Ministry for the Environment
Manatū Mō Te Taiao

National Policy Statement on Electricity Transmission

Further Guidance on Risks of Development near High-voltage Transmission Lines

Prepared by Transpower New Zealand Limited

New Zealand Government

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1 Introduction

1.1 Purpose

The National Policy Statement on Electricity Transmission (NPSET) established a range of policies to direct the management of effects generated by the national transmission network, and the management of effects on the network generated by development in close proximity to it. Specifically, the NPSET requires local authorities to give effect to Policies 10 and 11, which require them to manage adverse effects caused by development near high-voltage transmission lines.

This report has been prepared in response to a request from councils for further information on the risks of development and activities in relation to the transmission network, and how these could be regulated under the Resource Management Act 1991. This material could form part of, or help prepare, a section 32 assessment to implement the NPSET, and Policies 10 and 11 in particular. These policies relate to managing the effects of third-party development *on* the operational requirements of the network, as well as managing the effects *of* the network on third parties:

Policy 10 In achieving the purpose of the Act, decision-makers must to the extent reasonably possible manage activities to avoid reverse sensitivity effects on the electricity transmission network and to ensure that operation, maintenance, upgrading, and development of the electricity transmission network is not compromised.

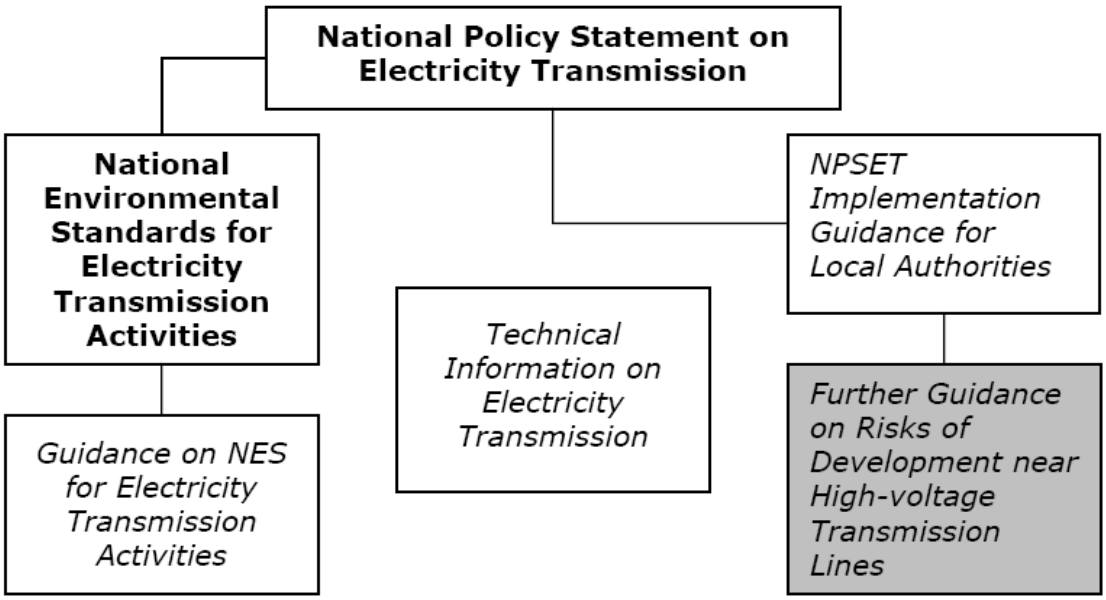
Policy 11 Local authorities must consult with the operator of the national grid, to identify an appropriate buffer corridor within which it can be expected that sensitive activities will generally not be provided for in plans and/or given resource consent. To assist local authorities to identify these corridors, they may request the operator of the national grid to provide local authorities with its medium to long-term plans for the alteration or upgrading of each affected section of the national grid (so as to facilitate the long-term strategic planning of the grid).

The question for local authorities is not *whether* to manage these effects (because they are required to be managed), but, working with Transpower, *how* these effects should be managed.

1.2 Other associated documents

Figure 1 below shows the relationship between the NPSET, the National Environmental Standard for Electricity Transmission Activities and the associated guidance documents.

Figure 1: Relationship of this guidance with other associated documents



This document is prepared as further guidance to help local authorities implement the NPSET.

The ***NPSET Implementation Guidance for Local Authorities*** provides local authorities with direction on how the National Policy Statement on Electricity Transmission, which came into effect on 10 April 2008, can be best given effect through regional and district planning instruments.

The ***Technical Information on Electricity Transmission*** will provide information on the technical aspects of electricity transmission, particularly the form and function of the national grid and the issues associated with planning for its long-term development, as well as its ongoing maintenance and upgrading requirements. This detailed guidance will be released as part of the guidance package for the National Environmental Standard for Electricity Transmission Activities.

2 The Problems with Development near High-voltage Transmission Lines

2.1 What are the risks created by development and activities near the transmission network?

The NPSET confirms that the national transmission network is a physical resource of national importance: its sustainable management is necessary to ensure the health and well-being of communities. One key component of that sustainable management is ensuring that adverse effects from development near transmission lines are addressed so that such development does not constrain the operation of the network. Another key component is ensuring that the operation of the transmission lines does not adversely affect third parties. NPSET Policy 10 requires these dual outcomes. Policy 11 promotes a buffer corridor approach for one of these outcomes: sensitive activities.

The need to manage development that poses a risk to, or is at risk from, the efficient operation of the transmission network was given significant consideration by the Ministry for the Environment and Board of Inquiry on the proposed National Policy Statement on Electricity Transmission during the development of the NPSET.[1] These two concepts were carried through to the development of Policy 10.

The main areas of risk arising from incompatible development and activities near the transmission network are:

- risks to the health, safety and well-being of persons and property
- risks to the operation of the transmission network
- risks to amenity.

Transpower itself has recognised these risks and has consistently opposed development occurring in close proximity to the network for these reasons. It also undertakes routine line inspection and maintenance to prevent and manage risks. Nevertheless, the encroachment of development into the line corridor remains a significant issue – with corresponding risks.

[1] Further information can be found on the Ministry for the Environment's website: http://www.mfe.govt.nz/publications/rma/nps-electricity-transmission-s32-evaluation-mar08/html/page5.html

2.2 Risks to persons and property: health, safety and well-being

NPSET Policy 11 requires the use of a buffer corridor to manage the issue of sensitive activities being established too close to the existing transmission network. The risks posed by the network, and by the effects of others' activities on the network, are articulated in the Ministry of Economic Development's Reference Group report[2] and are summarised below.

2.2.1 Risk of electrical hazard or injury

The main risk from development occurring too close to the transmission network is the creation of electrical hazard, due to either direct contact with lines or electricity arcing to contact structures, leading to injury to persons or damage to property. Risk of electricity earthing around transmission towers is a particular concern, as electricity can earth via support structures (towers or poles) or other objects coming into contact with the lines, or via 'flashover',[3] where electricity leaps to a structure such as a building. The risk of loss of life or injury therefore increases where buildings and other development or activities are located close to conductors or towers. An additional risk is from equipment or line components falling while in operation or when work is being undertaken.

Following are some examples of where these risks have been realised.

- In 2005, a concrete boom controlled by a mobile plant operator, working in an industrial area in Auckland, came into contact with the conductors of a line. This contact caused the line to trip, earthing via the mobile plant to ground, thus creating an extremely dangerous situation around that ground area, which included a school crossing. Had the development of the land under the lines been better managed this risk could have been minimised.
- In 2008, an incident occurred resulting in loss of life when an irrigator came into contact with live overhead lines. Had adequate separation distances been in place this death would have been avoided.
- In February 2009, a joint failure on the Otahuhu-Whakamaru-A (220kV) line resulted in a length of line falling on a residential area in Auckland, affecting 16 houses and causing damage to property (but with very real risk to public health and safety). Had there been a buffer or setback in place preventing residential development from occurring beneath the transmission lines this risk would have been eliminated, or at least significantly reduced.
- In October 2009, a mobile plant (forklift) carrying shipping containers within an industrial site under the Henderson-Otahuhu A (220kv) line in Auckland, came into contact with the line resulting in loss of supply to approximately 280,000 customers. The risk of line contact and service failure was directly related to the establishment of the industrial use under the line in the first instance.

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[2] Ministry of Economic Development. 2006. *The Merits and Potential Scope of National Guidance on the Management of Electricity Transmission under the RMA.* http://www.med.govt.nz/templates/MultipageDocumentTOC____21835.aspx

[3] 'Flashover' is the term used to describe a momentary, but major, electric arc, usually across an insulator string. A flashover or contact with the lines may result in an outage of electricity supply to communities, people and industry. A flashover or contact with the lines may also result in items becoming live, resulting in health and safety risks to the public.

- Other incidents have included tools or equipment falling during the routine maintenance of overhead lines.

The risk of injury or electrical hazard from such events increases significantly with increased development or activity within the corridor. Transpower considers this risk to persons and property unacceptable, and incompatible with the safe and efficient operation of the transmission network. Transpower believes its rigorous maintenance and safety standards are being undermined by ongoing development under, and close to, transmission lines. The prime intention of the NPSET is to prevent the exacerbation of these risks.

2.3 Risks to the transmission network

The national benefits of transmission are specifically recognised by the NPSET, in particular in Policy 1. Risks to the transmission network pose a threat to the environment that must be managed as part of promoting the sustainable management purpose of the RMA, and more specifically by the dual purpose of Policy 10 of the NPSET. Risks to the transmission network can occur as a result of failing to provide for maintenance, and by failing to prevent certain activities from locating in a position where they present a threat to the line.

2.3.1 Risks associated with 'reverse sensitivity'

The term 'reverse sensitivity' was defined by the Environment Court in *Auckland RC v Auckland CC*[4] as "the effects of the existence of sensitive activities on other activities in their vicinity, particularly when they lead to restraints in the carrying on of those other activities". That case also confirmed that it was legitimate to make rules to restrict the location of activities sensitive to low air quality, in or adjacent to areas where air quality was low (ie, that in principle, it was acceptable to introduce rules to address reverse sensitivity issues). This principle has subsequently been confirmed by a number of Environment Court decisions.

In relation to the transmission network, allowing development near or under existing transmission lines may introduce a more sensitive activity (eg, residential use) to the area. This may result in actual or perceived health, safety and operational risks. Encroachment may also lead to restrictions being placed on the continuation or upgrading of existing infrastructure due to concerns about health and safety, such as electromagnetic health effects, noise nuisance (eg, from substations or lines), or amenity concerns. These may, in turn, create an undue restriction on the ability for the assets to be used to meet forecast demand.

2.3.2 Risks of disruption to transmission, and effects on security of supply

NPSET Policy 10 requires that activities be managed to ensure that (among other things) the operation of the transmission network is not compromised. Just as the transmission network can pose a risk to the health and safety of people and property, so third-party activities and development can pose a significant risk to the operation of the network, which risks security of supply. Faults or outages on a line may be caused by physical contact with or proximity to conductors from other objects (trees, buildings, mobile plant), or the deposition of material

[4] *Auckland RC v Auckland CC* [1997], NZRMA 205.

(such as dust) that causes a line to flashover/fault. This may cause a fault or outage, and will have flow-on effects for system security, because taking a line out of service overloads the rest of the network.

Transpower's records show that third-party incidents were responsible for supply interruptions of 311 megawatt hours of non-supply over the period 1996–2006 (this relates to total interruptions caused by any third-party event). This equates to a cost of $6.22 million, using the Electricity Commission's value of lost load calculations, $20,000 per megawatt hour. A recent example is the power outage in October 2009 caused by a forklift carrying a container coming into contact with the 220 kilovolt transmission line between Otahuhu and Henderson. The incident resulted in the loss of electricity supply to North Auckland and Northland (about 280,000 customers). (For other specific examples, refer to appendix 1.)

The implications of a network fault include potentially hours of loss of electricity supply while faults are corrected. An asset fault could also cause an increase in the price of electricity. Depending on the location of the fault and the affected equipment, more pressure is placed on the remaining in-service transmission system. A reduction in the level of transmission equipment available to the electricity market could result in binding transmission constraints and, consequently, increased electricity prices.

Transpower (as the system operator) responds to and manages asset faults in its role as a reasonable and prudent operator. The system operator manages the security impacts of the fault in real time to ensure the security of scheduling and dispatch is not compromised. Time is also taken to reassess the security of planned outage and commissioning work in light of the fault. Afterwards, the system operator reviews the circumstances surrounding events that have had a material impact on its operations to determine appropriate process improvements and other actions to reduce the likelihood and impact of a recurrence.

However, despite Transpower's best efforts, faults continue to occur as a result of third-party encroachment in the transmission corridor.

2.3.3 Risks to structural integrity

NPSET Policy 10 requires that activities be managed to ensure that (among other things) the operation of the transmission network is not compromised. Development under, or too close to, transmission lines can also affect the structural integrity of transmission network components. Examples include the physical undermining of poles, towers or conductors by excavation of earth or scouring through the diversion of water; particulate build-up from smoke, or direct risks from fires, causing electrical hazard risks due to fires being too close to lines; or direct contact with conductors. For example, in 2003 excavation as part of construction at a site on the HEN-ROS line (Auckland) extended to 3 metres below a tower grillage and 2 metres from a tower leg. This excavation put at risk the structure and security of the line, and had operational implications in terms of security of supply to Auckland. This incident incurred significant cost, time and effort to rectify, including engineers' site assessments, site visits, infill and replacement of necessary earthworks. Supply to significant areas of Auckland was also at risk.

More detailed examples of this type of risk are provided in appendix 1.

2.3.4 Risks to the ability to inspect and maintain lines (conductors) and support structures

NPSET Policy 10 requires that activities be managed to ensure that (among other things) the operation and maintenance of the transmission network are not compromised. The encroachment of building and development within the line corridor can create a physical barrier to the network, preventing, for example, machinery from accessing towers, foundations or conductors along the line route. This can make vital ongoing maintenance and repair difficult or impossible. As well as creating hazardous situations for those under the lines, physical constraints along the line route can have significant time implications for routine line inspections, routine maintenance, and undertaking line upgrades. Preventing or inappropriately constraining the inspection and maintenance of existing lines does not promote the sustainable management of this important physical resource and is contrary to the NPSET, in particular Policies 1, 2 and 10.

2.3.5 Risks to the ability to undertake line upgrades

NPSET Policy 10 requires that activities be managed to ensure that (among other things) the development of the transmission network is not compromised. The encroachment of development into the transmission corridor can at worst foreclose, and at best significantly constrain, opportunities to upgrade those assets to meet future demand. The alternative to upgrading existing lines is to build new lines. However, these lines would still have to link the point of supply (generation) to demand nodes (substations or major users), which introduces a new set of adverse environmental effects. The inability to upgrade within the existing line corridor does not provide for the sustainable management of the resource (confirmed by the NPSET as being of national importance).

2.4 Amenity risks

Encroachment of development into the transmission corridor does not provide a good level of amenity generally, and this is the case for residential development in particular. Submissions from local authorities at the NPSET hearings commonly referred to a desire to prevent residential development from being established too close to lines on grounds of quality of amenity, as well as health and safety concerns.

Transpower's *Guide for Development near High-voltage Transmission Lines* http://www.transpower.co.nz/landowner-guides was developed to provide design solutions and encourage higher levels of amenity for compatible development near transmission lines. Minimising the potential for adverse effects on amenity, including appropriate design, is one means of addressing potential adverse effects under the RMA.

2.5 Summary

Policies 10 and 11 require that activities be managed, including through the use of a buffer zone, to avoid reverse sensitivity effects and ensure the transmission network is not compromised. The management of the effects of third-party activities on the national grid is necessary to ensure that:

- the public and property are reasonably protected from live transmission lines
- integrity of supply is maintained by ensuring that no activities that may affect or damage the line are located beneath, or in too close proximity to, the line
- existing lines can be operated, which includes a requirement for assets to be routinely inspected and maintained
- the option of upgrading existing lines, rather than building additional lines, to meet increased electricity demand is not precluded by the development of buildings under or immediately adjacent to existing lines
- a minimum level of amenity is retained for those living in close proximity to lines by not being located directly underneath lines.

The appropriate management of development and activities in close proximity to the transmission network would achieve these outcomes, thus giving effect to NPSET Policies 10 and 11. In this way, when promoting the sustainable management of natural and physical resources in resource management decisions, people and communities can provide for their social, economic and cultural well-being and for their health and safety, while providing for the reasonably foreseeable needs of future generations and avoiding, remedying or mitigating adverse effects. Conversely, if third-party effects are not appropriately managed, then the purpose of the RMA will not be met.

3 NPSET Policy 10 and Policy 11 Implementation Options

3.1 What are the options to manage the effects of development near the existing transmission network?

Policy 10 of the NPSET requires that councils, through their district plans, manage third-party development and activities that are sensitive to the effects of the electricity transmission network *and* development and activities that would compromise the operation, maintenance, upgrading and development of the electricity transmission network. Policy 11 requires that councils consult with the operator of the national grid to identify an appropriate buffer corridor.

There are a number of regulatory options to consider that may achieve the sustainable management of the transmission network with respect to the effects of nearby development and activities. However, any regulatory options considered must demonstrate how the requirements of the NPSET (Policies 10 and 11) will be achieved.

4 Transpower's Corridor Management Policy

The Corridor Management Policy (CMP) was developed in response to the limitations of the *New Zealand Electrical Code of Practice 34:2001* (referred to as NZECP 34) in managing the risks posed by third-party development near the transmission network. The CMP provides a policy framework for managing and protecting Transpower's transmission corridors. The CMP is Transpower's internal policy which guides the company's input to plan development and submissions on specific development and activity proposals including proving its affected party approval, lodging submissions, or appealing resource consents. As a company policy, it does not hold any statutory weight. However, when adopted into district plans as an appropriate method to manage the issue of third-party risks to transmission lines, the approach holds the same status as other district plan rules. Either Transpower or your local authority can provide information on how this policy might affect existing use rights.

The CMP provides a consistent and rational basis for managing the issue of development near transmission lines. A nationally consistent approach is warranted because the effects of the lines do not vary across the 12,000-kilometre network, even though the receiving environment might. It is therefore just as important to consider the full suite of risks in rural Southland as in urban Auckland. Because of the sheer scale and national nature of this issue, a consistent approach is appropriate.

The objectives of the CMP are to:

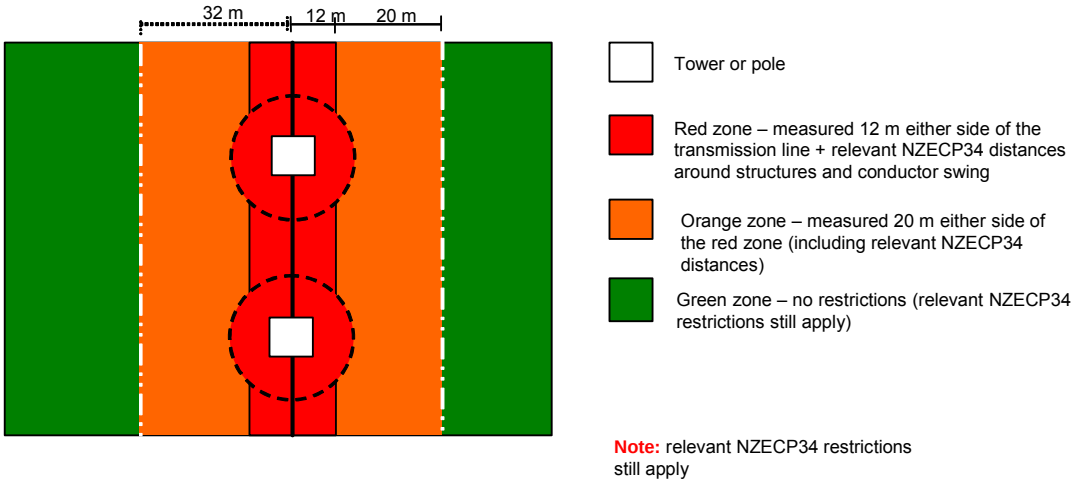
- **protect**, through appropriate mechanisms, the land immediately under existing lines from activities that undermine the safe and efficient operation, maintenance and upgrade of existing lines – this can be achieved by seeking clear space immediately under transmission lines, to a distance of 12 metres either side of the centre of the line, as well as all relevant NZECP34 distances[5] (the 'red zone')
- **manage**, through appropriate mechanisms, activities within close proximity of transmission lines, to a distance of 20 metres either side of the red protection zone (the 'orange zone')
- **inform**, educate or liaise, where relevant, where issues are raised by development occurring beyond the orange zone but in proximity to transmission lines (the 'green zone'), although orange zone provisions may still be relevant outside of the set distance of the orange zone.

These zones are illustrated in Figure 2.[6]

[5] Applies to all voltages.

[6] Not to scale.

Figure 2: Transmission Corridor Activity Management



The policy is based on the specific effects of development and activities on the network, and managing the effects of the network on those activities. Different types of activities are considered against the following key criteria:

- risks of electrical hazard or injury
- risks associated with 'reverse sensitivity' issues
- maintaining a level of amenity
- risks of disruption to transmission and effects on security of supply
- physical risks to structural integrity
- risks to the ability to inspect and maintain lines and support structures and to undertake line upgrades.

The details of the policy were developed by Transpower's transmission experts and practitioners after considering anecdotal evidence, experience, specific examples, practices and case studies across the network (ie, on a national basis).

The red zone was agreed to as the minimum distance that could reasonably accommodate the heavy machinery required to undertake line maintenance works. It was agreed that to reduce risk of injury to persons, or damage to property, and to enable necessary maintenance and operational requirements, it was not appropriate for *any* development to occur in this zone. This analysis also included a review of international practice, which concluded that it is very unusual (and not good engineering practice) to allow buildings and structures (including, but not limited to, residential use) to develop near to existing high-voltage transmission lines.

A more considered approach was felt to be appropriate for a wider area either side of the red zone. Experts' experience concluded that development proposals need to be taken on their merits in this zone, as some development may be appropriate with certain measures in place to mitigate additional electrical risk, accommodate future line upgrades, provide a level of amenity, etc. Thus it was considered a zone of 20 metres either side of the red zone would capture approximately 80 per cent of the conductor swing distances for spans along the 12,000-kilometre network. This approach is also consistent with the distances of easements obtained for significant line upgrades.

Further details of the justification for the CMP zones is provided in appendix 2.

Appendix 1: Further Information on the Risks of Development near High-voltage Transmission Lines

Costs of third-party activities on the transmission network – general

The following table provides further information on the frequency, consequences and costs of the effects of incompatible development on the transmission network. This information was provided on request by the Ministry for the Environment[7] as background to its work on a National Environmental Standard for Third Party Risk Management. Under the Ministry's instruction, costs provided are to Transpower only; costs to the national economy, or to local authorities, have not been included in this material.

Note that the risks posed to, and by, development near high-voltage transmission lines represent *low probability, high consequence* risks. Because of the nature of transmission, the consequences of these risks will vary depending on variables such as the location of assets (eg, whether supplying to rural or urban areas or direct to industry), the supply loads at that particular time, or constraints placed on the network as a result of a fault.

Activity	Examples/ frequency	Consequences	Costs to Transpower
Building	Third-party underbuilding represents the single most significant risk to the existing line corridors. This issue underpins all other activities, because the more development and people are allowed within the corridors, the greater the *frequency* and *consequence* of accidents, faults and costs. **Examples** Multiple examples of underbuilding in urban areas in particular. Transpower can provide photos if required.	**Risks to public include:** • increased risk of electrical hazards to the public from arcing, flashovers, earthing issues, and coming into direct contact with lines (eg, TV aerials or water overflow pipes inducing current under the lines) • increased risk to the public from maintenance or acts of God (eg, a conductor may fall after a storm event, which could have significant effects if it occurred in a residential area) • risks from loss of power supply (eg, event in October 2009 where third party activity caused power fault resulting in loss of supply to approximately 280,000 customers).	**General** This activity can result in costs due to: repair/rectification; loss of supply; effects on network operations/security of supply; increased risks to public safety; and increased risks to network operations. A recent example includes an event in October 2009 where a mobile plant carrying shipping containers came into contact with the Henderson-Otahuhu A (220kv) line in Auckland, resulting in loss of supply to approximately 280,000 customers. Third-party activity costs relate to increases in development or activity in close proximity to line corridors. Transpower's records show that third-party incidents resulted in supply interruptions of 311 MWh of non-supply (1996–2006) (this relates to total interruptions caused by any third-party event).

[7] This information was provided in 2007. Incidents that have occurred since then (such as a conductor being dropped on 16 properties in Manukau in February 2009 and the power failure in Auckland city and north in October 2009 caused by a mobile plant carrying containers coming into contact with national grid transmission lines) have not been included. Costs will vary, and typically increase over time.

Activity	Examples/ frequency	Consequences	Costs to Transpower
Building (continued)	**Frequency** There were estimated to be approximately 5000 encroachments of development (buildings, fences or structures) into NZECP34 areas in 2004. Most of these occurred in Auckland and other rapidly growing urban areas. Transpower's records show that between 2004 and 2006 there were approximately 633 *new* land parcels around the country (subdivisions) within a zone 25 metres either side of the line. Note: Any number of buildings may be established on these parcels, and this does not address *existing* land parcels and what could be built on those.	**Risks to assets include:** • increased risk of contact with lines, resulting in an operational fault, or outage • increased impediments to access to towers and poles, which can impede routine maintenance programmes, resulting in increased risks to structural integrity • increased health and safety risks for line workers, because unsafe work places are created. **Process** Transpower reviews, weekly, all notified consents on a national basis and submits on relevant consents. There are significant costs to Transpower to submit on resource consents, seek conditions of consent, appeal decisions, etc. There are increased costs from requirements for line inspections and patrols, and more work for field officers. (Transpower's contractors undertake routine six-monthly patrols to look for encroachments or other threats to the operation of lines.) There is increased risk of reverse sensitivity issues (eg, more people living nearby, which leads to complaints about the operation of the grid, such as objections to resource consents, requirements for electric and magnetic field (EMF) readings, or health and safety assessments).	This equates to $6.22 million (using the Electricity Commission's value of lost load calculations of $20,000 per MWh). However, this value is contested (as being too low) by local lines distributors and will vary significantly depending on where supply is removed (eg, rural or urban, or direct industry supply). **Costs to raise conductors as the result of building occurring under lines** Options to raise conductors in order to correct a breach of NZECP34 (eg, where separation distances are reduced as a result of third-party activities) vary significantly, but can cost up to $135,000 per tower (depending on the work and type of tower, and not including Transpower staff time and other costs). **Costs of property acquisition (as an alternative to managing building within the corridor)** The cost of acquiring property rights for the existing 12,000-kilometre network has been estimated by Transpower at $7 billion. Notwithstanding the fact that Transpower already has statutory rights to operate its land, incurring this cost is not seen by Transpower as a feasible solution. **Process costs** There are the costs to Transpower from staff reviewing and responding to nationally notified consents (relating to a range of third-party activities). *All* of Transpower's processes are affected by underbuilding. For example, where a tower is located on one lot with one interested party, due to encroachment there may now be 15 landowners or affected persons who must be negotiated with to achieve access, inform about maintenance, remove or repair structures to get machinery to the site, etc. This is a substantial cost in terms of time, money and effort. There are significant costs to address underbuilding issues (eg, going through RMA stop-works procedures). For example, in one territorial local authority in Auckland, building platforms were established within 3 m of a tower, approved by the council, despite a Land Information Memorandum (LIM) advice note referring to compliance with NZECP34.

Activity	Examples/ frequency	Consequences	Costs to Transpower
Building (continued)			There were significant process costs to rectify this one example of underbuilding. Also refer to the 'Consequences' column for process costs.
Excavation Deposition/ earthworks	Excavation (eg, for gravel extraction) causes destabilisation of the assets. Deposition can create hazards by reducing safe ground-clearance distances. **Examples** In 2002 gravel extraction works on the West Coast undermined the stability of existing poles. Transpower's involvement to rectify the situation (which involved seeking buttressing or new batters) is ongoing (five years plus). (See under 'Costs'.) **Frequency** Excavation that destabilises assets occurs about five times per year around the country. Material is commonly deposited under lines around the country, in breach of NZECP34.	Risks to structural integrity – the tower/pole may be destabilised, and may cause the structure failure (fall). Costs of rectification – the tower/ pole may be removed, requiring replacement. Deposited material presents electrical safety risks to the public. Excavation and deposited material increase the risk of a faults or flashovers, thus posing a risk to the functioning of the network. **Risks to the public include:** • risk of injury/loss of life from faults caused by encroachment into the safe separation distance. **Risks to assets/system security include:** • the risk resulting from faults to lines, or destabilisation of towers. There are health and safety risks to contractors because unsafe work situations are created for routine maintenance jobs (eg, road stoppages, traffic management).	**General** This activity could result in costs due to: repair/rectification; loss of supply; effects on network operations/security of supply; and increased risks to public safety. **Costs to rectify (eg, raise conductors as result of building occurring under lines)** Options to raise conductors to correct a breach of ECP34 (eg, where separation distances are reduced as the result of deposition of material) vary, but can cost up to $135,000 per tower (depending on the work and type of tower, and not including Transpower staff time and other costs). For example, one landowner built up piles of rubble that have cost approximately $100,000 to remedy. Costs are also incurred to strengthen foundations or recreate batters and/or restabilise. **Process costs** There are significant additional process costs for routine maintenance work (eg, requirements to remedy NZECP34 breaches may require inspections, surveys of breaches, road stoppages, traffic management plans, etc as a result of new earthworks or new roads being established under lines, as occurred in Auckland). Transpower staff, contractors, consultants and lawyers are involved in processes (eg, enforcing NZECP34 requirements/remedying hazards). **Risks to grid operation** Tower destabilisation may require remediation works to the tower. Loss of a tower may result in service disruption/line outage, which may require load shedding (ie, blackouts), which incurs significant cost to urban areas and industry. There are process costs to obtain resource consents/property access to remedy affected towers/poles. This could vary between very low costs (eg, time, phone calls) to hundreds of thousands of dollars to resolve access or to obtain the RMA approvals required to undertake works).

Activity	Examples/ frequency	Consequences	Costs to Transpower
Particulate discharges (dust, smoke)	Particulate matter such as dust from earthworks, emissions from industry, or burn-off from farming activities can build up on transmission equipment. **Example** In January 2007 in Auckland, sparking insulators caused a fire service call-out and evacuation of residences under lines. The line was taken out of service and the insulators were cleaned. **Frequency** This is difficult to estimate. All development, burn-off etc near lines will result in some level of deposit on equipment. This is monitored as part of maintenance (regular line inspections and condition assessments), and specific insulator washing programmes are instigated where needed.	Dust or particulate build-up from earthworks or discharges can build up and corrode equipment. This increases the risk of circuits tripping or flashovers, resulting in loss of supply of electricity to customers. An increased risk of electrical hazard means an increased risk to public safety, particularly where the public has located within the line corridor. This activity requires an increase in maintenance costs (eg, through washing insulators). **Risks to public safety** Particulate build-up can result in arcing of insulators, causing sparking, resulting in increased risks to public safety. This risk is closely associated with the core issue of development occurring within the corridor.	**General** This activity could result in costs due to: repair/rectification; loss of supply; effects on network operations/security of supply; increased risks to public safety; increased risks to network operations. **Risks to grid operation** Additional maintenance may be required (eg, washing of insulators), which can incur significant costs. There is increased risk of flashovers, which can cause line faults, resulting in costs to system security.
Vegetation (commercial forestry or other vegetation)	The main areas of concern relate to plantation forestry (commercial or small-scale life-stylers) and rural areas, such as shelterbelts and bush. There are fewer concerns with landscaping planting in urban areas (although this varies from region to region). **Example** In 2004, on the Glenbrook deviation line, a shelter belt tree was growing too close to conductors, and flashover caused current to be induced along a fenceline. Around 300 m of shelterbelt burned. The fire service was called out. There was no outage on the line and no other damage to property. **Frequency** Vegetation caused an estimated 85 hours worth of equipment outages (lines and substations) over 1996–2006, resulting in supply interruptions totalling 50 MWH over that period.	**Risks to the public include:** • risk of injury caused by fire or other flashover effects (including induced current) • loss of private property (eg, shelterbelts burned) • cost of call-out of emergency services. **Risks to assets/system include:** • faults or outages as the result of fires, flashovers, or direct contact with lines • system security consequences where faults occur (which increases the load on alternative circuits). **Risks to processes include:** • significant costs for line patrols to inspect, maintain and trim any vegetation growing too close to lines, which is exacerbated when trees are purposely planted within the Tree Regulations zone (eg, shelterbelts).	**General** Vegetation management costs are incurred across Transpower's eight regions on an annual basis. For example, vegetation management is estimated to cost $2 million/year in the Auckland region. In addition to ongoing management costs, vegetation can cause costs in terms of supply outages or equipment failure. Third-party vegetation-related incidents caused supply interruptions totalling 50 MWh (valued at $1 million) between 1996 and 2006. Third-party vegetation-related incidents also caused 85 hours of equipment unavailability, resulting in reduced security of supply over this period.

Activity	Examples/ frequency	Consequences	Costs to Transpower
Mobile plant	The operation of mobile plant (such as crane or forklift) can cause significant risk to the safety of the public and operation of the network. This risk is closely associated with allowing development within the corridor, because mobile plant is used in association with new buildings or industry operation. **Example** In 2005, a concrete boom struck a line in Auckland, tripped the line (caused a fault), and earthed to ground, resulting in significant risk to the public and significant damage to the mobile plant itself. **Frequency** It is estimated that mobile plant operation causes approximately eight incidents/ faults per year on a national basis and results in approximately 100 enquiries (eg, process costs) a year on a national basis.	**Risks to the public include:** • significant risks to safety and property • risk of injury or loss of life • cost of emergency services call-outs. **Risks to assets/system include:** • significant risk of damage to structures/structural integrity • significant risk to the plant operator and the wider public, because faults can earth to ground (resulting in electrical hazard risk if nearby) • significant risk to the security of supply, because contact with lines can disrupt or disable the transmission line. **Process costs include:** • field officers responding to public enquiries (estimated to be approximately 100 per year nationwide).	**General** This activity could result in costs due to: repair/rectification; loss of supply; effects on network operations/security of supply; increased risks to public safety; and increased risks to network operations. Process costs arise from Transpower responding to enquiries, conducting earth-conductor surveys and responding to incidents. **Costs to grid operation** Line outages may require load shedding (which has significant cost to urban areas/industry). Transpower has recorded that third-party incidents involving cranes and machinery (including forestry machinery) between 1996 and 2006 resulted in 58 MWh not supplied, valued at $1.16 million (based on the Electricity Commission calculation of the MWH value of lost load), and 174 hours of equipment unavailability. As the majority of mobile plant use is associated with construction or the operation of industry, the risk of incurring these costs is significantly reduced if underbuilding does not occur in the first instance.
Subdivision (note that in terms of effects on the network, this activity is inextricably linked to building / development)	**Frequency** Transpower's records show that approximately 633 *new* land parcels (subdivisions) were established between 2004 and 2006 within a zone of 25 m either side of the line. Any number of buildings may be established on these parcels. This total does not include *existing* land parcels and what could be built on those. It is understood that these records are likely to be an underestimate. Transpower estimates that new NZECP34 non-compliances may be occurring at approximately 750 per year (around the country). Transpower lodged 79 submissions to notified subdivision consents over the 2005/06 year. Transpower also made submissions on structure plans (private plan changes or council led) – approximately 15 in 2006.	**Physical** Increased subdivision can facilitate significant building encroachment under lines, because building on a subdivision often does not require resource consent (therefore Transpower does not become aware until it is built). Increased subdivision can result in increased safety risk to the public, violations of Tree Regulations as subdivisions are landscaped, and lower amenity outcomes (residential development under lines). Increased subdivision and development increases the time, effort and cost of routine line patrols (eg, fences may have to be dismantled, vegetable gardens reinstated, etc). **Process** Transpower has significant involvement in the submission/council process. As a result, either development is set back to meet the conditions of consent, or those conditions are not imposed, resulting in electrical risks to the network's operation, public well-being, and property.	**General** There are Transpower staff and process costs due to involvement in resource consent, plan change and structure plan processes on a national basis. (Note: These costs overlap with 'building' activity because most of the subdivision submissions raise issues to do with encroachment and managing the underbuilding issue.)

Activity	Examples/ frequency	Consequences	Costs to Transpower
Subdivision (note that in terms of effects on the network, this activity is inextricably linked to building / development) (continued)		There are operational implications because all future works are hampered/affected by increased activity (buildings/structures/risks) within the corridor. Reverse sensitivity issues are increased as a result of increased dwellings or development under lines.	
Water and other hazards (damming and diverting, swimming pools	**Example** Dams are established upstream (and in the path) of assets. **Frequency** This is mainly an issue in the South Island. It has low frequency but high consequence.	**Physical risk** There is the potential to damage or destroy structures if dams break. **Process risk** Reinstatement of structures involves a significant number of Transpower staff (eg, environmental, field services, legal, and associated costs).	**General** This activity could result in costs due to repair/rectification; loss of supply; effects on network operations/security of supply; increased risks to public safety; and increased risks to network operations.
Fencing	Metallic fences can conduct fault currents if they are near a line support structure (tower/pole). **Frequency** There are numerous fences erected in breach of NZECP34 in rural and urban situations around the country.	**Safety risks** There is a risk to the public from current being induced along fences that are located too close to towers/poles. This could cause shocks even at significant distances away from towers/ poles. **Process risks** Fences around towers or within the transmission corridor have to be removed, repaired or replaced to get machinery in to undertake routine maintenance works. This creates significant additional time and process costs. Note: This risk is closely associated with allowing subdivision and development within the corridor, as fences are erected in association with new buildings or industry.	**To grid operation** A line fault or outage reduces the security of the line, and may require load shedding (which has a significant cost to urban areas or industry). **Process costs** Fences around towers or within the transmission corridor have to be removed, repaired or replaced to get machinery in to undertake routine maintenance works. This creates significant additional time and process costs.

Appendix 2: Further Information on Transpower's Corridor Management Policy

The following provides a summary of the justification for the Corridor Management Policy zone approach.

Red zone

The red zone**,** measured 12 metres either side of the centre of the line, plus NZECP34 distances around support structures, represents the minimum reasonable distance required for access for maintenance and operations (ie, to work around foundations, use mobile plant or a four-wheel drive vehicle, etc). This results in protecting the 'conductor shadow' area from development. Access is most important around structures, but is also necessary along the whole length of the line so as not to restrict the range of vehicles/plant being used, and to allow for future movements of towers along the line route if necessary.

The red zone:

- is based on the requirements to maintain and operate 220 kilovolt flat-top towers – this distance would also incorporate other smaller line configurations
- is consistent with and incorporates most NZECP34 requirements – some additional area may be needed around the tower foundations (ie, where 12 metres from the foundation may be further than 12 metres from the centreline), and this would extend into the orange zone
- provides limited ability to alter existing line specifications (maintenance or upgrading) without adversely affecting activities underneath, or being constrained or affected by those activities
- is consistent with international good electrical industry practice.

Orange zone

The orange zone, occupies an additional 20 metres beyond the red zone. The red zone provides protection for access for maintenance/operation works, but does not incorporate other adverse environmental effects, including structural and safety risks, electromagnetic field effects, earth potential rise, amenity, effects on operational requirements, and efficient management of the network (not foreclosing the ability to upgrade lines). Thus a restricted discretionary zone where these matters can be considered is appropriate.

The 64-metre 'zone of interest' (12 metres plus 20 metres on either side of the centreline) is estimated to encapsulate approximately 80 per cent of line spans across the country.[8] The zone approach provides for an appropriate buffer corridor that can be applied as one consistent rule. This distance is consistent with the width of easements that Transpower has obtained for significant line upgrades (eg the 'ROX-ISL-A' line, running from Roxburgh to Islington).

The 'discretionary zone', assessing specific proposals on a case-by-case basis, is also consistent with international practice, and enables any NZECP34 distances that extend beyond the red zone to be captured.

Green zone

The green zone extends beyond the orange zone (with no set distance). Transmission lines do not sit in a vacuum, but are located within, and have an impact on, a wider context/environment. Therefore, it is appropriate for Transpower to acknowledge the relationship between the existing lines and the surrounding environment.

Some activities located in the green zone may actually directly affect the lines; for example, plantation forestry (fall hazard from trees), quarrying (dust), and subdivision (with the potential for reverse sensitivity issues, including amenity). Options include applying orange zone processes (eg, for forestry or dust), or sending out information or educating developers on ways to screen new houses from existing lines (eg, for subdivisions nearby). The zone is not defined, and so appropriate action will be determined on a case-by-case basis.

[8] NZECP34 Table 2: Safe distances from conductors.