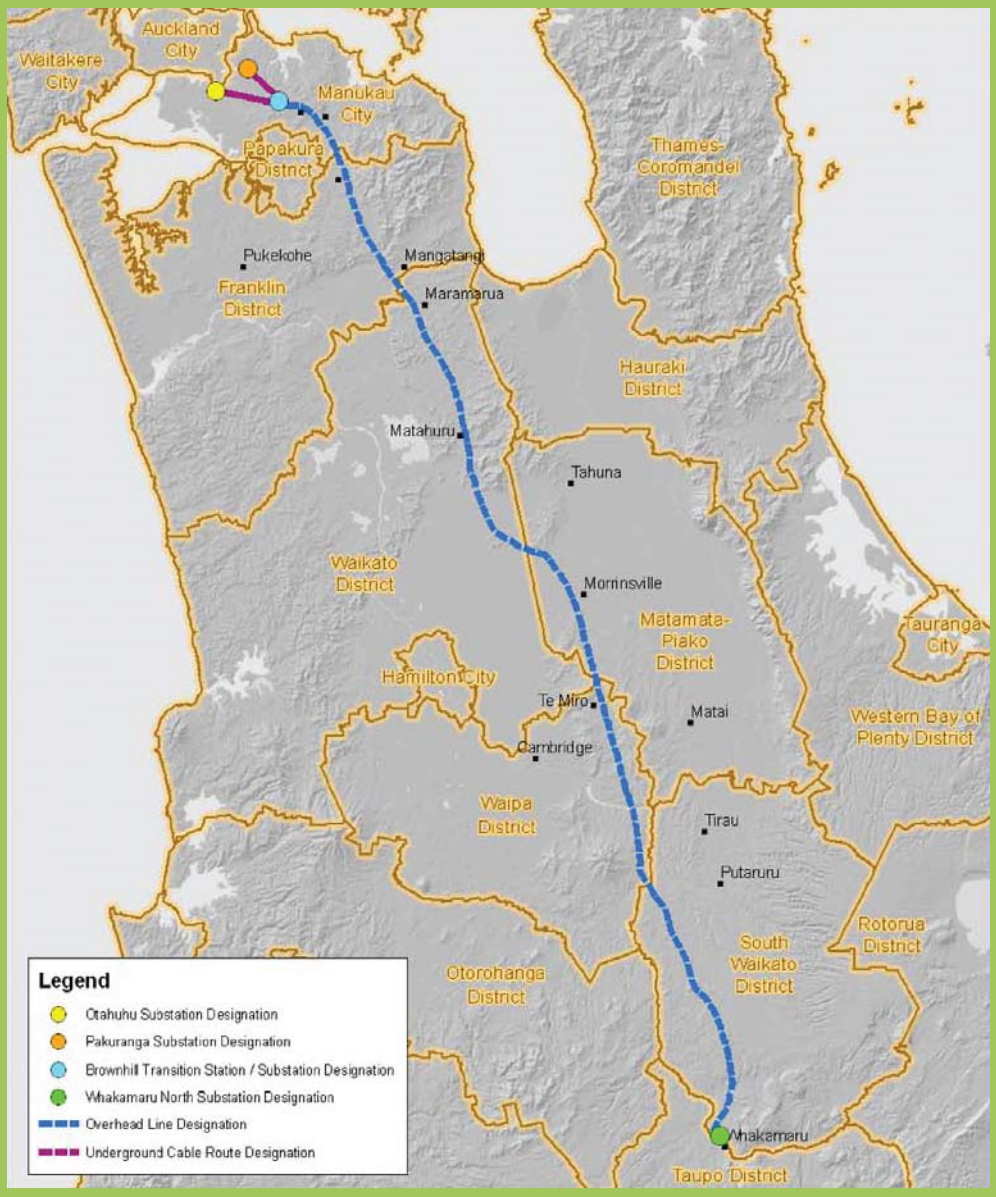
Transpower New Zealand Ltd
North Island Grid Upgrade Project

Notices of Requirement Documentation

Part VII



National Grid Upgrade

TRANSPOWER

KEEPING THE ENERGY FLOWING

PART VII

INFORMATION, DESCRIPTION AND ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

UNDERGROUND CABLE SECTION BROWNHILL TO OTAHUHU

CONTENTS

1. Introduction

1.1 Purpose of this document

Part VII relates to the Notice of Requirement for the 220kV underground cable from the proposed Brownhill Substation/Transition Station to the Otahuhu 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 a new substation and transition station at Brownhill Road to Otahuhu and Pakuranga.

This report has been prepared to support Transpower's Notice of Requirement (NOR) to Manukau City Council (MCC) to designate the 220kV underground cable route to Otahuhu. The route extends from a proposed Substation/Transition Station at Brownhill Road, through the suburbs of Flat Bush, East Tamaki and Otara to the Otahuhu Substation. The location of the proposed underground cable route is shown in Figure 1.1.

The proposed works involve the installation of a 220kV underground double circuit consisting of cables with associated joints, link pits and ancillary equipment. 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 to overhead transmission circuits from the existing urban boundary of Auckland to 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 entire 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.

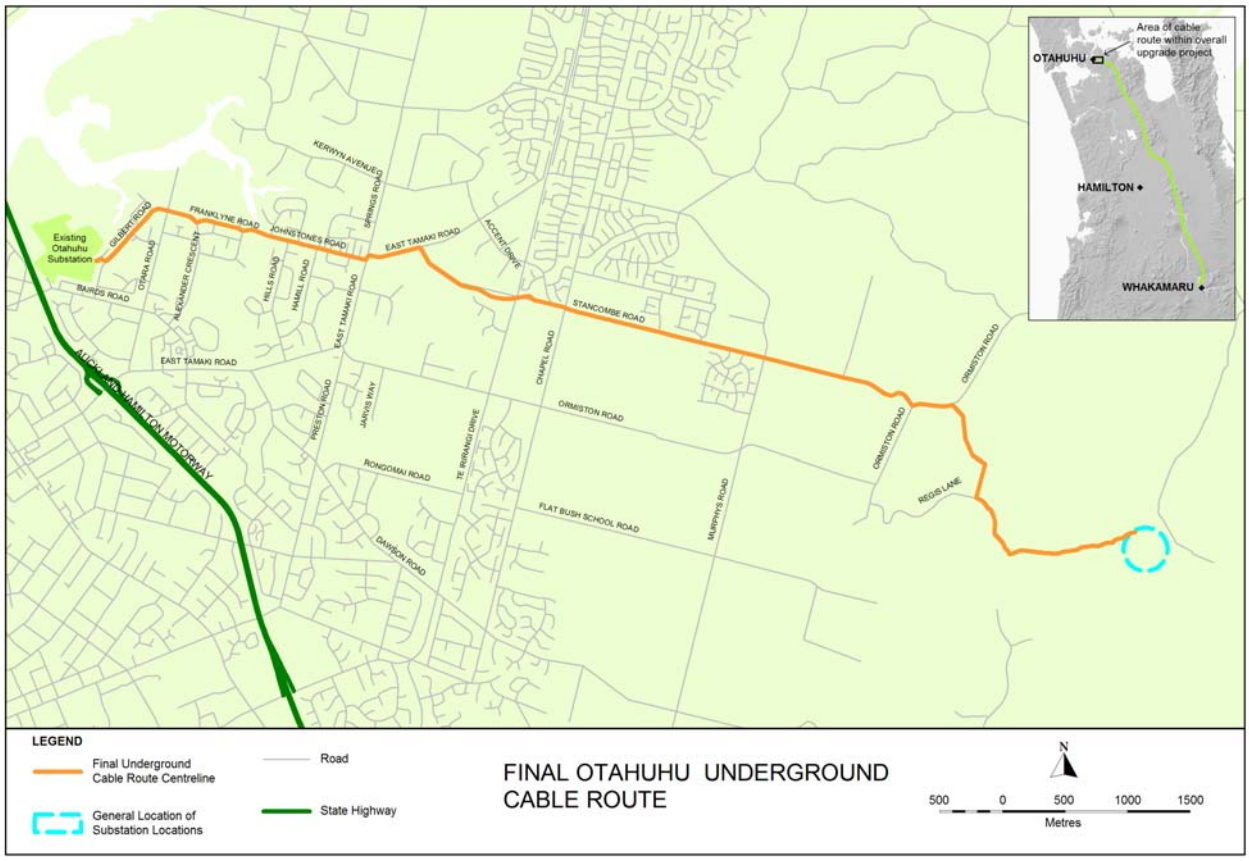


Figure 1.1: Locality Map

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.

1.3 Route location

The underground portion of the route is located entirely within Manukau City. The preferred option that the route investigation process identified exits the site of the existing Otahuhu Substation at Kaitawa Street, then heads north along Gilbert Road into Alexander Crescent and onto Franklyne Road. From there, the route crosses Otara Creek near the existing footbridge and runs onto Johnstones Road. It then crosses the junction of Johnstones, East Tamaki and Springs Roads and heads along East Tamaki Road.

The route leaves East Tamaki Road some 440 metres east of the Springs Road intersection, traverses MCC's Stormwater Management Area to the south of East Tamaki Road and then crosses Te Irirangi Drive. From this point, the route follows another MCC Stormwater Management Area before crossing Chapel Road and then following Stancombe Road through the car parking areas along the edge of Barry Curtis Park.

The route follows Stancombe Road in an easterly direction until it reaches the intersection with Jeffs Road, it then continues up the hill until it intersects with Ormiston Road. It is necessary to traverse privately owned land between the end of Jeffs Road and the intersection with Ormiston Road as no public road connection exists between the two roads.

The route crosses Ormiston Road in a southerly direction, following a proposed extension of Redoubt Road, before turning south-east to link onto the currently formed section of Redoubt Road. The proposed extension of Redoubt Road is shown as proposed road in both the Manukau District Plan maps and Variation 13.

The final portion of the route then traverses private property to the proposed Substation/Transition Station at Brownhill Road.

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 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 the 9.9 kilometres between the Otahuhu Substation and the Substation/Transition Station at Brownhill Road. 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 and in open ground (most of which will be private property). Figures 2.1 and 2.2 show typical installation cross sections for roads and open ground.

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 load until 2034 after which forced cooling

will be required. To allow for the later application of forced water cooling, polythene pipes will be laid alongside the cables.

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 130-160 mm and weigh approximately 30-40 kilograms per metre i.e. 90-120 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 2000-3000 mm^2. 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 (XPLE) (refer to the cross section drawing shown in figure 2.3). 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.

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 maybe 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.

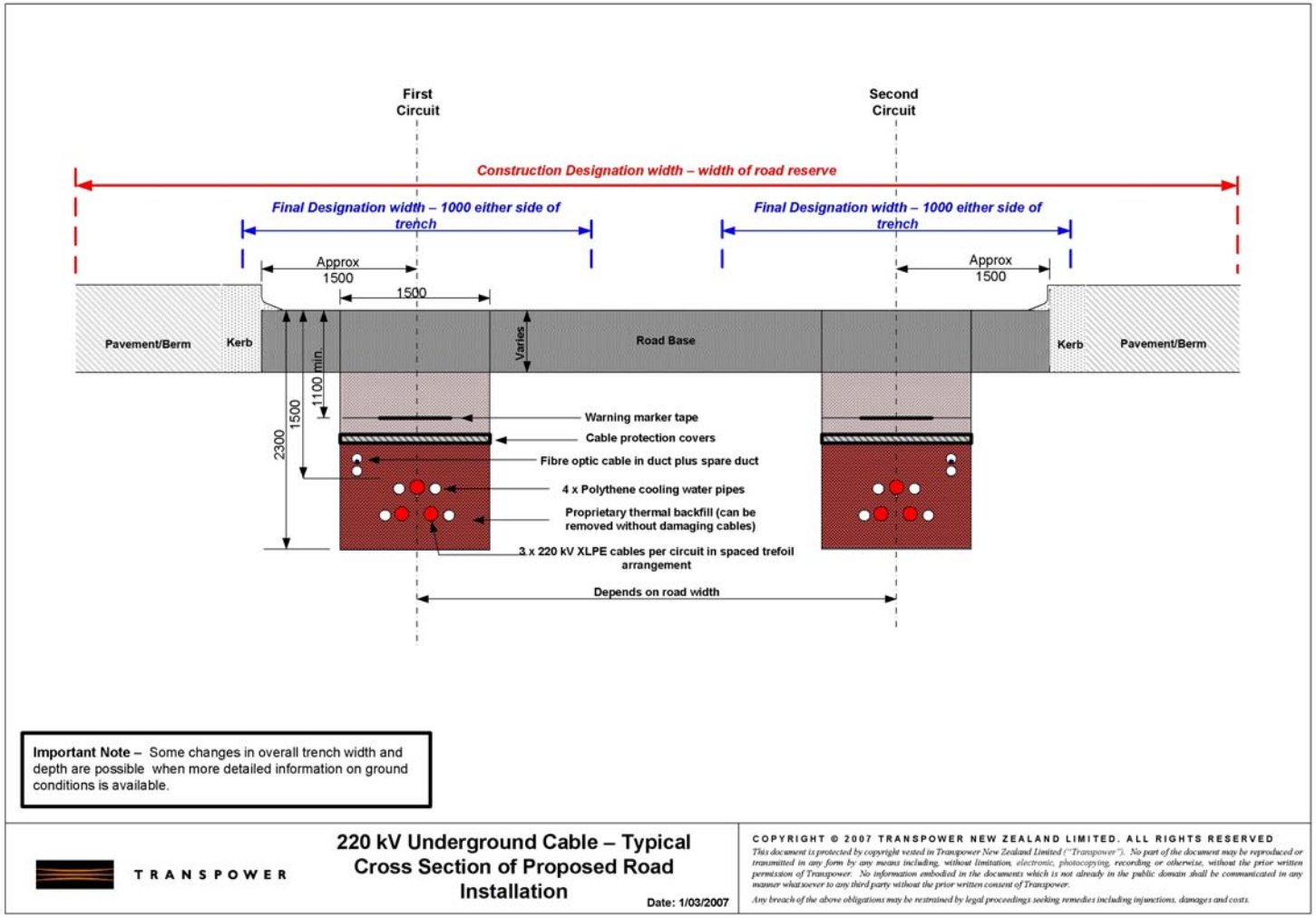


Figure 2.1: Typical Installation Configuration Within Road Reserve

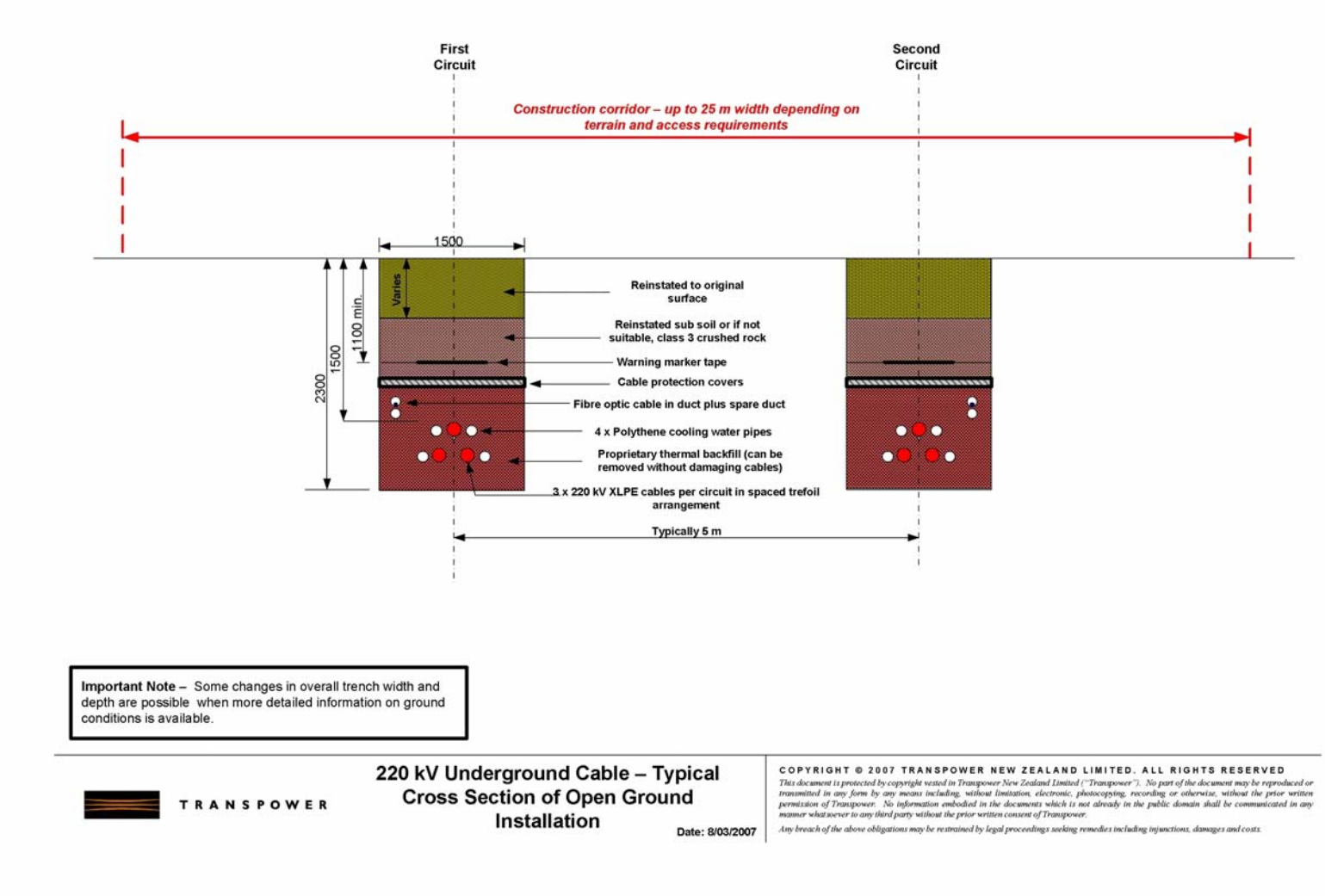


Figure 2.2: Typical Installation Configuration Within Open Ground

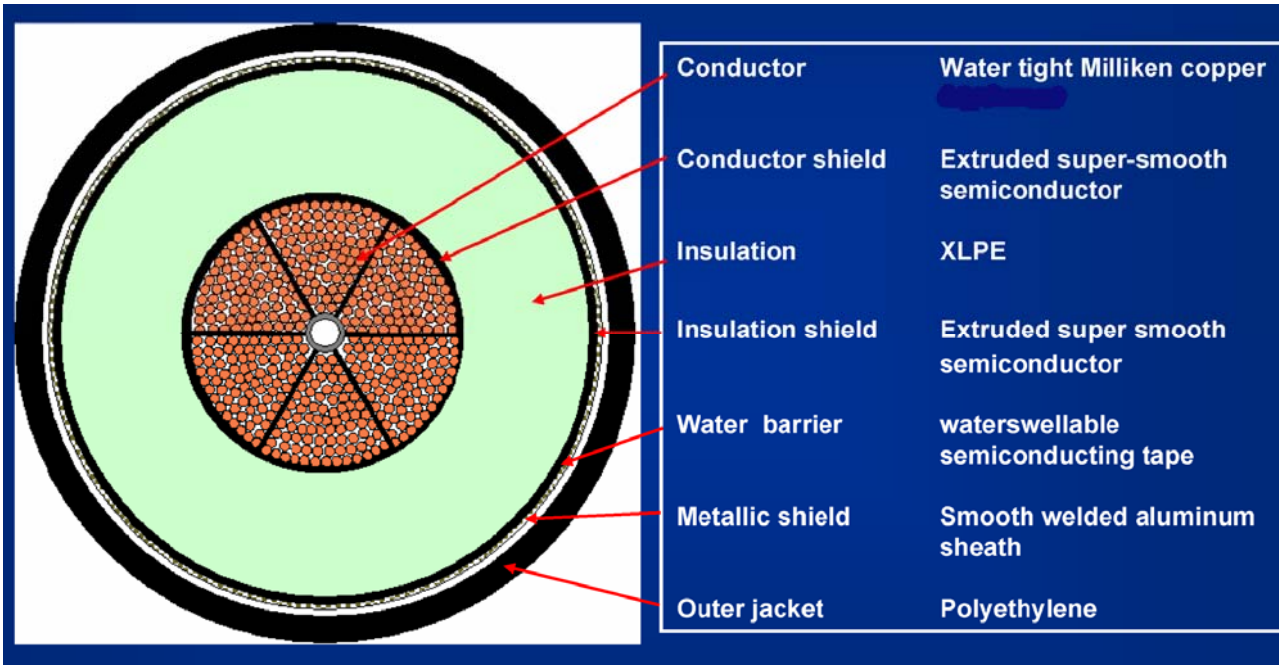


Figure 2.3: Typical 220kV XLPE Cable Cross section

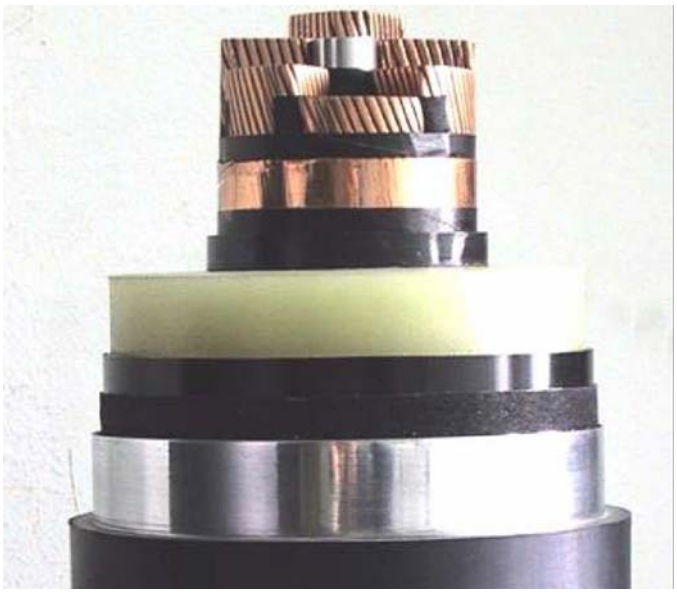


Figure 2.4: Typical 220 kV XLPE Cable Cut Away View

Outer jacket

An outer jacket of polythene is extruded onto the aluminium sheath. The firm bond between the polythene and aluminium sheath 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.

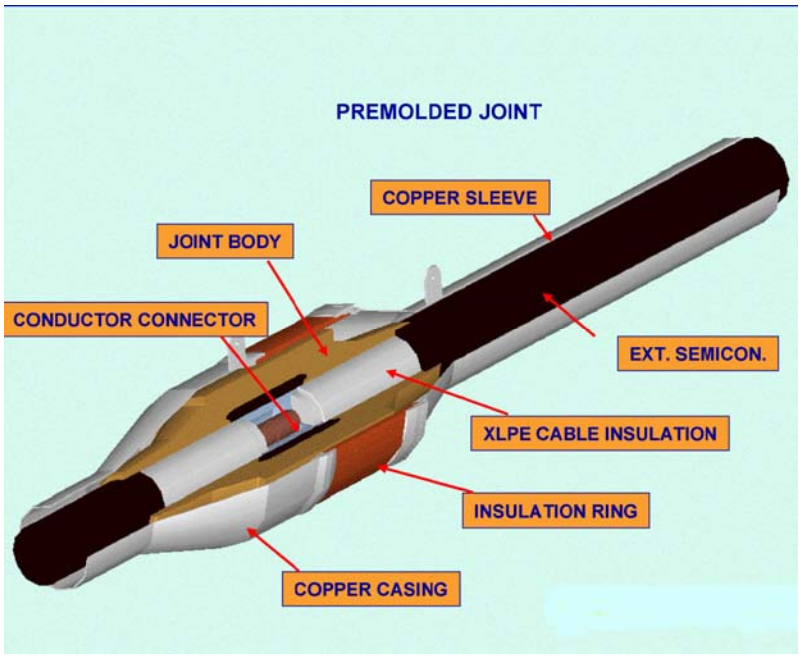


Figure 2.5: XLPE Cable Joint components

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 400 kV capable overhead line. In addition, the fibre optic cables will form part of the communication links between Otahuhu, Brownhill, Pakuranga 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 and future forced cooling provision

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

When load growth requires it, the cables will be uprated by the addition of forced water cooling. This will require the construction of cooling stations at each end of the cable route and at intermediate positions approximately 3km to 4km apart along the route. These will contain the plant to pump the water through the route pipe work

and discharge the heat to the atmosphere. A cooling system design study will 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. This limit will be significantly affected by the number and severity of the changes in direction.

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

As shown in Figures 2.1 and 2.2 it is proposed to install the cables so the top cable or duct 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: Excavated 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 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 1500 mm 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 detailed design stage.

Forced water cooling provides a parallel path of very much lower thermal resistance to that provided though the ground. In the system proposed, cooling water is passed down two of the pipes and returned via the other two pipes 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 67% 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 the inability 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^2 copper conductor, with 3000mm^2 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^2 to 3000mm^2. Preliminary calculations indicate that, using 2500mm^2 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 2300m 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.

Figures 2.1 and 2.2 show typical installation cross sections for roads and open ground.

2.1.6 Possible cable vault

A cable vault as part of the underground cable route may also be required adjacent to the Brownhill Substation/Transition Station 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 Brownhill Substation/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 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^{o} 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 restricted, 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 programme 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 required.

Normal practice would be to excavate across the road junction, possibly at stages to lay ducts, through which the cable could be pulled through later. This is not practical for water cooled cables as the water pipes must be laid in close proximity (25mm to 50 mm).

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 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.

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 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 100 mm 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.

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 Construction management

2.3.1 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.

2.3.2 Contractor's facilities

The contractor will require facilities for a site office, staff amenities and secure storage for 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.

2.3.3 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. 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.

2.3.4 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.

2.3.5 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.

2.4 Otara Creek crossing

A preliminary study investigating the options for the cable crossing of the Otara Creek between Johnstones and Franklyne Roads has been undertaken. The following options were investigated:

- Use of the existing pedestrian bridge.
- Purpose built cable bridge aligned with the end of Johnstones Rd.
- New pedestrian/cable bridge aligned with the end of Johnstones Rd (to replace existing bridge and move existing services to the new bridge).
- Burying by trenching the cables in the bed of the Creek.
- Directional drilling under the Creek.

The investigations concluded that burying the cables within the creek bed provides the most beneficial solution in terms of cable operation, and security and maintenance of cable spacing and depths. However, it must be stressed that the eventual decision on the method to be adopted will be made by the contractor after performing detailed investigations. It is recognised that any change in the method adopted by the contractor for crossing Otara Creek will in any event be subject to assessment through resource consent applications.

If the cable is to be buried in the creek bed by trenching, the anticipated procedure would be to lay two 600mm diameter pipes in separate trenches, excavated within the creek bed about 5 metres apart. Each pipe would contain the cables and polythene pipes for one circuit. The method to be adopted for installing the pipes is dependent on the ground conditions on the approaches to and beneath the creek. A detailed ground investigation would therefore be required in order to determine a suitable cable route and depth. The route would also be determined by the location of trees on the banks of the creek. Where it is not possible to avoid the tree roots, the removal of trees may be required.

It is anticipated that the crossing will be installed during periods of lower flow a few hours either side of low tide. The creek bed and banks will be excavated, to a depth of between 1 and 2 metres. However, this will be dependent on the ground conditions, which will be determined through geotechnical testing. Prior to commencement of trenching activities, a temporary silt fence will be installed across the stream, down stream of the works.

It is anticipated that an access/working platform called a cofferdam will be constructed using hard fill to provide the working platform for the excavation activities. The cofferdam will be built out from the edge of the creek following the route of the trench. This work will be undertaken in two stages, first from one bank to mid channel and then from the other bank to mid channel. The trenches will be suitably shored to prevent collapse, to minimise the width of the excavation and to enable construction in dry conditions using similar techniques to those employed elsewhere on the project.

It is anticipated that the cofferdams will be used to divert water flow around the works area so that trench excavation and positioning of the cable duct can be undertaken in the dry.

The pipes would be laid in a bedding material to provide adequate support and be suitably protected i.e. encasement in concrete or covered with sand cement filled bags. The trench will be filled to just below existing levels so that it will then fill in naturally over time with the accumulation of sediments in the estuary.

The cofferdam and trench shoring will be removed once the pipes are laid. A new cofferdam will then be constructed from the other side of the creek to lay the second section of pipes from the creek midpoint to the opposite bank.

Soil stabilisation measures will be immediately applied to the banks as determined during the detailed design. This may include protective blankets of biodegradable organic material, seeding, turfing, planting or other measures as appropriate. The sediment barrier will be retained in the creek bed downstream of the worksite for as long as practicable after completion of the work.

Burying by trenching the cables in the bed of the creek method of laying the pipes could also be achieved using a barge to excavate the trench or a trestle. If a barge or trestle is used as a working platform to dig the trench and lay the pipeline, there would be no need to construct a cofferdam, reducing the environmental effects of this method. It would however, be difficult to send excavated materials (sediments and mud) from the trench to landfill using a barge system.

Burying by trenching the cables in the bed of the creek is the option preferred by Transpower as it represents the most cost effective method of installation. Adverse effects of this method are mainly associated with the potential mobilisation of sediment during the trench excavation and pipe laying operation. To mitigate the risk presented by the trench excavation and subsequent activities, shoring inside the trenches and construction of cofferdams around the works area before excavation begins will prevent large quantities of sand and mud moving through the estuary.

A technical report on the potential effects on marine ecology is included as section 11 in Part VIII of this documentation. This indicates that effects are able to be mitigated adequately during the construction period on the basis of the above techniques, and will in any event be subject to resource consent applications.

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 Manukau City Council 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
- Vegetation restoration
- Land stability management and water quality and sediment controls
- Community information and liaison

The design/build 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, could involve an alteration to the designation 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 2002 (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 to be considered 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 VIII, 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 Manukau District Plan (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" classifies 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.[1]	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 NOR 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, 5, 6.13, 7.1 and 7.2.
- 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

[1] The installation of the proposed underground cable fails to comply with Figure 7.1, because the cable will mainly be located in the carriageway.

- 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.

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 NOR 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 6.3, 6.4, 6.5, 6.16 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 VIII, 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^3 of earthworks in respect of any site is a permitted activity unless it is near the coast or waterways, within 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 should be classified as a restricted discretionary activity.

Activity	City Wide[2]
Land Modification or Development (including that which involves earthworks) not otherwise permitted in this table.	Restricted Discretionary
Activity	Land in Stormwater Management 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 NOR 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 NOR 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 VIII, section 5. It is considered that the proposal is generally consistent with the policy framework for earthworks.

[2] Except for Explosives Zone and Whitford Landfill Zones

3.3.3 Variation 13 – Asbestos Containing Land

The route for the proposed underground cable passes through the area identified in Variation 13 to the MDP as potentially containing asbestos (Area 2). As set out in Rule 17.10.12.13, within Area 2:

> *earthworks (regardless of the area or volume of the soil disturbed) required for the installation of services such as electricity, water, telecommunications, sewerage and drainage;*

whould be assessed as restricted discretionary activities. For activities falling under this rule, MCC may impose conditions in respect of:

- Site assessment
- Means of remediation
- Management of remediation
- Validation
- Management Plan
- Monitoring

Section 6.13 of this report addresses the management of effects associated with any contaminated land and possible mitigation measures.

The key objectives and policies contained in Variation 13 in respect of Asbestos Containing Land that are considered relevant in assessing the NOR are contained in Part VIII, section 5. It is considered that the proposal is generally consistent with the policy framework for asbestos containing land.

3.3.4 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.

<u>Construction Noise</u>
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.

<u>Vibration</u>
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.

<u>Temporary Activities</u>
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.

3.4 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 VIII, 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 (HGMPA) 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 the HGMPA to the 220kV underground cable NOR 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 HGMPA 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 (NZCPS) issued under the RMA and where there are any conflicts between the two, the NZCPS 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 HGMPA 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. It should also be noted that the activities associated with the crossing of the Otara Creek are subject to a separate resource consent process in terms of the requirements of the RMA and the Auckland Regional Council.

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

- A coastal permit to install and use a 220kV underground transmission cable under the bed of Otara Creek
- A coastal permit to disturb the foreshore and seabed associated with the construction and installation of the underground cable
- A coastal permit to disturb the foreshore and seabed associated with the removal of mangrove vegetation as a requirement of the construction and installation of the underground cable.
- A coastal permit to occupy the coastal marine area with the 220kV underground transmission cable
- A coastal permit to temporarily dam parts of the width of Otara Creek to enable dry working conditions, during the construction and installation of the underground cable.
- 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 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.

As noted above applications for the above consents will be made separately to the ARC.

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, the two key alternatives that have been considered relate to transmission alternatives and route alternatives.

Transpower made a decision to underground the proposed 220 kV transmission line from the Otahuhu Substation to the new Substation/Transition Station at the urban edge of Manukau City at Brownhill Road (in a location, which has been generally identified as the urban/rural boundary). The underground section of the cable route mainly runs 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.

The approach of installing the underground cables within roads or within other areas of public land wherever practicable provides minimises the 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 to the overhead line.

4.2 Alternative cable types

There are three main types of cables used for voltages above 36 kV, 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 three possible route options were identified. These route options utilised public roads and public land wherever practicable and provided the most direct routes between the Otahuhu substation site and the eastern end of Ormiston Road. This route assessment process involved data collection, assessment and evaluation of the main options that comprised:

Route 1 – Stancombe (eastern end of the route follows Stancombe Road)

Section 1 Kaitawa Street– East Tamaki Road
Section 2(a) Accent Drive
Section 2(b) Stancombe Road Extension
Section 3 Stancombe Road / Jeffs Road – Previous Transition Point[3]

Route 2 – Ormiston (eastern end of the route follows Ormiston Road)

Section 1(a)(i) 23/24 Gilbert Road – Julian Place
Section 1 (a)(ii) 10 Gilbert Road – Lappington Road
Section 1(a) Lappington Reserve – East Tamaki Road
Section (b) 10 Gilbert – East Tamaki Road
Section 2 East Tamaki Road / Ormiston Road – Previous Transition Point[4]

Route 3 – Flat Bush School Road (eastern end of the route follows Flat Bush School Road)

Section 1 10 Gilbert Road – Capstick Road
Section 2(a) Preston Reserve
Section 2(b) Rongamai Road
Section 3(a) Robin Brooke Drive
Section 3(b) Medvale Avenue
Section 4 Rongamai Road / Flat Bush School Road / Ormiston Road – Previous Transition Point[5]

Each main option had a number of sub-options allowing different route combinations to be comprehensively assessed. For a full description of each of the options and the evaluation process refer to the *"Report on Underground Cable Section, Transition Station and Substations. August 2005"*[6].

Multi-criteria analysis led to the identification of the preferred underground route. A preliminary list of aspects for analysis was considered, refined through discussion and confirmed in the early stages of the underground route decision expert workshop. The aspects considered included number of dwellings, sensitive land uses, recreation, impact on heritage, impact on ecology and vegetation, engineering degree of difficulty, property degree of difficulty, tangata whenua values, compensation costs, traffic and access impacts, and cable security.

The preferred option that the route investigation process identified was Route 1 – Stancombe. The route exits the site of the existing Otahuhu Substation at Kaitawa Street. It then heads north along Gilbert Road into Alexander Crescent and onto Franklyne Road. From there, the route crosses Otara Creek near the existing footbridge and runs into Johnstones Road. It then crosses the junction of Johnstones Road, East Tamaki and

[3] When the route assessment process was undertaken it was proposed that cable route would cross Ormiston Road in a southerly direction, follow a proposed extension to Redoubt Road and then turn south-east to the proposed Transition Station. The proposed Transition Station has now been relocated to a site in Brownhill Road.
[4] When the route assessment process was undertaken it was proposed that cable route would cross Ormiston Road in a southerly direction, follow a proposed extension to Redoubt Road and then turn south-east to the proposed Transition Station. The proposed Transition Station has now been relocated to a site in Brownhill Road.
[5] When the route assessment process was undertaken it was proposed that cable route would cross Ormiston Road in a southerly direction, follow a proposed extension to Redoubt Road and then turn south-east to the proposed Transition Station. The proposed Transition Station has now been relocated to a site in Brownhill Road.
[6] See references in Part II, Section 16

Springs Road and heads along East Tamaki Road for approximately 400metres to a point opposite St. John's Church.

The route then split into two sub-options – Section 2(a) following Accent Drive and Section 2(b), which traverses MCC reserves, including a stormwater management area. Further technical investigations and the outcomes from the consultation process indicated a clear preference for Sub-option (b) Stormwater Management Area due to the reduced impacts on both the roading network and access to properties along Accent Drive.

As stated in the Final Underground Cable Route Report (November 2005), there are obvious advantages in terms of traffic and access impacts in utilising the stormwater management area and not roads and this was strongly supported in the submissions from land and business owners who would be directly affected by sub-option(a).

The only unresolved issue in respect of selecting Sub-option (b) is the concerns raised by Ngai Tai Umupuia Te Waka Totara Trust who have a preference for Sub-option (a) because of concerns regarding the possible discovery of koiwi in stormwater management areas. However, through the development of agreed protocols in respect of monitoring and waahi tapu, as well as the establishment of other appropriate mitigation measures, it is considered that the risks and concerns raised can be addressed in a manner that is agreeable to the Trust.

The consultation process regarding the underground route options led to an alternative route being identified by the owner of the land that the cable traverses at the eastern end of the route north of Ormiston Road. The alternative route followed Transpower's preferred option along Stancombe Road until the intersection of Stancombe Road and Chapel Road. From this point, the alternative suggested route headed diagonally south-east across Barry Curtis Park and proceeded to the previous transition point, following Ormiston Road.

An assessment of this alternative route indicated that the overall impacts and constraints would be of greater significance than those of the preferred route (see *Underground Cable Route Report, November 2005*). The key reasons for this conclusion were traffic impacts on the intersection of Ormiston and Murphys Road, and the number and location of other underground network utilities along the route.

The cable route at the eastern end will serve a dual purpose in that it will provide physical access to the Brownhill Substation/Transition Station site and provide security for the location of the underground cable. It may also contain part or all of the cable vault described earlier in this report.

4.4 Otara Creek crossing alternatives

Four options in respect of installing the cable across Otara Creek were investigated and assessed by Transpower. A summary of the options follows.

4.4.1 Existing pedestrian bridge

The option of attaching the cables in a similar way to the existing single service duct underneath the pedestrian bridge that crosses Otara Creek from Franklyne Road to Johnstone Road was investigated.

The advantages of attaching the cable to the existing pedestrian bridge across the Otara Creek are that it involves no vegetation or tree removal, and there will be minimal visual impact. However, any route across the

bridge would leave the cables or their ducting exposed and would be accessible to the public, thereby posing risks associated with vandalism and damage to the cables. There was also a possibility of public exposure to electromagnetic fields given the exposed nature of the cable placement.

A number of options for affixing the cables to the bridge were considered, but all would have required the strengthening to piers, abutments and the deck.

4.4.2 Purpose built cable bridge

A stand alone purpose built cable bridge across Otara Creek was considered, with a likely location being to the south of the existing footbridge. The installation of a cable bridge would require extensive clearance of trees and vegetation from the riverbanks, together with possible land purchase for the new foundations. The proposed circuit spacing of 3.5 metres also posed a variety of logistical and technical problems. Due to the exposed nature of the cable/ducts there was a high risk of vandalism.

4.4.3 Combined pedestrian and cable bridge

This option involved a new footbridge being constructed alongside the existing footbridge to accommodate pedestrian traffic and the cable and services currently carried by the existing bridge. This option would require demolition of the existing footbridge. As with the other two bridge options, this option would require extensive vegetation clearance and involve risks of vandalism and the possibility of public exposure to electromagnetic fields.

4.4.4 Creek bed

Two alternative methods for placing the cables beneath the creek (rather than above) were explored by Transpower. One option was directional drilling and installation of individual of a 600 mm diameter pipe for each cable circuit below the Creek from one bank, with the pipes maintained with a cover of 1.5metres. The second installation option was that of laying the cables in an open trench excavated within the Creek bed. The pipes laid in the open trench would be sealed and continuous to prevent ingress of water.

Although some tree and vegetation removal would be likely, the main advantages of embedding the cable in the Creek bed are the high level of security given that the cable would be below ground at all times any visual impacts would be minimal and the proposed circuit spacing and cable configuration could be appropriately achieved.

The investigations determined that the preferred option was to install the cable in the bed of the Otara Creek by laying the cables in an open trench excavated within the Creek bed.

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 VIII, section 17). Each section is also prefaced with a location map for ease of reference.

The route adjoins a number of road designations including road widening along the southern edge of Stancombe Road, and road widening on the southern corner of Ormiston Road. Once the route crosses Ormiston Road, it follows the proposed extension to Redoubt Road, which is not as yet formed. The Redoubt Road extension is shown as proposed road on the Manukau District Plan maps and in Variation 13.

5.2 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 route traverses a number stormwater management areas. The first is the stormwater management area to the west of Te Irirangi Drive which currently consists of a stream running through a fenced paddock.

The second stormwater management area is located to the east of Te Irirangi Drive and consists of two sediment (water quality, stormwater retention) ponds, each of which has a stream running through it. One stream runs through from under Accent Drive and through the northern retention pond. The second stream flows from the east and flows through the southern retention pond. The two streams converge to the west of the ponds and the flow is conveyed through a large culvert, 3 metres in diameter and the invert is about 5 metres below Te Irirangi Drive.

Following the crossing of Te Irirangi Drive, the cable will continue within another stormwater management area, north of Sancta Maria College. The stormwater management area between Te Irirangi Drive and Chapel Road has already been landscaped and planted with natives on either side of the stream.

5.3 Reserves and open space

Only a small amount of public open space land that will be utilised for the underground route, as road corridors will mostly be used.

However, the link between Franklyne Road and Johnstones Road will need to traverse areas of public open space adjoining Otara Creek. The public open space located between Otara Creek and Franklyne Road is zoned as Public Open Space 2, which is described in the Manukau District Plan for the purposes of passive outdoor informal recreation such as walking, resting, picnicking, enjoying nature or jogging. Areas zoned Public Open Space 2 also contribute to the greening and beautifying of the urban environment, and to the City's walkway and cycleway network.

This reserve consists of a wide grassed strip following the Otara Creek, with some flaxes and conifers planted near the creek banks. A narrow metalled walkway runs parallel to the creek and a formed concrete path links Franklyne Road to the footbridge which crosses the creek. The edges of the creek are covered with reasonably mature mangroves.

The esplanade reserve located on the eastern side of Otara Creek, adjacent to the end of Johnstones Road is zoned Public Open Space 5. This is for the purpose of protecting public access to the coastal environment and lakes, rivers and streams. The area between Otara Creek and Johnstones Road is relatively steep, with a formed concrete path leading from the end of Johnstones Road to the footbridge crossing the creek. Due to the slope, the footpath zigzags down to the footbridge. The vegetation consists of relatively mature mangroves along the edges of the creek and a mix of willows, flax and overgrown weed species above the mangroves.

5.3.1 Barry Curtis Park

Some 750 metres of the route is located along the northern edge of Barry Curtis Park. The Park is zoned Public Open Space 2 as part of Variation 13 – Flat Bush which became operative in January 2006. Significant landscaping has been undertaken in the Park adjacent to Stancombe Road including planting, stormwater ponds and art works. There have also been considerable plantings alongside Stancombe Road. Plane trees were chosen because of their rapid growth rate and large mature size. The plane trees are all located on platforms with reasonably steep ground sloping away from them into the park (in some cases up to 5m difference in height between the tree platform and the adjoining stormwater management pond behind it).

A children's playground is located adjacent to Stancombe Road and is surrounded by more plane trees – particular on the corner nearest to Stancombe Road.

The decision to locate the cable route within the Barry Curtis Park parking bays was made on the recommendations of MCC officers. Locating the cable in Barry Curtis Park was seen as a means of mitigating the potential traffic effects along Stancombe Road. Effects on the Park will be limited to the carparks on Stancombe Road, as the cable will not encroach into the dripline of trees indicated on the Masterplan (22.02.06 Revision B) prepared by Isthmus Group.

5.4 Recreation

There is minor informal recreational use of the open spaces areas through which the underground cables traverses.

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

Proposed Plan Change No. 8 – Whitford Rural to the MDP, which was notified in July 2005, identifies a recreational trail which runs along Brownhill Road and adjacent to the Brownhill Substation site 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 by way of 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 MCC.

5.5 Private land

The first area of private land that the underground route passes through is where the route diverges off East Tamaki Road. The area is identified for development in the Manukau District Plan and is zoned Business 5 and Stormwater Management Area. Manukau City Council has purchased the properties at 383 and 359 East Tamaki Road as a future recreational open space. This land is currently fenced and used for grazing cattle.

The second area of private land that the route passes through is at the end of Jeffs Road. This property is located between Jeffs Road and Ormiston Road and there is no public road between the two. This land and an adjoining parcel of private land that is also passed by the route (but to a lesser extent) are rural residential properties with some subdivision potential. The land is currently used for farming purposes and grazing.

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 Substation/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 Substation/Transition Station site in Brownhill Road. This site is owned by Transpower.

5.6 Adjoining landuses

5.6.1 Sensitive land uses

There are three schools that have frontage to the roads within which the underground cable will be located. These are Sir Edmund Hillary Collegiate on Gilbert Road, Mayfield Primary School which is located off Johnstones Road, and Sancta Maria College owned by the Roman Catholic Diocese of Auckland which is located on an unformed legal section of Stancombe Road. In addition, a new state school comprising at least two levels (intermediate and secondary) is proposed at the eastern end of Jeffs Road.

The Buddhist Temple located on the corner of Stancombe and Chapel Roads could also possibly be considered as a sensitive land use.

5.6.2 Residential activities

The surrounding environment at the start of the route near the Otahuhu Substation consists of residential dwellings, schools and public open space. The residential areas adjacent to the initial part of the route are zoned as Main Residential. The minimum lot size for this zone is 400m^2. These areas mostly comprise detached dwellings however, Johnstones Road has a number of multi-unit state house developments.

After passing through the industrial area of East Tamaki Road, the surrounding environment changes to residential dwellings at the intersection of the route with Te Irirangi Drive and continues along Stancombe Road and Jeffs Road. Residential developments are under construction along the length of Stancombe Road and Jeffs Road. A large proportion of the area will accommodate higher density residential growth than the traditional urban environment created throughout older areas of Manukau City.

These new residential areas are subject to the provisions of Variation 13 – Flat Bush. The Flat Bush Residential 1 Zone primarily has a residential emphasis and promotes a graduation of higher residential densities generally related to (and increases with) the proximity to the Flat Bush Town Centre. Lot sizes vary between 250m^2 to 425m^2.

The Flat Bush Residential 2 Zone is intended for lower residential densities due to its more distant location from the Flat Bush Town Centre and likely passenger transport routes. Detached dwellings are likely to make up the majority of housing in this zone on lots that range between 375m^2 and 500m^2.

5.6.3 Business activities

There are a number of business activities adjacent to the portion of the route following East Tamaki Road. The Otara Fire Station is located at the intersection of Johnstones Road, East Tamaki Road and Springs Road and there are a number of businesses located in the area including offices, heavy machinery hire, maintenance contractors, boat building and car sales yards.

There are also areas of small neighbourhood shops located on the corner of Gilbert and Franich Streets, and on the corner of Johnstones Road and Pearl Baker Drive. These neighbourhood shops are zoned as Business 1 and can be described as convenience shops.

5.6.4 Rural and Rural Residential

The section of the route from Jeffs Road through private property and onto Ormiston Road is zoned Rural 1 and Flat Bush Countryside Transition. While the Countryside Transition Zone provides for countryside living opportunities, the development potential within the zone is restricted because of the relatively steep and dissected landscape, land instability, limited accessibility and the significance of the visual backdrop this area provides to the basin below. The Zone therefore provides for low-density development, being one household unit per 5000m^2. The undeveloped land along Jeffs Road is currently used for farming purposes, mostly for grazing sheep.

After crossing Ormiston Road, the route follows the proposed extension to Redoubt Road (yet to be formed and vested as road) then enters private property. This is shown as proposed road in the Manukau District Plan maps. Land beyond this in part falls into the area covered by Proposed Plan Change No. 8.

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 Reboubt Road extension and the Substation/Transition Station traverses land zoned proposed Whitford Rural A (average carrying 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 level is generally more visible, and any development is subject to evaluation in terms of specified criteria relating to rural character and amenity values.

5.7 Tangata whenua values

The underground section of the 220kV line is within the same "cultural area" as the Otahuhu Substation and the same considerations apply. The three urban marae: Otara marae (in Papatoetoe), Whai Ora and Ngati Otara Kohanga Reo in Otara, are in the general vicinity of the underground section but none of them are directly affected. Otara is regarded as a "manuhiri" marae while the other two have a mostly religious focus (Catholic and Latter Day Saints) rather than tribal affiliations.

On 28 October 2005 and 29 September 2005 hui were held with the Ngai Tai Umupuia Te Waka Totara Trust to discuss the preferred underground route and sub-options.

The route of the underground cable is within the rohe of several different iwi groups. After the initial round of consultation with the Ngai Tai Umupuia Te Waka Totara Trust, Te Aki Tai and Ngai Tai ki Umupuia and Ngati Paoa ki Tamaki, it was agreed that the Trust would represent:

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

Following further consultation on the underground route, Ngai Tai Umupuia Te Waka Totara Trust indicated their preference for the option following Accent Drive rather than utilising the stormwater management areas. The Trust expressed concern about the potential to uncover koiwi (skeletal remains) or sites of significance (or of archaeological interest) within these areas. However, as the route largely follows existing roads, the possibility of koiwi finds is low. It is therefore considered that these concerns can be addressed through use of appropriate protocols.

There are no sites of along the route that have been identified as of being significance to Maori in the Manukau District Plan. However, Ngai Tai Umupuia has advised that Te Puki Otara was a maunga and Pa site of Ngai Tai. It is now the Greenmount landfill and in close proximity to the final route. Burial sites around Greenmount and Smales Road have been found in the last 10 years. The last find of two koiwi (approx 1998) were found

near Crooks Road and Blackburn Road. They are now scheduled and protected under the Manukau District Plan.

Ngai Tai Umupuia has also advised that there is a risk of finding koiwi or sites of significance. Two unrecorded sites (iwi and midden) have been found in the northern section of Sir Barry Curtis Park. However, Ngai Tai Umupuia consider that it is unlikely that any unrecorded sites will be uncovered along Stancombe Road as development to date in the area has not uncovered any sites.

5.8 Heritage values

The reserve located at 334R East Tamaki Road contains St Johns Church and Hampton Park sunken garden and stables. Both buildings are listed as heritage buildings and features in the Manukau District Plan. The proposed route is located in the road adjacent to the reserve, at sufficient distance from the site and buildings not to affect heritage values.

5.9 Otara Creek and other water courses

5.9.1 Otara Creek

Most of the Otara Creek tributaries originate in the south east of the catchment, on the slopes running from Redoubt Road around the hills above Point View Drive. The Creek runs north to its confluence with the Tamaki River, a tidal estuary that reaches out to the Hauraki Gulf.

The main marine habitat type in the upper Tamaki Estuary and lower Otara Creek is the mangrove community, which extends upstream past the footbridge at the end of Johnstones Road. A short distance upstream of this point the mangroves give way to a freshwater community.

A total of six species of freshwater fish have been recorded in Otara Creek and tributaries (from New Zealand Freshwater Fish Database) these include short fin eel, long fin eel, banded kokopu, Crans bully, mosquito fish and koi carp. The short fin eel is the most common and the most widespread.

The Otara Creek at Hills Road is described in an ARC monitoring report as being (in terms of water quality) amongst the worst streams monitored by ARC in the Auckland Region. In particular the data show:

- very low dissolved oxygen concentrations during summer; and
- elevated concentrations of biochemical oxygen demand, indicator bacteria, ammonia nitrogen, nitrate nitrogen and phosphorus.

The poor water quality is attributed to urban stormwater runoff, sewerage overflows, industrial spills, and diffuse runoff from agricultural land in the upper catchment.

Otara Creek at the Johnstones Road footbridge is a tidal estuary approximately 14 metres in width and 1.5 metres deep at high tide. It is just inside the coastal marine area. The Creek bed is littered with a variety of items including household rubbish, plastic bags, bottles, bicycles and shopping trolleys.

The riparian vegetation along the Creek margins is dominated by mangroves, which grow on both sides of the Creek in bands up to 30 metres wide, but more typically 5 to 10 metres wide in the vicinity of the footbridge. Beyond the mangroves the terrestrial vegetation includes a variety of native and exotic species including flax, taupata, willow and pine.

Tidal influences carry water both upstream and downstream past the footbridge, but velocities are low in dry weather, typically less than 1 metre per second. Water is normally turbid with low clarity in this reach due to inputs of fine colloidal material from the catchment. The stream bed has a soft sediment overlay.

5.9.1 Otara Creek Tributary near Te Irirangi Drive

A drain originating on Barry Curtis Park and running beside Stancombe Road receives stormwater inputs from residential developments to the north as it runs in a westerly direction under Chapel Rd, Te Irirangi Drive, East Tamaki Road and Hills Road before joining Otara Creek proper within the Otara Creek Reserve. The area between Chapel Road and East Tamaki Road has been designated as a Stormwater Management Area, within which a series of stormwater detention ponds have been constructed. The Creek in this reach has a relatively low base flow and a low flow channel width of 1 to 2 metres.

This was a rural farming area until fairly recently but is rapidly being converted to commercial and residential use. The watercourse is heavily modified and has retained little of its natural character.

5.9.2 Perennial streams Regis Lane vicinity

Between the Brownhill Substation/Transition site 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

5.10 Vegetation

5.10.1 Otara Creek Reserve

The bank between the end of Johnstones Road and Otara Creek is covered in a variety of vegetation. This includes a number of mature native and exotic species (London plane tree, weeping willow trees and a pohutakawa tree). A number of these trees are festooned with vines and weed species are prevalent. A cover of taupata and flax prevail next to the mangroves bordering the tidal channel.

The park itself beyond the Creek bank features a large area of lawn and a number of amenity plantings occurring either as single trees or in small stands in the vicinity of the footpath.

5.10.2 East Tamaki Road - Stormwater Management Area

The majority of the area is covered in grass and is periodically grazed by cattle. Clumps of rushes and weeds are scattered throughout the area. Indigenous vegetation is restricted to a small area of riparian plantings by Te Irirangi Drive near the Mitre 10 megastore.

5.10.3 Accent Drive – Stormwater Management Area

This area is bounded by Accent Drive and Sancta Maria College and encompasses a tributary of Otara Creek and a recently constructed stormwater retention basin. The batters and terraces created around the retention basin and along the banks of the watercourse have been extensively planted in a range of indigenous trees and shrubs. The most significant plantings consist of an established and dense stand of manuka, mahoe, kowhai and cabbage trees that are situated beside the creek next to Te Irirangi Drive. Extensive plantings of flax, karamu and other shrubs have also been established along the creek margins adjacent to the college boundary.

5.10.4 Jeffs Road to Ormiston Road

The land between the two roads features moderate to steep sloping pastureland, with some paddocks more intensively grazed than others. Woody vegetation in the vicinity of the route at about mid slope includes several old macrocarpa trees, a small area of native trees and shrubs. Further uphill there are several large gum trees, a stand of totara and a row of pine trees. Much of this vegetation is situated in the vicinity of a house sited on a promontory off Ormiston Road.

5.10.5 Redoubt Road Extension to Brownhill Substation/Transition Station

At the Brownhill Substation/Transition Station end of the route, the alignment climbs paddocks between Brownhill 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.

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.

5.11.1 NGC pipelines

NGC has advised that one high pressure gas pipeline runs near the proposed 220 kV cables. The pipeline crosses over the proposed 220 kV cable route where Murphys Road intersects with Stancombe Road.

5.11.2 Vector Pipelines

Vector has advised there are a number of pipelines that run in close proximity to the 220kV cables, these include:

- A medium pressure plastic coated steel gas pipeline which runs parallel with the proposed 220 kV cables for approximately 2.5 km along Gilbert Road, Alexander Crescent, Franklyne Road and Johnstones Road.
- A number of low pressure gas distribution pipelines of various types, which have three sections of contiguous steel pipeline parallel with the proposed 220 kV cables, principally along Gilbert Road and East Tamaki Road, with a maximum parallel distance of approximately 750 m.

5.11.3 Water Pipelines

Two water pipelines have been identified, which the 220kV cables will cross. These are:

- East Tamaki No 2 water main at the junction of Murphy's Road and Stancombe Road.
- East Tamaki No 2 CLS water main at the junction of Murphy's Road and Stancombe Road.

5.11.4 Wastewater and Stormwater Pipelines

The 220kV cable circuits will be laid parallel with the Watercare Chapel Branch sewer pipeline, which runs along East Tamaki Road through a storm water management area and across Te Irirangi Drive to the junction of Stancombe Road with Chapel Road.

6. Assessment of Construction Effects

6.1 Transportation network

Description
Typically, the construction methodology will involve excavation of the trench in section lengths of 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 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 East Tamaki Road and Springs Road.

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. For example, a limited amount of increased congestion can be expected on East Tamaki Road whilst active construction is underway, however, this will be short term. Congestion from the roadworks could result in traffic tailing back into Springs Road and East Tamaki Road leading to more widespread disruption on the Springs Road / East Tamaki Road arterial route. It is important therefore, that disruption should be minimised in this particular section through avoiding peak periods and careful traffic management during the construction stage.

The works will disrupt some bus services, however it is anticipated that 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.

Potential Effects - Major Arterial Roads
The East Tamaki Road / Johnstones Road / Springs Road signalised 4-arm intersection is the location on the underground cable route with the greatest potential for traffic impacts. This is due to:

- the staggered configuration of the intersection
- (111) emergency access at the fire station
- current high traffic flows on all arms
- crossing a key north-south arterial

There are two other arterial road crossings that have the potential to cause traffic impacts, these are the crossing of Te Irirangi Drive and to a lesser degree the Chapel Road / Accent Road / Stancombe Road.

Each location has undergone a detailed study to arrive at the best option to cause the least traffic impact. This inevitably involves some road closures and in places the use of temporary signals. All of the options cause a degree of congestion and traffic queues, which require mitigation measures.

The works will disrupt some bus services, which will be able to be militated against through discussions with the service operator.

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 Rd 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 bus services will generally be minimal due to maintaining the north and southbound movements other routes will be managed through implementing the following measures:

- 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.

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.

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 minimal. 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 a 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 exceeds 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 natural gas pipelines, 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 the 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 the 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 route of the underground cable leaves East Tamaki Road some 440 metres east of the Springs Road Intersection, traverses MCC's stormwater management area to the south of East Tamaki Road and then crosses Te Irirangi Drive. From this point, the route follows another stormwater management area before crossing Chapel Road and then following Stancombe Road.

The stormwater management area to the west of Te Irirangi Drive currently consists of a stream running through a fenced paddock. The stormwater management area to the east of Te Irirangi Drive consists of two sediment

(water quality) ponds, one for each stream that runs through this area. The two streams converge and the flow is conveyed in a large culvert, 3 metres in diameter, the invert is about 5 metres below Te Irirangi Drive.

The stormwater management area between Te Irirangi Drive and Chapel Road is landscaped and planted with natives on either side of the stream.

The method proposed by Transpower for cable installation through the stormwater management areas is open trenching. Installation of the cable will also require open trenching through the banks of the ponds, streams and in the wet areas of the ponds.

The pipe location and construction methods are affected by several constraints including changes in direction, drum size and weight and laying depth. It is proposed to install the cables at a depth of 1500mm below ground level. There will be several joint bays located within the stormwater management areas. The 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.

There could a need to construct a temporary road that can sustain the load from the cable drum transportation truck if the existing ground conditions are not suitable to sustain the loads.

Potential Effects

The stormwater management area serves a large stormwater catchment and the amount of flow during a storm event is significant. The construction involving open trenching and cable installation in the stormwater management area will have an effect on the functionality of the area during a storm or heavy rainfall event. These effects can be summarised as follow:

- Obstruction of stormwater runoff during a heavy rainfall event, such incident may have the potential to cause flooding.
- The open trenching through the stormwater management areas, especially through the area on the eastern side of Te Irirangi Drive has the potential to cause erosion unless appropriate mitigation measures are implemented.
- Trenching through the bank of the streams, detention ponds and other a number of areas along the route has the potential to impact on the stability of these banks and areas and increase the potential for erosion.
- Impact on the existing services (mainly the existing Watercare wastewater pipe) which is located in the vicinity of the work. Any damage to these services could result in cross contamination.
- Dewatering of trenches could result in the discharge of sediments into downstream watercourses
- Spillage of fuel and oil from machinery or storage tanks could contaminate downstream water course.

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 a 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 the resource consents required for working within the 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.
- Locate and protect the Watercare sewer line from any damages that could be caused by trenching or running heavy machines over its route, so as to avoid any cross contamination.
- Activities within the stormwater management area shall be carried out in the dry season to avoid any adverse impacts on these areas and their functionality.
- 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 be removed and the site reinstate to its original condition.

6.8 Land stability and erosion

6.8.1 Stormwater management areas

Description
Preliminary geotechnical investigations have been undertaken in respect of the stormwater management areas. These investigations indicate that overall conditions are considered suitable for trenching operations, although open trench support and dewatering (pumping from a sump in the trench) will probably be necessary. However, further investigations are required prior to detailed design and development of Construction Management Plans.

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.

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
- Reinstatement procedures
- Erosion protection measures
- Slope maintenance and monitoring

6.8.2 Brownhill Substation/Transition Station and Redoubt Road Extension

Description
Preliminary geotechnical investigations have been undertaken in along the section of the route from the Substation/Transition Station west to Redoubt Road, then north along the ridge of the proposed redoubt Road extension. This area is part of the South Auckland Landslide Zone and evidence of past instability is widespread on the moderate and steep slopes. From the Substation/Transition Station site, a possible route that avoids steep and unstable slopes is along 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 unlikely to be feasible without considerable earthworks and retaining structures.

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

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.

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

The need for this mitigation will be determined during further geotechnical investigations and detailed design.

6.9 Recreation

Description
The main part of the route of the proposed underground cable will be located on legal road. However, it does cross a public open space located between Otara Creek and Franklyne Road. This area is zoned Public Open Space 2 in the Manukau District Plan 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 the edge of Barry Curtis Park for a length of 750 metres.

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.

Significant landscaping including planting, stormwater ponds and art works has been undertaken in that part of Barry Curtis Park adjacent to Stancombe Road. There are extensive plantings alongside Stancombe Road including a number of groups of Plane trees. The effects on the Park should be no more than minor as the cable route will only encroach on the car parking areas on Stancombe Road, and will not encroach into the dripline of trees indicated on the Barry Curtis Park Masterplan prepared for MCC by Isthmus Group (23.02.06 Revision B).

Mitigation
The Construction Management Plan will include a plan demonstrating how the open space area between Otara Creek and Franklyne Road, and Barry Curtis Park will be re-vegetated. All affected car parks will be reformed and sealed to their original standard.

6.10 Tangata whenua

Description
The route contains no sites of significance to Maori that have been identified in the MDP. 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.

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 (HPA) 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 HPA 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 will require the cessation of work in the vicinity of any such find until such time as the appropriate authorities and nominated iwi representatives have had the opportunity to examine the “find site” and make appropriate recommendations on how the matter will be dealt with. The protocol will be developed as part of the Construction Management Plan.

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
Most of the proposed underground cable route will be located on legal road. However, it does cross public open space located between Otara Creek and Franklyne Road and stormwater management areas adjacent to East Tamaki Road and Accent Drive that contain riparian vegetation and amenity planting.

At the Brownhill Substation/Transition Station end of the route, 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.

Potential Effects
The trenching works are likely to result in the partial clearance of shelterbelt trees, exotic amenity trees and native shrubs below Ormiston Road, amenity plantings within the stormwater management areas and the mangroves and amenity trees within Otara Creek Reserve. However, there is scope to avoid the amenity trees and shrubs across parts of the Reserve due to the expanse of lawn situated adjacent to the footpath and extending from the footbridge to Franklyne Road. The degree to which these plantings will be affected will be governed by the location of trench alignments. This matter will require careful consideration at the outset of the project to avoid mature trees and their root plates where possible.

The extent of vegetation clearance is likely to be greatest within Otara Creek Reserve at the end of Johnstone Road where there is a mature London plane, pohutakawa tree and several large willow trees. The underlying riparian vegetation and the mangroves that border Otara Creek and the footbridge will also need to be cleared in advance of the trenching works.

The native plantings within the stormwater management areas bordering Te Irirangi Drive by the Mitre 10 Megastore will also need to be removed as there is no scope in this area to deviate the cable route. It is probable that some of the native plantings on the batters surrounding the retention basins and side creeks upstream of Te Irirangi Drive, adjacent to Sancta Maria College may also need to be removed.

At the eastern end of the cable route the alignment 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 Manukau District Plan 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 in “mitigation measures” below.

Mitigation
The following measures are proposed to reduce the extent of clearance of the vegetation within these open space areas to a practical minimum:

- define all construction site boundaries clearly on the ground;
- ensure that no vegetation is disturbed or removed beyond the defined construction zone;

- engage an arborist to assess the extent of the root beds of mature trees within Otara Creek Reserve between the footbridge and Franklyne Road to ensure the selected route does not adversely affect nearby trees;
- replace any amenity trees removed near the footbridge in Otara Creek Reserve with new plantings;
- replace native riparian vegetation removed during the trenching works across Otara Creek;
- replace native plantings removed in the stormwater management areas;
- replace amenity trees removed on the land between Ormiston Road and Jeffs Road;
- minimisation of (as far as practical) disturbance to the small patch of indigenous forest located below Regis Lane; and
- replanting of (as far as practical) indigenous plant species removed from the small patch of indigenous forest below Regis Lane.

It is possible that the younger native plantings within the stormwater management areas could be uplifted without unduly disturbing their root beds and stockpiled at an appropriate site prior to the works commencing. Through careful tending these plantings should be able to be reinstated successfully at the conclusion of the trenching works in this area. This work will be subject to separate resource consent applications to the ARC.

The Construction Management Plan will include the above mitigation measures and a Vegetation Restoration Plan and Programme. 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.

6.11.2 Aquatic ecology – Otara Creek

Description
The proposed cable route will cross the Otara Creek between Franklyne Road and Johnstones Road. The preferred option for installing the cable in the Creek bed is to lay the cable ducts in two parallel trenches, excavated within the Creek bed. Excavation will normally take place directly through the bed of the Creek to a depth of between 1 and 2 metres.

A distance of 3.5 metres will separate the two trenches. It is anticipated that cofferdams will be used to divert water flow around the works area so that trench excavation and laying of the cable can be undertaken in the dry. This work will be undertaken in two stages, first from one bank to mid channel and then from the other bank to mid channel. Much of the preliminary works, including construction of the cofferdams, can be done at low to mid tide, during periods of fine weather, to minimise works in the wetted channel.

After the cable ducts have been installed they will be encased in concrete and protected with sand-cement filled bags, prior to reinstatement of the creek bed and banks.

The Otara Creek at Hills Road is described in an ARC monitoring report as being, in terms of water quality, amongst the worst streams monitored by ARC in the Auckland Region.

Otara Creek at the Johnstones Road footbridge is a tidal estuary, with a high tide width of approximately 30 metres and depth of up to 1.5 metres. It is just inside the coastal marine area. The Creek bed is littered with a variety of items including household rubbish, plastic bags, bottles, bicycles and shopping trolleys.

Potential Effects - Riparian Vegetation
The trench from the end of Johnstones Road (east bank) would run down the stream bank and cross Otara Creek a short distance (between 10 and 40 metres) upstream of the footbridge. The route then passes approximately 100m through reserve land before joining Franklyne Road on the west bank of the Creek.

The parallel trenches will occupy a strip some 5 to 10 metres wide in total, depending on ground conditions. It is also anticipated that a strip up to 15 metres wide would need to be cleared of vegetation on both banks to allow machinery access for the excavation. This would affect mangroves and other trees on both banks. It is estimated that the area of mangroves affected would be up to 150m^2 on the west bank and up to 50m^2 on the east bank.

Potential Effects - Water Quality and Aquatic Ecology
Trenching across Otara Creek would inevitably release significant quantities of sediment into the water column, causing a reduction in water clarity and an increased rate of sediment deposition on the Creek bed downstream of the works.

Sediment is a component of most natural aquatic systems, which is transported as suspended sediment and bedload, mostly at times of high river flows and floods. Small particles, such as clay and silt, are generally transported in suspension, whereas larger particles, such as sand and gravel, usually roll or slide along the riverbed. Increases in suspended sediment reduce water clarity and increase turbidity, thus reducing primary production. High sediment concentrations can harm fish directly causing death (in extreme cases), reducing growth or resistance to disease or preventing successful egg and larval development, affecting natural migrations, and indirectly by reducing the abundance of their food (Alabaster & Lloyd 1982).

The banded kokopu, which has been recorded in Otara Creek, is particularly sensitive to suspended solids concentrations and its juvenile migratory stage fish is known to avoid turbidity levels greater than 25 NTU (Boubee et al 1997). Other species known in the Creek such as the short and long finned eel are far less sensitive to suspended solids. Observations of Otara Creek at Johnstones Road on a number of occasions indicate that water clarity is normally very low in this reach and suspended solids levels are typically elevated.

This is naturally a depositional reach in which fine sediments accumulate on the stream-bed to form a soft sediment substrate. Many of the potential adverse effects associated with the release of sediment to the water column would therefore be much reduced at this location because of the relatively low sensitivity of the receiving environment. Juvenile banded kokopu migrate upstream mainly between September and November and are unlikely to be present in the estuarine reach of Otara Creek at other times of the year. The effects on fish populations could be significantly mitigated if the instream works were confined to a short period in late summer, when little if any fish migration through the works area will be occur.

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

- That all instream works are undertaken during late summer.
- That the release of sediment from the creek bed is minimised by the use of coffer dams or other structures to divert water flows away from the works areas to allow trenching, pipe laying and concrete pouring to be undertaken in the dry.

- That stormwater is diverted around the works area on the banks of Otara Creek, and that sediment transport into the Creek is minimised.
- That any spoil removed from the trench that is required to be temporarily stored on site prior to removal to landfill, is placed within a stable bunded area so as to minimise sediment transport to the Creek.
- That any spoil removed from the trench is properly disposed of at a suitable landfill.
- That all areas of disturbed soil on the Creek's banks are stabilised immediately on completion of the works by appropriate measures which may include protective blankets of biodegradable organic material, seeding, turfing, planting with appropriate species, or other measures.

The Construction Management Plan will include these mitigation measures. The Plan will also include a Vegetation Restoration Plan and Programme.

6.11.3 Aquatic ecology – Otara Creek Tributary crossing near Te Irirangi Drive

Description
The proposed cable route will cross a tributary of the Otara Creek near Te Irirangi Drive.

A drain originating on Barry Curtis Park and running beside Stancombe Road receives stormwater inputs from residential developments to the north as it runs in a westerly direction under Chapel Rd, Te Irirangi Drive, East Tamaki Road and Hills Road before joining Otara Creek proper within the Otara Creek Reserve. The area between Chapel Road and East Tamaki Road has been zoned a stormwater management area, within which a series of stormwater detention ponds have been constructed. The Creek in this reach has a relatively low base flow and a low flow channel width of 1 to 2 metres.

This was a rural farming area until fairly recently but is rapidly being converted to commercial and residential use. The watercourse is heavily modified and has retained little of its natural character.

Potential Effects - Riparian Vegetation
Virtually none of original riparian vegetation remains in this reach, which has been in pasture for many years. However, significant planting has been undertaken throughout the stormwater management area in order to stabilise the recently developed detention ponds. Depending on the exact alignment of the cable route, some of this recent planting may be affected by trench excavations.

Potential Effects - Water Quality and Aquatic Ecology
Trenching across the bed of the Creek would release significant quantities of sediment into the water column, causing a reduction in water clarity and an increased rate of sediment deposition on the Creek bed downstream of the works. High sediment concentrations can potentially have a range of adverse effects on fish and other aquatic biota.

As this reach of the stream, is a stormwater management area, it is significantly modified and is subject to periodic inundation during heavy rainfall. During such events it is likely that high suspended sediment concentrations are experienced in the stream and that significant sediment deposition occurs on the stream bed. The aquatic biota of this area will have adjusted to local conditions and can be expected to be relatively tolerant of short-term disturbances. In light of this, and provided that the trenching operation can be completed quickly at a time when fish migrations are unlikely, the potentially adverse effects associated with trenching are expected to be minor.

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

- That the instream works are limited to a short period during late summer,
- 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 to the Creek, and
- That all areas of soil disturbed by these works within the stormwater management area 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 and Programme. These measures may also be incorporated as conditions of ARC resource consents.

6.11.4 Aquatic ecology – perennial streams Regis Lane vicinity

Description
At the Brownhill Substation/Transition Station end of the route, the alignment climbs paddocks between Brown Hill Road and Regis Lane and crosses two perennial streams in this area. The stream beds are vegetated in pasture and are considered to provide no more than limited benefits in terms of biological diversity or ecological function.

As these streams do not have a continuous flow (assumption based on Manukau District Plan stream category) these will be categorised as "Category 2 Streams" under the Proposed Auckland Regional Plan: Air, Land and Water. These streams are not classified as "Natural Stream Management Areas".

Potential Effects
In terms of ecological diversity and function, the perennial streams are of a modified nature having been impacted by historical vegetation clearance and being exposed to the influences of pastoral landuse. The installation of the proposed underground cables will involve excavation of trenches 1 to 2 metres deep crossing the stream beds. It is anticipated that given the 'perennial' nature of these streams, cable installation works will be undertaken when the streams are dry.

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

- Carryout trenching works (as far as practical) across the two perennial streams located below Regis Lane only when they are dry

The Construction Management Plan will include these mitigation measures. The Plan will also include a Vegetation Restoration Plan and Programme. These measures may also be incorporated as conditions of ARC resource consents.

6.12 Heritage

Description
An archaeological and historical assessment of the proposed underground cable route has been undertaken and no archaeological sites were identified along the proposed route.

The reserve located at 334R East Tamaki Road contains two historic buildings and a site which are listed in the Manukau District Plan as Heritage Resources to be Protected. The buildings and site are St Johns Church and Hampton Park (stables and sunken garden).

Potential Effects
The archaeological assessment found that the majority of the underground route is within formed roads that have a number of services already contained beneath them. It is therefore unlikely that archaeological evidence exists beneath the formed roads and should any have survived construction of the road, they 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 possible is in the vicinity of Otara Creek. Archaeological surveys were conducted in the area where the cable will cross the Creek, however rubbish, footpaths, vegetation, and overburden prevented full surveys from occurring.

The historic buildings and site in East Tamaki Road, are well set back from the road frontage. It is therefore unlikely that the installation of the cable will have any adverse effects on the sites. Compliance with the vibration performance standards in the Manukau District Plan should ensure that any vibration effects are minimised.

Mitigation
The following measures are proposed to mitigate the potential adverse effects on possible archaeological sites:

- Any earthworks within 20m either side of the Otara Creek crossing are archaeologically monitored; and
- 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.

The Construction Management Plan will include these requirements.

6.13 Contaminated land

Description
As set out in section 3.3.3 the proposed underground cable route traverses an area of Flat Bush that has been identified in the MDP as land potentially containing asbestos. The area was formerly rural land where asbestos containing material may have been used for farm tracks, cleanfill and other uses.

A search of the Auckland Regional Council's contaminated land database 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. Notwithstanding these comments, the asbestos-containing material previously disposed in the Flat Bush area was primarily asbestos-cement building board. This product, by its composite nature, contains the asbestos fibres in a tightly bound matrix and thus release of fibres which could then become airborne is negligible.

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
The approach to contamination assessment and, if contamination is suspected or found, to quantification, mitigation and possibly clean-up will be based around the hierarchy of approaches and procedures to be found in the Ministry for the Environment's (MfE) Contaminated Sites Guidelines series. These MfE documents set out the detailed protocols for qualitative site assessment through to soil sampling methodologies, concentrations of contaminants which trigger specific further actions, and the nature and necessary extent of these action.

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. 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 Manukau District Plan 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
The underground connection between the Substation/`Transition Station and Ormiston Road follows a relatively easy grade along a ridge and tributary spur. The route itself is in pasture, with adjacent areas of pine plantation on side slopes, and regenerating bush in nearby gullies. The landscape has a mixed use characteristic of lifestyle areas. However, the area on the main ridge to the south is being developed in a comprehensive way with large lot 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 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, water courses and reserves.

Section 2.5 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 VIII of this documentation, transmission conductors in service produce electric and magnetic fields (EMF)[7]. 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% to 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.

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 it is carrying. The magnetic field strength will fall 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, it's positioning under roads and through open space areas also has the effect of reducing prolonged exposure at residences.

[7] Electric and magnetic fields are not a form of radiation. Electric and magnetic radiation generally refers to higher frequencies such as that emitted by cell phone towers and radio masts.

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, except for the retaining wall structures which may have a visual impact on the properties east of Regis Lane that have an outlook to the west. However, there are a number of similar structures in this area and in the long term these structures are likely to be obscured by residential development and planting.

Mitigation Measures
Affected groundcover will be reinstated and carriageways and footpaths sealed in accordance with Manukau City Council 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 management phase is provided through contract specifications, which include a wide range of requirements including the preparation and implementation of a Construction Management Plan. This will address and seek to avoid or minimise potential adverse effects including (but not limited to) traffic disruption, constraints on property access, construction noise, dust, sediment and any community effects.

Any potential effects relating to earth potential rise and induced voltage can be addressed through compliance with best practice, 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 economic well-being of the country.

9. Consultation

The consultation on the preferred cable route and the final cable route commenced in 2005. At that time the main interest came from property and business owners on Accent Drive and from landowners at the eastern end of the route.

As a result of the consultation process, the following changes were made to the cable route in finalising its location:

- The selection of Sub Option B through the stormwater management areas over Sub Option A following Accent Drive
- The final route was realigned to partially move it off Stancombe Road and into car parking area on the edge of Barry Curtis Park;
- An investigation of an alternative route proposed by the Van Het Bolschers – refer section 4.3; and
- Minor adjustments were made to the cable route location on the Van Het Bolscher and Smith properties.

Further public consultation activities in relation to the amendments made to the underground cable route at the eastern end (Brownhill) of the route, the proposed Pakuranga to Brownhill underground cable and the Brownhill Road Substation was carried out in late 2006 and included:

- 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 on the proposed underground cables was relatively modest with only 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 the preferred cable route and the final cable route is documented in section 2 of Part VII of this documentation.

10. Conclusion

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 underground cable from the Otahuhu Substation to the Brownhill Substation/Transition Station is the most suitable option both in terms of the route chosen and the use of underground cables. 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 made into 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

The burial of the cable through the tributary of Otara Creek will be subject to a separate consent process with Auckland Regional Council. As the effects on the Coastal Marine Area (CMA) and coastal environment will be addressed through the consent process and, given the nature of the proposed activity, as well as the existing environment and the mitigation measures proposed, 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 VIII 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 is generally consistent with the relevant rules and standards, and is not inconsistent with the objectives and policies of the relevant parts of the Manukau District Plan.

11.2 Consideration of alternatives

As 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 likely 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 reasonably 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, and, where appropriate, also the associated applications for resource consents.

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 is relevant to this notice of requirement. It is considered however, that while the cable route passes through the Coastal Marine Area, the tributary of Otara Creek has very low natural character and, due to the burial of the cable, any long term effects on the natural character of the coastal environment will be negligible in this location.

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) – the protection of areas of significant indigenous vegetation - as only minor removal of vegetation is proposed and there are no significant vegetation or habitats affected by the cable route.

In terms of section 6(d), apart from a brief period during construction, the proposal does not further impact on public access to the coastal environment in comparison with the existing situation. The location of the cable is not in an important location for access to the coastal marine area.

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 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 220 kV 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