of an appropriate education programme to promote safe work practices in the vicinity of the cables.

As every reasonable precaution will be taken to minimise the chance of the public coming into accidental contact with the cable and associated structures, it is anticipated that there will not be any significant risk to public or worker safety as a result of the presence of the high voltage underground cable.

### 7.3 Visual

#### *Description*

Once the cable has been installed it will not be visible. However, evidence of its presence will be observable in terms of pit covers, cable markers and retaining wall structures.

#### *Potential Effects*

Once the cable is installed, there will be no ongoing visual effects from the cable except possibly for the Option 1 retaining structures, which may have a visual impact on the properties east of Regis Lane who have an outlook back to the west. However in the long term, any obvious structures are likely to be obscured by residential development and/or planting.

#### *Mitigation Measures*

Affected groundcover will be reinstated and carriageways and footpaths sealed in accordance with MCC requirements. In reserves and Stormwater Management Areas, vegetation restoration plans and programmes will be implemented. Restoration planting will require careful planning and management to ensure that amenity levels are not compromised, while at the same time mitigating any effects of planting on the underground cable.

### 7.4 Ground conditions and vegetation

#### *Description*

Over the daily load cycle, the cable temperature will rise and fall a few degrees from its average level. The material surrounding the cable will conduct heat from the cable surface to the atmosphere.

A temperature gradient will be established through the ground from near-ambient temperature at the ground surface to a maximum of about 50 to 60 degrees Celsius on the outside of the cable. Ground temperature will not fluctuate significantly during the daily load cycle owing to the time required to heat and cool the ground.

#### *Potential Effects*

Slightly elevated ground temperature can reduce soil moisture in the immediate vicinity of the cable trench. However, the operation of the cable is unlikely to significantly affect surface soil or water conditions. Vegetation should re-establish over the cable route, although Transpower will prevent large trees from becoming established directly over the cable or in any location that might prevent future maintenance access.

#### *Mitigation*

Correct installation techniques, including use of appropriate backfill materials to minimise heating effects in the surrounding soil, will be undertaken by Transpower.

### 7.5 Summary of mitigation measures

Mitigation of the operational effects of the 220kV underground cable is achieved through route selection, design requirements and the imposition of conditions on the designation. As the cable will be placed under the ground there will be no long term visual effects or noise effects.

Mitigation through the construction phase is provided through contract specifications, including a construction management plan, as discussed in section 6.17.

Any potential effects relating to earth potential rise and induced voltage can be addressed through compliance with best practice best practice and Transpower's standards and policies and other industry requirements.

It is considered that any long term adverse effects of the operation of the 220kV underground cable are minor and no ongoing mitigation is required beyond that which is an integral part of the project design and operation.

## 8 Other Effects

### 8.1 Cumulative effects

It is considered that there will be very little on-going or cumulative effects once the cable is in place.

In the short term, there may be a cumulative effect relating to an increase in noise levels and vibration due to the use of heavy machinery. However, these effects will only be temporary (i.e. for the duration of construction) and will be managed through the implementation of the construction management plan.

### 8.2 Positive effects

The installation of the underground cable is an integral part of the North Island Grid Upgrade Project from Whakamaru to Auckland. The upgrade will help to meet the growing demand for electricity in the upper North Island and to ensure that homes and workplaces have a secure electricity supply by the time preliminary works are completed in 2011. The grid upgrade project is nationally significant and will have a range of benefits and positive effects for both the regional and national economy, and as a consequence for the social and cultural well being of the country.

## 9 Consultation

A consultation programme for the underground cable route was undertaken as part of the wider consultation for the amended North Island Grid Upgrade Project. This is described in section 7 of Part II and in section 2 of Part X. A brief outline is provided here.

On the advice of Mikaere and Associates Ltd, Transpower consulted with the following iwi, hapu and organisations.

- Ngai Tai Umupuia, Umupuia Marae;
- Ngati Paoa, Kaiaua Marae;
- Te Aki Tai, Pukaki Marae; and
- Te Ahi Waru, Makaurau Marae.

Iwi representatives have been taken along the route and the sites pointed out and discussed. No issues have subsequently arisen. The conclusion is that all the cultural issues identified during consultations to date and as outlined in submissions have or can be addressed.

Stakeholder and statutory organisations consulted included:

*Utility Operators*  
Watercare Services

Vector  
Natural Gas Corporation

*Statutory Bodies*

Auckland Regional Council  
Manukau City Council  
Department of Conservation  
New Zealand Historic Places Trust

*Others*

Botany Community Board  
Forest and Bird (Northern Office)

Public consultation activities in relation to the underground cable routes were also undertaken, including:

- Customised letters and dedicated information sheets about the proposal for the Pakuranga substation delivered to properties in the vicinity of the existing substation;
- Drop in days six days a week at the Botany Downs Library Friday 27 Oct – Sat 11 Nov 2006
- Website information;
- Address to the Botany Community Board
- Media releases
- Personal one on one meetings with directly affected landowners when requested

Community feedback in the consultation on the cable route options from Brownhill Road to the Pakuranga substation was modest with six submissions received. The topics addressed in the submissions were route selection, construction issues, what was perceived as an abuse of rights; development planning, easement, ecology/environment, and economic effects. Landowners in the section near the Brownhill Road substation were concerned about the impact of the proposal on the development potential their properties.

The consultation on Option 2 running along Brownhill Road-Whitford Park Road-Sandstone Road to Caldwell's Road raised concerns about the impact on Brownhill Road and its subsequent reinstatement. The principal changes to Brownhill Road are the result of the upgrading needed to be able to transport heavy equipment to the substation site. The main impact of cable installation on the road would be in terms of bringing the works forward to about 2009. Consultation is ongoing.

## 10 Conclusion

The installation of the underground cable is an integral part of the North Island Grid Upgrade Project from Whakamaru to Pakuranga (and Otahuhu). The upgrade will help to meet the growing demand for electricity in the upper North Island and to ensure that homes and workplaces have a secure electricity supply by 2013.

The underground cable from the Pakuranga Substation to the Brownhill Substation site is the most suitable option. It is considered that designating the route is the most appropriate method to holistically consider all aspects of the operation and obtain longer-term security to compensate for the large investment involved in the infrastructure upgrade.

The mitigation measures proposed, including the preparation and implementation of a construction management plan, will ensure that any adverse effects are avoided, remedied or mitigated.

## 11 Section 171(1) of the RMA

Section 171(1) of the RMA requires that particular regard must be had to a number of matters when considering a notice of requirement, submissions received on the notice, and the effects on the environment of allowing a requirement. These considerations are subject to Part II of the RMA, which sets out the RMA's purpose and principles. With regard to the section 171(1) matters, the following commentary is provided.

### 11.1 Relevant provisions of plans and policy statements

Given there are no works within the coastal marine area and, given the distance of the route from most of the coastal area, it is considered that the NZCPS has no particular relevance in terms of the Notice of Requirement.

There are no other relevant national policy statements. The provisions of the Hauraki Gulf Marine Park Act 2000 are also not considered to be of particular relevance to this Notice of Requirement because of the mitigation proposed, particularly while working in water courses.

The relevant provisions of the Auckland Regional Policy Statement are set out in section 4 of Part X of the documentation, and it is considered that the proposal is generally in accordance with the objectives and policies that relate to the provision of national and regional infrastructure in the interest of the economic and social wellbeing of people and communities in the regions. Generally, the route has avoided areas that may bring it into conflict with other policy provisions. In summary, the Notice of Requirement for the underground cable between Pakuranga Substation and Brownhill Substation is generally consistent with the relevant rules and standards, and is not inconsistent with the objectives and policies of the relevant parts of the MDP, which are set out in section 5 of part X of the Notice of Requirement documentation.

### 11.2 Consideration of alternatives

As a requiring authority, Transpower is required to consider alternatives in terms of section 171(1) (b) of the RMA as it does not have an interest in all the land affected sufficient for undertaking the work. It is also possible that some effects on the environment could be considered to be significantly adverse at a local level.

As explained in section 4 of this report, numerous alternatives have been considered. Transpower has carried out detailed consideration of alternatives in terms of the potential route options and has considered feedback from consultation. It is considered that alternative sites, routes and methods have been adequately considered, taking into account a range of relevant matters including environmental effects.

### 11.3 Work and designation reasonably necessary to achieve objectives

This aspect is addressed in section 1 of this report (and in Part II as part of the overall project), and it is concluded that both the work and the designation are reasonable for achieving Transpower's objectives.

## 11.4 Other relevant matters

There are no other matters, which are considered reasonably necessary to consider in relation to the Notice of Requirement, other than to emphasise that while components of the entire project are addressed in separate documents because of the legal requirements of the RMA, the entire project is an integrated project. This means that there is a need to consider the Notices of Requirement for all parts of the project together in an integral manner.

## 11.5 Part 2 of the RMA

The purpose and principles of the RMA are set out in Part 2 (sections 5, 6, 7 and 8) of the RMA. The notice of requirement is ultimately required to be consistent with Part 2 of the RMA.

Section 6 of the RMA identifies matters of national importance, which must be recognised and provided for in achieving the purpose of the RMA. Section 6(a) - the preservation of the natural character of the coastal environment, wetlands, lakes and rivers may be relevant to this notice of requirement. The cable route does not traverse the coastal marine area and traverses several small streams under or on other structures already crossing their bed, thereby minimising any impact on the natural character of those watercourses.

It is considered that no issues are raised with regard to section 6(b) – the protection of outstanding natural features and landscapes from inappropriate subdivision, use and development, in that the route is mostly through an urban area and the location of the cable underground will avoid visual effects. The proposal does not affect section 6(c) resources – the protection of areas of significant indigenous vegetation - as only minor removal of vegetation is proposed, there are no significant vegetation or habitats affected by the cable route and revegetation where practicable will be undertaken.

In terms of section 6(d), the route is not located within the coastal environment and therefore does not impact on access to the coastal environment. The choice of the route predominantly along roads and without directly affecting any known archaeological or cultural heritage features ensures that section 6(e) is met. No resources to which section 6(f) – the protection of historic heritage – applies are directly affected, and section 6(g) is not considered relevant in this instance.

The proposal is not inconsistent with other relevant matters in section 7 of the RMA to which particular regard must be had. The proposed archaeological protocol ensures consistency with sections 7(a) and (aa) kaitiakitanga and the ethic of stewardship. Stewardship is also included in the approach to construction management planning and environmental care over that period. Section 7(b) refers to the efficient use and development of natural and physical resources. The underground cable forms an integral part of the transmission link between Whakamaru and Pakuranga (and Otahuhu) and it is Transpower's objective that the link is safe, efficient and consistent with grid reliability standards. In addition, the location of the cable both underground and largely within legal road, which is frequently used as a utility corridor, is considered to be an efficient use of the land and existing physical resources in the vicinity. Due to the nature of the existing environment, and the proposed mitigation measures, it is considered that amenity values and the quality of the environment along the cable route will be maintained, consistent with sections 7(c) and (f).

## 12 Suggested conditions

Proposed restrictions and indicative outline conditions for the 220kV underground cable are set out in this Notice of Requirement. Transpower would wish to discuss further the precise wording of any specific conditions with the Manukau City Council during the processing of this Notice of Requirement.

### 12.1 Proposed restrictions

#### Noise levels:

- Compliance with New Zealand Standard 6803:1999 Acoustics – Construction Work

#### Traffic

- Compliance with Code of Practice for Temporary Traffic Management (COPTTM)

#### Electromagnetic fields:

- Compliance with ICNIRP Guidelines

#### Radio frequency emissions

- Compliance with Radio Frequency Standards – NZS 6869:2004 Limits and Measurement Methods of Electromagnetic Noise from AC Power Systems

#### Vibration

- Compliance with German Standard DIN 4150

### 12.2 Other proposed conditions

- A construction management plan to be provided to Manukau City Council prior to the commencement of any construction, as set out in section 2.5 of this report.
- An accidental discovery protocol for archaeological and cultural sites to be implemented should any sites be uncovered.