2005
ASSET MANAGEMENT
PLAN

ASSET MANAGEMENT SUMMARY

This summary is provided to meet the mandatory disclosure requirements of Regulation 24 of the Commerce Commission Electricity Information Disclosure Requirements 2004.

THE VECTOR NETWORK

The Vector network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington – an area of approximately 5,200km^2. Vector has 651,000 customers.

NETWORK SUMMARY

Peak Demand	2,085MW
Area Covered	5,200km^2
Customer Connections	651,000
Supply Points from Transpower	22
Zone Substations	123
Distribution Substations	25,480
Subtransmission Cables	693km
Subtransmission Lines	470km
HV Distribution Cables	4,018km
HV Distribution Lines	4,530km

PURPOSE OF THE ASSET MANAGEMENT PLAN

The purpose of the Asset Management Plan (AMP) is to describe how Vector will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set.

Vector's AMP is provided to enable customers and other interested parties to identify Vector's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment planned to manage its asset base. The plan also identifies our approach to network risk management and contingency planning. The AMP is an important part of Vector's engagement with consumers.

Vector's approach to asset management is one which seeks to strike the appropriate balance between the needs and expectations of our customers, and the cost of providing the network service – this incorporates the risk and consequences of asset failure.

Vector's asset management approach is to:

- Ensure that the required standard service levels are met, including reliability of supply to customers
- Provide a safe environment for operating personnel and the general public
- Proactively manage environmental issues
- Manage the assets to achieve the required functionality, performance and value of assets to enable the continuation of a viable network business

This AMP gives an overview to Vector's approach to maintenance, development, asset renewal and replacement. This may change over time as Vector seeks to continually advance work in this area, including as a result of further appreciation of the Commerce Commission's regulatory regime.

DATE AND PLANNING PERIOD

The AMP has been developed as part of the Information Disclosure for 2005 and covers a period of ten years from 1 June 2005 until 31 May 2015.

The plan is a view going forward and does not commit Vector to any of the individual projects or initiatives set out in the plan. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within Vector as we gain better information on our customer expectations, asset capabilities and condition.

ASSET MANAGEMENT SYSTEMS AND INFORMATION

Central to Vector's goals of providing superior customer service are information systems. Our systems combine the three components of customer management, network management and financial management into one network management strategy.

Decisions on asset performance, asset maintenance, asset replacement, customer responsiveness and optimisation of expenditure require current and accurate information. Enhancing the level of information Vector holds on its assets and network, together with implementation of tools to support the effective use of this information continues to be a high area of focus.

In addition to system development, Vector has invested heavily in staff training and has staff members involved in international technical working groups such as CIGRE and ESAA to ensure we actively participate in industry initiatives and advancements.

NETWORK AND ASSET DESCRIPTION

Vector's network is divided into three regions geographically and can be separated into three levels based on operating voltage as follows:

1. 110kV transmission network, which connects from the Transpower network to Vector bulk supply substations and also provides additional security for the Transpower transmission system.

2. 33kV and 22kV subtransmission network, which connects between the Transpower grid exit points and Vector zone substations, each of which serves a particular geographic area with similar asset and customer characteristics.

3. 11kV and 6.6kV, and 400/230V distribution network linking our customers to our zone substations.

Each part of the network is designed, operated and maintained to achieve the levels of reliability set out in this AMP.

SERVICE LEVEL OBJECTIVES

Service for Vector is about understanding what our customers value and meeting these requirements cost-effectively.

Vector has a number of standard service levels against which we assess and measure our performance. The standards give Vector a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value. These service standards vary between the network areas reflecting differences in both network design and security standards in addition to customer expectations. As part of our integration process and reflecting the outcomes of the current regulatory environment, we have integrated these service standards.

Common to all network areas is the continuation of health and safety as an area of focus for the business. Vector's policy is to:

> *"Create and maintain a safe and injury free working environment for our employees, our service providers, our suppliers and the public we serve."*

Our safety target for 2005/06 remains:

> *"No lost time injuries to any person working on our network."*

ASSET DEVELOPMENT AND MAINTENANCE PLANS

Ensuring the network meets the future demands of customer requirements, load growth, statutory requirements, environmental and safety issues, requires Vector to continually improve its asset management.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions to defer major capital expenditure, so long as our reliability objectives are met and maintained.

Ensuring that asset maintenance, refurbishment and replacement programmes are value-based is also critical to Vector. Asset maintenance can be a significant proportion of the total lifecycle costs and Vector's approach is one of value-based maintenance to achieve the required reliability standards.

Asset maintenance plans are developed taking into account the variety of customer, environmental, operational performance and condition factors. Generic maintenance plans are developed for each asset type, but are applied based on performance requirements and criticality.

The underlying objective of the asset replacement programme is to identify opportunities where value can be gained through programmes of replacement rather than incurring ongoing remedial and preventative maintenance costs.

To enhance and simplify this process, Vector continues to develop and refine the tools and approaches it takes to analysing network information. The objective has been to allow key trends and areas needing focus to be quickly and accurately identified. This information is available to Vector and its service providers to assist in the decision making approach.

Our continued focus on improved asset condition and network performance information will improve our decision making process. This in turn will enhance the ability for customers to evaluate their service requirements in terms of cost and performance – enabling a choice to either take their own measures to achieve the performance they require, or contract Vector to do so.

RISK ASSESSMENT

Risk is managed in Vector by a combination of:

- Reducing the probability of the failure, through the capital and maintenance work programme and enhanced working practices
- Reducing the impact of failure, through contingency and emergency plan development

Management of risk is undertaken by management overseen by Board and Executive Risk Committees.

Vector has a suite of contingency plans in place developed under the framework of risk reduction, readiness, response and recovery. Plans are in place to cope with storms, total loss of supply of a zone substation, loss of a Transpower grid exit point, and loss of the Control Room or Call Centre.

EVALUATION OF PERFORMANCE

Measurement and communication of performance measures is an integral part of Vector's management process. Physical performance is tracked through the measures of:

- Reliability
- Safety
- Customer satisfaction
- Environmental impact

All employees and service providers are accountable for achieving the performance targets. Our service providers are incentivised through a contract bonus structure to achieve their targets whilst Vector employees have the performance measures embedded in their performance related pay scheme.

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GLOSSARY OF TERMS

AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductor
ABC	Aerial Bundled Conductor
ABS	Air Break Switch
AMP	Asset Management Plan
ARC	Auckland Regional Council
CAIDI	Customer Average Interruption Duration Index
CBD	Central Business District
CIGRE	Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems)
CCT	Covered Conductor Thick
Cu	Copper
DC	Direct Current
DGA	Dissolved Gas Analysis
DMS	Distribution Management System
DTS	Distributed Temperature Sensing
ENA	Electricity Networks Association
ESAA	Energy Supply Association of Australia
FPI	Fault Passage Indicators
GWh	Gigawatt hour
GIS	Geographical Information System
GIS	Gas Insulated Switchgear
GPD	Group Peak Demand
GPS	Global Positioning System
HRC	High Rupturing Capacity fuse
HV	High Voltage
Hz	Hertz
ICP	Installation Control Point
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IED	Intelligent Electronic Data
IP	Internet Protocol
IPC	Insulation Piercing Connector
km	Kilometre
kV	Kilovolt
kVA	Kilovolt Ampere
kW	Kilowatt
LTI	Lost Time Injuries
LTIFR	Lost Time Injury Frequency Rate
LV	Low Voltage
MEN	Multiple Earthed Neutral
MW	Megawatt
MVA	Mega Volt Ampere

n-1	Security Standard
NICAD	Nickel Cadmium battery
Nilstat ITP	Nilstat Protection Relay
ODV	Optimised Deprival Value/Valuation
OSH	Occupational Safety and Health
PILC	Paper Insulated Lead Cable
PVC	Polyvinyl Chloride
RMU	Ring Main Unit
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	Sulphurhexafluoride
SREI	Safety Rules Electricity Industry
TASA	Tap Changer Activity Signature Analysis
TCP/IP	Transmission and Control Protocol/Internet Protocol
TLS	Transformer Load Simulator
TMS	Transformer Management System
V	Volt
VRLA	Valve Regulated Lead Acid battery
VT	Voltage Transformer
XPLE	Cross Linked Polyethylene Cable
ZAIDI	Zonal Average Interruption Duration Index

1. INTRODUCTION

1.1. VECTOR ASSET MANAGEMENT OVERVIEW

With around 651,000 electricity customers in the Auckland and Wellington regions, Vector continues to maintain a customer focused approach to effective asset management. Now, more than ever, customers are demanding greater performance, security and innovation to assist them in growth and development. A key challenge for Vector is to continue to understand these needs and push industry boundaries to translate them into solutions that benefit customers and lead the industry forward.

In developing the AMP, Vector has been mindful of the requirements of the regulatory regime and what they mean for asset management. Vector also has additional work underway internally to manage the ramifications of the Commerce Commission's thresholds and targeted control regime for asset management. For example, Vector is currently examining the optimal specification of its investment models, including how to explicitly encapsulate in those models a range of trade-offs relevant to the Commission's regulatory regime (eg, between price (cost) and quality, between capital expenditure and maintenance).

This AMP gives an overview to Vector's approach to maintenance, development, asset renewal and replacement. This may change over time as Vector seeks to continually advance work in this area, including management of the Commerce Commission's regulatory regime.

Vector engages consumers, consumer groups and retailers, as part of Vector's standard business processes and commitment to offering quality customer service, to provide input and feedback on the proposed AMP.

Vector strives to provide an appropriate level of quality (defined in terms of four aspects: safety, customer satisfaction, reliability and power quality), at any given price level. To do this, Vector has developed and implemented industry leading business systems and practices such as:

- Ensuring a company wide focus on quality by linking staff performance bonuses to team and company performance on quality, as well as publishing an internal newsletter (*On Target)*, which focuses on Vector's performance with respect to quality and the ways in which this performance can be improved
- Ensuring world class health and safety and environmental processes are in place by providing training to all staff; having zero tolerance for work place accidents and employing a world leader in safe work practices (Shaw Energy Delivery Service) to audit Vector's practices; ensuring a company wide focus on safety through assessing staff and service provider performance with respect to specific Key Performance Indicators (KPIs) related to safety
- Using network modelling in order to simulate the workings of Vector's network in entirety, starting from Transpower grid exit points down to distribution transformers; and using the model to perform scenario analysis for changes in quality. The outputs of such analysis are used as an input into asset management planning decisions, as well as to present options to large consumers
- Implementing systems that effectively report and manage the impact of power quality on Vector's customers; an electronic mail system that automatically sends large customers a power quality report in real-time; and a web-based reporting system that makes both real-time and historical power quality information available to customers
- A dedicated business information unit utilising industry leading technology to gather, integrate and present information from a number of systems in a way that facilitates better understanding of Vector's quality performance, which enhances Vector's ability to better plan and manage its network

The objective of the AMP is to describe how Vector will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set across its networks.

Vector is made up of three network areas – Northern, Auckland and Wellington, as shown in Figure 1.1, each of which have differing asset configuration, management and service characteristics. Vector's three network areas currently operate under two different customer contractual models. At the time of publication, the Auckland network operates under a conveyance agreement which means it has a direct relationship with each of its 295,000 customers in the Auckland, Manukau and Papakura area. The Northern and Wellington networks are currently run under an interposed agreement which means the company has a direct contract with retailers, which buy lines services and in turn manage the end customer relationship.

Figure 1.1 The Vector Network

The continued focus for asset management at Vector is one based on greater utilisation of the existing assets achieved through higher performance. This is achieved through understanding customer drivers, enhanced value-based maintenance strategies, better real-time use of capacity, timely system upgrades and utilisation of advanced condition monitoring techniques and technology. Each investment we make is considered specific to the characteristics of the network areas which the investment serves and, underlying this, what levels of service our customers expect. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements, asset condition, operational performance and future costs.

To support this objective Vector has turned the way information is managed on its head and developed a system that combines the three components of customer management, network management and financial management into one network management strategy. This integrated system provides a common platform for supporting and improving asset management planning, day to day network operations and customer service provision. The system which delivers flexibility, integration of information sources, simplicity and speed for optimal decision making has had huge benefits for network performance, field operations and customer satisfaction.

The asset planning process prioritises the programmes for maintenance and development to balance customer service, safety, security and operational efficiency. Implicit in the asset planning process is an understanding and evaluation of the risks to operation and the consequences of failure. Also critical is the collection of information from which performance can be monitored and improvement targets set.

The AMP describes Vector's asset management approach and outcomes. From this document, customers and other interested parties will be able to identify Vector's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment, and their rationale. The plan also identifies our approach to the management of network risks and our approach to contingency planning.

1.2. NETWORK SUMMARY

The Vector network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington - an area of approximately 5,200km^2. Vector has 651,000 customers.

Peak Demand	2,085MW
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HV Distribution Cables	4,018km
HV Distribution Lines	4,530km

1.3. ASSET MANAGEMENT PHILOSOPHY

Vector's approach is designed to ensure a balance between the needs and expectations of our customers, business objectives, regulatory framework and the cost of maintenance and replacement. This is balanced against the risk and consequences of asset failure.

Vector's approach to asset management is to:

- Ensure that the required standard service levels are met, including reliability of supply to customers
- Provide a safe environment for operating personnel and the general public
- Proactively manage environmental issues
- Manage the assets to achieve the required functionality, performance and value to enable the continuation of a viable network business

Assets must be operated and maintained to continue to meet performance standards cost-effectively. Functionality and performance requirements are continually reviewed and revised to reflect the changing operational and customer requirements on the network.

Vector has a comprehensive set of environmental guidelines and response procedures for managing equipment installations and work carried out by contractors. Input from Regional Councils ensures that these guidelines are appropriate and minimise any adverse environmental impacts from works.

Trees interfering with lines still remain a problem across the network. Vector has significantly increased spend in vegetation management this year in response to reliability concerns and also in response to the new tree regulations.

In line with Vector's approach to a customer driven level of service provision, the asset management plans are continually developed from analysis of customer requirements, an assessment of the condition of the asset, the risk and consequences of asset failure and analysis of least cost solutions, as shown in Figure 1.2.

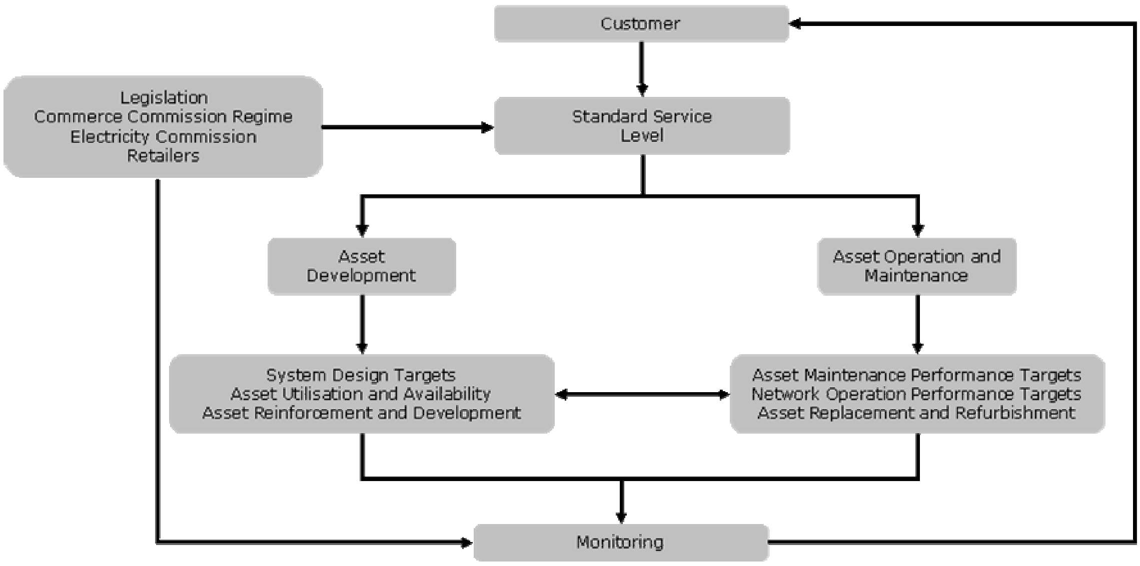

Figure 1.2 Asset Management Philosophy

1.4. ASSET MANAGEMENT PROCESS

Vector's asset management process is shown in Figure 1.3.

1.4.1. INFLUENCERS

- ***Shareholders***
  Vector is currently fully owned by the Auckland Energy Consumer Trust. The Trust is responsible for appointing the Board of Directors and agreeing the Statement of Corporate Intent. The ownership structure will change in the near future with the planned IPO later in 2005.

- ***Customers***
  Vector manages the network to meet the needs of its customers and works with the energy retailers within the Northern and Wellington networks to manage customer issues.

- ***Regulations***
  Statutory requirements impact on how Vector operates to meet its service delivery standards. The following statutes and all subsequent amendments are of particular relevance to this AMP:

Commerce Act 1986
Electricity Information Disclosure Requirements 2004
Electricity (Hazards from Trees) Regulations 2003
The Electricity Act 1992 and Electricity Amendment Act 2001
Electricity Regulations 1997
Electrical Codes of Practice 1993
New Zealand Standard NZS3000 1999
Australian/New Zealand Standard ANZS3000 2000
Health and Safety in Employment Act 1992
Resource Management Act 1991
Civil Defence Emergency Management Act 2002
Electricity and Gas Industries Bill 2003
Electricity Governance Rules 2003

Other statutes apply to the business as a whole, but are peripheral to the asset management philosophy.

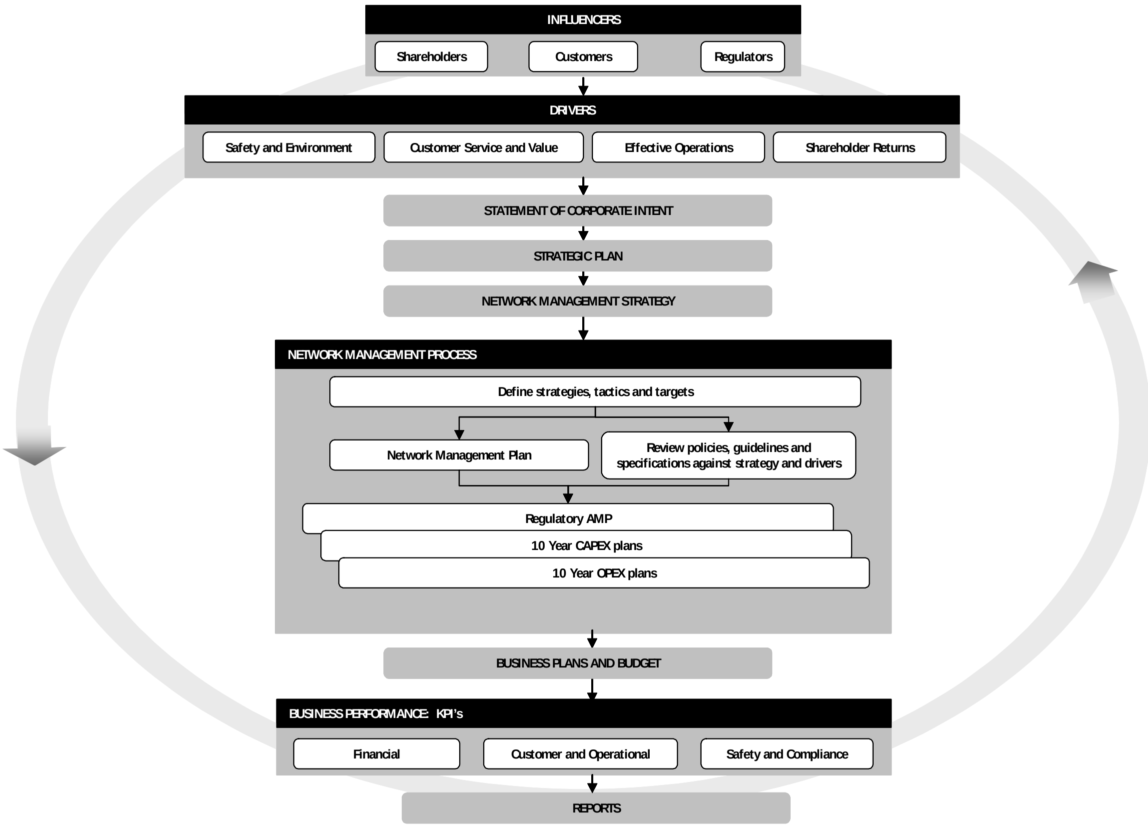

Figure 1.3 Vector's Asset Management Process

1.4.2. ASSET MANAGEMENT DRIVERS

- ***Customer Service and Value***
  Vector's objective is to deliver improved customer value by matching the performance of both its assets and service providers to the performance its customers expect and are willing to pay for.

- ***Core Business Enhancement***
  Vector's objective is to manage the operation of its assets in such a way as to deliver the required performance at the lowest overall cost.

- ***Health and Safety and Environmental Responsibility***
  Vector will at all times ensure its employees, service providers and customers safety is not put at risk by the management of its assets. Vector will manage the network and act in an environmentally responsible manner and comply with all legal environmental requirements.

- ***Shareholder Returns***
  Vector's objective is to manage its assets to meet the shareholders' requirements for return on investment, preservation and enhancement of the value of the company, and community obligations.

1.5. RELATIONSHIP WITH BUSINESS PROCESS

The AMP is directly influenced by a number of other policy documents and processes:

- ***Deed Recording Essential Operating Requirements***
  Vector and AECT are parties to a deed dealing with dividend policy, reporting and with pricing and undergrounding in the Auckland network area.

- ***Strategic and Business Plans***
  Vector has developed a strategic intent and a set of supporting organisational values. Its strategic intent has two thrusts, namely to enhance its core business and to pursue significant growth opportunities in selected market spaces. It has documented a business plan which details the strategic intent, budget and initiatives that will be undertaken by all functions and business lines during the forthcoming year.

- ***Network Management Strategy***
  This defines the approach and direction for network management in terms of network value, performance, revenue and customer expectations for service and quality.

- ***Performance Targets***
  Performance targets are established for the company as part of the long-term and annual planning rounds. These include customer service, network performance and financial targets. These are cascaded down to individual business units and service providers.

1.5.1. PLAN IMPLEMENTATION

The outputs from the asset planning process, which incorporates continual review of asset functionality requirements and customer feedback, are the operational, maintenance and capital work programmes.

- ***Asset Maintenance Plans/Schedules***
  For each customer area, asset or asset group, specific maintenance programmes are established annually, taking into account long-term strategic positioning.

- ***Asset Development Plans/Programmes***
  For each customer area, capital works programmes are developed to ensure service delivery.

- ***Equipment and Design Standards***
  Equipment and design specifications, based on the required functionality of the assets, are included in the Network Standards Manuals, policies and guidelines. These documents are continually reviewed to ensure the standards are based on current performance and functionality requirements, and to take advantage of new working practices and technology, to ensure minimum asset lifecycle costs.

1.6. PLANNING PERIOD

This AMP covers a period of ten years from 1 June 2005 until 31 May 2015. The plan is a view going forward. It does not commit Vector to any of the individual projects or initiatives set out in the plan. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within Vector. Vector encourages and welcomes stakeholder comment on the plan.

1.7. RESPONSIBILITIES AND ACCOUNTABILITIES FOR ASSET MANAGEMENT

The responsibilities for asset management are outlined in Figure 1.4.

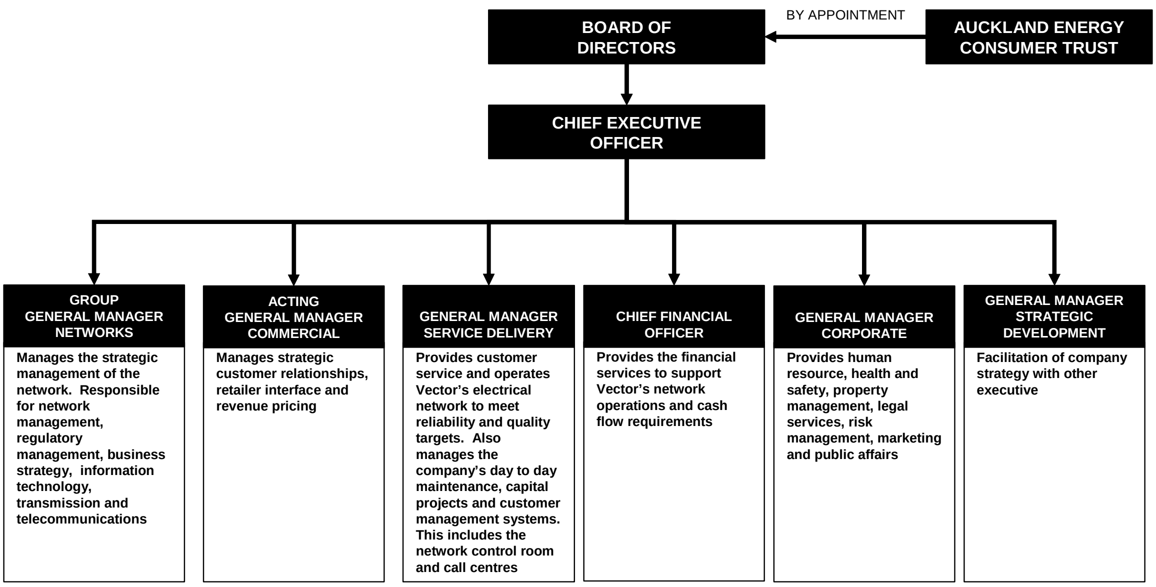

Figure 1.4 Asset Management Structure Chart

1.8. ASSET MANAGEMENT INFORMATION SYSTEMS

1.8.1. OVERVIEW

Decisions on asset performance, asset maintenance, asset replacement, customer responsiveness and optimisation of expenditure require current and accurate information. Enhancing the level of information Vector holds on its assets and network, together with implementation of tools to support the effective use of this information continues to be a high area of focus.

The GIS is the physical asset information system and remains the central focus for asset information collected within Vector and information flows between the GIS and other corporate systems. Our service providers are accountable for the provision of accurate, timely asset maintenance and fault data into the GIS, and are contractually incentivised to do so.

Collection and validation of asset information using field computers is a key feature of Vector's information system strategy.

1.8.2. GIS SYSTEM

The GIS system is the cornerstone of Vector's asset management information systems. The system is used for the following business requirements:

- Performance monitoring of assets for customer management
- Analysis of asset performance
- Data for calculation of the network ODV
- Exported data files for import into network analysis applications
- Geographic based analysis of customer data
- Asset preventative maintenance and test recording
- Base data for asset maintenance scheduling
- Reference for asset location
- Network model for import into SCADA/DMS
- Vector's asset physical register link to SAP financial register

The following developments to the system have been completed over the past 12 months.

Extension of the System to Support Requirements for SCADA/DMS in the Auckland Region

The GIS system provides the foundation data for the SCADA/DMS system. To allow this, the accuracy, range and type of data recorded in the GIS has been expanded significantly over the past 12 months.

A key area has been the establishment of an integrated schematic view of the HV and subtransmission network.

Network Drawings

All the Vector network drawings were merged into Projectwise (Bentley). This replaced the old Vector drawing register (Access database) and the United Networks previous version of Projectwise.

Field Data Collection and Verification

A GIS based field application has been developed and implemented to allow recording of inspections, tests and defects as part of Vector's preventative maintenance programmes.

In addition, the system also allows errors in the GIS data, noticed during field inspections, to be corrected in the field, thereby efficiently improving data quality.

1.8.3. SCADA/DMS (SUPERVISORY CONTROL AND DATA ACQUISITION/DISTRIBUTION MANAGEMENT SYSTEM)

The project to implement a new "real-time" network management system has continued during 2004/05.

Following comprehensive evaluation of systems available, a solution from Telegyr Systems (SCADA) and SPL WorldGroup Pty Ltd (previously CES International) (DMS) was implemented.

SCADA/DMS System

The solution provides base SCADA functionality, integrated with advanced distribution management system (DMS) functions including outage management, switching management, real-time load flow analysis and dynamic asset rating.

The system is integrated, both with Vector's GIS system (for network data) and with its Customer Management System (Siebel - for customer call taking and for provision of information on outages to customers).

The system provides Vector with advanced tools, that improve customer service (through more accurate and up to date information on faults), reduce restoration times, improve asset utilisation and reduce the potential for human error.

1.8.4. NETWORK ANALYSIS TOOLS

DIgSILENT Powerfactory

Vector uses a specialised electricity network simulation software package, DIgSILENT Powerfactory, for all power system related modelling and analysis.

The complete subtransmission and high voltage distribution network is modelled for all three regions, from the Transpower grid exit points to the low voltage terminals of Vector's distribution transformers.

These network models are being used for investment decisions and enhancement to customer service based on load flow, short circuit, network reliability assessment, protection device coordination, motor starting, network loss assessment and power quality analysis.

CYMCAP

CYMCAP continues to be used for calculation of ratings for underground cables.

PI

PI continues to be used for evaluating network and feeder loadings, on an on-line basis.

1.8.5. THE NEXT 12 MONTHS

The following are the principal planned developments of Vector's network information systems:

- Selection and refinement of field information tools
- The upgrade of GIS (Smallworld) to leverage new functionality, such as semi-automated schematic builder
- Deploy aerial imagery in the GIS
- Continue to move the land base from DCDB to CRS/Terralink. Northern region is currently the target area and Wellington will follow thereafter
- Implement a GIS/SAP asset register connector
- Investigate the implementation of expanding the DMS to the Northern and Wellington regions
- Continue to improve data quality

1.9. NETWORK PERFORMANCE REPORTING AND ANALYSIS

1.9.1. CURRENT SYSTEMS

Over the past 12 months, Vector has developed a comprehensive suite of reporting and analysis tools to help track and understand the performance of the network.

To support the reporting, a network performance "datamart" has been created which extracts and then consolidates key information from Vector's transactional systems.

All reporting is automatically updated each morning so that staff are dealing with accurate, up to date information. Access is company wide, through Vector's intranet.

The following tools are in place:

Automated Daily Fault Reports

Each morning a summary of HV faults from the past 24 hours is automatically sent to key staff across Vector and its zone based contractors, as outlined in Figure 1.5 below.

Daily Fault Report for 20/04/2005 Website

Click on the Fault Number to be taken to more detailed information. For other information please click on the website link

	Customers Affected	SAIDI	MAX TIME OFF
	0	0	0
	1-200	0 - 0.1	0 - 2hrs
	201-500	0.1 - 0.5	2 - 2.5hrs
	501-1000	0.5 - 1	2.5 - 3hrs
	1001+	> 1.0	3hrs+

Unplanned Faults since midnight yesterday

Fault Number	Region	Zone Sub/ Transmission Line	Cause	Reason	Customers Affected	Regional SAIDI	MAX TIME OFF
141614	NORTHERN	NORTHCOTE	EQUIPMENT - UG	TRANSFORMER	70	0.173	485
05-74	AUCKLAND	AVONDALE	EQUIPMENT - OH	CROSSARM	395	0.039	29
141612	NORTHERN	WELLSFORD	EQUIPMENT - OH	BINDER	182	0.081	87

Planned outages since midnight yesterday

Event Number	Region	Zone Sub / Transmission Line	Circuit Out	Customers Affected	SAIDI
141613	NORTHERN	MANLY	20SCOT	19	0.035

Figure 1.5 Automated Daily Fault Report – Summary Report

This information provides awareness of the faults that have occurred for the 24 hour period. Further detailed information on each fault is linked to this report as shown Figure 1.6.

05-74 | AUCKLAND

FAULT DETAIL

Date	19/04/2005	Service Request Nr	1-28936299
Fault Time	19:12	Vector Engineer	R Newton
System Level	FEEDER	Fault Cause	EQUIPMENT - OH
Faulted Circuit	AVON 13	Equipment - Primary Type	
Sub/Line	AVONDALE	Equipment - Secondary Type	
Street Location	Addison Rd by Taylor St	Fault Reason	CROSSARM
Nearest Pole	0	Fault Type	UNPLANNED
Contractor	Energex		

PERFORMANCE MEASURES

Regional SAIDI	0.039	Customer Minutes	11,452
Regional SAIFI	0.0013	Customers Affected	395
Regional CAIDI	29	Maximum Time Off	29

OUTAGE DETAIL

Feeder	Date	Start Time	Trips	Switch Operated	Protection	Description	Notes	Further Repairs
AVON 13	19/04/2005	19:12	0	Emergency Shutdown	nil	Broken Xarm Addison St	Xarm replaced.	no

RESTORATION DETAIL

Feeder	Customers	Total Time Out	Area Description
AVON 13	395	29	Addison , Taylor St

Figure 1.6 Automated Daily Fault Report – Summary Report for Specific Fault

HV Outages Reporting

A range of reports have been developed to provide access to information to support decision making on network performance improvement initiatives.

The reports allow access to seven years history of HV fault events, analysed in a variety of ways. The reports allow users to easily change parameters to meet their particular information requirements as shown in Figure 1.7.

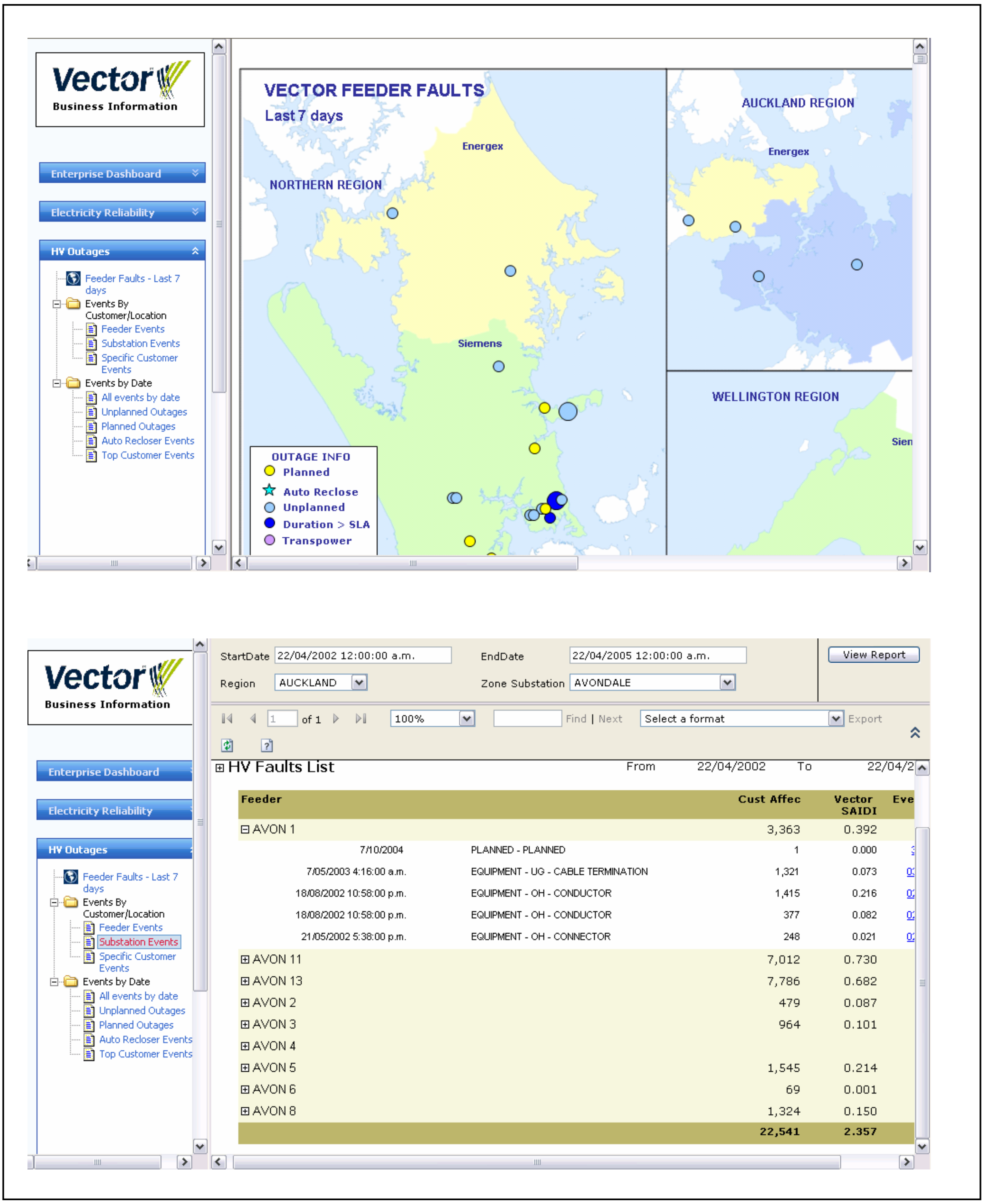

Figure 1.7 HV Outages Reporting

Reliability Reporting

In addition to information on individual events, overall monitoring against performance targets is also reported.

These reports track performance against a variety of measures including SAIDI, SAIFI, CAIDI and service level objectives. Examples are show in Figures 1.8 and 1.9.

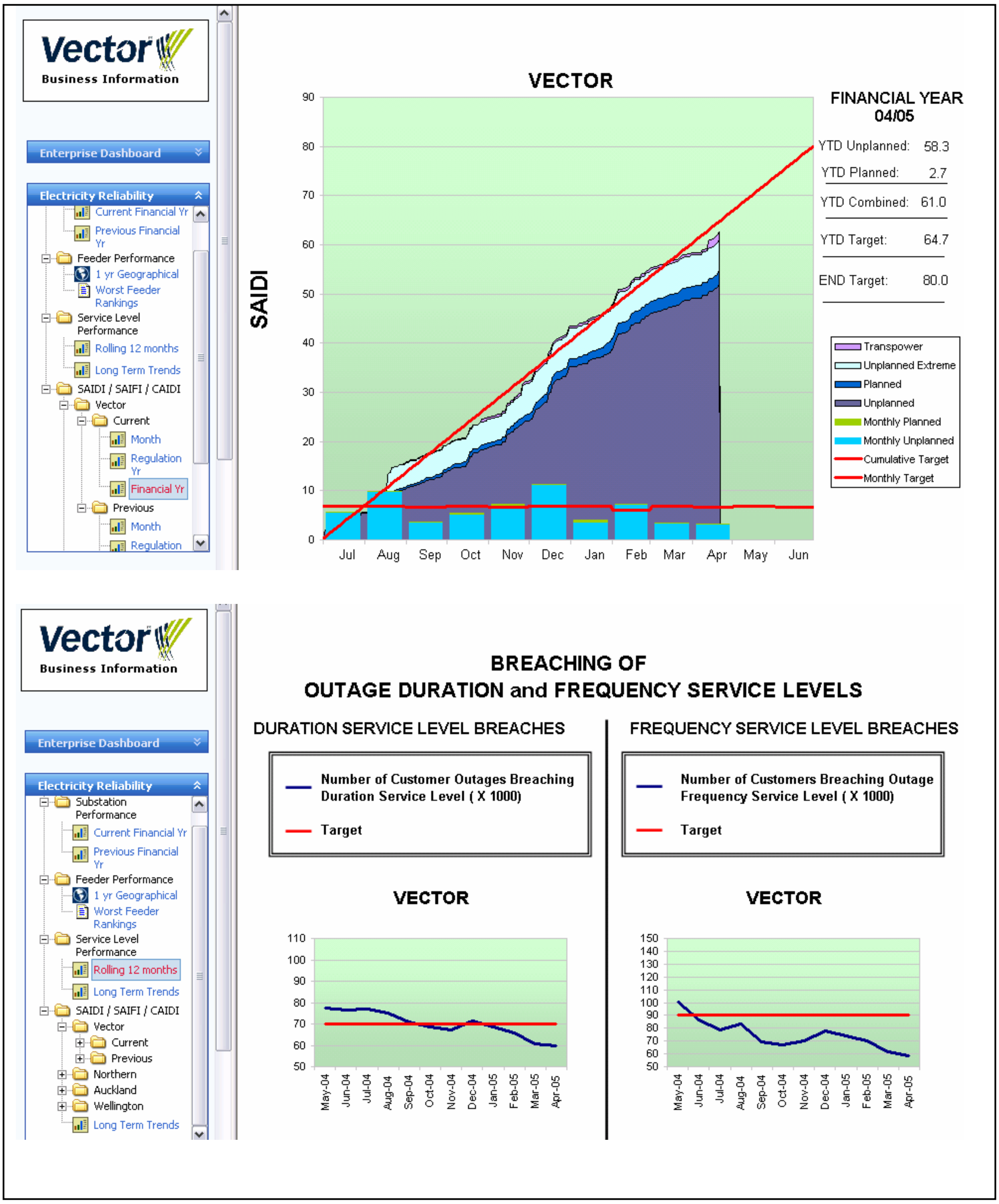

Figure 1.8 Service Levels

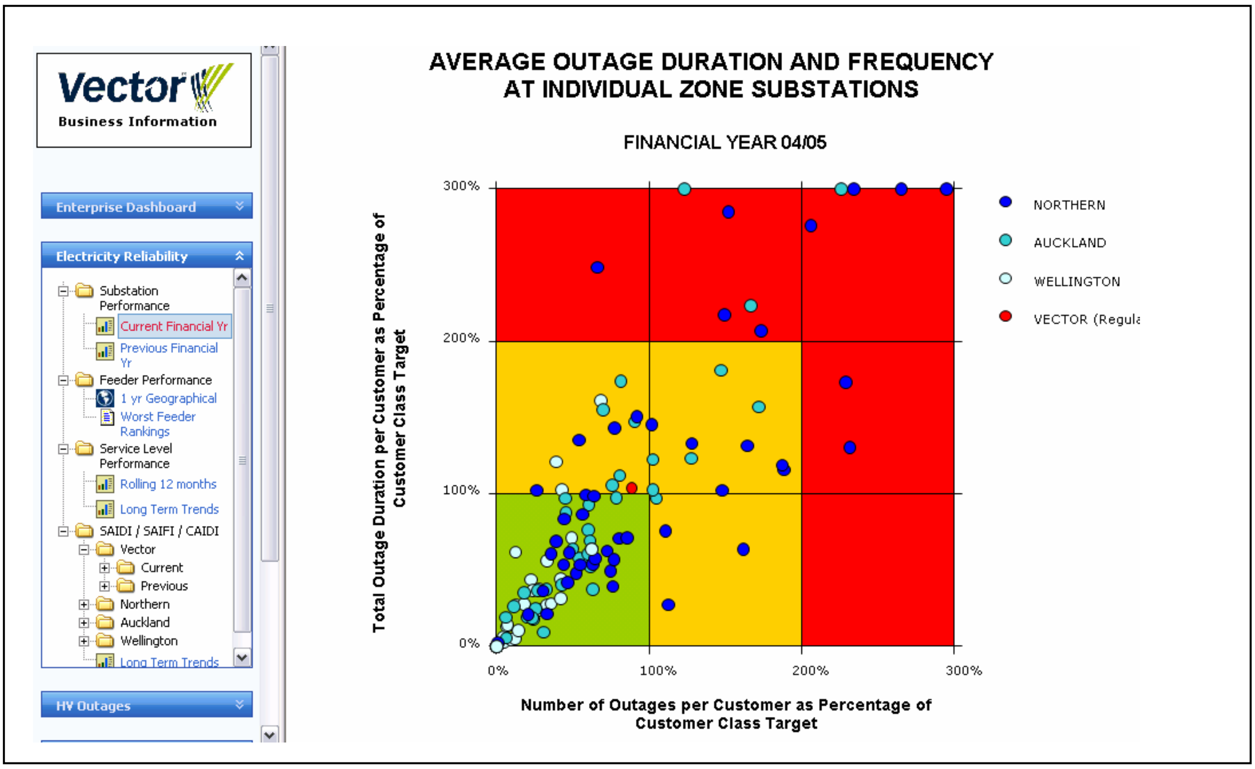

Figure 1.9 Reliability Reporting

Focused Analytical Reports

Interactive reports have been implemented which allow staff to discover underlying trends and patterns.

In Figure 1.10 each feeder is analysed across a variety of performance measures. The user is able to select a particular measure to sort by. Colour is used to indicate relative ranking for each measure.

WORST 15 FEEDER RANKINGS

Based on performance for the year up to Friday, 22 April 2005

RANKED BY SAIFI

REGION	ZBC	SLA TYPE	SUBSTATION	FEEDER	SAIDI	SAIFI	CAIDI	Frequency SLA	Duration SLA
NORTHERN	SIEMENS	RURAL	HENDERSON VALLEY	15PIHA	1	1	97	42	1
NORTHERN	SIEMENS	RESIDENTIAL	MANLY	20MOTU	4	2	206	2	5
NORTHERN	SIEMENS	RESIDENTIAL	EAST COAST ROAD	08KNIG	11	3	336	1	9
NORTHERN	SIEMENS	RURAL	WAIMAUKU	40MURI	28	4	406	49	69
AUCKLAND	NORTHPOWER	RURAL	TAKANINI	TAKA 12	6	5	199	102	12
AUCKLAND	NORTHPOWER	RURAL	OTARA	OTAR 16	7	6	217	55	72
NORTHERN	SIEMENS	RURAL	SPUR ROAD	29REDB	54	7	436	111	107
NORTHERN	SIEMENS	RESIDENTIAL	OREWA	26MAIR	35	8	408	6	178
NORTHERN	SIEMENS	RESIDENTIAL	EAST COAST ROAD	08ROSE	13	9	260	3	25
AUCKLAND	NORTHPOWER	RURAL	SOUTH HOWICK	SHOW 3	5	10	120	112	17
NORTHERN	ENERGEX	RURAL	WARKWORTH	38MATA	12	11	201	169	91
NORTHERN	SIEMENS	RURAL	COATESVILLE	07MAHO	19	12	276	52	37
NORTHERN	ENERGEX	RURAL	SNELLS BEACH	44PARK	57	13	415	142	472
NORTHERN	SIEMENS	RESIDENTIAL	BIRKDALE	04FORD	21	14	284	4	472
NORTHERN	SIEMENS	RURAL	SWANSON	31BETH	8	15	124	143	8
NORTHERN	SIEMENS	RESIDENTIAL	MANLY	20SCOT	40	16	373	9	136
NORTHERN	SIEMENS	RURAL	HELENSVILLE	13WAIT	15	17	205	25	15
NORTHERN	SIEMENS	RURAL	SPUR ROAD	29WADE	3	20	67	129	2
NORTHERN	ENERGEX	RURAL	WARKWORTH	38WHAN	10	25	125	180	7
NORTHERN	SIEMENS	RESIDENTIAL	OREWA	26HATF	26	26	246	17	10
NORTHERN	SIEMENS	RURAL	SPUR ROAD	29REDV	14	27	143	124	53
NORTHERN	SIEMENS	RESIDENTIAL	JAMES STREET	09ELLI	95	42	365	8	129

Figure 1.10 Focused Analytical Reports

GIS Maps

A large number of maps are produced to geographically show where faults are occurring on the network.

The map shown in Figure 1.11 indicates the "density" of overhead faults. It was used as one of the many criteria in determining priority areas for undergrounding in Vector's Auckland network.

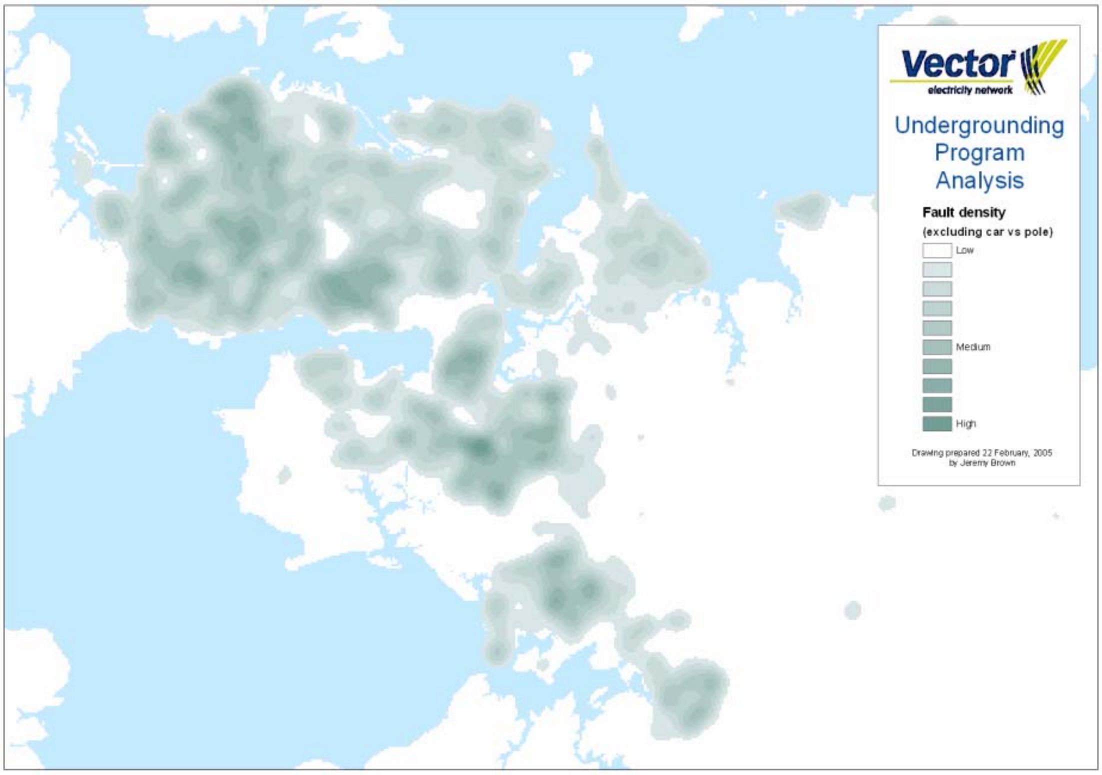

Figure 1.11 Underground Programme Analysis

The map shown in Figure 1.12 indicates areas where tree faults are occurring. This map colours each feeder based on number of tree contact faults. It was used to help design Vector's tree trimming programme.

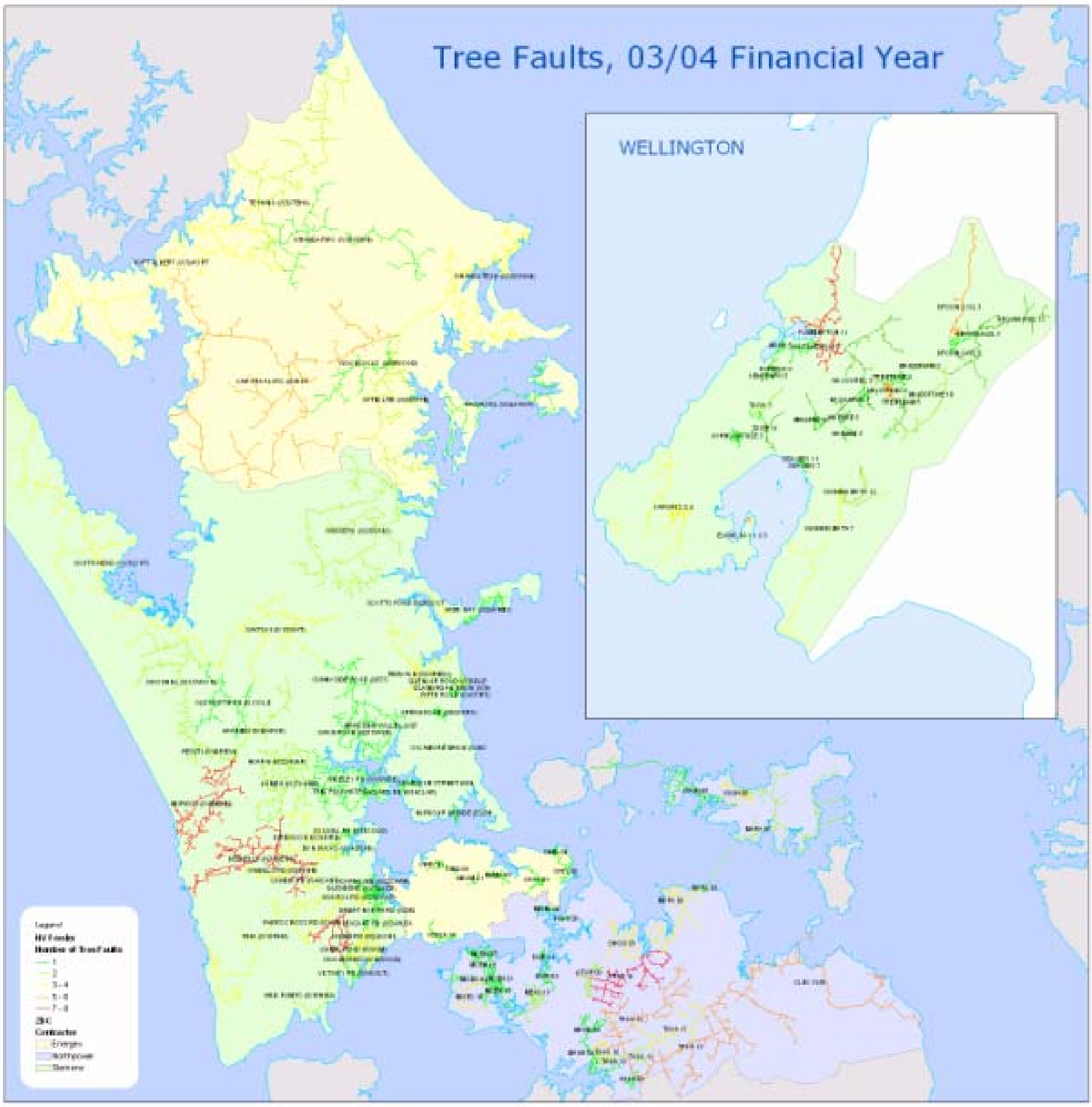

Figure 1.12 GIS Maps

1.9.2. FUTURE PLANS

The current reporting suite provides a retrospective view of asset and network performance. This information allows decisions to be made to address current problems.

The direction from now is to develop predictive tools, which model historic performance and from this forecast future trends. The objective is to allow actions to be taken before problems occur.

In addition further "focused analytical reports" will be developed to further refine decision making processes.

2. NETWORK ASSETS

2.1. NETWORK OVERVIEW

The overall architecture of the network is shown in Figure 2.1.

The network can be considered as three networks – transmission, subtransmission and distribution. The 110kV transmission network connects the Transpower network to the Vector bulk supply substations for Vector supply, but also supports security on the Transpower transmission system. The subtransmission network connects the Transpower network at the grid exit points to zone substations, at 33kV or 22kV. Each substation serves a particular geographic area, with known asset and customer characteristics. At the substations the voltages are further stepped down to 11kV or 6.6kV. The distribution network then carries the electricity to distribution transformers, or for some commercial customers, directly to their premises. At the distribution transformers electricity is stepped down to 400/230V for final delivery to customers.

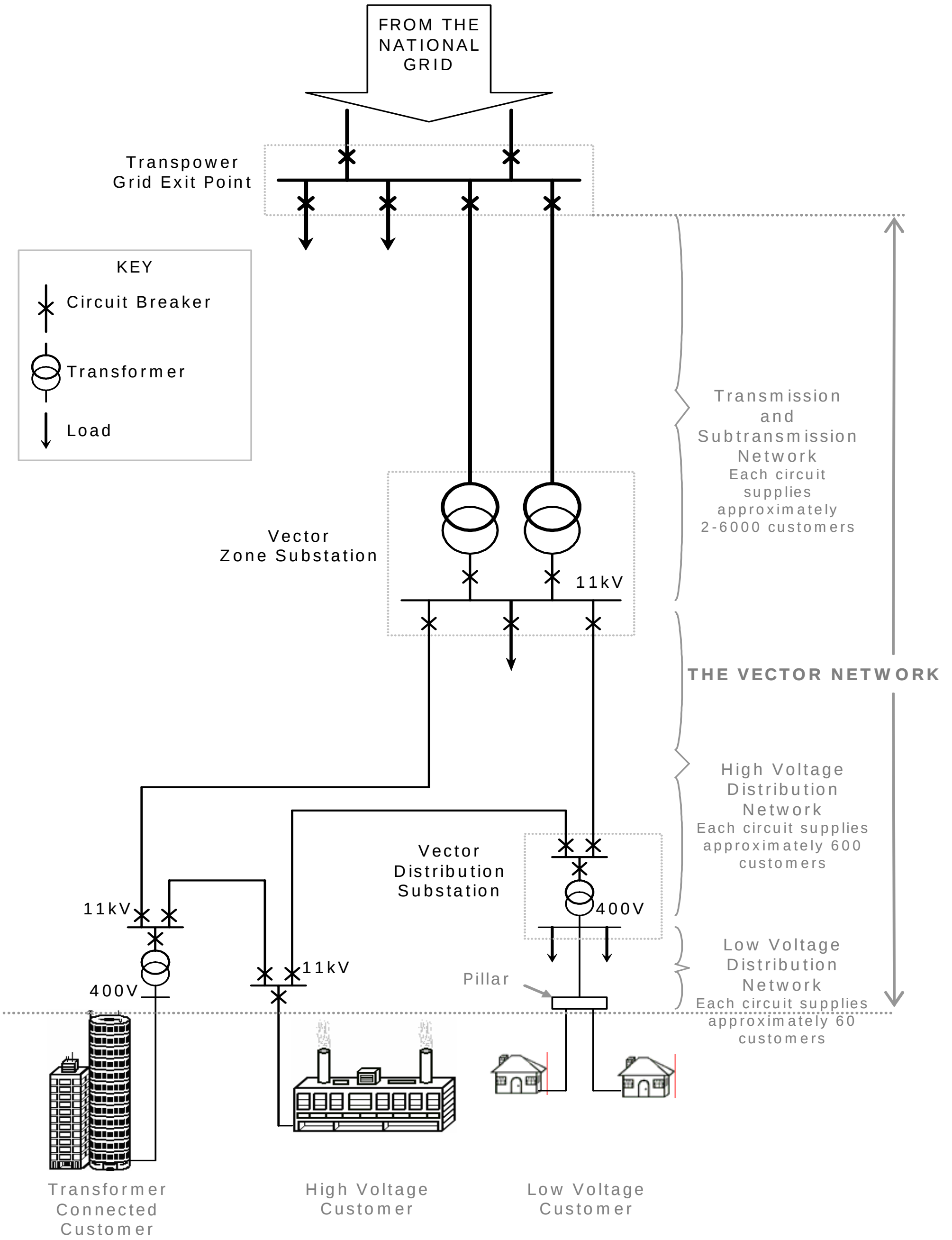

Figure 2.1 Schematic of Vector's Network

2.2. TRANSMISSION AND SUBTRANSMISSION NETWORK

The higher voltage transmission and subtransmission network is designed to transfer large amounts of electricity efficiently, and also provides additional security to the Transpower cross isthmus network. The network transfers electricity from Transpower's network via 22 grid exit points, to 123 zone substations. A zone substation typically supplies between 2,000 to 6,000 customers. The subtransmission network consists of a combination of overhead lines and underground cables.

At the zone substations, the subtransmission voltages are stepped down to 11kV (or 6.6kV) to supply the distribution network. The zone substations are all remotely controlled via the SCADA system, which allows remote operation to be carried out from the Control Room and returns load and equipment operation information.

2.3. TRANSMISSION AND SUBTRANSMISSION DESIGN

The transmission network has been developed essentially as a radial network.

The subtransmission networks in Auckland and Wellington have been designed as radial feeders, with two or three transformers at each zone substation. There are no ties between zone substations at subtransmission level (other than in the Auckland CBD). The subtransmission network in the Northern region is a combination of radial feeders and meshed networks.

The future development of the subtransmission system will be driven by the reliability and design standards and customer service levels, and may include single transformer stations, and more interconnections at subtransmission voltage.

Auckland Network

Generally the load on a zone substation should not exceed 30MVA in the Auckland network, in order to keep the number and size of 11kV feeders within practical bounds. In some cases where the load is relatively concentrated, the design maximum load can rise to 50MVA (eg, in the Auckland CBD, where land for new zone substations is expensive and difficult to obtain, or in heavily industrial areas).

If there is to be no loss of supply for a single subtransmission circuit fault, the allowable load on the station is limited to the sum of the short-term ratings of the remaining healthy circuits. Vector's design philosophy permits the station load to be increased beyond this limit by accepting a small probability that in the event of a fault, load will have to be shed immediately while load transfers are carried out, with the proviso that all supply is restored by network switching. For the subtransmission security targets see Section 3.

Wellington Network

In the case of Wellington, each zone substation was designed to a single contingency security standard. Because of the closed ring formation of the 11kV distribution network, the amount of interconnection between different zones is very limited. The size of transformers in Wellington varies between 10MVA to 30MVA depending on the load density of the area the zone substation supplies. The design for zone substations in the Hutt and Porirua areas are similar to that for Wellington, ie, to maintain a single contingency security. The radial (interconnected) nature of the distribution network however provides additional backup supply under multiple contingency situations. It should also be noted that due to fault level constraints, the transformers at 12 of the Wellington network zone substations can not be operated in parallel.

Northern Network

The subtransmission network in the Northern Region is configured in a mesh formation. Security of the network is dependent on the power flow in the network under different contingency conditions. The transformers at six of the Northern network substations can not be operated in parallel due to fault level constraints.

2.4. DISTRIBUTION NETWORK

The function of the distribution network is to deliver electricity from the zone substations to customers. It includes a system of cables and overhead lines operating mainly at 11kV, with some 6.6kV, which distribute electricity from the zone substations to distribution substations. Typically 600 customers are supplied at the high voltage distribution level. At the distribution substations the electricity is then stepped down to 400V and delivered to customers either directly, or through a reticulation network of overhead lines and cables. Approximately 30 to 150 customers are supplied from each distribution substation, via the low voltage distribution network. For larger loads, electricity can also be delivered at 6.6kV, 11kV or (for very large loads) 33kV. Four main categories of customer connection are available and the final network connection type is determined through consultation with the customer. The connection types are:

- Single phase low voltage
- Three phase low voltage
- Transformer connection
- High voltage connection

A number of customers are fed by dedicated substations, and take supply at 33kV or 11kV.

2.5. DISTRIBUTION DESIGN

The distribution system in Auckland, Northern and the Hutt areas consists of interconnected radial circuits originating from zone substations. The design is based on the concept of availability of feeder backstopping capacity, according to the security standards. A distribution feeder fault may result in an outage, but in urban substations supply should largely be able to be restored within two to three hours by switching operations on the distribution network. This system provides a very reliable means of electricity supply. In the case of Wellington, the backbone 11kV network is constructed in the form of closed rings fitted with unit protection. In this type of network, no supply loss will be experienced by customers under single contingency situations. From the backbone closed ring networks, radial feeders have also been developed to supply the marginal demand. These radial feeders are interconnected to allow backup under emergency conditions.

The distribution circuits are controlled by automatic circuit breakers at the zone substations. Switches are installed at strategic locations on the circuits to provide operational flexibility. A key focus is on automation of these switches in the network where applicable to improve service levels. For details, see Section 7.2.2. For the distribution security targets see Section 3.

There are a number of large customers in the Auckland network connected to the network at high voltage. The ownership of the substations serving these customers varies from site to site, but generally Vector owns the incoming switchgear and any protection equipment associated with it. The customer usually owns the transformer(s), any outgoing switchgear and associated protection, and the building. Similar arrangements exist in the Wellington and Northern areas. All customers in the Wellington CBD are supplied at low voltage.

2.6. SCADA

The role of SCADA systems is being extended from being just a network management tool to a knowledge management tool that is serving a more diverse range of users.

Vector's SCADA system consists of a number of SCADA sub-systems. These sub-systems have been installed over time and some of them are based on technology that has become obsolete or does not integrate well with the other business applications and is being replaced.

A need has been identified to formulate and implement an integration and replacement strategy for the SCADA system components. This is described below.

2.6.1. INTEGRATION STRATEGY

The integration strategy enables Vector to deploy the selected technologies across the whole network, using standard communication protocols.

The integration strategy provides Vector with the ability to easily migrate to a future overall SCADA system.

2.6.2. SCADA MASTER STATIONS

A Siemens Telegyr master station has recently been deployed for monitoring and control of the Auckland electricity network.

A LN2068 SCADA master station, from Leads and Northrop, with Foxboro workstations is used for the Northern and Wellington regions' electricity networks.

2.6.3. REMOTE TERMINAL UNITS (RTU'S)

A number of different RTU's have been installed in Vector's network.

A large proportion of the RTU's has reached or exceeded its technical life and has become obsolete. Vector has embarked on a planned replacement programme of the RTU's. The implemented SCADA integration strategy enables Vector to deploy the selected modern RTU from Foxboro and Serce as the replacement across the whole network.

2.6.4. COMMUNICATION PROTOCOLS

A number of SCADA communication protocols are presently used to facilitate communication between the SCADA systems and different type of Intelligent Electronic Devices (IEDs) installed in the network.

Adoption of the industry standard communication protocols benefits Vector in reduced purchasing, implementation and maintenance costs.

The choice of DNP3 protocol over TCP/IP protocol has been adopted as the IEDs communication protocol between SCADA master station and the IEDs. It has also been recognised that IEC61850 protocol may be used in the future for this role.

2.7. COMMUNICATION SYSTEM

Vector's communications network consists of different architectures and technologies of which some are based on proprietary solutions. The physical network infrastructure consists of optical fibre and copper wire telephone type pilot cables as well as third party radio communication systems.

The network is used to provide communication paths for protection signalling, SCADA, operational telephony, access security, metering, remote equipment monitoring and maintenance, and automation.

Vector is committed to an open communication architecture and to industry standards. This has resulted in the adoption and deployment of Ethernet and Internet Protocol (IP) based communication technology.

IP based technology is the most cost effective and future proof technology for communication within and outside electricity substations.

2.8. POWER SYSTEM PROTECTION

Vector's network is protected by protection relays and fuses.

The main role of protection relays is to detect network faults by monitoring various parameters and initiating the opening of relevant circuit breakers should an abnormal situation be observed. This minimises damage to the equipment, hazards to people and loss of supply to customers.

All new and refurbished substations are equipped with multifunctional IEDs. Each IED combines protection, control, metering monitoring, and automation functions within a single hardware platform and communicates with the substation computer or directly to SCADA central computers over the IP based communication network using the industry standard communication protocols.

2.9. ENERGY AND PQ METERING

Vector's supply point energy and power quality metering system consists of a number of intelligent web-enabled revenue class energy and power quality meters. The meters communicate to the metering central software over an Ethernet based IP routed communication network.

The metering system provides Vector with essential information to control the cost, quality and reliability of the power delivered to Vector's customers, and is currently used to:

- Improve operational efficiency by controlling peak demands at the bulk supply points, which ultimately reflects in reduced line charges to Vector's customers
- Provide comprehensive power quality and reliability information that will enable the verification of the quality of power delivered to our customers against the published Vector service levels, and faster resolutions of power quality issues

- Increase the power system stability by initiating instantaneous load shedding during under frequency events.

In order to reduce the metering installation and maintenance cost at the supply points, Vector, in collaboration with the national grid operator Transpower, has initiated and is funding a trial project for sharing metering data from ION® intelligent revenue and power quality meters recently installed at the new Silverdale substation.

2.10. LOAD CONTROL SYSTEM

Vector's load control system consists of a number of audio control frequency ripple control plants, pilot wire and DC bias systems, as well as a small number of CylcoControl plants. These assets together with our metering system give us the ability to:

- Control residential hot water cylinders (load shedding)
- Control street lighting
- Meter switch for tariff control

Vector is investigating the feasibility of lowering the existing audio control frequencies to a lower value in the areas where the attenuation of the existing control frequency signals is excessive.

2.11. IMPROVEMENTS TO NETWORK DESIGN

The current network architecture is continuously reviewed to ensure an architecture that is structured around meeting the customers needs while achieving technical excellence (the customers needs are reflected by Vector's service level standards and feedback from customers) at an economically sustainable level.

The approach is to develop an optimised network architecture based on customer needs, cost, reliability and network losses. Network simulation software is one tool that will be used to select the optimum solution. Performance parameters will be established to measure the success of any project and we will continuously strive to improve our performance through feedback and optimisation.

Technological developments and innovation in areas such as distribution network automation and distributed generation technology will be considered in the process.

Data collected by Networks, Service Delivery and Commercial will be used for analysis, to determine trends and to perform investigations with the ultimate goal of identifying areas for improvement.

In addition to technical performance, the network architecture will address issues such as amenity value and health and safety requirements.

3. SERVICE STANDARDS

Service for Vector is about understanding what our customers value and then meeting these requirements cost-effectively where appropriate. It encompasses providing our customers with a safe, reliable supply of electricity, providing customer specific solutions, being accessible to customers, and providing accurate timely information.

Our customer research has shown that different groups have different needs and tolerances of power fluctuations in terms of length and time of day. All research indicates that reliability in terms of fault frequency and duration of outages is important to customers, but with different levels of criticality.

An important consideration in considering improvements to Vector's network is the Commerce Commission's regulatory regime for electricity lines businesses. In addition to thresholds set for price and quality levels, lines businesses are also required to engage with consumers to better understand price-quality trade-offs. While the thresholds are not direct regulatory control, they have a controlling effect. Investment decisions, therefore, clearly need to be considered in the context of compliance (or otherwise) with the thresholds. The Commission has indicated that there may be valid reasons for breaching a threshold, so long as there is a sound explanation for such behaviour and it is shown, in effect, to be in the long-term interest of consumers. Vector will consider its investments within this context, including making judgements about whether an explanation (ex post) would likely be accepted by the Commission, if the restrictions of the thresholds themselves constrained Vector's ability to introduce appropriate improvements to the network.

For a number of commercial and industrial customers, feedback has indicated that power quality is, in many cases, as critical as outages. Power quality is the provision of supply within acceptable parameters such as voltage, frequency and waveform distortion. In the Vector networks we have a number of customers sensitive to voltage fluctuations, many of whom run continuous process operations with high costs associated with a disturbance or loss of supply. Customer requirements and willingness to pay for varying service levels will ultimately drive performance.

Vector has maintained a number of standard service levels against which we assess and measure our performance. The standards give Vector a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value.

Network performance at Vector is managed at three levels:

1. Reliability targets set at network level to align with our standard service levels by customer type, SAIFI and CAIDI (which in turn, give SAIDI).

2. The ability to handle extreme contingencies with the minimum impact to the customer, through risk mitigation. This is managed through our formal risk management process as in the “loss of substation” and similar scenarios.

3. Power quality and customer responsiveness.

3.1. RELIABILITY

Reliability reflects what the customer sees, as it is a measure of how often the power is off and for how long. Reliability is primarily a function of the original design and specification, equipment selection, external impacts (eg, adverse weather), maintenance practices and the operating regime. Reliability is generally measured by the industry standard measures of SAIDI, SAIFI and CAIDI.

$$\text{SAIDI} = \frac{\text{Sum of (Number of Interrupted Customers} \times \text{Interruption Duration)}}{\text{Total Number of Connected Customers}}$$

$$\text{SAIFI} = \frac{\text{Sum of (Number of Interrupted Customers)}}{\text{Total Number of Connected Customers}}$$

$$\text{CAIDI} = \frac{\text{Sum of (Number of Interrupted Customers} \times \text{Interruption Duration)}}{\text{Sum of (Number of Interrupted Customers)}}$$

The measures of SAIDI, SAIFI and CAIDI are used as they provide a consistent measure of performance across the network that can be compared on a year by year basis. Vector's reliability performance targets are disclosed in accordance with the Electricity Information Disclosure Requirements 2004. The results and targets for 2004 and targets for 2005 are shown in Table 3.1.

Measure	2004 Target	2004 Actual	2005 Target
SAIDI	80	83.09	80
SAIFI	1.3	1.25	1.3
CAIDI	61.5	66.62	61.5

Table 3.1 Results for SAIDI, SAIFI, CAIDI

The following Figures 3.1, 3.2 and 3.3 show SAIDI, SAIFI and CAIDI for the combined Northern, Auckland and Wellington networks.

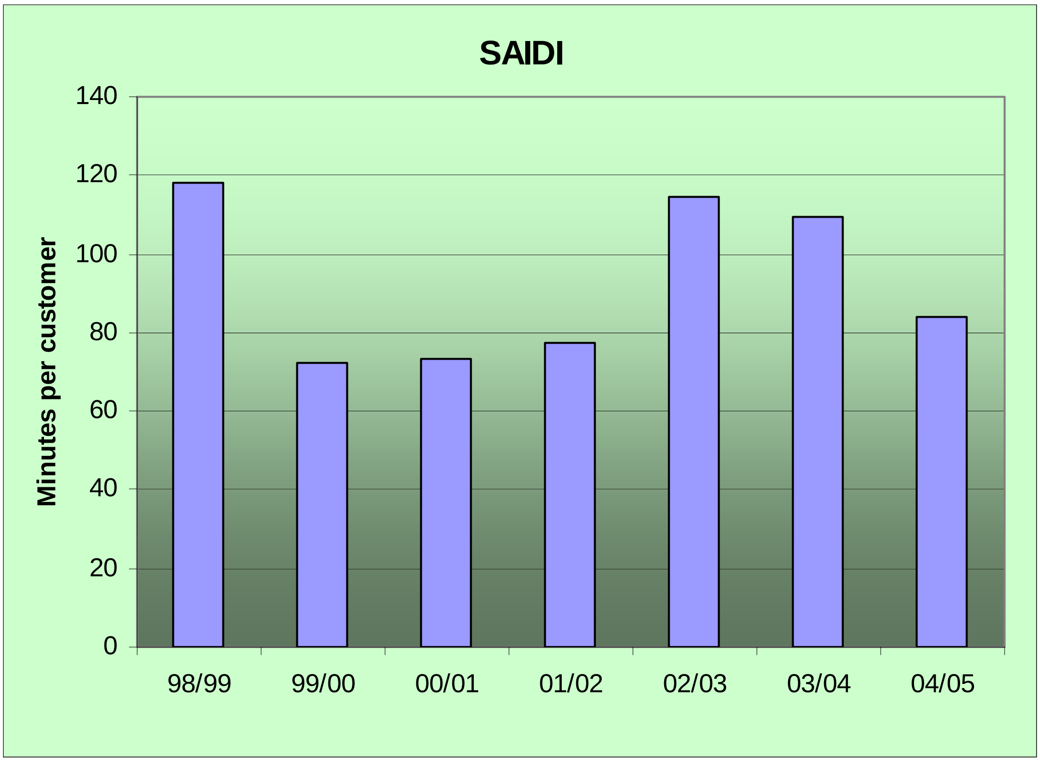

Figure 3.1 SAIDI Actuals (including Transpower outages)

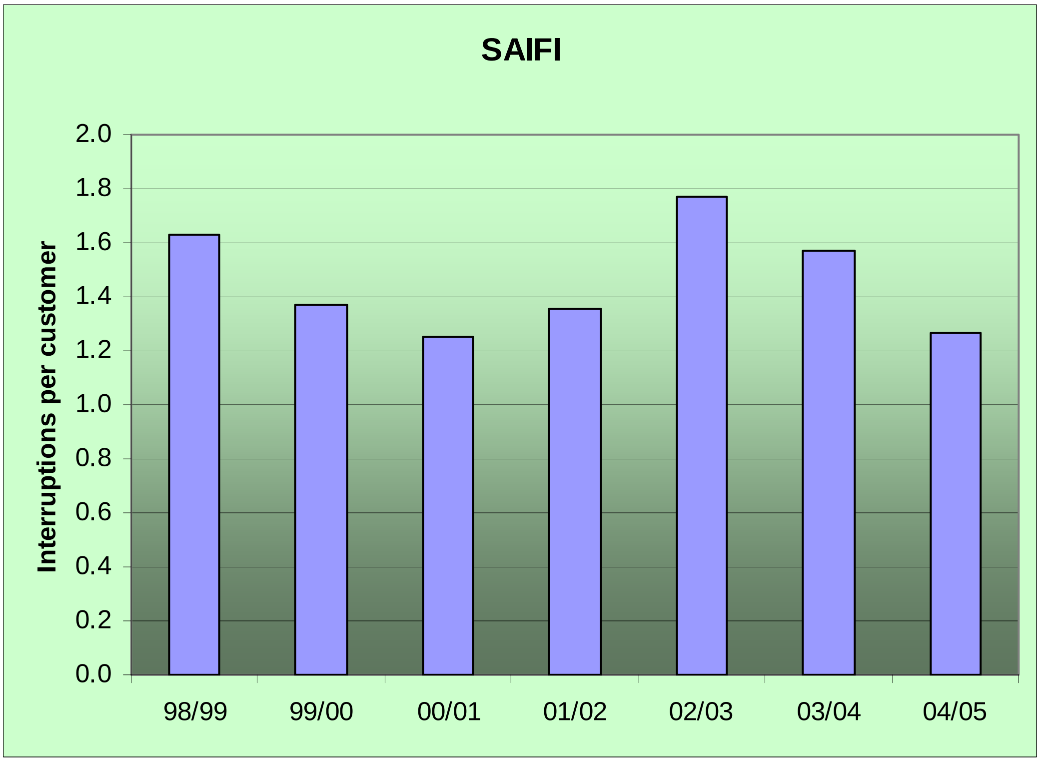

Figure 3.2 SAIFI Actuals (including Transpower outages)

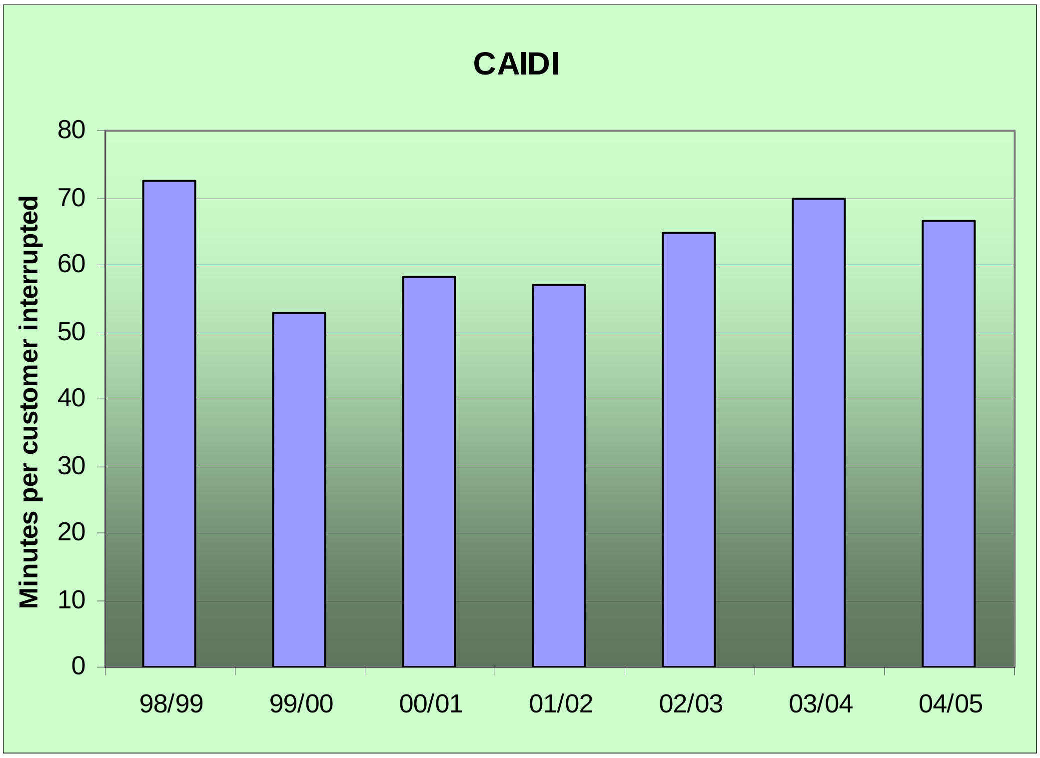

Figure 3.3 CAIDI Actuals (including Transpower outages)

Although we are not yet reaching the key reliability targets we have set for our networks, we are seeing the benefits of targeted asset management practices. There is no regulatory incentive to improve SAIDI.

Whilst weather has had a significant impact, there are a number of areas we will focus attention on in the coming year to improve this position. These include planned maintenance practices in the Northern and Wellington network areas and vegetation management practices in all network areas.

Our focus on reducing the human error component of the reliability results has had very good results. Initiatives included working with our service providers to improve switching practices – we will continue to maintain focus on this area.

3.2. NETWORK MANAGEMENT

Within the Vector network, the risk of an outage occurring for customers in a given area is calculated and assessed against the baseline level of service for that customer type. This ensures that effort is directed to proactively highlight poorly performing areas and specific corrective actions taken to enhance reliability.

To align the reliability targets with our customers requirements and expectations which vary across the network, we have implemented specific outcome targets for different zones. These standard service levels, shown in Table 3.2, give our customers a reasonable expectation of what level of service they will receive from Vector, dependant upon what region they live in. Customers will be able to contract for higher levels of reliability and quality where required.

	CBD	Industrial	Urban	Rural
Restoration time	0 to 2 hours	0 to 2 hours	0 to 2.5 hours	0 to 4.5 hours
Fault frequency per annum	0 to 3 times	0 to 3 times	0 to 4 times	0 to 10 times

Table 3.2 Standard Service Levels: Reliability and Restoration Times

For network management purposes, reliability targets and standard service levels are translated into SAIDI, SAIFI and CAIDI targets for our service providers.

The SAIFI fault frequency results are reviewed to understand if there is a particular asset or group of assets causing high fault frequencies, or a particular fault cause in an area. The results of the analysis can then be used to initiate revised preventative maintenance, asset refurbishment or replacement programmes, or other solutions if the fault cause is external, such as car versus pole or directional drilling.

The CAIDI fault duration results are reviewed to understand what is causing the high duration outages and what the potential solutions could be. The solutions could range from restructuring of the fault crew response, automation, or installation of fault passage indicators, to assist efficient fault location.

We have developed sophisticated analysis techniques to enhance our understanding of fault patterns, based on time of day, area, and assets to enable focus to be placed in areas which are causing problems.

Service providers are incentivised under the performance nature of the contract to manage the operation and maintenance of the network to achieve the network reliability targets and customer service standards. The annual maintenance plans are developed as a result of the review and analysis of SAIFI and CAIDI performance, and the optimum management plan to achieve the standard service level for that network is established.

3.3. SYSTEM DESIGN SECURITY

In last year's AMP, we reported different security criteria for the Auckland and Northern and Wellington regions. These criteria have now been changed and are now common for all three regions of Vector.

3.3.1. NETWORK SECURITY

Vector's approach to asset management and network planning has historically been driven by the following principles:

- Customer needs, which vary by market segment and are reflected by service level standards, are trending towards higher reliability and improved power quality
- Capacity and network reinforcements are investments and Vector strives for least cost solutions (optimum asset utilisation) and the deferring of capital expenditure
- Investment strategies and service offerings provide improved value to customers and improved return to shareholders
- Risk management strategies are aligned with the planning philosophy
- Continuously strive for innovation and optimisation in network design and introducing leading edge technology like sophisticated scheduling and remote switching technology to improve utilisation

In support of these principles, Vector is moving away from a deterministic planning approach to a probabilistic approach, which recognises that our product has variable reliability and quality and that the customers needs and business strategy should drive investment in the network.

Reliability based planning is the foundation of this approach. It is a probabilistic evaluation of the networks ability to meet customer needs. It assesses the probability of failing to supply customers load by applying long-term industry averages cross checked with actual Vector statistics for failure rates and repair times for all network elements (cables, lines and transformers) in a stochastic model. The outputs of the model are then used to assess the reliability of the network and to compare the relative reliability of different options.

The success of reliability based planning depends on the data and the model used. This means overlaying the industry long-term averages with Vector data.

The ability to predict the reliability of the network with confidence, combined with alternative technical solutions, advances in information management, communication and distributed generation are providing the framework within which planning can meet customer expectations while improving the return to shareholders.

The reliability implied by the current service level standards will apply until the output of the reliability based planning modelling provides more customer and network specific service levels.

The security criteria for the subtransmission network and the distribution network are listed in Tables 3.3 and 3.4 below.

3.3.2. SUBTRANSMISSION AND DISTRIBUTION RELIABILITY

	Type of Load	Security Criteria Single Contingency Only
1	Predominantly residential substations	Full backup available at all times. No interruption of supply for 95% of the time in a year. Any supply loss will be restored within 2.5 hours in urban areas and 4.5 hours in rural areas.
2	Mixed commercial/industrial/residential substations	Full backup available at all times. No interruption of supply for 98% of the time in a year. Any supply loss will be restored within 2 hours.
3	CBD or predominantly industrial	Full backup available at all times. No interruption of supply for 99.5% of the time in a year. Any supply loss will be restored within 2 hours.

Table 3.3 Subtransmission Network

Note 1: *Brief interruption acceptable if an upgrade can not be economically justified, but the supply interruption shall be for no more than 1 minute in high load density areas, 2.5 hours in urban residential areas and 4.5 hours in rural areas.*

Note 2: *Full backup can be provided via the subtransmission or distribution network, or other means such as mobile generation.*

	Type of Load	Security Criteria Single Contingency Only
1	Overhead spurs supplying up to 1MVA urban area	No back stop. Total loss of supply upon failure. Supply restoration upon repair time.
2	Overhead spurs supplying up to 2.5MVA rural area	No back stop. Total loss of supply upon failure. Supply restoration upon repair time.
3	Underground spurs supplying up to 400kVA	No back stop. Total loss of supply upon failure. Supply restoration upon repair time.
4	Predominantly residential feeders	Full backup available 95% of the time in a year. Supply might be lost for 5% of the time in a year.
5	Mixed commercial/industrial/residential feeders	Full backup available 98% of the time in a year. Supply might be lost for 2% of the time in a year.
6	CBD or high density industrial	Full backup at all times.

Table 3.4 Distribution Network

Note 1: *There will be a supply interruption for every feeder fault, but supply will be restored through backup (except in the case of spurs).*

Note 2: *Restoration of supply, in the event that there is an interruption, shall be targeted at no more than 2 hours in CBD and industrial areas, 2.5 hours in urban areas and no more than 4.5 hours in rural areas.*

No customer will be without supply for longer than three hours following any single feeder fault (except for customers on spurs, where in some circumstances the repair time may exceed three hours).

The variation between areas is for two reasons:

1. The reliability requirements of CBD, industrial and commercial customers are higher than residential.

2. The load profiles in different areas vary; residential areas have peaks of typically less than three hours, so an outage which leads to an inability to supply all customers in a peak time is basically self-correcting, but commercial and industrial areas have much longer peaks.

This approach will lead to more consistent levels of reliability and security across the network.

For all network areas the reliability and security standards represent the continued steps down a new path in network asset management. With a true customer focus, we will establish baseline or customer specified reliability standards for each feeder. This will drive capital investment decisions, maintenance and fault repair practices, long-term spares holding policy and emergency response plans. Our continued focus on improved asset condition and network performance information will improve the decision making process. We will be able to provide customers with reliability options and associated costs, allowing them to choose whether they will take their own measures to achieve the reliability they want, or contract Vector to do so.

3.4. POWER QUALITY

The Vector networks are designed to deliver a quality of supply that most modern equipment can effectively operate with. However, as technology advances, new energy efficient electronic equipment is becoming increasingly sensitive to voltage disturbances. In addition, some specific businesses, such as those in manufacturing and service industries, have a higher reliance on disturbance free power supply.

Vector continually strives to reduce voltage disturbances that affect our customers. However, all electricity networks are subject to unplanned disturbances and it is impossible to guarantee a perfect power supply free of voltage sags, surges, flicker or harmonic distortions. A sag is a momentary decrease in voltage below the normal tolerance, typically lasting less than some milli-seconds. They are often the result of short circuit faults or incidents occurring in the network, including disturbances originating from the Transpower network, and supply voltage polluting loads at customers premises, the effect of which ripples through parts of our network. Changes in large industrial loads or changes in Transpower assets can affect voltage disturbances.

The following strategies have been implemented to effectively report and manage the impact of power quality on customers and Vector's network.

- Power quality monitoring equipment installed at selected grid exit points and zone substations
- An electronic mail system that automatically sends a power quality disturbance report in real-time to customers informing them that their plant could have experienced a power quality related event
- A web-based reporting system that makes both real-time and historical power quality information available for diagnosis of customers power quality issues. Figure 3.4 illustrates a typical report that is available to assist resolve power quality issues experienced at their premises
- The application of network modelling software and tools to predict the impact of power quality disturbance on customers
- The application of portable power quality instruments to investigate power quality related complaints

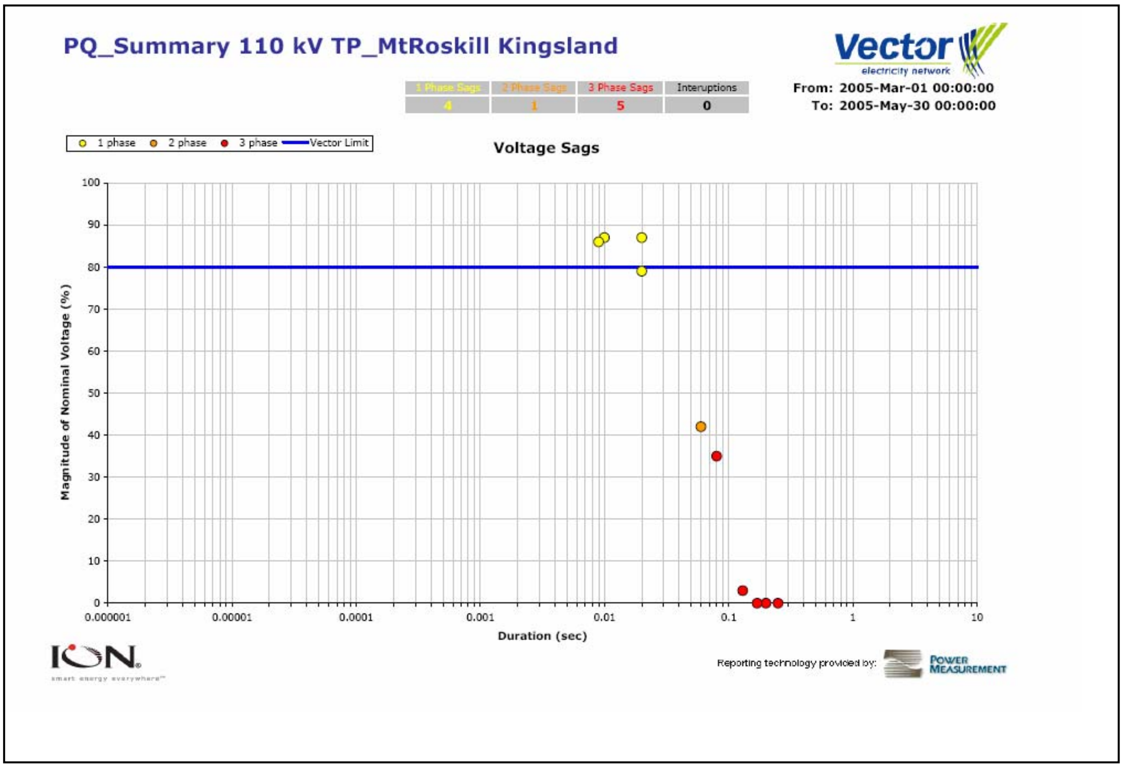

Figure 3.4 Example of a Voltage Sag Report

4. NETWORK DEVELOPMENT

The network must efficiently meet the future needs in terms of customer requirements, load growth, statutory requirements, environmental and safety issues. As part of the strategic planning process, it is critical to ensure that any investment is cost-effective over the planning period and phased in at the optimum time. Risks, costs and benefits are reviewed and revised as new load growth and asset capacity, utilisation and capability information becomes available.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions, and thereby defer major capital expenditure, provided that our reliability objectives are not compromised. Capital expenditure is driven by growth and new connections, but compliance with regulations and safety issues, and replacement of aging assets contribute significantly to the capital spend.

This section gives an overview of the major development projects planned for the network.

4.1. FORECAST GROWTH

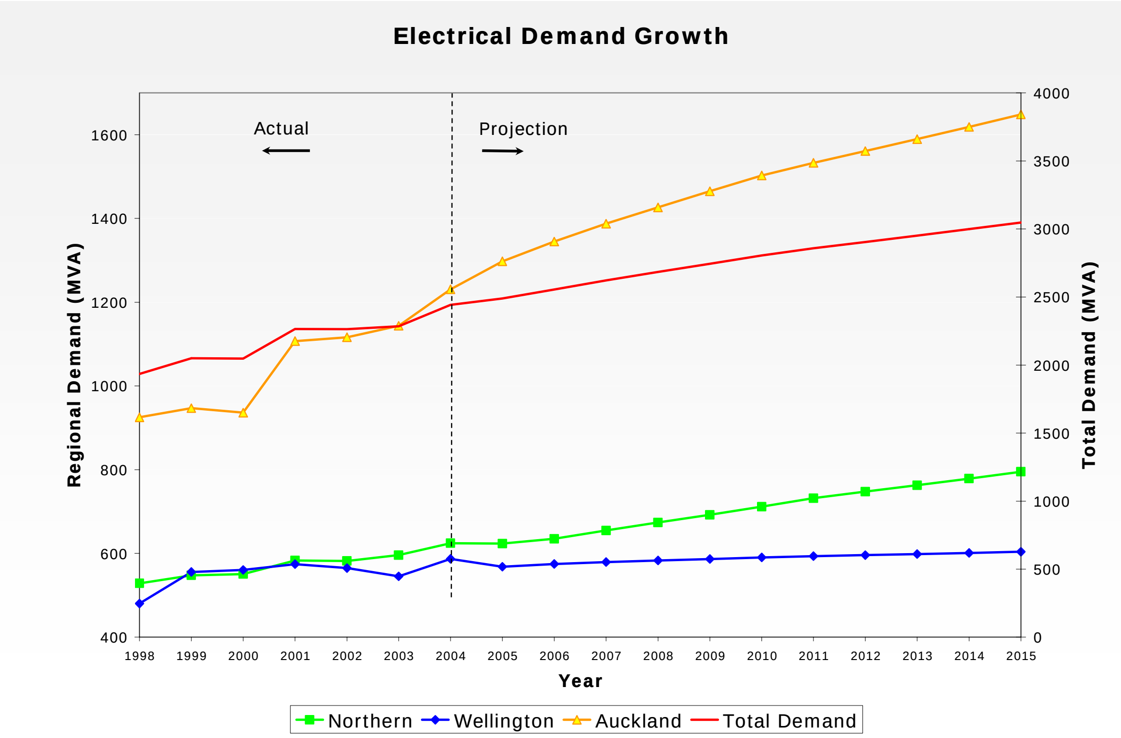

Figure 4.1 Forecast Maximum Demand Across the Network

The long-term forecast for Vector's total network shows an average growth rate of 1.4% per annum. Figure 4.1 shows the forecast demand growth across the network. Vector forecasts peak demand at a zonal level based on data from the SCADA system at zone substations and 11/6.6kV feeders. The forecast is for a "normal" climate year. Peak demand is then forecast for the next 15 years. An underlying basic growth factor specific to the particular zone substation is applied, reflecting the expected impact of economic growth, population growth, available land for development, district plan changes etc. Individual commercial developments are accounted for where known. The forecasts are then adjusted to include block load transfers between zone substations, which are planned as a capital expenditure deferral strategy, but also deliver improved asset utilisation as well.

Short-term maximum demand in Vector's network is mainly influenced by climate, particularly the severity of winter. Medium-term demand is mainly driven by population growth with specific area growth being governed and regulated by regional council development and district plans, and also area specific commercial developments.

The load on Vector's network is primarily an urban load, consisting of:

- Residential load
- Small commercial loads, such as dairies and single shops or small blocks of shops
- Large commercial loads, including shopping malls and light industrial factories
- Large industrial loads, ranging from large factories to steel mills

Peak demands do not occur simultaneously. Advantage is taken of the diversity of load profiles when designing the network. Residential loads tend to peak in the evening, with a peak lasting two to three hours from 17:00 hours. Commercial loads tend to peak during the day with a peak lasting five or six hours. Peak demands are seasonal and area specific, with some areas peaking in winter and others in summer. The underlying trend for peak demands is moving towards a summer peak, particularly in commercial areas, and the network will have to be designed and operated to ensure performance is maintained under changing customer usage patterns.

Growing demand for air conditioning, especially for residential use, is increasing overall electricity consumption and increasing the peak demand in summer. This is putting strain on existing electricity infrastructure.

A study of the influence air conditioning load will have on Vector's 11kV electrical network indicates an 11% increase in 11kV feeder reinforcement over the next 15 years due to additional air conditioning load.

The challenge for Vector is to manage the maturing network at an economic level. Reinforcement and development projects are reviewed and planned for when the forecast loads exceed the system design security criteria outlined in Section 3.

4.2. NETWORK INVESTMENT

Vector invests in its network for the following reasons:

1. To ensure the assets comply with health, safety and environmental statutory requirements.
2. To replace assets which have come to the end of their economic lives.
3. To provide capacity for growth.
4. To maintain and improve the service provided by the network.

Vector's approach to network investment is to seek the best value. This is done by considering a wide range of traditional and non-traditional solutions for each investment.

As part of the network investment decision framework project, a work stream has developed a framework that encourages the use of new solutions to minimise the long-term investment expenditure in the electricity and gas networks while maintaining the service and risk level. A new solution may incorporate the use of (but is not limited to):

- Demand-side management
- Embedded or distributed generation (interconnected or behind-the-load)
- Non-traditional technologies eg, intelligent metering technology

Most alternative solutions, such as automation and load management, provide incremental increases in capacity from existing assets at a fraction of the cost of traditional, capital intensive solutions. These solutions are an efficient way of deferring traditional investment and reduce the risk of large traditional investments being stranded, especially in low load growth areas.

Vector has a process of evaluating and, where appropriate, implementing alternatives to traditional investment in network assets eg, mobile transformers to enable connection of generation to the 11kV network. Each investment is considered specific to the characteristics of the network area it serves. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements and associated costs.

4.2.1. NETWORK CONSTRAINT MANAGEMENT

As load grows throughout the network the spare capacity of existing assets will be soaked up. Eventually constraints will emerge where the load on the existing assets is such that Vector's service levels are compromised. Prior to this point being reached, Vector looks to invest to relieve the constraint.

Constraints are local to the specific area served by the constrained assets. Constraints are also time dependent – they occur only when existing capacity is exhausted and are relieved as soon as further capacity is provided through investment. Constraints can occur at any point in the network, but generally, the lower down the network, the smaller the number of customers affected and the smaller the level of investment required to relieve the constraint.

Investment to relieve constraints is evaluated in the same manner as other Vector network investments. A range of alternative solutions is considered. To ensure that as wide a range of solutions as possible is considered, Vector looks to signal constraints to potential solution providers.

A particularly cost-effective means of relieving constraints is via load management. Constraints can be relieved by:

- Reconfiguring the network to reduce the load in the constrained area
- Encouraging customers to shed load at peak times
- Local generation

In addition to the major proposed projects outlined in the AMP, Vector makes a number of smaller, but sizeable investments throughout its network each year, such as making provision for the future by installing ducts in new bridges and upgraded footpaths. Vector is investigating other ways of signalling the need for these investments to encourage third party solutions eg, embedded generation.

4.2.2. NON-TRADITIONAL INVESTMENT SOLUTIONS

Non-traditional investment solutions fall into the following areas:

Increasing the utilisation of existing assets

- Improved control of network assets (remote controlled and automated switches)
- Real-time monitoring and rating of assets
- Targeted maintenance programmes

Demand-side response

- Embedded generation (both new generation and use of existing generation – eg, CBD building emergency generators)
- Customer load management; real-time access to sheddable loads in peaks
- Customer demand reduction; through price signals, demand reduction programmes; run by Vector or third parties
- Energy storage devices
- Demand Exchange; evolving market mechanism developed to enable load to be traded

Customer investment

- Investment in site equipment (power factor correction, voltage conditioners etc)
- Insurance to cover risks
- Determining specific service levels

New technologies are emerging in all of the above areas.

4.2.3. DISTRIBUTED GENERATION

Distributed generation refers to energy production embedded within the distribution network. It includes production from power plants, customer back up generators and smaller generation technologies such as solar panels and fuel cells.

There is approximately 105MW of installed generation in the Vector foot print including biogas plants at Greenmount (5MW), Whitford (2MW), Rosedale (4MW), Redvale (3MW) and Silverstream (2.7MW). In addition to the physically embedded plants, Vector has one notionally embedded power plant at Southdown (120MW). A number of customers also generate power from their own solar panels.

Vector has prepared guides detailing the application and approval process for customers who wish to install embedded generation on the distribution network. Separate guides have been prepared for generation less than 5kW and for generation greater than 5kW. These guides are published on the Vector corporate internet site along with the detailed technical requirements for generator connection and draft connection contracts.

Vector employs distributed generation as a non-traditional investment solution that is considered and applied where appropriate. A current initiative is to actively purchase on the Vector Demand-side Exchange (www.demandexchange.co.nz) back up diesel generation and non-essential interruptible load for load management during peak load times on the Vector network. It is also envisaged that the exchange will help provide the tools necessary in utilising the demand-side for investment deferral.

4.2.4. THIRD PARTY SERVICE PROVISION

Vector recognises that third parties can provide some of the above investment solutions. Vector encourages third party service provision through the communication of:

- The required outcome the solution must provide
- The area the solution is required in
- The timeframe in which the solution is required

Vector's policy is to compensate third parties for the provision of services, including distributed generation, so long as:

- The risk of the non-provision of the service can be managed so that Vector's service standards are not compromised as a consequence
- The provision of the service complies with Vector's technical codes and does not interfere with other Vector customers
- Payments to service providers are linked directly to the provision of the service
- Commercial agreements are reached on connection, including use of network costs

Compensation is based upon the actual benefit received by Vector. To ensure Vector receives the maximum value from these investments it seeks to:

- Encourage the number of possible solutions and participants
- Set prices through competitive process

- Ensure timeframes are short (to enable other solutions to emerge over time)

4.3. ASSET DEVELOPMENT

A number of localised areas within the Vector network have been identified as approaching the point where Vector's supply reliability criteria can not be maintained. Each issue and constraint is reviewed to determine the optimum operational and economic approach to addressing the problem and maintaining customer service by considering the following options:

- Increased asset utilisation, through advanced automation, dynamic ratings etc
- Load management (including demand-side management)
- Level of acceptable risk
- Asset performance improvement
- Customer requirements and customer based solutions
- Capital investment

This results in a revised asset development programme in terms of the:

- Solution adopted to address the issue or constraint
- Timing of the solution
- Cost of the solution

It is expected that by improving the utilisation of assets, Vector will be able to stage investments and defer or reduce overall capital expenditure. Detailed investigation of the options will occur before any new project is committed. Significant projects are summarised in this section, with their approximate cost range (ie, <$1 million, between $1 and $3 million, and >$3 million). "Committed" status indicates that the project has an approved budget.

The timing of the projects is indicative only. The Auckland area (Auckland and Northern networks) has significant works occurring across the region which is putting pressure on construction resources. Some projects may be delayed due to these resourcing constraints.

4.4. AUCKLAND CUSTOMER AREA

4.4.1. GROWTH IN THE AUCKLAND AREA

This area covers Auckland City, Manukau City and parts of Papakura District.

Demand growth is not consistent throughout the Auckland area, with some areas experiencing rapid growth due to new developments and others experiencing low or negative levels of growth as areas become fully developed or existing commerce and industry move away.

Residential demand is expected to increase in central Auckland with the development of new apartments and refurbishment of offices into apartments, which will continue at a high rate for the next few years. Residential growth in the Manukau City and Takanini/Alfriston areas are also high because of a high number of planned subdivisions. Residential growth elsewhere in the Auckland network is expected to be low, with infill housing being the major form of development.

Industrial and commercial development is expected to continue to be focused in the Avondale area and around East Tamaki, with large retail development in Mt Wellington. Industrial and commercial load growth is also expected to continue in the Wiri and Manukau areas, and in the vicinity of Auckland airport.

4.4.2. ISSUES AND OPTIONS IN THE AUCKLAND AREA

A1: Manukau Area

Project	*Reinforcement at Manukau*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital $1-3 million*

Manukau substation will be upgraded with a third transformer in 2005. This transformer will be relocated from Mangere Central substation. Additional 11kV circuit breakers will be installed to accommodate cable reinforcement in the network.

A2: Auckland CBD 22kV Distribution Network

Project	*22kV distribution*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital >$3 million*

A 22kV backbone distribution network will be established in 2005 to supply the new load (Arena, etc) as well as connecting load transferred from the existing 11kV network. This will avoid the need for a third 22/11kV transformer at Quay substation. Extension of the 22kV switchboard at Quay will be investigated to enable future stages of the 22kV network development.

Part of the 11kV switchgear (panels 1-9) at Quay is scheduled for replacement in the next 10 to 15 years due to the age of the equipment. This will be reviewed in light of the development of the 22kV distribution network in the CBD.

A3: Pacific Steel

Project	*Backup supply cable*	
Driver	*Security*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital <$1 million*

Agreement has been reached with Pacific Steel to extend a 33kV cable from Hans substation to provide a backup supply to the Pacific Steel site.

A4: Freemans Bay Area

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

The uprating of Freemans Bay zone substation from 6.6 to 11kV was completed in February 2002. This overcomes the supply problems within the area. However, the 22kV cables supplying Freemans Bay are 36 year old gas pressure cables. Vector has recently replaced cables of similar age and technology. The performance of these cables is being closely monitored and we will initiate replacement when condition monitoring confirms actual performance is unacceptable.

A5: Hobson/Quay Interconnector

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

There are currently four 22kV cables between Hobson and Quay substations. These cables act as a backstop to the main 110kV supply to Quay substation. However, the Quay 110kV gas pressure cables are expected to be retired from service within the next five years. The exact timing depends on the condition of the cables. When these cables are no longer in service, the 22kV cables connecting Hobson and Quay will become the primary supply to Quay, and will need to be replaced to provide the required security.

A6: Ellerslie, Penrose Area

Project	*McNab 11kV switchboard replacement*	
Driver	*Replacement*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

The 11kV switchgear at McNab substation is 52 years old and is nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. However, the protection relays on the switchgear have reached the end of their useful life and require replacement as they no longer provide minimum accepted performance. The options to address this issue are to replace the switchgear including the relays or to only replace the protection relays. Load forecasts indicate replacement of the switchboard will be required in 2006 for reasons of equipment rating.

A7: Auckland CBD 22kV Distribution Network

Project	*CBD 22kV distribution*	
Driver	*Growth*	
Timescale	*2006*	
Status	*In progress*	*Estimated capital >$3 million*

A 22kV backbone distribution network stage 1 and 2 is under construction and stage 3 and 4 will be established in 2006 to supply new load (See A2) as well as connecting load transferred from the existing 11kV network.

A8: Sylvia Park Substation

Project	*New zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital >$3 million*

A major development is occurring at Sylvia Park and a new substation is required to supply the load.

A9: Highbrook Development

Project	*New subdivision*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Committed*	*Estimated capital >$3 million*

A major subdivision is currently being reticulated at 22kV from Otahuhu GXP.

A10: Ponsonby Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

One of the cables supplying Ponsonby substation is a gas pressure cable which is 39 years old. We are closely monitoring the performance and reliability of all remaining gas cables on our network and we will initiate replacement when condition monitoring confirms actual performance is unacceptable. The other two cables supplying Ponsonby are 55 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project (see A13) although they could be done at the same time.

A11: Hobson Substation

Project	*New 110kV switchgear and transformer*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

Additional 22kV capacity is required at Hobson by 2007. It is proposed to install a 110/22kV transformer to provide the additional capacity. Installation of this transformer will require the installation of a 110kV switchboard at Hobson. The additional 22kV capacity will also provide a source of supply to Quay substation upon retirement of the Penrose-Quay 110kV cables.

A12: Penrose Area

Project	*McNab 33kV cable replacement*	
Driver	*Replacement*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$1 million*

The cables are solid PILC cables and their performance is being monitored. Load forecasts indicate replacement of the cables will be required in 2007 for reasons of equipment rating.

A13: Ponsonby and Chevalier Area

Project	*Uprating Ponsonby and Chevalier substations to 11kV*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

As outlined in last year's AMP, Ponsonby and Chevalier are the last remaining substations operating at 6.6kV. It is becoming progressively more difficult to maintain security of supply to customers supplied from these substations as the load grows. The uprating will require new transformers for Chevalier, unless suitable surplus transformers become available from elsewhere on the network. Indications are that uprating will need to occur within the next two years. Uprating to 11kV is the most cost-effective option for increasing the rating of the distribution network. The existing Ponsonby transformers were replaced in 2001 with dual ratio units so these will not require replacing as part of the upgrade.

A14: Hillsborough Zone Substation

Project	*Establish Hillsborough zone substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

To maintain security to the area supplied by Onehunga, Drive and White Swan zone substations, it is proposed to establish a new zone substation at Hillsborough area. A site has been purchased by Vector.

A15: Mahuru Substation

Project	*Establish Mahuru substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

To supply expected growth from commercial developments in the Newmarket area, it will be necessary to establish a new zone substation. Further investigations will be required when more information related to the developments becomes available.

A16: Chevalier Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital >$3 million*

One of the cables supplying Chevalier substation is a fluid filled cable which is 23 years old. The other two cables are 72 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project (see A13) although they could be done at the same time.

A17: Kingsland Area

Project	*Replace Kingsland 22kV switchgear*	
Driver	*Performance*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

This switchgear is 38 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A18: Penrose Area

Project	*New substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

A large customer in the Penrose area is planning to increase its load requirements. Options to supply this increased load are being investigated and include installing a new zone substation on the customer's site.

A19: Flat Bush Substation

Project	*Establishment of new Zone substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital >$3 million*

Based on the present demand forecast, Flat Bush substation will be required in 2008 to supply the new residential development in the Ormiston Road - Flat Bush area.

The exact timing for the establishment of the substation will be determined by the load growth and the cost of reinforcements at Otara and Greenmount. It is planned to supply Flat Bush from Pakuranga grid exit point due to transmission line constraints at Wiri grid exit point. Discussions are being held with Transpower on possible reinforcement of Wiri grid exit point, and if it is technically feasible and economically attractive, consideration will be given to supplying Flat Bush from Wiri grid exit point. Land will be purchased for Flat Bush substation within the next 12 months to ensure the substation is established by 2008.

Construction to extend Ormiston Road is scheduled to begin in early 2005. Additional power ducts will be installed during that time for future network reinforcement.

A20: Hans Substation

Project	*Third Transformer*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

Additional capacity will be required to supply the Savill Drive industrial subdivision. Options for reinforcement include a third 33/11kV transformer at Hans substation or a new substation closer to the load centre. Further investigation will be carried out to determine the optimum network solution for the area.

A21: Otahuhu Area

Project	*New Equipment*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

A large customer in the Otahuhu area is planning to expand production. Options are being investigated with the customer on ways to supply the increased load.

A22: St Johns Substation

Project	*Establish zone substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital >$3 million*

The substation is a 33kV switching station at present. Due to the development around Winstone Quarry site and the Auckland University Glen Innes Campus, it is required to build a zone substation in the area. The establishment of St Johns zone substation will provide the capacity and security to meet the long-term growth.

A23: North-Western Auckland CBD 22kV Distribution Network

Project	*North-western 22kV distribution network*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$3 million*

This project is required to meet the long-term development at Auckland city's north-western area around the tank farm.

A24: Mangere South Substation

Project	*New zone substation*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$3 million*

The AIAL (Auckland International Airport Limited) owns a significant amount of land north of the airport complex and runway which is intended for supporting commercial and industrial development purposes. The expected load, when the area is fully developed, could reach 18MVA. Depending on the timing and the way the area is to be developed, a new substation may be required.

A25: Maraetai Area

Project	*11kV switchgear replacement*	
Driver	*Replacement*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

The 11kV switchgear at Maraetai substation is 46 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A26: Takanini Area

Project	*Substation reinforcement*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

There is strong growth in the Takanini area with a prediction of around 3,000 houses per annum to be built over the next few years. This will require reinforcement of the capacity at Takanini substation to maintain adequate security of supply.

Options for the reinforcement include:

- New cables from existing supply point (Takanini)
- New 33/11kV transformers
- Additional 33/11kV transformers
- Combination of the above
- New substation

A27: Liverpool Substation

Project	*New 110/22kV transformers*	
Driver	*Replacement*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1.5 million*

Liverpool substation has three 110/22kV transformers, two of which are 28 years old, and the third is seven years old. One of the older transformers has undergone a mid-life refurbishment and the second is scheduled for refurbishment in 2005. The condition of the two older transformers will be monitored, and when they reach the end of their technical life they will be replaced. This is expected to be within the next 10 years.

A28: Onehunga/Te Papapa Area

Project	*Onehunga substation uprating to 33kV*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital >$3 million*

The Onehunga substation is 41 years old and reaching its design capacity. The substation is currently supplied at 22kV and allowance has been made at Transpower Penrose to uprate the substation to 33kV. A short-term solution of using automated load transfer was implemented in 2001. This will defer uprating to 33kV until the load increases above the new design limit or condition monitoring indicates that equipment at the substation needs replacement. Interim solutions have been investigated such as ties between Onehunga and Te Papapa in 2006 with uprating to 33kV in 2010. Timing of this project will depend on asset condition and the new Hillsborough substation.

A29: Hobson West Substation

Project	*New switching station*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

Land for Hobson West substation has been purchased. With the plan to phase in 22kV distribution and freeze the development of the 11kV network in the CBD, establishment of Hobson West substation as a 22/11kV zone substation is no longer required. Instead, the substation site will be used to accommodate a 22kV switchboard which will serve as a marshalling point for the 22kV distribution network to the south east part of the CBD.

A30: Parnell Substation

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

The 22kV cables supplying Parnell substation are 77 years old and nearing the end of their technical life. These are solid PILC cables, and their performance is being monitored. They will be programmed for replacement when their performance deteriorates to an unacceptable level.

A31: Liverpool/Quay Interconnector

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital >$3 million*

The existing gas pressure cable is 37 years old. Vector has recently replaced cables of similar age and technology. The performance of this cable is being closely monitored and it is expected that it will require replacement within the next 10 years.

A32: 22kV Switchboard at Victoria Substation

Project	*22kV switchboard at Victoria substation*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital >$3 million*

To accommodate the load growth at 22kV in the Auckland CBD, a 22kV switchboard will be established at Victoria substation. The switchboard will serve as a marshalling point for the 22kV distribution network as well as a point of connection for the 22/11kV transformers (in the medium-term).

A33: 33kV Cable at St Johns

Project	*33kV new cable at St Johns*	
Driver	*Growth*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital >$3 million*

Load growth in the St Johns area requires reinforcement of the 33kV capacity to St Johns substation. One option is to install a 33kV cable from Penrose to St Johns substation. Additional options will be investigated before a final decision is made.

A34: CBD 110kV Reinforcement

Project	*Additional 110kV capacity into CBD*	
Driver	*Growth*	
Timescale	*2015*	
Status	*Proposed*	*Estimated capital >$3 million*

With the retirement of Penrose-Quay 110kV cables and the connection of Freemans Bay load to Hobson substation, 110kV reinforcement will be required to the Auckland CBD to maintain the security of supply.

Options include:

- Install cable from Penrose to Liverpool or Hobson
- Install cable from Roskill to Liverpool or Hobson
- Install a 220/110kV auto transformer at Hobson substation teed off the 220kV cross isthmus cable

A35: Hobson 22kV

Project	*110/22kV transformer-Hobson*	
Driver	*Growth*	
Timescale	*2015*	
Status	*Proposed*	*Estimated capital >$3 million*

With the growth in the CBD and the progressive retirement of the existing 11kV network, additional 22kV capacity is required at Hobson zone substation. It is proposed to install a third 110/22kV transformer at Hobson.

4.5. NORTHERN CUSTOMER AREA

4.5.1. GROWTH IN THE NORTHERN AREA

This area covers the North Shore City, Waitakere City, and Rodney District and includes residential (both rural and suburban), commercial and industrial developments. Most of the commercial and industrial developments are centred around the Albany Basin, Takapuna, Glenfield, Henderson and Te Atatu areas. Areas north of the Whangaparaoa Peninsula and west of Henderson are predominantly rural residential.

Overall the load growth in the region is relatively high at around 2% per annum. The highest load growth in this region is expected to occur around the Albany Basin with the development of industrial and retail businesses. With the motorway from North Shore to Orewa (which is planned to be extended to Puhoi), it is expected that significant residential developments will take place in areas north of Silverdale. Demand in established areas is expected to remain relatively static.

4.5.2. ISSUES AND OPTIONS IN THE NORTHERN AREA

N1: Northern Area

Project	*Uprate various 33kV circuits*	
Driver	*Growth*	
Timescale	*2005-2011*	
Status	*Proposed*	*Estimated capital >$3 million*

Due to load growth in the area, the existing conductor on nine 33kV circuits is constraining capacity. Replacement with a larger conductor provides an economic way to defer major capital expenditure.

N2: Albany Basin Area

Project	*Establish a 33kV bus at Bush Road substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital >$3 million*

The two transformers at Bush Road are fed from the Albany grid exit point via a radial circuit and a tee off from the Albany-Sunset Road circuit. Security will be enhanced by installing a new 33kV feeder from Albany to Bush Road substation and on to Sunset Road substation. The installation of a 33kV switchboard will allow better utilisation of the feeder capacity and improve operational flexibility of the network. This project is underway.

N3: Orewa Area

Project	*New transformers at Orewa substation*	
Driver	*Regulatory*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital $1-3 million*

The existing transformers at Orewa exceed the noise requirements for the area and are being replaced with new low noise transformers. The existing transformers will be refurbished for reuse elsewhere on the network.

N4: Warkworth Area

Project	*Increase transformer capacity at Warkworth*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital <$1 million*

Capacity constraints exist at Warkworth substation. The existing transformers will be replaced with the refurbished ex-Orewa units.

N5: Henderson Area

Project	*Reconfigure the Henderson area 33kV network*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital <$1 million*

The presence of a number of tee off and spur line arrangements on the 33kV network in the area has resulted in performance issues. These will be addressed by reconfiguring the network at Waikaukau substation.

N6: Silverdale Area

Project	*Establish Red Beach zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital >$3 million*

With the extension of the Northern motorway towards the Silverdale/Orewa area, demand is expected to grow steadily. Forecasts indicate that additional 33/11kV capacity will be required in the next few years. The Red Beach substation will enable Manly and Spur Road substations to be offloaded and reinforce supply to the Red Beach area.

N7: Gulf Harbour Area

Project	*Lay 33kV cable to Gulf Harbour*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital >$3 million*

The load growth in Gulf Harbour means that the 11kV network from Manly substation requires reinforcement to ensure an adequate security of supply to the area. Load forecasts indicate that the area will eventually require a zone substation to supply the load. Therefore, a 33kV cable will be installed to the future substation site and operated at 11kV until the zone substation is constructed in 2009.

N8: Coatesville Area

Project	*Install second transformer and associated 33kV reinforcement at Coatesville zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Coatesville substation continues to grow and the transformer is loaded to around 90% during peak times. This project will provide sufficient capacity for a number of years. This project will use a transformer recovered from Warkworth substation when it is reinforced.

N9: Glen Eden Area

Project	*Establish a new zone substation at Oratia*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Waikaukau substation continues to increase. This project was initially to install a second transformer at Waikaukau substation but further analysis has indicated that building a new substation at Oratia provides a better solution by offloading Waikaukau and surrounding substations. This project will use a transformer recovered from Warkworth substation when it is reinforced.

N10: Albany Basin

Project	*Install additional 11kV switchgear at McKinnon zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital <$1 million*

The development in the Albany Basin requires additional 11kV feeders to be connected into McKinnon substation. Additional switchgear is required to allow the new feeders to be supplied.

N11: Albany Basin Area

Project	*33kV cable to McKinnon substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital $1-3 million*

Following reinforcement and changes to the operating regime, reinforcement of the Browns Bay 33kV ring network is required to maintain security of supply. Options include:

- Installation of a 33kV cable from the Albany grid exit point to McKinnon substation
- Installation of a 33kV cable from the Albany grid exit point to Browns Bay substation

Load flow analysis shows that a higher level of security will result from installing a 33kV cable to McKinnon substation. This project has been brought forward due to high load growth.

N12: Triangle Road Area

Project	*Reinforce Triangle Road zone substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Triangle Road substation is increasing and additional capacity is required to maintain security of supply to the area. Two new transformers will be installed together with new 11kV switchgear.

N13: North Shore Area

Project	*33kV cable to Forest Hill substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital>$3 million*

The installation of a 33kV cable from Sunset Road to Forest Hill and reconfiguration of the 33kV network will allow load to be transferred from Wairau substation to Albany GXP. This is a backup plan if the 220kV reinforcement of Wairau substation has been delayed.

N14: Kaukapakapa Area

Project	*Establish a new zone substation at Kaukapakapa*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on the Kaukapakapa 11kV feeder continues to increase. This project is to resolve the loading on a long rural feeder by establishing a new zone substation. This substation will also be able to reinforce the network and backstop adjacent zone substations. This project will use a transformer recovered from Triangle Road substation when it is reinforced.

N15: Waimauku Area

Project	*Install second transformer at Waimauku zone substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital <$1 million*

The load in this area continues to grow and a large load (1.0MVA) has recently been installed close to this substation. Reinforcement is required to maintain the security of supply to customers. This project has been deferred due to lower growth than expected. One of the Triangle Road transformers being replaced in 2007 will be relocated to Waimauku.

N16: New Lynn Area

Project	*Reinforce 33kV capacity at New Lynn substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

As the demand around the New Lynn area increases, reinforcement is required to maintain the security of supply. Various options have been considered including the installation of additional 11kV ties between Sabulite Road and New Lynn and between Sabulite Road and McLeod Road to enable load transfer from the 33kV group, or reinforcement of the 33kV ring by adding a new 33kV cable. The 11kV option was discarded as it involved complicated switching operations in addition to not providing a long-term solution. A 33kV cable will be installed between Sabulite and New Lynn zone substations.

N17: North Titirangi Area

Project	*Install new transformers at Atkinson Road zone substation*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Atkinson Road substation has increased to the point where larger transformers are required. An area study has indicated that increased capacity at Atkinson Road is the best solution for additional capacity for the area.

N18: Greenhithe Area

Project	*Establish a new zone substation at Greenhithe*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$3 million*

As the demand in the Greenhithe area increases through residential development, there will be a need to increase the 11kV capacity to maintain the security of supply in the area. As this area is already supplied by long 11kV feeders from remote zone substations, extending the 11kV network does not provide sufficient security of supply or an economic solution to the issue. It is proposed to establish a new zone substation.

N19: Westgate/Whenuapai Area

Project	*Establish a new zone substation at Whenuapai*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$3 million*

As the demand in the Westgate area increases through large commercial development, there will be a need to increase the 11kV capacity to maintain the security of supply in the area. This area is currently supplied from Hobsonville substation but developments proposed around the Westgate shopping centre and the old Hobsonville airbase will mean additional capacity will be required. It is proposed to establish a new zone substation.

N20: Whangaparaoa Area

Project	*Establish Gulf Harbour substation*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$3 million*

Demand on the Whangaparaoa Peninsula has been growing steadily and due to the geographic layout, backup supplies are limited. Over recent years, incremental capacity enhancements such as the dual rating of zone substation transformers have been implemented to defer major reinforcement. The stage has now been reached where additional 33kV and 11kV capacity is required to maintain the level of security. A new zone substation will be established at Gulf Harbour, which will utilise the existing 33kV cable from Manly zone substation to the Gulf Harbour zone substation site.

N21: Swanson Area

Project	*Install second transformer at Swanson zone substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Swanson substation continues to increase. The load will be monitored to determine the exact timing of this reinforcement.

N22: Henderson Area

Project	*Install second transformer at Keeling Road zone substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Keeling Road substation continues to increase with commercial development in the Henderson area. The load will be monitored to determine the exact timing of this reinforcement.

N23: Henderson Area

Project	*Keeling Road substation to Woodford substation 33kV tie*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital $1-3 million*

Due to load growth around the Henderson Valley area, a 33kV tie line between the Woodford and Keeling Road substations, which are currently supplied by single 33kV radial circuits, will be required to maintain sufficient security of supply.

N24: Albany Basin Area

Project	*Install second transformer at McKinnon substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital <$1 million*

As the demand around the Albany Basin industrial area increases, additional capacity will be required at McKinnon substation. Additional switchgear is planned to be installed in 2006 and additional 33kV cabling in 2007.

N25: East Coast Bays

Project	*Install second transformer at Forest Hill zone substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Forrest Hill substation continues to increase. The load will be monitored to determine the exact timing of this reinforcement.

N26: North Shore Area

Project	*Highbury substation second transformer*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital <$1 million*

There is steady load growth in the Highbury/Northcote area. The establishment of Takapuna zone substation in 2001 enabled both Hillcrest and Northcote zone substations to be offloaded as an interim measure. However, additional 11kV capacity will be required towards the end of the planning period. Options include installation of a second transformer at Northcote, Highbury or Balmain substations. The Highbury option is currently preferred as additional capacity located there can be used to backup the other two zone substations.

N27: Albany Basin Area

Project	*Rosedale Road new zone substation*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital $1-3 million*

As the demand in the Albany Basin/Browns Bay area increases, reinforcement of the 11kV capacity will be required to maintain the security of supply in the area. Options include:

- Installation of a second transformer at East Coast Road substation
- Establishment of a new substation near 33kV switch P79 near Rosedale Road

Economic analysis has shown that the establishment of a new zone substation in Rosedale Road is the preferred option.

N28: Whangaparaoa Area

Project	*33kV cable to Manly substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

As demand in the Whangaparaoa Peninsula continues to grow, reinforcement will be required to maintain security of supply. Due to the geographic location of the area, backup from the 11kV network is limited. Options under consideration include the uprating of the existing submarine cables or installation of a new 33kV circuit. The 33kV circuit would provide a long-term solution.

N29: Silverdale Area

Project	*Wainui Road new zone substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

The load on Silverdale is expected to continue to grow rapidly with residential and commercial developments in the area. The load forecasts indicate that Spur Road substation will require a second transformer in 2012. However, it may be more economic to install a new substation in Wainui Road, closer to the load centre. The loads in the area will be monitored and the options fully evaluated closer to the time the reinforcement is required.

N30: Northcote Area

Project	*Reinforce 33kV supply to Northcote zone substation*	
Driver	*Growth*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital >$3 million*

The load on Northcote substation continues to increase. The load will be monitored to determine the exact timing of this reinforcement. This project will be evaluated in conjunction with the project to install a second transformer at Highbury (see N26), which could affect the timing of the project.

N31: Snells Beach Area

Project	*Sandspit Road zone substation*	
Driver	*Growth*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital >$3 million*

Snells Beach continues to grow as more land is made available for subdivision. Backstopping is becoming a problem for Snells Beach substation and rather than reinforce Snells Beach substation, it is proposed to install another substation at Sandspit Road. The two substations will then provide mutual backstopping.

N32: Ranui Area

Project	*Install second transformer at Simpson Road zone substation*	
Driver	*Growth*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Simpson Road substation continues to increase. The load will be monitored to determine the exact timing of this reinforcement.

N33: North Shore Area

Project	*Reinforce supply to Wairau Road substation*	
Driver	*Growth*	
Timescale	*2014*	
Status	*Proposed*	*Estimated capital >$3 million*

In recent years, a series of small capital projects has been initiated to maintain the security of supply in the area. In the next five to 10 years, further reinforcement will be required. Options for reinforcement include installing a fourth 110kV feeder to Wairau Road substation, or installing 220/33kV transformers at Wairau Road, supplied from the proposed 220kV cross isthmus cables. This project will be reviewed when more definite information regarding the cross isthmus project becomes available.

N34: Henderson Area

Project	*Install second transformer at Woodford zone substation*	
Driver	*Growth*	
Timescale	*2014*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Forest Hill substation continues to increase. The load will be monitored to determine the exact timing of this reinforcement.

4.6. WELLINGTON CUSTOMER AREA

4.6.1. GROWTH IN THE WELLINGTON AREA

The Wellington area 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. The Wellington CBD is by far the most significant business and retail centre in the region. There are also business and retail centres scattered around the area at Lower Hutt, Porirua, Upper Hutt, Seaview, Gracefield, Petone and Johnsonville. Small industries and warehouse developments centre along the Lower Hutt, Ngauranga Gorge, Petone, and Naenae areas.

Overall demand growth in the region is expected to be low with most of the growth expected to take place around the Wellington CBD area.

4.6.2. ISSUES AND OPTIONS IN THE WELLINGTON AREA

W1: Wellington CBD/CBD Fringe

Project	*Reinforcement of the 33kV capacity to zone substations*	
Driver	*Growth*	
Timescale	*2006-2010*	
Status	*Proposed*	*Estimated capital >$3 million*

There are cable rating and cable condition issues around a number of 33kV cables in the Wellington CBD. An integrated programme of cable replacements and upgrading is planned to address these issues holistically. The affected zone substations are:

- University
- Palm Grove
- Moore Street
- The Terrace
- Frederick Street

W2: Wellington CBD / CBD Fringe

Project	*Reinforce the 11kV feeder network at various substations*	
Driver	*Growth*	
Timescale	*2006-2008*	
Status	*Proposed*	*Estimated capital >$3 million*

Due to the general load growth, various parts of the Wellington network have reached the point where under contingency conditions, there is insufficient 11kV backstopping capacity. In addition to this, there is a protection issue which impacts on the rating of some sections of cable. A co-ordinated 11kV reinforcement programme is planned to address these issues.

W3: Hutt Valley

Project	*Rearrange connection between Haywards and Trentham busbars*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital <$1 million*

There is a backup capacity shortfall of about 3MVA upon loss of the single transformer at the Haywards 11kV grid exit point. At Trentham the two 33kV circuits and transformers are very under utilised. The current proposal is to reconnect the 33kV Haywards-Trentham circuit to form an 11kV interconnector between the Haywards and Trentham 11kV boards. This will provide sufficient backup capacity to both substations, and also improve the utilisation at Trentham. This project needs to be reviewed in light of the regulatory issues, the Transpower transformer re-ratings and the load growth which has occurred since the project was first conceived. Also, discussion is required with Transpower in relation to their revised transformer ratings and the ability of Transpower to provide 11kV backup supply to Vector.

W4: Hutt Valley

Project	*Replace Melling ripple injection plants*	
Driver	*Performance*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The existing rotary injection units are 45 years old, situated on the flood plain and have insufficient signal strengths in certain areas. A new static plant will be installed within the Transpower substation.

W5: Wellington CBD

Project	*Install reactors at Moore Street and The Terrace*	
Driver	*Security*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital <$1 million*

The 11kV busbars can not be operated solid due to the fault level exceeding the 11kV circuit breaker ratings. With the installation of reactors, the 11kV busbars can be operated solid in order to increase the security of supply and to even out the loadings on the incoming 33kV subtransmission circuits.

W6: Wellington CBD

Project	*Establish Bond Street substation*	
Driver	*Growth*	
Timescale	*2014*	
Status	*Proposed*	*Estimated capital >$3 million*

As the demand in the Wellington CBD and the fringe areas grows, reinforcement will be required to maintain the capacity and security of supply in the area. A site has already been reserved in the area for a new zone substation.

4.7. CHANGES FROM PREVIOUS PLAN

4.7.1. AUCKLAND AREA

Hillsborough zone substation

This project has been brought forward as a cost-effective solution for reinforcing Onehunga, Drive and White Swan substations.

Mahuru substation, Sylvia Park and Pacific Steel

These projects are the result of customer requirements.

St Johns substation

This project has been brought forward as a cost-effective solution for reinforcing Remuera, Mt Wellington, Glen Innes and Orakei substations.

4.7.2. NORTHERN AREA

Oratia substation

This project replaces the project to install a second transformer at Waikaukau substation because it provides better long-term benefits to the network.

Gulf Harbour, McKinnon, Triangle Road and Atkinson Road substations

The 33kV cables to Gulf Harbour and McKinnon have been brought forward after re-evaluating the load growth. New 33/11kV transformers at Triangle Road and Atkinson Road have been introduced after reviewing the existing and forecast loading on these substations.

Kaukapakapa, Westgate, Rosedale and Sandspit substations

New zone substations at Kaukapakapa, Westgate, Rosedale and Sandspit are part of the Northern area strategy of installing single transformer substations to support the load growth. There have been timing changes on other projects, due to changes in forecast load growth.

4.7.3. WELLINGTON AREA

A project has been introduced to install reactors at Moore Street and Terrace substations to allow better utilisation of equipment and improve security of supply to customers.

4.8. TRANSFORMER REDEPLOYMENT

4.8.1. AUCKLAND AREA

To ensure optimum utilisation of existing assets, transformers are relocated when released if performance and condition criteria are met. The Hobson and Onehunga projects will release the following transformers:

- Hobson transformers 2 x 22/11kV units (to be relocated to Chevalier)
- Existing Chevalier 22/6.6kV units to be scrapped
- Onehunga 22/11kV transformers to be scrapped

Other transformers to be relocated include:

- Mangere Central 33/11kV transformer to be relocated to Manukau
- Spare 110/22kV transformers to be relocated to Liverpool

4.8.2. NORTHERN AREA

Subject to condition assessment:

- Orewa transformers 2 x 33/11kV units (to be relocated to Warkworth)
- One Warkworth 33/11kV unit (to be relocated to Coatesville)
- One Warkworth 33/11kV unit (to be relocated to Oratia)

Other transformers to be relocated include:

- Triangle Road 2 x 33/11kV units, to be relocated to Waimauku and Kaukapakapa

Although the Auckland and Northern area transformers have a different Vector group, they can be configured to operate in either area if required

4.8.3. WELLINGTON AREA

There are no plans to relocate transformers in the Wellington area.

4.9. TRANSPOWER SUPPLY POINTS

Transpower supplies the Vector network through 22 grid exit points. Transpower and Vector liaise on works programmes to ensure priority and critical issues are addressed.

4.9.1. ISSUES AND OPTIONS AT THE GRID EXIT POINTS

Central Park Grid Exit Point

Driver	*Growth and security of supply*
Timescale	*2005*
Status	*Committed*

The age and condition of the existing 110/11kV transformers has prompted the need for replacement. A long-term solution involving installation of a third 110/33kV transformer and replacement of the 110/11kV transformer with 33/11kV units has been agreed with Transpower. Work is currently progressing on this project.

Hepburn Grid Exit Point

Driver	*Security of supply*
Timescale	*2006*
Status	*Committed*

The existing transformer capacity at Hepburn is insufficient to meet the Vector's security standard although there is limited back up capacity from within the 33kV and 11kV networks. A proposal to install an additional new 110/33kV 120MVA transformer at Hepburn has been agreed to be commissioned before winter 2006.

Albany Grid Exit Point

Driver	*Security of supply*
Timescale	*2006*
Status	*Committed*

The existing transformer capacity at Albany is insufficient to meet the Vector's security standard although there is limited backup capacity from within the 33kV and 11kV networks. A proposal to install a third 220/33kV 120MVA transformer at Albany has been agreed with Transpower, to be commissioned before winter 2006.

Penrose Grid Exit Point

Driver	*Security of supply*
Timescale	*>2006*
Status	*Proposed*

Vector has current concerns over the security of the 220kV supply into Penrose (one double circuit tower line). Options to address this issue are currently being studied jointly with Transpower.

Silverdale Grid Exit Point

Driver	*Security of supply*
Timescale	*2007*
Status	*Proposed*

Silverdale GXP was commissioned in 2003. A single 220/33kV 120MVA transformer was installed. Load flow analysis shows that the 33kV network backup capacity will be exceeded in 2007. It is proposed to install a second 220/33kV 120MVA transformer at Silverdale to improve the security of supply.

4.10. CUSTOMER INITIATED NETWORK DEVELOPMENTS

Customer initiated capital expenditure is driven primarily through the growth of the city, and with North Shore and South Auckland areas being some of the fastest growing areas in New Zealand, Vector experiences a significant level of the following growth related activities:

- New subdivisions account for around 40% of customer activity, including reticulation and streetlighting for commercial and residential developments
- New service connections in areas where reticulation already exists or only requires moderate extension account for a further 20% of expenditure
- Customer substations are installed for commercial customers with loads unable to be supplied from the low voltage reticulation

The remainder of the expenditure is divided between:

- Cable relocations; mainly driven by Council or Transit New Zealand roading projects
- Capacity changes; where transformer connected customers require an upgrade or downgrade in capacity
- Low voltage reinforcements; where a change in customer capacity requires an upsizing of the low voltage network

The demands from the customer led initiatives are included in the load forecasts and influence the timing and priority of capital works in the Vector network.

4.11. SCADA

Replacement of Remote Terminal Units

Driver	*Replacement*
Timescale	*5 year plan*
Status	*Committed*

RTUs that have reached the end of their technical life, are obsolete (GPT Dataterm, GPT Miniterm, SIU, C5, C25) and lack adequate support or spare parts are being replaced with modern RTUs across all three regions.

Protocol converters have been installed at the communication hubs in Wellington and Northern region in order to interface the new RTUs with the existing SCADA master station.

4.12. COMMUNICATION NETWORK

Vector's communication network provides the communication path for various applications and operational services such as:

- Protection signalling
- Automation
- SCADA
- Metering and load control
- Remote equipment monitoring and maintenance
- Operational telephony
- Substation security
- Transfer of a large amount of power system data available within modern microprocessor based IEDs

The communication network's physical layers are mainly based on the copper wire telephony type pilot and optical fibre cables. Third party communication networks (UHF/VHF, GSM/GPRS, digital microwave, Ethernet/IP) are used to extend the network coverage.

Vector is migrating its operational services to an IP based communication network. Digital communication over existing copper pilot cable has been successfully implemented using international standard g.shdsl communication technology.

All new substations built are interconnected to the communication network via optical fibres.

The existing pilot cables that have reached the end of their technical life are being replaced with optical fibre cables.

4.13. DEPLOYMENT OF COMMUNICATIONS NETWORK

4.13.1. AUCKLAND REGION

Driver *Growth/Performance/Replacement*
Timescale *Ongoing*
Status *Committed/as required*

The IP communication network backbone has been established. The extension of the network to zone substations is an ongoing process and is part of other projects where new primary equipment or replacement of the protection and control system is taking place.

4.13.2. NORTHERN REGION

Driver *Growth/Performance/Replacement*
Timescale *Ongoing*
Status *Committed/as required*

Part of the pilot wire based communication network in the western part of Auckland, which connects major Vector and Transpower substations, has reached the end of its technical life and is being replaced with equivalent optical fibre network.

4.13.3. WELLINGTON REGION

Driver *Growth/Performance/Replacement*
Timescale *Ongoing*
Status *Committed/as required*

An IP based network is being established utilising existing Vector and third party infrastructure.

4.14. EXPENDITURE FORECAST

The capital expenditure plan that corresponds to the asset replacement, refurbishment and development projects is given in Figure 4.2. These forecasts are based on known and current solutions only. Extensive analysis of alternate approaches, including load management, increased asset utilisation through advanced technology etc may enable the forecast expenditure to be reduced.

Network projects include:

- Compliance projects, where the main drivers are regulatory, environmental, health and safety etc
- Growth projects, where the main driver is growth in demand
- Performance projects, where the main driver is improved network reliability and/or reduced maintenance costs
- Replacement projects, where the main driver is replacement of assets that are at the end of their useful life, or where the whole of life maintenance and remedial costs are higher than the replacement costs. Risk analysis is another key driver in this category

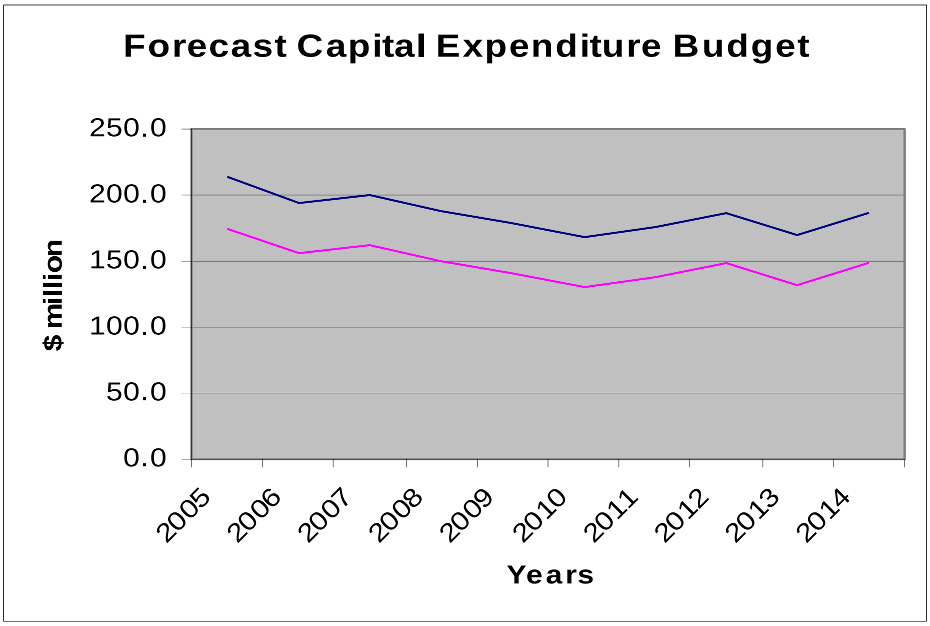

Figure 4.2 Forecast Capital Expenditure Budget ($ million)

The expenditure may vary between the upper and lower bounds depending on customer growth, asset condition and economic conditions.

5. ASSET MAINTENANCE

5.1. ASSET MAINTENANCE STRATEGY

Vector operates and manages a wide range of assets from 110kV power transformers to 230V service connections. Each asset is managed in terms of risk and criticality and the optimum maintenance, refurbishment and replacement strategies defined.

The foundation of the asset maintenance plan is the customer service targets, based on customer type and service expectations. The resulting maintenance refurbishment and replacement strategies for each asset ultimately address the impact on customer service targets, power quality, health and safety implications, reliability management and cost.

This section gives an overview to Vector's approach to maintenance, asset refurbishment and replacement.

In general, across all network areas, preventive maintenance on Vector's network consists of the following:

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

Detailed maintenance criteria for each asset are documented in the service providers and Vector's maintenance instructions and standards. These include the inspection, testing and condition assessment requirements for each asset, together with decision guides on the appropriate countermeasures.

The maintenance criterion receives constant attention and review to ensure that our practice and policy reflect the optimal needs of individual assets or areas. Assets that are considered to have a greater risk of failure, or for which the consequence of failure is considered unacceptable, have enhanced preventive and condition based maintenance schedules.

As a general philosophy, the timing of any individual asset or area replacement is based on the following condition and performance assessments:

- The asset is approaching the end of its useful life and is no longer suitable for its application, in terms of asset functionality or customer requirements
- The asset presents an unacceptable risk regarding its function, environment, or to the safety of public or operating and maintenance personnel
- The whole of life maintenance and remedial costs are higher than the expected replacement costs

When the requirement arises for an individual asset or area to undergo replacement, the opportunity is taken to consider an upgrade and/or capacity increase to meet future supply requirements.

5.1.1. FAULT ANALYSIS

Continuous evolution and improvement of our asset maintenance and replacement strategies relies heavily on the feedback and analysis of asset failures, their impact in terms of frequency and duration, cost and resulting consequence on customer satisfaction.

Figure 5.1 HV Failure Analysis Data - SAIFI

Reducing the incidence and impact of asset failures is a major asset management driver and will remain under scrutiny to ensure customer service and reliability targets are achieved. As an example, the industry measure of the incidence and impact of failures (SAIFI - System Average Interruption Frequency Index) is represented in Figure 5.1 above, which profiles by major fault type and performance across the different network areas.

At the same time, minimising the impact of any planned interruptions retains a similar level of commitment. Vector continues to reduce the impact of planned outages through the application of local generation to maintain supply during planned shutdowns, and increased use of live line work on the network.

Trees remain a significant contributor to fault incidence. Substantial expenditure on vegetation management has resulted in a significantly reduced rate of tree-related incidents and a continuing focus will remain on vegetation management especially the enforcement of new tree regulations.

To reduce the defective equipment component of SAIFI across the networks, asset replacement will be targeted.

5.2. ASSET MAINTENANCE BY ASSET TYPE

In this section the following terms are used:

Asset description
A brief description of the asset, age profiles.

Asset maintenance
Brief description of the generic planned maintenance activities.

Asset issues and risks
Indication of asset specific risks, their impacts, current controls and planned actions.

Asset replacement
Major work that does not increase the capacity of the asset, but maintains the capacity and functionality of the asset at its lowest whole of life cost.

5.3. TRANSMISSION AND SUBTRANSMISSION CABLES AND LINES

5.3.1. ASSET DESCRIPTION

The subtransmission network consists of 1,163km of cables and lines rated at 110kV, 33kV and 22kV as detailed in Table 5.1.

Cable Type	110kV	33kV	22kV	Total Length (km)
Overhead	28	440	3	471
Underground PILC	-	33	68	101
Underground XLPE	27	195	43	265
Underground Fluid Filled	26	175	19	220
Underground Gas Pressurised	20	74	12	106
Total by Voltage	101	917	145	1,163

Table 5.1 Transmission and Subtransmission Cable Lengths and Voltages

5.3.2. ASSET MAINTENANCE

- Regular route patrols, with enhanced frequency in parts of the CBD, to identify any potential problems in the Auckland network
- Proactive work with external service providers to prevent third party damage
- Annual cable termination inspections and thermographics
- Regular serving tests

5.3.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the subtransmission cable and line assets this year.

5.3.4. ASSET REPLACEMENT

Cables

Cable replacement is determined by a combination of condition assessment and performance assessment relating to the risk of loss in functionality, analysis of failure and defect rates, associated costs of repair, failures and condition tests. Over and above routine maintenance all fluid filled and pressurised gas cables are continuously monitored via the centralised SCADA system, to provide early warning alarms of falling pressure, and associated leaks can be rectified before a failure has the chance to occur.

5.4. TRANSMISSION AND SUBTRANSMISSION TRANSFORMERS

5.4.1. ASSET DESCRIPTION

Vector owns 244 transformers, including two at Lichfield, which lies outside of Vector's network footprint. The subtransmission transformers range in rating from 5MVA to 65MVA. The age profile of the subtransmission transformers is shown in Figure 5.2.

The ODV design life of a transformer is 45 years, but if the transformer is not subject to abnormal operating conditions and is well maintained, the design life can be extended.

Figure 5.2 Subtransmission Transformers Age Profile

5.4.2. ASSET MAINTENANCE

- Annual dissolved gas analysis
- Monthly visual checks for moisture, oil levels and leaks, and fan operation
- Thermal imaging of terminations and connections
- Annual TJH2b Tap Changer Activity Signature Analysis (TASA) condition assessment
- As required TJH2b Transformer Condition Assessment (TCA) condition assessment as an alternative to dissolved gas analysis

The timing for the transformer refurbishment is scheduled based on DGA and other condition assessment results. Transformers scheduled for movement to another site are refurbished as part of the move where their condition and assessed remaining useful life makes this an economic option. To improve the decision accuracy associated with major refurbishment, we are currently reviewing the PDC method, a non-invasive test to determine the moisture content of the winding insulation.

5.4.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the transformer assets.

5.4.4. ASSET REPLACEMENT

Transformer asset replacement is based on a combination of non-invasive and invasive condition assessment. Components that have deteriorated beyond acceptable parameter range are taken out of service for a detailed inspection of moisture levels, the core and windings. The investigation gives an indication of remaining life expectancy of the transformer and a decision is made on refurbishment or replacement based on the functionality and performance requirements of the asset.

5.5. TRANSMISSION AND SUBTRANSMISSION SWITCHGEAR

5.5.1. ASSET DESCRIPTION

Vector owns and operates 1,788 subtransmission circuit breakers, rated at 110kV, 33kV, 22kV, 11kV and 6.6kV. The circuit breakers are oil, vacuum, SF_6 and Gas Insulated Switchgear (GIS). Figure 5.3 shows the age profile of circuit breakers.

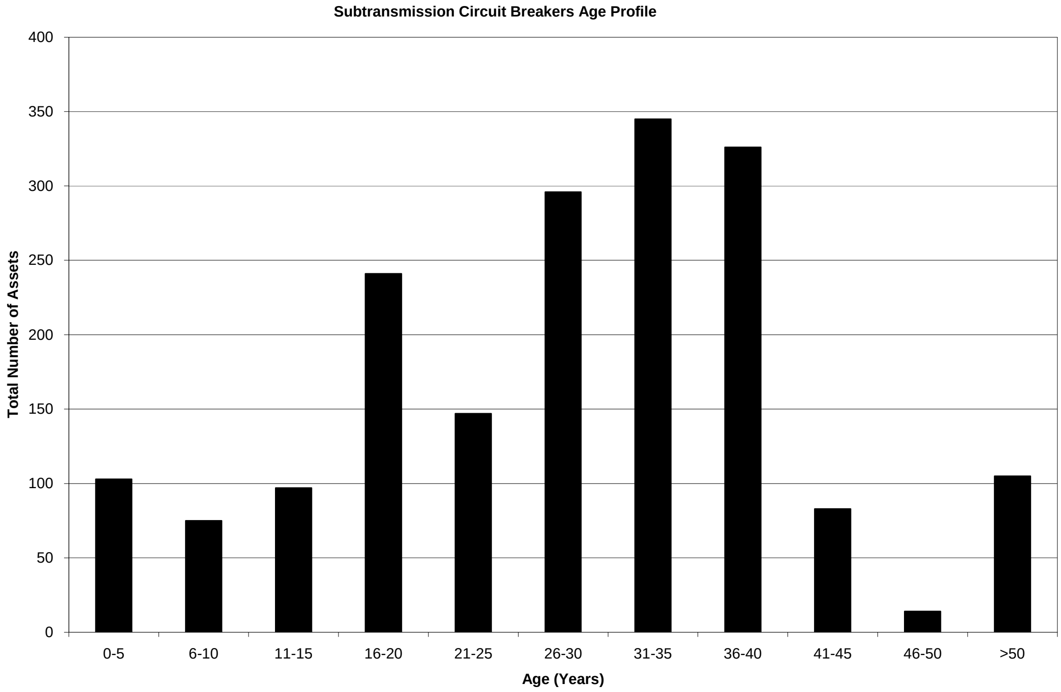

Figure 5.3 Subtransmission Circuit Breakers Age Profile

5.5.2. ASSET MAINTENANCE

- All switchgear is visually inspected regularly for leaks and general condition
- Thermographic examination is undertaken on all switchboards annually
- Kelman profile testing and non-invasive partial discharge location and monitoring is carried out on a two yearly cycle
- Major maintenance on the switchgear including inspection and performance testing of the circuit breakers on an eight year cycle and testing of the protection relays and systems on a two and four year cycle

5.5.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the switchgear assets.

5.5.4. ASSET REPLACEMENT

Circuit breaker replacement is based on a combination of condition assessment, end of useful life, economics and asset functionality.

5.6. ZONE SUBSTATION BUILDINGS

5.6.1. ASSET DESCRIPTION

There are 123 zone substations in the Vector network.

5.6.2. ASSET MAINTENANCE

All zone substations and ground and ripple injection spaces are maintained with regard to access security, condition and safety. The routine inspections include the building and other assets such as lighting, fire systems, fans, heaters and safety equipment.

5.6.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the zone substation assets.

5.7. POWER SYSTEM PROTECTION

5.7.1. ASSET DESCRIPTION

Vector operates over 5,200 relays. 80% of the relays are electromechanical, 6% solid state and 14 % of digital or numerical type.

5.7.2. ASSET MAINTENANCE

Electromechanical relays are tested on a four yearly cycle.

Solid state relays of the Nilstat ITP type are tested an annual basis, to monitor their condition prior to replacement.

Numerical relays are equipped with self-diagnostic functions, but international experience has shown that not all protection relay faults can be detected by the self-monitoring functions; therefore Vector has adopted the recommendations on testing numerical protection relays from the CIGRE Study Committee 34 Power System Protection and Local Control.

5.7.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the relay asset group.

5.7.4. ASSET REPLACEMENT

Individual replacement of relays is based on as failed, and asset replacement programmes are based on condition and whole of life costs.

5.8. SUBSTATION DC AUXILIARY SUPPLY

5.8.1. ASSET DESCRIPTION

A substation DC auxiliary system is regarded as a vital part of each substation installation. The DC auxiliary system provides power supply to the substation protection, control, metering, monitoring, automation and communication systems, as well as power to the circuit breaker tripping and closing coils.

Vector's standard DC auxiliary system consists of a string of batteries, battery charger, number of DC/DC converters and battery monitoring system.

The major substations are equipped with a redundant DC auxiliary system.

5.8.2. ASSET MAINTENANCE

Maintenance for the VRLA batteries 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).

5.8.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified.

5.8.4. ASSET REPLACEMENT

In all networks batteries are replaced when failed or based on condition assessment results with VRLA batteries.

5.9. SCADA

5.9.1. ASSET DESCRIPTION

The existing SCADA system consists of three sub-systems, the main SCADA system, the ripple control RTUs at the grid exit points and the grid exit point metering system. Control systems for all network areas are now based in Auckland.

5.9.2. ASSET MAINTENANCE

The main SCADA system is self-diagnostic in terms of failure being immediately apparent in the Control Room. The existing SCADA RTUs do not have full back up and maintenance is based on failure.

5.9.3. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the SCADA system.

5.9.4. ASSET REPLACEMENT

Communication and control assets are replaced as part of the overall system development to ensure compatibility.

5.10. ENERGY AND PQ METERING SYSTEM

Vector's bulk metering systems consists of a number of intelligent web-enabled revenue class energy and power quality meters communicating with the metering central server over an Ethernet based IP routed communication network.

The system provides Vector with essential information to control cost, quality and reliability of the power delivered to Vector's customers. It is currently used to:

- Improve operational efficiency by controlling peak demands at grid exit points, which ultimately reflects in reduced line charges to Vector's customers
- Provide comprehensive power quality and reliability information that will enable the verification of quality of power delivered to our customers against the published Vector service levels, and faster resolutions of power quality issues
- Increase the power supply stability by initiating instantaneous load shedding during grid under frequency events

5.11. 11KV AND 400V OVERHEAD NETWORK

5.11.1. ASSET DESCRIPTION

The overhead system consists of over 4,500km of 11kV line and over 5,300km of 400V line. Over 155,000 poles support the overhead distribution network, of which 22% are wooden and 78% concrete. Conductors vary across the overhead network, but are predominantly copper or aluminium. Modern line reconstruction utilises aluminium alloy (AAAC). ABC and CCT are used in areas susceptible to tree damage, where the trees can not be cut or removed due to resource consent and council restrictions.

5.11.2. ASSET MAINTENANCE

- Annual visual line patrol of poles and hardware, including clearance checking to meet the Electrical Code of Practice
- Five yearly condition assessment of wooden poles using ultrasonic methodology
- Five yearly detailed inspection of all poles and hardware
- Proactive vegetation management and local council vegetation management agreements
- Three yearly inspection of earthing connections
- Five yearly measurement of earth sites
- Three yearly ABS inspection and operation

5.11.3. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for this asset group.

5.11.4. ASSET REPLACEMENT

Poles

Wooden poles are replaced based on the outcome of ultrasonic testing and engineering analysis. Any poles that when assessed have a remaining strength of less than 60% of original strength are subject to an engineering analysis to determine their serviceability index as defined in HbC(b)1-1999 and AS/NZ4676 (2000). Poles with an unacceptable serviceability index are tagged for replacement within six weeks.

Cross Arms and Hardware

Cross arms are visually inspected and replaced as required.

Pole cross arms and hardware are replaced to meet the current equipment standards when a pole is replaced, and as individual items when condition indicates this is the best option.

Conductors

The conductors are inspected on an annual basis. Replacement is based on condition assessments and analysis of fault history.

Air Break Switches (ABS)

ABS are replaced based on a set of performance criteria. Condemned ABS are replaced with enclosed SF_6 switches when required.

5.12. 11KV AND 400V UNDERGROUND DISTRIBUTION NETWORK

5.12.1. ASSET DESCRIPTION

The underground distribution network consists of over 3,900km of HV cable and over 6,100km of LV cable. HV cable types are predominantly PILC, with XPLE now standard for new cables. LV cables are predominantly PILC and PVC insulated cables.

5.12.2. ASSET MAINTENANCE

- Maintenance for both 11kV and 400V cables is reactive, based on faults
- Two yearly visual inspection of pillars, plus pillar internal checks and loop impedance testing

5.12.3. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for this asset group.

5.12.4. ASSET REPLACEMENT

Cable Terminations

Cable termination replacement is driven by visual inspection and analysis of fault rates. The exception to this are cast metal terminations, where analysis of fault rates and economic consideration have resulted in a decision to replace cast metal cable terminations with modern equivalent heatshrink terminations, The replacement programme is scheduled for completion during 2005.

Cables

Cable replacement is based on a combination of fault rate analysis and the tests performed following fault repairs.

Pillars

Pillars are replaced based on fault or damage, normally through foreign interference. Each damaged pillar is assessed to determine the risk of future potential damage by vehicles due to location. If the risk is high the pillar is replaced with a pit.

5.13. DISTRIBUTION TRANSFORMERS

5.13.1. ASSET DESCRIPTION

Vector owns and operates over 25,480 distribution transformers of which 61% are ground mounted and 39% are pole mounted. Ground mounted transformers are either stand alone, enclosed in metal or fibreglass canopies, open enclosures or fully enclosed within other buildings. The transformers are generally rated between 30 and 1,000kVA, although there are a small number rated at 1.5kVA, 5kVA, 7.5kVA and 10kVA. Figure 5.4 shows the age profile of the distribution transformer assets.

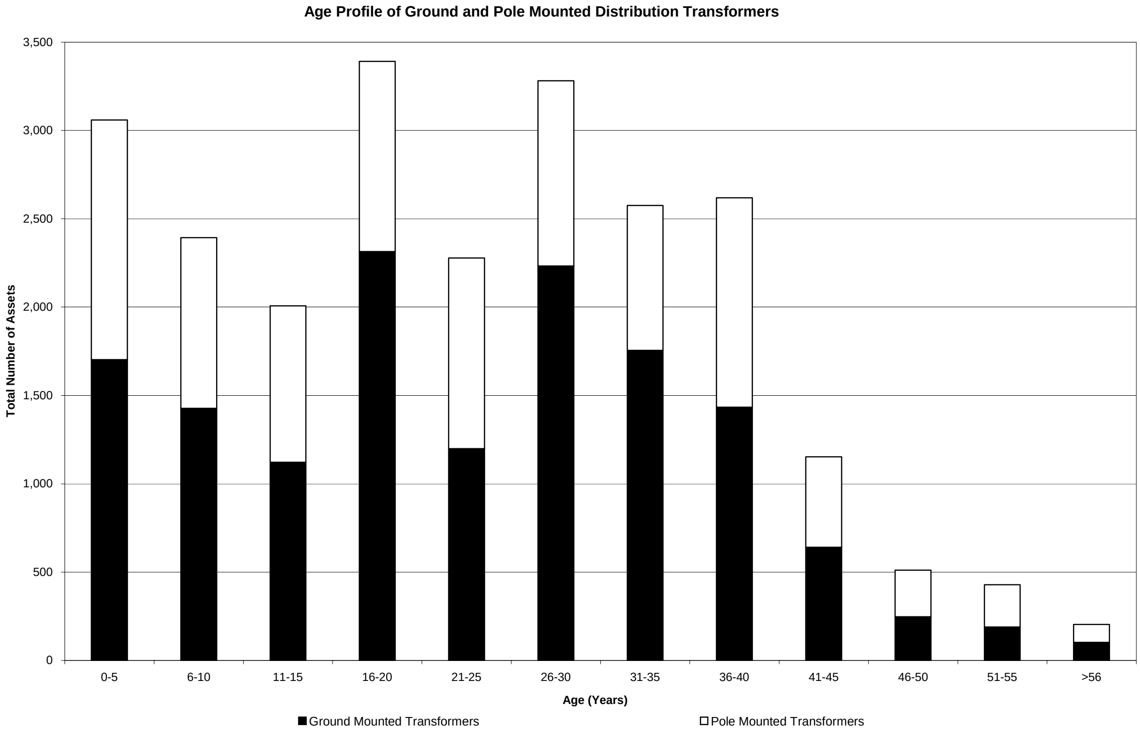

Figure 5.4 Distribution Transformers Age Profile

5.13.2. ASSET MAINTENANCE

- Visual transformer inspection on a three yearly cycle
- Load records on a three yearly cycle
- Earthing resistance tests on a three yearly cycle, including MEN resistance, individual bank resistance and step and touch potential

5.13.3. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for this asset group.

5.13.4. ASSET REPLACEMENT

Transformer replacement is determined from condition criteria, assessed during regular inspection. Any failed transformer returned to the depot for investigation of the failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset.

5.14. DISTRIBUTION SWITCHGEAR

5.14.1. ASSET DESCRIPTION

Ground mounted switchgear is a mix of oil, SF_6 and resin insulated equipment and is of varying ages and manufacturers.

5.14.2. ASSET MAINTENANCE

- Visual inspection on a three yearly cycle
- Full service on an eight yearly cycle

5.14.3. ASSET REPLACEMENT

Switchgear replacement is based on condition and availability of components for repair. Any failed switchgear units are returned for investigation of failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset.

As part of Vector's continual improvement process, the use of oil filled switchgear has been reviewed and other types of switchgear investigated. The outcome of this review has been a change in specification to implement SF_6 switchgear. The use of equipment without oil will eliminate damage to the environment caused by oil spills and leaks.

5.15. DISTRIBUTION SUBSTATIONS

5.15.1. ASSET DESCRIPTION

Vector owns and operates over 25,480 distribution substations. The substations are maintained with regard to security, condition and safety.

5.15.2. ASSET MAINTENANCE

Distribution substations and enclosures are visually inspected and maintained annually. Checks and maintenance include access, security, signage, graffiti removal, vegetation management, cleaning and weatherproofing. The condition of the substations and enclosures is generally good. The types of defects found and maintenance required are consistent across the networks and relatively minor in nature with the main issues being vegetation, access problems, and security of the substation.

5.15.3. ASSET ISSUES AND RISKS

No new asset risks or issues have been identified.

5.15.4. ASSET REPLACEMENT

Distribution substation enclosure and equipment replacement is on an as failed or condition basis.

5.16. FORECAST MAINTENANCE EXPENDITURE

Table 5.2 shows forecast operational maintenance expenditure over the planning period.

	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Maintenance Expenditure	63	58	54	47	47	46	46	46	46	46

Table 5.2 Forecast Maintenance Expenditure ($ million)

6. RISK MANAGEMENT

Asset risk management in Vector is an integral part of the asset management process. Asset risks, the consequences of failure, current controls to manage this, and required actions to make risks acceptable are all understood and evaluated as part of the asset function and performance analysis. Any risks associated with the assets or operation of the network are evaluated, prioritised and dealt with as part of the asset maintenance, refurbishment and replacement programmes. The acceptable level of risk will differ depending upon the level of risk our customers are willing to accept and the circumstances and the environment in which the risk will occur. This analysis includes very low probability events with high impact, such as total loss of a zone substation. From this analysis, contingency plans are developed. Risk is managed in Vector by a combination of:

- Reducing the probability of the failure, through the capital and maintenance work programme and enhanced working practices
- Reducing the impact of failure, through contingency and emergency plan development and insurances

The capital and maintenance asset risk management strategies are outlined in the Asset Maintenance and Development sections. Vector's contingency and emergency planning is based around procedures for restoring power in the event of a fault occurring on the network, and are detailed in Section 6.5.

6.1. RISK ACCOUNTABILITY AND AUTHORITY

6.1.1. VECTOR BOARD

The Board endorses the risk context under which Vector operates. A Board Risk Committee meets regularly, reviewing the risk register and risk methodologies in terms of their corporate governance responsibilities.

6.1.2. EXECUTIVE RISK MANAGEMENT COMMITTEE

The Executive Risk Management Committee (which reports to the Board Risk Committee) oversees and monitors the implementation of appropriate and consistent risk management in each business unit, and across the company as a whole, by:

- Developing and maintaining, for the Board's review and approval, a risk management policy for Vector consistent with the company's objectives
- Overseeing and monitoring the implementation of risk management across Vector to ensure that it is in compliance with the risk management policy

In terms of implementation, the Executive Risk Management Committee on a monthly basis:

- Assesses all new risks identified, confirms the priority and actions determined by each functional unit in terms of managing these risks
- Reviews priority and actions for entries on the active register
- Monitors progress on actions assigned against entries in the register
- Reviews new high priority entries and progress on resolution of existing high priority entries

One of the requirements of the Charter of the Executive Risk Management Committee is:

> *"Secure a comprehensive third party audit of the application of risk management at Vector at least every two years, and a third party audit of key elements at least annually."*

The aim of the audit is to consider:

- The extent to which Vector is applying its risk management structures, accountabilities, processes and reporting mechanisms in support of its risk management policy

- Opportunities for improving Vector's established risk management policy, structures, accountabilities, processes and reporting mechanisms in support of the company's business goals

The most recent audit was carried out by Deloitte and determined that "the current framework compares favourably to local and international practice and is consistent with, and in some cases exceeded, our expectations and the industry average". The audit report noted some improvement opportunities which are currently being implemented.

6.1.3. EXECUTIVE TEAM (GENERAL MANAGEMENT)

The General Management team are responsible for the management of risk within their functional area or as otherwise assigned. Each functional area within Vector has a risk register on which risks, solutions and accountabilities are listed and reported. Networks and Service Delivery, which cover the network management and operational management functions of the networks, have unique registers reviewed consistently by the staff from those areas.

6.1.4. ALL EMPLOYEES

All staff and service providers are responsible for reporting any identified risks that come to their notice. Individuals may then also have responsibility for managing an individual risk, a risk control or be responsible in delivering a specific risk treatment.

6.2. RISK MANAGEMENT PROCESS

The risk management process classifies risks into "strategic" and "operational" categories. The "strategic risks" which are those which the company believes would have catastrophic or major consequences to the company, are regularly reported to the Board. The risk management process includes understanding the consequences of failure from the events, evaluating the impact of the event and defining response plans. Operational risks which do not receive direct Board overview are monitored and reviewed by the Executive Risk Management Committee.

The risk management process adopted by Vector is shown in Figure 6.1.

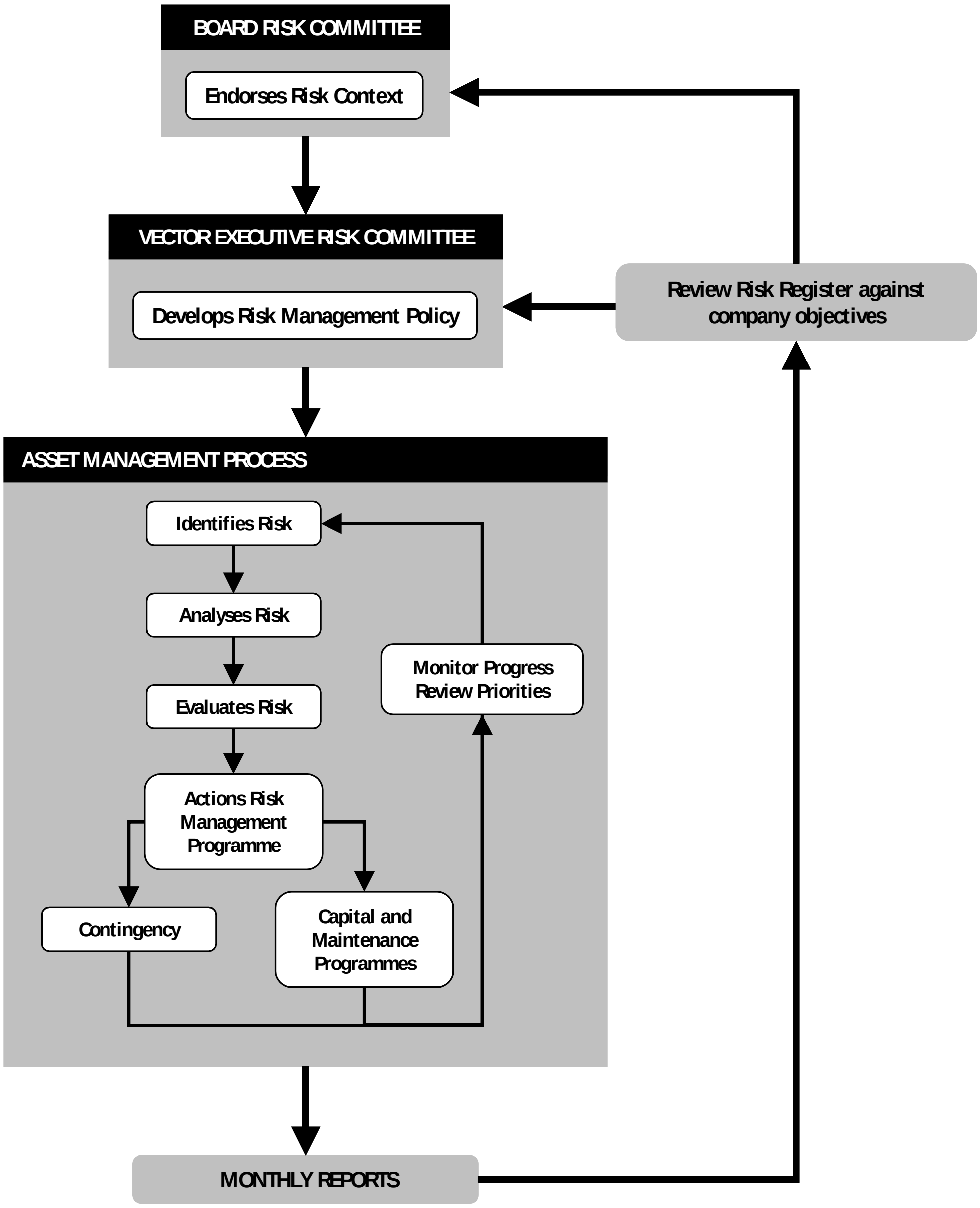

Figure 6.1 Vector's Risk Management Process (Based on AS/NZ4360)

Vector's risk management policy is defined to ensure that:

- Risks to the business are identified, understood and work is prioritised to mitigate them as appropriate. A catastrophic and major risk register is maintained and tracked at Board level
- Practices that could cause disruption to service and operations, injury to people or the environment, or significant financial loss are understood, documented and mitigated as part of the process
- The business is protected by suitable insurance polices, or contingency plans, wherever necessary

6.3. RISK IDENTIFICATION AND ANALYSIS

All risks are assigned a risk level based on the consequence and likelihood of the risk as shown in Figure 6.2. Vector chooses to focus first on consequence and then review likelihood rather than initially looking at the level risks as a combination of these two factors.

Likelihood						
	Almost Certain	*1++per yr*				
	Rare	*1per yr*	Operating / Efficiency		Strategic	
	Possible	*1per 1yr-10yr*				
	Unlikely	*1 per 10yr-50yr ++*				
			Minor	**Moderate**	**Major**	**Catastrophic**
				Cost/benefit decisions at appropriate mgmt levels	Med/long term under performance	Short/med term survival
			Consequence			

Figure 6.2 Vector's Risk Prioritisation Matrix

Catastrophic and major risk includes loss of life, extended loss of supply, or financial loss of a magnitude sufficient to impact on the company.

6.4. CONTINGENCY PLANS

6.4.1. SWITCHING

For all major feeders, the network is designed to allow reconfiguration by switching so that power can be fed through an alternative path if there is a failure or a need to shift load. In the Wellington CBD, some distribution switching can be carried out remotely via SCADA. A small number of distribution switches in the Northern and Auckland networks can also be operated by SCADA.

In the event of failure of a minor feeder, Control Room operators undertake network analysis and instruct field crews to undertake manual switching to restore power to as many customers as possible (while the fault is repaired), especially to critical customers.

The Control Room has prepared contingency switching plans for major outages such as complete loss of a zone substation for all three networks.

6.4.2. CRITICAL SPARES

A stock of spares is maintained for critical components of the network so that fault repair is not hindered by the lack of availability of required parts. Whenever construction of a new part of the network is undertaken, an evaluation is made of the spares that will be retained to support repair of any key equipment installed.

6.4.3. DISASTER ANALYSIS

Plans are developed, as part of the overall management of the network, which consider the actions that would be taken in the event of a major failure of part of the network. Such plans consider switching options and the rapid construction of temporary lines.

If there is specific concern regarding a risk to the network, detailed contingency plans are developed, which include detailed design of the required temporary lines and the securing of materials required to allow immediate construction.

6.4.4. CIVIL DEFENCE AND EMERGENCY MANAGEMENT ACT

Vector is required under the Civil Defence and Emergency Management Act 2002 (CDEM) to be "able to function to the fullest possible extent, event though this may be at a reduced level, during and after an emergency" and also to have plans for functioning during and after an emergency.

A business continuity plan for Vector has been developed and is current being finalised. Vector is also a member of the Auckland and Wellington Engineering Lifelines Group (AELG and WELG) and through this membership keeps abreast of development in the CDEM area to ensure it is fully prepared for an emergency.

Vector has in place emergency response plans for major events and a Civil Defence and Emergency Management plan that sits above these plans for use in the event of a declared civil defence emergency.

6.4.5. HEALTH AND SAFETY

At Vector safety is a fundamental value, not merely a priority.
Vector's policy is to:

> *"Create and maintain a safe and injury free work environment for our employees, our service providers, our suppliers and the public we serve."*

To support the Vector safety policy a set of Safety Guiding Principles have been adopted by the company and our service providers. They reflect the principles of other world class companies, and define the ultimate responsibility of management to lead and implement the safety process, while at the same time recognising each individual's responsibility to work safely.

- 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

Vector's Safe Work Practices define the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for Vector and our service providers to identify and eliminate accident causes.

All service providers working for the company are required, as a minimum, to comply with these Safe Work Practices whilst carrying out any work on the network. Service providers are also required to report all employee accidents/incidents and near misses to Vector together with their relevant investigations and intended corrective actions. The service providers are incentivised through the contract bonus structure to achieve the Vector safety targets.

As part of our focus to continually improve health and safety, we have employee safe teams and a Safety Leadership Team – a task force which encourages all staff to voice their opinion on company safety standards, raise concerns and suggest improvements.

In conjunction with Shaw Energy Delivery Service we have undertaken a number of audits of our health and safety systems and processes. The latest audit classed us overall as good, and that we had made significant progress in a number of areas. There is no scope to relax and we will be looking for further significant improvements in health and safety.

Our progress on health and safety is shown in Figure 6.3.

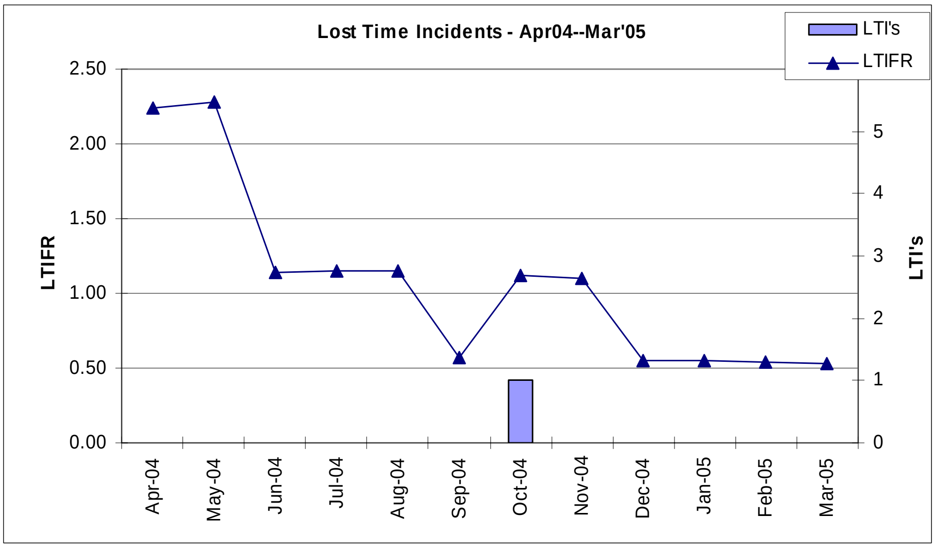

Figure 6.3 Network Safety Performance

Our ongoing safety target is simply:

"No lost time injuries to any person working on our network."

7. ■ EVALUATION OF PERFORMANCE

7.1. PROGRESS AGAINST PLANS

7.1.1. CAPITAL PROJECTS IN THE VECTOR NETWORK

The 2004/05 capex plan included a total of $71.4 million for new network capital projects. The total value of new network capital projects actually approved (excluding customer initiated projects) was $60.5 million. The significant variances were due to:

- Deferment of asset replacement projects based on better or new condition information indicating that assets were achieving the required functionality at low or acceptable risk
- Cancellation of projects when detailed analysis showed the expected performance improvements and/or cost savings would not be realised
- Timing issues
- The deferral of a number of replacement related projects due to changing third party circumstances

7.2. PERFORMANCE AGAINST TARGETS

Vector has in place detailed performance targets that are defined and linked to ensure that we are striving for and achieving the company goals in an optimum and efficient way.

Physical network performance in Vector is tracked through:

- Reliability
- Safety
- Customer satisfaction

These measures:

- Are directly applicable to the core business
- Support the strategic aims of the business
- Enable Vector to track and easily communicate performance
- Enable direct comparison with other companies for the purposes of benchmarking

The ongoing results of these measures are communicated on a monthly basis to all Vector employees and service providers. Accountability for the performance targets is a function of all employees. The service providers are incentivised through the contract bonus structure to achieve their targets and Vector direct employees have the physical performance measures embedded in the performance related pay scheme.

7.2.1. RELIABILITY

The reliability targets and actuals for the combined network for 2004/05 are shown in Table 7.1.

Measure	2004 Target	2004 Actual
SAIDI	80	83.09
SAIFI	1.30	1.25
CAIDI	62	66.62

Table 7.1 Reliability Statistics (inclusive of Transpower outages)

The targets set for 2004/05 were again stretch targets designed to push the assets and service providers who are incentive driven to achieve the reliability targets.

7.2.2. RELIABILITY IMPROVEMENT

In 2005, the company has budgeted almost $4 million on proactive reliability of supply improvement initiatives. The initiatives continue to target the worst performing feeders and network areas, aiming to bring performance back in line with customer service expectations. The 15 worst performing feeders are shown in Table 7.2, ranked by SAIFI.

Region	Customer Type	Substation	Feeder	Ranking
Northern	Rural	Henderson Valley	Piha	1
Northern	Residential	Manly	Motutapu	2
Northern	Residential	East Coast Road	Knights	3
Northern	Rural	Waimauku	Muriwai	4
Auckland	Rural	Takanini	Mill Road	5
Auckland	Rural	Otara	Sandstone Road	6
Northern	Rural	Spur Road	Red Beach	7
Northern	Residential	Orewa	Maire Road	8
Northern	Residential	East Coast Road	Rosedale Road	9
Auckland	Rural	South Howick	Meadowland Drive	10
Northern	Rural	Warkworth	Matakana	11
Northern	Rural	Coatesville	Mahoenui Road	12
Northern	Rural	Snells Beach	Parklands	13
Northern	Residential	Birkdale	Fordham	14
Northern	Rural	Swanson	Bethells Beach	15

Table 7.2 Worst Performing Feeders

These initiatives do not just focus on minimising the time customers are without electricity but will also reduce the number of interruptions customers experience (customer consultation having identified frequency of interruption as the highest priority item for reliability improvement) and improve the quality of power delivered to customers.

Improvement initiatives consider both long and short-term solutions. The short-term initiatives are generally failure-mode specific. All initiatives are evaluated through a cost benefit framework that considers the effect on average zonal frequency and duration performance, together with outlier frequency and duration performance.

In general the types of initiatives are as follows:

- Automated circuit reclosers; provide monitoring and protection to help minimise the number of customers affected by faults should they occur, and to avoid tripping the entire feeder for a transient fault.
- Automated switch/sectionalises: provides monitoring and control functionality to allow the control centre to quickly locate a fault and restore supply to customers
- Fault passage indicators; to allow operators to locate faults more quickly and accurately, thus reducing the fault isolation and supply restoration time

Vector sees automation as a key enabler for improving distribution network reliability and network performance.

The initiatives, locations and background service levels are represented geographically in Figure 7.1 (Northern area), Figure 7.2 (Auckland area) and Figure 7.3 (Wellington area).

Figure 7.1 Northern Network Reliability of Supply Initiatives 2005/06

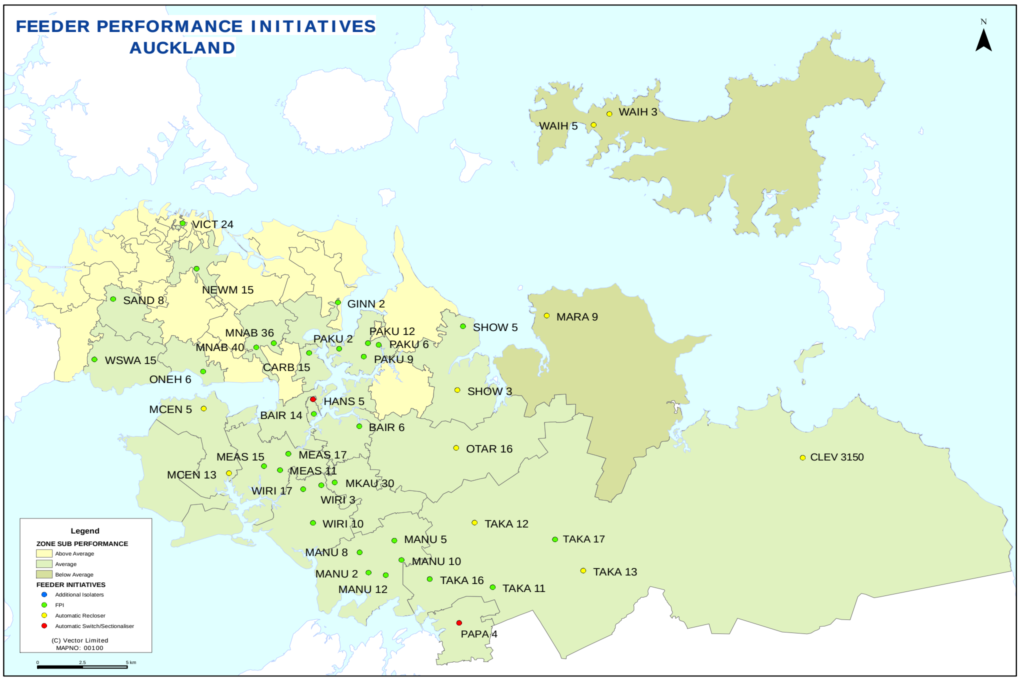

Figure 7.2 Auckland Network Reliability of Supply Initiatives 2005/06

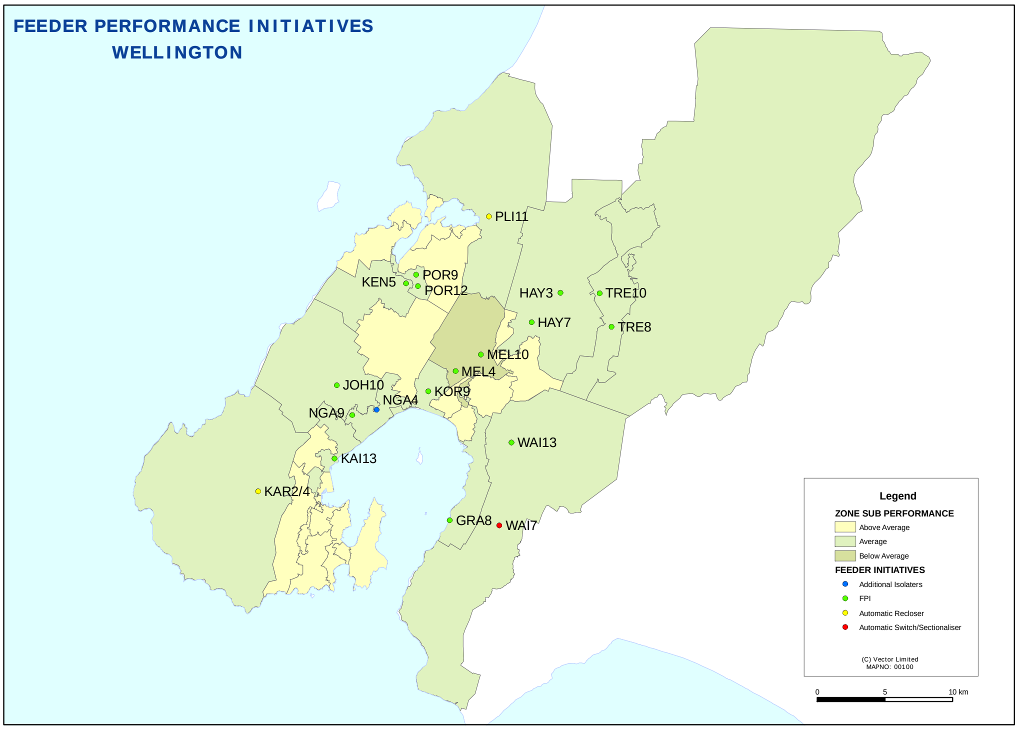

Figure 7.3 Wellington Network Reliability of Supply Initiatives 2005/06

7.2.3. SAFETY

Vector sets safety targets around lost time injury frequency per million man hours worked. These statistics include all lost time injuries sustained by their employees and employees of their service providers including sub-contractors whilst working on the network.

The target set for the year ending June 2005 was:

- Achieve a further 1 million man hours lost time injury free on the Auckland network
- Achieve a 50% reduction in the LTIFR for Northern and Wellington networks

Performance at 31 March 2005 year end was:

- One lost time injury during the period on the Auckland network, after a record two million man hours without an LTI
- Five lost time injuries on the Northern and Wellington networks
- A resultant lost time injury frequency of 0.0 for Auckland and 9.9 for Northern and Wellington

7.2.4. CUSTOMER SATISFACTION

Vector continues to monitor customer satisfaction as a key performance indicator both for Vector staff and our contracting business partners. For the year 2004/05 this measure included all three electricity networks for the first time as shown in Figure 7.4. Previous years have been for the Auckland network only. We also included separate measures for gas and telecommunication customers.

The targets for each area are as follows:

Electricity:	6 month rolling average score for the three networks to meet or exceed 80.3%
Gas:	8 month rolling average score of the customer connection monitor to meet or exceed 84.8%
Communications:	the score for a 12 month snap shot survey to meet or exceed 78.0%

All targets relate to Vector's financial year which is to 30 June 2005. For electricity we are currently tracking above the target at 83.4% while the gas score is below target at 79.7%. Though the target for the year for gas is unlikely to be achieved, results have been trending upwards in the surveys conducted throughout the year.

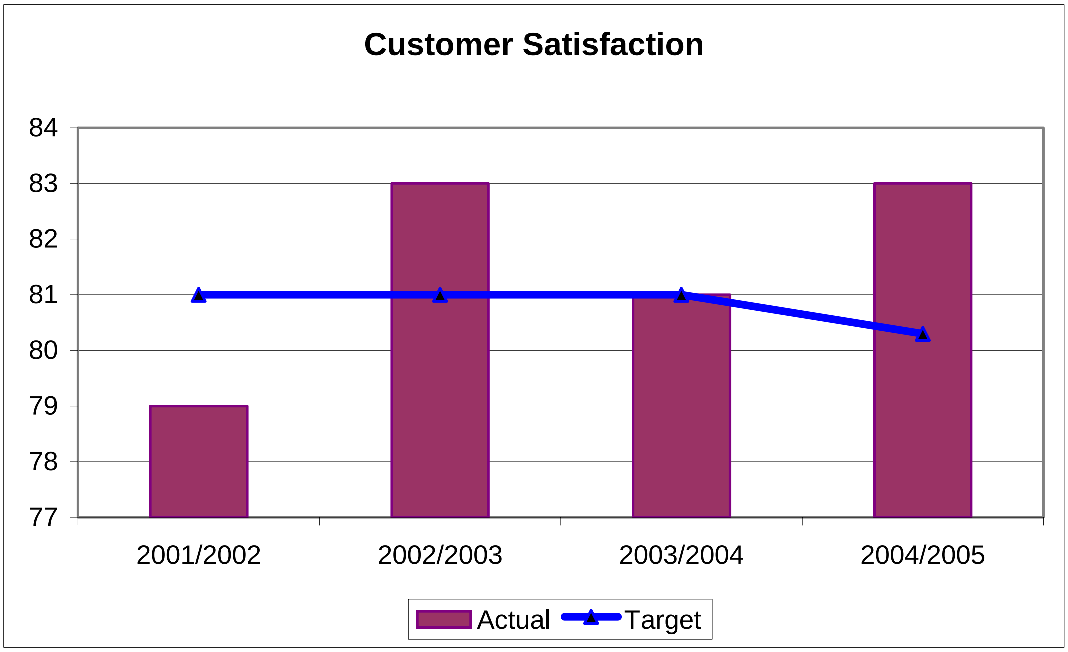

Figure 7.4 Customer Satisfaction Score

Vector is currently assessing how, going forward, we will interact with our customers, but regardless of the outcome of this decision, customer satisfaction will remain a core key performance indicator for internal staff and business partners. Targets for 2005/06 will include all networks.

7.3. PLANNED IMPROVEMENTS FOR PERFORMANCE

To improve performance and to ensure resources are targeted most appropriately, Vector has a number of planned improvements for 2005/06:

- Continued development of tools to enable Vector and the service providers to spot trends and improvement opportunities quickly and efficiently
- Continued implementation of smarter equipment in the field to enable more efficient fault finding and a focus on innovative field practices to substantially reduce outage times