wellington electricity™

Wellington Electricity

10 Year Asset Management Plan
1 April 2010 - 31 March 2020

Asset Management Plan

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1 April 2010 – 31 March 2020

Any comments or suggestions regarding the Asset Management Plan can be made to:

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Information, outcomes and statements in this version of the AMP are based on information available to Wellington Electricity at the time of preparation. Some of this information may prove to be incorrect and some of the assumptions and forecasts made may prove inaccurate. Consequently some of the information, outcomes and statements made in this document may not be valid. In addition, with the passage of time, or with impacts from future events, circumstances may change and some of the information, outcomes and statements may need to change.

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Any person wishing to use any information contained in this AMP should seek and take expert advice in relation to their own circumstances and rely on their own judgement and advice.

Statement from the Chief Executive Officer

Wellington Electricity welcomes the opportunity to submit an updated Asset Management Plan (AMP) following its first year of operation as a new entrant into the New Zealand electricity distribution industry. We confirm that this AMP has been prepared to meet the Commerce Commissions' "Electricity Distribution (Information Disclosure) Requirements 2008".

The first year of operations has been focused on establishing the organisation and leveraging from the $17.3m invested by the new shareholders in best-of-breed Information Technology platforms installed across the finance, accounting, operations, and asset management areas of the business. Apart from establishing the business, the focus has remained on maintaining the existing high levels of safety, reliability, service and performance of the network for its customers.

The AMP has been developed to confirm the organisation structure along with the business drivers for setting policies and procedures around best practice asset management. This includes a summary of the systems employed and an outline of processes adopted around maintenance, planning, investment, risk mitigation and outage management. A more detailed treatment of the asset classes has been included as well as areas where we are targeting to continue to improve our knowledge around the specific characteristics of assets which are nearing the end of their service life. This will drive a condition decision point for either elevated maintenance or capital replacement for these particular assets.

Network capacity appears adequate for the planning period based on maintaining the modest forecast growth rates, load management systems remaining effective and no large developments being disclosed at the time of AMP review.

The AMP has made a number of assumptions around the regulatory review currently taking place and positively forecasts that regulatory outcomes will continue to encourage lines businesses to be able to invest in asset maintenance and renewal on the basis of making a fair market return. Although new technology developments have yet to be fully commercialised, Wellington Electricity continues to evaluate opportunities for integration of advancements that benefit the efficient operation and effective utilisation of the network.

Our customers have been consistent in their feedback and are appreciative of a reliable network that is delivering services at affordable prices.

The new control room is performing well and providing the sound operational control of the Wellington network through state-of-the-art communication and control systems. It is our belief that this will position Wellington Electricity to become an industry leader in asset management practices. Being a member of the CKI/HEH Group allows Wellington Electricity the ability to access skills and knowledge from our other electricity distribution businesses and have direct access to international best practice in asset management. In conjunction with our service companies and in alignment with its business strategy, Wellington Electricity will continue to focus on the development of asset management strategies in parallel with the short to long term planning of the network to ensure that appropriate levels of capital and operational expenditures are made to deliver a safe, reliable and cost effective supply of electricity to consumers within the Wellington region.

We welcome any comments or suggestions regarding this AMP.

Greg Skelton
Chief Executive Officer


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Contents

1. Summary of the AMP

AMP Purpose

Wellington Electricity's distribution network was purchased by Cheung Kong Infrastructure Holdings Limited (CKI) and Hong Kong Electric Holdings Limited (HEH) in July 2008. In the 12 months following the purchase, Vector Limited provided services to the network under a Transition Services Agreement. Wellington Electricity Lines Limited (Wellington Electricity) is the name of the new lines business.

This AMP has been prepared to:

- Inform stakeholders of how Wellington Electricity plans to manage its electricity distribution assets in order to ensure that connected electricity consumers continue to receive a supply of above average quality and reliability at a reasonable price;
- Provide a working plan for use by Wellington Electricity for the management of the network as per the implementation of policies and processes outlined; and
- Satisfy the Commerce Commission's Electricity Distribution (Information Disclosure) Requirements 2008.

The AMP covers the 10 year period commencing 1 April 2010 and finishing on 31 March 2020. The plans described in this document for the year ending 31 March 2011 reflect Wellington Electricity's current business plan. Plans for subsequent years of the planning period are likely to be affected by the outcome of an asset management review currently being undertaken as well as by unforeseen changes to the environment in which Wellington Electricity operates.

This AMP was approved by the Wellington Electricity Board of Directors on 30 March 2010.

Assets Covered

Wellington Electricity's distribution network supplies the cities of Wellington, Porirua, Lower Hutt and Upper Hutt. A map of the supply area is shown in Figure 1.1. As of 31 December 2009, there were over 163,000 connected customers. The total system length (excluding streetlight circuits and DC cable) was almost 4,600 km, of which 61% was underground. Peak demands and energy distributed for the last three years is shown in Figure 1.1.

Year to	30 Sept 2007	30 Sept 2008	30 Sept 2009
System Maximum Demand (MW)	555	537	565
System Energy Injection (GWh)	2,569	2,581	2,595

Figure 1-1 Peak Demand and Energy Delivery

Figure 1-2 Wellington Electricity Network Area

Basis of the AMP

The AMP is based on the following assumptions:

Demand growth	Demand growth will continue to be lower than the national average and will remain steady through the forecast period.
Quality targets	The quality targets for the Wellington Electricity business in the period 2010 – 2015 will be maintained as per the Commerce Commissions decision paper on the default price path, November 2009.
Regulatory environment	The regulatory environment will encourage Wellington Electricity to continue to employ Capex and Opex to invest in the network to maintain the quality targets.
Shareholders	Shareholders will be incentivised to invest in the network to allow the business to be able to achieve market returns.
Economy	The commodity markets will remain stable during the forecast period.

Business cycle	Wellington Electricity continually undertakes detailed assessments of network assets. It is assumed there will be no uncovering of any new information that changes the premise of network assets being in a reasonable condition.
Technology	There will be no dramatic changes that would result in a rapid uptake of new technology leading to higher expenditure or stranding of existing assets.

Figure 1-3 AMP Assumptions

Network Reliability

The reliability of Wellington Electricity's distribution network is high by both New Zealand and international standards. In the absence of severe storms and other external events, the average consumer connected to the network can expect an outage lasting a little over an hour about once every two years. Wellington Electricity plans to maintain supply reliability at current levels over the planning period and its asset management strategies and forecast levels of expenditure and investment are designed to achieve this by replacing assets that are at end of life and maintaining in service assets through to end of life.

Network Development

The growth of electricity consumption and demand in the Wellington Electricity's network area is around 1.5%, which is lower than the national average of around 2.1%.

Wellington Electricity is in the planning stages of a project that will transfer load from the heavily loaded Frederick Street zone substation in the Wellington CBD to utilise spare capacity at the Nairn Street zone substation. Later in the planning period a new zone substation within the CBD area may be required. Other areas with potential capacity constraints are Mana-Plimmerton, Wainuiomata and the Johnsonville-Paparangi areas. Investment options including reinforcement of sub-transmission into these areas will be analysed and may be required inside the planning period.

Asset Replacement and Renewal

The design of the Wellington network is biased towards obtaining high availability and reliability. This is evidenced by the fact that there are about 100 ICP's per HV circuit breaker in Wellington Electricity, where the national average is around 250, and the Wellington CBD area comprises many HV rings which provides for uninterrupted supply in the event of the loss of any one component. The Wellington Electricity network also comprises a high percentage of underground cabling with 66% of the sub-transmission circuits being cabled. Of this, 61km is of pressured gas filled construction most of which was installed in the 1960's and is now considered to be approaching end of life.

The high number of circuit breakers, the HV rings and the predominance of cabling help with achieving the high levels of reliability mentioned above, but they are asset intensive. As equipment ages, Wellington Electricity is forecasting a period of high capital expenditure on asset replacement and renewal being required to maintain present levels of reliability.

Wellington Electricity has programmes in place to regularly monitor the condition of its older assets. This ongoing condition assessment indicates that the existing assets are still serviceable and are generally in reasonable condition for their age. Notwithstanding this, almost 50% of forecast capital expenditure over the planning period is expected to be on the proactive asset replacement and renewal of older assets. This level of expenditure is designed to maintain present supply reliability. The scale of renewal and replacement will be higher than previously experienced on the network, and the number of planned outages required will in turn have a negative impact on the network reliability indicators in the short term.

Asset Management Systems

The migration of asset management data from Vector's asset management systems to Wellington Electricity's asset management and business systems has been completed and was a major component of the transition plan that culminated in the termination of the Transition Services Agreement with Vector. Wellington Electricity is now focusing on identifying gaps in its asset management processes information and streamlining processes over time.

The transition programme included the re-establishment of a fully functional and operational network control centre at Haywards substation. This was completed in June 2009. The transition included the provision of a disaster recovery site at Transpower Central Park. Final cut-over to the new SCADA platform will occur in 2010.

Risk Management

Wellington Electricity has risk assessment processes in place that provide input to the planning of network development and maintenance strategies. A major objective of the network development and lifecycle asset management plans is to mitigate the risks inherent in operating an electricity distribution business. Risk assessment therefore plays a major role in the prioritisation of network development and asset replacement projects.

The detailed design and operation of the network is not described in this AMP, but it is summarised at a high level to demonstrate it is in accordance with industry standard practices and procedures. These practices and procedures have been developed and refined over time to mitigate the risks and hazards associated with high voltage electricity distribution.

Emergency plans are in place to respond to foreseeable high impact low probability events that stress the network beyond its design envelope.

2. Background and Objectives

2.1. History and Ownership Overview

Wellington Electricity is an electrical distribution business that supplies electricity to approximately 400,000 consumers through over 163,000 installation connection points (ICP's) in its network that covers the Wellington, Porirua and the Hutt Valley regions of New Zealand.

The ownership of Wellington Electricity has changed significantly since the early 1990's. At the start of the 90's, the Wellington City Council Municipal Electricity Department (MED) and the Hutt Valley Electric Power Board (HVEPB) merged their electricity assets. As part of the Energy Companies Act 1992 two new companies were formed, Capital Power and Energy Direct respectively. In 1996 the Canadian owned Power Company Transalta acquired both companies to form a consolidated Wellington Electricity Distribution Network business. Ownership was passed to United Networks in 1998, which Vector acquired in 2003.

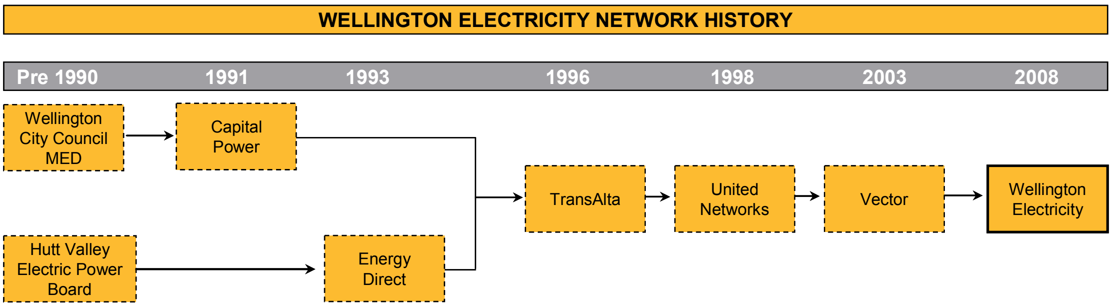

Figure 2-1 Wellington Electricity Ownership History

In July 2008 the network was purchased by Cheung Kong Infrastructure Holdings Limited (CKI) and Hong Kong Electric Holdings Limited (HEH) to create Wellington Electricity Lines Limited (Wellington Electricity). Since then Wellington Electricity has established business systems for independent operation and control of the network.

CKI and HEH together own 100 per cent of Wellington Electricity with both companies being members of the Cheung Kong group of companies and are listed on the Hong Kong Stock Exchange (HSE).

For further information regarding the Wellington Electricity ownership structure please visit our website at www.welectricity.co.nz.

2.2. AMP Purpose and Objectives

The primary purpose of the AMP is to communicate with consumers and other stakeholders the asset management strategies, polices and processes and to demonstrate an effective and responsible management of the network assets.

Other goals of the AMP are to:

- Ensure that all stakeholder interests are considered and integrated into the business to achieve an optimum balance between levels of service and the cost effective investment while maintaining regulated service targets. The level of service is reflective of a customer price/quality trade off upon which appropriate pricing can allow the ability of Wellington Electricity to maintain, renew and replace the network assets to meet stakeholder quality needs. The Commerce Commission as the industry Economic Regulator has a part to play in recognising and ensuring that electricity distribution businesses achieve adequate levels of return on investment for their regulated asset base to maintain service quality to consumers;

- Provide a consolidated governance and management framework that encompasses the asset management and planning strategy in a 'live' document;
- Address the strategic goals and objectives of the business by focusing on prudent life cycle asset management planning, stakeholder levels of service and appropriate levels of network investment which provide a sustainable and equitable return to the shareholders;
- Provide a platform for monitoring and demonstrating continuous improvement in alignment with best industry practice.

The AMP is a key internal planning document and will become a consolidated repository for asset management planning. It is a dynamic document requiring continuous review and adjustment to align with the changes in the business environment.

This is a collectively produced document that draws from all parts of the Wellington Electricity business with contributions from consumers, field service provider, asset and planning team, operations and maintenance team, CAPEX delivery, QSE, commercial and finance and the executive team before being submitted to the Board of Directors for disclosure approval.

The AMP is compiled in accordance with the Electricity Information Disclosure Requirements 2004 and the 31 October 2008 Amended Requirements.

2.3. Interaction between AMP and Other Business Plans

The AMP aims to incorporate information from internal business and asset management related documents (some of which are presently under development following the recent change in ownership) which cascade down from the Business Plan and Strategy to the asset maintenance and lifecycle plans through to the annual Capital and Maintenance works delivery plans and programmes.

The mission sets the context for all strategic positioning and tactical action planning within the business from a top down approach which effectively drives the asset management planning and delivery.

MISSION – *"To own and operate a sustainably profitable electricity distribution business which provides a safe, reliable, cost effective and high quality delivery system to our customers."*

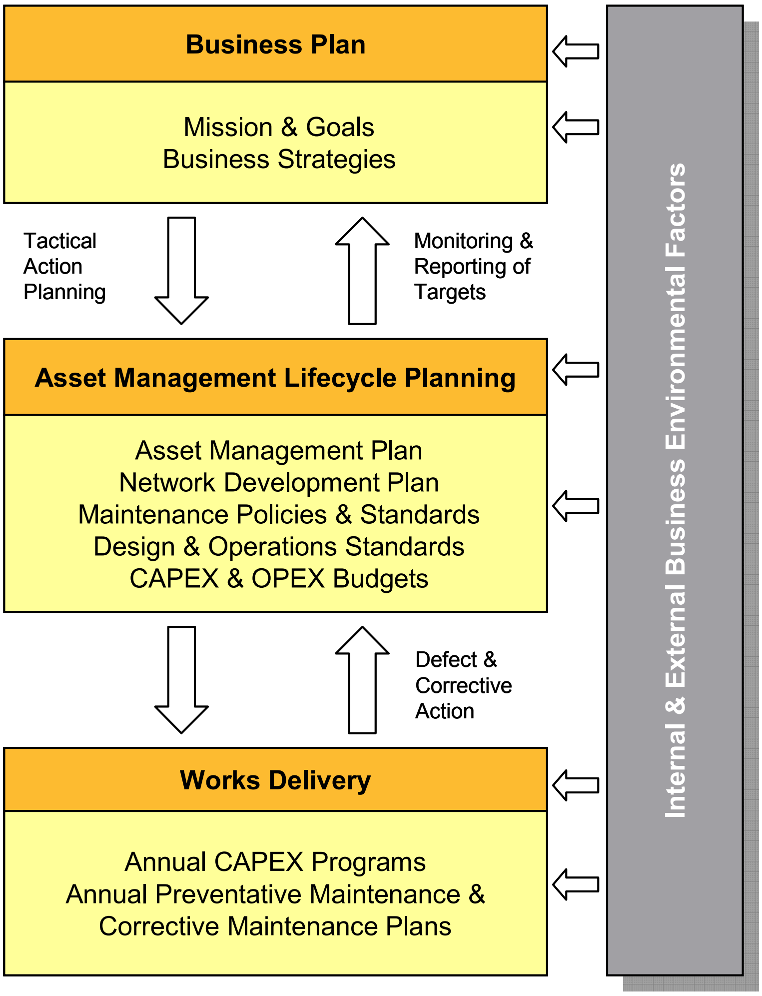

Figure 2-2 AMP Interaction with Business Planning

2.3.1. Business Plan and Strategy

The Company's strategic business direction is supported by the Business Plan and Wellington Electricity aims to deliver a long-term sustainable business to all of its Stakeholders.

Wellington Electricity's business strategy is driven in response to both internal and external business environments and defines the Company's actions and outcomes to meet the business vision.

WELLINGTON ELECTRICITY BUSINESS PLAN

"To own and operate a sustainably profitable electricity distribution business which provides a safe, reliable, cost effective and high quality delivery system to our customers."

INTERNAL BUSINESS ENVIRONMENT

Financial

Meeting our financial targets
Manage our treasury responsibilities

People

Working safely
Developing a great team & organisational culture
Employees are aligned with business goals & direction
Building strong relationships with our service providers
Reputable employer

Assets

Meeting regulatory targets through prudent asset management
Effective life cycle management of assets
Appropriate risk management
Engaged with our stakeholders

EXTERNAL BUSINESS ENVIRONMENT

Consumers

163,000 reasons to provide effective and efficient service
Understand our investment in their future for a quality service

Regulatory

Commerce Act – Price/Quality Path reset & controls
Electricity Act & Regulations
Health & Safety in Employment Act

Economic

Recession recovery and pressure to maintain price stability

Image & Reputation

Well managed media and stakeholder communication
Local people managing the business well with high quality service

Political

Responsibility of 4th largest ELB serving nation's capital
Government & business leaders interested in affordable & reliable supply
Managing local & regional council expectations

Figure 2-3 Wellington Electricity Business Plan

The business strategies effectively 'shape' the AMP taking into consideration the changing regulatory environment which impacts directly upon Wellington Electricity meeting the needs and interests of its stakeholders.

BUSINESS STRATEGIES	
Safety - Our Primary Focus	Continuous review of incidents/accident reporting Establishment of Public Safety Management System Closer engagement with Contractors on the importance of Safety Implement the 'Great Safety Performance Programme'
Financial & Corporate	Generate an adequate return to shareholders Manage treasury outcomes Meet the corporate obligations Review effectiveness of Risk Management controls
Network & Assets	Produce annual Asset Management Plan Produce Network Development Plan Review and test Business Continuity & Disaster Recovery Plans Enhance condition assessment process for asset life cycle
Our People	Set personal & company objectives/targets for growth Stimulate & challenge our people Expand staff capability through mentoring & coaching
Regulatory	Establish appropriate business models Manage well all regulatory submissions Review all distribution pricing tariffs Preparing for price reset
Service Providers	Leverage best international practices from group companies Review all existing business contracting models
Growth	Explore increased revenue opportunities Leverage ripple control for Demand Side Management opportunities Support generation development for the Network Support load aggregation and stand-by generation dispatch projects
Image & Reputation	Support a positive public image through customer engagement Enhance reputation by delivering a consistent and quality service Be a leader in public safety initiatives

Figure 2-4 Wellington Electricity Business Strategies

2.4. Planning Period Covered by the AMP

This AMP covers the 10 year period commencing 1 April 2010 to 31 March 2020 and replaces the April 2009 AMP. Plans for subsequent years of the planning period are likely to be affected by the outcomes of the continued development of the asset management reviews as well as changes to the internal and external environment in which Wellington Electricity operates. The AMP aims to provide clear plans for the management of assets over the next 12 to 36 months, with the subsequent three to seven years being broader and plans for the eight to ten year period being indicative only. This reflects the impact of uncertainty over the longer timeframes.

The AMP will be continuously reviewed in conjunction with the development of asset management strategies driven by:

- A greater understanding of the condition of the Network assets and risks
- Assessment of load growth and network constraints
- New and emerging technologies
- Changes to business strategy driven by internal and external factors

The AMP was approved by the Wellington Electricity Board of Directors on 30 March 2010.

2.5. Managing Stakeholders

2.5.1. Stakeholder Interests and Identification

Wellington Electricity has identified stakeholders, their interests and how interactions are managed by all of the business through a number of activities. The following tables identify the key stakeholders, how they are identified and what their interests are with Wellington Electricity.

Shareholders		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Governance and Board mandates ▪ Board Meetings and committees ▪ Business Plan & Strategic Objectives	Shareholders require a fair economic return for their investment in this critical infrastructure as well maintaining a positive public image through engagement with our consumers needs and effective management of the network.	▪ Customer initiated projects produce appropriate revenue levels to meet the cost of capital ▪ Meeting reliability and customer service levels

Consumers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Customer satisfaction and engagement surveys ▪ Feedback received via complaints and compliments ▪ Media related enquiries and sponsorship ▪ Price / Quality trade-off	The consumers connected to Wellington Electricity's network require a safe and reliable supply of electricity of acceptable quality at a reasonable price. While consumers generally appreciate that delivery of an extremely high quality of supply with no interruptions is unrealistic, expectations can differ as to the level of reliability and quality that can be considered acceptable.	▪ Meeting reliability and customer service levels ▪ Appropriate investment in the network ▪ Public safety initiatives ▪ Price / Quality trade-off

Retailers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Electricity Governance Rules ▪ Relationship meetings and direct business communications ▪ Via Use of Network Agreement terms	As retailers rely on the network to deliver the energy they sell to consumers, they also require the network to be reliable and electricity distribution services to be provided at a reasonable price. Retailers are reliant on electricity distribution services to conduct their business and therefore want Wellington Electricity to assist them in providing innovative products and services for the benefit of their customers.	▪ Meeting reliability targets ▪ Achieving customer service levels ▪ Consultation

Regulators		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Commerce Act Part 4 and other legislation ▪ Relationship meetings and direct business communications ▪ Industry working groups ▪ Information disclosure	To ensure that the consumer achieves a supply of electricity at a fair price commensurate with an acceptable level of quality. Regulators need to provide an investment framework for business to make adequate returns on infrastructure.	▪ Meeting reliability compliance targets and controls for price and quality ▪ Compliance with legislation, engagement and submissions as required ▪ Monitoring information disclosures

Staff & Service Providers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Team and individual direct discussion ▪ Employee satisfaction surveys ▪ Relationship meetings and direct business communications ▪ Contractual agreements	Staff and contractors want job satisfaction, a safe and enjoyable working environment and to be fairly rewarded for the services they provide. Contractors also want assurance around work delivery continuity and the mitigation of working hazards by appropriate asset management planning.	▪ Health & Safety policies and initiatives ▪ Forward planning of work through asset management practises ▪ Performance reviews ▪ Life balance

Transpower		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Electricity Governance Rules ▪ Relationship meetings and direct business communications ▪ Annual planning documents ▪ Grid notifications & warnings	Transpower obtain sustainable revenue earnings from the allocation of connected and inter-connected transmission assets. Wellington Electricity under the EGR's will operate and interface under instruction as and when required. Further assurance is required that all downstream connected distribution and generation will not unduly affect their assets.	▪ Implementation of Operational standards and procedures ▪ Appropriate investment in the network

Central & Local Government		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Through legislation ▪ Relationship meetings and direct business communications ▪ Focus working groups	Local Councils require that appropriate levels of investment are made in the electricity network to allow for levels of local growth. Regional Councils require that both current and new network assets do not affect the environment. Central Government's interests are mainly managed through the respective ministries e.g. MED, DOL, to ensure the general public receive a safe, reliable and fairly priced electricity supply. All three require appropriate emergency response and contingency planning to manage a significant civil defence event.	▪ Compliance with legislation, engagement and submissions as required ▪ Emergency Response Plans ▪ Environmental Management Plans

Figure 2-6 Stakeholder Identification

2.5.2. Managing Conflicting Interests

Safety will always be a 'non negotiable' attribute when managing a Stakeholder conflict, Wellington Electricity will not compromise the safety of the public, its staff or service providers.

Other Stakeholder interests that conflict will be managed on a case-by-case basis. This will often involve consultation with the affected stakeholders and may involve the development of innovative "win-win" approaches that are acceptable to all affected parties. However Wellington Electricity is obliged to follow approved business policy to ensure it meets its obligations and responsibilities to deliver an electrical supply in accordance with all legislative requirements.

2.6. Wellington Electricity Structure and Asset Management Accountability

2.6.1. Governance

The Wellington Electricity Board of Directors is responsible for the overall governance. The Board has approved capital and operational expenditure budgets and business plans for the 2010 calendar year. Information is provided to the Board as part of a monthly consolidated business report that includes health and safety reports, capital and operational expenditure vs. budget, reliability statistics against targets and consumer satisfaction survey results.

All network capital projects greater than $400,000 will require approval from the Capital Investment Committee (CIC). The CIC shall comprise as a minimum one company director and the CEO.

2.6.2. Executive and Company Organisation Structure

The Wellington Electricity CEO leads the business management and implements the company mission through business plan and strategy and is accountable for overall business performance and direction.

The International Infrastructure Services Company (IISC) is a separate infrastructure services company which provides services to Wellington Electricity Limited.

Further services are contracted to Wellington Electricity through external service providers.

As Wellington Electricity is part of the CKI group of infrastructure companies, it can access skills and experience from across the world. For example, CKI's Australian group companies (which distribute electricity to over 1.7 million customers) have considerable knowledge and experience in electricity distribution business asset management including strategy and planning. This group has provided the IT systems and platforms into the Wellington business to allow synergy gains across the business. Being part of a larger CKI group of companies has provided Wellington Electricity with direct access to international best practice systems to support world class asset management.

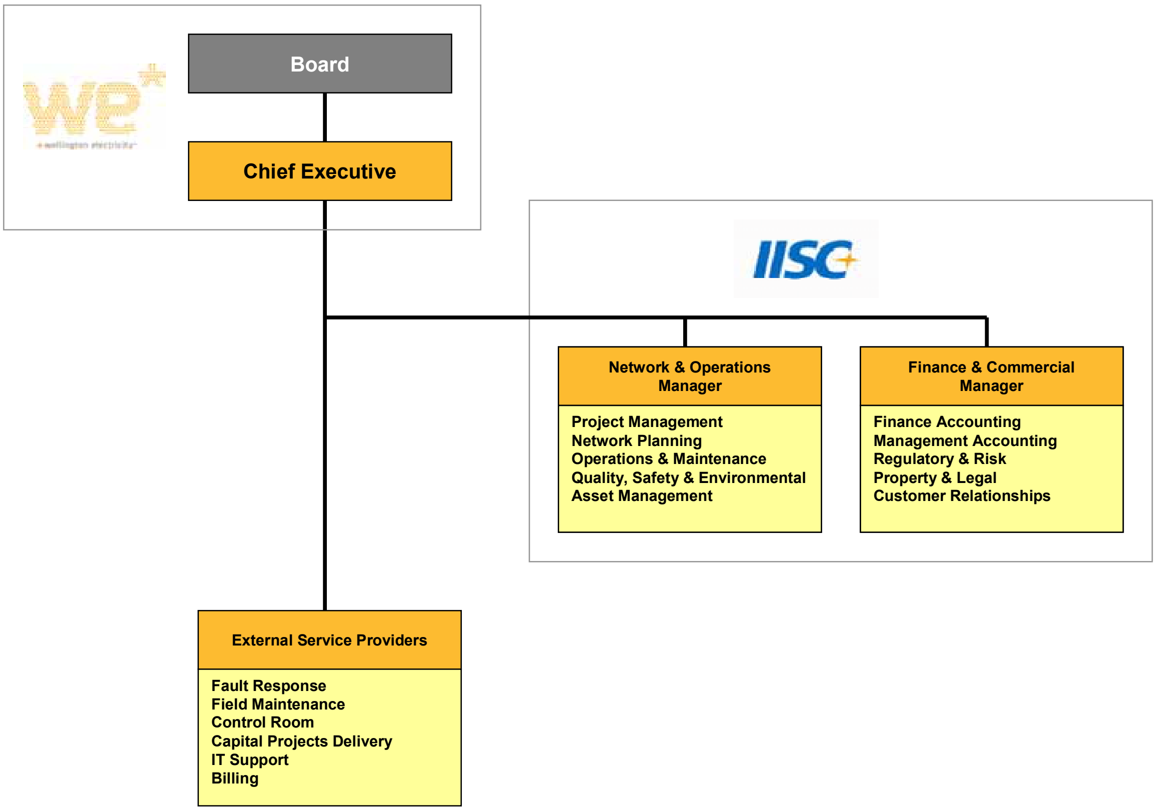

Figure 2-7 Wellington Electricity Organisation Structure

2.6.3. Network & Operations Team Structure and Asset Management Accountability

The management of network assets for Wellington Electricity falls under the accountability of the IISC Networks and Operations team, however the entire business has some direct or indirect interaction with the network assets on a daily basis.

The Wellington based Networks and Operation Manager is accountable for delivery of asset management services to Wellington Electricity. These services include asset planning, project management, capital expenditure delivery, operations and maintenance and safety, quality and environmental performance.

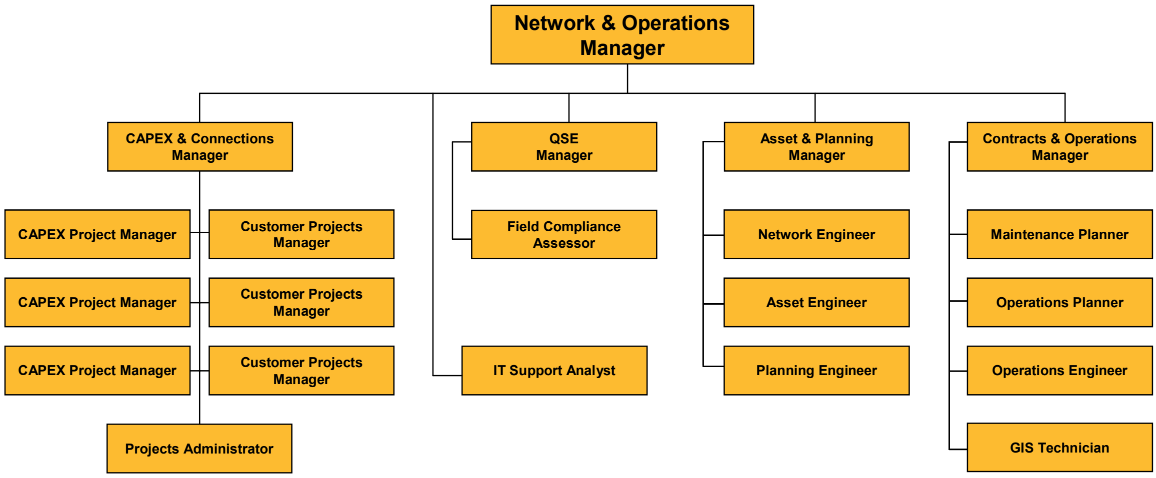

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Figure 2-8 IISC Network and Operations Support Structure for Wellington Electricity

2.6.4. Finance and Commercial Team Structure and Asset Management Accountability

Financial and accounting support for the management of network assets is also provided for within the IISC structure for service delivery to Wellington Electricity. The Finance and Commercial team provides indirect interaction with the network assets through managing support systems on a daily basis.

The Wellington based Finance and Commercial manager is responsible for all indirect asset management functions including customer service, retail services, regulatory management, legal and property management as well as financial modelling and accounting support services.

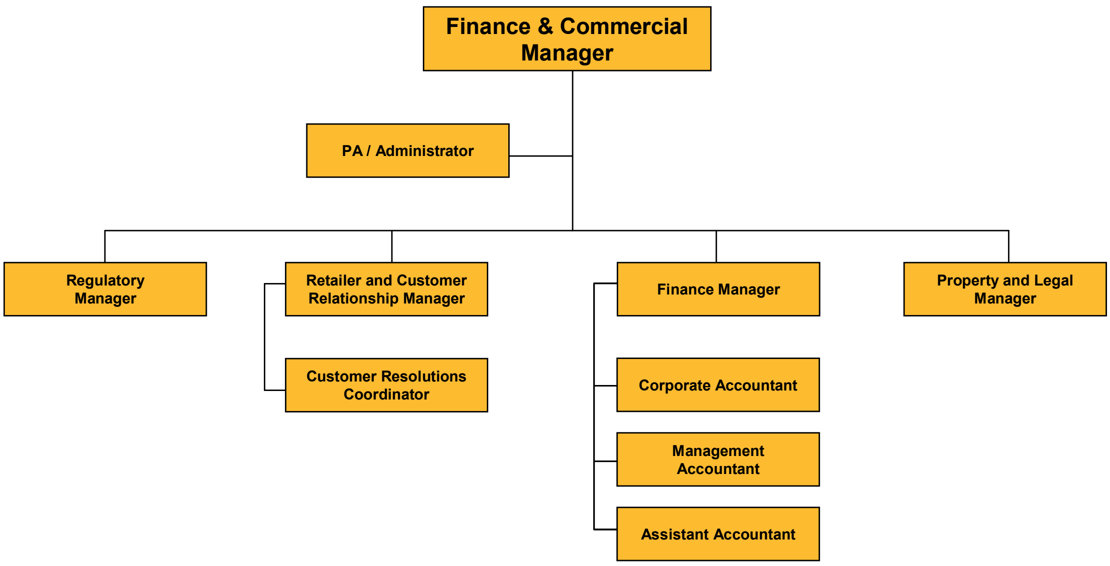

Figure 2-9 IISC Finance and Commercial Support Structure for Wellington Electricity

2.6.5. External Service Providers – Field Operations

Wellington Electricity operates a Contracted out-sourced Field Operations model on its network. These Field Operations include:

- Fault Management – 24/7 response for fault restoration
- Asset Maintenance – Asset inspection and condition monitoring including capture, storage of asset condition data and feeding back of this information to the Asset Owner
- Value added services – on site cable mark-outs, sub-transmission standovers and the provision of buried asset plans are provided to third parties by the maintenance contractor
- Asset Construction – Major capital projects are tendered on a contestable basis to pre-qualified contractors
- Vegetation Management – Tree Clearance programme, tree owner liaison and reactive availability
- Network Control Services – 24/7 management of Wellington Electricity Network Control Room (NCR) at Haywards with relocation to the disaster recovery site at Central Park substation if necessary
- Contact Centre – providing a dispatch function for all HV and LV outages, management of customer and retailer service requests, outage notification to retailers and handling general enquiries

Wellington Electricity manages and audits the contractors, and also collates reports on network operations and maintenance performance and expenditure, customer satisfaction, safety statistics and network reliability.

Wellington Electricity will continue to review the extent that these activities remain outsourced in order to achieve optimum asset management outcomes.

Night Work at Wilton Substation

2.7. Asset Management Systems and Processes

The purchase of Wellington Electricity has seen the stakeholders invest over $17.3m in state of the art, best of breed IT systems in establishing the business. This level of investment is unprecedented in the New Zealand industry and places Wellington Electricity in a strategically strong position for establishing best practice asset management services to its customers.

This section of the AMP identifies the key repositories of asset data that is used in the asset management process, the type of data held in the repositories and what the data is used for. Areas where asset data is incomplete are identified and initiatives to improve the quality of this data are disclosed.

2.7.1. Systems for Managing Asset Data

The key repositories of asset data are described below.

2.7.1.1. SCADA / ENMAC

A new GE ENMAC SCADA system has been installed to provide real time operational management of Wellington Electricity's network. The ENMAC system will be fully commissioned following the implementation of an integrated load control solution targeted for completion in 2010. In the interim Wellington Electricity will continue to use the existing legacy Leeds & Northrup Foxboro SCADA system. Once fully implemented the GE ENMAC system will provide a total integrated solution of SCADA, DMS (Distributed Management System) and OMS (Outage Management System).

2.7.1.2. Geographic Information System (GIS)

The geographic information system (GIS) is a representation of the system fixed assets overlaid on a map of the supply area. Wellington Electricity uses the GE Smallworld application for planning, designing and operating the distribution system and is the primary repository of network asset information. A process is required to link asset condition data to the GIS information to further improve asset management outcomes by streamlining manual business processes into linked electronic database for more efficient information management which will aid engineering decision making.

2.7.1.3. ProjectWise

Wellington Electricity stores all drawings and historic asset information diagrams in ProjectWise where users can access PDF files of all substation and system drawings.

2.7.1.4. DIgSILENT Power Factory

Power Factory is a leading network simulation tool used in the analysis of load flows, development planning, reliability and protection studies. The Power Factory database contains detailed connectivity and asset rating information. Wellington Electricity is presently reviewing the Power Factory model to determine its accuracy and completeness. As the review proceeds, the model will be progressively updated and processes will be developed to ensure it remains synchronised with the actual power system through such means as an automated cross reference with GIS.

2.7.1.5. Cymcap

Cable rating information is derived via CYMCAP (cable ampacity and simulation tool) which is used to model the ratings of underground cables at all voltages, for both existing cables in service, and also for new developments.

2.7.1.6. DIgSILENT Station Ware

Station Ware is a centralised protection setting database and device management tool. It holds relay and device information, parameters and settings files. Station Ware interfaces directly to Power Factory to allow for protection discrimination studies to be carried out.

2.7.1.7. Hard Copies and Spreadsheets

Wellington Electricity inherited much of the asset condition information of the network in the form of hard copies and/or spreadsheets of inspection records and test results. These are stored in various locations including with the services provider. Examples of hard copies of asset condition data include:

- Scanned copies of inspection results
- Spreadsheets of transformer oil analysis
- Scanned copies and hard copies of historical cable test results

In some cases it has proven difficult to locate asset condition data records more than a few years old. Wellington Electricity is working through the challenge of establishing electronic records into the new systems in order to more effectively manage asset information for future decision making.

2.7.1.8. GenTrack

GenTrack is an application designed to manage ICP and revenue data as well as deliver billing services. GenTrack is populated and synchronised with the central ICP registry. It interfaces with the GIS and ENMAC systems to provide visibility of consumers affected buy planned and unplanned network outages. GenTrack also interfaces to SAP for billing.

2.7.2. Financial Systems

In keeping with best-of-breed investment in IT systems, SAP is the financial and accounting application used by the business as the commercial management platform. It is an integrated finance system for billing, fixed asset registers, payroll, accounts payable and general accounting.

2.7.2.1. Summary Table

	Physical Attributes	Equipment Ratings	Asset Condition	Connectivity	Customer Service
SCADA / ENMAC		✓		✓	✓
GIS	✓			✓	✓
Project Wise	✓				✓
Power Factory		✓		✓	
Station Ware	✓	✓			
Spreadsheets / hardcopy	✓	✓	✓		
GenTrack				✓	✓
SAP (Financial)					✓

Figure 2-10 Asset Data Repositories

2.7.3. Data quality

Wellington Electricity is presently reviewing the converted data to check the quality of the records in the above repositories as some inconsistencies have been found between some of the data in different locations. An initiative has been identified to establish one 'source-of-truth' system for each category of information, and the subsequent synchronisation of data between the various repositories.

2.8. Process Overview

The three main processes that Wellington Electricity use as part of managing network assets are:

- Inspection and Maintenance process
- Planning process
- Investment selection process

The interaction of the processes is illustrated in the diagram below. Each of these processes and the asset works plan is described in detail in the following sections.

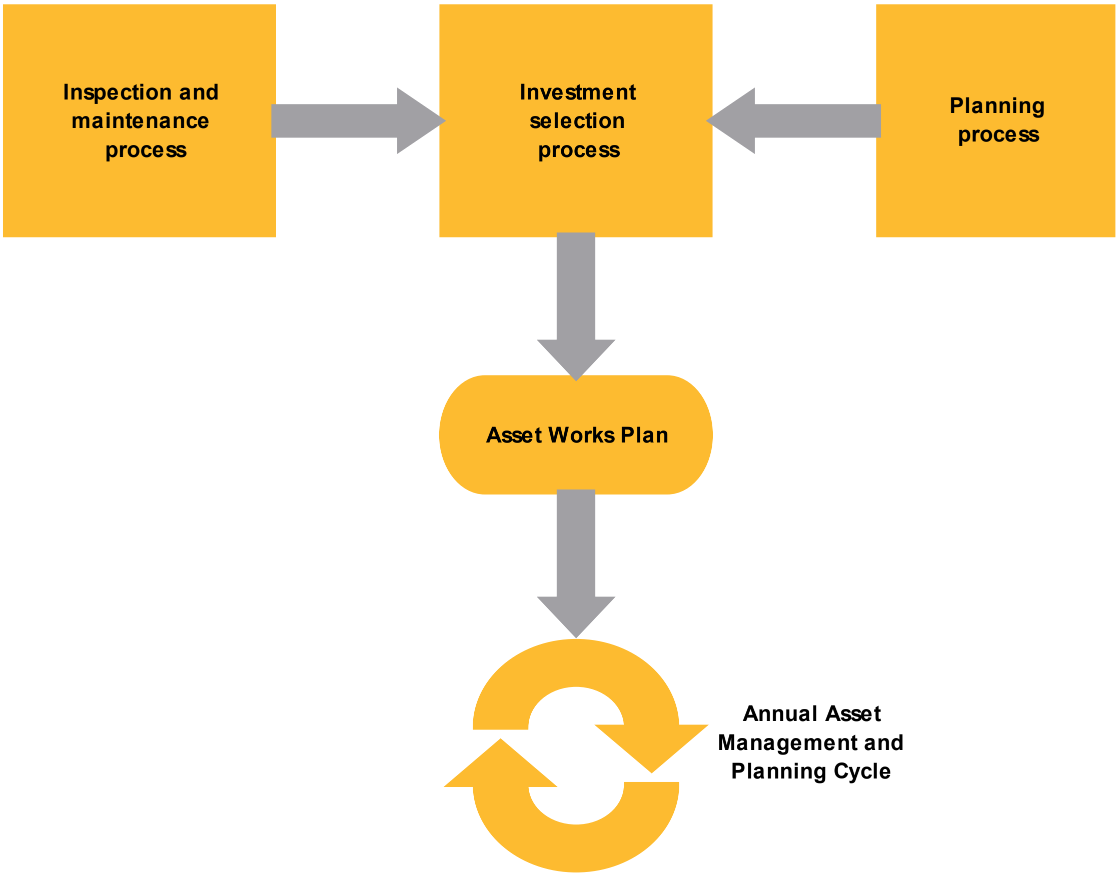

Figure 2-11 Asset Management Processes

A key output from these processes will be an Asset Works Plan (AWP), which in turn feeds in to the annual asset management and planning cycle. The AWP is discussed in more detail in a subsequent section of this chapter. The development of the AWP is in its early stages and it is not yet in use in the AMP process.

2.8.1. Inspection and Maintenance Processes

The existing asset inspection and maintenance process is centred around the Preventative Maintenance (PM) programme that is prepared annually by the Wellington Electricity engineering and maintenance groups. The PM programme lists all assets by group and details the inspection and routine maintenance activities that are required for them. Each type of asset has an associated policy that details the scope and frequency of the inspection and maintenance required for that asset category. The timing and scope of these activities are determined by a number of factors including:

- Manufacturers recommendations
- Experience of how often inspections are required (e.g. for substation buildings)
- Age (older assets may be inspected more regularly than new ones)
- Type history (assets that have known issues may be inspected more regularly)
- Condition (assets that show signs of deterioration may be inspected more regularly)
- Operation frequency (assets that have operated frequently under fault conditions)
- Risk (likelihood and consequence of asset unavailability)

The PM programme is implemented by the field service provider who is accountable through their service contract to execute the programme. The service provider will inspect the assets, carry out routine maintenance and also carry out corrective maintenance (i.e. correction of issues uncovered during routine inspection) provided the total cost of this is under a threshold set by Wellington Electricity. Inspection results and work records are reported to Wellington Electricity on a regular basis. Wellington Electricity engineering staff analyse the inspection records and through discussion with the service provider may approve further corrective maintenance or initiate the investment selection process to address refurbishment and renewal works. Additionally, the cyclic review of asset performance (e.g. feeder performance) may initiate either corrective or project works.

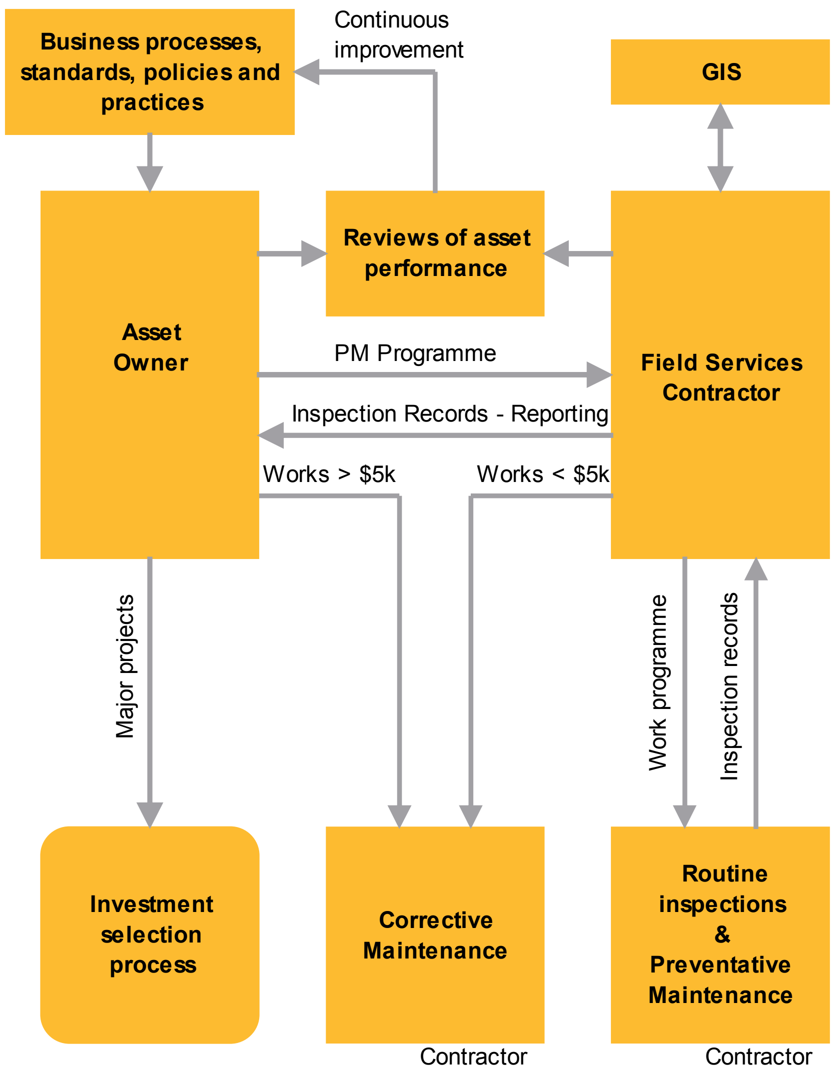

Figure 2-12 Inspection and Maintenance Process

The system is largely paper based. Inspection records comprise scanned copies of handwritten forms. These sheets are filed but not stored electronically. This is discussed in the following section.

2.8.1.1. Review of Inspection and Maintenance Process

Wellington Electricity is reviewing its asset inspection and maintenance processes. A number of initiatives have already been identified that aim to improve data capture and records management. These are associated with improving the way information is handled in conjunction with continually improving the maintenance standards.

2.8.2. Planning Process

Network constraints are identified by reviewing the capacity and the security of the network on a regular basis against network standards. Should a constraint be identified, options for addressing it through reconfiguration of the network (e.g. by moving an open point) will be considered first. Should no reconfiguration options be available, then other options will be investigated as part of the investment selection process. Key inputs to the capacity and reliability review are the planning criteria and load forecasts. These are described in detail under separate headings.

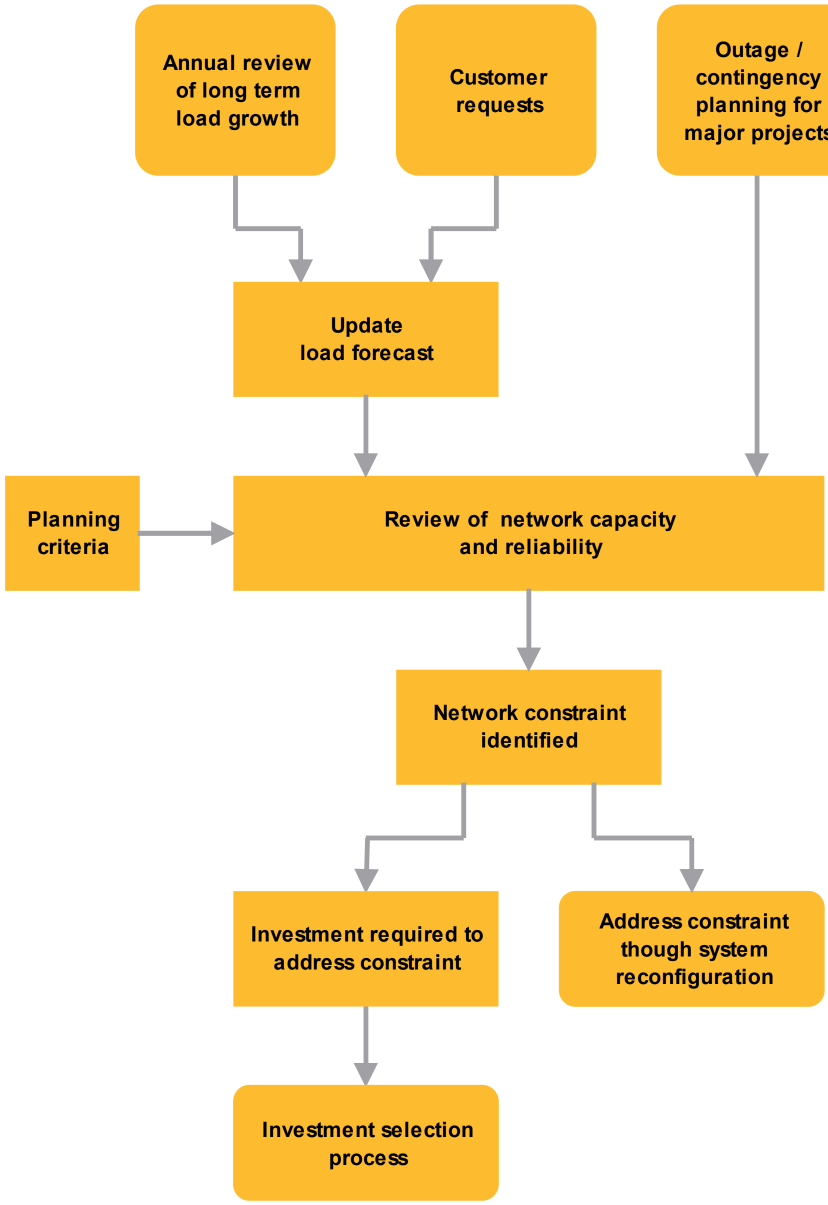

Figure 2-13 Planning Process

2.8.3. Investment Selection Process

This process describes the way in which network investments are taken from a high level need though to a preferred investment option. The process takes a 'need for investment' through to a preferred option that in turn results in a business case. It includes consideration of a long list of options, refinement of the long list to a short list of practicable options followed by detailed analysis and selection of a preferred option. The asset works plan (once implemented), will become the repository for all potential network investments including those at the early 'needs have been identified' stage and 'preferred option' stage. This process is a refinement, rather than a replacement of existing processes as described in the previous AMP.

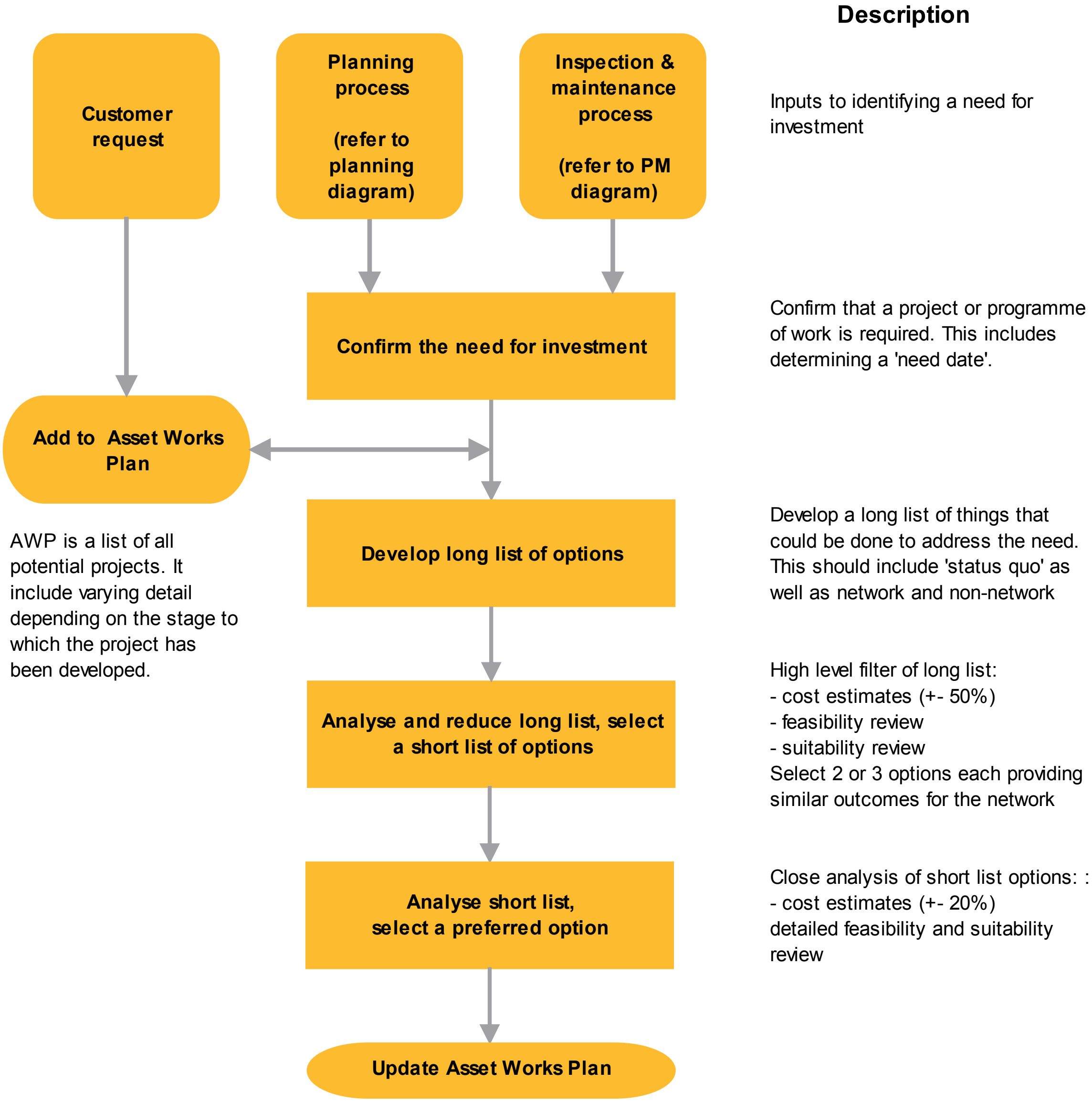

Figure 2-14 Investment Selection Process

2.8.4. Asset Works Plan

The Asset Works Plan (AWP) will be a repository that comprise a list of potential projects at the high level 'need has been identified' stage and at the 'preferred option' stage of the 'Investment Selection Process'. The AWP will be a dynamic list that includes dates on when projects are required. It will include projects up to ten or more years in the future and it will be continually updated and amended as new 'needs' are identified, project details are refined and projects are executed. Every year the AWP will be frozen and all of the projects in it for the next financial year will be developed to the 'preferred option' stage of the Investment Selection Process. This list of projects will then be prioritised (refer to separate section describing the annual planning cycle). Following prioritisation, each project will be matched against the available budget for Capital works and a list of projects for the following year (i.e. the capital works spend plan) will be prepared for Board approval.

The AWP is not a system per say, rather it is a place that information will be stored. It does not represent a departure from the way projects are dealt with at present, but it will add discipline by creating a central repository for this type of information.

2.8.5. Processes for Measuring Network Performance for Disclosure Purposes

SCADA and ICP allocation information stored within the ENMAC database[1] is extracted using reporting tools to provide the business with fault (unplanned) and planned outage information. All relevant details of HV and LV faults are entered into the ENMAC fault log database, which will calculate the impact of each fault on SAIDI and SAIFI. Where supply is restored progressively through switching over a period of time, the switching sequence will be recorded and used as the basis for recording the actual SAIDI impact on customers. The ENMAC database may also be used to measure and monitor the faults per 100 circuit-km performance indicator.

Information on the reliability of the network is available on an ongoing basis throughout the measurement period and will be regularly reported both within the business and to the Board through its monthly reports.

2.8.5.1. Unplanned Outages

The process for handling and recording the impact of unplanned outages is illustrated diagrammatically below.

[1] SCADA includes the status of circuit breakers and switches as well as system voltages and currents. ICP allocation information comprises connections made to each part of the network.

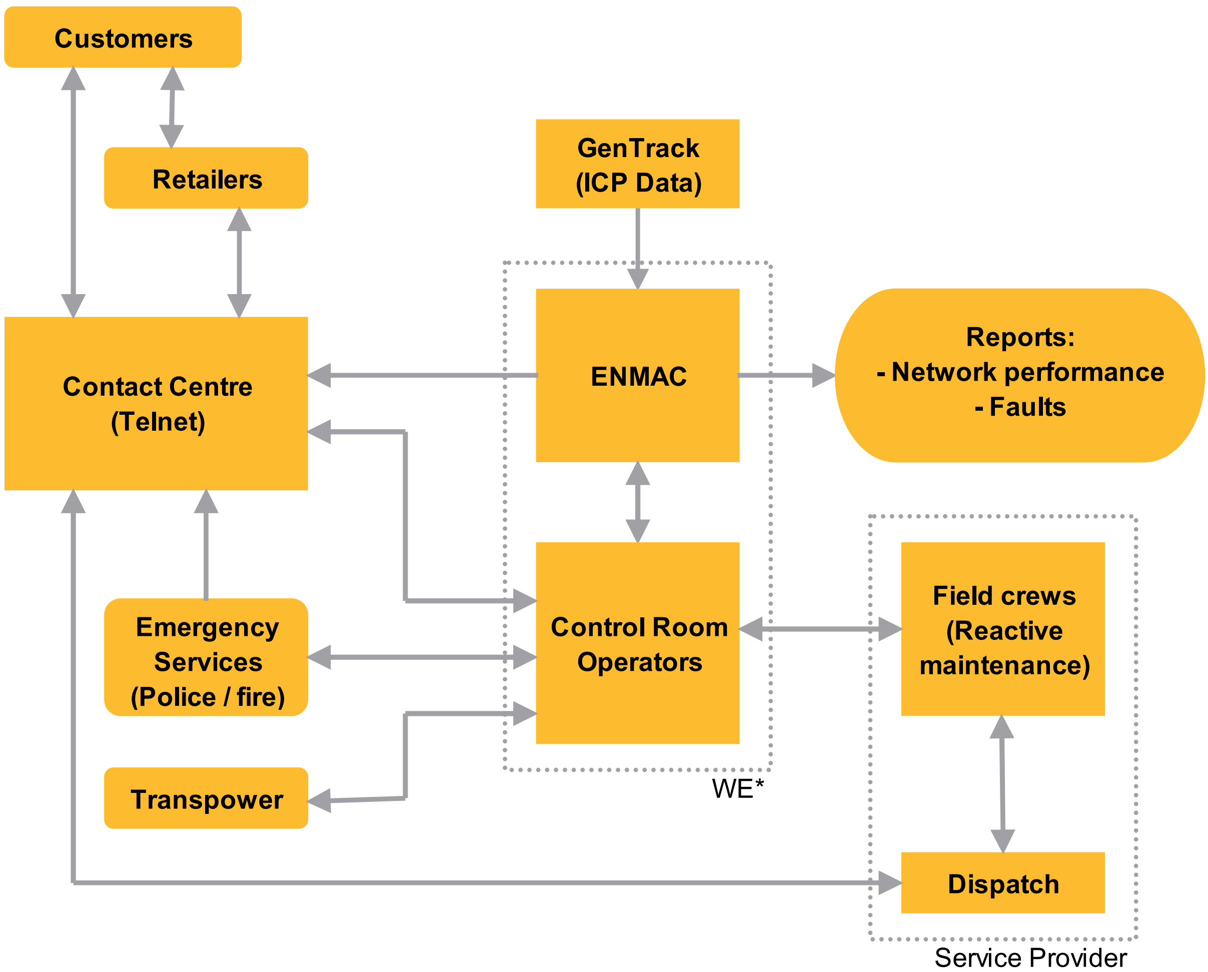

Figure 2-15 Unplanned Outage Process

The major components that comprise this system are:

- Telnet: Wellington Electricity's call centre provider
- Control Room: Operators and ENMAC
- Field service provider

Notification of a fault may be raised though calls from customers (either direct to Telnet or via retailers). Telnet field these calls and compile them into an outage notification report that is sent to the control room and the service provider's dispatcher. The control room will also be immediately aware of any HV tripping event via SCADA.

The fault is lodged in ENMAC and by the field services provider dispatch centre, which will in turn dispatch field crew to the location of the fault. As identification of the fault is carried out and supply is restored, the control room operators will (via the field crews) update the fault log in ENMAC.

Fault logs are available from ENMAC via a reporting tool. On a regular basis, these logs are interrogated and network performance statistics are obtained.

2.8.5.2. Planned Outages

Planning of outages for maintenance is undertaken by the field services contractor. Maintenance Planners use the Preventative Maintenance plan to produce a forward schedule of planned works. Outage planners use the schedule to request network outages from the control room operators. The Wellington Electricity customer services team will discuss major outages, and outages that effect sensitive customers directly with them prior to the outage being confirmed. Following the confirmation of an outage, the control room will liaise with the retailers (who notify all affected customers) to advise them in advance of planned works that will interrupt their supply. As the outage takes place, ENMAC is updated with switching operations. A log of effected customers and the duration of interruption to their supplies is recorded in ENMAC. This log is interrogated to determine network performance.

The planned outage process is illustrated below.

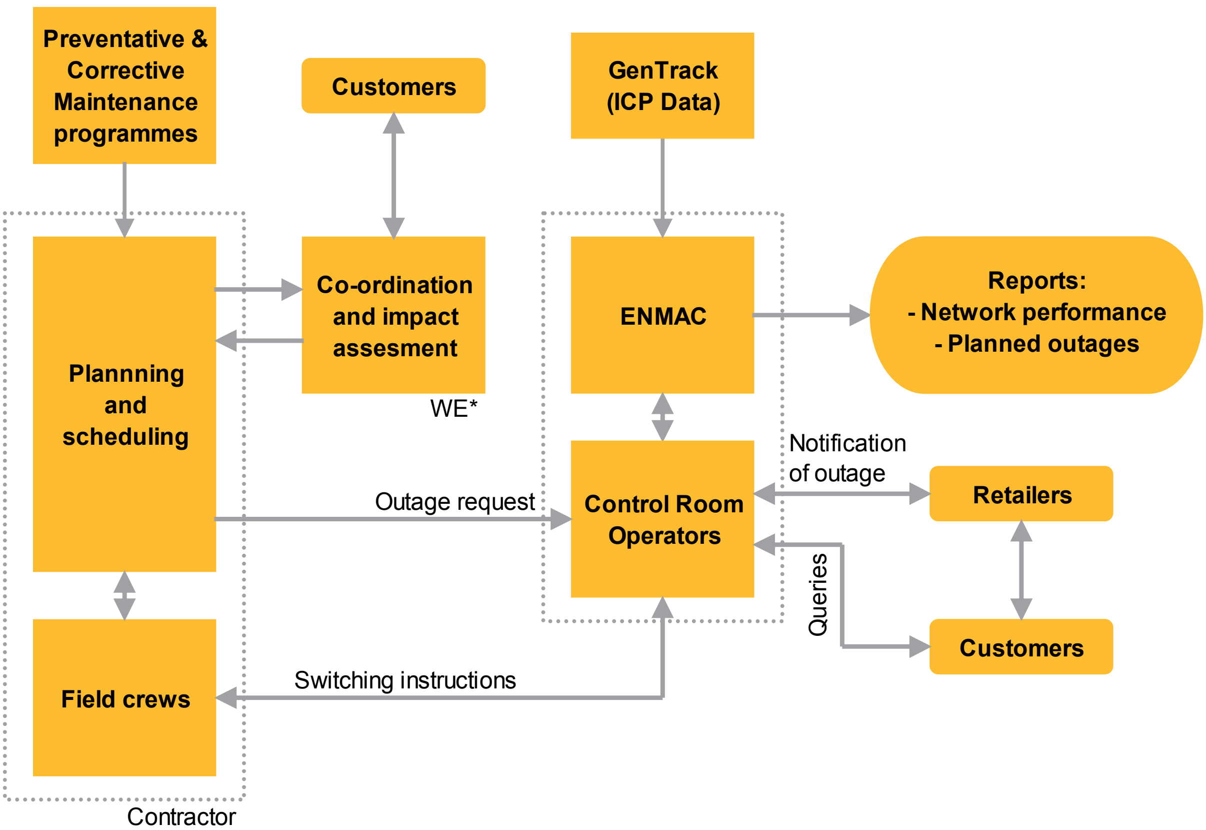

Figure 2-16 Planned Outage Process

3. Assets Covered

3.1. Distribution Area

Wellington Electricity's distribution network covers the cities of Wellington, Porirua, Lower Hutt and Upper Hutt. Wellington City is one of the major metropolitan centres in the country with high density commercial developments. It is also the seat of government and includes Parliament Buildings and the head offices of most government departments. A map of the network area is shown below.

Figure 3-1 Wellington Electricity Network Area

As of 31 December 2009, there were over 163,000 connected customers. The total system length (excluding streetlight circuits and DC cable) was 4,590 km, of which 61.4% was underground.

3.2. Load Characteristics

Peak demands and energy distributed for the last three years is shown below

Year to	30 Sept 2007	30 Sept 2008	30 Sept 2009
System Maximum Demand (MW)	555	537	565
System Energy Injection (GWh)	2,569	2,581	2,595

Figure 3-2 Peak Demand and Energy Delivery

The Wellington CBD is the largest business and retail centre for the region, although there are also significant retail centres in Lower Hutt, Porirua and Upper Hutt. Apart from the CBD there is widespread residential load throughout the area. This is interspersed with pockets of commercial and light industrial load.

The network area covers four local councils, namely Wellington City, Hutt City, Upper Hutt City and Porirua City. In addition to the local councils, the Wellington Regional Council covers the entire network areas. The different council areas have varying requirements for permitted activities as an electrical utility, road corridor access and environmental compliance.

Major customers with significant loads include Parliament, Councils, Wellington Airport and Victoria University. Wellington Electricity also supplies the electrified suburban railway network and the trolley bus network. The supply area is notable for the absence of large industrial loads.

The trolley bus network is supplied through Wellington Electricity owned DC assets comprising 15 converter transformers, 19 mercury arc rectifiers, 2 solid state rectifiers and 53 DC circuit breakers. There are approximately 53 km of underground DC cables linking various DC substations. These DC assets are managed in accordance with a network connection and services agreement with NZ Bus Limited (the sole customer supplied by these assets) and are therefore not covered by this AMP.

Typical load profiles for CBD and residential loads are shown below. These graphs illustrate that CBD loads are relatively even throughout the year with a slight trend towards a summer peak, and their daily profile is relatively flat though the day. Residential loads however are winter peaking with a pronounced dip in demand during the middle of a typical working day. Load profiles that are representative of urban and residential areas are shown on the following graphs of Nairn Street and Naenae zone substation demand respectively.

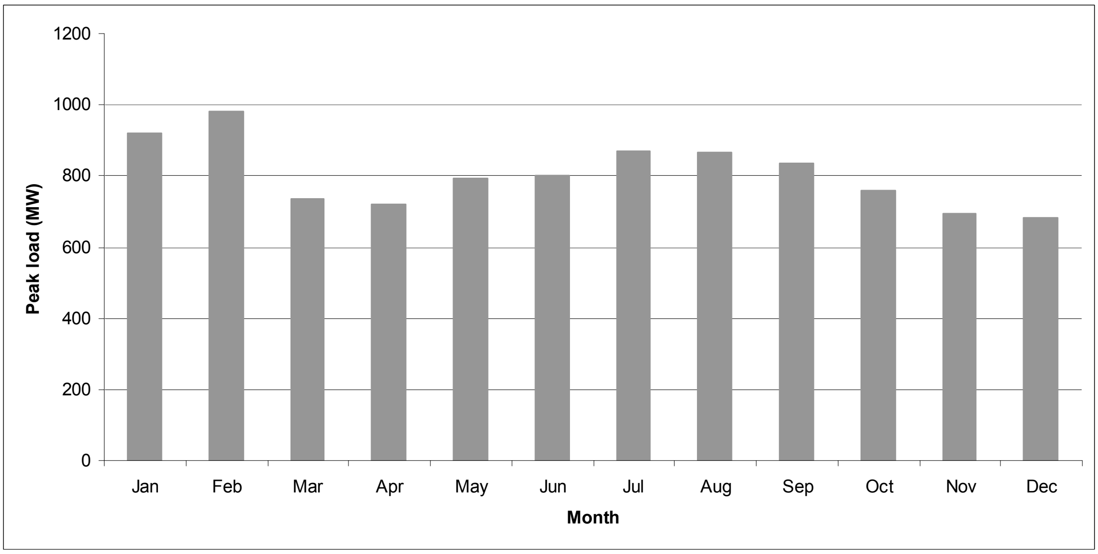

Figure 3-3 Typical CBD Monthly Peak Load Profile

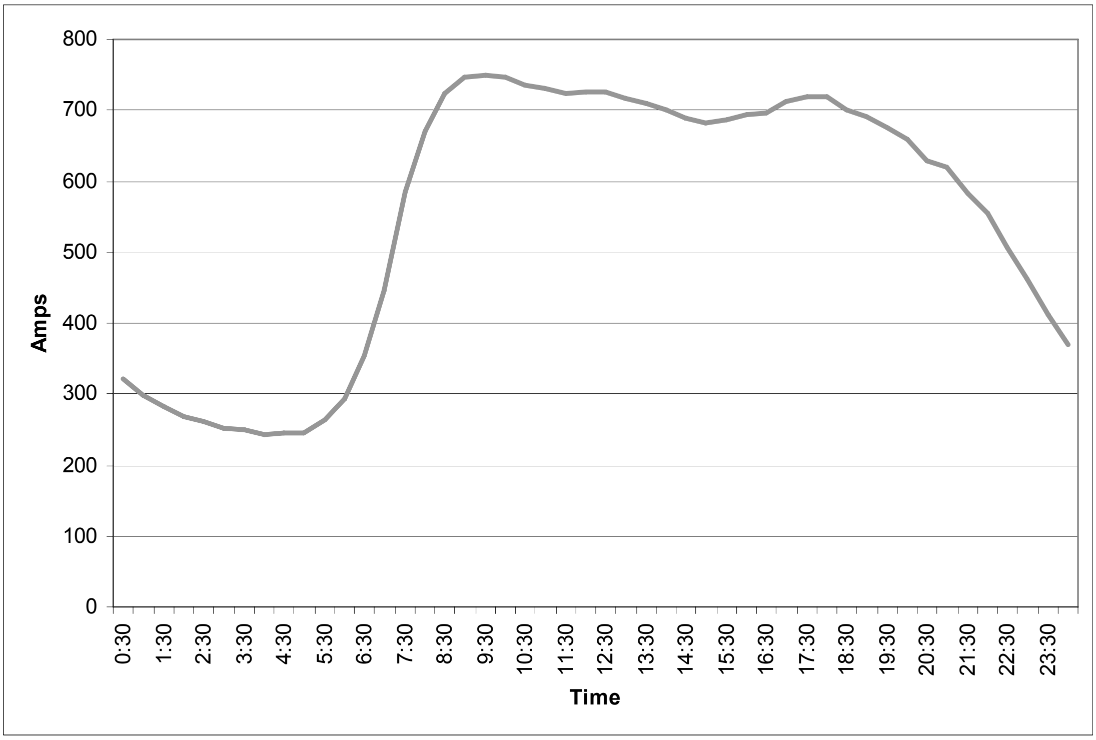

Figure 3-4 Typical CBD Daily Load Profile

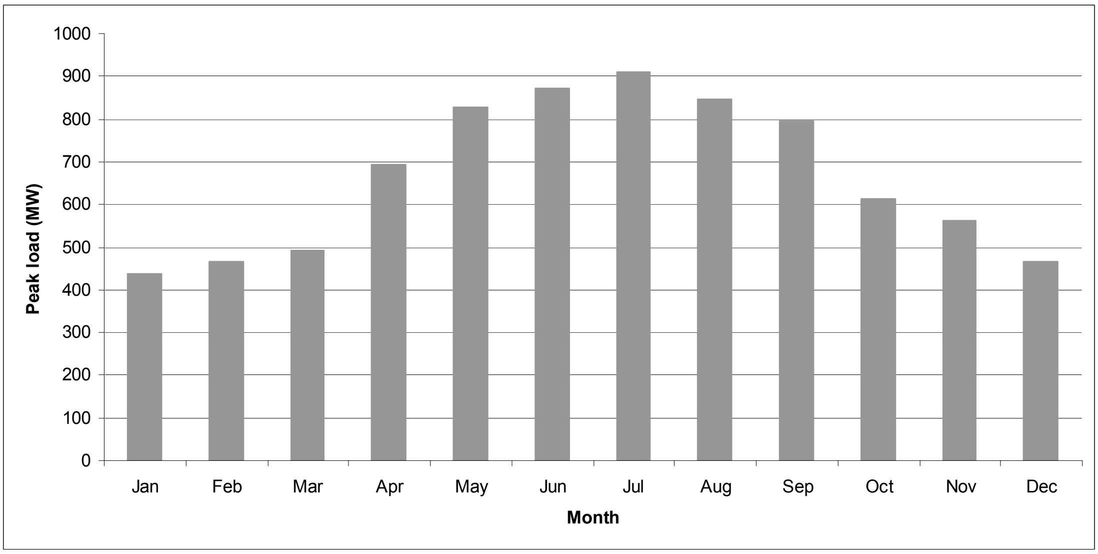

Figure 3-5 Typical Residential Monthly Peak Load Profile

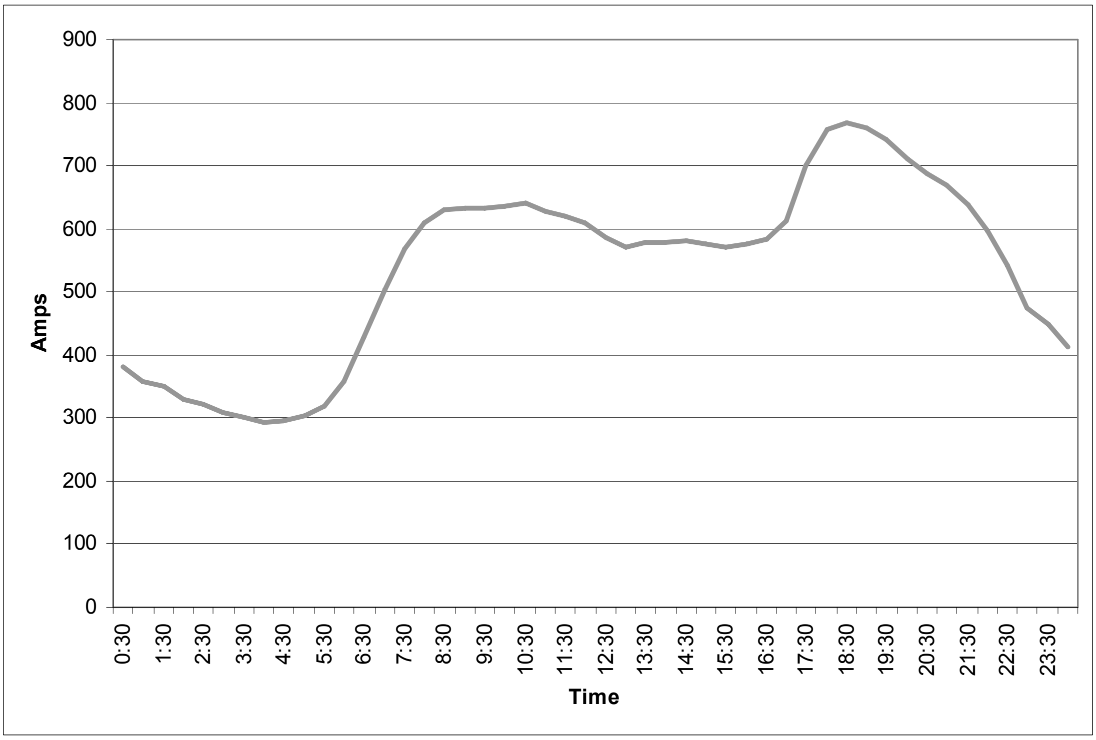

Figure 3-6 Typical Residential Daily Load Profile

3.3. Network Configuration and High Level Asset Description

Any electricity distribution system can be broadly categorised into primary and secondary assets. The primary assets carry the energy that is distributed to consumers. The secondary assets are an integral part of the distribution system and support the operation of the primary assets.

3.3.1. Grid Exit Points

Wellington Electricity's network is supplied from the Transpower owned national transmission grid through nine grid exit points (GXPs), as shown in Figures 3-7 to 3-10. Central Park, Haywards and Melling supply the network at both 33 kV and 11 kV, and Kaiwharawhara supplies it at 11 kV only. The remaining GXPs (Gracefield, Pauatahanui, Takapu Rd, Upper Hutt and Wilton) all supply the network at 33 kV only. The GXP's are described in more detail below.

3.3.1.1. Upper Hutt

Upper Hutt GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 37 MVA each. Peak winter load on the Upper Hutt GXP in 2009 was 30.5 MW. Upper Hutt GXP supplies Maidstone and Brown Owl zone substations via duplicated 33kV underground circuit connections.

3.3.1.2. Haywards

Haywards GXP comprises an unconventional arrangement of one 110/11kV transformer nominally rated at 20 MVA feeding an 11kV point of supply at the Haywards site, and one 110/33 kV transformer nominally rated at 20 MVA supplying Trentham zone substation via duplicate 33kV connections. Peak load at the 11kV and 33kV busses in 2009 were 18.4MW and 20.15MW respectively. A 5MVA transformer supplies the Haywards local service switchboard and also links the 33 and 11kV switchboards.

This arrangement provides satisfactory service at present however a review is planned for the Haywards GXP to consider whether the existing arrangement will provide the security appropriate for the Wellington Electricity network in the future.

Transpower has advised that the 33kV circuit breakers have been scheduled for refurbishment.

3.3.1.3. Pauatahanui

Pauatahanui GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 20 MVA each. Peak winter load on the Pauatahanui GXP 2009 was 20.75 MW. This is within the transformers 22MVA cyclic rating, however loads growth in this area is relatively strong and Wellington Electricity will review the adequacy of the existing arrangement. Pauatahanui GXP supplies Mana and Plimmerton zone substations via single 33kV overhead circuit connections. Note that these two zone substations are linked at 11kV providing a degree of redundancy should one of the 33kV connections be out of service.

Transpower has advised that taking additional load out of Pauatahanui will affect the ability of down stream customers at Paraparaumu to supply their demand. This is due to constraints on the Transpower 110kV system. Transpower has indicated in their Annual Planning Report that this issue is planned to be addressed circa 2014.

3.3.1.4. Takapu Road

Takapu Road GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 90 MVA each. Peak winter load on the Takapu Road GXP in 2009 was 90.1 MW. This is within, but close to, the transformers 92MVA cyclic rating. Takapu Road GXP supplies zone substation at Waitangarua, Porirua, Tawa, Ngauranga and Johnsonville via duplicated 33kV connections. These circuits leave the GXP as overhead lines across rural land and become underground at the urban boundary.

Transpower has advised that capacity out of Takapu road is presently constrained by a secondary systems limit that will be removed in 2010, allowing the full cyclic n-1 capacity of 116MVA to be utilised. Once this work is complete, there will be no capacity constraints at Takapu Road inside of the forecast period, subject to load growth continuing at present levels.

A review is planned for the Takapu Road GXP to consider how future load growth may be accommodated and whether the existing arrangement will provide the security appropriate for the Wellington Electricity network in the future. Transpower has advised that Takapu Road is a high salt pollution site and washing of the bus is taking place at six monthly intervals.

3.3.1.5. Melling

Melling GXP comprises two parallel 110 / 33 kV transformers nominally rated at 50 MVA each supplying zone substations at Waterloo, Naenae and Petone via duplicated 33kV underground circuit connections. It also accommodates an 11kV point of supply fed via two parallel 110/11kV transformers nominally rated at 25MVA each. Peak 2009 winter load on the Melling GXP (including both 33kV and 11kV busses) was 68.1 MVA.

A grid emergency was declared at Melling on 16 June 2009 when the 11kV transformer cyclic capacity was exceeded (the load was above 27MVA). Following this event, a secondary systems constraint was removed by Transpower allowing the full cyclic transformer rating of 32MVA to be utilised, alleviating capacity constraints for the forecast period.

3.3.1.6. Gracefield

Gracefield GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 85 MVA each. Peak winter load on the Gracefield GXP in 2009 was 53.8 MW. Gracefield GXP supplies Seaview, Korokoro, Gracefield and Wainuiomata zone substations via duplicated 33kV connections. There are no issues with the Transpower owned assets at Gracefield GXP at present.

3.3.1.7. Kaiwharawhara

Kaiwharawhara is an 11kV point of supply where Wellington Electricity takes bulk 11kV supply from Transpower and distributes this via a Wellington Electricity owned switchboard with the GXP. Kaiwharawhara is supplied at 110kV via Transpower owned circuits from the Wilton GXP, and has two 20/40MVA transformers in service. These assets are owned by Transpower.

Kaiwharawhara supplies load at the northern end of the Wellington CBD such as Thorndon and surrounds, and also light commercial and residential load around Ngaio Gorge and Khandallah areas.

Peak load at Kaiwharawhara for 2009 was 23.6 MW. This is lower than normal as a significant portion of the load has been moved to adjacent zone substation in order to balance demand with the capacity of the temporary transformer arrangement at the GXP.

3.3.1.8. Central Park

Central Park GXP comprises three 110/33kV transformers, T5 (120MVA), T3 and T4 (100MVA units) supplying a 33kV bus. There are also two Transpower owned 33/11kV (25MVA) units supplying local service and an 11kV point of supply to Wellington Electricity. Peak load at Central Park GXP in 2009 was 176.9 MW, which is well within the n-1 rating of the supply transformers. However, due to not having a 110kV bus, should a contingency occur at times of high load that results in the loss of a 110kV infeed (i.e. a circuit or transformer outage), Transpower will split the 33kV bus in order to allow them to manage any subsequent contingency. Load management is required to prevent transformer overloading in this configuration, which reduces peak loading to 109MVA

The two 100MVA units (T3 and T4) are relatively old single phase units, whereas T5 is a new 120MVA three phase unit. One possible solution to the capacity issue would be to replace these units with new units similar to T5, which has a cyclic rating of close to 150MVA. Wellington Electricity has raised a high level request (HLR) for an investigation into options for addressing the capacity issue with Transpower. Discussions on the outcome from the HLR and identification of possible solutions will take place through 2010. This will also include discussions on the security need for a 110kV bus to alleviate the requirements for controlled load shift during contingencies.

3.3.1.9. Wilton

Wilton GXP comprises two 220/33kV transformers operating in parallel, supplying a 33kV bus that feeds to zone substations at The Terrace, Karori, Moore Street, and Waikowhai. These transformers are nominally rated at 100MVA each, and the peak load in 2009 was 81.0 MW. There are no issues with the Transpower owned assets at Wilton GXP at present. The 220/110kV interconnecting transformer T8 has been replaced at Wilton in the first quarter of 2010, whilst not directly supplying Wellington Electricity; this allows improved operational flexibility and allows paralleling of Kaiwharawhara and other zone substations supplied from the Wilton 220kV bus..

3.3.2. Embedded Generation

The network currently has a range of connected embedded generation including several connections of less than 10 kW (typically residential), two landfill sites greater than 1 MW, and a hospital with synchronised generation of approximately 8 MW. In addition, there are a number of customers with standby generation plant of varying sizes (typically less than 1 MW), which generally cannot be synchronised to the network.

Resource consent has recently been granted for a wind farm with an installed capacity of approximately 8MW, located on the south coast of Wellington. Wellington Electricity is working with the wind farm developer on options for providing a connection into the 11kV network.

There is a larger scale windfarm operated by Meridian, West Wind, connected into the Transpower 110kV system between Wilton and Central Park. Whilst not directly connected to the Wellington Electricity network, it may have impact on ripple signal propagation and also the introduction of harmonics into the system. Wellington Electricity are in discussions with Meridian over this potential issue.

The Wellington Regional council is currently reviewing a number of small scale hydro generation plants at existing water facilities storage and pumping facilities around the region. These are in the order of 1MW each.

3.3.3. Subtransmission

The 33 kV subtransmission system is comprised of assets that take supply from the Transpower grid exits points and feed a total of 28 Wellington Electricity zone substations, incorporating 54 33/11 kV transformers. This 33 kV system is radial with each feeder supplying its own dedicated power transformer, with the exception of Tawa and Kenepuru where two feeders supply four transformers (one feeder shared per bank at each substation). All 33 kV feeders supplying zone substations in the Wellington area are underground while those in the Porirua and Hutt Valley areas are a combination of overhead and underground. The total length of the 33 kV system is 212 km, of which 153 km is underground.

All Zone substations have N-1 subtransmission supply at 33kV, generally with one supply from each side of a Transpower bus (where available). Plimmerton and Mana each have a single 33kV supply to a single power transformer, however they are connected together on the 11kV bus, and as a result they operate as an N-1 substation with a geographic separation of 1.5kms. At certain times the 11kV bus tie cable can be constrained, although load control and 11kV network switching can alleviate this constraint.

The 33 kV subtransmission system is also backed up by a limited number of “express” 11 kV circuits that perform a subtransmission function in that they do not supply any directly connected loads. These are used as backups to the 11 kV supply at some zone substations and also to supply a number of 11 kV switching nodes, which in turn are used as the source for 11 kV distribution feeders.

A list of each zone substation’s capacity, incorporating 33kV cables and transformers, is provided in the section on demand forecasts.

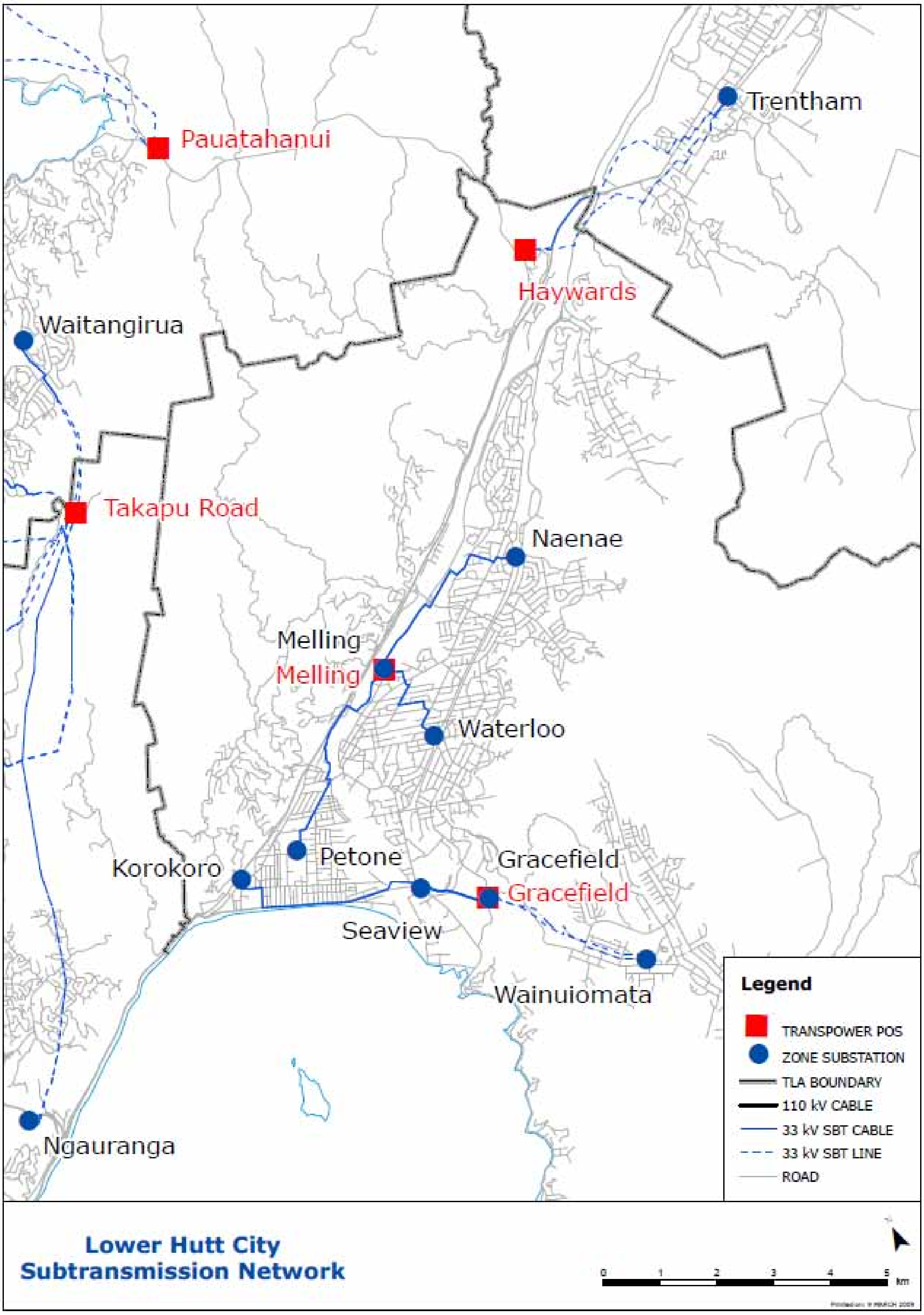

Figure 3-7 Lower Hutt Subtransmission Network

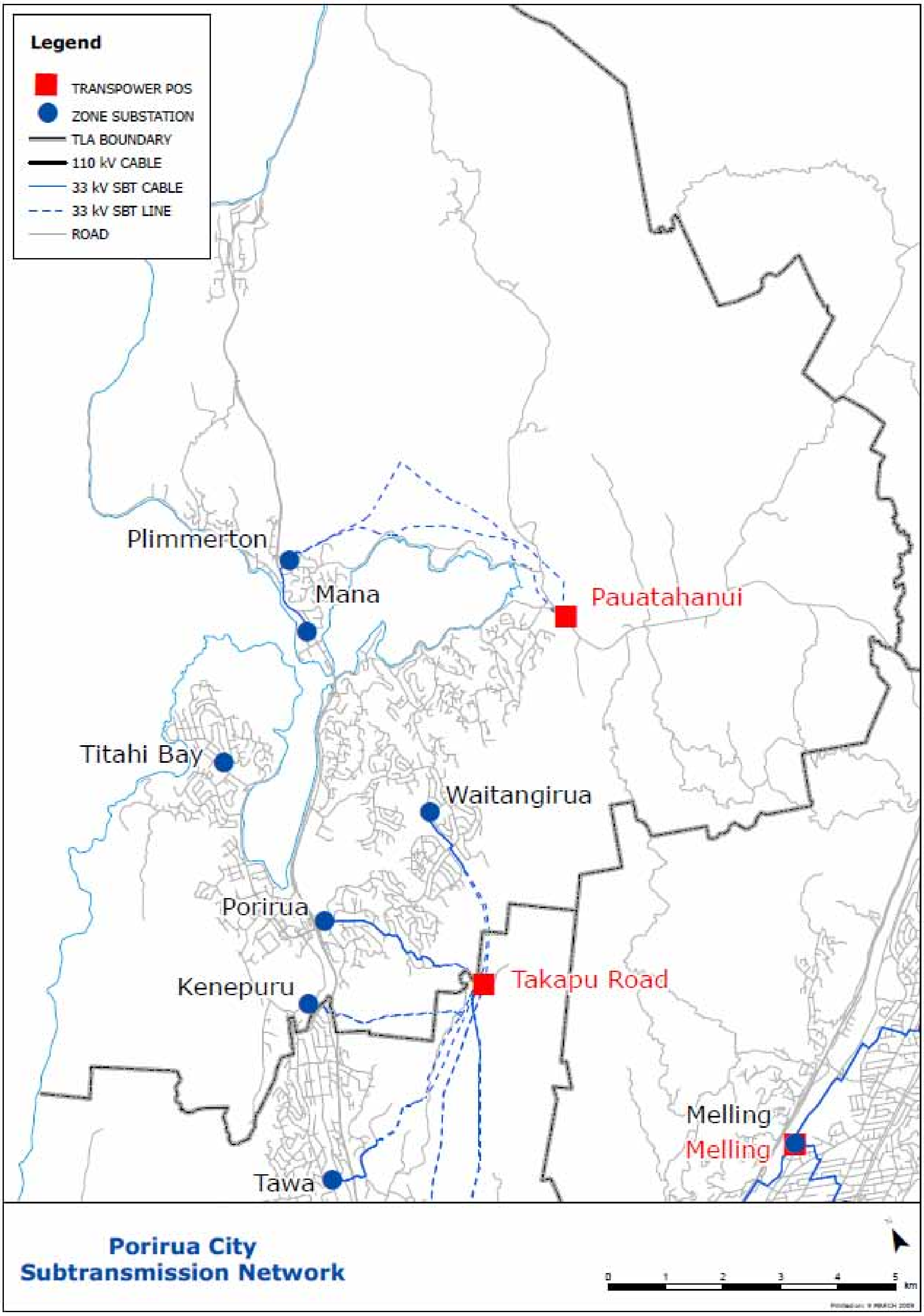

Figure 3-8 Porirua City Subtransmission Network

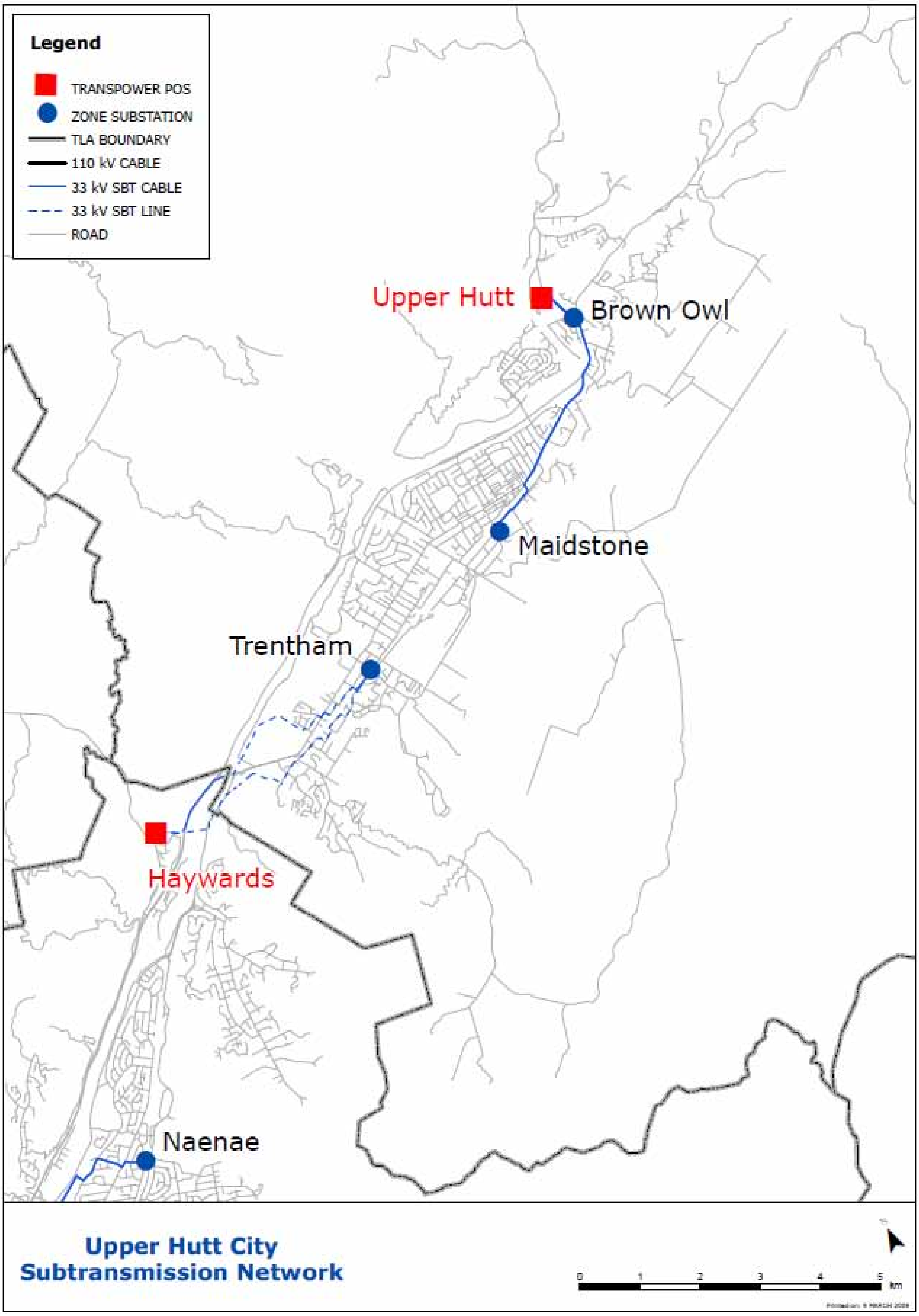

Figure 3-9 Upper Hut City Subtransmission Network

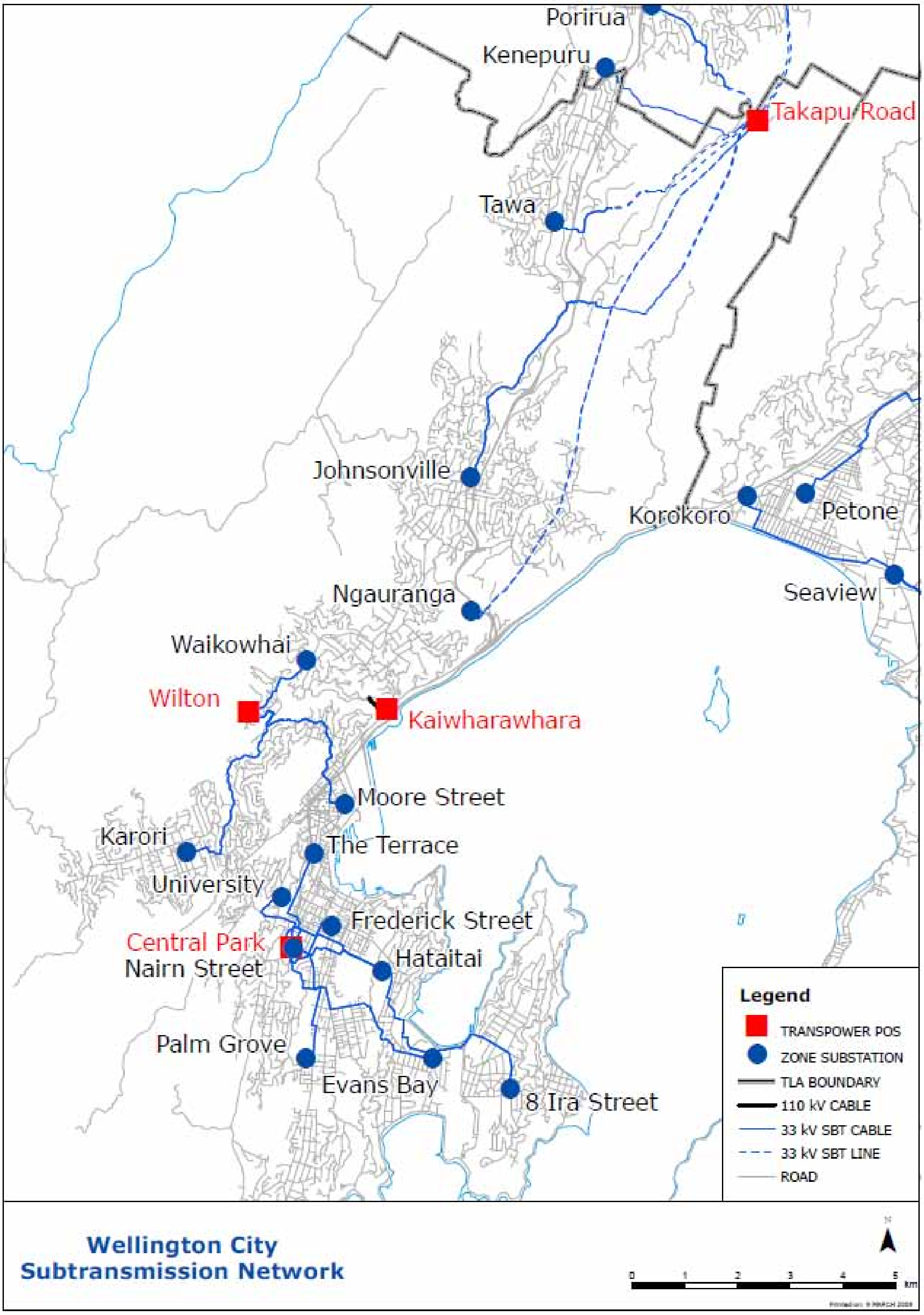

Figure 3-10 Wellington City Subtransmission Network

3.3.4. Distribution System

The 11 kV distribution system is supplied from the zone substations, or directly from the grid in the case of the 11 kV supply points at Central Park, Melling, Haywards and Kaiwharawhara. While some larger consumers are fed directly at 11 kV, the system mainly supplies approximately 4,100 11/415 kV distribution substations located in commercial buildings, industrial sites, kiosks, berm-side and on overhead poles. The total length of the 11 kV system is approximately 1,715 km, of which 65% is underground. In Wellington City, the 11 kV network is largely underground whereas in the Hutt Valley and Porirua areas there is a higher proportion of overhead 11kV lines. The varying proportions of overhead and underground distribution on the different parts of the system reflect the different design philosophies of earlier network owners, as well as geography of the various areas.

Most of the 11 kV feeders in the Wellington CBD[2] are operated in a closed ring configuration with radial secondary feeders interconnecting neighbouring rings or zone substations. This arrangement provides a high level of security and hence a high level of supply reliability. Most of the 11 kV network outside the Wellington CBD, both in the Wellington City and Hutt Valley areas, comprises radial feeders with a number of mid feeder switchboards with circuit breakers and normally open interconnectors to other feeders so that, in the event of an equipment failure, supply to customers can be switched to neighbouring feeders. To allow for this, distribution feeders are not operated at their full thermal rating under normal system operating conditions.

There are approximately 1,600 11kV circuit breakers operating within the distribution system. Almost 400 of these are located at the zone substations and control the energy being injected into the distribution system. The remainder are located within distribution substations, mostly situated within or close to the Wellington CBD or in the Wellington City area, and allow the primary feeders in their respective areas to be operated in a closed loop arrangement. These circuit breakers are used to automatically isolate a faulted section of the network and to improve the ability to maintain an uninterrupted supply to all customers not directly connected to the faulted section. This is subject to cables having sufficient rating to carry extra load to support these contingent events.

The number of circuit breaker used in the distribution network is high in relation to other networks in New Zealand as illustrated in figure 3-1.

[2] The CBD area is considered to be the commercial areas supplied by Frederick St, Nairn St, University, The Terrace, Moore St and Kaiwharawhara.

Network	ICP count (approx.)	CB count (approx.)	ICP/ CB ratio (approx.)
Vector Networks	520,000	1550	330
Orion NZ	190,000	800	240
Wellington Electricity	**160,000**	**1600**	**100**
Unison	107,000	270	400
WEL Networks	84,000	380	220
Aurora Energy	81,000	400	200
NorthPower	53,000	200	260

Figure 3-11 Comparison of Number of Circuit Breakers in Various Networks

The high number of circuit breakers in the Wellington Electricity network is a result of historic design practices aimed at delivering a very reliable network. The present network configuration will be reviewed to consider the opportunity for further system automation as equipment condition determines the need for replacement. The economics for smart network developments will be considered based on a fair return for the investment in line with the improved customer services.

3.3.5. Distribution Substations

Throughout the distribution network there are approximately 4,100 distribution substations sites (3,400 owned by Wellington Electricity as standalone sites and 700 housed on consumer sites) with around 4,300 associated distribution transformers in service, as some sites have multiple transformers installed. Pole-mounted distribution transformers are typically less than 150 kVA and are generally simple platform structures or hanging bracket type arrangements. Ground-mounted distribution substations include a range of designs from the more significant reinforced concrete block buildings that can accommodate single transformers (typically a switch unit and low voltage (LV) distribution panel or frame) up to larger style three-transformer, multiple circuit breaker (CB) switchboards and extensive LV distribution framing. The more compact substations are generally the kiosk style, with an LV frame, transformer and ring main unit enclosed in a metal canopy. Other common styles are stand alone, open fenced enclosures or fully enclosed within customer owned buildings.

Thorndon Substation

In Wellington City the majority of the distribution transformers are ground mounted. The Hutt and Porirua areas are a combination of ground mounted and overhead installations. Individual capacities range from 5 kVA to 2,000 kVA, and the weighted average capacity is approximately 300 kVA.

Enclosure Type	Quantity
Outdoor cage	272
Indoor	962
Padmount	1,094
Pole	1,809

Figure 3-12 Overview of Distribution Substation Types

3.3.6. Low Voltage Lines and Cables

Low voltage lines and cables are used to connect individual customers to the low voltage network supplied from the distribution transformers. The total system length is around 2,660 circuit-km, of which approximately 58% is underground.

Consumers are supplied via a low voltage fuse, which is the installation control point (ICP) used by the network to connect the consumer installation. This fusing is either an overhead pole fuse or located within a service pillar or pit near the consumers boundary. Some other styles of fuse installation exist, however these are being progressively replaced following faults, or when work is required on them.

In addition to service pillars there are approximately 400 link pillars on the network that allow isolation, reconfiguration and back feeding of certain LV circuits. These vary in age and condition and are being replaced in situations where their condition is poor and where they provide operational flexibility, or where the type of load served is sensitive to outages on the low voltage network, and back feeding will ensure compliance with service levels. In some cases, the LV network configuration has changed and there is no longer a requirement for a link pillar and they are removed if they have become unserviceable.

3.3.7. Secondary Systems

3.3.7.1. Protection Assets

Protection assets are used to automatically detect thresholds that indicate a potential equipment fault and to automatically issue control signals to disconnect faulted equipment. This ensures that the system remains safe, that damage is minimised and also limits the number of consumers affected by an equipment failure.

On the HV system, there are more than 1,200 protection relays in operation. Around 95% are older electromechanical devices. The remainder are newer relays that use solid state electronic and microprocessor technology. Relays are generally mounted as part of the substation switchboard and are normally changed at the time of switchgear upgrade. At distribution level, 11kV fuses are used for protection of equipment.

On the LV system, fuses are used for the protection of cables and equipment.

3.3.7.2. Supervisory Control and Data Acquisition (SCADA)

The SCADA system is used for real time monitoring and to provide an interface to operate the network. SCADA can monitor and control the operation of primary equipment at the zone substations and larger distribution substations, as well as providing indication from Transpower owned assets at GXPs. It is used to:

- Monitor the operation of the network from a single control room by remotely indicating key parameters such as voltage and current at key locations;
- Permit the remote control of selected primary equipment in real time;
- Graphically display equipment outages on a dynamic network schematic; and
- Transmit system alarms to the controller for action.

System information is collected by remote terminal units (RTUs) at each substation and is transmitted to a central master station located in a control room at Haywards substation through dedicated communication links. Control signals travel in the opposite direction over the same communications links.

3.3.7.3. Load Control

Wellington Electricity uses a ripple injection signal load control system to control selected loads at consumer premises such as water heating and storage heaters, to control street lighting and also to provide some tariff signalling as required by retailers using the network. The system is automatically operated by the master station at the Haywards Control Centre to control loads at peak times.

3.3.7.4. Communication

Operation of secondary systems requires the use of high security communication links between the master station and the different control points. Like most distribution businesses, Wellington Electricity operates its own communications system with a small number of communications links being leased from service providers such as Telecom, Vector Communications and Transpower.

Wellington Electricity's own network comprises mainly copper pilot cable with a small amount of fibre-optic and UHF radio infrastructure. Communications links leased from other service providers are either fibre-optic or radio links.

3.4. Categories of Assets and Age Profiles

3.4.1. Subtransmission Cables

Wellington Electricity own approximately 153km of subtransmission cable operating at 33kV. These cables, comprise some 52 circuits connecting Transpower grid exit points to Wellington Electricity's zone substations. Around 11 km of subtransmission cable is of XLPE construction and requires little maintenance. The remainder is of paper insulated construction, with a significant portion of these cables being relatively old pressurised gas or oil filled, with either aluminium or lead sheath. A section of the subtransmission circuits supplying Ira St zone substation are fluid filled PIAS cables with copper conductors rated for 110 kV but operating at 33 kV. The lengths, age profile and spare holdings of this asset class are shown below.

Construction	Design Voltage	Percentage	Quantity
Paper Insulated, Oil Pressurised	33kV	32%	49 km
Paper Insulated, Gas Pressurised	33kV	53%	82 km
Paper Insulated	33kV	2%	3 km
XLPE Insulated	33kV	7%	11 km
Paper Insulated, Oil Pressurised	110kV	6%	9 km

Figure 3-13 Summary of Subtransmission Cables

There are also 33kV rated oil cables supplying the Titahi Bay switching station from Porirua zone substation which are operated at 11kV, these are not counted in the subtransmission circuit length. These could in future be energised at 33kV if Titahi Bay was developed into a full substation and operated as subtransmission cables, although the likelihood of this occurring is low. Elsewhere in the network, there are abandoned 33kV cables being run at 11kV that will not be used as subtransmission again.

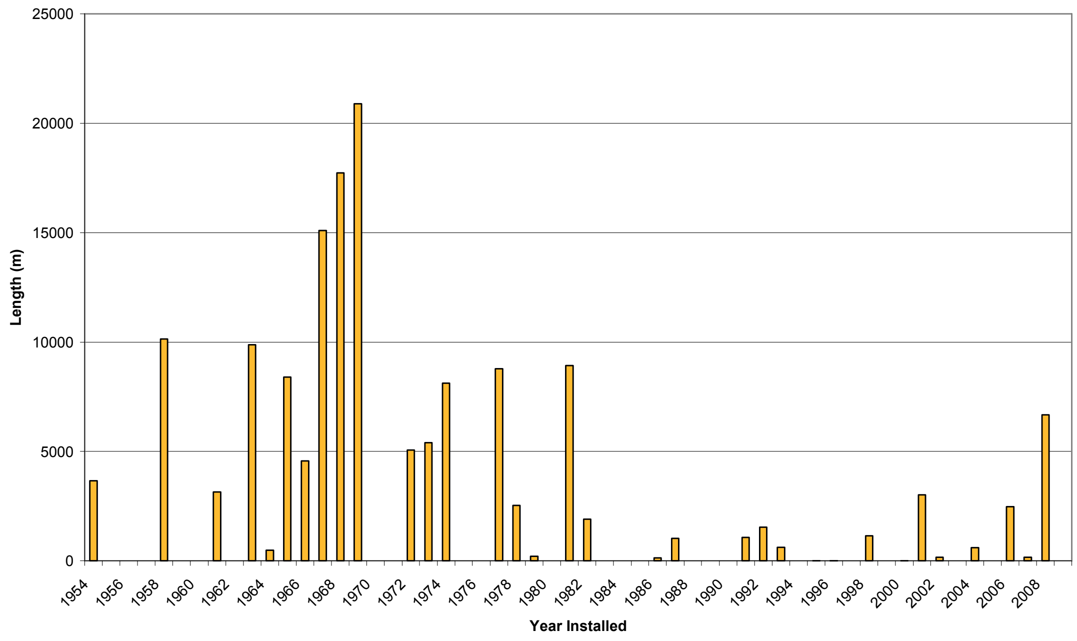

Figure 3-14 Age Profile of Subtransmission Cables

Strategic Spares	
Medium lengths of cable	It is necessary to hold medium lengths of oil and gas cable in store to allow replacement of short sections following damage. By holding oil and gas cable lengths, field contractors are able to repair without requiring termination and transition to XLPE cable.
Standard joint fittings	Stock is held by the field service provider to repair standard oil and gas joints, these need to have a minimum stock level held, and where stock levels drop replacement parts need to be sourced and if necessary be manufactured locally.
Termination/transition joints	Two gas / XLPE cable transition joints have been purchased and will be held in storage to allow quick repair and alteration to gas cables.

Figure 3-15 Spares Held for Subtransmission Cables

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.2. Zone Substation Buildings

There are 30 major substation buildings, 28 of which are located at zone substation sites and 2 at major 11kV switching stations. The buildings generally stand alone and have switchgear, protection equipment, local AC and DC supplies installed inside. Some buildings also contain transformers and ripple injection plant. Wellington Electricity also has a large number of kiosk type distribution substations; these are covered separately later in this section as they form part the distribution substation asset class. The age profile of zone substation buildings is shown below.

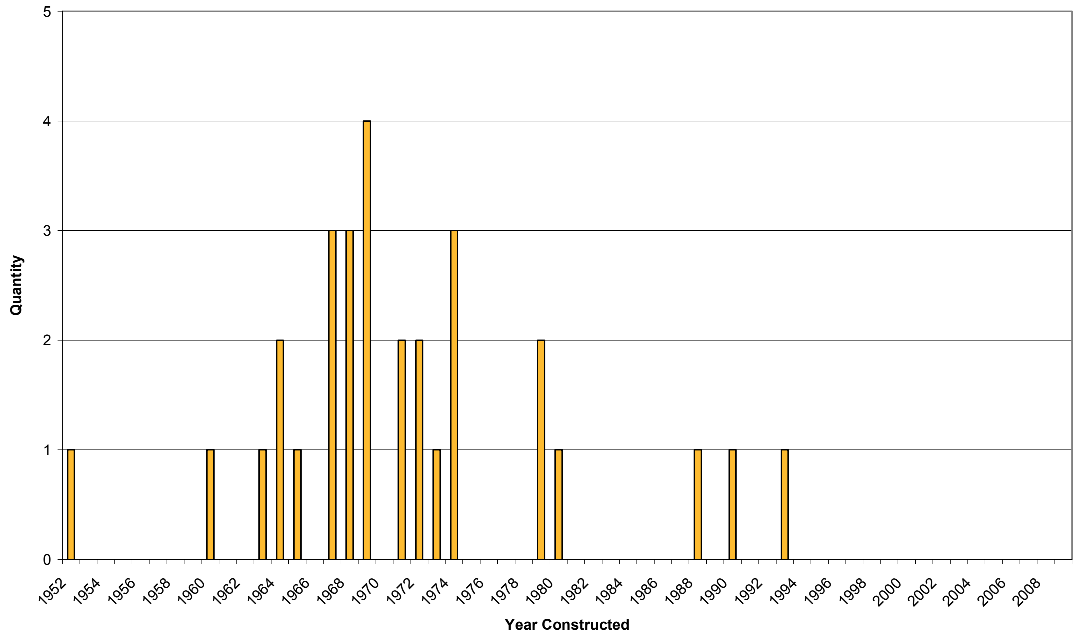

Figure 3-16 Age Profile of Zone Substation Buildings

The average age of the buildings is 37 years and they are generally in a good condition, however from time to time require maintenance or replacement of some components such as doors, roofs and spouting. Wellington Electricity is required to undertake seismic strengthening activities on buildings as required by the local councils on some of the older buildings. A seismic review and assessment has been undertaken on the majority of zone substation buildings. Remedial work has been undertaken as a result of this review, including securing plant inside substations.

In some cases, Wellington Electricity does not own the land under the zone substation, and has arrangements in place for a long term lease with the landowner.

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.3. Zone Substation Transformers

Wellington Electricity has 54 33/11kV power transformers in service on the network. All zone substation transformers are operated well within their specified ratings and are regularly tested and condition assessments undertaken. Overall the transformer fleet is in a generally sound condition even though a number of transformers are reaching their end of design life of 55 years. However, based on their operating conditions and maintenance it is expected that most transformers will continue to operate beyond their design life. Nevertheless older transformers require more intensive monitoring to assess and evaluate their condition. Recent estimated DP tests[3] on the transformers, using the Furan analysis method, indicate a high level of remaining life given the age. Whilst not as conclusive as taking internal paper samples, this is a good indicator of internal condition. Mechanical deterioration is an issue that needs to be monitored on

[3] Degree of Polymerisation, an indicator of dielectric strength of paper insulation.

older units, both for condition of external fittings, as well as internal components such as tap changer contacts and mechanisms.

The age profile and spares holdings for zone substation transformers are shown below.

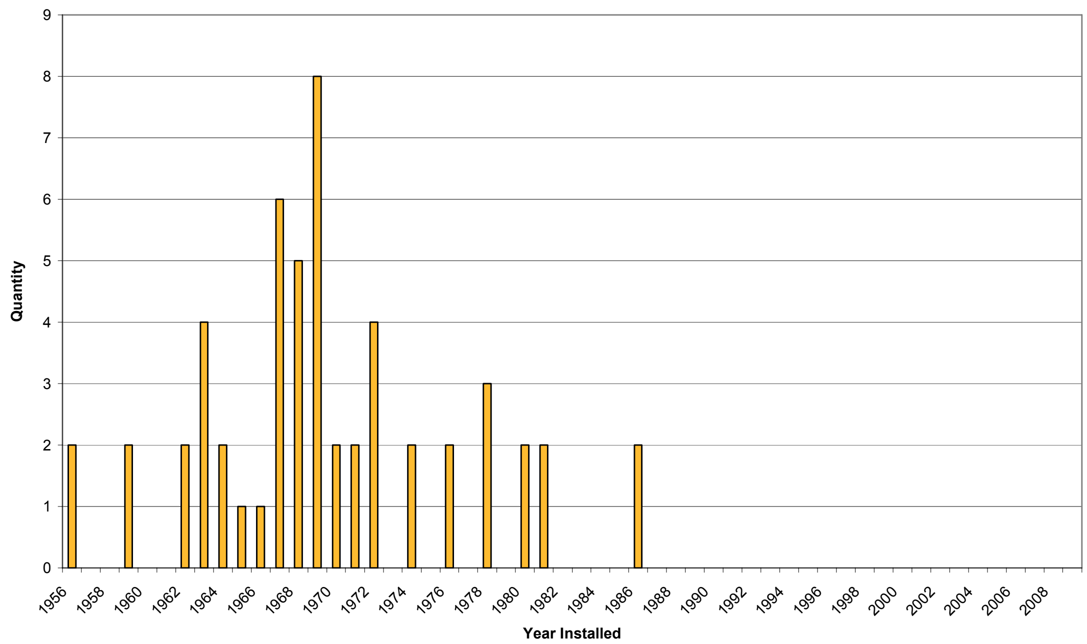

Figure 3-17 Age Profile of Zone Substation Transformers

The age profile indicates that the average age of the transformer fleet is reasonably high (around 39 years). Based on the assumption that zone transformers have an economic life of around 55 years then 95% of the zone transformers have exceeded midlife and around 45% of transformers have exceeded an age of 40 years.

Wellington Electricity holds certain spares for the power transformers and tap changers in the system, and a list of current and target spares is listed below:

Strategic Spares	
Tap Changer fittings	Wellington Electricity holds a number of spares for the tap changers on Zone substation transformers, typically contacts and related components. These components have high wear and are eroded by arcing during operations. Generally, the components held are for tap changers that have not had recent maintenance, and are therefore used in the next maintenance cycle. Where excessive wear is noted during maintenance, spares are ordered and held in stock for that model of tap changer. Spares are generally available for all models that are operated on the network.

Strategic Spares	
Transformer misc. fittings	Various other transformer fittings have been identified and held for sites where having a transformer out of service for a prolonged period is unacceptable for minor repairs. Fittings include Bucholtz relays, high voltage bushings etc. For major repairs, a unit will be swapped out.
Spare transformer	There is one unit from Trentham (Tyree / 1980) that can be easily removed from service due to low loadings and ease of back feeding. Should Wellington Electricity require a second spare transformer, one of the units from Petone substation can be utilised. This area also has good 11kV backfeed options and low loadings. Trentham has external bushings, and Petone has a cable box, so there is a transformer for either situation. Other sites with low loading include Gracefield, Tawa and Kenepuru. In extreme cases, these sites can be evaluated for transformer removal.

Figure 3-18 Spares Held for Zone Substation Transformers

3.4.4. Substation DC Systems

The DC auxiliary systems provide power supply to the substation protection, control, metering, monitoring, automation and communication systems, as well as circuit breaker tripping and closing mechanisms. The standard DC auxiliary system comprises batteries, battery chargers, DC/DC converters and a battery monitoring system. Wellington Electricity has a number of different voltages, 24, 30, 36, 48, and 110V largely for historical reasons, however has standardised on 24V for all new or replacement installations.

A range of spares is held, mostly chargers of different voltages that have been removed from sites over recent time. Batteries are available locally at short notice so these are not held.

3.4.5. Switchboards and Circuit Breakers

11kV circuit breakers are used in zone substations to control the power injected in to the 11 kV distribution network and also within the network to increase the reliability of supply in priority areas such as in and around the CBD. The largest single type is Reyrolle Pacific type LMT circuit breakers but other types are also in service in large numbers. There are approximately 1,600 CBs forming 400 11kV switchboards on the Wellington Network.

An age profile of the circuit breakers and spare parts holdings are shown below.

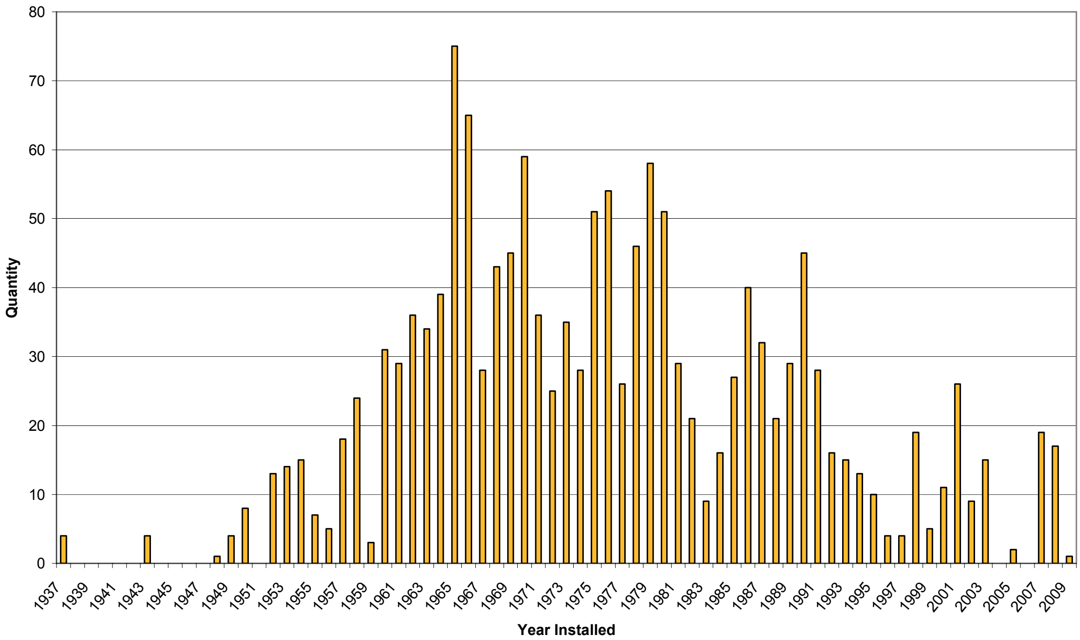

Figure 3-19 Age Profile for Circuit Breakers

The age profile indicates that the average age of circuit breakers in the Wellington Network is around 34 years, with the age of individual breakers ranging from relatively new to more than 50 years. The mix of circuit breaker technologies reflects the age of the equipment. The oil type circuit breakers are the oldest in the network followed by SF6 and vacuum type circuit breakers. Most circuit breakers are oil insulated with relatively intensive maintenance regimes.

There are two 33 kV oil circuit breakers at Ngauranga which have been in service at this site for approximately 17 years having been installed in 1993 when the substation was constructed, however they were originally manufactured in the 1960s. A protection scheme proposed for the subtransmission circuits from TP Takapu Rd will see these being made redundant and all circuit breakers remaining will be 11kV. Certain oil-type circuit breakers are approaching or have passed the end of their technical life of 40 years. Inadequate fault level rating, equipment failures, lack of spare parts, and increased maintenance costs compared to newer SF_6 or vacuum equipment are areas of concern for this aging equipment.

Category	Quantity
33kV Circuit Breakers	2
11kV Circuit Breakers	1,593

Figure 3-20 Summary of Circuit Breakers

Given the high number of circuit breakers in service on the Wellington network, it is important to keep adequate quantities of spares to enable quick repair of minor defects. Some types of circuit breakers, such as early Statter and AEI CBs have limited numbers of spares available; however there are low numbers of these types installed on the system. There are large numbers of spares held for the Reyrolle type circuit breakers; this is reflective of the number in service.

The largest quantity of CBs on the network, and used predominantly at zone substations, are Reyrolle type LMT. The RPS Switchgear (formerly Reyrolle Pacific) factory is located in Petone, there is a good relationship between parties and spares above those normally held by the network are available within short timeframes if required for LMT type switchgear

Strategic Spares	
Circuit breaker trucks	At least one CB truck of each rating (or the maximum rating where it is universal fitment) shall be held for each type of withdrawable CB on the network.
Trip/Close Coils	Spare coils held for each type of circuit breaker, and all operating voltages
Spring Charge Motors	Spare spring charge motors held for each voltage for the major types of switchgear in service (Reyrolle C gear, LMT, etc)
Current Transformers and primary bars	Where available, spare CTs and primary bars should be held to replace defective units. In particular 400A CTs for Reyrolle LMT as this type of equipment has a known issue for PD

Figure 3-21 Spare parts held for Circuit Breakers

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.6. Protection and Control Systems

Due to the closed-ring architecture of the central Wellington distribution network there are a large number of protection relays, the majority (around 87%) of which are electromechanical type. Numerical type relays are the latest additions to the network but constitute only 9% of the population. Solid state or static type relays ranging in age from around 15 to 25 years represent around 4% of the total number of relays.

The average age of the protection relays on the Wellington network is around 32 years and it is estimated that around 400 or 30% of the protection relays are 40 years or over in age. Generally all protection relays are in good condition with the exception of PBO electro mechanical and Nilstat ITP solid state relays. These relays have performance and functionality issues, which had triggered an ongoing replacement programme under previous owners. 11 PBO type relays were replaced in the old Hutt Valley area but few have been replaced in the Wellington City area.

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.7. SCADA

Wellington Electricity's SCADA master station is located at the Transpower-owned Haywards substation. It is a Foxboro (formerly Leeds & Northrup (L&N)) LN2068 system and was initially installed in 1986 and is being replaced with a GE ENMAC system, which is in the process of being fully commissioned.

Data is communicated to the master station by remote terminal units (RTUs) that are located at the different control and monitoring sites. The age and technology of the RTUs vary and many are now obsolete. The protocols in use on the Wellington network are Conitel, DNP3.0 and IEC61850. Wellington Electricity has

230 RTUs installed in sites from GXP level down to small distribution substations. An age profile of SCADA RTUs is shown below.

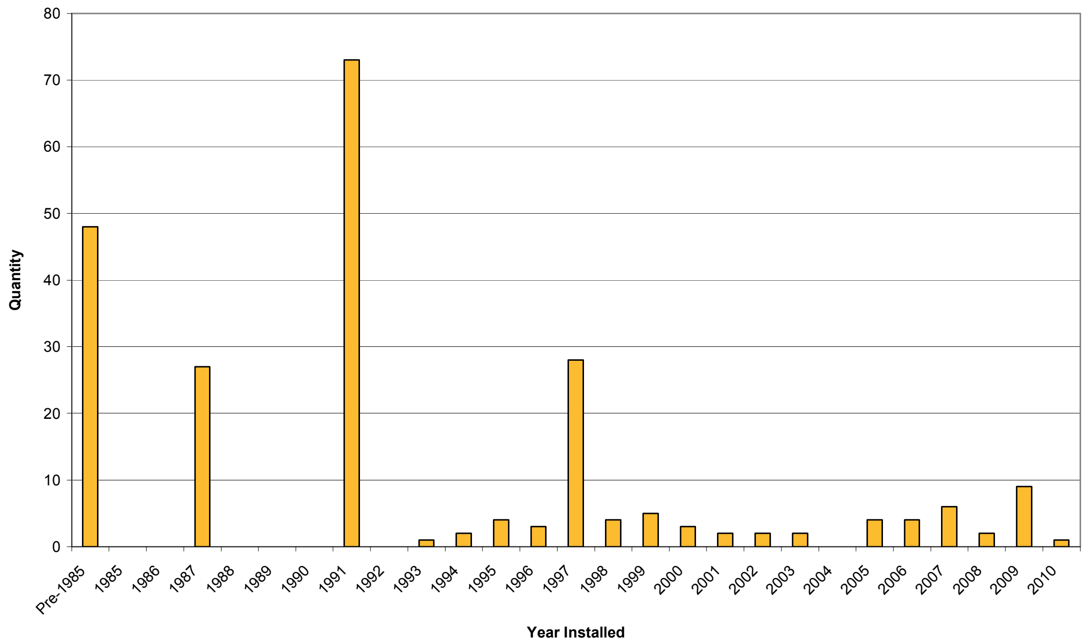

Figure 3-22 Age Profile of SCADA RTUs

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.7.1. Substation Level TCP/IP Communications

Presently the substation level TCP/IP (a protocol used in data communications, Transmission Control Protocol/Internet Protocol) network hardware is leased from Vector Communications Ltd, a subsidiary of the previous network owner.

The contract with Vector Communications will expire in June 2012 at which point it is envisaged that Wellington Electricity will review these arrangements.

As substation sites are being upgraded or developed, and if IP network connections are available, the station RTU is upgraded and moved onto the substation TCP/IP network. Presently there are 18 sites (a mixture of zone and distribution substations) on the substation TCP/IP network.

There is one Siemens Power Automation System (PAS) unit that acts as a protocol converter between the Siemens IEC61850 field devices and that of the DNP3 SCADA master station and is seen as a single point of failure as multiple sites are reporting to one point, the PAS. Substation base equipment will be installed, in due course, to eliminate the reporting of multiple sites through a single device and reduce this risk.

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.8. Load Control Systems

Wellington Electricity uses a ripple injection signal load control system to inject 475Hz and 1050Hz signals into the network for the control of selected loads at consumer premises such as water heating and storage heaters, to control street lighting and also to provide some tariff signalling as required by retailers using the network. There are 24 ripple injection plants on the network and these are located at GXPs and Zone Substations. The Wellington City area has a 475Hz signal injected into the 33kV network with one plant per GXP and two plants injecting at Kaiwharawhara 11kV point of supply. The Hutt and Porirua areas have a 1050Hz signal injected at 11kV at each zone substation. All ripple injection is controlled by the master station at the Haywards Control Centre. An age profile of ripple plant is shown below.

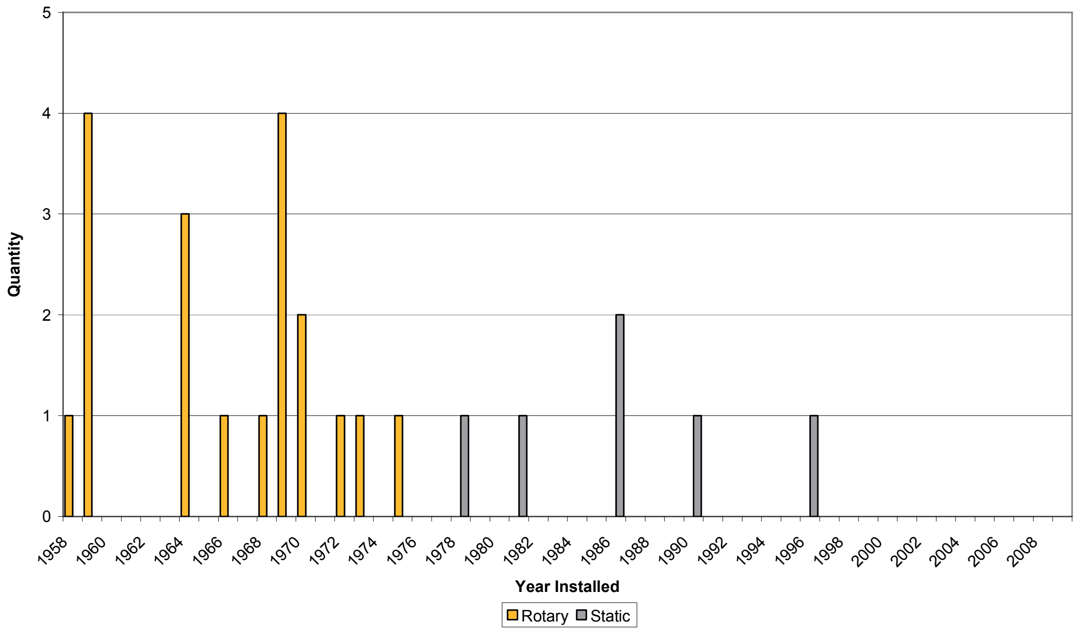

Figure 3-23 Age Profile of Ripple Plant

There is significant benefit in having a fully functional load control system and being able to control loads at peak times and to defer energy consumption by interruptible loads until times of lower demand on the system. This allows for better asset utilisation as the distribution network does not need to be oversized to allow for short duration peaks. Wellington Electricity does not own the ripple receivers installed at consumer premises and is experiencing decreasing levels of control as these devices fail and are not replaced by the asset owner. As receivers fail, Wellington Electricity has noted that they are not being replaced by the retailers, hence over time the network will continue to lose controllable load which may accelerate the need for investment in the distribution system. Wellington Electricity is encouraging retailers and metering providers to ensure investments and upgrades preserve the ripple control system due to its importance to managing loading on the network and transmission system. Wellington Electricity believes ripple control is the most cost effective technology for load control due to the existing installed base and will continue to operate this system. Wellington Electricity also uses ripple control to participate in the Instantaneous Reserves market, and for supporting the Transpower AUFLS (Automatic under frequency load shedding) system.

There are some small areas of network that receive DC bias load control signals. This system is no longer supported and it is unknown how many consumer installations still use the DC bias system. It is proposed to decommission this system in 2011 and affected consumers will be moved to ripple load control.

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.9. Overhead Lines

The overhead lines in Wellington Electricity's network consist of 56% wooden and 44% concrete pole lines. There are a total of approximately 50,000 poles in the network at present, however Wellington Electricity is reviewing its pole ownership policy for common service lines. This is likely to alter the total number of poles owned.

Pole and Overhead Lines – Nairn Street

3.4.9.1. Poles

The average age of concrete poles is around 23 years. Although the standard asset life for concrete poles is 60 years, there are a number of concrete poles that have been in service for longer. The average age of wooden poles is around 34 years of age and nearly 50% of all wooden poles are older than 45 years, the standard asset life of wooden poles. Crossarms are predominantly hardwood and are generally in a fair condition. Crossarms have a shorter life than poles, especially concrete poles, and will generally require replacement approximately half way through the life of the pole.

Along with Telecom accessing the poles for their services, a previous network owner entered into agreement with Saturn (now TelstraClear) to support cable TV circuits from the majority of the network poles across the region. This is now causing problems for maintenance and operations due to congestion on the poles. Due to this congestion, Wellington Electricity must consider the impact and full life cycle costs of future access for wide scale attachment to poles. Each case will be evaluated on its own merits. An age profile of the poles on the network is shown below.

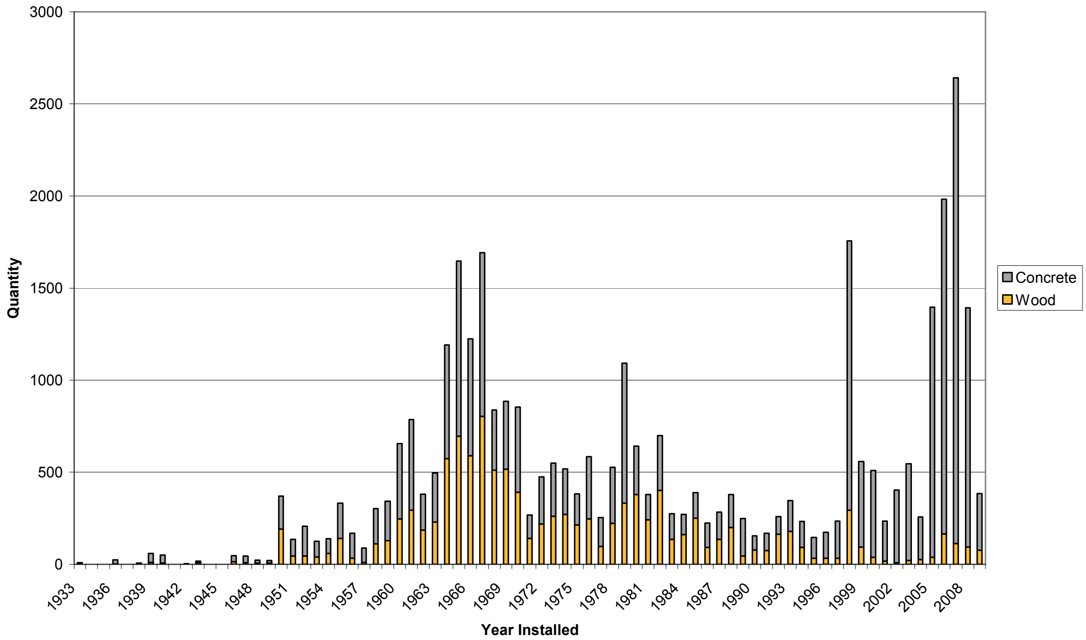

Figure 3-24 Age Profile of Poles

3.4.9.2. Lines/Conductor

Overhead conductors are predominantly copper (Cu), all aluminium conductor (AAC) and aluminium conductor steel reinforced (ACSR). New line reconstruction generally utilises all aluminium alloy conductor (AAAC). Where possible, low voltage aerial bundled conductor (LVABC), and covered conductor thick (CCT) for 11 kV lines are used in areas susceptible to tree damage. An age profile of overhead line conductors is shown below.

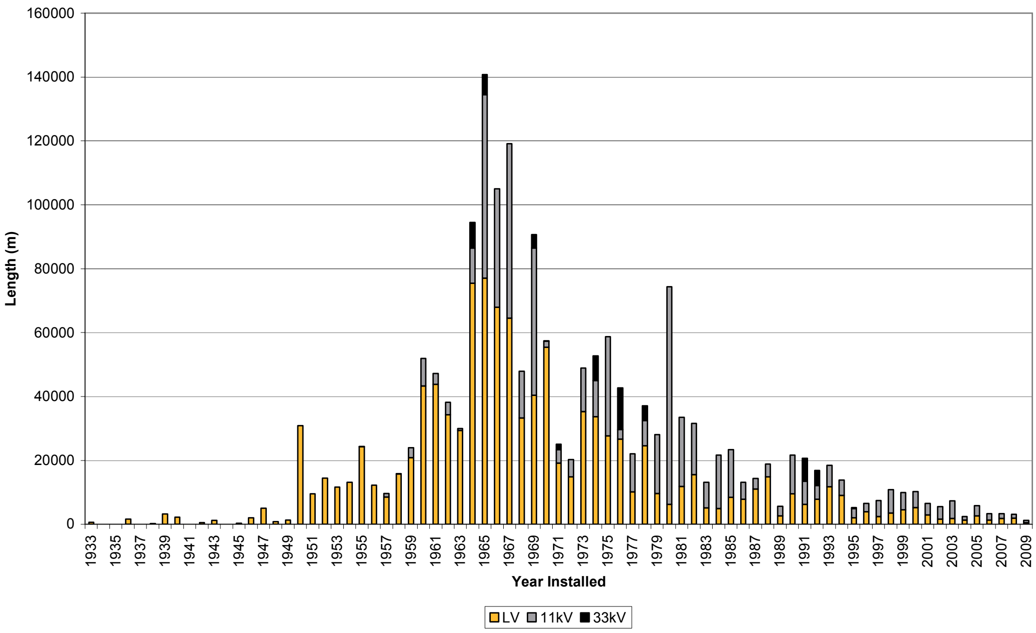

Figure 3-25 Age Profile of Overhead Line Conductors

Category	Quantity
33kV Line	60 km
11kV Line	661 km
Low Voltage Line	1162 km

Figure 3-26 Summary of Overhead Lines

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.10. Overhead Switchgear and Devices

There are 337 air break switches (ABS), 27 auto-reclosers, 171 knife links, 38 gas insulated overhead switches and a mix of expulsion type drop out fuses for breaking the overhead network into sections.

Most of the ABSs are more than 20 years old and are not cost effective to refurbish and generally range from fair to poor condition. Switch replacement occurs when poles or crossarms are replaced, or upon inspection results. Gas insulated load break switches are being used in strategic areas, and are equipped with motor actuation for future automation. Conventional air break switches are also widely used.

The majority of the 27 overhead auto-reclosers are oil filled, with only five being gas insulated.

Wellington Electricity has a single 11kV voltage regulator that was installed around 1977, and a 400V voltage regulator that was installed in the mid 1980s.

An age profile of these overhead line devices is shown below.

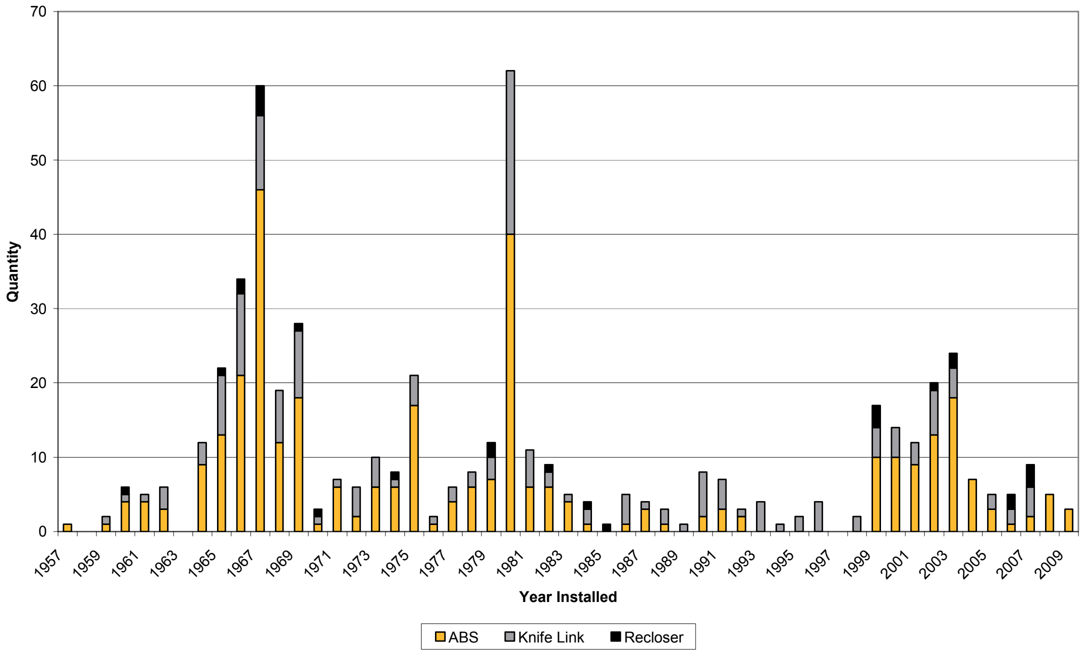

Figure 3-27 Age Profile of Overhead switchgear and devices

Fault passage indicators, both remote and local, have been installed at a number of major tee offs on the overhead lines. This practice will continue to aid fault detection to allow quicker restoration of areas affected by interruptions.

3.4.11. Distribution Transformers

Approximately 57% of the distribution transformer population is ground mounted and the remaining 43% is pole mounted. The pole mounted units are installed on single and double pole structures and are generally 3 phase units rated between 10 and 200 kVA. The ground mounted units are also generally 3 phase units rated between 100 and 1,500 kVA. Wellington Electricity holds a variety of spare distribution transformers, in serviceable condition, to allow for quick replacement following a major defect. Other than complete units, few other spares are held for this type of asset. The standard life of a distribution transformer is 45 years, although in indoor environments a longer life may be achieved, and in some outdoor environments a transformer will not reach this age. The age profiles of distribution transformers are shown below.

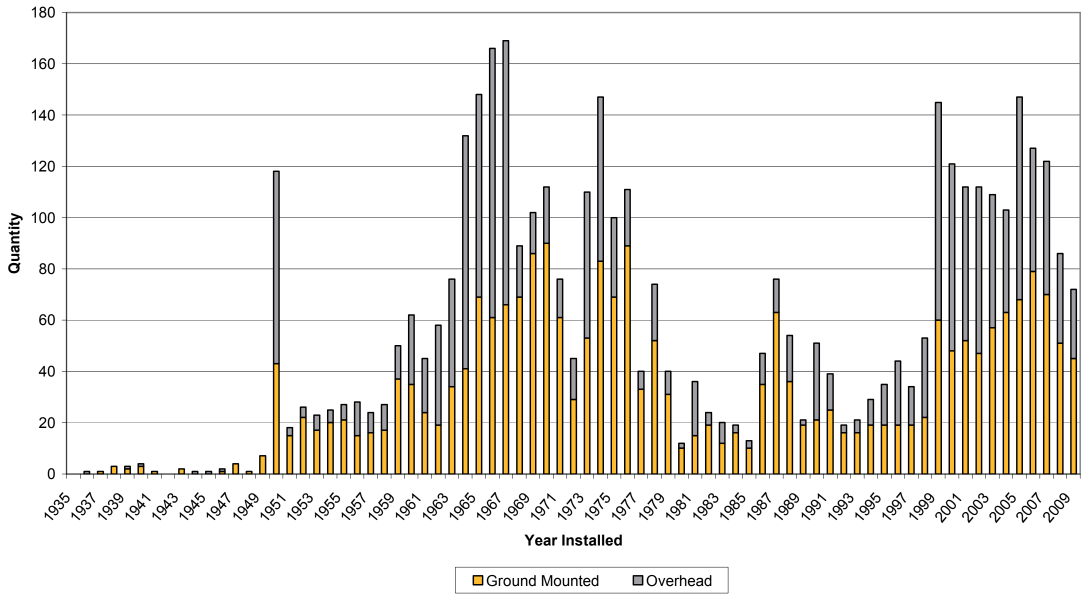

Figure 3-28 Age Profile of Distribution Transformers

In addition to pole and integral berm substations, Wellington Electricity has over 400 kiosk type substations (typically of masonry or block construction) in the Wellington City and Hutt Valley areas. These are categorised under substation enclosures, although a large number are quite sizeable and reside on Wellington Electricity owned plots of land.

Category	Quantity
Distribution Transformers	4,335
Distribution Substations (enclosures, earthing, land)	3,414

Figure 3-29 Summary of Distribution Transformers and Substations

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.12. Ground Mounted Distribution Switchgear

This section covers ring main units and similar switching equipment, which is often mounted outdoors. It does not cover indoor circuit breakers which are widely used on the distribution network outside of zone substations. There are around 1,700 ground mounted switchgear units in the Wellington Electricity network, both of the Holec Magnefix type and conventional oil insulated ring main switches such as ABB, Long and Crawford, and similar. Most of the older switchgear is oil insulated; however the newer ones use SF_6 as the main insulating medium, Magnefix has a resin casing to provide insulation. The age profile of ground mounted switchgear is shown below.

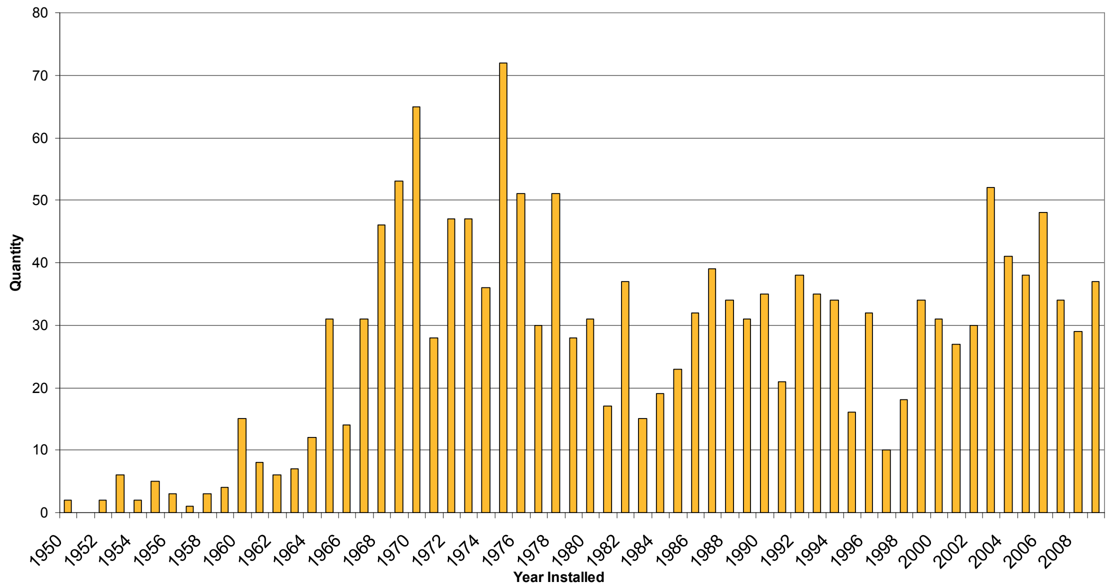

Figure 3-30 Age Profile of Ground Mounted Distribution Switchgear

The average age of the ground mounted switchgear is 23 years.

Category	Quantity
Ring Main Units	1,638
Extra Oil Switches	299
Extra Fuse Switches	283

Figure 3-31 Summary of Ground Mounted Distribution Switchgear

Full details of maintenance, refurbishment and renewal are covered in Section 6.

3.4.13. HV and LV Distribution System

Wellington Electricity's network has a relatively high percentage of underground cables, which has contributed to its relatively high level of reliability. The 11 kV underground distribution system has normally open interconnections between feeders, and feeders are segmented into small switching zones using locally operated ring main switches. In the event of a cable fault the faulted cable section can be isolated and supply to downstream customers can be switched to neighbouring feeders.

Wellington CBD is operated in a closed ring configuration with radial feeders interconnecting neighbouring rings or zone substations. This part of the network uses automatically operating circuit breakers, using Solkor differential protection between sites, rather than manually operated ring main switches between switching zones. This results in higher reliability as smaller sections of network are affected by cable faults, however due to the nature of the CBD, any repairs required to the distribution system take considerably longer than standard replacement times, and incur considerable costs for traffic management and pavement reinstatement.

In rural areas, the lines are generally radial, with limited back feeds in areas such as Akatarawa, Paekakariki Hill and Wainuiomata towards the south coast. The use of auto reclosers and sectionalisers aims to reduce the impact on these feeders, an outage is likely to affect customers for the duration of the repair.

Category	Quantity
11kV Cable (incl. risers)	1,130 km
Low Voltage Cable (incl. risers)	1,610 km
Pillars and Pits	14,500

Figure 3-32 Summary of Distribution Cables and Pillars

3.4.13.1. HV and LV Distribution Cables

Approximately 95% of the underground distribution cables are PILC and PIAS and the remaining 5% are newer XLPE insulated cables. PILC cables use a relatively old technology but are in good condition and have proven to be very reliable.

The majority of low voltage cables are PILC or PVC insulated, and a much smaller number are newer XLPE insulated cables. In general the low voltage cables are in good condition.

An age profile of distribution cables of both voltages is shown below.

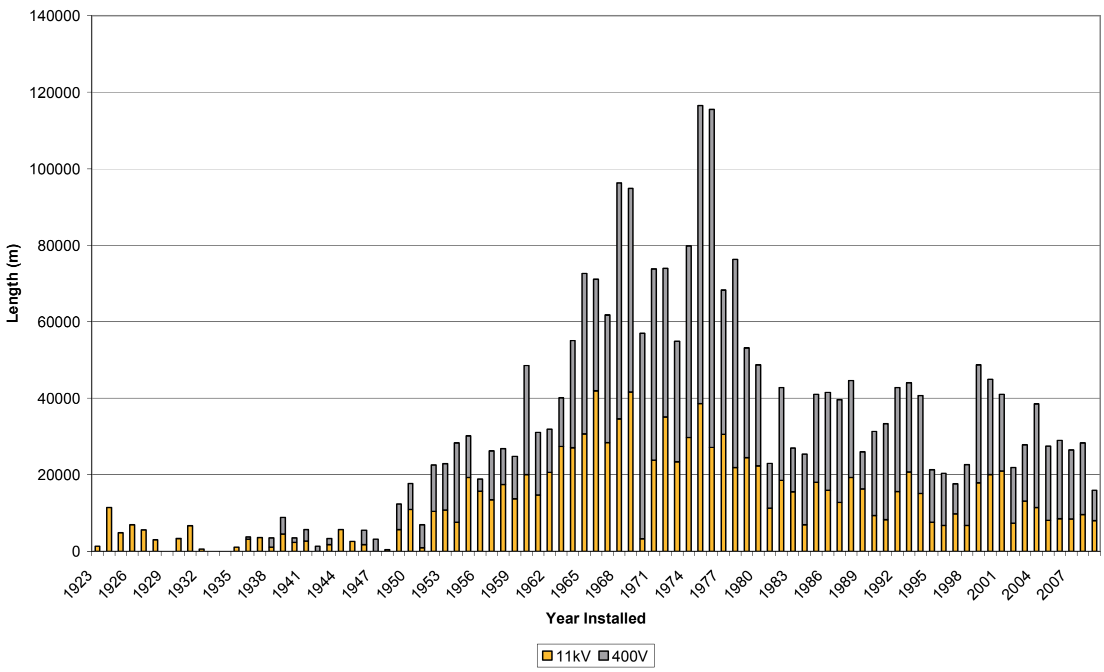

Figure 3-33 Age Profile of Distribution Cables

3.4.13.2. LV Pillars and Pits

Pillars and pits provide the point for the connection of customer service cables to the Wellington Electricity underground low voltage reticulation. They contain the fuses necessary to isolate a service cable from the network. Pits are manufactured from polyethylene as are most of the newer pillars. Earlier style pillars were constructed of concrete pipe, steel, or aluminium. There are approximately 400 link pillars and pits in service on the Wellington network; these are used to parallel adjacent LV circuits to provide back feeds during outages, as well as providing the ability to sectionalise large LV circuits. A high level breakdown of types is listed below.

Type	Approximate Quantity
Customer Service Pillar	13,250
Customer Service Pit	850
Link Pillars and Pits	400

Figure 3-34 Summary of LV pillars and pits

3.4.14. Metering

Wellington Electricity does not own any revenue metering assets as these are owned by retailers and metering companies supplying consumers.

There are check meters installed at GXPs and a large number of Maximum Demand Indicator (MDI) meters installed in distribution substations. These are for operational and planning purposes only and are considered to be part of that asset.

3.4.15. Generators and Mobile Substations

Wellington Electricity does not own any mobile generators or substations. There is a fixed generator supporting the network control room at the Haywards substation, and Wellington Electricity is making provision for shared use of a generator at the corporate office in Petone.

All generation required for network operations and outage mitigation is provided by the works contractor.

Wellington Electricity own a container with 11kV switchgear installed and this is used in instances where switchgear replacement or other major works is occurring at a substation and 11kV supply cannot be out of service for extended periods.

Wellington Electricity is evaluating where in the network private backup generation is installed, particularly large generators in the CBD that can be synchronised, and how this can be utilised for maintaining customer supply or assisting during network outages or Grid Emergencies

3.4.16. Asset Category Value

The value of Wellington Electricity network assets is summarised by ODV category below:

Asset Category	Category Value (ODRC at 31 March 2004)
Subtransmission Assets	$54.3 m
Zone Substations	$41.7 m
Distribution LV Lines and cables	$247.6 m
Distribution Substations and Transformers	$54.8 m
Distribution Switchgear	$36.2 m
Other System Fixed Assets	$16.2 m

Figure 3-35 Asset category values

3.5. Asset Justification

The distribution system is designed to provide an electricity supply of sufficient capacity and reliability to meet the customer service levels for the load type and with consideration of the price/quality trade-off consumer groups are prepared to make. In addition, the network is planned and constructed with some additional capacity to cater for forecast load increases. This strategy (which is generally adopted by electricity network businesses) is an efficient approach to network development due to the high cost and long life cycles of electricity distribution assets.

Urban Network

The urban network, both in residential and business/CBD areas, is designed to support present and recent forecast loads, and to be operated within the disclosed service levels for the period of this AMP. Where shortfalls are identified, network reinforcement projects or demand side initiatives (or a mixture of both) may be undertaken. There are different network architectures between the old Capital MED and Hutt Valley areas, and as such there is a higher level of security in the Wellington CBD, and surrounding suburbs, which incorporates an increased number of circuit breakers and protection devices, a predominantly underground network due to the building density, as well as offering a high level of redundancy. This legacy system architecture is appropriate to meet the security criteria for the CBD and also reflects the significance of the Wellington CBD as being the centre of Government, Government Departments and Commerce, and their reliance upon secure electricity supply. Supply is taken at 33kV to supply zone substations from Transpower grid exit points, this is an industry standard voltage and is appropriate to minimise losses, as well as carry the required loads. Distribution feeders are all 11kV, which is stepped down at distribution substations to 400V for distribution to consumer premises. In some areas, supply is taken from Transpower at 11kV where the load centre is close to the GXP. There has been reasonably low load growth in the Wellington network over recent years and the decline of manufacturing industry from the 1980s onwards has created headroom in some areas of the network, especially the Hutt Valley and Porirua areas. Despite this, changing load demands (apartment conversions, air conditioning etc) in the CBD has created some constraints that will require further network development.

Rural Network

The rural network is supplied at 11kV from Urban zone substations, and often a rural feeder passes through an urban area supplying load before entering a rural area. There are fewer back feed options for rural feeders, and this is reflected in lower service levels. Less than 30% of the Wellington network is rural and the load served is very low density. There is no major rural sector in the Wellington area so loading and voltage is not an issue, however the exposure to weather and vegetation interference necessitates a large number of line reclosers, remote switches and sectionalisers to meet service level targets.

Voltage Levels

11kV has been the predominant distribution voltage as this was the original supply voltage from the Khandallah substation established in 1924 to supply Wellington, and the subsequent development and connection of Melling and Central Park substations in the 1930s and 40s.

33kV was introduced in the late 1950s for subtransmission when load growth exceeded the capacity of the 11kV system. Wellington Electricity has no intention in the short term to use other voltages for distribution or subtransmission.

110kV cabling was installed by the Wellington MED in the early 1980s to future proof supply capacity to the Miramar peninsula area, although this is presently operated at 33kV.

4. Service Levels

4.1. Consumer Orientated Performance Targets

4.1.1. Network Reliability

Network reliability is measured using two internationally recognised performance indicators, SAIDI and SAIFI, which taken together are indicators of the availability of an electricity supply to the average customer connected to the network.

- SAIDI[4] is a measure of the total time in a measurement year that an electricity supply is not available to the average consumer connected to the network. It is measured in minutes.
- SAIFI[5] is a measure of the total number of supply interruptions that the average consumer experiences in the measurement period. It is measured in number of interruptions[6].

These indicators include both planned and unplanned outages. On average, planned outages account for approximately 25% of the total number of outages every year but only contribute to 6% of the annual SAIDI minutes. Consistent with the approach taken by the Commerce Commission the following supply interruptions are not included in the measured performance indicators.

- Interruptions caused by the unavailability of supply at a GXP, or as a result of automatic or manual load shedding directed by the transmission grid operator[7], or as a result of some other event external to the Wellington Electricity network.
- Interruptions lasting less than one minute. In these cases restoration is usually automatic and sometimes the interruption will not be recorded.
- Interruptions resulting from an outage of the low voltage network or a single phase outage of the 11kV distribution network. The Commerce Commission does not require these interruptions to be recorded for information disclosure or for the operation of the threshold control regime. In practice such interruptions do not have a material impact on measured system reliability and the business processes required to accurately record these interruptions and measure their impact are not cost effective.

Wellington Electricity has calculated reliability thresholds using the methodology set down by the Commerce Commission[8]. This method adopts a reference sat of reliability data taken from the period 1 April 2004 to 31 March 2009. The mean reliability over this period is set as the threshold for network and the mean plus one standard deviation become the limit. This method is applied to both SAIDI and SAIFI. The mean and limit values for Wellington Electricity calculated using this method presented below.

---

4 System Average Interruption Duration Index

5 System Average Interruption Frequency Index

6 Due to the effect of averaging, SAIFI is reported as a non integer number.

7 The transmission grid operator has the authority to direct electricity distributors to shed load. This is necessary during emergencies to ensure that the power system continues to operate in a secure and stable state.

8 Commerce Commission, Decisions paper on the initial reset of the DPP, 30 November 2009.

	2009-10	2010-11	2011-12	2012-23	2013-14	2014-15
SAIDI threshold (mean)	**29.70**	**33.90**	**33.90**	**33.90**	**33.90**	**33.90**
SAIDI limit (mean + 1SD)	NA	40.74	40.74	40.74	40.74	40.74
SAIFI threshold (mean)	**0.44**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**
SAIFI limit (mean + 1SD)	NA	0.60	0.60	0.60	0.60	0.60

Figure 4-1 Reliability Thresholds (as Defined by the Regulator)

Note 1: SAIDI is measured in minutes and SAIFI in average number of interruptions.

Note 2: Targets for 2009-10 are existing targets.

The thresholds have been calculated in accordance with the Commerce Commission's current requirements for the reporting of reliability and include the impact of major event days when the number of outages exceeded the ability of Wellington Electricity's contractor to respond in a timely manner. The impact of these major event days on the reported reliability can be significant – there were two major event days in 2003-04 when a SAIDI of over twice that recorded in a normal year was experienced. These events fall outside of the 'reference dataset' five year averaging period and hence are not included in the above graph however should a similar event occur in the future, it would have a significant impact not only on this years SAIDI, but also on a rolling average.

Major event days are usually caused by environmental factors, such as severe storms, that are outside Wellington Electricity's direct control. They are relatively infrequent – Wellington Electricity has experienced only three major event days in the last six years, two in 2003-04 and one in 2004-05. They generally have a much bigger impact on SAIDI than on SAIFI because during such events consumers may only experience one interruption but can be without power for hours or, in extreme situations, days.

Storm Clouds Over Wellington

The measured historic reliability of Wellington Electricity's network is illustrated in the graphs below. In broad terms, the graphs show that, under normal circumstances, the average consumer can expect one sustained interruption every two years and that this interruption will last a little over an hour.

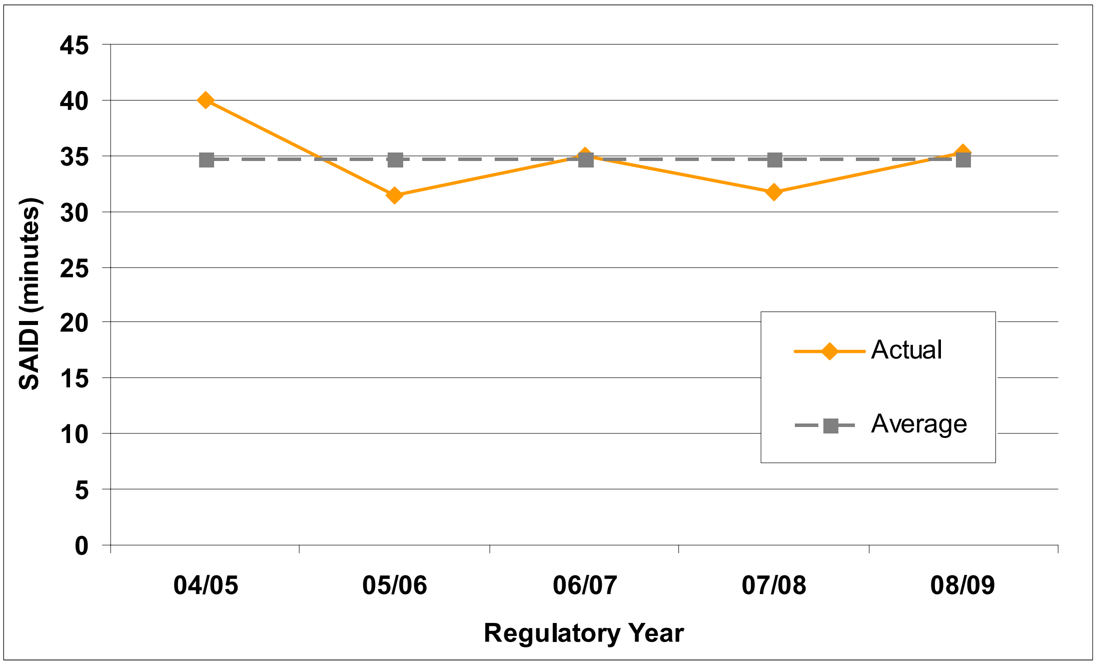

Figure 4-2 Historic SAIDI of the Wellington Electricity Network

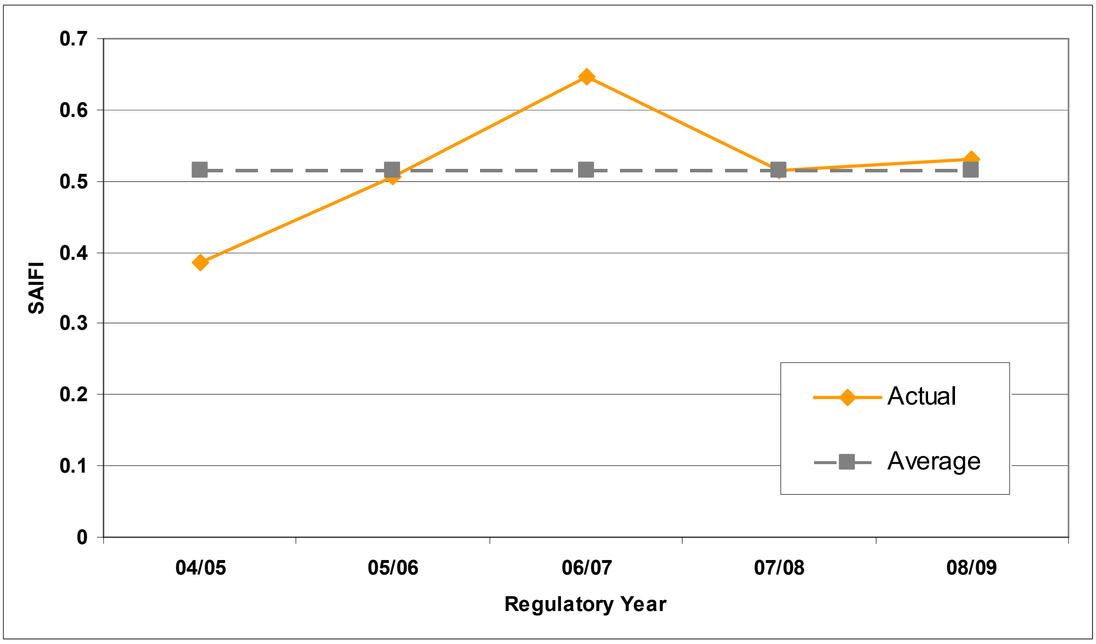

Figure 4-3 Historic SAIFI of the Wellington Electricity Network

4.1.2. Contact Centre Service Levels

Wellington Electricity is developing a set of key performance indicators and financial incentives that will serve as service levels with its call centre provider – Telnet. These are presently under development but will include:

General service levels – time taken to answer calls, number of missed calls etc.

Response times – time taken to notify all relevant parties for various types of call centre request, e.g. street light faults, new connection requests etc.

Information quality – keeping knowledge bases up to date

Customer experience – how well Wellington Electricity is represented to the consumers

Energy retailer satisfaction - how well Wellington Electricity is represented to the retailers

4.1.3. Customer Enquires and Complaints

Enquiries and complaints are channelled to Wellington Electricity Investigations Managers via a number of avenues including retailers, service contractors, call centre and direct approaches. When an enquiry or complaint is received, it is entered into a central registry (SAP–CARE database). The target response time for enquires is eight working days, and for complaints is ten working days. Failure to meet these targets will result in automatic prompting for seven days followed by internal escalation.

4.2. Asset Management Performance Targets

Other performance targets used by Wellington Electricity relate to the efficiency with which Wellington Electricity manages its fixed distribution assets. The indicators have been selected on the basis that Wellington Electricity considers them particularly relevant to the operation and management of its assets.

The selected asset performance targets use indicators that are required to be reported to the Commerce Commission under its information disclosure regime.

4.2.1. Standard Service Levels for Restoration of Power

Wellington Electricity's published 'Electricity Network Pricing Schedule' provides standard service levels for three different categories of customers as shown in the map below. These service levels are agreed to between Wellington Electricity and all of the retailers who are signatories to the use of network agreement. This agreement provides Wellington Electricity with financial incentives to not exceed the maximum restoration times detailed below.

	Urban	Rural
Maximum time to restore power	3 hours	6 hours

Figure 4-4 Standard Service Levels for Residential Customers

	Urban	Rural
Maximum time to restore power	3 hours	6 hours

Figure 4-5 Standard Service Levels for Business Customers

	CBD / Industrial	Urban	Rural
Maximum time to restore power	3 hours	3 hours	6 hours

Figure 4-6 Standard Service Levels for Industrial Customers

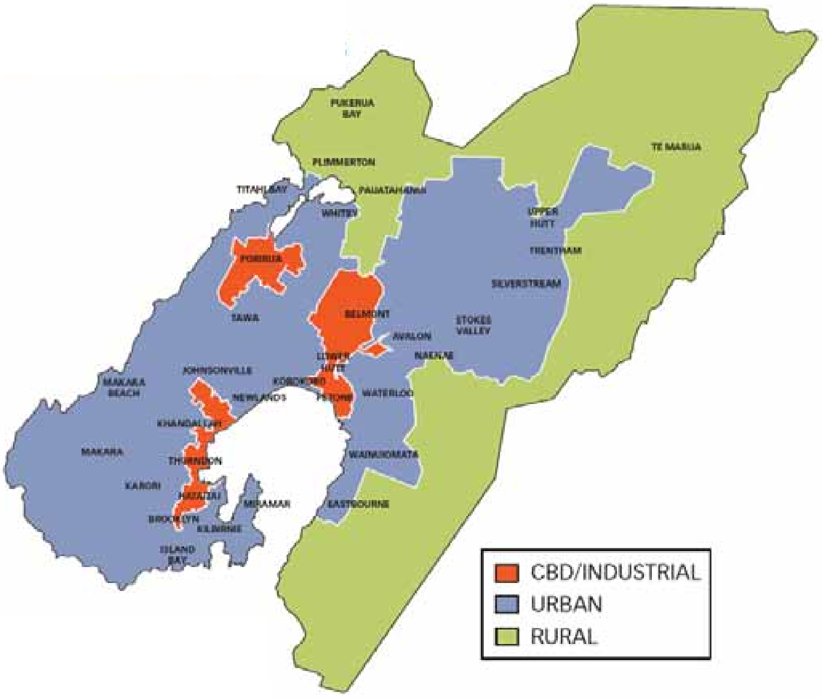

Figure 4-7 Standard Service Level Areas

Time taken to restore power is recorded in ENMAC. Refer to section 2 for details on how unplanned outages are recorded.

4.2.2. Faults per 100 Circuit-km

This is a measure of how well the system is designed and operated from a technical perspective. Wellington Electricity designs its network to withstand the environmental conditions to which it is exposed, particularly the severe Wellington winds and the high level of atmospheric salt contamination. As discussed in Section 6, Wellington Electricity has a preventive maintenance system in place whereby assets are regularly inspected to identify and remedy defects that could potentially cause an asset failure. Further, Wellington Electricity has a vegetation management system in place to reduce the number of faults resulting from trees coming into contact with overhead power lines. Faults also are subject to a root causes analysis aimed at identifying systemic issues that may be causing unplanned outages followed by projects that will address the issue. This performance indicator is a measure of the effectiveness of these asset management strategies.

For the purpose of this performance indicator a fault is considered an unplanned failure of an in-service line or cable asset on the subtransmission or high voltage distribution systems, irrespective of whether or not it causes a loss of supply to customers. Circuit-km relates to the total circuit length of the subtransmission and high voltage distribution systems, irrespective of whether the circuit is overhead or underground.

The current target for the planning period is shown in the table below and has been set on the basis of the current performance of the network. It is intended to set targets for the planning period that reflect a continuation of the current level of asset performance.

2010-11	2011-12	2012-23	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3

Figure 4-8 Performance Targets for Faults per 100 Circuit km / annum

4.3. Justification for Targets

Wellington Electricity operates its distribution system in accordance with all relevant legal requirements, including the Electricity Act 1992, the Health and Safety in Employment Act 1992, and the Resource Management Act 1991. This legislation and its subsidiary regulations have a significant influence on the way in which Wellington Electricity manages its assets. In the main the legal requirements are non-discretionary and therefore act as a constraint on the way in which the system must be managed (and on the cost of managing the network).

Within these legal constraints Wellington Electricity has discretion in managing its assets to meet the requirements of its stakeholders. It must ensure that the reliability of supply meets or exceeds the reasonable expectations of the retailers and consumers that use the network. Further, it must ensure that the assets that provide distribution service are used efficiently if the conflicting expectations of stakeholders regarding price and profitably are both to be met in a reasonable way.

4.3.1. Consumer Survey

Wellington Electricity surveys its consumers to determine their expectations on a regular basis. The most recent survey was completed in February 2010 and involved sampling:

- All of the top 25 consumers
- A random sample of 25 of the top 26 to 130 consumers
- A random sample of 1100 mass market consumers

The survey involved phoning consumers and asking a series of questions. Of the 1150 consumer's phoned, a total of 251 completed the survey, a response rate of 22%. The questions included:

- What is important to consumers (e.g. keeping power on?, low prices? etc)
- How well Wellington Electricity are performing
- What price / quality tradeoffs are consumers prepared to make (e.g. pay less for lower quality etc)

Graphs of the responses to these questions are provided below.

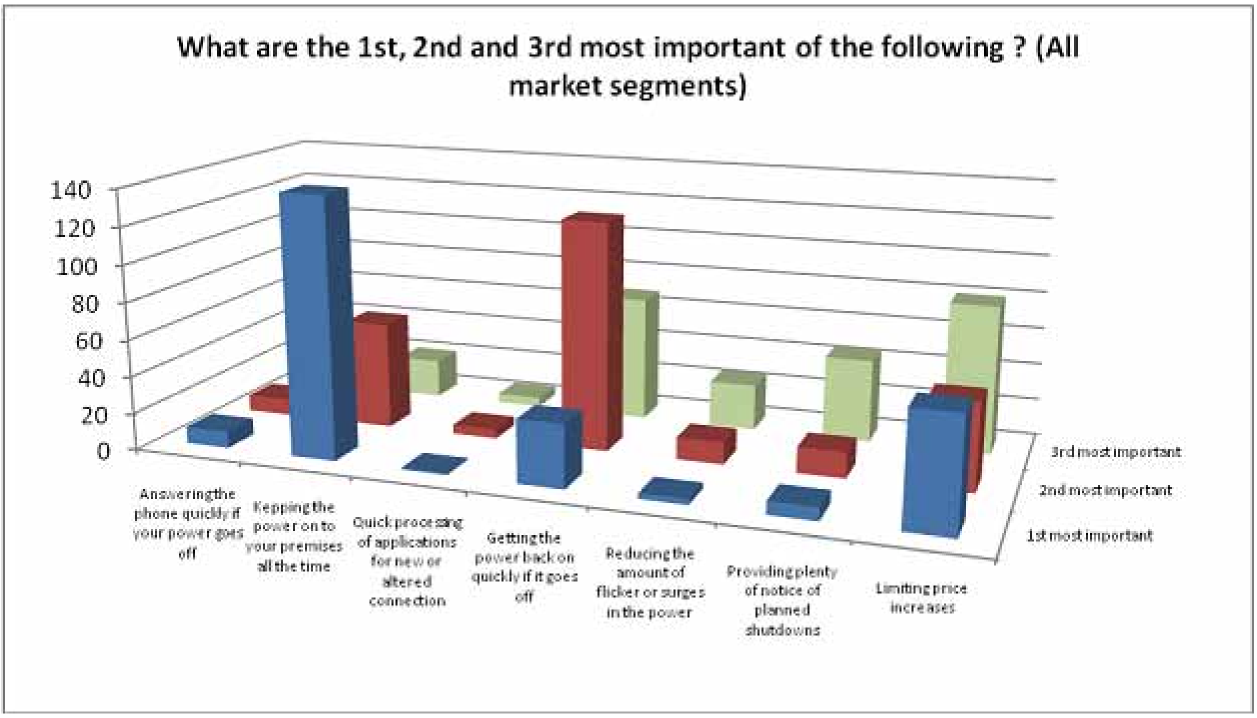

Figure 4-9 What is most important?

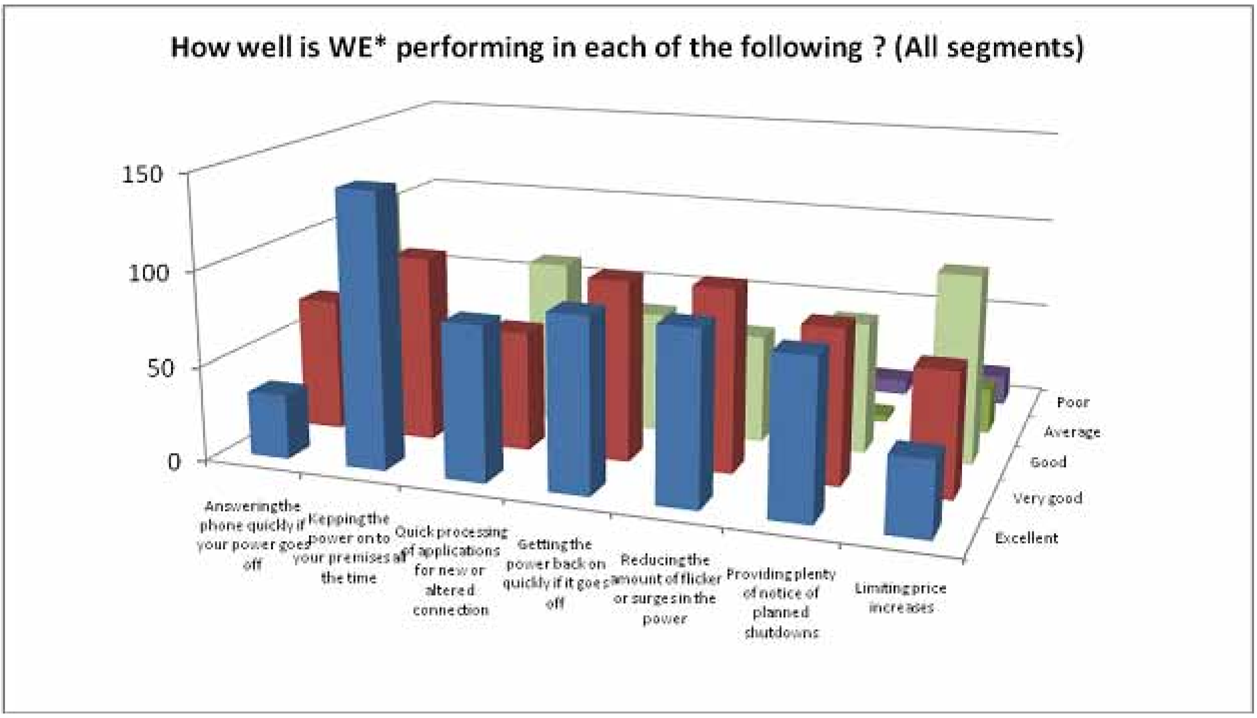

Figure 4-10 How well are Wellington Electricity performing?

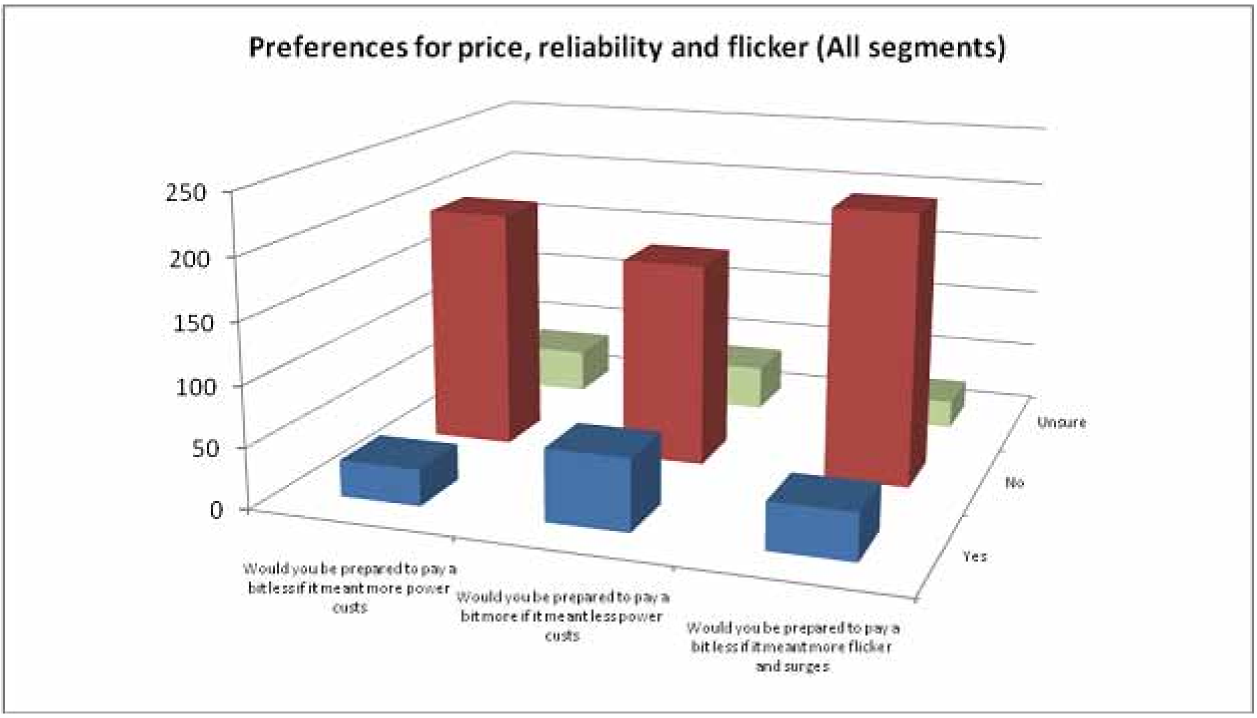

Figure 4-11 Price / Quality Tradeoffs?

Key results from the survey are:

- Consumers in all segments regard continuity ("keeping the power on") and restoration ("getting the power back on") as the first and second most important components of electricity line services
- Consumers across all segments regard Wellington Electricity's performance in regard to the above two components as either excellent or very good
- Limiting price increases is the third most important component behind 'keeping the power on' and 'getting the power back on'
- The majority of consumers across all segments indicated a clear preference against paying either a bit less if it meant more power cuts or a bit more if it meant less power cuts i.e. a strong preference for paying about the same line charges to have about the same reliability
- The majority of consumers across all segments indicated a clear preference against paying a bit less to have more flicker or surge i.e. a strong preference for having either the same or less flicker

The survey shows that consumers are advising Wellington Electricity that:

- Efforts and resources should be focused on continuity and restoration
- Price increases matter less than maintaining the status quo on quality
- Present levels of quality are about right

These results are reflected in Wellington Electricity's asset management approach of investing to maintain reliability at present levels. This approach focuses on managing an aging fleet of assets and replacing those assets that are at their and of life before they fail.

5. Network Planning

5.1. Security Criteria and Assumptions

The security criteria on which the design of the system is based is shown in Figures 5-1 and 5-2.

While the reliability of the Wellington Electricity distribution system is high, notwithstanding the difficult physical environment in which the system must operate[9], it is uneconomic to design a network where supply interruptions will never occur. Hence the network is designed to limit the amount of time over a year when it is not possible to restore supply by reconfiguring the network following a single unplanned equipment failure. This approach recognises that the electricity demand on the network varies according to the time of day and season of the year, and that the time over which the system is exposed to its peak demand is very small during the course of a year. It also recognises that equipment must at times be taken out of service for planned maintenance and that, when this occurs, parts of the network are exposed to a lower level of security and as a consequence a higher risk of interruption.

Wellington Electricity's network design and asset management systems also have regard to the time taken to restore supply following an interruption. When an unplanned equipment outage does occur, considerable effort is made to restore supply to customers not directly affected by the equipment fault by switching load to other parts of the network. However at times of peak demand, or where equipment is out of service for maintenance at the time of the unplanned outage, it may not be possible to switch all load in this way, and in these cases an extended outage may occur with maximum restoration times as shown in Figures 5-1 and 5-2.

The criteria generally do not apply to the low voltage network or to failures of connection assets used to supply individual customers, which are usually designed for 'n' security. In such situations an interruption will last for the time taken to make a repair.

The criteria also do not apply when multiple equipment outages affect the same part of the network or when major storms or other severe events have a high impact on the system and can stretch the capacity of Wellington Electricity or its contractors to respond in a timely manner. Wellington Electricity has emergency plans in place to mitigate the impact of such situations but when they occur, longer supply interruptions than shown in the tables are possible.

[9] Much of Wellington Electricity's supply area is renowned for its high winds. There can also be a high concentration of salt in the atmosphere, blown in off the sea.

Type of Load	Security Criteria
CBD	N-1 with a break[2] for 99.5% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Mixed commercial / industrial / residential substations	N-1 with a break[1] for 98% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Predominantly residential substations	N-1 with a break[1] for 95% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.

Figure 5-1 Security Criteria for the Subtransmission Network

Type of Load	Security Criteria
CBD or high density industrial	N-1 with a break[2] for 99.5% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Mixed commercial / industrial / residential feeders	N-1 with a break[3] for 98% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Predominantly residential feeders	N-1 with a break[3] for 95% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Overhead spurs supplying up to 1MVA urban area	Loss of supply upon failure. Supply restoration upon repair time.
Underground spurs supplying up to 400kVA.	Loss of supply upon failure. Supply restoration upon repair time.

Note 1: A brief supply interruption of up to 5 minutes may occur following an equipment failure, while the network is reconfigured.

Note 2: A brief supply interruption of up to 1 minute may occur following an equipment failure, while the network is automatically reconfigured.

Note 3: In areas other than the CBD, an operator may need to travel to the fault location to manually operate network switchgear, in which case the supply interruption could last for up to one hour.

Figure 5-2 Security Criteria for the Distribution Network

5.1.1. Capacity of New Plant

When planning an augmentation to the network to increase its existing capacity, it is necessary to determine the capacity of the new equipment to be purchased and installed. This often involves a trade-off between cost and the size of the increased capacity because:

- If the capacity is too large either Wellington Electricity or its consumers have to pay the cost of any capacity that will not have been economically utilised before the equipment reaches the end of its economic life; and
- If the capacity is too small then premature asset replacement will be required and this generally increases costs.

The problem of determining the optimum capacity is made more difficult by the fact that the economic life of most primary distribution assets is between 40 and 60 years and the difficulty of forecasting electricity demand over this period into the future other than from underlying growth averages.

Wellington Electricity uses the Commerce Commission's 10 year planning period as the starting point for making equipment capacity decisions and then takes the following into consideration:

- On the basis of the current load forecast, determine the maximum potential load on the equipment at the end of the planning period under the most severe operating condition that the network is planned to withstand.
- Select the next highest standard equipment size as per the tables below.

5.1.1.1. 11kV Switchgear

Application	Standard Ratings	Fault Rating
Incomer CB	1200A, 2000A	25kA
Feeder CB	630A	25kA
Dist transformer CB	200A	25kA
Ring main unit	400A minimum	25kA

Note 1: These are manufacturer's standard ratings.

Note 2: Existing equipment may have rating different form those listed in the table.

Figure 5-3 Standard Ratings for 11kV switchgear

5.1.1.2. 11kV Cable

Application	Standard Ratings
Feeders – backbone	300A minimum
Feeders – branch	200A minimum
Dist transformer	Match transformer

Note 1: Larger cable ratings may be employed on a case by case basis.

Figure 5-4 Standard ratings for 11kV cable

5.1.1.3. Distribution Transformers

Standard Ratings (kVA)
15, 30 50, 100, 200, 300, 500, 750, 1000
1500kVA upon request for special customer projects

Note 1: All distribution transformers: 11kV/400V delta-wye.

Note 2: These are manufacturer's standard ratings.

Figure 5-5 Standard ratings for distribution transformers

It is important to note that this is only a starting point for making capacity decisions. An engineering and economic judgement is then made as to whether this size is appropriate taking other factors into account. Such factors include:

- Compliance with the network security criteria
- Margin between the required capacity and the next highest standard size
- Incremental cost of different equipment sizes
- Forecast rate of demand growth
- Back-up capacity to adjacent areas

In certain cases customers may desire a level of security above that offered by a standard connection. Should this arise Wellington Electricity will offer a range of alternatives that provide different levels of security at different prices. The customer can then choose to pay for a higher a level of security that meets their expectations for the load they are supplying.

Given the relatively modest demand growth in its supply area, it is unlikely that Wellington Electricity would expose itself to optimisation risk by installing asset capacities greater than indicated by the above approach.

5.2. Prioritisation of Capital Works Projects

The processes described in this document invariably identify more potential work than can be accommodated by budgets or resources available to Wellington Electricity, hence the need for a project prioritisation process.

Every year, as part of the capital works budgeting process, the list of potential projects will be reviewed for currency and all of the projects will be ranked. The details of how projects are ranked and selected is a work in progress, however any ranking tool is likely to include the assessment of a number of weighted project 'drivers' that are assigned values based on their assessed impact to the Wellington Electricity. Examples of these drivers are:

- Health and Safety
- Legal and Statutory obligations
- Company policies and standards
- Risk to the network
- Environmental
- Financial value
- Quality of supply
- Strategic benefit
- Stakeholder satisfaction

A subset of the projects will be non-discretionary and will not be deferred. These projects include:

- Works necessary to ensure public and employee safety
- Works necessary to meet legal requirements. However, where changes to legal requirements impose significant additional costs it may be necessary to undertake the required works over an extended period of time. This is usually agreed with the authority responsible for monitoring compliance with the changed requirement.

All other projects will generally be prioritised on the basis of cost-benefit and risk analyses using an assessment of the project 'drivers' as outlined above . Projects that mitigate extreme or high risks to the business and projects with high benefit-cost ratios will be generally given the highest priority.

5.3. Demand Forecasts

5.3.1. Methodology

Loads on individual feeders and zone substations are captured by the SCADA system. The load at each GXP is metered through the time of use revenue metering. This information allows Wellington Electricity to trend actual demands at the GXP, zone substation and feeder level and to project these trends into the future using an extrapolation analysis model.

Demand forecasting is carried out using a 'bottom up' approach, starting at the zone substation level. The first stage of this process involves extrapolating historical zone substation load data into the future, to the extent of the 10 year planning horizon. Known step changes are then applied to the forecasts. These steps may be the result of:

- System reconfigurations where load has been moved between substations
- Major developments that introduce large new loads onto the network
- Changes to the Wellington Electricity load control system
- New generation that is expected to affect peak demand
- Load reductions caused by movement of businesses or the closure of businesses.

A subjective review of the load forecasts for each zone substation is then undertaken. This comprises a check of the forecasts against local knowledge of network developments. Reviewers will include project managers and customer service staff who have a good overview of customer connection trends. Property developers and businesses are also canvassed for information on plans that may result in introducing new loads to the network. Forecasts are modified if necessary to reflect this local knowledge. The zone substation load forecasts are then 'rolled-up' to the GXP level, taking diversification factors into consideration as the peak zone substation demands may not always occur at the same time as each other.

The Wellington Electricity 'bottom up' GXP forecasts are then compared to Transpowers 'top down' GXP forecasts. It is taken that Transpowers forecasts are derived from the national load and energy forecasts which take into account economic and population growth indicators. While this forecast is usually accurate at the national level, it can be difficult to aggregate the national growth down to the GXP level which in turn can lead to discrepancies with 'bottom up' forecasts. Any significant differences between the two forecasts are investigated and addressed or explained.

Detailed forecasts for the planning period are provided in the next sections. They indicate that forecast growth in Wellington Electricity's supply area is relatively low when compared to demand growth in many parts of the country.

5.3.2. GXP Demand Forecast

The forecast demand at each GXP supplying Wellington Electricity's distribution network is shown in Figure 5-6.

GXP	System Maximum Demand MW [2] (including DG)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Central Park 33 kV	182.6	185.3	188.1	190.9	193.8	196.7	199.7	202.7	205.7	208.8
Central Park 11 kV	17.8	18.1	18.4	18.6	18.9	19.2	19.5	19.8	20.1	20.4
Gracefield 33kV	55.2	55.9	56.6	57.3	58.0	58.7	59.5	60.2	60.9	61.7
Haywards 33 kV	20.5	20.8	21.1	21.4	21.7	22.0	22.4	22.7	23.0	23.4
Melling 33 kV	46.7	47.3	47.9	48.4	49.1	49.7	50.3	50.9	51.6	52.2
Pauatahanui 33kV	21.0	21.3	21.5	21.8	22.1	22.4	22.6	22.9	23.2	23.5
Takapu Rd 33 kV	94.3	95.5	96.7	97.9	99.1	100.3	101.6	102.9	104.1	105.4
Upper Hutt 33 kV	31.6	32.2	32.8	33.3	33.9	34.5	35.1	35.7	36.4	37.0
Wilton 33 kV	82.4	83.8	85.3	86.8	88.3	89.9	91.4	93.0	94.7	96.3
Kaiwhara'11 kV [1]	37.8	38.4	39.0	39.5	40.1	40.7	41.4	42.0	42.6	43.2
Haywards 11 kV	19.7	20.0	20.3	20.6	20.9	21.2	21.5	21.9	22.2	22.5
Melling 11 kV	26.4	26.7	27.1	27.4	27.8	28.1	28.5	28.8	29.2	29.5

Note 1: Kaiwharawhara GXP has a summer peak. All other GXPs have a winter peak

Note 2: Base MD value for the projection is the actual for the year ending 30 September 2009

Figure 5-6 GXP Demand Forecast

5.3.3. Zone Substation Demand Forecasts

Zone Substation	98th Percentile Demand (MVA, Calendar Year)									
	2010	'11	'12	'13	'14	'15	'16	'17	'18	'19
8 Ira St	14.6	14.8	15.1	15.3	15.5	15.7	16.0	16.2	16.5	16.7
Brown Owl	14.1	14.4	14.6	14.9	15.2	15.4	15.7	16.0	16.2	16.5
Evans Bay	13.5	13.7	13.9	14.1	14.3	14.5	14.7	15.0	15.2	15.4
Frederick St	32.1	32.6	33.0	33.5	34.0	34.6	35.1	35.6	36.1	36.7
Gracefield	10.8	10.9	10.9	11.0	11.1	11.2	11.3	11.4	11.4	11.5
Hataitai	15.7	16.0	16.2	16.5	16.7	16.9	17.2	17.5	17.7	18.0
Johnsonville	21.3	21.6	22.0	22.3	22.6	23.0	23.3	23.7	24.0	24.4
Karori	16	16.2	16.9	17.0	17.1	17.3	17.4	17.5	17.7	17.8
Kenepuru	12.4	12.4	12.5	12.5	12.6	12.7	12.7	12.8	12.9	12.9
Korokoro	12.7	12.8	12.9	13.0	13.1	13.2	13.3	13.4	13.5	13.6
Maidstone	14.2	14.5	14.7	15.0	15.3	15.5	15.8	16.1	16.4	16.7
Mana-Plmtn	17.3	17.5	17.7	18.0	18.2	18.4	18.7	18.9	19.1	19.4
Moore St	26.0	27.2	28.4	29.6	30.7	30.9	31.1	31.3	31.5	31.7
Naenae	17.6	17.7	17.9	18.1	18.3	18.5	18.7	18.8	19.0	19.2
Nairn St	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.3	21.6	21.9
Ngauranga	7.3	7.4	7.5	7.6	7.8	7.9	8.0	8.1	8.2	8.4
Palm Grove	24.3	24.6	25.0	25.4	25.7	26.1	26.5	26.9	27.3	27.7
Petone	10.2	10.3	10.3	10.4	10.5	10.6	10.6	10.7	10.8	10.9
Porirua	15.5	15.7	15.9	16.1	16.3	16.5	16.7	16.9	17.1	17.3
Seaview	14.6	14.7	14.8	14.9	15.1	15.2	15.3	15.4	15.5	15.6
Tawa	13.0	13.2	13.3	13.4	13.6	13.7	13.8	14.0	14.1	14.2
The Terrace	39.2	39.8	40.4	41.0	41.6	42.2	42.8	43.5	44.1	44.8

Zone Substation	98th Percentile Demand (MVA, Calendar Year)									
	2010	'11	'12	'13	'14	'15	'16	'17	'18	'19
Trentham	15.2	15.4	15.6	15.9	16.1	16.3	16.5	16.8	17.0	17.3
University	24.5	24.8	25.2	25.6	26.0	26.4	26.7	27.1	27.6	28.0
Waikowhai	14.1	14.2	14.3	14.4	14.5	14.6	14.8	14.9	15.0	15.1
Wainuiomata	15.3	15.7	16.0	16.4	16.9	17.3	17.7	18.2	18.6	19.1
Waitangirua	12.6	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4
Waterloo	15.8	15.9	15.9	16.0	16.1	16.2	16.3	16.3	16.4	16.5

Note 1: 98th percentile demands are used for zone substation forecasts because short term peaks that result from operational switching of loads between substations can give a misleading impression of 'normal' loads.

Figure 5-7 Zone Substation Demand Forecast

5.3.4. Step Load changes

Wellington Electricity has identified the following new major loads that may occur over the next few years.

Anticipated Start Date	Likely Peak Demand (MW)	Expected Load Factor (%)	Type of Demand	GXP	Likelihood
2010	1.5	0.35	Commercial	Central Park	Certain
2010	1	0.2	Infrastructure	Haywards	Certain
2010	1	0.2	Infrastructure	Kaiwharawhara	Certain
2010	1	0.2	Infrastructure	Kaiwharawhara	Certain
2010	1	0.2	Infrastructure	Takapu Road	Certain
2010	1	0.2	Infrastructure	Melling	Certain
2010	1	0.2	Residential	Melling	Certain
2010-2014	5	0.3	Commercial	Wilton	Likely
2011	1	0.35	Commercial	Takapu Road	Likely

Figure 5-8 New Step Change Loads

These loads have been incorporated into the demand forecasts for the network as described in the previous section.

5.3.5. Embedded Generation and Demand Control

The load forecast figures provided are inclusive of embedded generation and demand control. Further details on embedded generation and demand control is presented under separate headings.

5.4. Network Constraints

5.4.1. Grid Exit Points

The table below provides grid exit point capacities and forecast demands for the beginning and end of the forecast period. This table is intended to provide an indication of loadings on the GXP's.

GXP	Installed Transformers (MVA)	Cyclic n-1 Capacity (MVA)	System Maximum Demand MW [2] (including DG)	
			2010	2019
Central Park 33 kV	2x100 + 1x120	228	182.6	208.8
Central Park 11 kV	2x25	30	17.8	20.4
Gracefield 33kV	2x85	89	55.2	61.7
Haywards 33 kV	1x20	0	20.5	23.4
Haywards 11 kV	1x20	0	19.7	22.5
Melling 33 kV	2x50	52	46.7	52.2
Melling 11 kV	2x25	32	26.4	29.5
Pauatahanui 33 kV	2x20	24	21.0	23.5
Takapu Rd 33 kV	2x100	116	94.3	105.4
Upper Hutt 33 kV	2x37	37	31.6	37.0
Wilton 33 kV	2x100	106	82.4	96.3
Kaiwharawhara 11 kV	2x38	41	37.8	43.2

Figure 5-9 GXP Capacities

Haywards

The Haywards 33 kV and 11 kV supply points each have only a single transformer. However the Haywards 33 kV supply can be backed up from the Upper Hutt GXP and the 11 kV supply points can be backed up from the Melling GXP though Wellington Electricity owned 11 kV sub transmission circuits. Transpower has proposed that a 33/11 kV transformer be installed at Haywards, to serve as a back up to both the 33 kV and 11 kV supply busbars. Wellington Electricity is considering the suitability of this arrangement for the future, but because there are backup options at the distribution system level, there is no short term concern. This situation will be kept under review[10].

Melling and Kaiwharawhara

The Melling 33kV and Kaiwharawhara 11 kV supply points may be approaching firm capacity near the end of the forecast period. Wellington Electricity will monitor the situation and take action as necessary to ensure that the security of supply is not compromised. Actions may include transferring load to adjacent GXP's or increasing the capacity of the 11kV points of supply.

Central Park

The operational constraints at Central Park as discussed in section 3 of this report, effectively restrict the n-1 capacity of the 33kV system to 114MVA. Wellington Electricity and Transpower are working together to implement a short term solution which will be implemented prior to winter 2010 and will comprise a special protection scheme (SPS) that will be armed to automatically control loads should one 110kV circuit be out of service. This scheme would prevent the need for pre contingency load control at Central Park following a single contingency. A long term solution is also being developed that may include a 110kV bus at Central Park. The time frames for implementing the long term solution are 2011 – 2012.

5.4.2. Distribution System

The table below provides installed sub-transmission capacities and forecast demands for the beginning and end of the forecast period. This table is intended to provide an indication of loadings on the sub-transmission system.

Zone Substation	Transformer Cyclic Capacity (MVA)	Single Incoming Circuit Capacity (MVA)	Peak Season	Forecast 98 percentile demand (MVA)	
				2010	2019
8 Ira St	24	21/15	Winter	14.6	16.7
Brown Owl	23	19/13	Winter	14.1	16.5
Evans Bay	24	19/15	Winter	13.5	15.4
Frederick St	36	28/20	Winter	32.1	36.7
Gracefield	23	17	Winter	10.8	11.5
Hataitai	23	20/10	Winter	15.7	18.0
Johnsonville	23	19/12	Winter	21.3	24.4
Karori	24	21/11	Winter	16	17.8

[10] The installation of an interconnecting transformer would not impact the capital expenditure in this asset management plan as the asset would not be owned by Wellington Electricity. It would result in an increase in transmission connection charges, which are not included in any of the forecasts presented in this plan.

Zone Substation	Transformer Cyclic Capacity (MVA)	Single Incoming Circuit Capacity (MVA)	Peak Season	Forecast 98 percentile demand (MVA)	
				2010	2019
Kenepuru	23	19/14	Winter	12.4	12.9
Korokoro	23	13/10	Winter	12.7	13.6
Maidstone	22	18/10	Winter	14.2	16.7
Mana-Plmtn	16	27/23	Winter	17.3	19.4
Moore St	36	33/29	Summer	26.0	31.7
Naenae	23	19/14	Winter	17.6	19.2
Nairn St	30.1	25	Summer	19.2	21.9
Ngauranga	11	20/14	Summer	7.3	8.4
Palm Grove	24	17/13	Winter	24.3	27.7
Petone	20	19/13	Winter	10.2	10.9
Porirua	20	22/14	Winter	15.5	17.3
Seaview	22	21/13	Winter	14.6	15.6
Tawa	16	21/14	Winter	13.0	14.2
The Terrace	36	50/45	Winter	39.2	44.8
Trentham	23	20/14	Winter	15.2	17.3
University	24	32/28	Winter	24.5	28.0
Waikowhai	19	22/15	Winter	14.1	15.1
Wainuiomata	23	18/12	Winter	15.3	19.1
Waitangirua	16	22/16	Winter	12.6	14.4
Waterloo	23	21/13	Winter	15.8	16.5

Figure 5-10 Zone Substation Capacities and Loadings

Consideration of zone substation asset capacities compared against loads forecasts using the planning criteria indicates that there is sufficient capacity available in most instances, however there are eight situations where the potential peak demand at individual substations either exceeds, or could exceed during the planning period, the firm transformer or incoming circuit capacity at that substation. These substations are:

- Fredrick Street
- Moore Street
- Palm Grove
- Johnsonville
- Mana - Plimmerton
- Korokoro
- Naenae
- Wainuiomata

For each of these site, the mismatch between firm capacity and maximum demand is only a problem should an equipment failure occur since under normal operating conditions the load is shared between the two transformer feeders in service at each substation. In all of the above cases, potential overloads can be reduced by transferring the excess load to adjacent substations using spare capacity available in the distribution system, after an equipment fault occurs[11]. Where there is a potential for equipment to become overloaded following an unplanned equipment failure, Wellington Electricity monitors the ability to offload the affected substation and puts operating plans in place to ensure that this will occur should the need arise. The nature of the situation at each of the above substations is detailed below.

5.4.2.1. Fredrick Street

At present, the maximum demand loading at the Wellington CBD substations is uneven, with Fredrick Street being highly loaded, while the adjacent Nairn Street substation has spare capacity. A project is planned for 2010 to move a portion of the Fredrick Street substation load to Nairn Street. Following the load transfer, peak loads at Fredrick Street zone substation will be within n-1 capacity limits.

5.4.2.2. CBD (Palm Grove, Moore Street, The Terrace, University)

Following the transfer of load from Fredrick to Nairn Street, all CBD zone substations will be roughly evenly loaded. Analysis shows that as loads, and importantly, load densities, will continue to grow in the CBD with the result that all of the substations will be approaching their firm capacity at about the same time, highlighting an emerging problem within the forecast period. Most of the substations identified as potentially constrained, including Frederick Street, Moore Street, Palm Grove, Terrace and University supply the CBD or surrounding inner city area. One possible option that will be investigated is the building of a new CBD zone substation on land owned by Wellington Electricity at the end of Bond Street. This is central to the above CBD zone substations and load would be transferred from existing substation to Bond Street thereby freeing capacity throughout and around the CBD area.

[11] Transformers and cables have short term emergency ratings that provide some time for load to be transferred manually after an equipment failure without interrupting supply.

Wellington Electricity are also presently undertaking a detailed review of the distribution system in the CBD with a view to determining the best way to configure the distribution system for the future with respect to the ring system presently in place. Ring systems provide high levels of reliability but at the cost of flexibility. The review will include a look at how other utilities have addressed similar issues with CBD ring type distribution systems. One of the outcomes may be a recommendation to radialise the CBD network system. Radial systems are a more conventional configuration for distribution systems, however converting the CBD ring system to a radial system will have an impact on reliability.

5.4.2.3. Hutt Valley

Constraints in the Lower Hutt Valley area out of Korokoro, and Naenae zone substations are relatively minor and can be managed within the forecast period through operational load shifts as required.

5.4.2.4. Wainuiomata

The level of constraint expected at Wainiuiomata within the forecast period is relatively low but as there are no back feed options for this area, a project aimed at addressing this may be required within the forecast period. Wellington will monitor actual load growth in this area as it may be lower than the forecast hence deferring the need for investment.

5.4.2.5. Johnsonville

Load at Johnsonville may presently exceed the capacity of the sub-transmission cables at peak times. Back feed connections form adjacent substations allow n-1 operation at present, but this capacity will be eroded over time and reinforcement of the sub-transmission system may be required within the planning period.

5.4.2.6. Mana - Plimmerton

Load at the combined zone substations of Mana and Plimmerton may presently exceed the capacity of the sub-transmission transformers at peak times. Back feed connections form adjacent substations allow n-1 operation at present, but this capacity will be eroded over time and uprating of the sub-transmission transformers may be required near the end of the planning period.

5.5. Network Development – Options Available

The process that Wellington Electricity follows when analysing major network investment opportunities includes the long listing of options. The long list represents a range of possible solutions to address a clearly defined investment need. The long list of options will be relatively similar for most of the investment opportunities that occur on the network and projects will unusually fall under one or more of the following headings:

- Do nothing (status quo)
- Network solutions such as:
  - Redistributing demand (e.g. network reconfiguration)
  - Reinforcing the network (this may include many sub-options)
- Non-network solutions such as:
  - Reducing network demand (e.g. energy efficiency, load control, demand side initiatives)
  - Installing generation (e.g. distributed generation)

Non-network solutions are discussed in more detail in the following sections.

Each long listed option will have a cost estimate associated with it, a benefit in terms of how it addresses the need for reinforcement and an assessment of its feasibility. The long list will be ranked using the above criteria (i.e. cost, benefit and feasibility) in order to allow for a short list of options to be developed. The short list will typically be limited to 2 or 3 options that have roughly similar cost, benefits and feasibilities.

The implementation of this part of the network investment process is presently under development. Once the process is embedded in the company, major investment projects will each have associated with them a long list of alternatives that had been considered.

5.6. Distributed Generation Policy

There is already a small but significant amount of generation embedded within the network. Wellington Electricity welcomes third parties investing in initiatives such as the installation of embedded generation that might defer the need for capital investment on the network. However if such investment is to achieve the required outcomes there are a number of issues that need to be managed. In particular:

- The risk of non-provision of service needs to be managed. There is little point in paying a third party for a service such as generation or load reduction if the service cannot be guaranteed at the time that the network demand is at a peak.
- The service must comply with relevant technical codes and not interfere with other consumers.
- Any payments made to third parties must be linked directly to the provision of a service that gives the required technical and commercial outcomes.
- Commercial arrangements must be consistent with avoided cost principles.
- Commercial agreements must be reached on other issues not directly related to any benefit provided to Wellington Electricity. These can include the cost of connection and payment of use of network charges.

Wellington Electricity is presently reviewing the distributed generation policy that was inherited from the previous owners of the network. Until the review is completed and any changes to the policy are approved internally, the existing policy is being used.

5.7. Non-Network Solution Policy

Wellington Electricity's load control system is already used to manage peak demands on the network, and therefore has the effect of deferring demand driven system augmentations. Wellington Electricity tariff structure also encourages retailers to offer time of use pricing and other supply products that provide an incentive for consumers to shift electricity consumption away from periods of peak network demand. The load control system provides significant benefits to the network by reducing peak demand and moving it to the shoulder periods. This has resulted in the significant deferral of network investment as well as providing an effective means of dealing with network loading during outages.

Other non-network solutions may include demand response, where consumers may be given an incentive to switch off demand at certain times when the network is approaching a period of constraint. For Wellington, the type of demand that may prove useful in deferring network investment is air conditioning plant in the CBD. Demand response is less likely to provide benefit in suburban areas as the loads are diluted amongst a large number of consumers and the load control system already provides a similar benefit.

Wellington Electricity has not pursued demand response to date because the load control system is so effective. Demand response will however be included as a long list option in any major network investment options analysis where it may be useful. Should it prove to warrant further investigation as a way of meeting the needs of an investment opportunity in the short term, then Wellington Electricity will pursue it accordingly. Not withstanding this, a non-network solution policy that includes demand response will be developed over the longer term as Wellington Electricity progresses with establishing such systems and processes.

5.8. Major Network Investment Programme

Major network investment works include new development works driven by load growth, and replacement works driven by asset condition. Major network projects driven by asset condition are included in this section as the considerations for making the investment are the same for both types of projects and they follow a similar process.

5.8.1. Major Network Investments for the Current Year

The following projects and programmes of work are expected to take place or commence in the 2010 calendar year.

5.8.1.1. Fredrick Street 11kV Load Transfer

Frederick Zone Substation 11kV Load Transfer	
Driver: Growth Commissioning: 2010 Status: Committed	Due to load growth in the CBD area, reinforcement of the 11 kV network supplying this area is required to maintain security. Two new 11 kV feeders will be installed and the network configured to transfer a portion of Frederick Street substation load to Nairn Street. This load transfer will reduce the load at Frederick Street to below the firm capacity of the transformers and incoming circuits. Wellington Electricity had planned to uprate the 33 kV incoming cables to Frederick Street but the transfer of load to Nairn Street will defer the need for this. Non-network options were also considered as an alternative to the network expansion, but were not able to provide a satisfactory solution.

5.8.1.2. HV Reinforcement - General

This is an aggregated budget allowance for minor HV network reinforcement projects that are not able to be directly attributed to individual customers. Examples of such projects include installing a new 11kV cable section. Projects expected in 2010 include reinforcement of 11kV cables in The Terrace.

5.8.1.3. LV Reinforcement - General

This is an aggregated budget allowance for minor LV network reinforcement projects that are not able to be directly attributed to individual customers. Examples of such projects include installing a new berm substation or a 400V cable reinforcement project.

5.8.1.4. Customer Growth and Relocations

These projects have been aggregated in the budget as per the categories below. Overall, the 2010 budgeted expenditure is lower than the 2009 budget, reflecting a decline in the amount of enquiries for carrying out this type of work. In general this is being attributed a slow down in the economy.

New Connections

A reduction in the number of requests revived for new connections has been observed over the last 12 to 18 months. Overall it is predicted new connections requiring new infrastructure will fall to 130 in 2010 from previous levels exceeding 200 per year. On a more positive note, Telecom is continuing with its program to provide telecommunications services from roadside cabinets (rather than the local exchange) and PowerCo will commence a SCADA rollout for its gas network. Both programmes will require a number of small supply connections.

Substations

Reduced expenditure in customer substations is being predicted with fewer large scale substation reinforcements. This is attributable to the deferral of major developments in the Wellington CBD. From discussions with local city councils there is little infrastructure activity that is likely to correspond to notable spend on the network.

Subdivisions

While small and infill subdivisions look to remain at similar levels of previous years, a notable downturn in large scale subdivisions (>100 lots) is being predicted by local developers. With this air of uncertainty by developers only a 142 lot subdivision in Belmont is being recognised in the 2010 expenditure. While a number of potential medium size subdivision projects have been identified it is expected that some may not be undertaken in the 2010 year. However this is offset by smaller subdivision projects being undertaken although not allowed for in original expenditure. Overall it is predicted new subdivision connections will be less than 500 in 2010 from previous levels exceeding 1000 per year.

Streetlights

Expenditure is budgeted to install new infrastructure associated with the New Zealand Transport Agency(NZTA)'s project to upgrade lighting on SH1 between Johnsonville and Tawa. Note that replacement of existing streetlight network is funded from network integrity.

Capacity Changes

Expenditure associated with transformer upgrades or downgrades is included with customer substations to align with the function code structure adopted at time of company sale.

Relocations

The estimated 2010 budget is significantly lower than in recent years. For 2010 the NZTA will be investing little in infrastructure projects requiring relocation of existing electricity network. Minor relocation works has been identified by local city councils in 2010. An allowance for these and other customer initiated relocations has been made based on an average of the previous three years.

5.8.2. Prospective Investments for 2011 – 2014

The following projects are expected to occur in the period between 2011 and 2014. The level of detail for these projects is less than that applied to current projects, and the scope of them may change as the development and analysis of the projects proceeds.

Reinforcement of 33 kV Capacity at Palm Grove Zone Substation	
Driver: Growth Commissioning: 2011-2014 Status: Proposed stimated cost: $1-5 million	The current load at Palm Grove zone substation exceeds the capacity of the existing incoming cables. One of the options for addressing this issue is to connect the two existing cables in parallel to supply one transformer and to run a new 33 kV XLPE cable to supply the second unit. This will allow the two transformers to be operated up to their full rated capacity. At this stage it is not intended to upgrade the two Palm Grove transformers so that the firm transformer capacity exceeds the current and forecast substation load. Should a transformer fail, the situation will be managed using load transfers. This project is linked to the possible building of a new substation at Bond Street as it will allow the feeders in all CBD and surrounding areas to be reconfigured thus reducing the load on the Palm Grove substation.

33kV Reinforcement of Johnsonville Zone Substation	
Driver: Growth Commissioning: 2014 Status: Proposed Estimated cost: $>5 million	Load on Johnsonville zone substation is exceeding the incoming cable ratings by a significant margin, to the extent that it will soon be difficult to manage the situation operationally should an equipment failure occur. This project will focus on addressing the load on the sub-transmission cables. Options that will be investigated include reinforcing the 33 kV network, shifting load away from Johnsonville via the 11kV network, of controlling demand at peak times.

5.8.3. Prospective Projects for 2015 – 2020

Projects included in this section are speculative in nature. Whether or not they proceed, and their timing, will depend largely on whether forecast load growth materialises. It is possible that over the period before construction of any project must be committed, Wellington Electricity may identify more cost effective, including non-network, approaches that will supply the required load in accordance with the planning criteria.

33kV Cable Replacement	
Driver: Asset end of life Commissioning: 2015-2020 Status: Proposed Estimated cost: $1-5 million per zone substation	Wellington Electricity is reviewing all of its major asset categories in order to determine and prioritise those that exhibit deterioration in condition indicating the end of service life. A staged replacement of the assets that are at and of life will take place over the forecast period. These cable replacement works are included in this section as the justification for them is linked to their age, condition, loading, nature of the load supplied, maintenance history, ability to back feed loads etc.

Mana and Plimmerton Zone Substation	
Driver: Security Commissioning: 2015-2020 Status: Proposed Estimated cost: $1-5 million	Each of these zone substations is supplied by a single 33kV transformer feeder. Loss of one feeder at peak times can be accommodated by load transfer and load control at present, however by around 2015 there may be a short fall in capacity. Possible options to address this issue include up-rating the transformers, transferring load to adjacent substations at the 11kV level, installing additional transformers and/or load control.

New Bond Street Zone Substation	
Driver: Growth Commissioning: 2015-2020 Status: Proposed Estimated cost: >$5 million	It is envisaged that a new substation will be required during the planning period to reinforce the supply to the CBD. All substations supplying the CBD are heavily loaded and incremental upgrades can only defer the need for a more substantial reinforcement for a limited time.

5.8.3.1. Capital Expenditure Forecasts

Wellington Electricity's network development and growth capital expenditure forecast is shown in the table below. It includes the large projects described in Section 5.7 as well as expenditure on other growth related capital works such as customer projects and relocations. In comparison to asset renewal expenditure, the expenditure on growth projects is relatively modest, reflecting the low growth rates forecast. Expenditure on other line items generally reflects historic expenditure levels. The combined capital expenditure forecast is shown in Appendix A.

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2019/20
Customer Connections	7,323	5,428	7,412	5,895	5,699	5,633	8,593	8,162	6,332	6,877
Growth	3,276	2,279	3,449	8,368	5,380	4,075	6,191	6,645	2,274	4,852
Asset Relocations	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180
Sub Total	11,779	8,887	12,041	15,443	12,259	10,888	15,964	15,987	9,786	12,909

Figure 5-11 Capital Expenditure Forecasts

6. Lifecycle Asset Management

6.1. Maintenance Planning Criteria and Assumptions

This section provides an overview of Wellington Electricity's asset maintenance, refurbishment and replacement strategies over the planning period. The objective of these asset maintenance strategies is to ensure that the network is capable of meeting the consumer service level targets and to mitigate the risks inherent in running an electricity distribution network.

Generally, preventative maintenance consists of the following:

- Routine asset inspections, condition assessments and servicing of assets
- The evaluation of the results in terms of meeting customer service levels, performance expectations and risks
- Repair, refurbishment or replacement of assets when required

The preventative maintenance programme is typically based on a time based cycle, with each asset type, or maintenance task across a group of assets having a set cycle. Some maintenance activities are based on the number of operations undertaken by the asset (e.g. circuit breaker maintenance following fault trips), and some are based upon external testing results (e.g. tap changer maintenance based on oil tests). All inspections are undertaken on a time based cycle, which may vary for certain assets in each category based upon known issues and risks.

Electricity distribution assets do not have an infinite life and must eventually be replaced. Ideally assets should be replaced before they fail. However premature asset replacement is costly since it means that the service potential of the replaced assets is not fully utilised. Hence asset replacement requires the costs of premature replacement to be balanced against the risks of asset failure and the deterioration of supply reliability that will occur if assets are allowed to fail in service. There is a balance to be found, between the costs of maintaining an asset against the cost to replace it. Also for some asset types, it may be more cost effective, and have minimal impact on safety and service levels, to allow the asset to run to failure and replace on expiry of service.

Wellington Electricity uses the following criteria to determine whether an in-service asset should be replaced:

- The asset condition has deteriorated to the extent that there is a high risk that it will fail if left in service and repair or refurbishment is not practical or economic
- The asset technology is obsolete and spare parts are no longer available
- The asset presents an unacceptable risk to the environment or to the safety of public or operating and maintenance personnel
- The maintenance cost of the asset over its remaining life is expected to be higher than the asset replacement cost
- The asset failure creates a large impact to customer service or network reliability that would adversely impact our business reputation

The remainder of this section focuses on the different asset classes and provides an insight into the condition and maintenance of each class with an overview of the specific asset class, maintenance programs and renewal and refurbishment programmes.

One of the key assumptions Wellington Electricity has based its maintenance and renewal programmes on is that the assets are old, but are generally in fair condition due to sound maintenance programmes early in their service life, and a better view will be known upon further condition assessment.

6.2. Maintenance Practices

Wellington Electricity uses a Field Service Provider, Siemens Energy Services, to undertake and manage execution of the maintenance programme on the network. Under the present model, the contractor has scheduled inspection and maintenance activities in accordance with the Wellington Electricity standards and a high level programme is approved by the Wellington Electricity for the year ahead. This model results in the network owner receiving proposals from the field services contractors' for further reliability centred investment above the present maintenance expenditure guideline set by the network owner.

Going forward this model will be further enhanced and the Field Service Provider will undertake inspections according to a programme provided by Wellington Electricity and provide data back to Wellington Electricity for determination and scheduling of maintenance or replacement activities.

Vegetation Management is provided by Treescape in accordance with Wellington Electricity policies and in accordance with the Hazard from Trees Regulations. Wellington Electricity is reaching the end of the first cut and trim programme, and in future tree owners will be responsible for maintaining their vegetation to a distance that provides safe clearance of subsequent growth. Although controlled under regulations, this may not occur and vegetation related outages may start to increase again if tree owners neglect their obligations under the regulations.

The maintenance budget is categorised into the following areas:

1. Planned/Preventative Maintenance (PM) works – this PM plan is produced by the maintenance contractor based upon the requirements in the maintenance standards and asset quantities in service. This plan is submitted to Wellington Electricity for approval and any amendments. The PM plan also includes routine inspections undertaken on the network. The results of planned inspections, and also planned maintenance, drive corrective maintenance or renewal activities.

2. Corrective Maintenance works – this work is undertaken in response to defects raised from the planned inspection and maintenance activities, or from observations in the field. Generally the complete programme is unknown at the beginning of the financial year and budgets are set based on rolling averages from previous years, adjusted (if required) for any known defects beyond what would normally be expected. When common fault modes occur these may be progressed into an asset renewal programme to more efficiently manage the defect.

3. Reactive Maintenance works – this work is undertaken in response to faults or third party incidents and includes equipment replacement and repairs following failure or damage.

4. Management Fee and Value Added – this is to provide for the contractor management overhead and to provide customer services such as cable mark outs, stand over provisions for third party contractors, provision of asset plans for the 'B4U Dig' service etc.

5. Vegetation Management – covering planned and corrective vegetation work undertaken by Treescape.

The maintenance budget costs for 2010 are summarised at the end of this section.

6.2.1. Maintenance Standards

The following maintenance standards are referred to in this section. These standards are all ex-United Networks standards that are presently under review with the aim of converting them to Wellington Electricity standards.

Standard	Name
SMS-001	Substation maintenance standard: 11kV metal clad switchgear - oil, vacuum and sulphur hexafluoride (SF6) filled
SMS-002	Substation maintenance standard: Zone transformers
SMS-003	Substation maintenance standard: 33kV and 66kV minimum oil volume circuit breakers
SMS-004	Substation maintenance standard: 33kV bulk oil circuit breakers
SMS-005	Substation maintenance standard: 33kV sulphur hexafluoride (SF6) circuit breakers
SMS-007	Substation maintenance standard: 33kV and 66kV air break switches
SMS-008	Substation maintenance standards: Substation batteries
SMS-009	Substation maintenance standard: Miscellaneous equipment
SMS-010	Substation maintenance standard: Injection control equipment
SMS-013	Substation maintenance standard: Mineral insulating oil
SMS-015	Substation maintenance standard: Reporting on routine substation inspections
SMS-016	Substation maintenance standard: Zone substation sites and buildings
EMS-D.01	Electrical maintenance standards: 11kV ground mounted switches and fuse links
ENS-0055	Electrical maintenance standards: 11kV air break switches
EMS-D.03	Electrical maintenance standards: 11kV automatic reclosers and sectionalisers
EMS-D.04	Electrical maintenance standards: Distribution transformers
EMS-D.05	Electrical maintenance standards: Distribution earthing systems
ENS-0057	Electrical maintenance standards: Poles

Standard	Name
EMS-D.09	Electrical maintenance standards: Line components
EMS-D.10	Distribution maintenance standards: Overhead line equipment and supports

6.3. Maintenance and Renewal Programmes

This section includes excerpts taken directly from the Preventative Maintenance programme, illustrating the maintenance activities undertaken for particular asset classes and their frequency. Commentary is provided on renewal and refurbishment policies or criteria plus known systematic issues associated with each asset class.

6.3.1. Subtransmission Cables

Activity	Comments	Standard	Freq.
Cable sheath tests and cross bonding link boxes	3 phase 33 kV cables, providing the provision of asset information, for 33kV cables in service > 5 years, also inspect condition of cross bonding link boxes	draft std	2 yearly
Subtransmission - cable gas / oil injection equipment	Inspection and minor maintenance, every 6 months, record gauge readings	draft std	6 monthly
Subtransmission protection test (incl. remote end trip)	Testing of protection system associated with subtransmission cables, integrity of pilots and prove by remote end tripping	draft std	2 yearly
Testing of Sheath Voltage Limiters (SVLs)	Testing to confirm correct operation of SVLs installed > 5 years, or following circuit fault	draft std	5 yearly

Figure 6-1 Inspection and Routine Maintenance Schedule for Subtransmission Cables

In conjunction with the above routine maintenance, all oil filled and pressurised gas cables have pressure continuously monitored via the centralised SCADA system. This monitoring provides information that identifies cables where pressure is reducing and allows the situation to be promptly investigated. Leaks will occur either at joints, which can be rebuilt, or along the length of the cable which makes location and repair significantly more difficult.

One of the key tests is the sheath test, this will indicate where there is damage to the outer sheath and gives an early indication of where corrosion or further damage may occur (leading to leaks), as well as proving the integrity of the earth return path. Most of the subtransmission cables installed on the Wellington network are lead sheathed.

The historic fault information for each cable, where known, is used to assess and prioritise the need for cable replacement, as well as determining the strategic spares are required to be held.

6.3.1.1. Renewal and Refurbishment

The need for cable replacement is determined and prioritised by a combination of the consequence of a cable failure, condition and performance assessments, analysis of failure and defect rates, and a comparison of the estimated cost of maintaining the cable in service with the cost of replacement, as well as system capacity for supporting load whilst the subtransmission circuit is under repair.

Unfortunately for cables there are almost no options for refurbishment or extension of life once major leaks, discharge and electrical insulation breakdown has occurred. The solution is most cases is replacement of sections, or the entire length of cable. Gas and Oil filled cable require special transition and stop joints that range in cost from $100,000 upwards each. To relocate, replace sections or extend a cable would cost a minimum of $250,000 using this technology.

Wellington Electricity is presently working on developing a set of 'stage of life' criteria for subtransmission cables. When complete this will provide an indication of where investment in this asset class is best focussed.

6.3.1.2. Cable Condition

Gas filled cables

Gas filled HV cables have been in use internationally since the 1940's and are still in service in many utilities in New Zealand and Australia. They have been proven to perform well when they are installed in benign environments that are not prone to disturbance or damage. Wellington Electricity however has many of its gas filled cables installed under busy roads in urban environments, through structures such as bridges and crossing earthquake fault lines. This therefore requires close monitoring of their performance to manage any deterioration and consequent reduction in levels of service. For example, most of the Evans Bay gas filled cables run under State Highway One. These cables in particular have been repaired numerous times as a result of third party damage or through gas leaks being found. Vibration from traffic has been identified as a contributing factor to some mechanical failures.

When these cables develop a gas leak, they can usually be dug up and repaired without having to cut the cable. However when a more serious electrical fault occurs a new section of cable will be necessary. On some occasions a transition joint is employed to join the pressurised gas cables to XLPE cables. These joints are relatively expensive at circa $100,000 each and therefore it is not expected that it will be economic to have a large number of such joints in a cable. The likely outcome of this is that economically for any replacement projects, long lengths of cable will be required for replacement rather than for a number of short lengths.

A brief summary of the gas filled cable circuits is listed below:

Circuit	Length (km)[12]	Year Installed
Central Park - Evan's Bay	10.1	1958
Central Park - Frederick St	3.1	1978

[12] Circuit length is the total of all parallel circuits, divide length by number of circuits for route length

Circuit	Length (km)[12]	Year Installed
Central Park - Hataitai	4.8	1968
Central Park - Palm Grove	5.8	1967
Central Park - University	1.0	1986
Evan's Bay - Ira St	5.1	1961
Melling - Petone	8.4	1963
Upper Hutt - Maidstone	10.7	1968
Wilton - Karori	9.8	1967
Wilton - Waikowhai St	3.7	1962
Wilton - Moore St	16.6[13]	1965

Figure 6-2 Summary of Gas Filled Cable Circuits

A detailed analysis of age, performance and known condition is presently being undertaken with an aim to prioritise 'stage-of-life' management for the gas cable population.

The Evan's Bay cables are the oldest on the network and over time they have suffered from a number of leaks which have been repaired. These are however well supported by back-feed options and the load they support is residential. Depending on the outcome of the 'stage of life' analysis, these cables may be selected for replacement in the forecast period.

Any concerns that come to light following recent repairs to the Moore Street cables will be analysed and may result in a programme of increased monitoring, targeted joint maintenance or possibly capital investment.

The Petone gas cables have had, and continue to suffer from, heavy corrosion to the outer metallic sheath due to poor servings. These cables are lightly loaded due to decline in load around Petone with the closure of several large manufacturing plants. Network studies are being undertaken to determine if these cables should be replaced, or if the load can be supplied from existing 11kV feeders in the area, reducing the need for subtransmission supply.

Cable Joints

A known issue on some cables installed on steep terrain where joints expand and contract under cyclic loading, and have been known to pull the conductor from the joint ferrule under contraction. At this time the impact or consequences are unknown, however after initial inspection during United Networks ownership no remedial work occurred as the problem had not proved to be significant.

[13] The Wilton-Moore St cables are duplexed with the old Wilton-Terrace cables for capacity.

Cable Strikes

Wellington Electricity, like most lines businesses and other utilities, experiences a number of third party strikes on its underground assets each year. These impact on network performance, pose a serious risk to health and safety, and incur a large cost to repair.

To attempt to minimise the number of third party strikes, Wellington Electricity uses a service provider, B4U-DIG to facilitate the provision of obstruction plans to contractors working in the area. Wellington Electricity is planning to target these contractors with a road show to educate on the importance of cable location and excavation practices.

Additionally, cable maintenance staff patrols the routes of key subtransmission circuits on a regular basis and note any activities that may impact upon underground services.

6.3.2. Substation Buildings and Equipment

Activity	Comments	Standard	Freq.
Grounds maintenance - Lump sum	Mow lawns, trim edges, unblock drains, trim trees, remove rubbish, weed control, maintain gardens.		
Zone building and Equipment Inspections	Transformers - Inspect and test where applicable - silica gel, oil levels and leaks, abnormal noises, temperature, paint condition (corrosion and peeling paint). Record tap changer counts and start pumps and fans manually. Switchgear - Inspect	SMS-001, 02, 03, 04, 05, 07, 09	6 Monthly
Thermal image survey of substations including PD detection for switchgear	Thermal inspection of transformers, cable boxes, switchgear, LV frames and distribution boards, using a camera, as per equipment standards	SMS-001, 02, 03, 04, 05, 07, 09, 10	1 yearly
Building Inspections (3 monthly)	Visual inspection of buildings, fences and signage at stations. Ensure correct operation of building systems, lighting and amenities. Replenish consumable items as required. Check and clear roofs, spouting and drainage systems. Inspect oil containment as SEPA unit inspection	SMS-016	3 Monthly
SEPA Unit inspection	Remove obstructions, visual inspection of separator, visual inspection of pit confirming float switch is operational, check pump operation, check gear oil level, check waste oil tank levels (disposal not included in price).	TBC	3 Monthly

Activity	Comments	Standard	Freq.
SEPA Unit service	As per inspection, plus clean separator, drain sludge tank, Fill with potable water and check for leaks.	TBC	1 yearly
Fire suppression system tests (incl changeout extinguishers)	Ensure gas-discharge fire suppression systems (Inergen etc) are tested and maintained in accordance with manufacturers guidelines.		3 Monthly
Test Zone Substation Earthing system	Inspect and test earthing as per standard	draft SMP-014	5 yearly
Frame to earth protection	Identify and breakdown in resistance between the substation Frame Earthing and the Main substation earthing. Value to be >10 Ohms		4 yearly

Figure 6-3 Inspection and Routine Maintenance Schedule for Zone Substations and Equipment

Routine quarterly zone substation inspections include the building and other assets such as lighting, fire systems, security systems, fans, heaters and safety equipment. The grounds and ripple injection spaces are also maintained to ensure access security, condition and safety. Where appropriate annual building warrant of fitness inspections are carried out and any defects rectified. Building maintenance varies, and minor defects are corrected as they are identified.

6.3.2.1. Renewal and Refurbishment

The substation building refurbishment program includes tasks such as roof replacement, exterior and interior painting, security and fencing improvements to maintain the assets in good condition on an as-needed basis.

Given the average age of substation buildings, Wellington Electricity is approaching a period of increased spend to replace doors, roofs and other building components as the deterioration from the natural elements have resulted in maintenance being uneconomic to address the weather tightness issues. This work is critical to ensure ongoing reliability of electrical plant.

In addition to routine maintenance, the local councils require seismic improvement works on some of the older buildings. These are undertaken as required following engineering advice.

6.3.3. Zone Substation Transformers and Tap Changers

Activity	Comments	Standard	Freq.
Transformer oil test (TCA)	Take oil samples and test for acidity, breakdown voltage, moisture content, colour and DGA including Furan analysis. Record and analyse test results.	SMS-002	1 yearly

Activity	Comments	Standard	Freq.
Transformer Primary Protection	Check for correct operation & indication; bucholz relay, pressure relief valve; oil level switch, and coolant pumps & fan (if necessary), test all SCADA alarms.	SMS-002	4 yearly
AVR maintenance	All control equipment associated with the AVR, operation from top to bottom limit, all timer and voltage settings correct, test SCADA control and indications.	SMS-002	4 yearly
33/11 kV Zone Transformer	Check all external components for leaks, cracks, tightness, general condition. Check Buchholz and pressure relief devices, diagnostic insulation test of windings.	SMS-002	4 yearly
On Load Tapchanger (OLTC) oil test to TjH2b spec for TASA	Take oil samples and test for acidity, breakdown voltage, moisture content, colour and DGA. Record and analyse test results	SMS-002	1 yearly
On Load Tapchanger (OLTC) Maintenance	Fixed interval, or after 30000 operations, or condition based, or to manufacturers recommendation	SMS-002	4 yearly
33kV Cooling fin fans and pumps, confirmation of operation	Check the operation and condition of the fans and pumps on Zone Power Transformers		1 yearly

Figure 6-4 Inspection and Routine Maintenance Schedule for Zone Substations Transformers and Tap Changers

A programme of full oil analysis of all zone substation transformers and tap changers was initiated by Wellington Electricity and was completed in late 2009. Presently Wellington Electricity uses TjH2b analytical labs for oil analysis, who undertake a TCA and TASA test. These reports return a score of 1 to 4*, with 1 being normal, and 4* being worst, and activities such as tap changer maintenance can be programmed based on these results as well as on time or operation based intervals. The TCA result and information in the report can be used to determine whether major maintenance or repairs need to be undertaken on the transformer. Recent results of the oil analysis for the zone substation transformers and tap changers are provided in Appendix C.

Generally the condition of all transformers on the network indicates normal performance, where evidence of heating or arcing is present, corrective maintenance is undertaken if economic, such as tightening or renewing internal connections outside of the core. These tests will also give an estimated Degree of Polymerisation (DP) value that can be used to provide an initial overview of the transformer condition, and signal the need for further maintenance, refurbishment or replacement. Estimated DP tests completed in 2009 (furan analysis) show the majority of transformers to be above 450, it is proposed that once a transformer reaches 300 a paper sample will be taken to prove accuracy of the furan analysis and determine what further steps are required. A profile of estimated DP vs. Age is shown below:

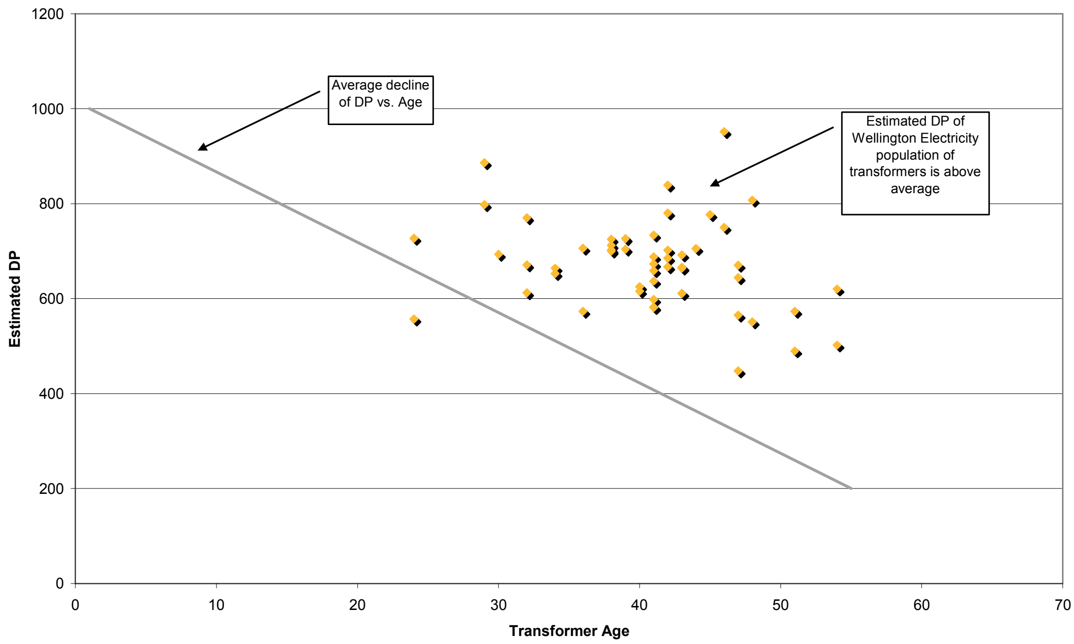

Figure 6-5 Profile of Estimated DP vs. Age

6.3.3.1. Renewal and Refurbishment

Where a transformer is identified for relocation, refurbishment is generally performed if it is economic to do so, based on the condition and residual life of the transformer. A non-invasive test to determine the moisture content of the winding insulation is used to aid the economic decision regarding major transformer refurbishments.

Transformer replacement and life-maintaining refurbishments are prioritised through a combination of invasive and non-invasive tests and inspections to determine the condition of the transformer. Tests are carried out on the oil and winding insulation to provide an indication of probable remaining life of the transformer. Based on this a decision can be made in conjunction with functional, financial and performance requirements of the transformer on whether to retain the transformer in service, to refurbish the transformer or to replace it outright.

The following has been allowed for in the asset maintenance and replacement forecasts for the planning period:

- Transformer replacements at two zone substations
- Ongoing transformer refurbishment costs
- Ongoing preventative maintenance including testing and inspections

Based on age information, and condition test results, replacement of at least two transformers can be expected to require replacement during the period 2011-2015. The replacement units need not be the oldest, nor the worst condition, but where capacity and security constraints indicate a high risk associated with failure. All factors are considered in the replacement decision making.

In some instances, where a power transformer is approaching, or at its service half life, and subject to condition assessment results, a refurbishment including mechanical repairs, drying and tightening of the core, and associated electrical repairs can be justified. There are 8 - 12 transformers that are at a stage where refurbishment is still economic, and some that are showing slight signs of arcing which may require minor refurbishment to check and tighten electrical components. For the majority of the power transformers in the Wellington network, the testing and inspection programme will aid in getting the best life from the transformer, and timing replacement of the unit, however not necessarily leading to full refurbishment.

6.3.4. Substation – DC Systems

Activity	Comments	Standard	Freq.
Inspection and monitoring of battery & charger condition (Zone)	Quarterly Checks (mainly voltage check) - All zone substations.	SMS-008	1 yearly
Inspection and monitoring of battery & charger condition (GXP)	Quarterly Checks (mainly voltage check) - All GXP substations.	SMS-008	1 yearly
Comprehensive battery discharge test (every second inspection)	Annual major maintenance, incl. deep discharge test, SMS-008,	SMS-008	1 yearly

Figure 6-6 Inspection and Routine Maintenance Schedule for Zone Substation Battery Banks

Valve regulated lead acid (VRLA) batteries are now used. Maintenance is based on the recommendations of IEEE–1188 (IEEE Recommended Practice for Maintenance, Testing and Replacement of Valve Regulated Lead Acid Batteries for Stationary Applications).

6.3.4.1. Renewal and Refurbishment

Batteries are replaced, using VRLA batteries, as they fail, which is based on condition assessment results, or when they exceed the manufacturers design life. For a number of sites, with higher ampere-hour (Ah) demand, 10 year life batteries are available. For smaller sites, or communications batteries where the ampere-hour demand is lower, batteries are only available with 5 year lives. As part of primary plant replacements, Wellington Electricity is intending to standardise the voltages used for switchgear operation as well as communications equipment.

Following failure of a large number of batteries in 2009, Wellington Electricity undertook a major project to replace 244 battery banks which had exceeded the manufacturers design life, and a further 173 banks will be replaced during 2010. Thereafter all batteries will be replaced every 4-5 years to ensure the standard design life of 5 years is not exceeded. Major replacement will be required again in 2014 and 2015, although the replacement may be staged from 2013 onwards. Battery replacement between 2011 and 2013 will be minor with only around 150 banks requiring replacement (50 per year average).

Battery chargers generally have no serviceable parts, maintenance is limited and are generally replaced upon failure with spares held locally. Some zone substations have an automated battery charger with supervisory monitoring which will alarm in the event of failure.

6.3.5. Switchboards and Circuit Breakers

Activity	Comments	Standard	Freq.
Major service on 33 kV OCB, bulk oil	Insulation resistance, contact resistance, mechanism lubrication and wear checks, replace oil and clean tank as per manufacturer's instructions, rack out switchgear and check truck and cubicles for damage and cleanliness. Kelman profile test. Check that shutters are operating.	SMS-004	8 yearly
Major service on 11kV OCB	Insulation resistance, contact resistance, mechanism lubrication and wear checks, replace oil and clean tank as per manufacturer's instructions, rack out switchgear and check truck and cubicles for damage and cleanliness. Kelman profile test. Check that shutters are operating.	SMS-001	4 yearly
11 kV OCB Switchboard inspection and test	Additional to OCB. Major service every 12 years (every second major maintenance) clean bus bar, CT chambers, and carry out bus bar insulation and ductor tests.	SMS-001	8 yearly
Major service on 33 kV vacuum/SF6 Circuit Breakers	Insulation resistance, contact resistance, mechanism lubrication and wear checks, as per manufacturer's instructions, rack out switchgear where applicable and check truck and cubicles for damage and cleanliness. Check that shutters are operating correctly	SMS-005	12 yearly
Major service on 11 kV vacuum/SF6 Circuit Breakers (VACCB's)	Insulation resistance, contact resistance, mechanism lubrication and wear checks, as per manufacturer's instructions, rack out switchgear where applicable and check truck and cubicles for damage and cleanliness. Check that shutters are operating correctly	SMS-001	12 yearly
11 kV SF6 & VCB switchboard inspection and tests	Additional to SF6/Vacuum. Major service every 12 years clean bus bar, CT chambers, and carry out bus bar insulation and ductor tests.	SMS-001	16 yearly

Figure 6-7 Inspection and Routine Maintenance Schedule for Zone Substation Circuit Breakers

In addition to the routine maintenance programme above, oil circuit breakers are maintained as required following a number of fault operations.

6.3.5.1. Renewal and Refurbishment

Based on the condition assessment carried out as part of the preventative maintenance routine, assets are identified for replacement, or targeted inspection and maintenance programmes to manage risks until replacement is possible. A large number of older circuit breakers remain in place and provide good service as they are in excellent condition due to regular maintenance over the majority of their service life. Some of the older units are showing their age with pitch leaks and failing mechanisms.

Condition, performance, ratings and operational history across the industry are considered when determining the timing for replacement of a circuit breaker. However other drivers that influence the decision for replacement include safety, operability and co-ordination with modern equipment.

Switchgear in Thorndon Substation

6.3.5.2. Switchgear Condition

Reyrolle Type C

Reyrolle Type C circuit breakers were installed between 1938 and the late 1960's, therefore the majority of units have reached the end of their effective service life. There are approximately 170 units in service on the Wellington network which are being replaced progressively, prioritised by condition and location. These CBs need to be inspected for leaks (oil, compound) as well as thermal imaging and partial discharge inspections are undertaken on an annual basis. This programme will ensure defects or potential issues are detected early and corrective actions can be taken. Several units are not able to be operated due to mechanical failure. Replacements are based on the following programme:

Substation	No of CBs	Year Installed	Replacement Year	Estimated Cost (2010)
174 Victoria St	12	1941	2010	$ 720,000
Taurima St	7	1950	2010	$ 420,000
59 Upland Rd	6	1953	2010	$ 360,000
Lombard St	5	1953	2010	$ 300,000
4 Kaiwharawhara Rd	8	1954	2010	$ 480,000
Evans Bay	12	1958	2010	$ 1,200,000
46 Hania St	5	1938	2011	$ 300,000
9 Duncan Terrace	3	1938	2011	$ 180,000
33 Brooklyn Rd	4	1938	2011	$ 240,000
Hankey St	9	1941	2011	$ 540,000
Newtown	8	1941	2011	$ 480,000
Cable Car Lane	5	1950	2011	$ 300,000
Gracefield	13	1958	2011	$ 1,300,000
Marion Street	4	1954	2012	$ 240,000
69 Miramar	8	1954	2012	$ 480,000
139 Thorndon Quay	5	1954	2012	$ 300,000
Chaytor St	7	1954	2012	$ 420,000
Karori	11	1962	2012	$ 1,000,000
Kilbirnie	9	1956	2013	$ 540,000
9 Parkvale Rd	9	1964	2013	$ 540,000
Palm Grove	11	1966	2013	$ 1,000,000
Cornwell St	5	1945		$ 300,000
Flag Staff Hill	5	1953		$ 300,000

Figure 6-8 Proposed C-type Circuit Breaker Replacement Programme

Yorkshire SO-HI

Yorkshire SO-HI switchgear was installed during the 1970s and 80s in kiosk type substations and there are approximately 130 units in service. SO-HI has a history of failing in service and a number of utilities have removed the equipment entirely, or imposed operational cautions. The installations in the Wellington network are in secondary sites and a programme of inspection, testing and bus bar chamber cleaning is being implemented to reduce service failure risks.

Wellington Electricity has imposed an operational restriction on these units so they are not operated manually under fault conditions. The constraint is being evaluated against the potential impact on network performance. Wellington Electricity has reviewed all installations of SO-HI switchgear and will initiate a programme of replacement for switch units at sites identified as being higher risk during the planning period.

Reyrolle LMT Current Transformers

Reyrolle LMT circuit breakers were installed on the network from 1970 onwards. There are over 400 units in service. Recent partial discharge testing has indicated potential issues around the CTs / or the CT chamber. Full partial discharge testing (or handheld TEV testing), and corrective maintenance is being completed on all Reyrolle LMT circuit breakers over a 2 year period. The estimated average cost of retro-fitting CTs is under $20,000 per set.

6.3.6. Substation Protection Relays

Activity	Comments	Standard	Freq.
Protection Testing for Electromechanical Relays	The protection test is to include: ▪ Check "as-found" settings of the relay ▪ Check for dirt and foreign objects on the disc or moving parts ▪ Check and record pick-up values ▪ Check and record relay timing ▪ Check in-service currents ▪ Check inter-tripping functions	draft SMP-012	4 yearly
Numerical relay Function check of the protection (without test equipment)	The function check is to include: ▪ Comparison of the quantities "current" and "voltage" with the displays; ▪ Tripping test by initiating a trip command; ▪ Reading-out and analysis of the event memory; and Check of the protection local and remote fault indications.	draft SMP-012	4 yearly
Numerical relay	The protection test is to include:	draft	4 yearly

Activity	Comments	Standard	Freq.
Protection test (with test equipment)	▪ Check of one measuring point of the input quantities "current" and voltage" both for each phase, neutral and for each measuring range by comparison with the display; ▪ Check of the function of all binary inputs and outputs; Interface test consisting of: ▪ Reading out and analysis of the indication and fault recording memory using PC interface; and ▪ Reading-out of all setting parameters and comparison with the initially set parameters ▪ Check of the protection local and remote fault indications.	SMP-012	
Numerical relay Parts replacement	Back-up battery replacement ▪ The lesser of: manufacturer's recommendation or 5 yearly	draft SMP-012	5 yearly

Figure 6-9 Inspection and Routine Maintenance Schedule for Zone Substation Protection Relays

Regular testing of protection relays is undertaken to determine correct operating functionality. Protection relay testing will continue on a regular basis and budgetary provision for this has been made in the maintenance expenditure projections.

The key focus of protection relay maintenance is to identify any equipment that is not operating correctly or has failed. In order to maintain network reliability performance it is necessary to identify these issues before a failed or mal-operating protection relay is required to operate. This is especially relevant with the large number of older electromechanical relays on the network. Electromechanical relays are tested on a four year basis.

Numerical relays, although equipped with self-diagnostic functions, are tested as shown in the table above.

6.3.6.1. Renewal and Replacement

The majority of electromechanical relays are approaching their technical life and ideally should be replaced over the next 10 years. However the economic impact of replacement with modern numerical protection relay equivalents is being carefully considered. Therefore, the replacement programmes that are in place generally focus on relay condition and coordination with other replacement programmes or projects especially for assets such as switchgear and transformers. At the time of primary equipment replacement the opportunity is taken to upgrade associated protection schemes to meet the current standards because the relays are usually mounted within switchgear panels as an integral system. To date, electromechanical relays have provided reliable service and are expected to remain in service for the life of the switchgear it controls – generally greater than 40 years. For newer numeric relays, it is not expected that the relay will provide the same length of service and a service life of less than the ODV standard life is expected.

The following programmes and projects have been allowed in the asset replacement and maintenance budgets.

- Ongoing replacement of PBO relays in conjunction with switchgear replacements in the short term, or individually where known risks exist. Sites with PBO relays will be identified in the maintenance programme over the next two years, and any replacement programme determined from then
- There are around 10 Nilstat relays still in service which will need to be replaced, however they are in a Reyrolle Type C switchboard, so total replacement will occur in the short term (switchboard scheduled for replacement in 2011) and an individual replacement project is not justified
- Ongoing zone substation and network protection and control replacement/upgrades for assets supplied from GXPs, particularly Takapu Rd, Haywards, Gracefield, Upper Hutt and Wilton as part of upgrades Transpower may undertake
- Ongoing protection and control replacements/upgrades across the network as identified by asset condition monitoring

6.3.7. Load Control Equipment

Activity	Comments	Standard	Freq.
Visual inspection and routine check	Signal output check, general equipment visual inspection and motor test run for rotary plant.	SMS-010	6 monthly
Major maintenance	Check signal level with tuned voltmeter, check injection current, clean all insulators and bushings, check correct operation of any isolator switches, transformers and motor generator sets. Maintain motor generator set.	SMS-010	2 yearly

Figure 6-10 Inspection and Routine Maintenance Schedule for Ripple Plant

6.3.7.1. Renewal and Refurbishment

Wellington Electricity has no short terms plans to replace any ripple injection plant. Repairs and maintenance are undertaken as required, as the plant is generally reliable. Basic spares are held locally. In the Hutt Valley area, interconnectivity at 11kV allows ripple signal to be provided from adjacent substations in the event of failure. In the Wellington City area, there is dual plant located to supply each of the GXPs at 33kV.

In the medium term, Wellington Electricity will look to replace older rotary plant installed on the 11kV system as these assets are approaching the service life. It is likely that replacement may involve rationalisation of plant by installing larger plant at GXP level, using modern low frequency ripple signals, rather than high frequency injection at Zone Substation level. Whilst technically straightforward, it may become a complex issue involving retailers and meter/relay asset owners.

The ripple control for the Central Park GXP loads is located at Frederick St zone substation and comprises two units operated in parallel. With one unit out of service, ripple signal strength is marginal in some parts of the network. This matter is presently under investigation and it believed to be related to the increased load on Central Park following the reconfiguration of supply to The Terrace substation initiated by the previous network owner.

6.3.8. Poles and Overhead Lines

Activity	Comments	Standard	Freq.
Visual check of sub-transmission, HV and LV overhead lines, replacement of pole numbers, reflectors etc	Visual check of: pole verticality; conductor ground clearance; condition of poles, cross arms, conductors, insulators, hardware and pole-mounted equipment. Includes thermal image of lines equipment. Routine monitoring as per standard. Replace missing or damaged components	EMS-D.10	1 yearly
Pole condition assessment	Detailed visual inspection of all poles, towers and hardware. Condition assessment of wood poles using ultrasonic methods and top load analysis.	MP 01 ENS-0057	5 yearly

Figure 6-11 Inspection and Routine Maintenance Schedule for Poles and Overhead Lines

Soon after taking ownership of the Wellington network, Wellington Electricity identified shortcomings in the regular pole inspection and testing method being used on the network and initiated a review of industry practice with respect to pole inspections. This review was undertaken for the purpose of helping to define the options available for a regular pole inspection programme, with a particular focus on how wooden poles are inspected. The review concluded that any inspection method should include a test of the below ground condition of wooden poles, and that the existing standard for pole inspection, ENS-0057, should be modified.

Three different methods for inspecting wooden poles were reviewed, namely:

- Digging around the pole to expose and allow inspection below ground level
- Pole Scan and Mole probe test
- Mechanical strength test using the Deuar MPT40 partial loading system

The review process consisted of:

- Witnessing the test being applied (Note – this was not done for the digging method as a demonstration scheduled with Alpine Energy was cancelled following a storm that required all staff to attend to network repairs)
- Discussing the method with those applying the test (i.e. the inspectors)

- Discussing the method with the asset owners who employ it
- Estimating the costs of each method
- Reviewing the history of each method with respect to their effectiveness at identifying unsafe poles

Of the three methods reviewed, it was concluded that the Deuar MPT40 best satisfies the need for objectivity, repeatability and accuracy. This conclusion is supported by independent analysis and referees. The next stage of implementing a new pole inspection method involves development of an internal business case for internal review prior to confirming commercial arrangements. Once these steps are competed, operator training will take place and the programme will be initiated. The target for having the revised inspection programme in place is mid 2010.

In the interim period, poles identified from previous tests with less than half their remaining strength are being retested and replaced as required.

6.3.8.1. Renewal and Refurbishment

Note - The following sections refer to the existing pole inspection process and are based on ex-Vector standard ENS-0057. As described above, this is presently under review.

Poles

Following inspection of poles, and failing the serviceability test, they are categorised as red tagged, or yellow tagged. Red tagged poles have a serviceability index of less than 0.5 or have a major structural defect, and are programmed for immediate replacement (6 weeks). Yellow tagged poles have a serviceability index of 0.5 to 1.0, or have moderate structural defects and are programmed for replacement within 6 months. Crossarms are identified for replacement from the detailed line inspections.

These systems will be reviewed pending formalisation of a more deterministic system of pole strength.

Overhead Lines

Conductors are programmed for replacement based on condition assessments and analysis of fault history. The numbers of joints per span or visible signs of damage are used to determine the need for replacement.

6.3.8.2. Overhead Line Condition

All new insulators are of the solid core post type as they provide a higher level of reliability in polluted environments and lightning prone areas than the pin type insulator historically used on the network. Pin type insulators are no longer used for new 33 kV or 11 kV line construction. There is no programme to proactively replace existing pin type insulators; this will occur under system maintenance or when line support assets require replacement.

High wind loadings can sometimes result in fatigue failures around line hardware such as compression sleeves, line guards and armour rods on the older All Aluminium Conductor (AAC) lines that have historically been used on the Wellington Network. Recent incidents have also shown fatigue problems with fittings supporting strain points. Conductor fatigue issues such as these can not be visually detected, therefore it is proposed to take a sample of conductor and components from service and have these analysed by materials scientists to determine remaining asset life in order to plan for a proactive replacement program. Where a conductor issue is identified, All Aluminium Alloy Conductor (AAAC) will be used as a replacement material due to its increased strength and improved fatigue resistance.

It should be noted that steel reinforced conductors have not been widely used in the Wellington region due to high salt pollution causing shortened service life from corrosion of the steel core.

6.3.8.3. Renewal and Refurbishment

In early 2010 a section of overhead line was replaced in the Korokoro area as this was prone to high winds and had suffered fatigue related failures.

It is likely that similar reconductoring will occur as further issues arise on the network, or where there are increased instances of conductor or component failure. This work usually involves sections of line of only a few hundred metres.

6.3.9. Air Break Switches, Links and Overhead Fuses

Activity	Comments	Standard	Freq.
HV ABS visual and thermal inspection (not in substations)	Annual routine monitoring	SMS-D.02	1 yearly
ABS Service	Inspect insulators, connections, tank (where applicable), cross arms, mounting bracket and operating handle. Inspect contacts, flickers, and arc chutes from close proximity. Jumper across switch and operate switch to check alignment and confirm smooth open	SMS-D.02	3 yearly
Inspection and Testing of Earthing	Inspect and test earthing as per standard	EMS-D.05	5 yearly

Figure 6-12 Inspection and Routine Maintenance Schedule for Air Break Switches

Air break switches and overhead links are treated in the same manner, and are maintained under the preventative maintenance programme detailed above. Overhead HV fuses are inspected during both the annual overhead line survey and also at the time of transformer maintenance (for fuses supplying overhead transformers), however the large quantity and low risks associated with fuses does not justify an independent inspection and maintenance programme.

6.3.9.1. Renewal and Refurbishment

There is no proactive programme to replace overhead switchgear or devices, and any renewal activity on these assets is driven from standard inspection rounds and resultant maintenance activities from the identification for corrective work. With the extensive pole and crossarm replacements undertaken by previous network owners, and continuing under Wellington Electricity, a large number of overhead switches have been replaced, and replacement generally occurs at the time of pole or crossarm replacement if the condition justifies replacement..

6.3.9.2. Condition of Drop Out Fuse Links

A problem has previously been identified with some types of expulsion drop out (EDO) fuses that are overheating, which as a result of the use of different metals is causing the pivot point on the fuse holder to seize and this is preventing the fuse holder from operating as designed. The situation is being monitored and, if warranted, a replacement programme will be put in place.

The coastal environment around Wellington causes accelerated corrosion on galvanised overhead equipment components and where possible, stainless steel fittings are preferred as they have proven to provide a longer component service life.

6.3.10. Auto Reclosers and Sectionalisers

Activity	Comments	Standard	Freq.
Visual Inspection and Thermal Image	Visual assessment of isolators, connections and mountings. Thermal image. As per standard	EMS-D.03	1 yearly
Recloser & Sectionaliser Service	General check of unit and supports, contacts and mechanisms correctly operating, inspection and maintenance of tank and contacts, replace oil on oil reclosers.	EMS-D.03	4 yearly
Inspection and Testing of Earthing	Inspect and test earthing as per standard	EMS-D.05	5 yearly

Figure 6-13 Inspection and Routine Maintenance Schedule for Auto Reclosers and Sectionalisers

6.3.10.1. Renewal and Refurbishment

Presently there are no programmes underway to replace auto reclosers as there are no major issues with the majority of the assets. Previous network owners have undertaken reliability and automation projects in recent years, and as a result there are appropriately placed reclosers and remote switches in service.

The Reyrolle OYT auto recloser at Takapu Road has malfunctioned and is scheduled to be replaced with an ex-stock McGraw Edison KFE recloser during 2010. Other Reyrolle OYT reclosers will be inspected and tested on their normal cycle with replacement occurring if the unit does not operate satisfactorily.

6.3.11. Voltage Regulators

Activity	Comments	Standard	Freq.
Visual Inspection and Thermal Image	Inspect enclosure & check access, gates/doors/locks, paintwork. Remove rubbish, cobwebs and vegetation. Inspect signs and sub no. and replace where necessary. Check silica gel and oil levels.	none	1 yearly

Activity	Comments	Standard	Freq.
	Record tap changer operations. Thermographic survey		
Inspection and Testing of Earthing	Inspect and test earthing as per standard	EMS-D.05	5 yearly

Figure 6-14 Inspection and Routine Maintenance Schedule for Voltage Regulators

6.3.11.1. Renewal and Refurbishment

Wellington Electricity has only one 11kV voltage regulator, and one 400V regulator. There are no plans to renew these in the short term. Replacement will be driven by unsatisfactory performance in service, or if inspection and maintenance programmes identify major issues.

6.3.12. HV Distribution Substations and Equipment

Activity	Comments	Standard	Freq.
Inspection of Ground Mounted Distribution Substations (Kiosk & Cage Types)	Inspect enclosure & check access, gates/doors/locks, paintwork. Remove rubbish, cobwebs and vegetation. Inspect signs, light bulbs, trenchcovers and sub no. and replace where necessary. As per standard	SMS-D.04	2 yearly
Inspection of Ground Mounted Distribution Substations (Berm Sub Type)	Inspect switchgear stand, paintwork, terminal covers, labels, tank (for rust) and terminations. Per substation/switchgear site.	EMS-D.01	2 yearly
Grounds maintenance	Mow lawns, trim edges, unblock drains, trim trees, remove rubbish, weed control, maintain gardens for Ground Mount Substations	None	Seasonal
Inspection and Testing of earthing	Inspect and test earthing as per standard. Per substation site.	EMS-D.05	5 yearly
Switch or RMU switch-unit maintenance	Major maintenance including testing, cleaning, changing of oil and checking for satisfactory mechanical condition.	EMS-D.01	8 yearly
Thermal inspection and PD detection	Thermal camera inspection, and handheld PD (TEV) testing.	SMS-001	4 yearly

Activity	Comments	Standard	Freq.
Inspection and monitoring of battery condition.	Where installed, tested in accordance with battery maintenance standards	EMS-D.05	1 yearly
11 kV CB maintenance	Where installed, tested in accordance with circuit breaker maintenance standards	SMS-001	8 yearly
Protection relay testing for (electromechanical relays)	Testing as per draft Standard	draft SMP-012	4 yearly

Figure 6-15 Inspection and Routine Maintenance Schedule for HV Distribution Substations and Equipment

Activity	Comments	Standard	Freq.
Visual Inspection and Thermal Image	General visual inspection to identify leaks, structural damage and corrosion. Thermal image	SMS-D.04	5 yearly
Inspection and Testing of Earthing	Inspect and test earthing as per standard	EMS-D.05	5 yearly

Figure 6-16 Inspection and Routine Maintenance Schedule for Pole Mounted Transformer

6.3.12.1. Renewal and Refurbishment

HV Distribution Switch Gear (Ground Mounted)

Note – This section excludes circuit breakers which are discussed in a previous section.

Any minor defects or maintenance issues are addressed on-site during inspections. This may include such maintenance as topping up oil reservoirs, replacing bolts, rust treatment and paint repairs. Major issues that cannot be addressed on site usually result in replacement of the device. Likewise, replacement of the device is carried out if it is unsafe or if it is uneconomic or impractical to undertake a repair on site. Wellington Electricity has an ongoing refurbishment and replacement programme for all ground mounted distribution switchgear. Provision is included in the asset replacement forecast to fund this programme. The drivers for replacement of ground mounted switchgear include:

- The assessed condition of the equipment
- The availability of spare parts
- The switchgear insulating medium

The continued use of oil insulated switchgear has been reviewed and the decision made to make use of other types such as vacuum or gas (SF_6) insulated types in future. When any switchgear device fails, the reason for the failure is studied and followed up with a cost benefit analysis to determine the best option from repairing, refurbishing, replacing or decommissioning the device and others of the same type. There are several types of ring main switch that have identified issues around age, condition and known operational or historic issues. These include early Reyrolle oil switches (LDI, JKSS, IA18), AEI, Statter, Long and Crawford, and early Andelect switches. These will be replaced based on the risks associated with each type, and summarised later in the document (these programmes are in addition to the annual budget for switch replacement).

LV Distribution Switch Gear (Substation)

LV distribution switchgear and fusing is maintained as part of routine substation maintenance and any issues arising are dealt to at that time. The Wellington City area has a large number of open LV distribution boards in substations, and a safety programme has been undertaken to cover these with clear Perspex covers, as additional sites are identified they are completed.

The overall performance of LV distribution switchgear and fusing is good, and there are no programmes underway to replace this equipment. All new installations use DIN-style fuse disconnectors, which are reliable and low maintenance.

Switchboard in The Terrace Substation

Distribution Transformers

If a distribution transformer is found to be in an unsatisfactory condition during its regular inspection it is programmed for corrective maintenance or replacement. An in-service transformer failure is rare and if it should occur it is investigated to determine the cause. Based on this assessment a decision is made to repair, refurbish, or scrap the unit. Typical condition issues include rust, heavy oil leaks, integrity and security of the unit. Some minor issues such as paint, spot rust and small leaks can be repaired and the unit will be returned to service on the network. The refurbishment and replacement of transformers is an ongoing programme, which is provided for in the asset maintenance and replacement budget, however it is undertaken on a needs basis (condition, loading, etc) arising from inspection rather than by age.

In addition to the transformer unit itself, the substation structures and associated fittings are inspected and replaced as need be. Examples include distribution earthing, substation canopies and kiosk buildings. In time, some renewal may be costly and time consuming as a large number of berm substations in the Hutt Valley area are an integral substation manufactured during the 1970s and 80s by the likes of Tolley. Replacement of these units will require complete foundation replacement and extensive cable works.

Wellington Electricity is also reviewing the construction standards for overhead transformers. Under previous owners, transformers up to 300kVA were mounted on overhead structures. A number of ELBs have made a move away from mounting transformers above 150kVA due to seismic and safety concerns, the present standards may change following review.

Distribution Cables

Maintenance of the underground distribution cable network is limited to visual inspections and thermal imaging of cable terminations. Cables are operated to failure and then either repaired or sections replaced. A more intensive maintenance regime is not considered cost effective, given that the network is generally designed so that supply can be maintained while cable repairs are undertaken.

A known issue on the 11kV network is a type of joint kit installed on early XLPE cables between 1980 and 1983 that did not adequately seal between XLPE and PILC cables on the outer sheath, these have been mostly remedied, however some may still exist. No active programme is in place to test or repair these joints, however it is noted and in time if performance deteriorates then a programme may be initiated. Cable replacements are prioritised based on a combination of fault history and frequency together with tests undertaken after earlier cable fault repairs. Cable replacements will be targeted at cables exhibiting high fault rates, or showing poor test results following a repair. The small number of natural polyurethane insulated cables is most likely to show high failure rates and hence this type of cable is more likely to be replaced following a cable fault. An allowance is made each year in the CAPEX programme to replace cable based upon historic trends and known defects.

Cable Terminations

Cable termination replacement is driven by visual inspection, either showing signs of discharge, or significant compound leaks, as well as analysis of fault rates. The exception to this is 11 kV cast metal pothead terminations, where analysis of fault rates together with a risk assessment has resulted in a decision to replace them with heat shrink terminations.

6.3.12.2. Distribution Switchgear Condition

Distribution Switch Gear - Magnefix

Magnefix switchgear is cleaned eight-yearly, with targeted cleaning for a number of sites undertaken more frequently. Magnefix switchgear is generally reliable, however there are specific cleaning requirements to avoid tracking problems associated with the resin body casing due to the accumulation of dust and other deposits.

6.3.13. LV Pits and Pillars

Activity	Comments	Standard	Freq.
Inspection of Service Pillars	Visually identify hazards and defects. Check connections for heat, corrosion.	ENS - 0064	6 yearly
Inspection of Link Pillars (incl Thermal Image of disconnecting pillars) - extra line item	Visually identify hazards and defects. Check connections for heat, corrosion.	ENS - 0064	6 yearly
Inspection of Service Pits	Visually identify hazards and defects. Check connections for heat, corrosion.	ENS - 0064	6 yearly
U/G link box inspection including Thermal Image	Visually identify hazards and defects. Check connections for heat, corrosion and misaligned spills	ENS - 0064	4 yearly

Figure 6-17 Inspection and Routine Maintenance Schedule for LV Pits and Pillars

The pillar inspection includes a loop impedance test to check the condition of the connections from the fuses to the source. Where practical, damaged pillars are repaired but otherwise a new pillar or a pit is installed.

6.3.13.1. Renewal and Refurbishment

Pillars are generally replaced following faults or reports of damage. Pillars with a high likelihood of future repeat damage by vehicles are replaced with pits. When large groups of older pillars, such as concrete or 'mushroom' type are located and their overall condition is poor, they are replaced as repair is impractical or uneconomic.

There are a number of different variants of service connection 'pillars' on the network that are being replaced in small batches, notably under-veranda service connection boxes in older commercial areas, as well as ongoing replacement of LV link boxes around Wellington City. The link boxes are either being jointed though, or they have been replaced entirely to provide the same functionality. These replacements were driven from an incident where a link box failed catastrophically, as well as the general poor condition of some of these link boxes which are now over 50 years old.

A small allowance is made each year in the CAPEX programme to replace service pillars with pits in areas subject to vehicle damage. This budget is based upon historic trends, but rarely exceeds 60 units per year.

6.3.14. SCADA

The SCADA system is generally self monitoring and as such is there is no preventative maintenance carried out on it. Master station maintenance is broken up into two categories (a) hardware (b) software.

(a) Hardware support for both Haywards and Central Park (disaster recovery site) will be provided as required by Wellington based maintenance contractors

(b) Software maintenance and support is to be provided by CHED services, part of Powercor, out of Melbourne via the TCP/IP linking between their control centres and Wellington Electricity's.

Existing RTUs do not have full back up and maintenance is based on failure. First line maintenance on the system is carried out as required by the maintenance contractor, within the scope of its substation maintenance contracts. The substation level IP network is monitored and supported from within New Zealand by the respective service providers of the IP network infrastructure.

6.3.14.1. Condition Assessment of SCADA System Components

C225 RTU

There are 26 of this type of RTU in service on the network. Power supply failure is the most common failure mode with around one failure a year. Spares are held at a central location and repairs are carried out when possible. These are being replaced in conjunction with substation switchgear replacements, and the redundant units held as spares.

C5 RTU

These RTUs are placed in very small distribution substations and there are seven in service. These RTU's are difficult to repair so as they fail they are interchanged with current technology alternatives.

Load Control PLC

There are 23 of this type of PLC in service on the network. Installed in 1996, these Toshiba PLC's are used to drive load control equipment. This type of PLC is an obsolete item, however one spare is held for cases of failure. These will be addressed as part of any Load Control upgrade and are unlikely to be replaced outside of any other replacement programme.

DataTerm RTU

There are 9 of these in service on the network. These RTU's have an inherent design flaw in the analogue card which, over time, causes the analogues to "jump". This is repairable with the replacement of reed relays on the analogue card with an approximate cost of $500 per card and there are normally 4 cards per RTU. The cards fail at a rate of about five per year. These units are being replaced with Foxboro SCD5200 RTUs as zone substations are upgraded and moved onto the IP network.

MiniTerm RTU

There are 72 of these in service on the network. These units fail at the rate of approximately two a year due to board level IC failure with replacement ICs gradually becoming harder to source. These RTU's cannot be directly replaced by current technology; however spare units are becoming available as a result of the switchgear replacement works. There is no active programme for replacing these however these are being replaced in conjunction with substation switchgear replacements, or where a risk or shortfall is identified with having this type of RTU installed.

Common Alarms

There are 50 of these in service on the network. These are a custom built device, placed in minor "ringed" distribution substations to give an indication back to control room of a tripping event. They are prone to failure and there are no spares. On failure, the units are being replaced by current technology.

Siemens Power Automation System (PAS)

There is one PAS unit that acts as a protocol converter between IEC61850 field devices at three sites and that of the DNP3 SCADA master station and is seen as a single point of failure as multiple sites are reporting to one point, the PAS.

6.3.14.2. Asset Renewal and Refurbishment

The asset replacement budget also provides for the ongoing replacement of obsolete RTUs throughout the network. Obsolete RTUs that may present a significant impact on network reliability are being targeted first with special attention being paid to the zone and major switching substations.

Where there is an RTU which exists at a zone substation or major switching points in the network that is adjacent to the existing TCP/IP network, consideration is given to upgrade equipment to allow TCP/IP connection in order to continuously improve communication system reliability.

Further, the TCP/IP infrastructure will also allow other substation based equipment, such as security alarms etc., to efficiently communicate with distant receive devices.

Master Station

As detailed earlier in this document, the SCADA master station is presently being replaced with a GE Enmac system. This new unit will last at least 15 years, so no major expenditure is foreseen during this planning period.

Siemens Power Automation System (PAS)

There is one PAS unit that acts as a protocol converter between IEC61850 field devices and that of the DNP3 SCADA master station. Substation base equipment will be installed in the medium term, which consist of SCD5200 RTU’s than can convert the substation 61850 protocol directly to DNP3.

Remote Terminal Units - Zone Substation and GXP RTUs

It is proposed to replace 7 Foxboro C25 and C225 RTUs at GXPs between 2011 and 2012. This coincides with Transpower’s move to TCP/IP networks and the resulting loss of the serial link presently used by Wellington Electricity from GXPs back to Haywards. These sites are Gracefield, Haywards, Wilton, Takapu Rd, Upper Hutt, Kaiwharawhara and Pauatahanui. Exact timing of the sites is still to be determined, following discussion with Transpower and to co-ordinate with their IP network roll-out. These units were installed in 1987 and will be 25 years old by the time the last is removed.

The substation RTU replacement will start with the 6 sites in the Wellington City area that have Plessey Dataterms installed. Three of these sites, Evans Bay, Karori and Palm Grove have Reyrolle C gear switchboards that are targeted for replacement between 2010 and 2013. At these sites the RTU upgrades will occur at that time. The remaining three sites (Frederick St, Hataitai and Ira St) are targeted for replacement during 2012 and 2013.

There is no medium-long term programme to replace RTUs at distribution substations, as these sites generally have a lower risk profile than GXPs and Zone Substations. However where a risk or need is identified, the RTU upgrade will be scheduled. In 2010 two sites, one a key CBD site, and the second, with Distributed Generation connection will have RTU replacement and migration to the IP network. Additionally, sites that have switchgear upgrades may have an RTU upgrade; however these are incorporated as part of the specific project.

From 2013 onwards, Wellington Electricity will commence the replacement of the remaining C225 RTUs installed at 19 Zone Substations with an aim to complete all replacements by 2018.

The medium term replacement plan is shown below:

Site	Site Type	Present RTU	Proposed RTU	Replacement Year
Evans Bay	Zone Substation	Dataterm	SCD5200	2010
25 Mein St	Distribution Sub	Miniterm	SCD5200	2010
176 Wakefield St	Distribution Sub	Dataterm	SCD5200	2010
Gracefield	GXP	C225	SCD5200	2011-2012
Haywards	GXP	C225	SCD5200	2011-2012
Wilton	GXP	C25	SCD5200	2011-2012
Takapu Rd	GXP	C225	SCD5200	2011-2012
Upper Hutt	GXP	C225	SCD5200	2011-2012
Kaiwharawhara	GXP	C225	SCD5200	2011-2012
Pauatahanui	GXP	C225	SCD5200	2011-2012
Karori	Zone Substation	Dataterm	SCD5200	2012
Frederick St	Zone Substation	Dataterm	SCD5200	2012
Ira St	Zone Substation	Dataterm	SCD5200	2013
Hataitai	Zone Substation	Dataterm	SCD5200	2013
Palm Grove	Zone Substation	Dataterm	SCD5200	2013

Figure 6-18 Proposed RTU Replacement Programme

6.4. Feeder Performance

In addition to the management of assets at the component level, Wellington Electricity also monitors the performance of asset groups at the feeder level. This provides a useful input to the asset maintenance process as it identifies feeders that are experiencing the most unplanned outages and hence may require remedial action to be undertaken in order to maintain network reliability. The number of unplanned outages that each feeder experiences each year, for the past year, are compared to each other and ranked. The worst performing feeders in the Wellington Electricity network over the last 10 years are shown in the graph below.

Performance will also be compared with the security of supply standard to check that expected outage times are being met. In some cases, the terrain, exposure to elements or vegetation may conspire to result in multiple faults. Review of network configuration to reduce impact is considered as part of post-fault reviews.

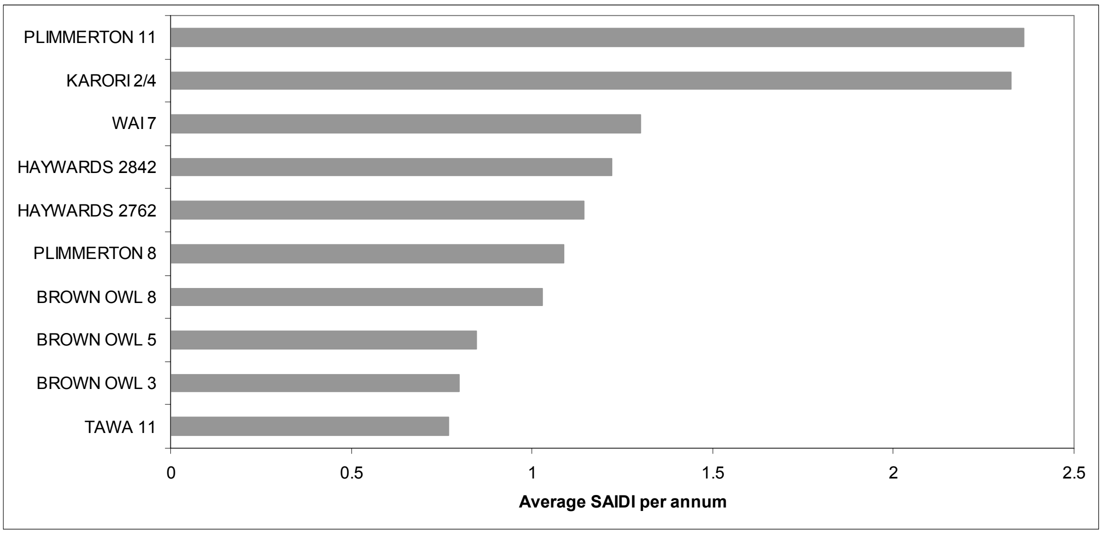

Figure 6-19 Worst Performing Feeders

The average SAIDI per annum for all feeders over the same period is 0.17.

Historical faults on these feeders will be scrutinised in order to determine if there is a common root cause that may be addressed. The remedial action identified as part of this review is fed back into to the maintenance process where the resulting projects are carried out either under corrective maintenance, or as a major project, depending on the scope of the work required.

6.5. Asset Renewal and Refurbishment Programme

6.5.1. Asset Replacement Projects for Current Year

The major asset replacement projects (greater than $100,000) that Wellington Electricity is planning to complete in the 2010 period, as detailed in section 6, are summarised below:

33kV Cable Replacement	
Asset Integrity	The condition and loading assessment of all of the 33kV cables is presently under review. This is likely to result in the identification of certain cables that need to be replaced or have their capacity augmented. Candidates include the gas filled cables that feed Evans Bay, Palm Grove, or Moore Street.
$5m - $6m	

Pole Replacement Programme	
Asset Integrity and Safety	Replacement of red and yellow tagged poles will continue in 2010, these are managed as packages of work following inspection. This work includes replacement of associated pole hardware.
$3.2 Million	

Reyrolle LDI Replacement	
Asset Integrity and Safety	There are 16 remaining units of Reyrolle LDI switchgear on the network, with most past their effective service life. There are minor issues around leaking compound and mechanical/physical conditions, however the biggest issue is an operational restriction on the units as they are non spring assisted closing and also it is a direct acting mechanism. This presents a huge risk to the switching operator as a successful operation is dependant upon the speed and accuracy of the switching operation. These are the highest risk switches on the network at this time, because of the safety consequences.
$980,000	

Reyrolle Type-C Replacement	
Asset Integrity	This includes for the replacement of Reyrolle C-type 11kV switchgear as described in section 6, at the following distribution substations: Lombard St, Taurima St, 174 Victoria St, Upland Road Rd, 4 Kaiwharawhara Rd This includes replacement of transformers at several of the sites.
$2.43 Million	

Evans Bay Switchboard Replacement	
Asset Integrity	The Evans Bay switchboard is the oldest zone substation switchboard on the network. As detailed in section 6, it is planned to replace this with new switchgear during 2010.
$1.2 Million	

Mana-Plimmerton Voltage Regulating Relay Replacement	
Asset Integrity	A specific issue exists at Plimmerton and Mana substations where the voltage regulating relays/tap changer controls are PLC based. The technology used is a 1980s PLC that has no support, and if it failed, would be impossible to reinstate. It is proposed to replace this PLC scheme with new Reg-DA controllers as these can work in remote master follower mode without using a pilot/comms link. These sites are run with a closed bus (comprising a cable tie) over some distance and as such the transformers need to be in step.
$175,000	

Substation RTU Replacement	
Asset Integrity	Replacement of 25 Mein St and 176 Wakefield St RTUs with SCD5200 RTUs and upgrade to TCP/IP communications.
$160,000	

In addition to the specific projects above, Wellington Electricity also makes provision for programmes of replacements that arise from condition assessment programmes during the year, a list of programmes with a forecast cost greater than $100,000 are listed below:

Driver	Programme	Forecast Cost
Safety	LV Pillar and Pit Replacement	$425,000
Asset Integrity	Cable Replacement	$400,000
Safety	Earthing Upgrades and Compliance	$350,000
Asset Integrity	Transformer Replacement	$180,000
Asset Integrity	Crossarm Replacement	$180,000
Asset Integrity	Switchgear Replacement	$150,000
Safety	Cast Metal Cable Pothead Replacement	$150,000

Figure 6-20 Asset Replacement Programme

6.5.2. Prospective Asset Replacement Projects for 2011 – 2014

33kV Cable Replacement	
Asset Integrity $5 - $10 Million	The condition and loading assessment of all of the 33kV cables is presently under review. This is likely to result in the identification of certain cables that need to be replaced or have their capacity augmented. Candidates include the gas filled cables that feed Evans Bay, Palm Grove, or Moore Street.

Pole Replacement Programme	
Asset Integrity and Safety $8 - $10 Million	Replacement of red and yellow tagged poles will continue, these are managed as packages of work following inspection. This work includes replacement of associated pole hardware.

Reyrolle Type-C Replacement	
Asset Integrity $8 - $10 Million	This includes for the ongoing programmed replacement of Reyrolle C-type 11kV switchgear as described in section 6. This will target the remaining 120 circuit breakers on the network.

SCADA RTU Replacement	
Asset Integrity $1 Million	Replacement of Zone substation, distribution substation and GXP RTUs, development of TCP/IP network.

Yorkshire SO-HI Replacement	
Asset Integrity $3 - $5 Million	This proposed programme will replace SO-HI switchgear in high profile locations. In some cases replacement will a simplified solution using ring main switches, and others will be like-for-like replacement.

Zone Substation Transformer Replacement	
Asset Integrity $2 Million	This includes for the replacement of two zone substation transformers as discussed in section 6.3.3.

Cast Metal Cable Pot Head Replacement	
Safety	Following an explosion of an old style cast iron cable pothead from water ingress, the previous network owner embarked upon a project to replace all cast iron, and aluminium pot heads across the network where public risk was high. In the short term the majority of high risk sites will be completed, however the programme is likely to need to be continued for a few years to eliminate them from the system.
$150,000 p.a.	

LVPpit and Pillar Replacement	
Safety	This includes for the ongoing programmed replacement of LV pits and pillars. Sites to be confirmed.
$150,000 p.a.	

6.5.3. Prospective Asset Replacement Projects for 2015 – 2020

Petone 33kV Cable Replacement	
Driver: Renewal	The Petone gas cables are of an lead sheath design which is susceptible to leaks and over recent times there has been a number of major leaks, this cable crosses a mixed route, including a number of structures which make access to the cable very difficult. Replacement may not be the only option, as the substation is lightly loaded and there is spare capacity at the adjacent Korokoro and Seaview substations, it may be possible to convert the substation to an 11kV switching station and make the 33kV cables redundant.

LV Pit and Pillar Replacement	
Driver: Safety	This includes for the ongoing programmed replacement of LV pits and pillars. Sites to be confirmed.

Cast Iron Cable Pot Head Replacement	
Driver: Safety	This includes for the ongoing programmed replacement of cast iron cable pot heads. Sites to be confirmed.

6.6. Asset Renewal and Replacement Expenditure

For clarity, the forecast provided below does not include the cost of operating the network from the upgraded control centre at Haywards and does not include other non-maintenance related operational expenditure. Asset replacement and refurbishment costs are shown below. It can be seen that the line item on which Wellington Electricity proposes to invest the most capital expenditure is asset replacement and renewals. This reflects the increasing age of the asset base.

Category	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Asset Replacement and Renewal	$12,951	$12,644	$11,943	$15,195	$17,587	$13,113	$12,836	$18,523	$16,067	$17,629
Reliability, Safety and Environment	$452	$606	$469	$468	$463	$621	$604	$492	$533	$389
Subtotal - Capital Expenditure on Asset Replacement and Safety	**$13,403**	**$13,250**	**$12,412**	**$15,663**	**$18,050**	**$13,734**	**$13,440**	**$19,015**	**$16,600**	**$18,018**
Routine and Preventative Maintenance	$5,499	$5,485	$5,535	$5,599	$5,603	$5,656	$5,709	$5,762	$5,816	$5,871
Refurbishment and Renewal Maintenance	$614	$614	$614	$614	$614	$614	$614	$614	$614	$614
Fault and Emergency Maintenance	$4,584	$4,630	$4,673	$ 4,726	$4,771	$4,815	$4,860	$4,906	$4,951	$4,996
Subtotal - Operational Expenditure on Asset Management	**$10,697**	**$10,729**	**$10,822**	**$10,939**	**$10,988**	**$11,085**	**$11,183**	**$11,282**	**$11,381**	**$11,481**

Figure 6-21 Lifecycle Asset Management Expenditure Forecast – 2010 to 2020 ($000 real as at 31-03-09)

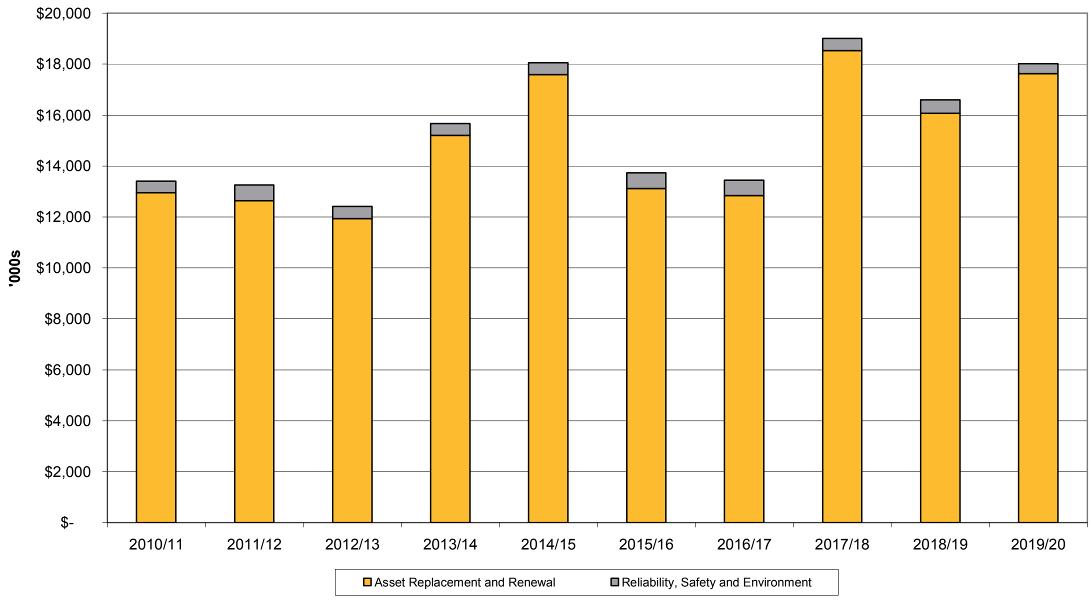

Figure 6-22 Lifecycle Asset Management Capital Expenditure Forecast – 2010 to 2020

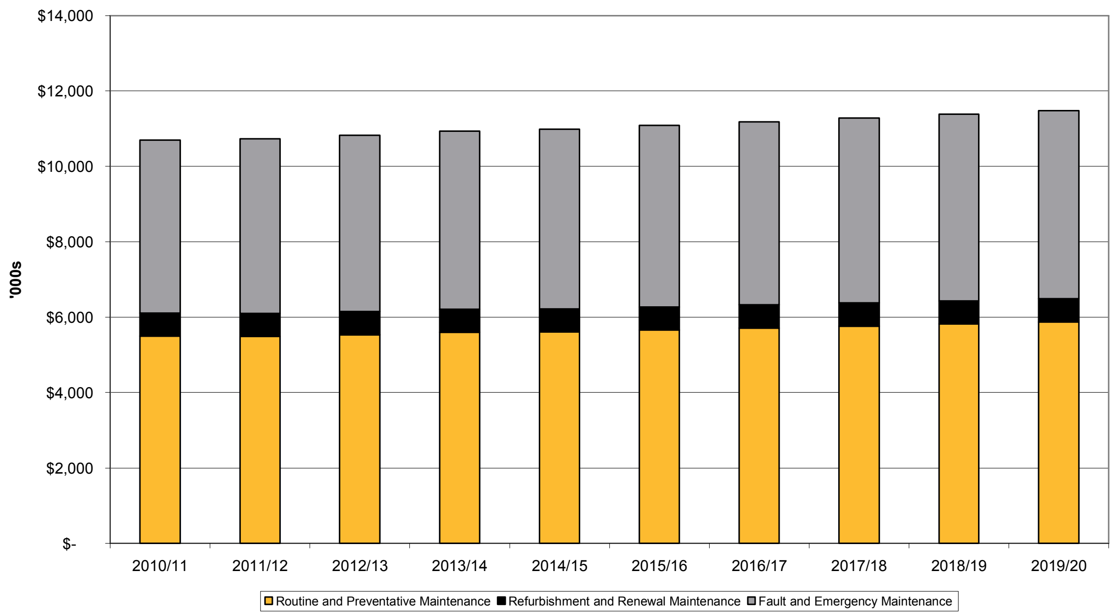

Figure 6-23 Lifecycle Asset Management Operational Expenditure Forecast – 2010 to 2020

7. Risk Management

7.1. Introduction

Risk management is an integral part of the asset management process. The consequences and likelihood of failure or non-performance of controls to manage this, and required actions to make risks acceptable all need to be understood, reviewed and evaluated as part of the asset management function.

Risks associated with network assets are evaluated, prioritised and dealt with as part of the network development and asset maintenance, refurbishment and replacement programmes. They are also taken into account in developing standard work practices. The acceptable level of risk will differ depending upon the level of risk that all key stakeholders are willing to accept and the circumstances and environment in which the risk will occur.

Risks associated with system assets are managed through a combination of:

- Reducing the probability of asset failure, through the capital and maintenance work programme and enhanced working practices
- Reducing the impact of failure, through contingency and emergency plan development and insurance, and through the development of an efficient fault response capability

High probability, low impact risks are managed through a combination of Wellington Electricity's network planning and design, asset maintenance and fault response strategies. Sections 5 and 6 of this AMP describe the network planning and asset maintenance strategies in some detail. In addition, Wellington Electricity's design standards, which are not described in detail in this AMP, are aligned with industry best practice and aim to take due account of the weather and environment conditions in the Wellington area, including the high earthquake risk. Further, Wellington Electricity has procedures in place to restore power in a timely manner should an asset failure cause a supply interruption.

While it is impractical and uneconomic to design an electricity network that is immune to all risks, low probability high impact events can occur that are either outside the network design envelope or require a response that is beyond the normal capacity of Wellington Electricity, or its contractors. For such events Emergency Response Plans (ERP) have been put in place as detailed later in this section.

7.2. Risk Framework

Wellington Electricity adopts the New Zealand Risk Management Standard AS/NZS 4360:2004 to provide a structured and robust methodology in managing risk. The risk framework provides a process for:

- Identification of the risk event, assessment of the potential causes and possible consequences of the event and quantification of the likelihood and consequence ratings to determine the inherent and residual risk ratings for the event

- Identification of risk controls and assessment of the effectiveness and reliance of these controls to reduce or mitigate the risk – this generates the residual risk rating

- Development of risk treatment plans to address unacceptable residual risk (high and extreme risks) or allow the business to accept a high risk activity

- Creation of a risk register to capture the above information

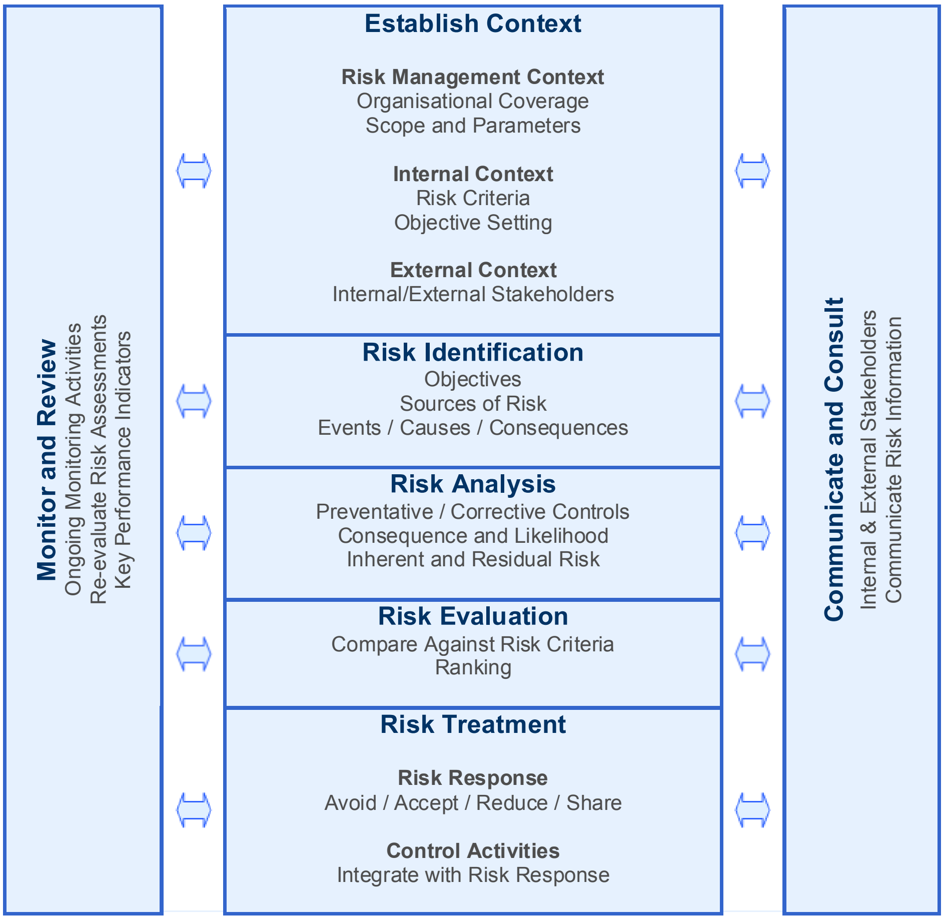

Figure 7-1 Risk Assessment Process

The intention of the risk treatment plans is to improve the control environment to reduce the residual risk as far as practicable. As the risk management process evolves Wellington Electricity shall develop appropriate risk treatment plans, these plans shall be assigned to a business risk owner and monitored to ensure that the business is taking proactive steps to mitigate risk. These plans shall include a basic cost analysis to assess the practicability of the improvement options for existing controls and/or additional control initiatives to further reduce the risk to an acceptable level.

7.3. Risk Rating

The magnitude of the consequences of an event, should it occur, need to be chosen based on the ***most likely or most realistic*** impact to the whole business and its stakeholders. The following risk profiling matrix is used to determine the level of the risk or risk rating based on a function of consequence and likelihood.

LIKELIHOOD	CONSEQUENCE				
	Minimal	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Low	Medium	High	High
Unlikely	Negligible	Low	Low	Medium	High
Rare	Negligible	Negligible	Low	Medium	High

Figure 7-2 Levels of Risk Rating

Wellington Electricity uses the following consequence and likelihood criteria (in no order of priority) with consideration of the business' long-term objectives and criteria for measuring success:

- Financial (cash loss & earnings)
- Health & Safety (employees, public & contractors)
- Environment (land, vegetation, waterways & atmosphere)
- Reputation (media coverage & stakeholders)
- Compliance (legislation, regulation & industry codes)
- Customer Service/Reliability (quality & satisfaction)
- Employee Satisfaction (engagement, motivation & morale)

The criterion is combined with a consequence scale, determining the level of consequence to the business of a particular risk ranging from minimal to catastrophic.

7.4. Risk Method Application

Controls are introduced to reduce/mitigate the likelihood or consequence of the risk with varying levels of effectiveness and reliance on the particular control. This helps reduce the inherent risk to a more acceptable residual risk to the business.

Risk Score	*Inherent 9500 / Extreme*	*Residual 400 / High*
Likelihood	95	25
	Almost Certain	Likely
Consequence	100	16
Compliance	Major	Minor
Customer Service / Reliability	Major	Minor
Employee Satisfaction	Major	Minor
Environment	Moderate	Minimal
Financial	$1m to $5m	$100k to $500k
Health & Safety	Major	Moderate
Reputation	Major	Minor

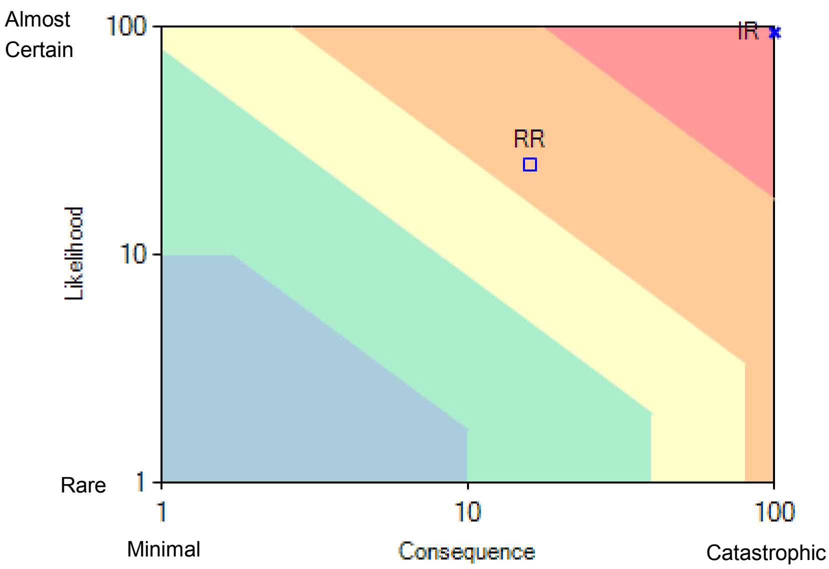

Figure 7-3 Example of Risk Methodology Application

7.5. Network Risks

There are a number of areas within a network business where certain types of assets can exhibit performance which is sub-optimal, or they may deteriorate to an in-service failure point ahead of their expected life. Provided these issues are understood and monitored, the risk of in-service failure can be managed to a point where it is tolerable and controls can be put in place to reduce their impact should they occur.

Areas where monitoring programs or additional controls have been implemented around certain specific assets are discussed within this section of the AMP.

7.5.1. Zone Substation Battery Supplies

Battery supplies are of critical importance for the correct operation of substation and field devices. Battery banks are therefore important assets to regularly monitor and service to ensure the batteries remain in good serviceable condition.

Programmed maintenance and inspection to ensure healthy battery condition is in place with programmed replacement of DC battery banks after five years of age. Refer to section 6 of the AMP.

7.5.2. Zone Substation Supply Security

The network is configured to maintain a level of redundancy at Zone Substation supply points so that continuity of supply can be maintained should a single element become unavailable for service. At peak demand times there can be insufficient capacity headroom to maintain the security level at some sites without the use of load control or reconfiguring the network connectivity to shift load to adjacent supply points.

These operational solutions are more efficient than investment in additional capacity however they need to be well planned and carefully thought through. Further monitoring and network reconfiguration plans to allow for load shifting during contingencies will be worked through for a number of substations during the planning period. Should load shifting not provide satisfactory security, then additional connectivity or capacity investment would be considered. Refer to section 5 of the AMP for details of further options and potential programmes of work.

7.5.3. HV Gas Filled Cables

The pressurised gas filled sub-transmission cables system is generally operating reliably. The cables are mature and supported with gas replenishment which is remotely monitored. There are a small number of cables consuming larger volumes of gas. These will be inspected to identify and repair leaks and their condition will be assessed to determine if there are other remedial requirements. A major leak on a gas cable that necessitates removal from service for repair can take a number of weeks before the cable can be returned to service. Refer to sections 5 and 6 of the AMP for management of these assets.

7.5.4. HV Oil Filled Cables

There are a number of pressurised oil filled cables in service on the network which are monitored. The risk of oil being lost from a cable is being reviewed with a proposed move to replacement with biodegradable oil. Refer to section 5 and 6 of the AMP.

7.5.5. Cast Iron HV Cable Terminations

A program is in place which systematically renews the older technology with modern materials to manage the known service problems from the cast iron cable termination design.

7.5.6. High Voltage Switchgear

There are a number of high voltage switchboards within the network which are being programmed for end-of-life replacement. The circuit breakers will be monitored by routine inspection and any operational controls put in place to manage the equipment effectively prior to replacement. The replacement programme has prioritised the switchgear based on condition and operational capability.

7.5.7. Ripple Injection Plant

Wellington Electricity operates a ripple system to control network loads (via operating hot water storage outside peak demand periods) and to initiate functions such as public lighting. The consequences of the load control system being unavailable are being reviewed and a set of controls for this risk is being developed. Mitigation measures include maintaining a stock of critical spares and investigating the commercial justification for investment in additional plant or alternative means of providing similar control.

7.5.8. Earthing and Neutral Connection Integrity

Earthing and neutral connections perform important electrical functions for service quality and safety. The network earthing system is regularly inspected and tested however the neutral integrity is difficult to assess and problems are addressed on discovery. A review of neutral connector performance will be undertaken should the frequency of neutral integrity problems increase above the present low incident levels.

7.5.9. Utilities Sharing Wellington Electricity Poles

The Governments Broadband Fibre roll out will require evaluation of the risks introduced from attaching additional services to power poles and the affect this will have on foundation strength, wind loading, structure integrity as well as operational considerations. A review of the consequences of supporting additional assets will be evaluated and the liabilities introduced allocated through contract to the parties introducing the additional services.

7.6. Risk Based Approach to Asset Management

The AMP assists the decision making process for phasing out an asset through a planned replacement programme, or continue in service supported with additional inspection and preventative maintenance activity. In addition to this, the prioritisation of capital works (refer to section 5) is based on an assessment of the risk that each potential project carries.

7.7. Risk Identification

All staff members are encouraged to identify hazards and raise these to the appropriate Supervisor or Manager. Risks are identified as part of the incident management process. New risks are added to the incident management register for evaluation, recommendation, action and close out. All risks that follow the incident management process will undergo root cause analysis to identify the underlying problem and appropriate mitigation action.

Business risk is managed through regular risk profiling workshops with the objective to identify and assess the risks which may impact on the business achieving it's strategic objectives. Some risks which cannot be eliminated are assigned controls to minimise or mitigate the impact to the business should the risk occur.

Wellington Electricity will further develop the incident management process over the next 12 months.

7.8. Risk Accountability and Authority

Wellington Electricity's Board of Directors oversees the risk management reporting from the CEO as a part of its corporate governance responsibilities via the Audit and Risk Committee as part of regular management reporting functions.

Wellington Electricity's Senior Management Team monitors the effectiveness of the risk controls by providing a report for the CEO to present to the Directors.

In developing and implementing its risk management strategy the CEO meets with senior management regularly to review business risks and controls. Strategic and operational risk categories are reviewed. High level risks are reported in a risk register while more detailed operational risks are captured in risk control procedures.

In developing the risk management strategy and process, the senior management team is supported by other CKI group companies. The aim is to migrate the risk management strategy of these utilities into Wellington Electricity's operation so that there will be a common risk management strategy and process across all businesses.

7.9. Emergency Response Plans

Wellington Electricity has a number of Emergency Response Plans (ERP's) to cover emergency situations. All of the ERP's require annual simulation exercises to test the plans and procedures and feedback any areas for improvement. All of the ERP's shall be continuously reviewed and revised to best meet the emergency management and response requirements of Wellington Electricity.

Examples of the plans are:

7.9.1. Major Incident Plan

The purpose of the Major Incident Plan (MIP) is to ensure that Wellington Electricity is prepared for, and responds quickly to, any major incident that occurs or may occur on its network. The plan defines a major incident and describes the actions required and the roles and responsibilities of staff during a major incident.

A particular focus of the MIP is how the internal and external communications is managed. The plan contains detailed contact lists of all key stakeholders who may contribute or be affected by the major incident.

7.9.2. Storm Response Plan

The purpose of this plan is to ensure that Wellington Electricity is prepared for and responds to any storm or potential storm that may impact on the network. The plan describes actions required and responsibilities of staff during a storm emergency and focuses on continuously improving systems and communications (internal and external) to benefit customers and retailers.

The regional weather patterns are monitored by the Wellington Electricity Network Control Room (NCR) on a daily basis using Metservice real-time information. The Storm Response Plan is invoked by the NCR if a storm warning or severe weather warning is declared by the Metservice for the Wellington region.

The Storm Response Plan has four stages of action; Storm Warning, Storm Standby, Storm Response and Storm Stand Down – each having varying levels of response and preparedness. The Storm Response Plan can escalate to the MIP if required.

7.9.3. Emergency Evacuation Plan

The purpose of this plan is to ensure that the Wellington Electricity Network Control Room (NCR) is prepared for, and responds quickly to any incident that requires the short or long term evacuation of the NCR located at the Transpower Haywards Substation.

In September 2009 an event occurred at Transpower Haywards GXP which provided a very real test of the Emergency Evacuation Plan when an equipment fire occurred in the basement of the Haywards building which houses the Wellington Electricity NCR. NCR staff had to evacuate the building, and by following the Emergency Evacuation Plan were able to re-establish a remote control room to maintain the operational control of the network.

Fortunately due to the availability of HVDC pole 1 later in the day (close to the afternoon peak load) the Emergency Load Shedding Plan was not required to be put into action by the NCR.

7.9.4. Civil Defence Emergency Management (CDEM) Plan

As an energy distributor providing essential services, Wellington Electricity belongs to the Lifeline Utilities group. There is an emphasis in the Civil Defence Emergency Management Act 2002 on ensuring that utilities provide continuity of operation, particularly where their service supports essential CDEM activity.

Wellington Electricity has prepared this plan to comply with the relevant provisions of the CDEM Act. It provides information for the initiation of measures for saving life, relieving distress and restoring electricity connections.

This plan follows the four 'Rs' approach to dealing with hazards that could give rise to a civil emergency:

- Reduction - Identifying risks and developing plans to reduce these risks
- Readiness - Developing emergency operational contingency plans
- Response - Actions taken immediately before, during or after an emergency
- Recovery - Rehabilitating and restoring to pre-disaster conditions

7.9.5. Pandemic Preparedness Plan

The purpose of this plan is to manage the impact of a pandemic related event by:

- Protecting employees as far as possible from spread of disease
- Create a safe working environment
- Maintain essential business functions with reduced staffing levels if containment is not possible

The Pandemic Preparedness Plan shall be reviewed annually by the QSE manager.

7.9.6. Other Emergency Plans

- Business Continuity Plan
- Priority Notification Procedures to key staff and contractors
- Total Loss of a Zone Substation Plan
- Loss of Transpower Grid Exit Point Plan (Transpower Plan)
- Emergency Load Shedding Plan
- Participant Outage Plan (as required by the Electricity Commission)
- Call Centre Continuance Plan

In addition contingency plans are prepared as necessary detailing special arrangements for major customers.

7.10. Health and Safety

Wellington Electricity has developed a comprehensive set of health and safety policies and procedures and prioritises safety is a core business value.

Summarising its policy, Wellington Electricity endeavours to:

- Provide a safe and healthy work place for all its people, contractors and visitors
- Ensure health and safety considerations are part of all business decisions
- Monitor and continuously improve health and safety performance across the business
- Communicate and engage with its people, contractors, consumers, and stakeholders on health and safety matters
- Operate in a manner that encourages the correct safety behaviours and values
- Encourage safe and healthy lifestyles, both at work and at home

It aims to achieve this by:

- Complying with all relevant legislation, standards and codes of practice for the management of health and safety
- Identifying, assessing and controlling workplace hazards
- Accurately reporting, recording and learning from all incidents and near misses
- Establishing health and safety goals at all levels both internally and externally, and regularly monitoring and reviewing the effectiveness of its health and safety management system
- Consulting, supporting and encouraging participation from its people on issues that have the potential to affect their health and safety
- Promoting its leaders', employees' and contractors' understanding of the health and safety responsibilities relevant to their roles
- Providing information and advice on the safe and responsible use of its products and services;
- Suspending activities if safety would be compromised
- Taking all practicable steps to ensure its contractors work in line with this policy

All employees and contractors are responsible for ensuring their own and other's health and safety by adhering to safe work practices, making appropriate use of plant and equipment (including protective clothing and equipment) and promptly reporting incidents, near misses and hazards.

Wellington Electricity's key health and safety values in regard to the conduct of its employees and contractors are:

- Everyone is responsible for safety
- We look out for each other
- Safety will be planned into our work
- All injuries are preventable
- Management is accountable for preventing injuries
- Employees must be trained to work safely

7.10.1. Contractor Health and Safety

A safe work practices manual defines the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for Wellington Electricity and its contractors to identify and eliminate accident causes.

All contractors working for the company are required, as a minimum, to comply with these safe work practices whilst carrying out any work on the network. Contractors are also required to report all employee accidents/incidents and near misses to Wellington Electricity together with the results of their investigations and intended corrective actions. It is important to note that all Contractors are responsible for developing, implementing and monitoring their own safe work practises.

Wellington Electricity has a comprehensive competency framework which comprises network access induction training, work type competency standards and contractor pre-qualification processes. Any internal staff and external service providers must obtain and be able to demonstrate the appropriate levels of competency under the framework as well as safety management systems before accessing, working on or near to the network.

7.10.2. Third Parties

A large number of third parties work around or close to Wellington Electricity's network assets, these third parties can range from the general public up to large contracting businesses (and their subcontractors) working under contract.

Wellington Electricity experiences a significant number of third party incidents on the network on a regular basis, typically these are:

- Road vehicles hitting power poles and LV pillars
- Civil excavation equipment striking live underground cables
- Various vehicles and equipment striking or touching live overhead lines

While these types of incidents can cause damage to the network assets, power outages to large numbers of customers and significant cost to the business, most significantly these incidents can result in serious harm, injury or death to the third party or nearby public.

Wellington Electricity provides a number of free of charge services to third parties to assist them in working around or near the electricity network. These consist of:

- Dial before U dig – the provision of underground plans showing Wellington Electricity's assets in the requested work area
- Cable mark-outs
- 33kV cable stand-over
- Close Approach Consents

Unfortunately not all of these third party incidents are identified and reported at the time of incident which may lead to future safety and network reliability problems.

Wellington Electricity shall be working closely with national and local territorial authorities and contracting bodies and educating their contractors and subcontractors on working safely around the electrical network.

7.10.3. Public Safety

In 2006 significant amendments were made to the Electricity Act 1992. As a consequence of these amendments changes to the Electricity Regulations 1997 were required. The major change affecting Wellington Electricity is the requirement for electricity distributors to have in place a Safety Management System directed at public safety.

Wellington Electricity monitors electricity related public safety and staff/contractor safety incidents around its public assets. On a regular basis these incidents are reviewed to ensure lessons are captured and where appropriate incorporated into its safety programmes.

With respect to community safety, Wellington Electricity offers cable location and residential isolation services. Public safety awareness and communications programmes on electricity have been undertaken.

Wellington Electricity shall continue to review and develop the systems, processes and other initiatives in regards to public safety and the continued improvement of its Safety Management System.

7.11. Environmental Practices

Wellington Electricity is committed to the principles of sustainable development and managing our business in an environmentally responsible manner. This is managed via an Environmental Management Plan. The key purposes of the Environmental Management Plan are:

1. To identify the range of environmental obligations associated with the project and to set guidelines for the allocation of responsibilities for the management of environmental issues between Wellington Electricity and the contractor.
2. To provide some assistance to the contractor to identify and meet its obligations throughout the course of the project.
3. That all environmental concerns are considered in the design, construction, operation, maintenance and disposal of network assets.

7.11.1. Asbestos Management

All asbestos-covered cables and DC circuit breaker arc chutes are located within non-publicly accessible substations and are only accessed by Wellington Electricity approved contractors with the appropriate competencies. The asbestos-covered cables are primarily short lengths used to connect switchgear and transformers. Surveys have been conducted to identify all asbestos cables and all asbestos cables have been tagged on the actual cable itself. The asbestos hazard has been inspected and the type of asbestos analysed has been categorised as a low risk.

Wellington Electricity has instigated an annual program within the capital expenditure budget to progressively replace the DC mercury arc rectifiers and associated equipment based on the asset condition and age. A risk assessment shall be conducted regarding the removal of the asbestos-covered circuit breaker arc chutes.

When asbestos is removed, specialist asbestos removal contractors are used to remove and dispose of the equipment and to ensure the remaining site is free of any asbestos dust or particulates. Also contractors working in areas containing asbestos have received appropriate training in working around asbestos.

7.11.2. Site Contamination Management

The Petone zone substation site in Bouverie St site was previously a gas works and has been identified as having ground contamination. An environmental assessment study has been carried out, which concluded that the risk to general site users from contamination is low and the risk to local groundwater or surface water is also low. Additionally an environmental management plan has been developed to manage the site contamination going forward.

8. Performance Evaluation

8.1. Review of Progress Against the AMP

Appendix A provides a comparison of forecast financial performance against actual for the previous year financial year (1 April 2008 to 31 March 2009). The variance for Capex was 78% and the Opex variance was -51%. It is noted that part of the discrepancy arises from the accruals covering the period from 24 July 2008 to 31 March 2009, i.e. eight months. Not withstanding this, actual and forecast data relating to this period has partly been provided by Vector. Wellington Electricity Lines Limited started operations on 24 July 2008, and is therefore not in a position to comment on the variances.

A more useful comparison is of the 2009 calendar year which is shown below.

	Previous Plan Forecast ($k)	Actual ($k)	Variance ($k)	Variance (%)
Opex	11,435	10,388	-1,047	-9.2
Capex	22,602	20,203	-2,399	-10.6
IT Infrastructure		17,300		
TOTAL	34,037	47,891		

Figure 8-1 Actual vs. Forecast for 2009 Calendar Year

The variation of around -10% is a reflection of:

- Savings on two of the larger capex projects completed in the year
- Lower activity due to establishing the business and making the transition which included integration of $17.3m of IT infrastructure investment

8.2. Evaluation of Performance Against Target

The service targets that Wellington Electricity has adopted are described in detail in section 4. These targets include:

- Network reliability (SAIDI, SAIFI)
- Contact Centre Service Levels
- Customer enquiries and complaints
- Power Restoration times
- Faults per 100 circuit-km

Of these targets, the contact centre service levels, and the customer enquiries and complaints both relate to systems presently being implemented and therefore there is no basis for comparison for target against actual performance for the 2008/2009 year.

Target data for power restoration times and faults per 100 circuit-km is not available due to the change of network ownership falling in the comparison period of 2008/2009, coupled with the fact that the previous owners did not publish an AMP in this year. Only SAIDI and SAIFI can be commented on with respect to comparison of actual against target performance for year 2008/2009, as the targets were regulatory.

8.2.1. SAIDI & SAIFI

The comparison of target and actual SAIDI and SAIFI for the year 2008/2009 is provided below.

	Target 2008/09	Actual 2008/09	Variance
SAIDI	29.70	35.33	+19.0%
SAIFI	0.44	0.53	+20.4%

Figure 8-2 Target vs. Actual Network Reliability for 2008/2009

It has been observed that the targets for 08/09 were set based on an average of the network performance between 1998 and 2003, which are not representative of the rolling average over the entire period (i.e. they were lower). This is illustrated in the SAIFI graph for the period since 1998, which is provided below.

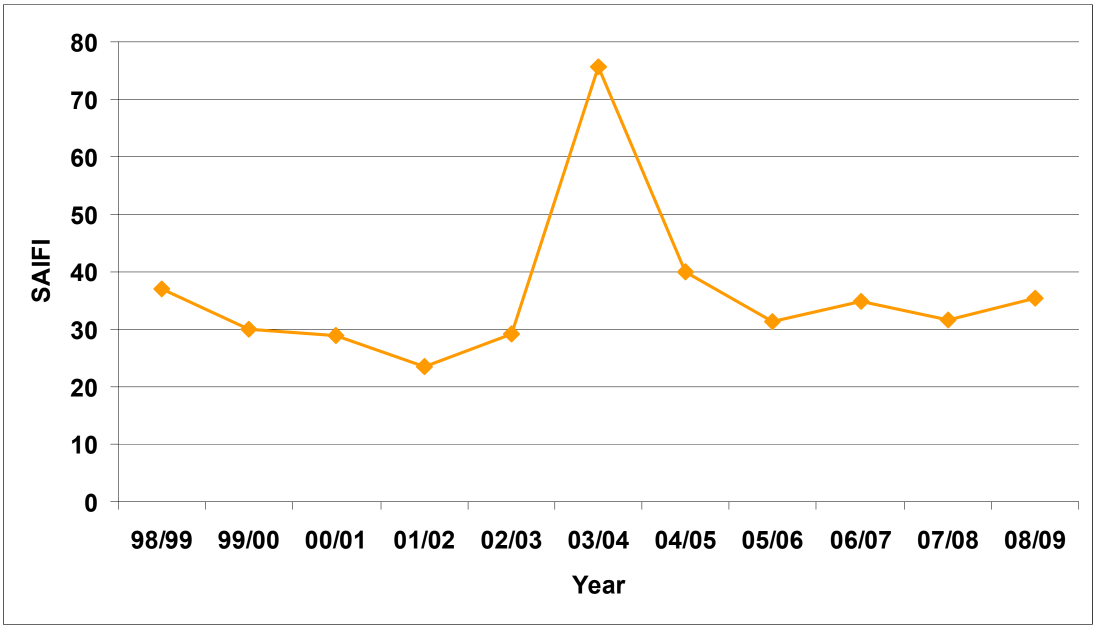

Figure 8-3 Historical SAIDI for Wellington Network 1998 to 2009

The revised regulatory threshold for SAIDI and SAIFI are:

	Threshold for 2010/11	Limit for 2010/11
SAIDI	33.9	41.5
SAIFI	0.52	0.60

Figure 8-4 Reliability Targets for 2010/11

It is noted that under the revised thresholds, Wellington Electricity's performance for 2008/09 would have been between the threshold target and limits.

8.3. Gap Analysis and Identification of Improvement Initiatives

Wellington Electricity has invested around $17.3m in delivering new IT systems to the business. Currently, the data sets transferred to the new systems have been identified as containing some gaps in information. These gaps are referred to throughout the report in the sections were they occur, and are summarised below.

Section	Item	Description
2.8	Planning cycles	Develop a cyclic annual calendar of work required to meet regulatory and internal reporting dates
5.2	Investment selection process	Develop a system for prioritising capital projects
5.5	Options analysis	Develop a process for evaluating a shortlist of network development options
6.3	Standards	Develop full suite of Wellington Electricity maintenance and inspection standards
6	Stage of Life analysis	Develop a system for determining the stage of life of assets within major asset categories

Figure 8-5 Gaps in 2010 AMP

Wellington Electricity aims to address these gaps over the coming years by refining existing processes, adopting new processes and continuing to build asset condition information.

Appendix A Expenditure Forecast and Reconciliation

ASSET MANAGEMENT PLAN REQUIREMENT: EXPENDITURE FORECAST AND RECONCILIATION ($000 real as at 31 March 2009)

For initial forecast year ending 31/03/2011

Ten Yearly Forecasts of Expenditure

	Actual	Previous forecast	Forecast									
Year Ending	31/03/2009	31/03/2010	31/03/2011	31/03/2012	31/03/2013	31/03/2014	31/03/2015	31/03/2016	31/03/2017	31/03/2018	31/03/2019	31/03/2020
Capital Expenditure: Customer Connection	-	7,323	5,428	7,412	5,895	5,699	5,633	8,593	8,162	6,332	6,877	5,887
Capital Expenditure: System Growth	-	3,276	2,279	3,449	8,368	5,380	4,075	6,191	6,645	2,274	4,852	4,930
Capital Expenditure: Asset Replacement and Renewal	-	10,019	12,951	12,644	11,943	15,195	17,587	13,113	12,836	18,523	16,067	17,629
Capital Expenditure: Reliability, Safety and Environment	-	492	452	606	469	468	463	621	604	492	533	389
Capital Expenditure: Asset Relocations	-	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	910
Subtotal - Capital Expenditure on asset management	**41,249**	**22,290**	**22,290**	**25,291**	**27,855**	**27,922**	**28,938**	**29,698**	**29,427**	**28,801**	**29,509**	**29,745**
Operational Expenditure: Routine and Preventative Maintenance	-	5,936	5,499	5,485	5,535	5,599	5,603	5,656	5,709	5,762	5,816	5,871
Operational Expenditure: Refurbishment and Renewal Maintenance	-	614	614	614	614	614	614	614	614	614	614	614
Operational Expenditure: Fault and Emergency Maintenance	-	4,575	4,584	4,630	4,673	4,726	4,771	4,815	4,860	4,906	4,951	4,996
Subtotal - Operational Expenditure on asset management	**5,653**	**11,125**	**10,697**	**10,729**	**10,822**	**10,939**	**10,988**	**11,085**	**11,183**	**11,282**	**11,381**	**11,481**
Total direct expenditure on distribution network	**46,902**	**33,415**	**32,987**	**36,020**	**38,677**	**38,861**	**39,926**	**40,783**	**40,610**	**40,083**	**40,890**	**41,226**

Overhead to Underground Conversion Expenditure No overhead to underground conversion expenditure included in the above expenditure.

Variance Analysis

	Actual	Previous	% Variance	
	31/03/2009	31/03/2009		
Capital Expenditure: Customer Connection	Note 2			
Capital Expenditure: System Growth	Note 2			
Capital Expenditure: Asset Replacement and Renewal	Note 2			
Capital Expenditure: Reliability, Safety and Environment	Note 2			
Capital Expenditure: Asset Relocations	Note 2			
Subtotal - Capital Expenditure on asset management	**41,249**	**23,219**	**77.7%**	Note 1
Operational Expenditure: Routine and Preventative Maintenance	Note 2			
Operational Expenditure: Refurbishment and Renewal Maintenance	Note 2			
Operational Expenditure: Fault and Emergency Maintenance	Note 2			
Subtotal - Operational Expenditure on asset management	**5,653**	**11,657**	**-51.5%**	Note 1
Total direct expenditure on distribution network	**46,902**	**34,876**	**34.5%**	Note 1

Notes:

1 Actual and forecast data relating to the year ending 31 March 2009 has partly been provided by Vector. Wellington Electricity Lines Limited started operations on 24 July 2008, and is therefor not in a position to comment on these variances.

2 In line with Transitional Provisions Part 16.3 (Information Disclosure Requirements), capital expenditure categories are not required as at 31 March 2009, but only totals must be included

Appendix B Glossary of Terms

AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductor
ABS	Air Break Switch
ACSR	Aluminium Conductor Steel Reinforced
AMP	Asset Management Plan
CB	Circuit Breaker
CBD	Central Business District
CCT	Covered Conductor Thick
CEO	Chief Executive Officer
CHED Services	Cheung Kong Infrastructure Holdings Limited & Hong Kong Electrical International Electricity Distribution Services Pty Ltd
CIGRE	Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems)
CKI	Cheung Kong Infrastructure Holdings Limited
Cu	Copper
DC	Direct Current
DGA	Dissolved Gas Analysis
DTS	Distributed Temperature Sensing
EDO	Expulsion Drop-out
FPI	Fault Passage Indicators
GWh	Gigawatt Hour
GIS	Geographical Information System
GXP	Grid Exit Point
HEI	Hong Kong Electrical International
HV	High Voltage
IEEE	Institute of Electrical and Electronic Engineers
IISC	International Infrastructure Services Company
km	Kilometre
KPI	Key Performance Indicator
kV	Kilovolt

kVA	Kilovolt Ampere
kW	Kilowatt
LV	Low Voltage
LVABC	Low Voltage Aerial Bundled Conductor
MW	Megawatt
MVA	Mega Volt Ampere
NICAD	Nickel Cadmium Battery
Nilstat ITP	Protection Relay
ODV	Optimised Deprival Value/Valuation
O&M	Operating and Maintenance
PDC	Polarisation Depolarisation Current
PIAS	Paper Insulated Aluminium Sheath Cable
PILC	Paper Insulated Lead Cable
PVC	Polyvinyl Chloride
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAP	Systems Applications and Processes
SCADA	Supervisory Control and Data Acquisition System
SF_6	Sulphur Hexafluoride
TASA	Tap Changer Activity Signature Analysis
TCA	Transformer Condition Assessment
VRLA	Valve Regulated Lead Acid Battery
W/S	Winter / Summer
XLPE	Cross Linked Polyethylene Cable

Appendix C Zone Substation TCA and TASA Results

Transformer	Manufacturer	Year	TCA	TASA
Ngauranga A	ASEA	1956	1	1
Ngauranga B	ASEA	1956	1	1
Evans Bay 1	Savigliano	1959	1	1
Evans Bay 2	Savigliano	1959	1	1
Waikowhai 1	GEC/Alstom	1962	1	2
Waikowhai 2	GEC/Alstom	1962	1	2
Mana A	South Wales	1963	1	1
Plimmerton A	South Wales	1963	1	1
Tawa A	South Wales	1963	1	1
Tawa B	South Wales	1963	1	1
Waitangirua A	South Wales	1964	1	1
Waitangirua B	South Wales	1964	1	1
Terrace 1	Fuller	1965	1	1
Terrace 2	Fuller	1966	1	2
Palm Grove 1	Fuller	1967	1	1
Palm Grove 2	Fuller	1967	1	1
Petone A	Fuller	1967	1	2
Petone B	Fuller	1967	1	2
Porirua A	Fuller	1967	1	2
Porirua B	Fuller	1967	1	2
Haitaitai 1	Fuller	1968	1	1
Haitaitai 2	Fuller	1968	1	1
Maidstone A	Fuller	1968	1	2
Maidstone B	Fuller	1968	1	2
Naenae B	Brush	1968	2	1
Brown Owl A	Brush	1969	1	1

Transformer	Manufacturer	Year	TCA	TASA
Johnsonville A	Brush	1969	1	1
Johnsonville B	Brush	1969	1	1
Kenepuru A	Brush	1969	1	1
Kenepuru B	Brush	1969	1	2
Naenae A	Brush	1969	2	1
Seaview A	Hawker Siddeley	1969	1	2
Seaview B	Hawker Siddeley	1969	1	2
Karori 1	Brush	1970	1	1
Karori 2	Brush	1970	1	1
Wainuiomata A	YET	1971	1	1
Wainuiomata B	YET	1971	1	2
Gracefield A	Hawker Siddeley	1972	1	1
Gracefield B	Hawker Siddeley	1972	1	2
Waterloo A	Hawker Siddeley	1972	1	2
Waterloo B	Hawker Siddeley	1972	1	2
Moore St 1	Hawker Siddeley	1974	1	1
Moore St 2	Hawker Siddeley	1974	1	1
Korokoro A	Tyree	1976	1	2
Korokoro B	Tyree	1976	1	2
Brown Owl B	Brush	1978	1	1
Frederick St 1	Tyree	1978	1	1
Frederick St 2	Tyree	1978	1	1
Trentham A	Tyree	1980	1	1
Trentham B	Tyree	1980	1	1
8 Ira St 1	Tyree	1981	1	2
8 Ira St 2	Tyree	1981	1	2
University 1	Tyree	1986	1	2
University 2	Tyree	1986	3	2