ALPINE ENERGY LIMITED

Major Network Asset Management Plan 2015-2025

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Major Network Asset Management Plan 2015–2025

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Foreword

We have taken a new approach to writing and publishing our 2015–2025 Asset Management Plan (AMP), than we have taken in the past.

For 2015 we have produced two documents instead of the usual one. The first document, the 2015 Asset Management Plan (AMP) is similar in layout and content of our 2014 AMP. Information on major network assets and Transpower GXP's, has now been placed into the Major Network Asset Management Plan (MNAMP). The MNAMP provides staff, contractors and other interested parties with key information on major network assets in the most accessible form.

Together, the AMP and MNAMP have been published to meet our regulatory requirements for asset management under the Electricity Distribution Information Disclosure 2012 (consolidated in 2015).

We encourage consumers to comment on both our AMP and MNAMP, as well comment on the approach taken to maintain a cost effective, safe and reliable supply to South Canterbury.

The Directors

Alpine Energy Limited

Liability disclaimer

The information and statements made in the MNAMP are prepared on the assumptions, projections, and forecasts made by us, and represent our intentions and opinions at the date of approval—25 March 2015.

Circumstances will change, assumptions and forecasts may be proved to be wrong, events may occur that were not predicted, and we may at a later date, decide to take different actions from those we currently intend to take as expressed in the MNAMP.

We cannot be held liable for any loss, injury or damage arising directly or indirectly as a result of use or reliance on any information contained within the MNAMP.

Director certification

Certification for Major Network Asset Management Plan 2015 to 2025

We, Stephen Richard Thompson and Alister John France, being directors of Alpine Energy Limited certify that, having made all reasonable enquiries, to the best of our knowledge:

a) The Major Network Asset Management Plan 2015 to 2025 of Alpine Energy Limited prepared for the purposes of clause 2.6.1 and sub clauses 2.6.3(4) and 2.6.5(3) of the Electricity Distribution Information Disclosure Determination 2012 (consolidated in 2015) in all material respects complies with that determination.

b) The prospective financial or non–financial information included in the attached information has been measured on a basis consistent with regulatory requirements or recognised industry standards.

Stephen Richard Thompson
25 March 2015

Alister John France
25 March 2015

1 Introduction

The MNAMP contains information on our network assets at the grid exit point (GXP), zone substation, and sub–transmission level, as well as possible developments at the strategic level.

Developments at the strategic level are at the concept stage. Details on planned work for the next 12 months are discussed further in chapter 5 of our Asset Management Plan (AMP).

Developments at the concept stage include; possible impacts from major industrial and agricultural developments, utility developments as well as plans and concepts envisioned to resolve major network issues.

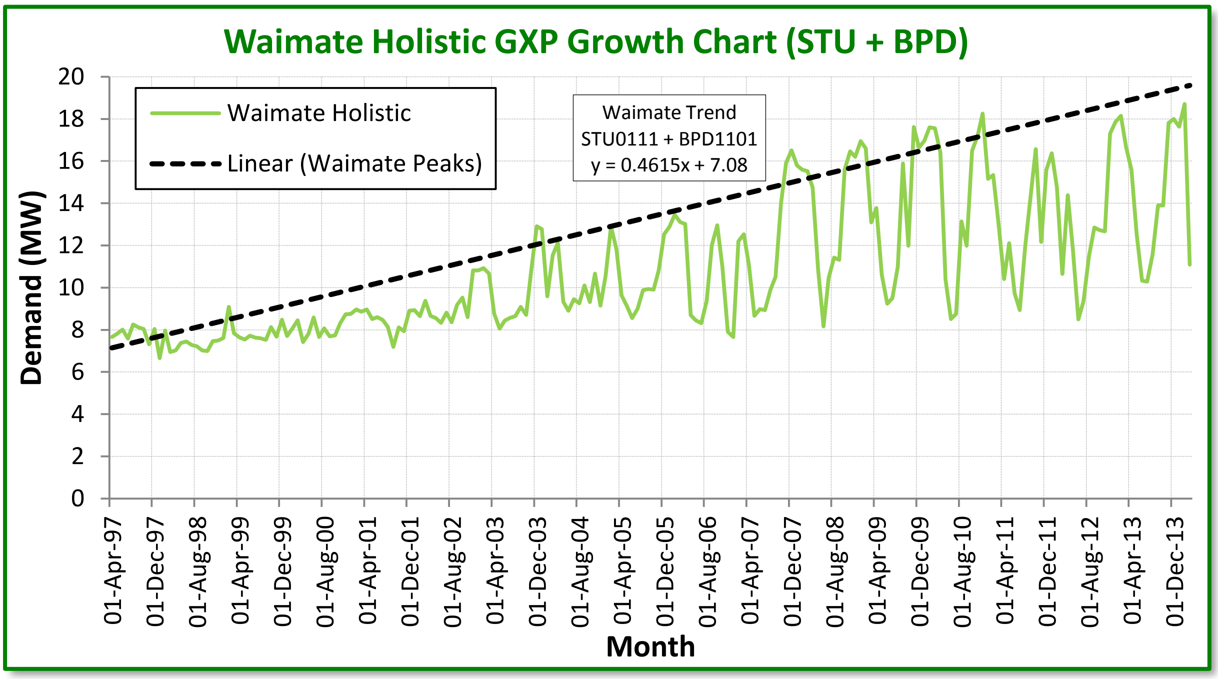
The MNAMP is divided into chapters based on Transpower's GXPs. Assets are further described in an order intended to correspond to the geography of the network.

The MNAMP provides a ready reference of the key information above LV reticulation level.

Figure 1.1 Our Area of Supply

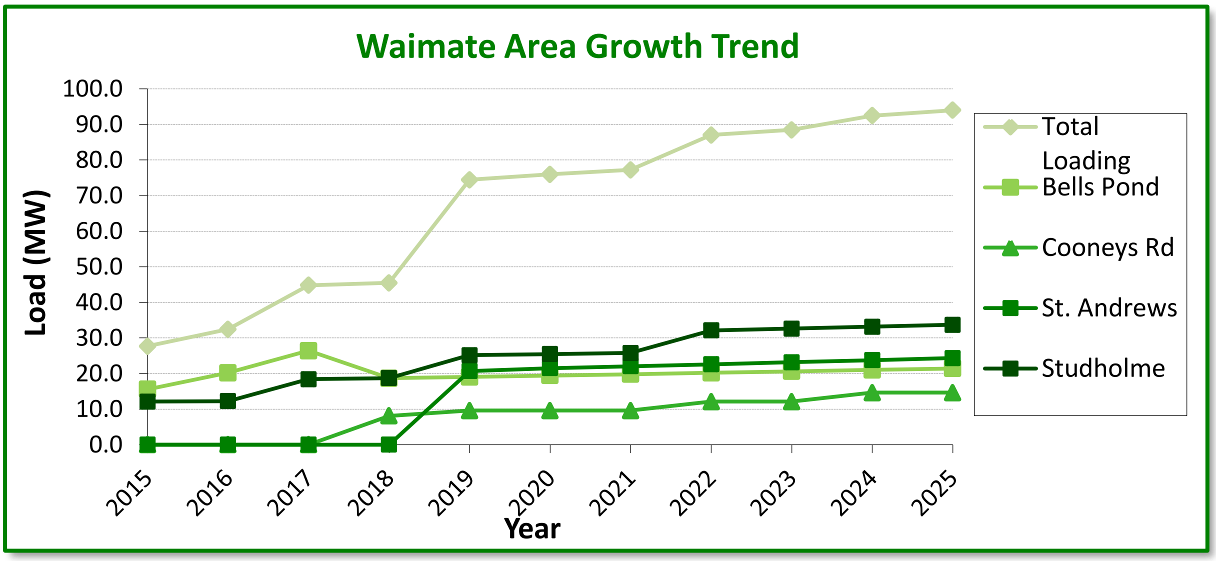
One of our main focuses at present is in the Waimate District. Waimate consists of the area supplied by the GXPs at Bell's Pond (BPD), Studholme (STU) and to a lesser extent from Pareora (PAR) zone substations.

Figure 1.2 Waimate Holistic GXP Load Growth Chart



When the larger irrigation projects and dairy factory expansion have progressed, it is foreseen that a new GXP will be required at St. Andrews (STA). Work will also need to be done to gain a new GXP at Waihao (WHO) to feed BPD, STU and Cooneys Road (CNR) from an alternate source than the present 110 kV Waitaki circuits.

Figure 1.3 Waimate Area Growth Trend shows we will be led into a High Growth Phase



Each of the following chapters refers to an individual GXP. The existing two GXPs (BPD and STU) in the Waimate district describe present loads, they also describe the expected loads after further development of two irrigation schemes and increasing dairy factory loads. Two new chapters have been added for the proposed new GXPs; STA and WHO.

We have been concerned about the burgeoning load growth in the Temuka area, which compounds on the whole supply chain back through the; Temuka (TMK) 33 kV bus, TMK 110/33 kV transformers, TMK–Timaru (TIM) 110 kV transmission lines, TIM 110 kV bus and then the TIM 220/110 kV inter–connection transformers.

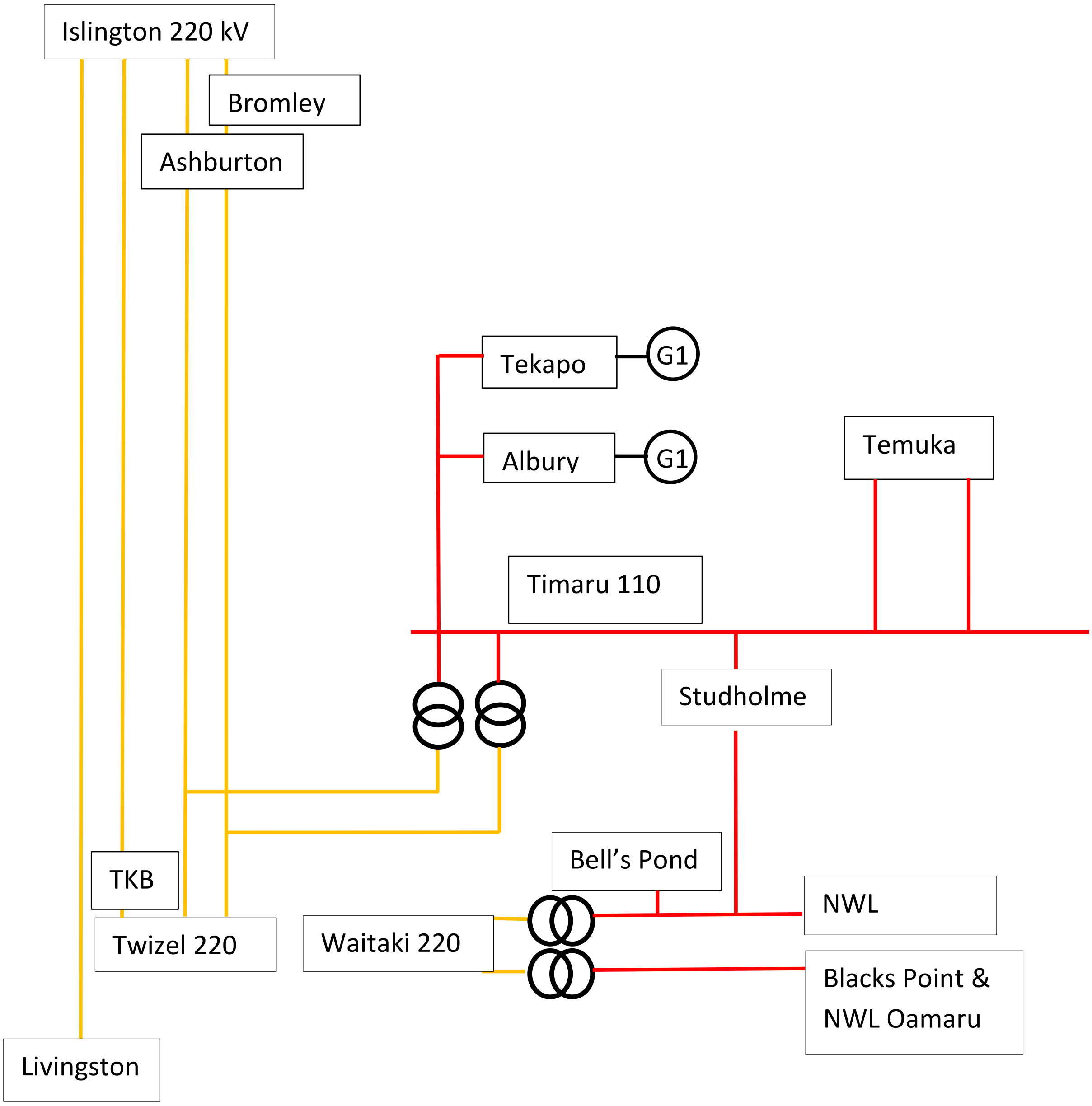
Transpower have been discussing the bussing of the four 220 kV circuits (i.e. CHH–TWZ A (2), BEN–ISL A, and ROX–ISL A) near Geraldine at Orari (OAI). We have seized the opportunity to include a new chapter in this document for OAI where a possible 220 kV GXP could be built to off–load Clandeboye and Rangitata (RGA) from the above mentioned TMK chain of supply by some 50 MW.

Photograph 1.1 11 kV cable terminations

1.1 The Grid

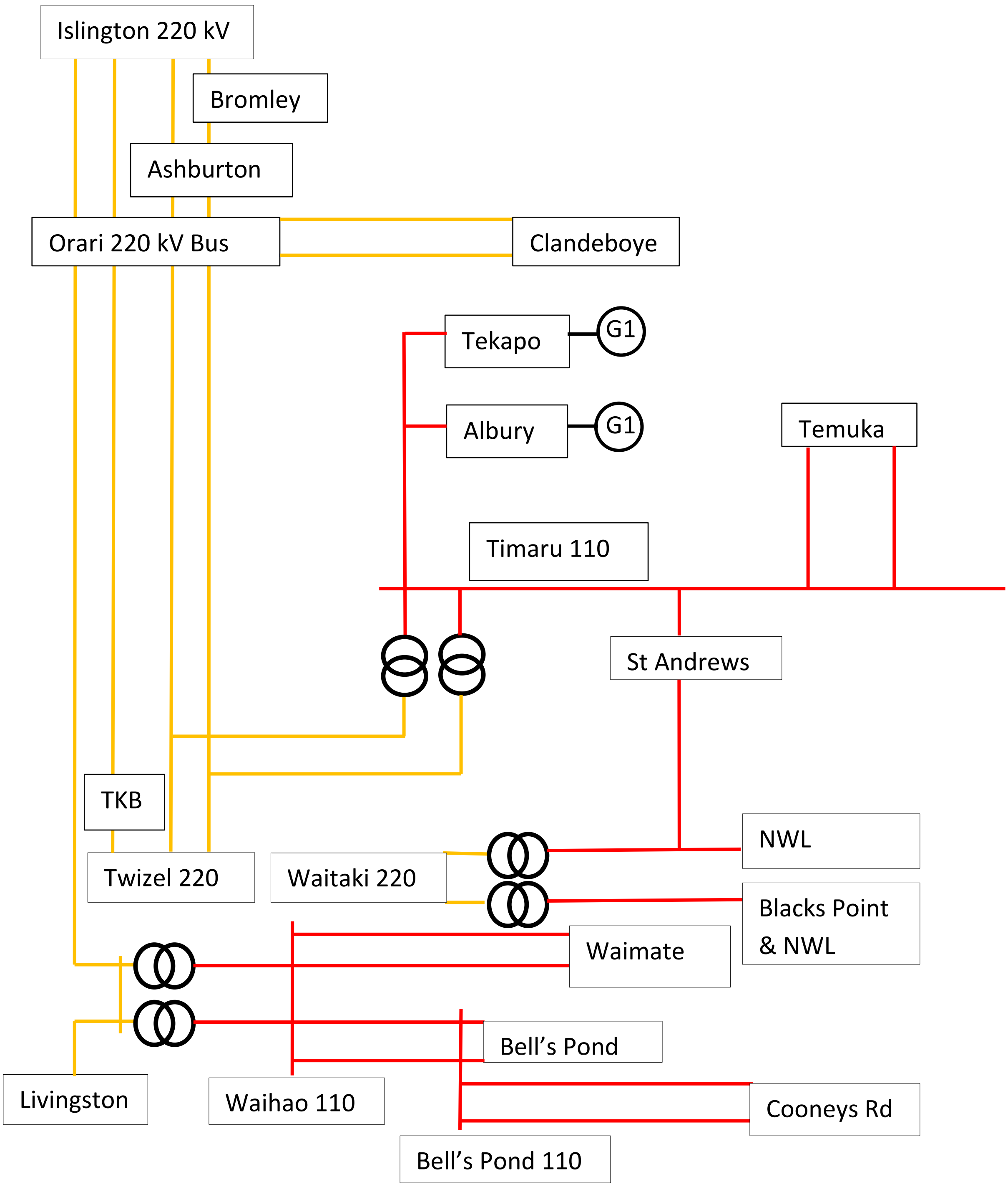
Figure 1.4 represents the Grid's present (2015) state:

Figure 1.4 2015's Grid



Negotiations are underway with Transpower to make alterations to the grid to allow increased demand from irrigators and food processors. Our view of how the gird will be configured at the end of the 10 year planning period is represented by Figure 1.5.

Figure 1.5 Future Grid Foreseen for End of Planning Period (i.e. by 2025)



1.2 Condition Assessment

This document includes ratings of network assets under each GXP and the network connected. A description of ratings is shown below:

- Poor—Will need to be replaced in the near future as failure is a possibility
- Good—Sufficient for present needs and security requirements
- Excellent—Unlikely to fail for the foreseeable and unforeseeable future.

1.3 Security Levels

Industry classifications for security level are described in Table 1.1 and are typically N, or N–1. We also include N–0.5, please refer below for a description of this term.

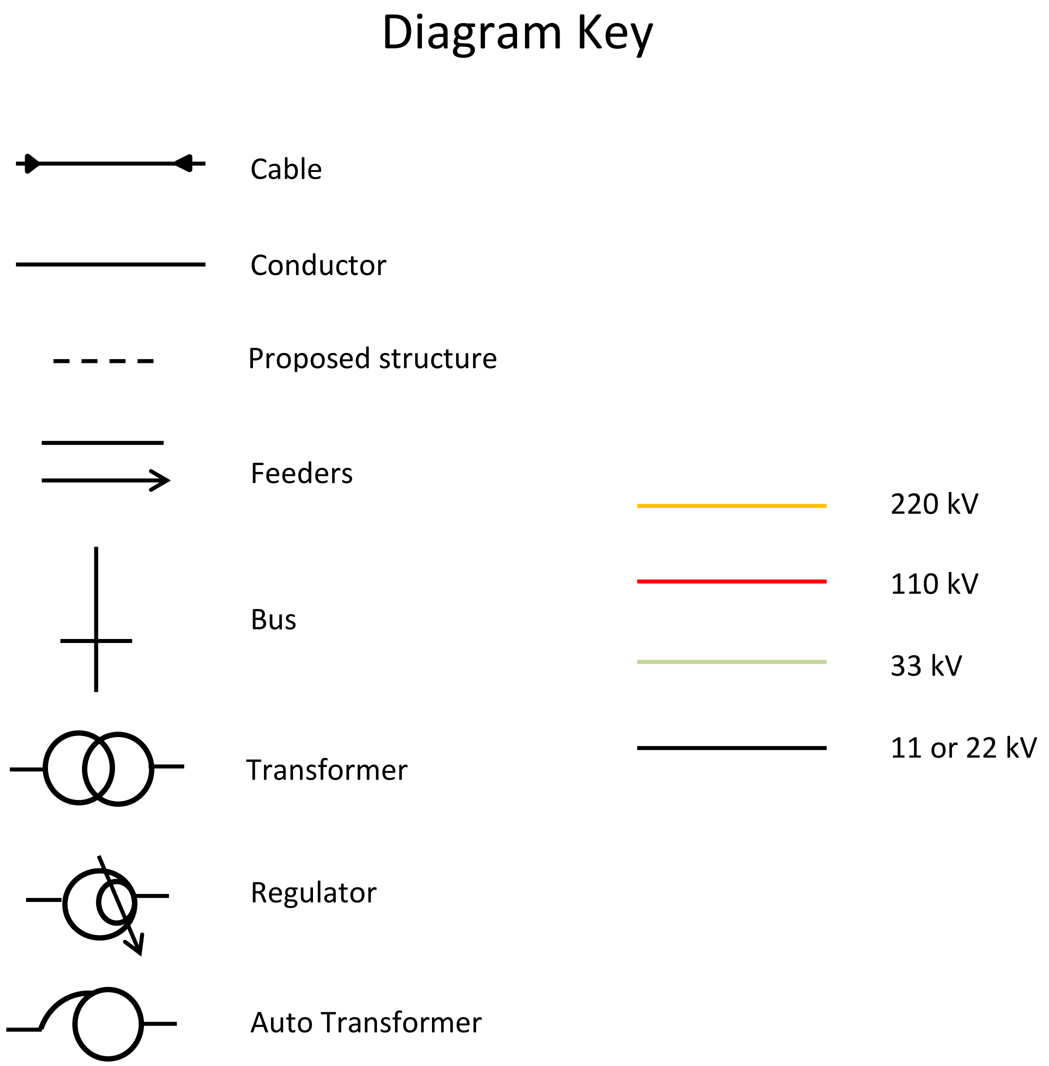
Table 1.1 Security Classifications

Security Level	Description
N	The security level at which any outage will cause load to be tripped, and is often found where there is only one supply circuit or transformer that provides supply.
N–0.5	The security level at which any outage will cause some load to not be supplied after ties are made to other substations.
N–1	The security level that ensures supply under a single contingency event.

1.4 Diagram Key

Figure 1.6 lists and describes the symbols used in the network diagrams included in this document.

Figure 1.6 Diagram Key



1.5 Substation List

Table 1.2 shows the existing seven Transpower GXPs, as well as the three new proposed GXPs, and associated zone substations in our network area. The three letter code used by us has also been included for reference purposes.

Table 1.2 Substation Reference Table

Section	Transpower GXP	Zone Substation	Three Letter Code
2	Albury (11 kV)		ABY
2.2		Albury (11/33 kV Step–up) (33 kV)	ABY
2.2		Fairlie (33/11 kV)	FLE
2.3	Albury (33 kV) (Future)		ABY
2.3		Albury (33/11 kV) (future)	ABY
2.3		Fairlie (33/11 kV) (future)	FLE
3	Bell's Pond (110 kV)		BPD
3.2		Bell's Pond (110/33/11 kV)	BPD
3.2		Cooneys Road (33/11 kV) (future 110/11 kV)	CNR
4	Orari/Clandeboye (220/33 kV) (Future)		OAI
4.3		Clandeboye 1 (33/11 kV) (future supply)	CD1
4.3		Clandeboye 2 (33/11 kV) future supply	CD2
4.3		Rangitata (33/11 kV) (future supply)	RGA
5	St Andrews (110 kV) (Future)		STA
5.3		St Andrews (110/11 kV) (future)	STA
6	Studholme (11 kV)		STU
6.3		Studholme (switching station) (11 kV)	STU
7	Tekapo A (33 kV)		TKA
7.3		Tekapo Village (33/11 kV)	TEK
7.3		Balmoral (11/22 kV)	BML
7.3		Haldon Lilybank (11/22 kV)	HLB
7.3		Glentanner (33/11 kV)	GTN
7.3		Unwin Hut (33/11 kV)	UHT
8	Temuka (33 kV)		TMK
8.3		Temuka (33/11 kV)	TMK
8.3		Clandeboye No.1 (33/11 kV)	CD1
8.3		Clandeboye No.2 (33/11 kV)	CD2
8.3		Geraldine Downs (33/11 kV)	GLD
8.3		Rangitata (33/11 kV)	RGA

Section	Transpower GXP	Zone Substation	Three Letter Code
9	Timaru (11 kV)		TIM
9.3		Grasmere St (switching station–11 kV)	GRM
9.3		Hunt St (switching station–11 kV)	HNT
9.3		North St (switching station–11 kV)	NST
9.3		Timaru (Grant's Hill) (11/33 kV Step–up) (33 kV)	TIM
9.3		Pareora (33/11 kV)	PAR
9.3		Pleasant Point (33/11 kV)	PLP
10	Twizel (33 kV)		TWZ
10.3		Twizel Village (33/11 kV)	TVS
11	Waihao (110 kV) (Future)		WHO
11.3		Bell's Pond (110/33/11 kV)	BPD
11.3		Cooneys Rd (110/11 kV)	CNR
11.3		Waimate (110/11 kV) (future)	WTE

Photograph 1.2 Albury GXP

Notes:

2 Albury Grid Exit Point

2.1 Introduction

Figure 1.4 on page 10, shows the position of Albury (ABY) GXP on the Timaru (TIM) to Tekapo (TKA) 110 kV transmission line.

ABY is fed off the TIM–TKA 110 kV line and has a single 110/11 kV transformer connected via one incomer to an 11 kV switchboard, there are three feeder CBs. The GXP transformer is run on fixed tap, which leads to some 11 kV voltage fluctuation as the 110 kV supply alters as load varies. With a new AVR being installed by Transpower, a request was made that the transformer's load tap changing function be restored, except when there is a reversal of power, i.e. while Opuha Power Station (OPU) is generating.

ABY's transformer is suitably rated for today's load but is fractionally under rated to pass the embedded generation from OPU back onto the grid. Trustpower have occasionally asked for generation to back off a small amount if there is less than 1 MW of Fairlie zone substation (FLE) load to offset the full generation. As irrigation growth occurs in the area the headroom on this transformer will be eroded.

Within our network the Totara Valley area is becoming difficult to supply off the Pleasant Point (PLP) zone substation. An option is to build a new zone substation in Totara Valley area which would be fed from ABY. This may influence accelerating the replacement of the ABY supply transformer with a larger unit, perhaps with a change from 110/11 kV to 110/33 kV (refer to commentary in Section 2.3).

We have taken ownership of the mid 1980's 110/33 or 11 kV 20 MVA transformer ex TIM T4, the cost being equivalent scrap value. This was held in case it can be used at ABY to replace the existing transformer.

Transpower have invested in a mobile sub with a 110 kV primary connection and one of 11, 22, or 33 kV secondary connection. TKA and ABY have just been equipped and fitted with the mobile substation to allow maintenance at each zone substation.

2.1.1 Critical Data

The critical GXP data shown in Table 2.1 summarises the key physical attributes of the substation, the voltages, the capacity, the security, and the power flow.

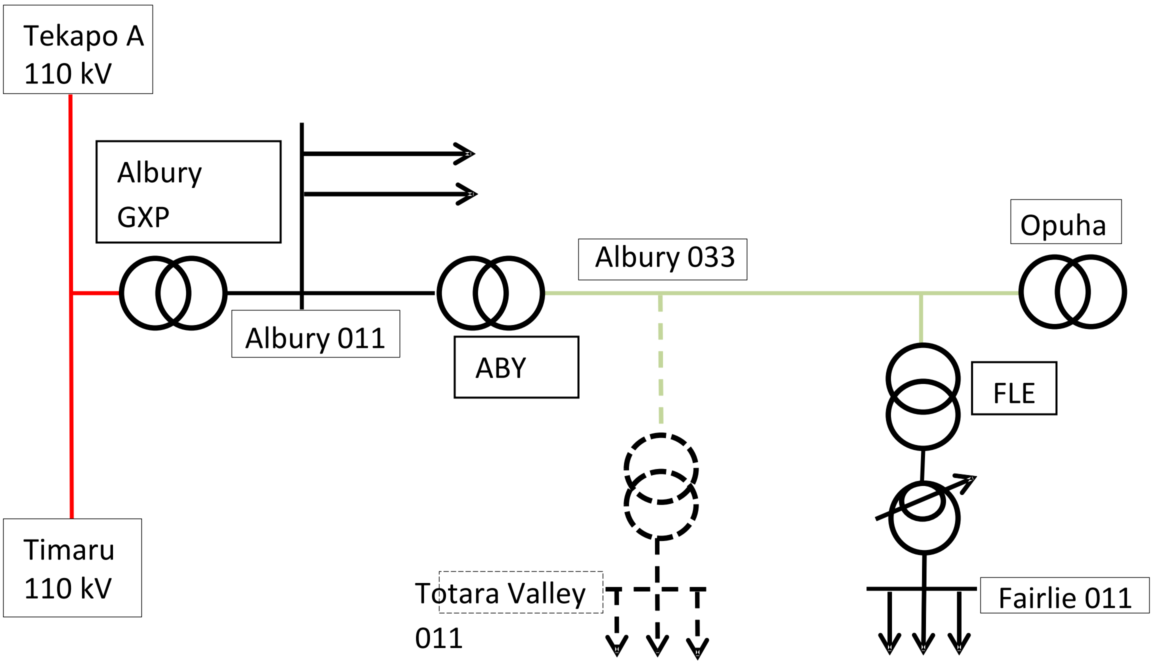
Table 2.1 Albury GXP Transpower System Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N–1 Capacity	Demand to March 2014	OPU Contribution
ABY	110 kV	11 kV	5/6 MW	0 MVA	4.21 MVA	7 MVA less load

2.2 Albury GXP Network Information

Figure 2.1 shows the key assets in the ABY GXP area. Transpower delivers 11 kV to our network at the ABY zone substation via its circuit breakers; 2722, 2732, and 2742. Both the GXP and zone substation site has the three letter code ABY. Circuit breaker 2722 feeds ABY zone substation to sub–transmit 33 kV to FLE. From FLE zone substation a further length of 33 kV sub–transmission connects the Opuha power station to our network. A zone substation is proposed in the Totara Valley area if demand necessitates network investment.

Figure 2.1 Albury–Fairlie Area Network



Photograph 2.1 Albury Step–up Structure 2012 Upgrade in Progress

2.2.1 Zone Substation Detail

The zone substation and sub–transmission key data shown in Table 2.2 details the major assets with respect to rating, age, and general condition. The maximum demand at the various substations is provided. The table also details the substation's communication systems and SCADA functions.

Table 2.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator		Switchgear	Ripple Plant
ABY	7.5 MVA (1997) 33/11 kV OCTC (2008 refurb) Excellent			1x 33 kV Recloser WVE (1994) Fair	Plessey/Met Vic 605/510 Hz Rotary
FLE	3 MVA 33/11 kV OCTC (1964) Fair	2 MVA		1 x 33 kV Recloser (1997) 1 x 11 kV Recloser (1989) Good	
Sub–Transmission	**Make Up**	**Limit at 6% p.d. (MVA)**	**Limit of Conductor at 50°C (MVA)**	**Limit of Cable (MVA)**	**Lowest Limit**
ABY–FLE	Dog	7.12	12.6		7.12
FLE–OPU	Jaguar/Cable 1/300	7.65	23.4	21.3	7.65
Communications	**VHF**	**UHF Analogue**		**UHF Digital**	**Fibre Optic**
ABY	VHF for voice traffic			ABY–BRC BRC–MEC MEC–WDK	None
FLE	VHF for voice traffic VHF for two bit alarms	None		None	
SCADA	**Supervision**	**Control**		**Automation**	**Data Acquisition**
ABY	Current, voltage and CB status at ABY. Security at ABY.	ABY CB control, ripple plant load control.		Auto reclosing CB	Load data at ABY
FLE	2 bit alarm Security at FLE	None		None	None

ABY connects via radio systems. There is a small amount of traffic on the UHF Analogue that is being decommissioned progressively.

Table 2.3 lists the existing level of security at the substation and justifies any shortfall.

Table 2.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
ABY Rural	N–0.75	N–0.75	Limited fault back up from adjacent feeders from FLE, PLP and TMK. Encourage consumers to be self–sufficient for essentials, as for CD emergencies.
FLE	N	N	Limited fault backup. Possibility of some supply from ABY and GLD or islanding FLE onto OPU, requires negotiation with generation management, careful islanding, no black start available, generator does not have a lot of inertia making speed control a challenge. Encourage consumers to be self–sufficient for their essentials, as for CD emergencies.

The estimated demand listed in Table 2.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 2.5 at page 22.

Table 2.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
ABY 11 kV board	4.20 (Summer)	1.59% historic on ABY Irrigation and dairying activity, residential load, small subdivision development.	5.0 (summer) 8.4 (with Totara Valley)	Transpower asset under its management. Overall load not expected to breach Transpower's capacity unless Totara Valley Sub built.
FLE	2.37 (Winter)	1.57% historic on ABY Residential load, small subdivision development.	2.9 (winter / shoulder)	Regulator upsizing or transformer with OLTC—expect demand to grow from current demand of 2.3 MW to about 2.9 MW over the planning period.

2.2.2 Albury–Fairlie Sub–transmission

The ABY–FLE line is receiving major maintenance which is due for completion after the publishing of this document.

2.2.3 Fairlie Zone Substation

FLE supplies the local CBD as well as the rural surrounds.

It has one incomer recloser and then short distances out from the zone substation there are various other line reclosures to protect the CBD from rural faults.

Back up for FLE used to be made via OPU if a controlled islanding could be made. OPU does not black start so alternate supply from OPU cannot be guaranteed. See also comment below under the Opuha Power Station, section 2.2.4, re: rough running.

Limited back up of FLE can be made from the 11 kV distribution from ABY and GLD, this may be sufficient at low load times to supply the CBD alone.

Photograph 2.2 Fairlie Zone Substation

2.2.4 Opuha Power Station

Opuha Power Station (OPU) is an asset owned by local irrigators and is operated by Trustpower. The primary purpose of the dam is to break the kinetic energy of outflows from the lake into the Opuha River. The generation rough runs at part load so its use as back up to FLE is limited.

2.3 Development of Albury GXP and Substations

The calculated load growth at the ABY GXP is 1.59%. This is mainly due to growth in the farming and tourism sectors. A new source of irrigation would be required to see step change growth.

Figure 2.2 Load Growth for Albury GXP

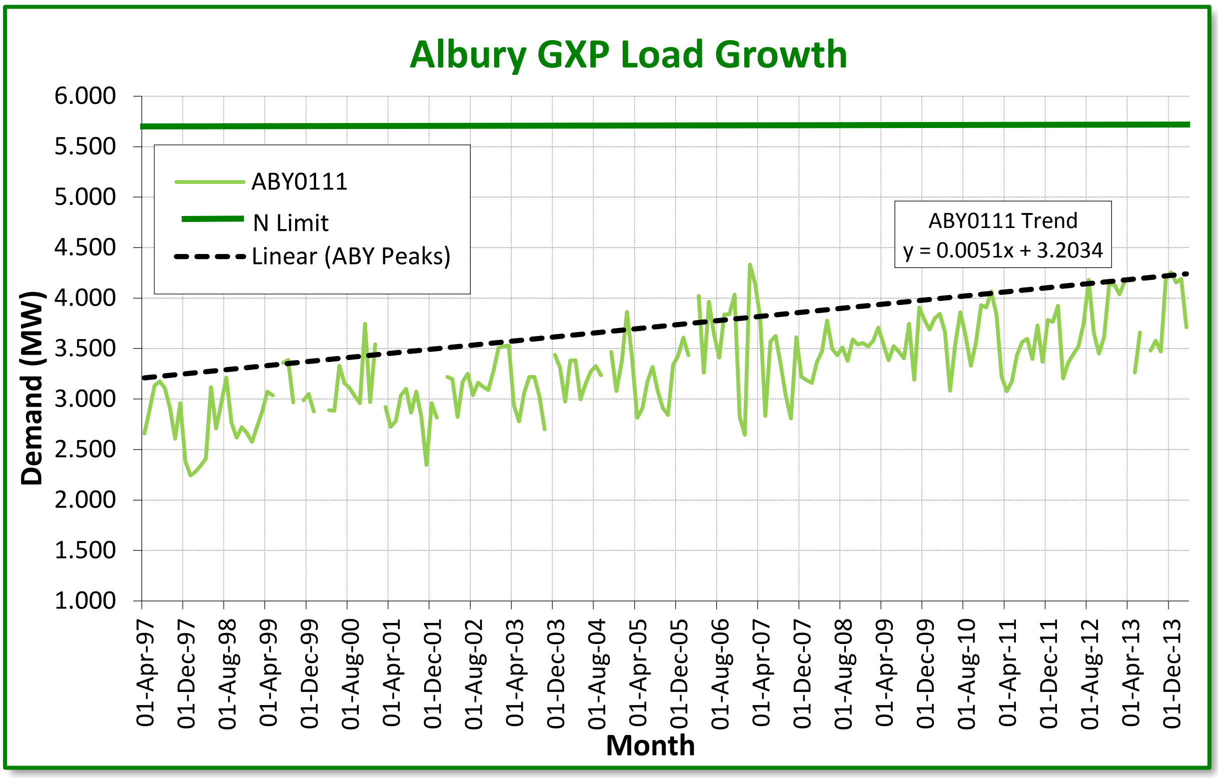


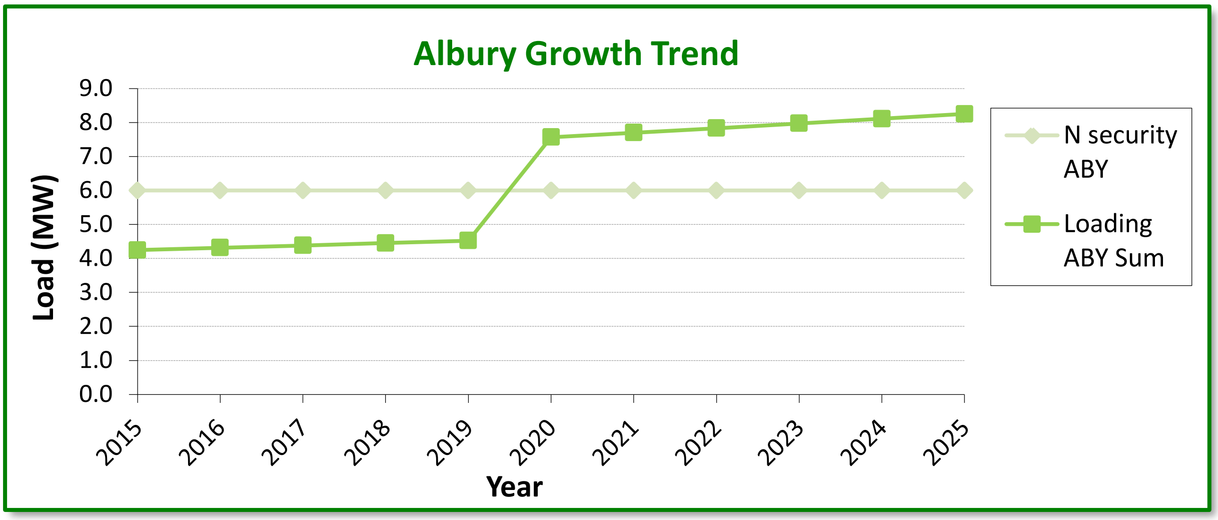
Table 2.5 shows the growth trend to the year 2025. The trend accommodates for a new zone substation to be built at Totara Valley in 2020.

Table 2.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ABY (Summer)	4.2	4.3	4.4	4.5	4.5	7.6	7.8	8.0	8.2	8.4	8.6

Figure 2.3 plots the security levels and the maximum demand at ABY.

Figure 2.3 Albury Growth Trend and Supply Security



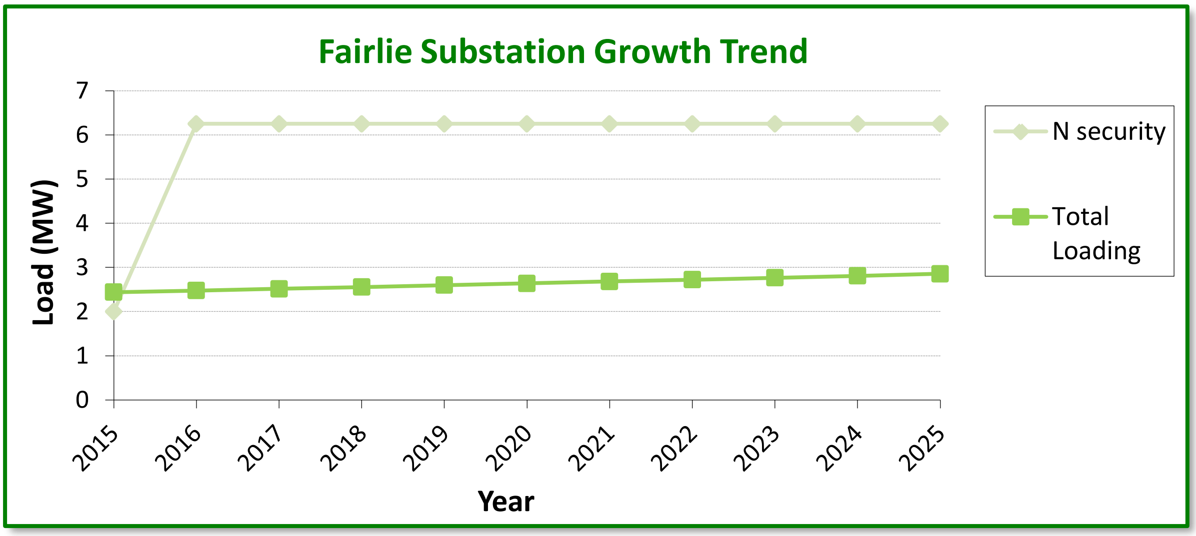
2.3.1 Substation Growth Trend and Supply Security

The load in the area continues to grow in response to the increase in farming and irrigation activities. Transpower's ex–TIM T4 is now available, it may be worth considering installing this at ABY (refer to note in Section 2.1).

The FLE regulator is undersized at 2 MVA to take the peak load of the day. Planning is in progress to move one of the 5/6.25 MVA OLTC transformers recently retired from PAR to FLE.

The FLE single incoming recloser is now upgraded to an arrangement of four RMUs fitted with CBs to enable individual feeder control.

Figure 2.4 Fairlie Growth Trend and Supply Security



2.3.2 Rate and Nature of GXP Growth and Provisions made

Table 2.6 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 2.6 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
ABY	Med—Rural	GXP investment if Totara Valley connected

2.3.3 Specific Developments

2.3.3.1 Totara Valley Development – Options of Totara Valley and Cave

Load flows indicate that the 33 kV PLP–TIM sub–transmission is capable of delivering 8.27 MVA load with a 6% potential drop. The line should only be operated to 9 MW. At present one of the PLP zone substation 11 kV feeders feeds into Totara Valley and up to Totara Valley while ABY feeds down to Cave.

The majority of the load in this mid ground is presently on the PLP substation. Two enquiries for pumping loads totalling 2 MVA (which have stagnated) have been received for the Totara Valley area. The transformer at PLP has an upper rating of 6.25 MVA with a present peak load of about 4.7 MVA noted. These new loads alone will load PLP's transformer to capacity if established, and in addition cause serious potential drop on the lengthy 11 kV feeder to the Totara Valley area. A drop that probably cannot be remedied by capacitors or voltage regulators.

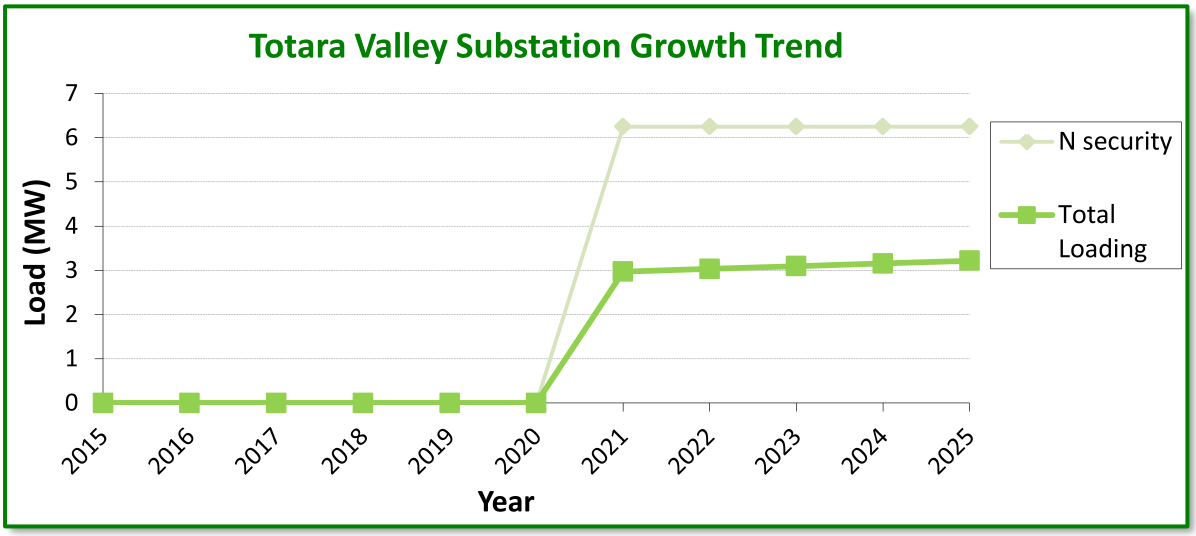
The option to install a second transformer at PLP to supply the load is not viable. The regulator installed at Tengawai to support the Totara Valley area growing load is already operating on upper taps.

Another option is to partially off load PLP with the possible establishment of a zone substation at Totara Valley fed off the 33 kV ABY–FLE sub–transmission. A zone substation will also solve voltage regulation concerns on the 11 kV feeders.

Earlier considerations were made to feed Totara Valley from TIM's 33 kV bus, but as the circuit is lengthy, volt drop issues would ensue.

Another discussion surrounded establishing a zone substation at the Cave regulator site. This, like PLP, is distant from 33 kV source and the load, volt drop issues in the sub–transmission and 11 kV feeders would therefore also ensue.

Figure 2.5 Totara Valley Growth Trend and Supply Security



Transpower's ABY transformer is rated 6 MVA. Presently there is about 4.2 MVA of load applied when OPU is off, there is limited spare capacity available. Transpower will be looking to upgrade the transformer at ABY in 2018/19.

For the transformer change out, we may look to request a larger capacity unit with fully capable OLTC and possibly a 33 kV secondary. This way voltage regulation will be achieved, and the transformer will supply the greater loaded 33 kV bus. Electrical efficiencies for the site will improve. Our existing 11/33 kV step–up transformer would be turned to become 33/11 kV and supply the 11 kV bus. Some phase displacement issues will need to be resolved around tying 11 kV between the ABY, FLE, Totara and GLD areas and the TIM and PLP areas.

A more detailed study is required to examine the above and other options not yet explored.

A further project is proposed that will replace the existing 33 kV neutral earthing transformer (NET) at ABY which has internal partial discharge concerns, and replace the existing earth fault protection relays which are at the end of their life.

2.3.3.2 Ripple Load Control

The ABY ripple plant's local service supply will be replaced with a modern vacuum switch, and a new local service transformer located outside the ripple plant building in 2015.

The ripple injection plant is presently a rotating plant. This will also be replaced by a static convertor in 2015.

Notes:

3 Bell's Pond Grid Exit Point

3.1 Introduction

Figure 1.4 on page 10, shows the position of Bell's Pond (BPD) GXP on the 110 kV circuit from Waitaki to Studholme/Oamaru.

Toward the end of the period BPD might be redeveloped and be fed off a new GXP at Waihao, see Figure 1.5 on page 11 for further information.

BPD GXP is a single tee off the STU–OAM–WTK 2 110 kV circuit. The GXP is essentially a 110 kV metering point which was made available to us so that a 110/33/11 kV zone substation could be connected.

BPD GXP was established and commissioned in August 2010 which off loaded just over 6 MW of load from STU. Transpower are reconsidering the opportunity to connect a second transformer at BPD to the second 110 kV circuit. The second transformer will remove the present need for STU to back up the BPD load.

A project to allow for a future connection to an alternative 110 kV supply is discussed further under the Waihao GXP, in chapter 11.

Photograph 3.1 Bell's Pond GXP and Zone Substation

3.1.1 Critical Data

The critical GXP data shown in Table 3.1 below summarises the key physical attributes of the substation, the voltages, the capacity, the security, and power flow.

Table 3.1 Bell's Pond Substation Key Data

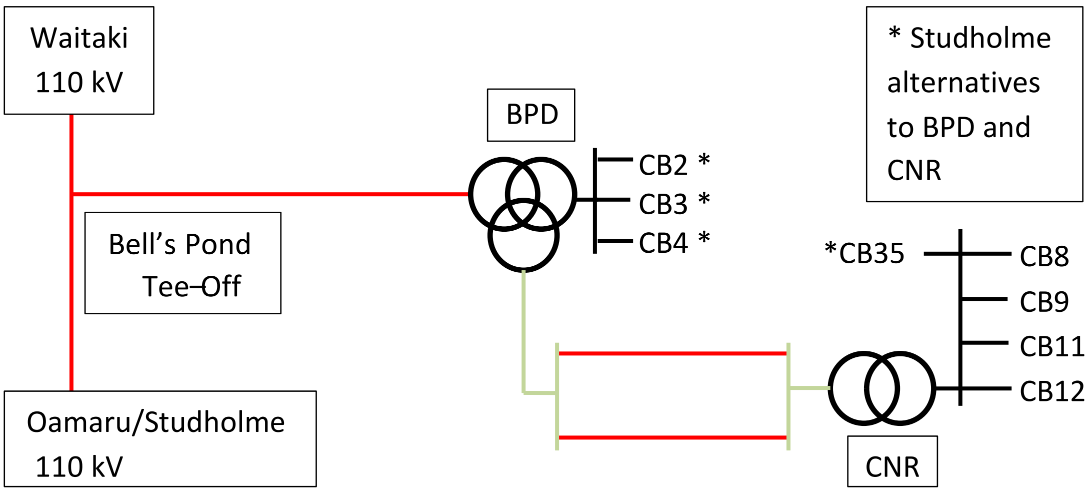
GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity from STU	Demand February 2014
BPD	110 kV	110 kV	20 MVA	5 MVA	7.38 MW

3.2 Bell's Pond GXP Network Information

Figure 3.1 shows the key assets in the area of the BPD GXP. Transpower delivers 110 kV to our network at BPD substation.

From the BPD 110/33/11 kV transformer's 33 kV winding, a sub–transmission line (rated for later use at 110 kV) has been constructed to a new zone substation at Cooneys Road (CNR). The new line and substation were livened in April 2014 and supply Oceania Dairy Limited (ODL). The BPD transformer's 11 kV winding supplies local rural feeders.

Figure 3.1 Bell's Pond GXP Area Network



3.2.1 Zone Substation Detail

The zone substation and sub–transmission key data for both BPD and CNR Road shown in Table 3.2 on page 29 details the major assets with respect to rating, age, and general condition. The maximum demands at the various substations are provided. The table also details the substation's communication systems back to Meadows Rd and the SCADA functions.

Table 3.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
BPD	20/15/15 MVA 110/33/11 kV (2010) Excellent		1 x 110 kV GL312 Areva (2010) Excellent 1 x 110 kV GL312 Areva (2014) Excellent 5 x 11 kV RPS (2010) Excellent	Abbey Systems RTU Landis and Gyr Ripple Plant (2010 cell/2011 processor) Excellent
CNR	9/15 MVA 33/11 kV (2014) Excellent		1 x 110 kV GL312 CB (SF_6) (2013) Excellent 8 x 11 kV RPS (2014) Excellent	

Sub–Transmission	Make Up	Limit at 6% p.d. (MVA)	Limit of Conductor at 50°C (MVA)	Limit of Cable (MVA)	Lowest Limit	Notes
BPD–CNR	110 kV double cct bonded, Jaguar, run at 33 kV					2013 build Maintenance Priority 10

Communications	VHF	UHF Analogue	UHF Digital	Fibre Optic
BPD	VHF for voice traffic	None	BPD–MEC MEC–CHC CHC–NST or WDK	None
CNR	Voice	None	CNR–MEC MEC–CHC CHC–NST or WDK	None

SCADA	Supervision	Control	Automation	Data Acquisition
BPD	Current, voltage, power and CB status at BPD.	BDP area CB, transformer and ripple plant control	CB and transformer control	Load data and power quality at BPD
CNR	Current, voltage, power and CB status at CNR. Security monitor.	CNR area CB and transformer control	CB and transformer control	Load data and power quality at CNR

Chorus provide telephone, fax services via Cu connection. Transpower use Chorus for certain data retrieval. Table 3.2 shows BPD's SCADA functions. BPD has an SEL 2032 for most IED connections and an Abbey RTU to control the ripple plant. CNR has dual SEL 3035 for most IED connections.

Table 3.3 lists the existing level of security at the substation and justifies any shortfall.

Table 3.3 Security Level for Bell's Pond GXP

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
BPD Rural	N–0.75	N–0.75	Back up supply from STU. STU can presently take majority of the 11 kV load if both STU transformers are in service (the spare STU capacity will be eroded should Fonterra build a drier at STU). Some irrigation and ODL would have to be disconnected to put BPD on STU. Encourage consumers to be self–sufficient for their essentials, as for CD emergencies. Second transformer being considered, to gain security this would have to connect to OAM–WTK 1 line.
Dairy Processing ODL	N–0.1	N–0.1	N-1 is not presently supplied, as agreed by ODL. Light back up supply from STU is available. Later investment when process proven to increase security.

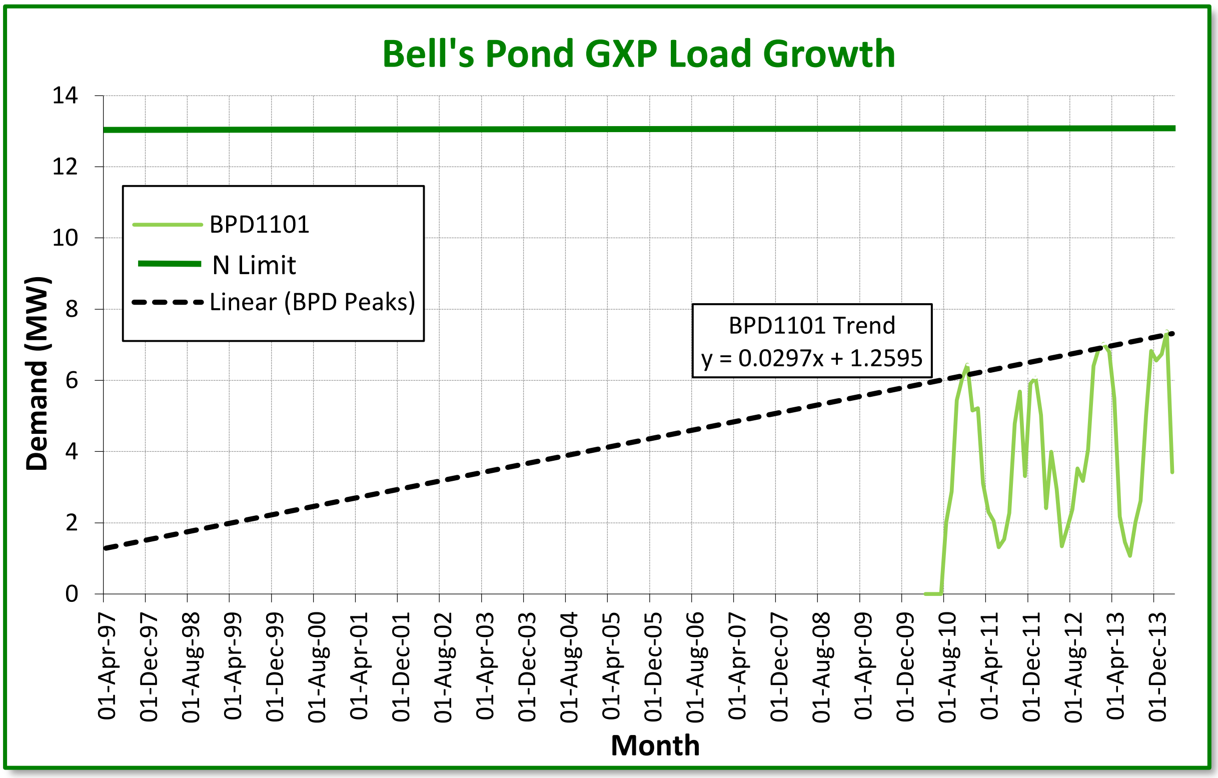
The estimated demand listed in Table 3.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 3.5 at page 32.

Table 3.4 Estimated demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
BPD	15.6 (summer)	4.8% per year expected Residential load. Dairy and irrigation development.	BPD 21.4 CNR 14.6 (summer) Sum 36.0	Increase substation assets to offload STU and provide more security and capacity. Work needed to carry load which depends on mooted projects progressing.
CNR	3.6 (summer/winter)	Dairy processing	14.6 (summer/winter)	Assumption is to prepare site for two driers/lactose and UHF products off BPD 33 kV initially with later extensions for two driers forcing the primary potential for the site to 110 kV. We have included for four 3.5 MW driers and other sundry loads in planning.

3.3 Development of GXP and Substations

Figure 3.2 Load Growth for Bell's Pond GXP



A second 20 MVA transformer and possibly an increase of capacity in the existing T2 will be required for the site to increase the N transformer security to 30 MVA. We are working with Transpower to gain a supply for the second transformer.

The ODL Drier 1 has been commissioned with a load 2.6 MVA. Additional stages are to be announced. A temporary supply off the 33 kV winding at BPD has been made to supply the initial stage of the dairy factory. As the factory grows beyond what BPD can supply at 33 kV a permanent 110 kV supply will be required.

In mid–2014 there was a new connection request for 3.2 MW for stage 1 of the Waihao Downs/Elephant Hills irrigation project. The expected load is 7 to 10 MW at the end of stage 3. The load will be supplied from the 11 kV BPD winding initially with this revisited for later stages.

Much of the on farm development that would flow on from this irrigation is too distant for existing 11 kV distribution so a new 11 kV bus in the Waihoa Downs area will be required.

Thought had been given to taking a double circuit 33 kV line from BPD to WHO to supply this bus, but this route is seen to be needed for a 110 kV double circuit from WHO to BPD. This is explained more fully in section 3.3.1.

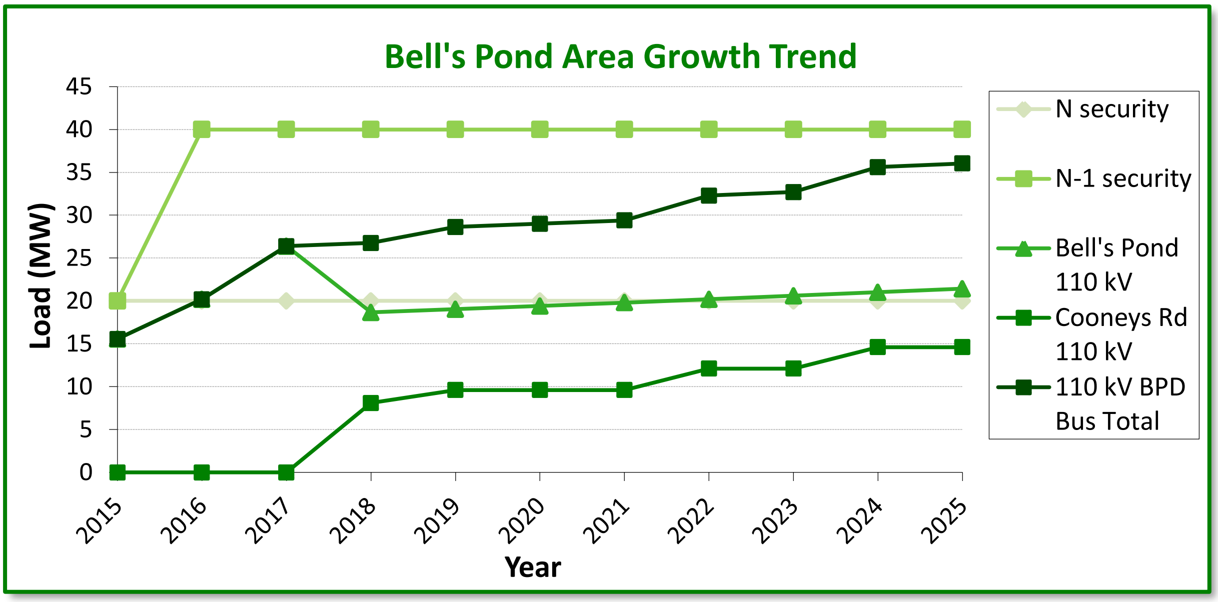
Table 3.5 shows the growth trend to the year 2025.

Table 3.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
BPD (Summer)	15.6	20.2	26.4	26.4	18.7	19.4	19.8	20.2	20.6	21.0	21.4

Figure 3.3 plots the maximum demand predictions in the BPD GXP area.

Figure 3.3 Bell's Pond Growth Trend



3.3.1 Substation Growth Trend and Supply Security

The load continues to grow in response to the farming and irrigation activities in the area.

ODL initially adds 2.6 MW to BPD's load, rising in the future to approximately 14 MW. The increased load will require the BPD–CNR 33 kV circuit to be re–connected to 110 kV.

A new application has been received for a 3.2 MW set of pumps at the start of the Waihao Downs irrigation scheme.

3.3.2 Rate and Nature of GXP Growth and Provisions Made

Table 3.6 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 3.6 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
BPD	High—Rural, Industrial Dairy factory	New investment to secure the energy needed off the grid.

3.3.3 Specific Developments

3.3.3.1 Cooneys Road Development—Options for Capacity Increase for Oceania Dairy Limited's (ODL) Milk Solids Plant

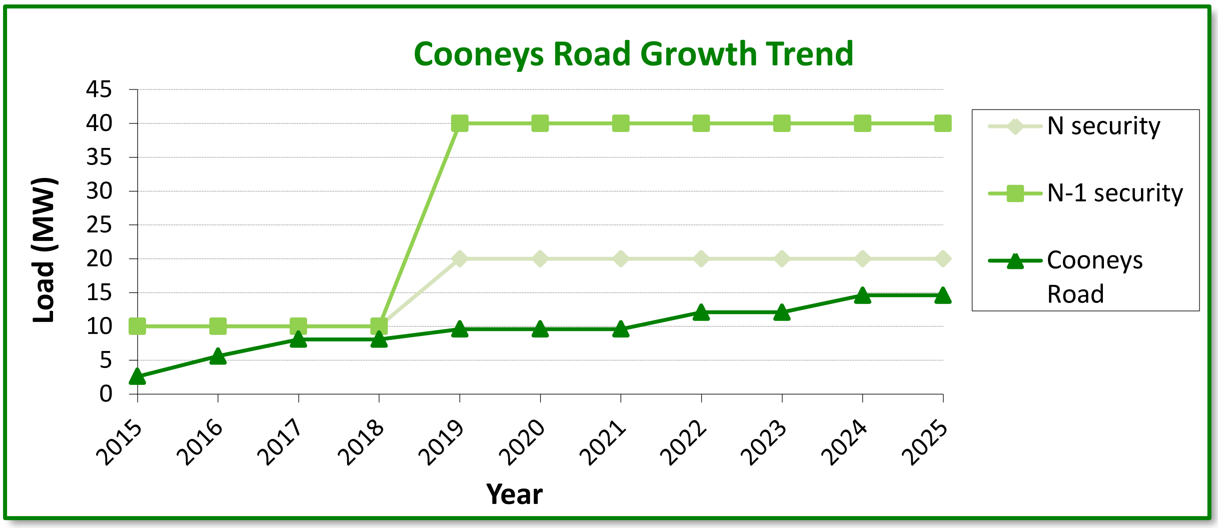
CNR zone substation has been fitted with 33/11 kV equipment to supply the first drier in ODL's dairy factory. The sub–transmission line from BPD to CNR is rated at 110 kV and with investment in 110/11 kV transformers at CNR the dairy factory will not be capacity constrained.

Photograph 3.2 Cooneys Road Zone Substation and Oceania Dairy Limited's Factory

Security is presently reliant on 11 kV feeders from CNR substation with a capacity of approximately 2 MW in the winter, but the capacity decreases in the summer as this is when other users also load the lines, primarily for irrigation.

Figure 3.4 plots the maximum demand predictions for Cooneys Road zone substation.

Figure 3.4 Cooneys Road Growth Trend



3.3.4 Issues Arising from Estimated Demand

In December 2013 Transpower communicated that a tripping of the OAM–WTK 110 kV circuit 1, would result in circuit 2, with BPD, OAM and STU connected, becoming overloaded at peak periods. Transpower communicated that the best option for resolving the overload was to ask us to shed BPD. Shedding BPD load will become increasingly difficult as BPD becomes more loaded from ODL.

We are still in the situation that if BPD GXP or the 110 kV circuit to it fails, essential loads on the BPD GXP need to be supplied off STU. Until BPD can be made secure by a second connection, then the ability to supply the load within STU's N–1 capacity is becoming reduced.

Photograph 3.3 Bell's Pond 33 kV Terminal for CNRs line

4 Orari Grid Exit Point

4.1 Introduction

Figure 1.5 on page 11, shows how the Orari (OAI) GXP is to be configured on the OAI 220 kV switching station near Geraldine. This work must follow Transpower's building of the OAI GXP that is presently scheduled for 2022.

OAI is proposed to allow the off–loading of the TIM T5 and T8 220/110 kV interconnectors, the 110 kV lines to TMK, the TMK transformers and TMK 33 kV bus.

More discussion on offloading TMK, see chapter 8 on the TMK GXP.

4.2 GXP Description

OAI is a proposed GXP to allow the connection of the existing Clandeboye and RGA loads. The exact makeup of the substation is yet to be determined.

4.2.1 Critical Data

The critical GXP data shown in Table 4.1 summarises the potential physical attributes of the substation, the voltages, the capacity, the security, and the power flow.

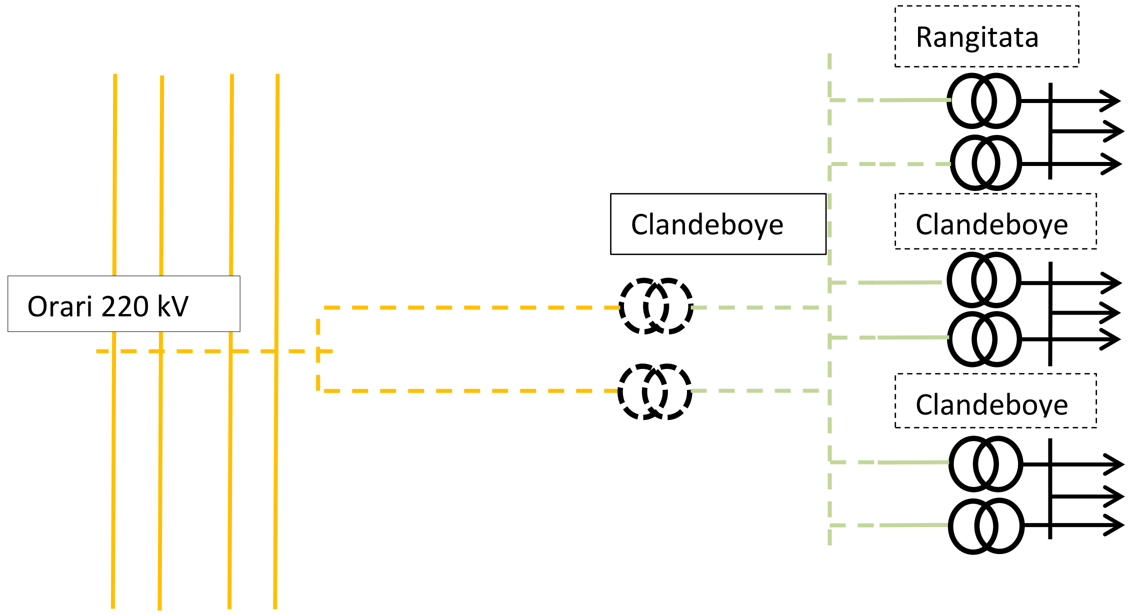
Table 4.1 Orari Zone Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N–1 Capacity	Demand 2015
OAI	220 kV	33 kV	Approx. 80 MVA	160 MVA	0 MW

4.3 Orari GXP Network Information

Figure 4.1 below shows the key assets within the OAI GXP's area. OAI GXP will deliver 33 kV to Clandeboye's four 33/11 kV transformers and a double circuit line will supply RGA.

Figure 4.1 Orari GXP Area Network



4.3.1 Zone Substation Detail

The zone substation key data for OAI shown in Table 4.2 details the major assets to be established. The table also details the substation's potential communications systems back to Meadows Rd.

Table 4.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator		Switchgear	Ripple Plant
OAI				To be established	Zellweger 317 Hz to be established
Communications	**VHF**		**UHF Analogue**	**UHF Digital**	**Fibre Optic**
OAI	VHF for voice traffic		None	OAI–CHC CHC–NST or WDK	TBA

OAI/Clandeboye SCADA systems would adopt the technology of the time.

Table 4.3 lists the existing level of security at the substation and justifies any shortfall.

Table 4.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
Clandeboye and RGA Rural		N–1	With a secure 220 kV bus nearby the station should have full redundancy. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

The estimated demand listed in Table 4.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 4.5.

Table 4.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
Clandeboye	0 (summer)	3.6% per year expected at RGA. Clandeboye growth comes from steps in dairy processing.	56 (summer)	Build to suit 10 year forecast

4.4 Development of GXP

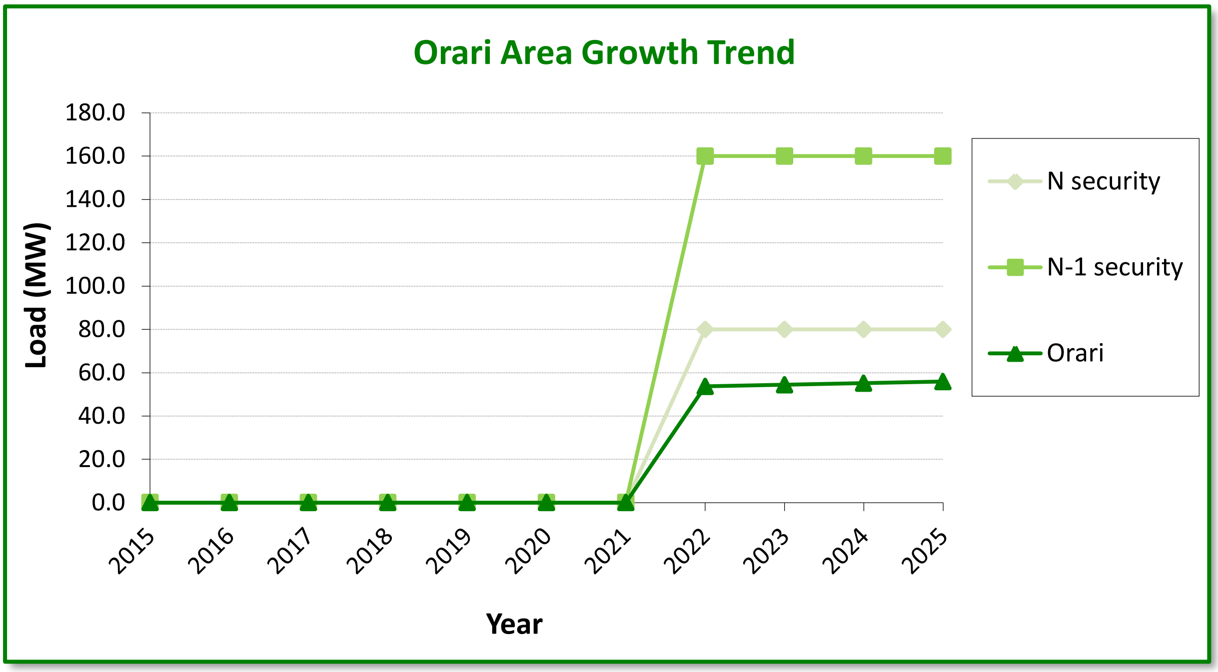
Table 4.5 shows the growth trend to the year 2025 at OAI.

Table 4.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
OAI (Summer)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.7	54.4	55.1	55.9

The date of introduction needs to be scheduled with other Transpower work. Figure 4.2 plots the OAI load growth.

Figure 4.2 Orari Growth Trend



Notes:

5 St. Andrews Grid Exit Point

5.1 Introduction

Figure 1.5 on page 11, shows how St. Andrews GXP (STA) is to be configured between the 110 kV circuit from TIM to the 110 kV Circuit 2 to WTK from about 2019.

5.2 GXP Description

STA is a proposed GXP to allow the connection of the Hunter Downs Irrigation (HDI) project load in the central region between PAR and STU. The exact makeup of the substation is yet to be determined.

HDI is seen to load STU with 9.3 MW of high pressure and lateral pumps and load STA with 6.3 MW. On–farm load due to HDI is seen to load STU by an extra 1.8 MW, STA by 8.4 MW and PAR by 1.8 MW.

We hope to accumulate the present loads taken at BPD and STU. We suggest supplying these from WHO, and apply for this accumulated load to be connected to the present STU–TIM 110 kV transmission line, for STA. BPD and STU will sum to about 24 MW this year.

Our view of the project would be to build an in/out deviation off the STU–TIM 110 kV transmission circuit.

Meridian communicated during the North Bank Tunnel investigation to build an in/out deviation off the Livingston/Islington 220 kV transmission circuit. Transpower are now looking at an option for the STA GXP to be built off the 220 kV with a double circuit built to STU. This initiative does not assist supplying our growing load at BPD and CNR which will become too large for the old WTK 110 kV circuits whilst we have to share the circuits with Network Waitaki Limited (NWL). A 220 kV option is required further south.

A 220 kV GXP is likely to be very costly for the sake of 24 MW (seen at the end of the planning period). We see an 110 kV GXP as being far more cost effective.

5.2.1 Critical Data

The critical GXP data shown in Table 5.1 summarises the potential physical attributes of the station, the voltages, the capacity, the security, and the power flow.

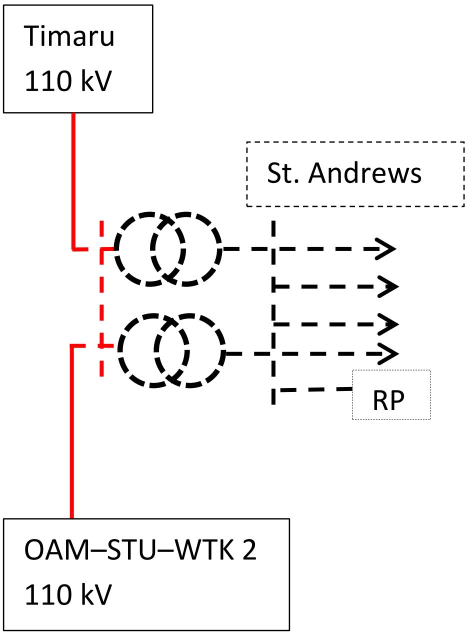
Table 5.1 St. Andrews Zone Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N–1 Capacity	Demand 2015
St. Andrews (STA)	110 kV	33 or 11 kV	Approx. 40 MVA	80 MVA	0 MW

5.3 St. Andrews GXP Network Information

Figure 5.1 shows the key assets in the area of the proposed STA GXP. STA will deliver 33 or 11 kV to supply the surrounding rural area.

Figure 5.1 St. Andrews GXP Area Network



5.3.1 Zone Substation Detail

The zone substation key data shown in Table 5.2 details the major assets to be established. The table also details the substation's communications systems back to Meadows Rd.

Table 5.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
STA			To be established	Zellweger 317 Hz to be established
Communications	**VHF**	**UHF Analogue**	**UHF Digital**	**Fibre Optic**
STA	VHF for voice traffic	None	STA–CHC CHC–NST or WDK	None

STA's SCADA systems will adopt the technology of the time.

Table 5.3 lists the existing level of security at the substation and justifies any shortfall.

Table 5.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
St. Andrews Rural		N–1	With an 'in/out' off the 110 kV line the station should have full redundancy. For a total loss, limited fault backup from STU and PAR will be available. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

The estimated demand listed in Table 5.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 5.5.

Table 5.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
STA	0 (summer)	3.6% per year expected as STU Rural development	24.3 (summer)	Build to suit 10 year forecast

5.4 Development of GXP

Table 5.5 shows the growth trend to the year 2025 at STA. The main load growth is a result of the HDI to be picked up by us.

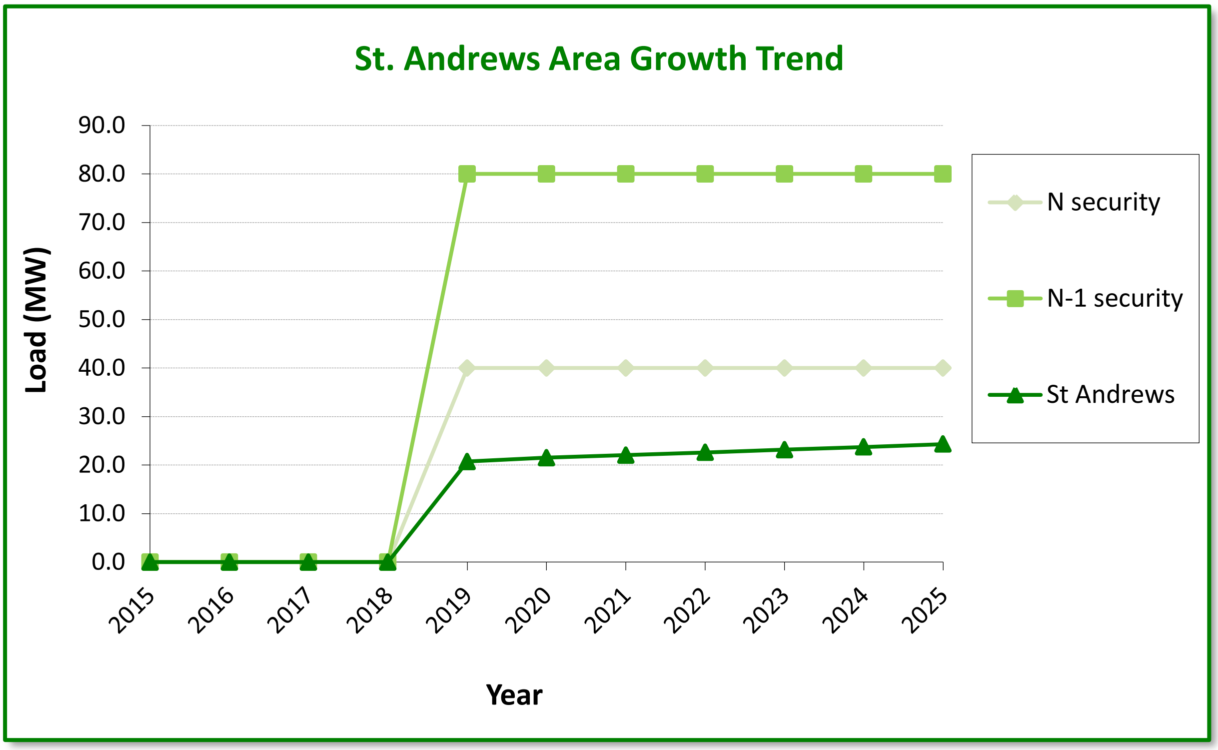
Table 5.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
St. Andrews (Summer)	0.0	0.0	0.0	0.0	20.7	21.5	22.0	22.6	23.1	23.7	24.3

The date of introduction is irrigation load dependant and needs to be scheduled with other Transpower work.

Figure 5.2 plots the forecasted load growth in the St. Andrews area.

Figure 5.2 St. Andrews Area Growth Trend



Notes:

6 Studholme Grid Exit Point

6.1 Introduction

Figure 1.4 on page 10, shows how Studholme (STU) is configured between the 110 kV circuit from TIM to the 110 kV Circuit 2 to Waitaki.

Toward the end of the period STU might be redeveloped to be Waimate (WTE) and be fed off a new GXP at Waihao, see Figure 1.5 on page 11 for this detail.

6.2 GXP Description

STU provides two 11 kV incoming supplies to our 11 kV switchboard which is co–sited at the GXP. Six 11 kV feeders provide supply to the Waimate township, Fonterra’s Studholme dairy factory’s Drier 1, and the surrounding rural areas. The substation demand is summer peaking from strong growth from the dairy factory, arable/dairy farming and irrigation demand.

Partial off load of STU occurred at the end of August 2010 with the full commissioning of BPD substation. The remaining load is still greater than the N security offered from a single transformer. At times BPD will have to be removed from service, for example, when the sole 110 kV line that supplies it is released. STU then has to have the firm capacity to uptake BPD load, or at least as much load as the STU feeders towards BPD can support.

From April 2014 STU has be called on to provide some energy to ODL on CNR to assist their environmental requirements while the main supply from BPD is released.

Photograph 6.1 Studholme GXP

6.2.1 Critical Data

The critical GXP data shown in Table 6.1 summarises the key physical attributes of the substation, the voltages, the capacity, the security, and the power flow.

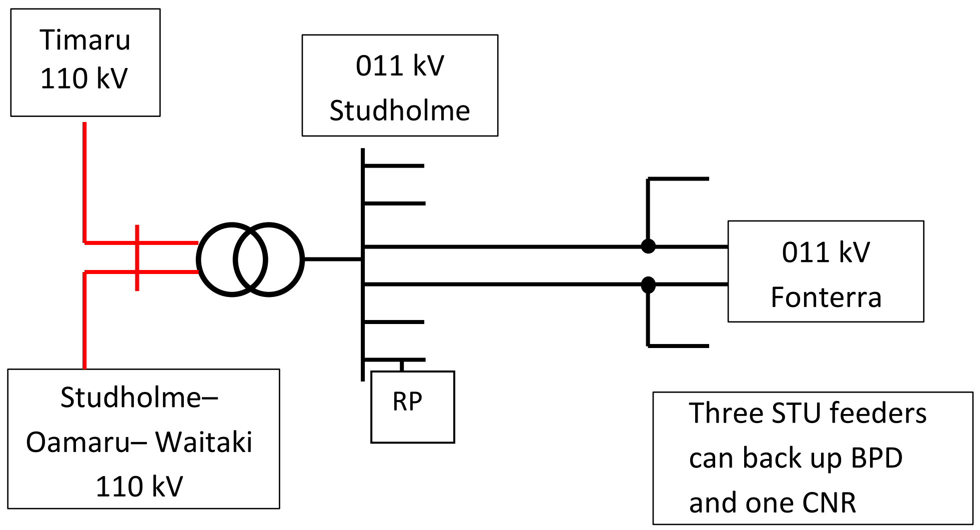
Table 6.1 Studholme Zone Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity	Demand 2014
STU	110 kV	11 kV	11 MVA	22 MVA	11.4 MW

6.3 Studholme GXP Network Information

Figure 6.1 shows the STU GXP area key assets. STU GXP delivers 11 kV to our indoor switch room. This switch room supplies 11 kV to Fonterra's Studholme dairy factory's drier 1 (and some rural load) via two feeders, and Waimate township and the surrounding rural area via the remaining four 11 kV feeders.

Figure 6.1 Studholme GXP Area Network



6.3.1 Zone Substation Detail

The zone substation key data shown in Table 6.2 details the major assets with respect to rating, age, and general condition. The maximum demand at the various substations is also provided. The table also details the capacity constraints, substation's communication systems and SCADA functions.

Table 6.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
STU			9x 11 kV VCB (2005) Excellent	Zellweger 317 Hz
Area of Network with Constraint	**Capacity Constraint**	**Description**	**Intended Remedy**	
STU GXP	Lack of capacity for Waimate area	Lack of capacity for STU, BPD GXP's	Work with Transpower to ensure capacity is made available	
Communications	**VHF**	**UHF Analogue**	**UHF Digital**	**Fibre Optic**
STU	VHF for voice traffic	Analogue for all 11 kV station SCADA and load control functions	None	None
SCADA	**Supervision**	**Control**	**Automation**	**Data Acquisition**
STU	Current, voltage and CB status at STU Security at STU	STU area CB and ripple plant control	Auto reclosing CB at STU	Load data and power quality at STU

Table 6.2 shows that Abbey RTU connects to IEDs. Abbey RTU controls ripple plant.

Photograph 6.2 Studholme Ripple Plant

Table 6.3 lists the existing level of security at the substation and justifies any shortfall.

Table 6.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
Waimate Residential	N–1	N–1	Limited 11 kV rings from STU. Limited fault backup from BPD.
Waimate Rural	N–0.5	N–0.5	Limited fault backup from BPD and PAR. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
Fonterra 11 kV	N	N–1	Load over 3 MVA requires customer investment for dedicated feeders/cables. Present load restricting load growth and increasing voltage problems towards end of feeders. Limited 11 kV rings.

The estimated demand listed in Table 6.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 6.5 at page 47.

Table 6.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
STU	11.4 (summer)	3.2% per year expected as TMK residential load. Dairy and irrigation development (not including step changes).	33.7 (summer)	Transformer upsizing required pending load split for Hunter Downs between STU and STA. 11 kV switchboard upsizing required after 24 MVA.

6.4 Development of GXP and Substations

Figure 6.2 shows the STU load growth. After the commissioning of BPD, STU's load was reduced and new investment differed.

Figure 6.2 Load Growth for Studholme GXP

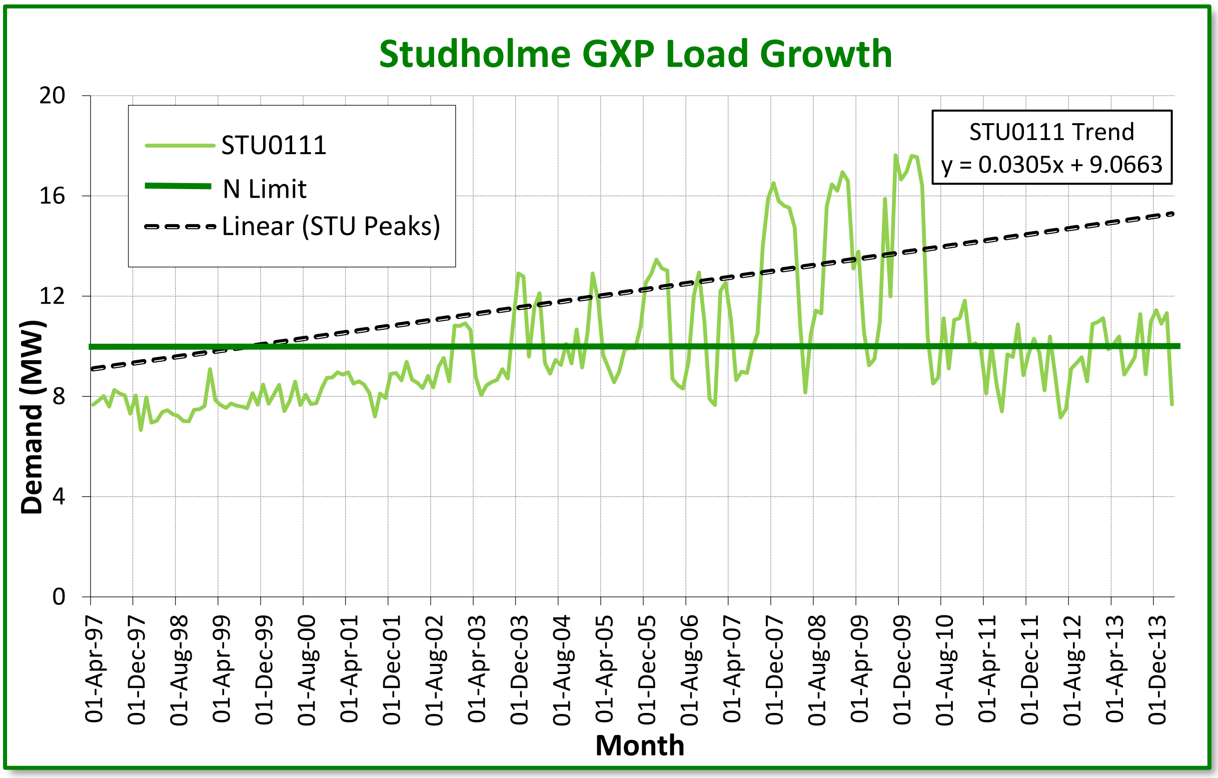


Table 6.5 shows the growth trend to the year 2025 at STU.

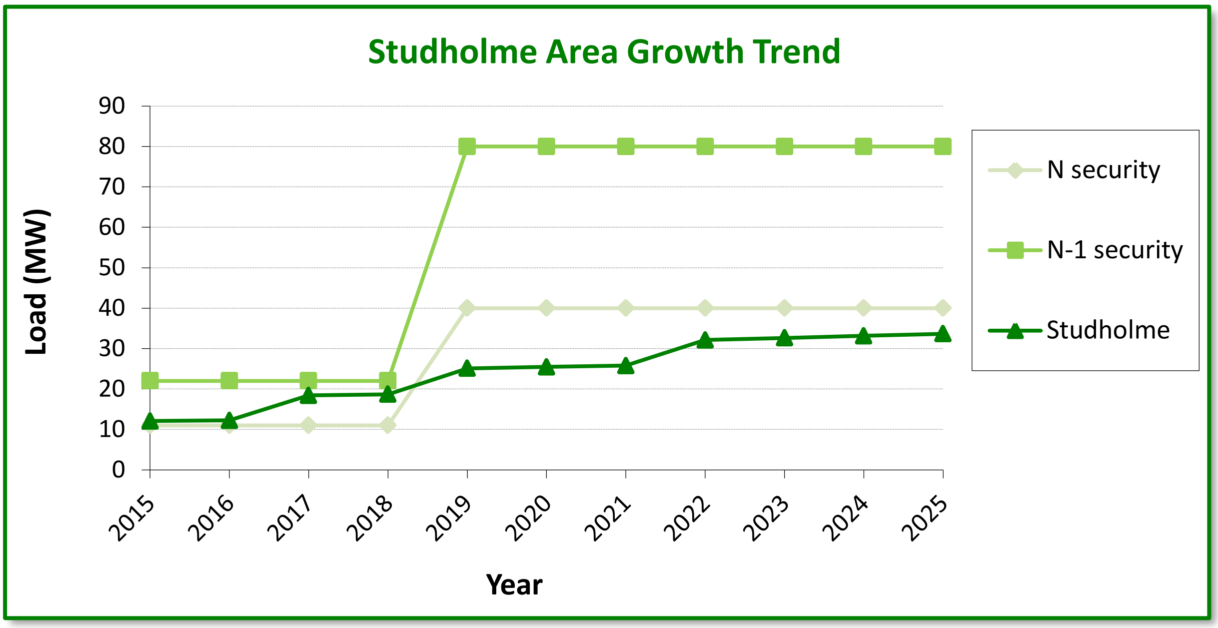
Table 6.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
STU (Summer)	12.1	12.2	18.4	18.7	25.1	25.5	25.8	32.1	32.6	33.1	33.7

New transformers for STU are taken as 40 MW as these are practically sized to suit standard 11 kV switchgear (i.e. 48 MVA practical limit on CBs).

The date of introduction is load dependant and needs to be scheduled with HDI, dairy factory load growth and other Transpower work. Figure 6.3 plots the STU load growth after BPD's second transformer commissioning and allowing for a new GXP at STA to take some of the existing Waimate area load.

Figure 6.3 Studholme Growth Trend



6.4.1 Substation Growth Trend and Supply Security

The Waimate district is presently fed off the 110 kV Waitaki circuit 2, this has no spare capacity. When the irrigation projects and dairy farm and factory projects progress it is foreseen that a new GXP will be required to feed the existing BPD, CNR and STU loads. Refer to chapter 11 on Waihao for greater detail.

The feeders to the north of STU and south of PAR will need a new STA GXP to support the HDI project. These feeders already have the maximum number of voltage regulators and capacitors applied.

STU GXP presently has two 10 MVA (allowed to run to 11 MVA each) transformers that are 'bolted' together giving 22 MVA capacity of N security. If one of the transformers fails (which has happened in the past), Transpower would 'unbolt' the transformers while the power is off and then liven the healthy transformer and restrict demand to 11 MVA of load. Present loads indicate that if this occurred some irrigation would have to be turned off until the faulty transformer had been repaired.

BPD GXP was established and commissioned in August 2010 which off loaded just over 6 MW of load from STU. STU still just breaches the 12 MW N—1 security rating and with the expected 3.6% load growth in the area by 2015, the security risk at STU is still not resolved.

The rating of the STU 11 kV board is 24 MVA, if BPD was no longer reliant on STU for security of supply the switchboard's rating would be sufficient until about half way into this planning period. The switchboard should only be contemplated for an upgrade when larger transformers are required.

6.4.2 Rate and Nature of GXP Growth and Provisions Made

Table 6.6 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 6.6 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
STU	High—Dairy and irrigation Med—Dairy processing	New GXP investment

6.4.3 Specific Developments

6.4.4 Issues Arising from Estimated Demand

We have a temporary arrangement with Transpower for a 110 kV bus tie through for the milk flush, this gives Fonterra security. Transpower have installed a special protection scheme at STU to cater for the summer security wishes. Transpower could still remove the tie; if this occurs Fonterra will experience less security of supply and significant economic losses.

Notes:

7 Tekapo Grid Exit Point

7.1 Introduction

Figure 1.4 on page 10, shows how Tekapo A GXP (TKA) is configured with our network and Transpower's transmission network. TKA GXP is supplied by 110 kV circuit from TIM 110 kV bus via ABY.

7.2 GXP Description

TKA is connected to the grid via a 110/11 kV transformer to the generation bus and then via an 11/33 kV step up transformer to our 33 kV feeder. Genesis Energy can make its generator available to supply our TKA load when the ABY–TKA 110 kV circuit is released, and the ABY and TKA load when the ABY–TIM 110 kV circuit is released.

TKA power station (25 MW) would be used in the case of the loss of 220 kV supply to Timaru to bolster a weak in–feed (15 MW) from Waitaki to Timaru. Plans are written and held by the regional operators to enact this.

Transpower invested in a mobile sub with an 110 kV primary connection and an 11, 22 or 33 kV secondary connection. In 2014 TKA had the mobile substation connected between the ABY 110 kV line and our 33 kV feeder up the hill to maintain supply whilst significant maintenance was carried out to the GXP and 11 kV generation bus.

Photograph 7.1 Tekapo GXP

7.2.1 Critical Data

The critical GXP data shown in Table 7.1 summarises the key physical attributes of the station, the voltages, the capacity, the security, and the power flow.

Table 7.1 Tekapo A Substation Key Data

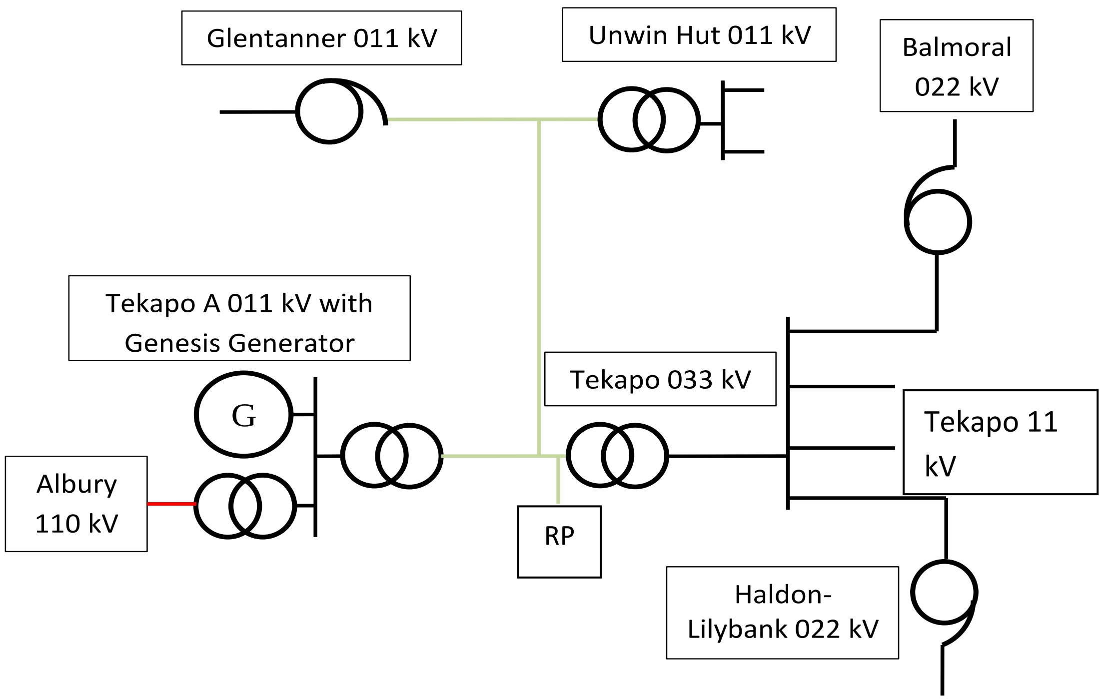
GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity	Demand 2014
TKA	110 kV	33 kV (via 11 kV bus)	10 MVA 7 MVA PCM limit	0	3.9 MW

7.3 Tekapo A GXP Network Information

Figure 7.1 shows the TKA GXP area network. There are a number of smaller zone substations to boost voltage to transmit energy to remote sparsely populated areas.

From TKA, we receive 33 kV which is sub–transmitted to the nearby TEK zone substation, which also hosts the ripple injection plant. From TEK 33 kV is sub–transmitted to Glentanner (GTN) and Unwin Hut (UHT). TEK zone substation supplies the Tekapo township and surrounding rural areas. Balmoral (BMR) and Haldon–Lilybank (HLB) are two zone substations fed off TEK which act as voltage boosters to transmit energy at 22 kV into the remote Haldon, Lilybank, and Simon's Pass areas.

Figure 7.1 Tekapo A GXP Area Network



7.3.1 Zone Substation Detail

TEK zone substation and sub–transmission key data, shown in Table 7.2 on page 53, details the major assets with respect to rating, age, and general condition. The maximum demand at the various substations is also provided. The table also details the capacity constraints, substation's communication systems and SCADA functions.

Table 7.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear		Ripple Plant
TEK	1x 3 MVA OCTC (1964) Fair		1x 33 kV Recloser Mt Cook line (1984) Good 1x 33 kV OCB (T1) (1960) Poor 7x 11 kV OCBs (1984) Good		Zellweger 500 Hz
HLB	1x 1 MVA 22/11 kV OCTC (2009) Excellent		1x 11 kV Eng. Elec. Ball and Chain (1972) Poor		
BMR	1x 0.6 MVA 22/11 kV OCTC (Aged) Fair		1x 33 kV Scarpa Magnano (Aged) Poor (run at 22 kV) 1x 11 kV DDO type fuse		
GTN	0.6 MVA 33/11 kV (1986) OCTC Fair		1x 11 kV Eng. Elec.Ball and Chain (1972) Poor 1x 33 kV DDO type fuse		
UHT	1x 1.5 MVA OLTC 33/11 kV (1974) Fair		1x 33 kV OCB (1974) Fair 2x 11 kV OCBs (1977) Fair		
Sub–Transmission Line	**Make Up**	**Limit at 6% p.d.(MVA)**	**Limit of Conductor at 50^{o}C (MVA)**	**Limit of Cable (MVA)**	**Lowest Limit**
TKA–TEK	Dog	82.48	12.6		12.6
Mt Cook Stn Tee–TEK	Dog/ Flounder	2.25	12.6 8.6		2.25
GTN–Mt Cook	Mink	6.84	10.3		2.25 (from Mt Cook 6% PD)
Mt Cook Stn–UHT	Mink/ Petrel	1.2	10.3 11.4		1.2

Area of Network with Constraint	Capacity Constraint	Description	Intended Remedy	
TKA GXP	None			
TEK	Transformer at 3 MVA	Transformer identified as becoming too small for the new Tekapo developments.	Install an ex PAR 5/6.25 OLTC transformer. This will allow additional load and provide better voltage control. Expected mid–2015.	
Tekapo Rural	Lines away	Light two phase, large spans	Feed HLB from TWZ.	
BMR	Lines away	Light three phase, large spans	Feed Simon's Pass from TWZ.	
GTN	Transformer at 0.6 MVA. Transformer causes additional voltage sag. No OLTC.	Glentanner Park may have additional accommodation built. 0.6 MVA rating will become too small.	Remove the 33/11 kV step down zone substation (GTN) and change out the distribution transformers for 33 kV primary rated units. Some primary insulator changes needed on the lines for new ones built since area was fed at 11 kV.	
UHT	None			
Communications	**VHF**	**UHF Analogue**	**UHF Digital**	**Fibre Optic**
TEK	VHF for voice traffic	TEK–MRC MRC–WDK		None
HLB	Vehicle radio	None	None	None
BMR	Vehicle radio	None	None	None
GTN	Vehicle radio	None	None	None
UHT	VHF for voice traffic	None	None	
SCADA	**Supervision**	**Control**	**Automation**	**Data Acquisition**
TEK	Current, voltage and CB status at TEK. Security at TEK	TEK CB control. TEK Ripple plant control.	Auto reclosing CB	Load data at TEK
HLB	None	None	None	None
BMR	None	None	None	None
GTN	None	None	None	None
UHT	Two bit alarms over VHF	None	None	None

Note—from Table 7.2 Mt Rollesby (MRC) is not our site, as this is rented space. It is also shown that TEK's SCADA has L&N C68 RTU equipment installed.

Table 7.3 lists the existing level of security at the substations and justifies any shortfall.

Table 7.3 Security Level for Tekapo A GXP

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
TEK CBD	N–0.5	N–1	No alternate supply to station. Substation being made mobile substation ready. Limited 11 kV rings. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
Mt Cook and GTN	N	N	No alternate supply to station. Substation being made mobile substation ready. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
TEK Rural	N	N	Radial lines, little backup. Generator port on 11 kV at HLB. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

Photograph 7.2 Tekapo Zone Substation

The estimated demand listed in Table 7.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 7.5 at page 57.

Table 7.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
TEK	3.2 (Winter/ shoulder)	3.9% historic on TKA. Residential load. Tourism development.	5.4 (Winter /shoulder)	Transformer being changed out in 2015 to 5/6.25 MVA.
HLB	0.2 (Est.) (Winter/ shoulder)	3.9% historic on TKA. Residential load. Tourism development.	? (Winter /shoulder)	Minimal unless lines away rebuilt. If irrigation expands toward Haldon then it is likely their supply will come from TWZ. This sub would be retained for Lilybank.
BML	0.3 (Est.) (Winter/ shoulder)	3.9% historic on TKA. Residential load. Tourism development.	? (Winter /shoulder)	Minimal unless lines away rebuilt. If irrigation expands toward Simon's Pass then it is likely their supply will come from TWZ. This sub may be decommissioned. Close in loads can be fed at 11 kV.
GTN	0.3 (Est.) (Winter/ shoulder)	3.9% historic on TKA. Residential load. Tourism development.	? (Winter /shoulder)	Consideration given to decommissioning sub and replacing downstream Dist. Transformers with 33 kV. Saves need to install OLTC transformer.
UHT	1.1 (Est.) (Winter/ shoulder)	3.9% historic on TKA. Residential load. Tourism development.	1.9 (Winter /shoulder)	Transformer likely to need a change out in planning period.

7.4 Development of GXP and Substations

Figure 7.2 shows the TKA GXP load growth.

Figure 7.2 Load Growth for Tekapo GXP

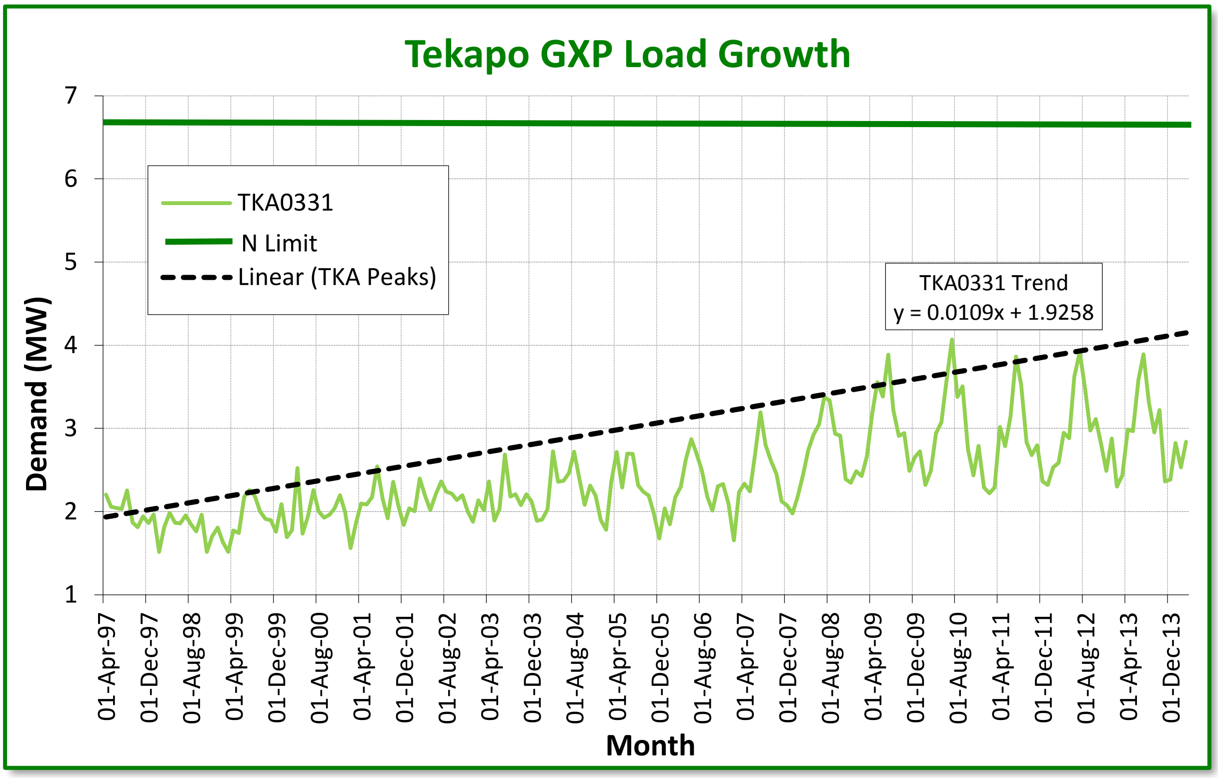


Table 7.5 shows the growth trend to the year 2025.

Table 7.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TKA Sum (Autumn/ Spring)	5.2	5.8	6.0	6.1	6.3	6.4	6.6	6.7	6.9	7.1	7.3
TEK Village	3.8	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.3	5.4
Mt Cook and Glentanner	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9

Figure 7.3–Figure 7.5 shows the predicted maximum demand within the planning period.

Figure 7.3 Tekapo Growth Trend

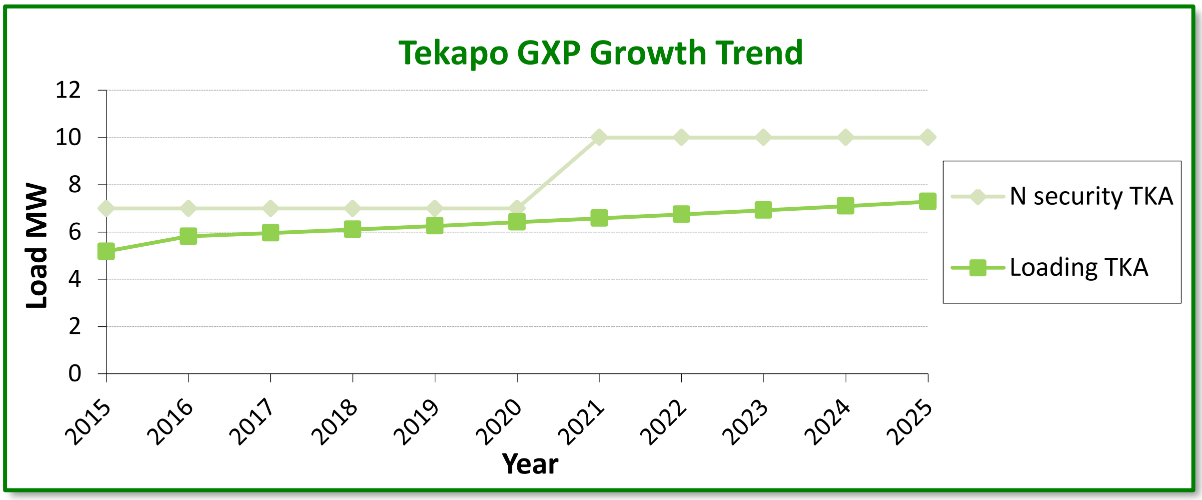


Figure 7.4 Tekapo Village Substation Growth Trend

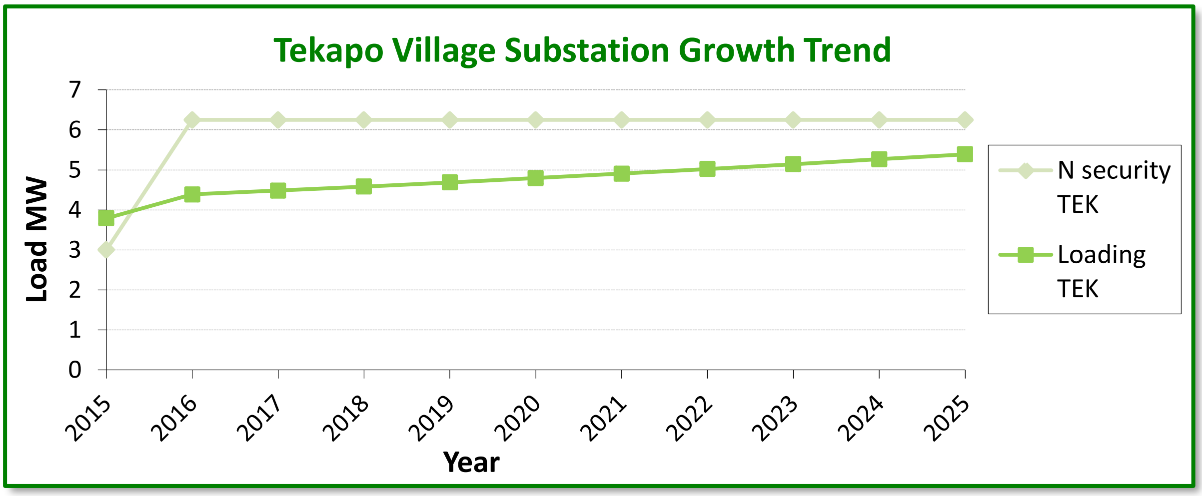
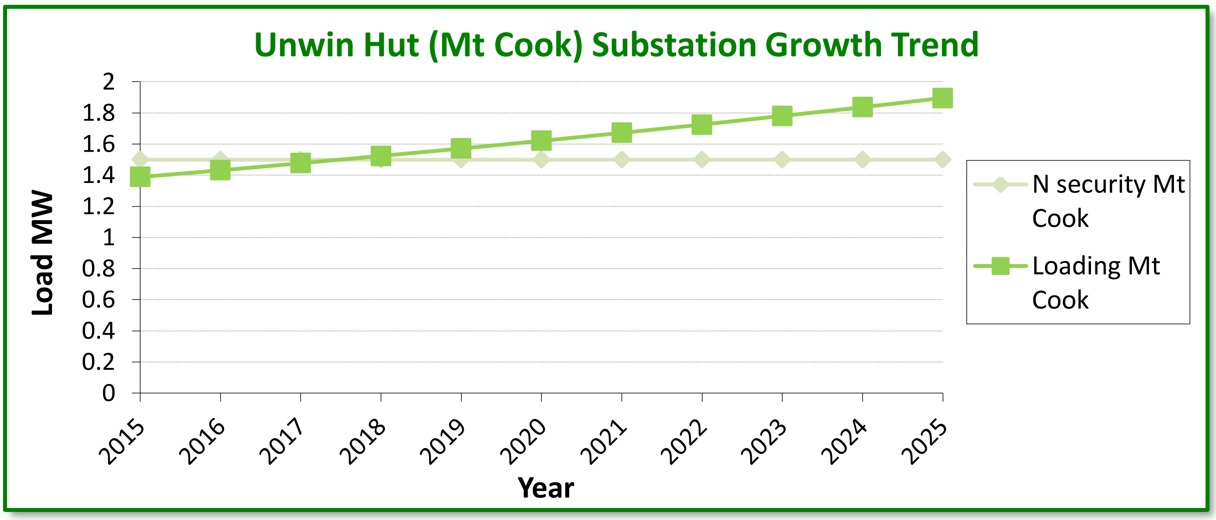


Figure 7.5 Unwin Hut (Mt Cook) Substation Growth Trend



7.4.1 Substation Growth Trend and Supply Security

The almost 6% load growth anticipated in the tourism sector in 2009 fell back. In 2014 the plans for expanding the CBD have progressed to construction starting and two major hotels announced. We are unsure of the speed of the uptake of this.

Our supply is on an N security basis from TKA. An 11 kV bus or 11 kV to 33 kV step up transformer fault would result in a total supply loss until repairs were undertaken or the Transpower Mobile Substation was installed. Since the spare transformer is not on–site, a fault within the transformer would result in a loss of supply for at least a day while a change out occurred.

We could support some of the TEK load with mobile generation.

7.4.2 Rate and Nature of GXP Growth and Provisions Made

Table 7.6 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 7.6 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
TKA	Medium—Subdivision and tourism business	Upgrade zone substation

7.4.3 Specific Developments

7.4.3.1 Tekapo A Transpower 11 kV Switchboard

Transpower carried out a strengthening and arc flash containment project on the switchboard in early 2014 while its mobile substation was deployed. This extended the life of the existing switchboard in the same electrical configuration.

7.4.3.2 Haldon–Lilybank Zone Substation Upgrade

Haldon–Lilybank (HLB) is a small step up substation on the edge of Tekapo. It consists of a ball and chain recloser, an 11/22 kV step up autotransformer and two phase lines away to Haldon and Lilybank. The neutral of the autotransformer has earth fault protection installed.

The substation is due for replacement. Options are being examined.

An enquiry has been made from a number of farmers about a stronger supply in the Haldon area for irrigation. The 22 kV system is not three phase and does not have capacity. The most economical solution for this is taking a supply from Twizel. In the meantime the farmers are still developing the proposal, and there is no time frame given for the irrigation to be commissioned.

7.4.3.3 Balmoral Zone Substation Decommissioning

BMR is a small step up substation on the edge of Tekapo that feeds Simon's Pass, it consists of; a primary 11 kV fuse, an 11/22 kV step up auto transformer, a 33 kV 600 A Scarpa Magnano minimum oil CB and post CTs, and a 22 kV line away. The neutral of the autotransformer has earth fault protection installed.

There are thoughts that the substation may be disestablished, the 22 kV line operated at 11 kV, and the several existing 22 kV distribution transformers replaced with standard 11 kV distribution transformers. However, there is a pause in this work until irrigation prospects in the Simon's Pass/Pukaki area are fully identified to us.

7.4.3.4 Ripple Plant Upgrade

A 10 year program to replace or decommission the old rotating ripple injection plants was commenced in 2000 although TEK still has a rotary ripple plant. This was delayed while a short wave radio load control system was considered.

Smart Meters may provide suitable load control in the future but this is not considered soon enough to meet our immediate requirements for replacing outdated equipment. Therefore it has been decided to recommence the original plan to replace the old rotary injection plants with modern electronic equipment as per the original program.

The ripple replacement will also require the replacement of the RTU and comms as the existing legacy equipment is passed its economic life. It is likely that this RTU and comms replacement at TEK would be done in conjunction with a similar replacement at the Twizel Zone Sub as the latter's legacy RTU and comms equipment (same vintage as TEK's) shares a common SCADA System comms link with TEK back to the Washdyke Control Room.

7.4.4 Issues Arising from Estimated Demand

Transpower have identified the supply transformer becoming too small in 2022, this is because the 10 MVA transformer is constrained via protection/control/metering (PCM). Changes will be required to extend the capacity of the transformer.

8 Temuka Grid Exit Point

8.1 Introduction

Figure 1.4 on page 10, shows how the Temuka GXP (TMK) is configured with our network and Transpower's transmission network. TMK is supplied by double 110 kV transformer feeder circuits from the TIM 110 kV bus.

8.2 GXP Description

Figure 8.1 at page 62 shows the TMK GXP area network. The 110/33 kV GXP has eight 33 kV feeders; four to Fonterra's Clandeboye Dairy Factory (of which two are direct cables and two are overhead circuits supported on a single pole line), two 33 kV cables to our 33/11 kV zone substation (co–sited at the TMK GXP), one 33 kV circuit breaker to supply an overhead 33 kV feeder to GLD and one 33 kV circuit breaker to supply an overhead 33 kV feeder to RGA. The latter two have a tying arrangement at the end of the CB cable/start of overhead line to give security for a CB failure. Our 33/11 kV zone substation supplies the Temuka township and surrounding rural area.

RGA also has a supply from a tee off of the CD2 circuit at CNL.

Peak demand occurs during summer based on the predominant dairy and irrigation load.

Photograph 8.1 Temuka Zone Substation

8.2.1 Critical Data

The critical GXP data shown in Table 8.1 below summarises the key physical attributes of the station, the voltages, the capacity, the security, and the power flow.

Table 8.1 Temuka Substation Key Data

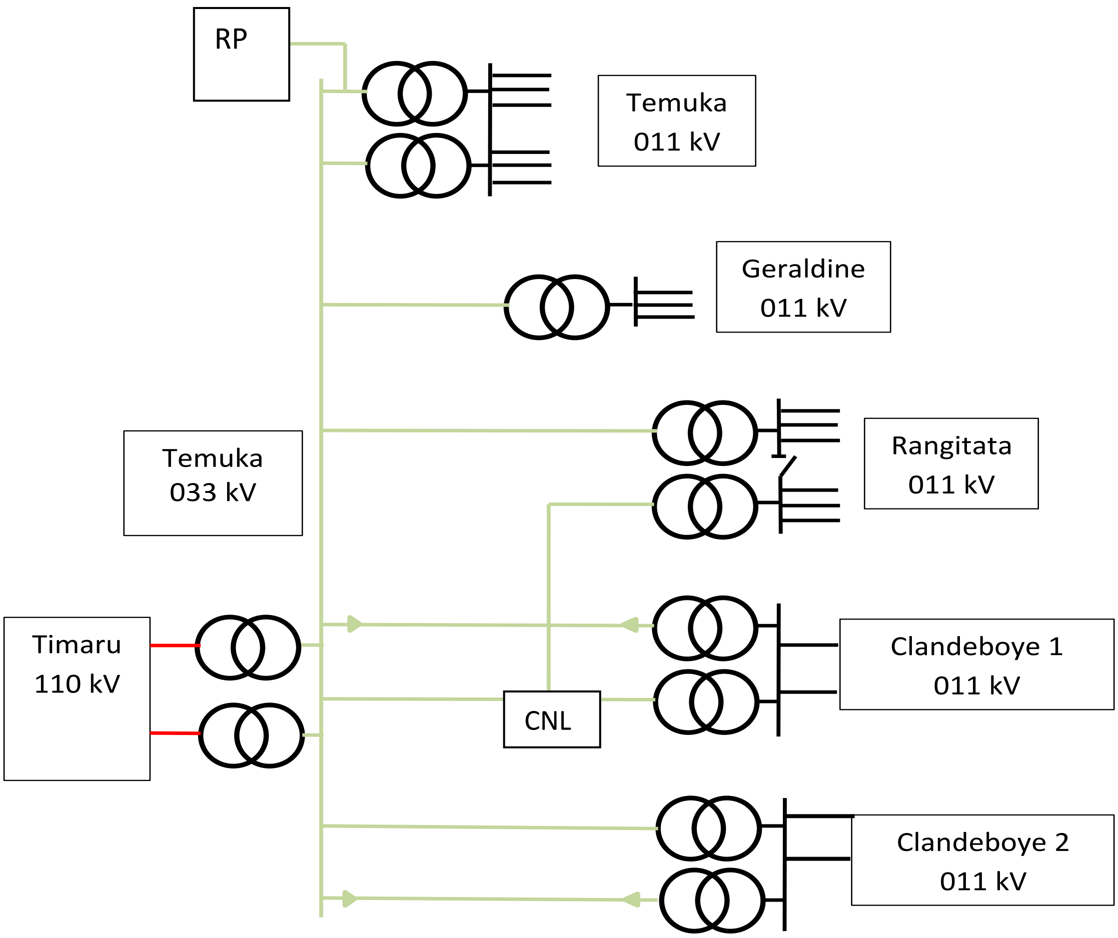
GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity	Demand 2014
TMK	110 kV	33 kV	120 MVA	60 MVA[1]	51.3 MW

8.3 Temuka GXP Network Information

Figure 8.1 shows the TMK GXP network area.

Our TMK 33/11 kV zone substation supplies the Temuka township and surrounding rural area.

Figure 8.1 Temuka GXP Area Network



[1] The Transpower GXP 110/33 kV transformers were uprated from 51 MVA to 60 MVA in 2010

8.3.1 Zone Substation Detail

The zone substation, switching station and sub–transmission key data for TMK, Clandeboye, RGA and GLD is shown in Table 8.2below. It details the major assets with respect to rating, age, and general condition. The maximum demand at the various substations is also provided.

Table 8.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
TMK	2x 25 MVA OLTC 33/11 kV (2007) Excellent		9x 11 kV VCBs (2006) Excellent	1x Zellweger 317 Hz 33 kV
CD1 16 MW	2x 20 MVA OLTC 33/11 kV (1997) Good		2x 33 kV Reclosers WVE (1997) Good 15x 11 kV VCBs (1997) Excellent	
CD2 14 MW	2x 25 MVA OLTC 33/11 kV (2004) Excellent		2x 33 kV Recloser VWVE (2004) Good 12x 11 kV VCBs (2004) Excellent	
RGA (9.8 MW)	2x 9/15 MVA OLTC 33/11 kV (2011, 2012) Excellent		2x 33 kV GL107X CB (SF_6) (2011, 2012) Excellent 5x 11 kV VCB Tamco (2004) Excellent 5x 11 kV VCB RPS (2011) Excellent	
GLD 6.1 MW	1x 5/6.25/9 MVA OLTC 33/11 kV (1980) Good		1x 33 kV Recloser VWVE, T2 (2009) Excellent 1x 11 kV Recloser U Nulec, T2 (2009) Excellent 3x 11 kV Recloser U Nulec, feeders (2007) Excellent	
Zone Switching Station Site	**Transformer**	**Regulator**	**Switchgear**	**Ripple Plant**
CNL 8.5 MW	None		1x 33 kV GL107X CB (SF_6) (2012) Excellent	

Sub–Transmission Line	Make Up	Limit at 6% p.d. (MVA)	Limit of Conductor at 50°C (MVA)	Limit of Cable (MVA)	Lowest Limit
TMK–CD 1	Cable 1/400 then 1/300	42.3		21.3	21.3
TMK–CD 2	Cable 2x1/300/ Jaguar then 1/300	33	23.4	21.3	21.3
TMK–CD 3	Cable 2x1/300/ Jaguar then 1/400	33	23.4	24.2	23.4
TMK–CD 4	Cable 1/400	42.3		24.2	24.2
RGA 1–TMK	Cable 1/400 /Dog/Iodine/Mink Cable 3/95/Wolf Core	8.4	10.3	11.5	8.4
RGA 2–TMK via Canal Rd teed off CD2–TMK 10 MVA take agreed with Fonterra	Cable 2x1/300/ Jaguar	21.26 (14.95 towards RGA2)	23.4	32	10
GLD–TMK	Cable 1/400 /Dog	8.64	12.6	24.2	8.64

Note that we have an agreed maximum limit of 10 MVA to be taken off the CD1–TMK 33 kV circuit.

Photograph 8.2 Canal Road Switching Station

Table 8.3 details the substation's communication systems and SCADA functions.

Table 8.3 Communication and SCADA Summary

Communications	VHF	UHF Analogue	UHF Digital	Fibre Optic
TMK	VHF for voice traffic	None	TMK–MEC MEC–WDK (main) TMK–WDK (backup)	CD2–TMK (services CD1and2 and CNL)
CD1 and CD2	VHF for voice traffic	None	CD1–CNL (services CNL)	CD2–TMK (services CD2) CD1–CD2 (services CD1)
CNL	VHF for voice traffic	None	CD1–CNL	None
SCADA	**Supervision**	**Control**	**Automation**	**Data Acquisition**
TMK	Current, voltage and CB status at TMK Security at TMK	TMK CB and Transformer Control Ripple plant control	Auto Reclosing CB	Load data at TMK
CD1 and CD2	Current, Voltage and CB status at CD1 and CD2 Security at CD1 and CD2	CD1 and CD2 CB and Transformer Control	Control of CBs	Load data at CD1 and CD2
CNL	Current, voltage and CB status at CNL Security at CNL	CNL CB Control	Control of CB	Load data at CNL

The SCADA in TMK consists of an Abbey RTU connecting to our 11 kV switchgear and transformer zone IEDs, it controls the ripple plant, and connects to Transpower's data bridge to its RTU in Transpower's 33 kV switch room.

CD1, CD2, CNL & RGA SEL 3530 substation processors connect the substation equipment.

TMK communications connects via radio systems to WDK via CHC and is a communications hub for CD1, CD2 and CNL via the CD2–TMK fibre. CD2 is a communications hub for CD1 (via fibre) and CNL (via radio).

Table 8.4 shows the capacity constraints in the TMK GXP.

Table 8.4 GXP Network Constraints

Area of Network with Constraint	Capacity Constraint	Description	Intended Remedy
TMK	Temuka Area—Holistic	Lack of capacity for TMK 33 kV GXP load	Work with Transpower on upgrading supply assets. Possibly establish new GXP off a proposed 220 kV OAI bussing point. Possibly establish new GXP at TMK off a 220 kV line diversion to TMK.
	TMK GXP Supply Security	Load constraint over 60 MVA on transformers. 70 MVA on 110 kV lines. 71 MVA on 33 kV switchboard.	New investment in line and switchboard upgrade—Transpower discussion (timing uncertain). Possibly establish new GXP off a proposed 220 kV OAI bussing point to offload TMK GXP. Possibly establish new GXP at TMK off a 220 kV line diversion to TMK.
RGA	Rangitata 33 kV sub–trans 1 line regulation	Voltage constraint over 8.4 MVA of load (6% volt drop)	Second 33 kV feeder to RGA took load in 2013. For a sub–trans tripping, shuffling of load is required, most can be done via remote control so quick response. Long term sub–trans review required.
GLD	Geraldine 33 kV sub–trans 1 line regulation	Voltage constraint over 8.64 MVA of load (6% volt drop)	Watch on GLD loading as RGA load is transferred. Load may be able to go back on RGA depending on the final irrigation scheme load.
	Geraldine CBD	Voltage constraint at end of feeder	Install capacitor from the 2014/15 plan, review required.

Table 8.5 lists the existing level of security at the substation and justifies any shortfall.

Table 8.5 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
TMK Residential	N–1	N–1	Capacity headroom eroding due to commercial developments fed via the residential area. Look to increase size of conductor to limit voltage drop, difficult through residential area due to TDC planning constraints for overhead lines.
TMK Rural	N–0.5	N–0.5	Limited fault backup from GLD, RGA, PLP and TIM. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
CD1 and 2	N–2 (Sub–Trans) N–1 (Zone Sub)	N–2	Fonterra invested with the additional installation of two 33 kV cables to their plant in addition to the two 33 kV overhead circuits that were initially installed. The source from Transpower to the TMK GXP consists of many components and is an N—1 supply. Discussion with Transpower held to try to reduce the number of components when the OAI bussing project occurs.
RGA	N	N	Station allows connection to TMK–CD1 cct 2 for supply to RGA. RGA has security via TMK's direct circuit. See RGA for further detail.
	N–0.5	N–1	Station runs with split 11 kV bus, 8.4 MVA available at worst after switching. Balance can be shifted onto 11 kV backup from GLD and TMK.
GLD	N–0.5	N–0.5	33 kV investment to be considered. Watch Transpower's proposal for an OAI 220 kV bussing point. May free a circuit passing near GLD on the TMK–RGA Cct 1 for use at GLD.

The estimated demand listed in Table 8.6 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 8.7 on page 69.

Table 8.6 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
TMK	60.2 (summer)	3.6% historic on TMK. Residential load. Dairy and irrigation development. Dairy processing.	26.8 (summer) Provided OAI offloads bulk of TMK. 82 If not.	Load growth due to expansion at Clandeboye which is not yet confirmed. More of a focus put on STU at present. Rangitata South Irrigation being commissioned, possibly 4 MW more to be loaded. Transmission solutions being discussed with Transpower.
CD1 and CD2	30.4 (summer)	3.6% Stepped to suit process expansion and any new drier	35 (summer). 43 With new drier.	Substation and sub–transmission capacity available. Additional CB's at substations and 11 kV cabling to new RMU and Dist Tx's required—expect demand to grow from current demand of 30 MW to about 43 MW by the end of the planning period. With careful load transfers existing assets can meet this demand and retain N—1 security.
GLD	6.1 (summer)	3.6% historic on TMK. Residential load. Dairy and irrigation development.	7.9 (summer)	Local concern may lead to a second 33 kV circuit to provide N—1 security—expect demand to grow from current demand of 6.5 MW to about 7.8 MW by the end of the planning period. We installed RMU to break rural load off CBD, this will improve reliability and allay some concerns.
RGA	9.8 (summer)	3.6% historic on TMK. Residential load. Dairy and irrigation development.	20 (summer)	Second 33 kV circuit installed to provide improved security to essential loads. Expect demand to grow from current demand of 9.8 MW to about 20 MW by the end of the planning period. Note some of RGA load can be transferred to TMK and GLD as a temporary measure.

8.4 Development of GXP and Substations

Figure 8.2 below shows the TMK load growth.

Figure 8.2 Load Growth for Temuka GXP

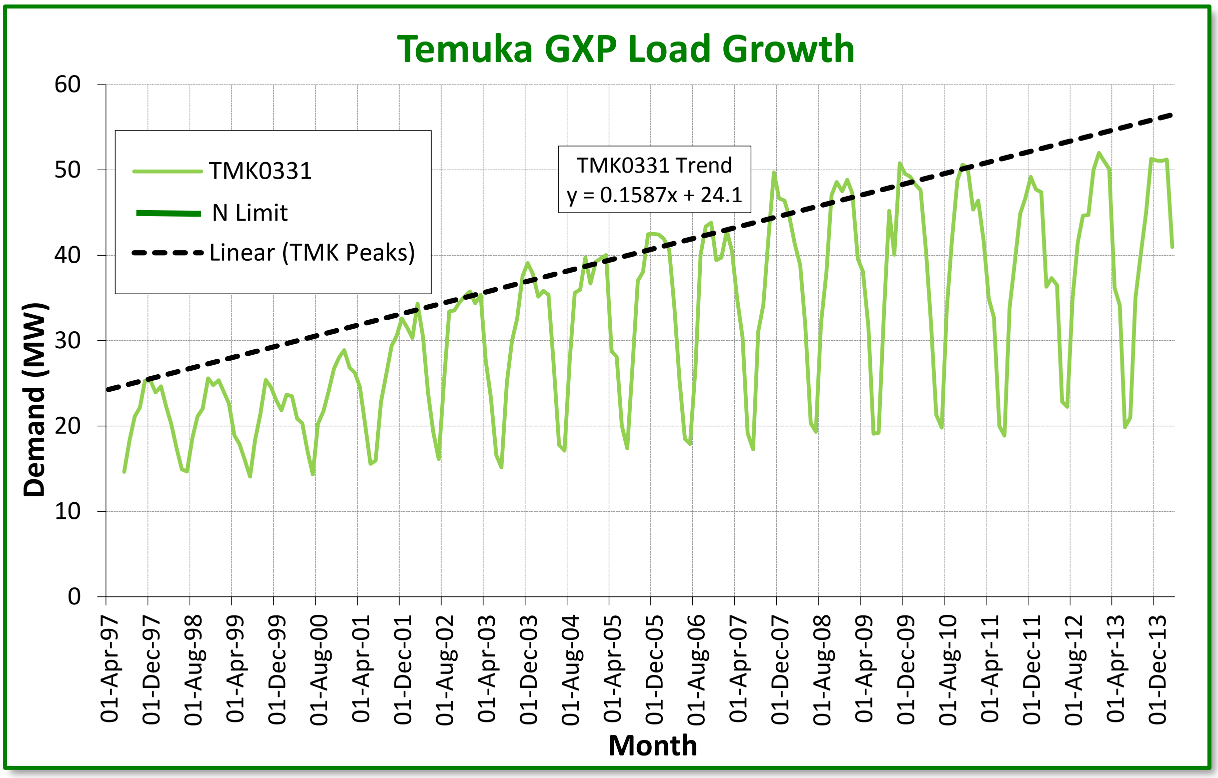


Table 8.7 shows the growth trend to the year 2025.

Table 8.7 Substation load growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TMK (Summer)	60.2	62.5	63.7	65.0	66.3	67.6	69.0	16.6	17.3	18.0	26.8

The above trend shows that the TMK 33 kV GXP load will exceed the secure supply capacity in 2016. We look to the introduction of a new GXP at OAI (with Transpower's 220 kV bussing project for the upper South Island) for transformer feeders to be built to Clandeboye, so Clandeboye and RGA loads can be applied to the new supply bus. Transpower bussing project seems to have been put back to 2022 (revised from 2013).

Without OAI TMK should reach 82 MW. See chapter 4 on OAI.

The 2016 prediction was for a supply limit by 2019 but the Rangitata South Irrigation scheme installed more than twice the transformers than first informed. Initially 3/4 MVA was requested which was then increased to 9 MVA. We are yet to see a full irrigation season run as the ponds are still filling and water has only been made available from 2014. 2015 should see Rangitata South's completion.

Options have been brainstormed for the future of TIM/TMK assets; diverting the Livingston 220 kV circuit in/out of TMK, creating a 110 kV GXP under the Livingston 220 kV circuit to bring 110 kV to site and creating a 110 kV supply at OAI and bringing it to TMK. None of these options are as beneficial as constructing a 220 kV GXP at OAI to supply a Clandeboye zone substation. It is also more important for us to use capacity at Waihao than Temuka, please see chapter 11 for more information.

Fonterra has advised a new cheese plant will be commissioned at Clandeboye in 2015 and that the new Clandeboye drier (D4) is on hold pending developments at the Studholme plant. We have however factored in additional drier load around 2025. Studies need to be carried out to ensure that the load growth that is presently being experienced doesn't curtail with the land becoming fully irrigated. All the farms must at some stage be 'wet' and no more dairy sheds able to be built. More research is required. Fonterra can build driers faster than Transpower can respond to capacity increases.

Any increase in capacity at TMK needs to be offset by an increase in TIM T5 and T8's inter–connection transformer ratings.

The 110 kV lines to TMK from TIM are rated 70 MVA, with either some lifting to provide better ground clearance or re–conductoring they could be re–rated to allow more power flow. Transpower has also identified the need to upgrade these lines to supply the new transformer arrangement at TMK.

Transpower has discussed possible upgrades at TMK to install one 120 MVA transformer and parallel the two existing. This would best be done onto a new two bus–section 33 kV switchboard as the existing one is only rated to 71 MVA.

Our studies suggest all the above is less effective than the OAI/Clandeboye solution.

8.4.1 Substation Growth Trend and Supply Security

TMK GXP is reaching capacity. Transpower and ourselves will jointly decide on a solution.

8.4.2 Rate and Nature of GXP Growth and Provisions Made

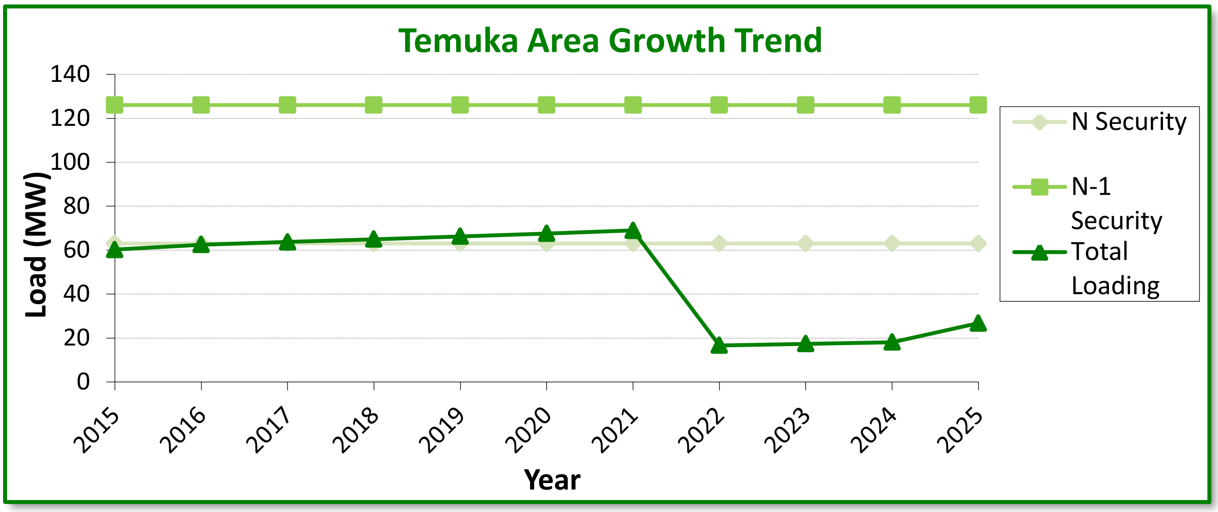
Table 8.8 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 8.8 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
TMK	High—Rural and industrial	GXP investment

Figure 8.3 shows the growth trends in the TMK GXP area.

Figure 8.3 Temuka Area Load Growth and Supply Security assuming Orari is Built 2022



8.4.3 Specific Developments

8.4.3.1 Temuka 110/33 kV GXP

TMK has two 110/33 kV transformer feeders from TIM supplying the 33 kV bus. The 110 kV lines are rated at 70 MVA and the transformers at 60 MVA. We have a peak load of 52 MVA (Jan 2013). A large number of additional loads will be realised with future dry years and Rangitata South's irrigation scheme being run hard.

If there was a loss of one of the 110 kV transformer feeders from TIM the remaining transformer would be running without spare capacity during peak load periods. Replacement of the existing transformers in TMK has been delayed.

8.4.4 Issues Arising from Estimated Demand

For now we await decisions on when OAI will be built and if a new 220 kV GXP can be built from it to Clandeboye; or if a better option presents itself.

In the meantime we will have to firm up load shedding schemes if TMK cannot run on its N capacity.

Notes:

9 Timaru Grid Exit Point

9.1 Introduction

Figure 1.4 on page 10, shows how Timaru GXP (TIM) is configured with our network and Transpower's transmission network. TIM GXP is supplied by the Twizel–Islington (via Ashburton/Bromley) 220 kV double circuit to TIM's 110 kV bus via T5 and T8 inter–connection transformers.

9.2 GXP Description

TIM is presently the largest supply point connecting two 220/110 kV interconnectors to provide a 110 kV bus which acts as a transmission hub for ABY, TKA, TMK and BPD/STU. The 110 kV is stepped down through three transformer banks to supply the TIM GXP 11 kV switchboard.

The 11 kV switchboard at TIM was replaced in early 2012 as it was at its end of life. The 11 kV is split across three buses with 20 feeder circuit breakers connected (room for four more).

Two feeders are stepped up to 33 kV by us to supply three single circuit 33 kV lines; two 10 km circuits to Pareora (PAR) zone substation supplying a 4.5 MW meat works and rural load, and one 12 km circuit supplying a rural community at Pleasant Point (PLP) zone substation for township and rural consumers.

Six 11 kV sub–transmission cables supply some 35 MW to the CBD area. These include four cables to Grasmere St (GRM) 11 kV switching substation, which then supplies cables to Hunt St (HNT) and North St (NST) 11 kV switching stations. Two additional sub–transmission cables have been recently laid from TIM to the NST 11 kV switching station. Each of these three switching stations has an indoor switchboard with between eight and 12 cable feeders. These supply the CBD, PrimePort, Redruth and surrounding residential areas.

TIM also supplies twelve 11 kV feeders to; the western residential areas, the northern residential and industrial areas of Washdyke, and the 4 MW meat–works at Smithfield.

In addition, there are two 11 kV CBs allocated for connecting a new ripple control plant and our local service transformer supplies. These are looking to be altered to supply the new A&P show–grounds shopping centre.

The new Holcim cement handling facility will be partially fed from GRM and NST.

The 110/11 kV transformer banks at TIM were replaced, with final commissioning in October 2014. The new 40/47 MVA transformers are operated with two in service and one on hot standby. This lowers the inter–phase fault levels in the surrounding area. Earth fault levels were lowered in 2012 with the inclusion of neutral earthing resistors (NERs).

A 33 kV GXP will allow the development of 33/11 kV zone substations in Washdyke and at NST to allow the supply of growing loads in the port and Washdyke areas.

Presently the TIM peak demand occurs during winter due to the dominant residential load. We are observing the gap between summer and winter closing.

Photograph 9.1 Timaru Zone Substation

9.2.1 Critical Data

The critical GXP data shown in Figure 9.1 over page and Table 9.1 summarises the key physical attributes of the substation, the voltages, the capacity, the security, and power flow.

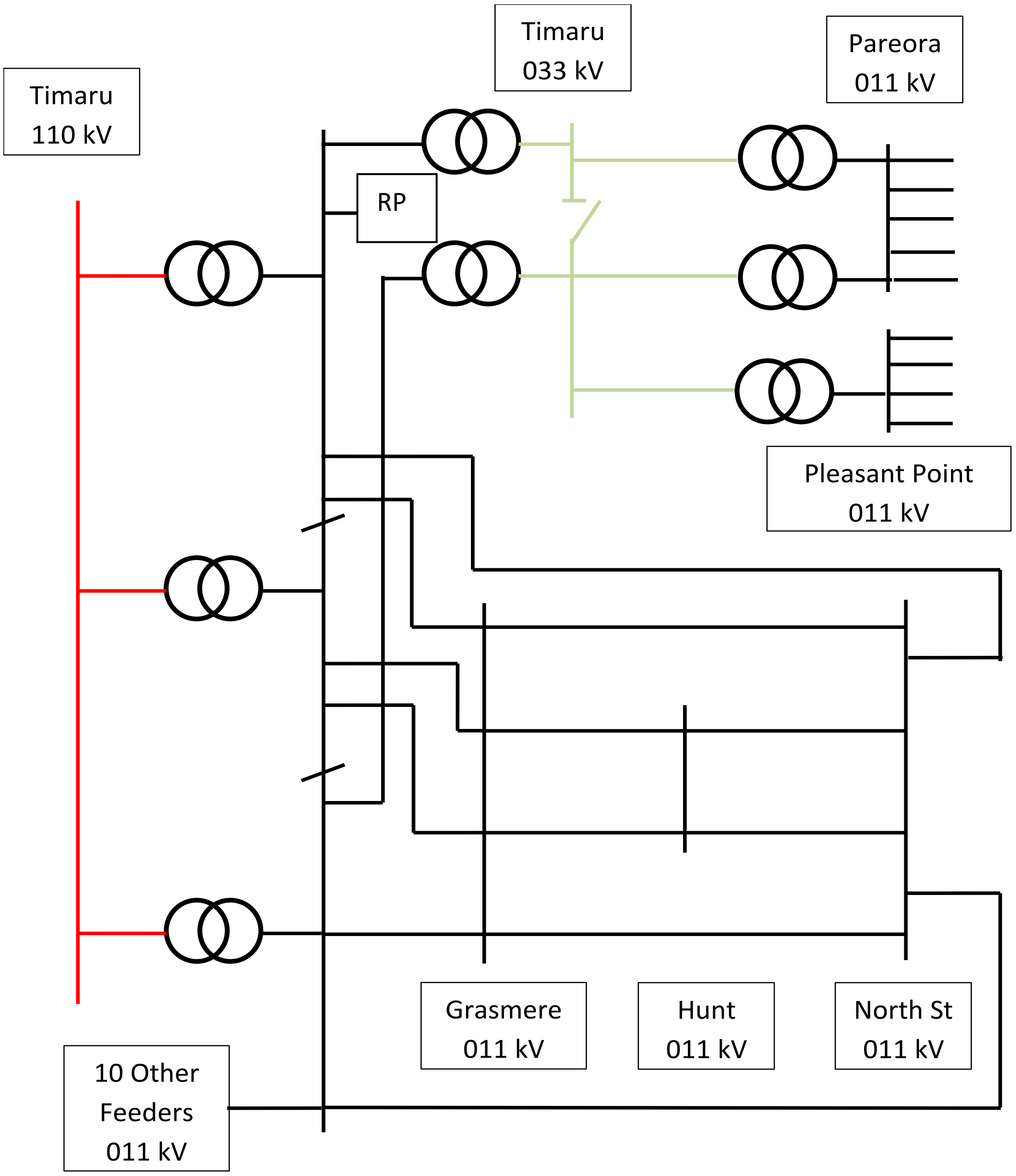
Table 9.1 Timaru Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity	Demand 2014
TIM	110 kV	11 kV	94 MVA	94 MVA	63.4 MW

9.3 Timaru GXP Network Information

Figure 9.1 shows the Timaru GXP area network.

Figure 9.1 Timaru GXP Area Network



9.3.1 Zone Substation Detail

The zone substation key data shown in Table 9.2 at page 76, details the major assets with respect to rating, age, and general condition. The maximum demand at the various substations is also provided. TIM zone substation was historically referred to as Grant's Hill. The substation's purpose is to step up 11 kV to 33 kV to feed the PAR and PLP zone substations. The site also hosts the ripple plant. Transpower switchgear onsite feeds the surrounding rural, residential, and Washdyke/Seadown areas.

Table 9.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
TIM	2x 25 MVA OLTC 33/11 kV (2006) Excellent		3x 33 kV Reclosers (1986) Fair	1x Zellweger 317 Hz
PAR 8.7 MW	2x 9/15 MVA OLTC 33/11 kV (2011) Excellent		6x 33 kV VCBs SF_6 isophases (2011) Excellent 9x 11 kV VCBs(2008) Excellent	
PLP 4.7 MW	1x 5/6.25 MVA OLTC 33/11 kV (1980) Good		1x 33 kV Recloser (1980) Good 5x 11 kV VCB (2006) Excellent	
Zone Switching Station Site	**Transformer**	**Regulator**	**Switchgear**	**Ripple Plant**
GRM 13 MW			20x VCBs (2012) Excellent	
HNT 11 MW			16x VCBs (1984) Good	
NST 11 MW			20x VCBs (2011) Excellent	

Sub–Transmission Line	Make Up	Limit at 6% p.d. (MVA)	Limit of Conductor at 50°C (MVA)	Limit of Cable (MVA)	Lowest Limit
GRM–TIM	4x 11 kV 400 mm^2 Cu PILC Cables (1983) Fair				
GRM–HNT and GRM–NST and HNT–NST (11 MW)	4x 11 kV 193 mm^2 Cu PILC Cables (1962) Fair				
NST–TIM (11 MW)	2x 33 kV 1200 mm^2 Al XLPE Cables (2011) Excellent				
PAR–TIM 1	Mink/Petrel/Rango Cable 1/95/37/0.016	6.8	10.3/11.4	11.5	6.8
PAR–TIM 1 (Rebuild underway)	Iodine/Petrel Cable 1/95	10.3	16.6/11.5	11.5	10.0

Sub–Transmission Line	Make Up	Limit at 6% PD (MVA)	Limit of Conductor at 50°C (MVA)	Limit of Cable (MVA)	Lowest Limit
PAR–TIM 2	Quail/ Cable 1/95/19/0.014	6.91	10.3	11.5	6.91
PAR–TIM 2 (Rebuild Underway)	Iodine/ Cable 1/95	10.09	16.6	11.5	10.09
PLP–TIM	Quail/Dog/Weke/ 19/0.014 Cable 1/95	8.7	10.3/12.6/ 16.6	11.5	8.7

Communications	VHF	UHF Analogue	UHF Digital	Fibre Optic
TIM	VHF for voice traffic	None	NST–MEC MEC–WDK (back up to fibre link break)	FO to WDK and back thru GRM/HNT to NST
GRM/HNT/NST	VHF for voice traffic	None	NST–MEC MEC–WDK (back up to fibre link break)	FO to WDK via a ring NST–WDK and NST–HNT–GRM–TIM–WDK
PAR	VHF for voice traffic	None	PAR–MEC MEC–WDK	None
PLP	VHF for voice traffic	None	PLP–BRC BRC–MEC MEC–WDK	None

SCADA	Supervision	Control	Automation	Data Acquisition
TIM	Current, voltage and CB status at TIM. Security at TIM.	TIM 11 kV CB control, though presently done thru TP. No remote control of 33 kV reclosers. TIM ripple on Abbey RTU to WDK via landline.	CB control	Load data at TIM
GRM/HNT/NST	Current, voltage and CB status. Security.	CB control	CB control	Load data
PAR	Current, Voltage and CB status. Security.	CB control and transformer control	CB control	Load data
PLP	Current, voltage and CB status. Security.	CB Control	CB control	Load data

Both PAR and PLP have an SEL 3032 to connect to IEDs as detailed in Table 9.2.

The capacity constraints on our network in the Timaru, Pareora and Pleasant Point areas are shown in Table 9.3.

Table 9.3 Network Constraints

Area of Network with Constraint	Capacity Constraint	Description	Intended Remedy
Timaru	Highfield (TIM2952) feeder loading	Heavily loaded feeder	Long term establish West End zone substation off 33 kV TIM GXP (timing uncertain).
	Morgans Rd feeder (TIM2702) loading	Heavily loaded feeder	Long term establish West End substation off 33 kV TIM GXP (timing uncertain).
	Levels feeder (TIM2852) loading	Heavily loaded feeder	Long term establish West End zone substation off 33 kV TIM GXP (timing uncertain).
	Mountainview feeder (TIM2712) loading	Heavily loaded feeder	Long term establish West End zone substation off 33 kV TIM GXP (timing uncertain).
	Timaru sub–transmission to CBD	Heavy cable loadings	Establish city 33/11 zone substation off 33 kV TIM GXP (timing uncertain).
Pareora	Pareora 1 and 2, 33 kV line regulation	Voltage constraint over 7 MVA of load (6% volt drop)	Planned releases shift some load to TIM and STU (as required). Fault response depends on load, shift loads as possible, non–supply if situation arises. Rebuild sub–transmission in iodine; currently underway but will take four years (requires new pole positions). Rebuild No. 2 first as it is more aged. Establish new STA GXP for partial load transfer (2018–19).
Pleasant Point	Pleasant Point T1	At present suitable, large connection enquiries in Totara Valley area cannot be met. Any new transformer to be selectable between Dyn11 and Dzn0 to suit TIM 33 kV GXP.	Larger transformer, or second or new substation at Totara Valley for load transfer (timing uncertain).

Table 9.4 lists the existing level of security at the substation and discussion on shortfall from target security.

Table 9.4 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
TIM 33 kV step up zone substation	N–0.7	N–0.75	Two step up transformers that feed a split 33 kV bus arrangement. PAR on each side of bus and have full redundancy available to the lines. PLP is fed off one bus, short duration loss can occur, with a loss to that 33 kV bus, until a tie is made to the remaining 33 kV bus.
Timaru Residential	N–1	N–1	One additional feeder to TIM area was gained with TP changing its board. Lead out cables to first tee points were increased in size where possible.
Timaru Rural	N–0.5	N–0.5	Limited fault back up from adjacent feeders from TIM and then as second resort PAR, PLP and TMK. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
Washdyke/ Seadown	N–1	N–1	Capacity is only sufficient for N—1; as new substantial loads are established, investment in new sub–transmission feeders to SDW will be required. Install 33 kV cables from SDW to TIM to run at 11 kV.
Timaru CBD (GRM, HNT, and NST)	N–1	N–1	None
Redruth	N–1	N–1	None
Port	N–1	N–1	None
PLP via 11/33 kV step up zone substation at TIM	N–0.5 N on the remainder that cannot be transferred.	N–1	In 2015 up to 1 MW of dairy load will come on from Waitohi area. Majority of new load increase likely in Totara Valley area. The 11 kV feeders from PLP to Totara Valley are too long to support major growth in irrigation. Consider investment of Totara Valley substation. A Totara Valley substation could halve the PLP substation load. Some load can be transferred from PLP to ABY, TMK and TIM in an emergency. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
PAR via 11/33 kV step up zone substation at TIM	N–1 on first 9/15 MVA (transformer limit), 7 MVA Sub–transmission limit to 6% voltage drop N on the remainder that cannot be transferred.	N–1 security for all periods. Some load can be transferred to STU and TIM in an emergency.	PAR via 11/33 kV step up zone substation at TIM.

Photograph 9.2 Pareora Zone Substation

The estimated demand listed in Table 9.5 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 9.6 at page 83.

Table 9.5 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
TIM	62.2	0.7% (winter)	74.3 (winter)	0.7% historic some steps expected to come from: residential growth, heat pump uptake and industry growth (Washdyke).
Timaru CBD	39 MW (winter)	0.7% historic on TIM	45 (winter)	None required for local assets as substation and sub–transmission capacity is available. Additional CBs at substations and 11 kV cabling to new RMU and distribution transformers required. Expect demand to grow from present demand of 39 MW to about 45 MW by the end of the planning period. Existing assets can meet this demand and retain N—1 security.
PAR	8.7 (summer)	3.2% per year expected on TMK until STA GXP built. From then 2% Residential load, dairy and irrigation development.	9.6 (summer). 11 If STA GXP not built by then.	Up–sizing of sub–trans lines required to retain full N—1 security—expect demand to grow from current demand of 8 MW to about 9 MW by the end of the planning period. Acceptable security for the major meat processing works supplied from this site required. Some security via 11 kV back up from STU and TIM. Possible partial off load to new St. Andrews GXP as it eventuates.
PLP	4.7 (summer)	4.62% per year expected as TMK experiences residential load growth, and dairy and irrigation development.	3.8 (summer). 8 If Totara Valley not built.	Existing transformer rated for the period. Some security via 11 kV back up from ABY, TIM and TMK. Possible substation built nearer irrigation load at Totara Valley to improve security.

9.3.2 Timaru (TIM) (Grant's Hill) Zone Substation Detail

TIM connects via fibre to WDK then via fibre to NST with a radio link over MEC to WDK in back up.

There is a small amount of traffic on the Cu twisted pair cable. TIM–WDK, mainly collects information from the three 33 kV reclosers and operates the ripple plant.

The main SCADA system is three SEL 3530 to connect to IEDs. Abbey RTU is used to control the ripple plant. There is also a small amount of data from the TP data bridge, mainly for ripple plant control off RevM.

9.3.3 Grasmere (GRM) and Hunt St (HNT) and North St (NST) Zone Switching Station Detail

Grasmere (GRM), Hunt St (HNT) and North St (NST) are switching stations which mean the stations perform important switching, protection, and SCADA operations but do not transform voltages as for zone substations. Whilst NST is presently a switching station there is space to fit 33/11 kV transformers when the sub–transmission is livened at 33 kV categorising NST as a zone substation. Please note that these three ‘switching stations’ are treated as ‘zone substations’ as far as operating and maintenance are concerned

GRM/HNT/NST connects via fibre to WDK then via fibre to NST with a radio link over MEC to WDK in back up.

NST is serviced with Chorus telephone and fax. A broadband connection is available over Chorus’ services.

There is a small amount of traffic on the Cu twisted pair cable HNT and Victoria (VIC) to WDK, it mainly collects information from the HNT 11 kV feeders and VIC building alarms.

Each of GRM/HNT/NST has two SEL 3530 to connect to IEDs.

HNT remote control of feeder CBs is over the Cu twisted pair cable. HNT sub–transmission is on fibre/3035.

9.4 Development of GXP and Substations

Figure 9.2 below shows the TIM load growth.

Figure 9.2 Load Growth for Timaru GXP

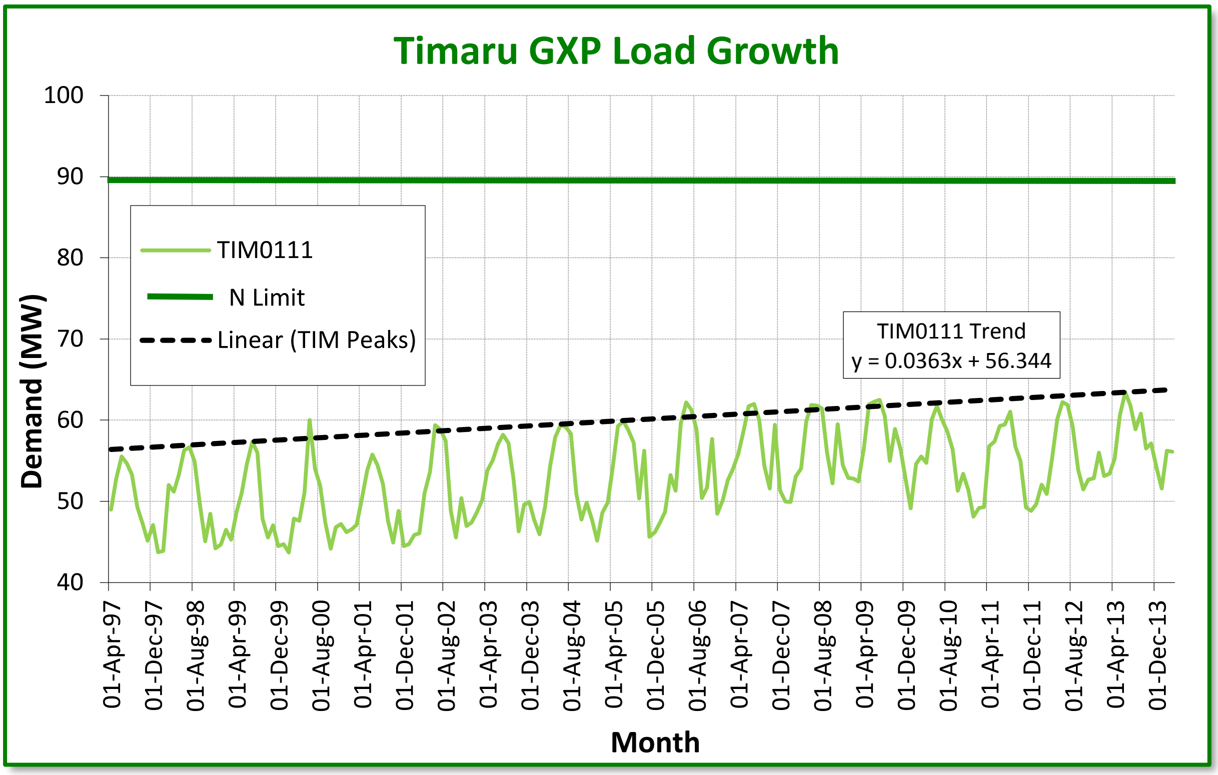


Table 9.6 shows the growth trend to the year 2025.

Table 9.6 Timaru 110 kV Bus Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TIM 110 kV (Summer)	125.9	130.3	133.1	135.1	134.8	139.9	140.5	89.0	90.6	92.2	101.8

Figure 9.3 on page 84 shows the TIM 110 kV bus growth trend, security level and capacity.

An initial Solution Study Report (SSR) undertaken by Transpower promotes a 220/33 kV GXP be built to extend the useful life of the T5 and T8 220/110 kV interconnectors. With us delaying the introduction of the 33 kV GXP, the interconnectors will require further examination by Transpower.

These inter–connection transformers supply the growing loads of ABY, TKA, TMK, and TIM. On occasion additional load is required to be supplied south to BPD, STU, and OAM. During the dairy season STU is tied through. A tripping of the Waitaki feed into STU will lead to the inter–connectors combined load being taken beyond their 120 MVA individual rating; options to off load T5 and T8 are given in OAI and TMK chapters.

9.4.1 Substation Growth Trend and Supply Security

The TIM 110 kV bus capacity is watched as it can run beyond firm capacity for the normal supply of ABY, TKA, TMK, and TIM. On occasion, supply to BPD, OAM, and STU could be expected from this bus as well. With the 220/110 kV inter–connection transformers at/below capacity, ongoing load growth will result in a reduction in N–1 security for certain periods.

Figure 9.3 Timaru 110 kV Bus Load Growth and Supply Security

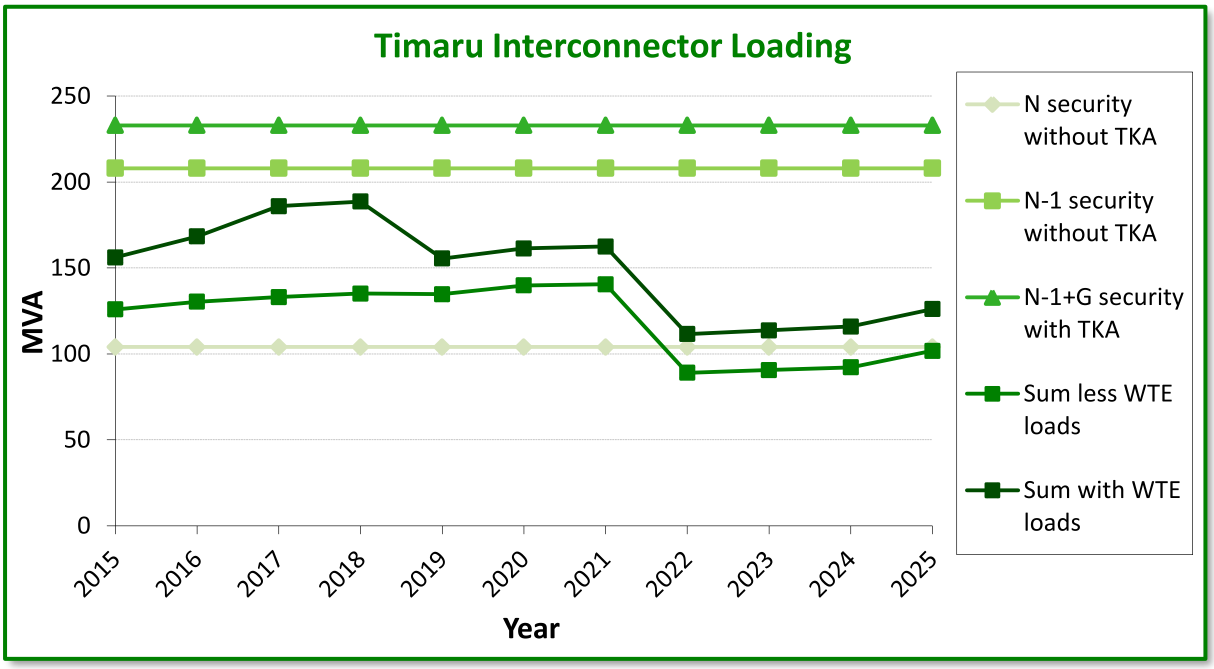


Figure 9.3 shows the introduction of Orari at year 2022. If Orari does not eventuate then the lowering of load in 2022 will not occur.

We have had recent discussions with Transpower for load to be limited through the T5 and T8 interconnectors during some maintenance periods on TKA generation. This means 5 to 10 MVA may not be able to be supplied. It seems the delays in having a solution for T5 and T8 will impact on South Canterbury. Other years may be dry with TKA constrained, or TKA is released for maintenance. The probability of a repeat of the situation is high.

Table 9.7 shows the growth trend by year for Timaru.

Table 9.7 TIM Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TIM 11 kV (Winter)	70.3	72.2	73.8	74.5	72.1	72.8	71.6	72.2	72.9	73.6	74.3

Transpower have installed three new supply transformers to run off two of these three with the third on hot standby. The TIM 11 kV GXP has plenty of capacity for the planning period, even with the known developments.

The 11 kV switch board was replaced in early 2012. The new board has been arranged to suit our needs for capacity and additional CBs to allow the new 33 kV rated sub transmission cables for the CBD to be connected and run at 11 kV for a period of some years. That is until a significant load growth is realised to justify the introduction of a 33 kV GXP.

Figure 9.4 shows the Timaru area growth trend, security level and capacity.

Figure 9.4 Timaru Area Load Growth and Supply Security

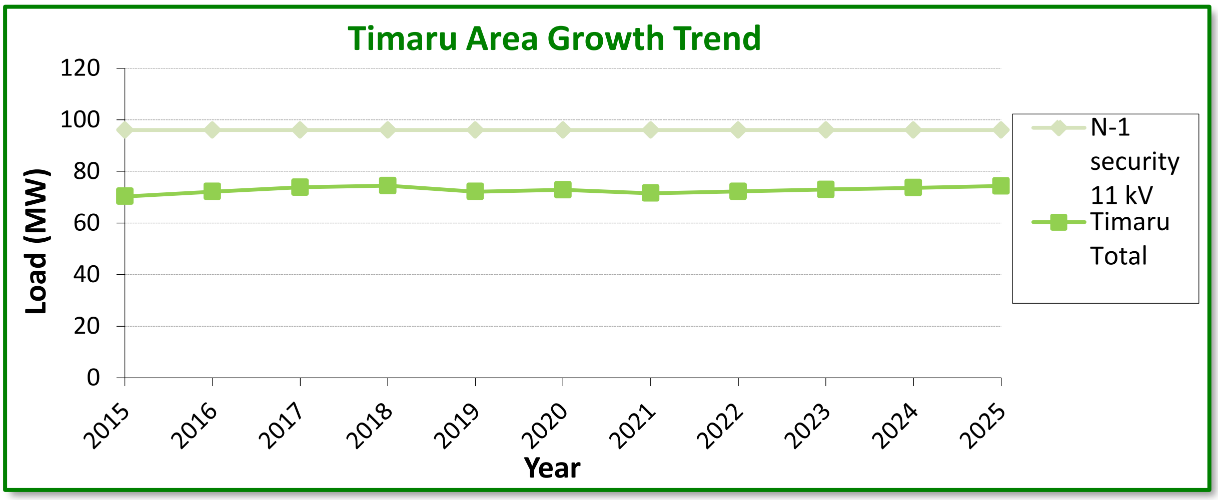


Table 9.8 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PAR	9.04	9.23	9.41	9.60	8.59	8.76	8.94	9.12	9.30	9.48	9.67
PLP	5.9	6.0	6.1	6.2	6.3	6.5	4.6	4.7	4.8	4.9	5.0

Figure 9.5 and Figure 9.6 show PAR and PLP area's growth trend, security level and capacity. PLP assumes the introduction of a zone substation in Totara Valley. See further details on Totara Valley under ABY GXP in chapter 2.

Figure 9.5 Pareora Substation Load Growth and Supply Security

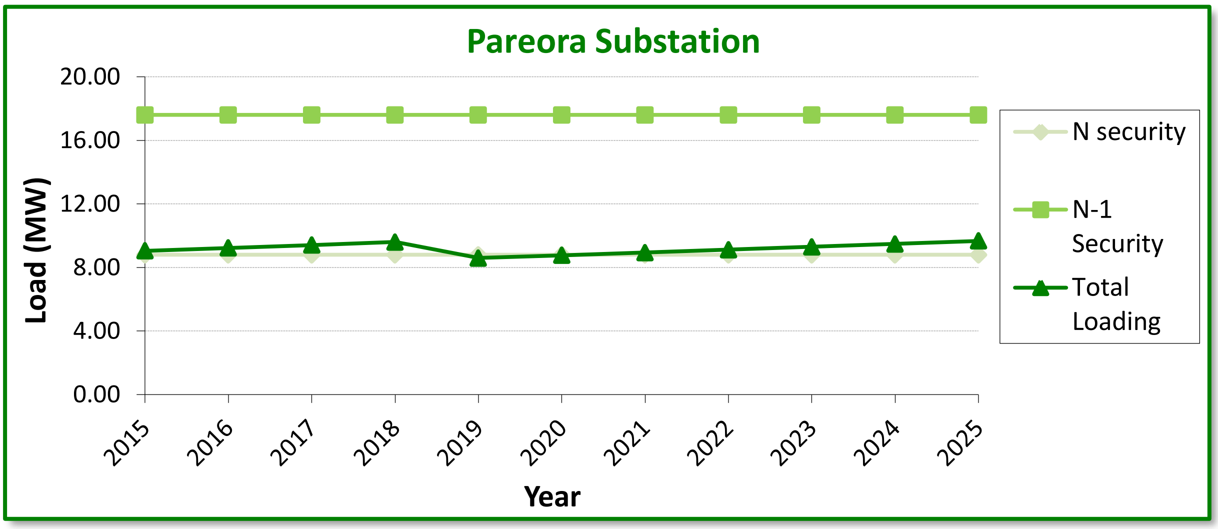


Figure 9.5 shows the introduction of St. Andrews substation at year 2022. If St. Andrews does not eventuate then the lowering of load in 2022 will not occur.

Figure 9.6 Pleasant Point Load Growth and Supply Security

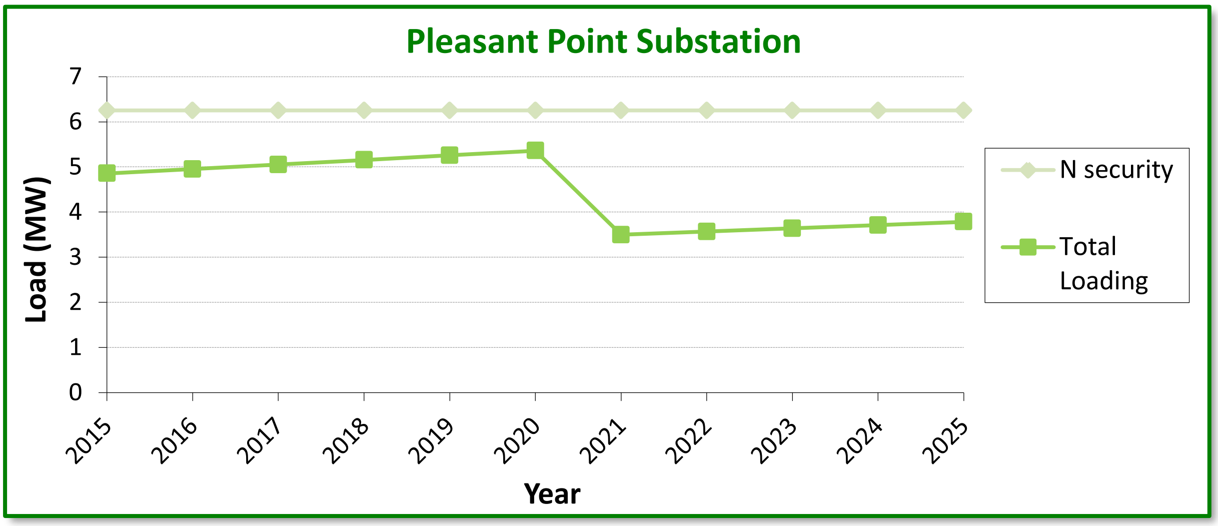


Figure 9.6 shows the introduction of Totara Valley substation at year 2022. If Totara Valley does not eventuate then the lowering of load in 2021 will not occur.

9.4.2 Rate and Nature of GXP Growth and Provisions Made

Table 9.9 summarises the characteristic of the growth and summarises the plans to meet the energy requirements of the growth.

Table 9.9 Growth and Response

Zone sub	Rate and nature of growth	Provisions for growth
TIM	High—Industrial/commercial	GXP investment
PAR	High—Dairy and irrigation	Zone substation and sub–transmission investment
PLP	High—Dairy and irrigation	Zone substation and sub–transmission investment at Totara Valley

9.4.3 Specific Developments

9.4.3.1 Timaru CBD and Residential Areas

The Timaru CBD supply is being monitored. We have postponed the introduction of a 33 kV GXP as a large load that was expected did not eventuate. Some other smaller projects are delayed.

In the meantime we have strengthened the 11 kV sub–transmission to the CBD. This was done with the use of 33 kV cables to the new NST zone substation, which in the meantime are being operated at 11 kV.

9.4.3.2 Timaru—Hunt Street

HNT was built in 1984 and is in good condition, vacuum circuit breakers (VCBs) are fitted. All the sub–transmission protection is now microprocessor based while the feeders are still electronic static type equipment. This type of board has a nominal 40 year life; replacement should be considered in 2024.

The feeder protection and control equipment is at the end of life being more than 20 years old. This is planned to be replaced in 2014/15 with SEL 751A + 55IC back up.

9.4.4 Timaru 11/33 kV Step–Up Substation

Limitations within the equipment in the Timaru step–up substation (involving; the existing 33 kV switchgear, Neutral Earthing Transformers (NETs) and protection) were originally expected to be eliminated with the proposed new 33 kV GXP at TIM. As this proposed 33 kV GXP has been delayed indefinitely it is now necessary to upgrade the existing Timaru 11/33 kV step–up substation to provide adequate protection and control for the Timaru 19/25 MVA 11/33 kV step–up transformers and the three 33 kV sub–transmission lines (PAR–TIM 1, PAR–TIM 2, and PLP–TIM).

The downstream PAR and PLP 33/11 kV substations are suitable for the immediate future. A watch is being held on PLP’s transformer.

Further studies on our Timaru 11/33 kV step–up substation are required.

9.4.4.1 PAR–TIM 33 kV Sub–transmission Lines No.1 and No.2 Upgrade

In 2010, load flows indicate that the existing 33 kV PAR–TIM line conductors were capable of delivering 6.8 and 6.9 MVA respectively for line 1 and 2 with a 6% voltage regulation, beyond this there was a marked drop in voltage leading to voltage collapse. The line should only be operated to just under 7 MVA. A five year re–conductoring exercise is being undertaken to increase the line rating to beyond 10 MVA. Re–conductoring the 33 kV lines (presently Quail/Mink) with Iodine will lift the line ratings to 10.7 and 10.1 MVA respectively.

9.4.5 Issues Arising from Estimated Demand

In December 2013 Transpower raised capacity constraints on TIM's T5 and T8 main 220/110 kV inter–connection transformers. This was identified during studies for the TKA generator release for canal repairs, we have been asked to be able to shed load for contingent events.

Notes:

10 Twizel Grid Exit Point

10.1 Introduction

Figure 1.4 at page 10, shows how Twizel GXP (TWZ) is configured with our network and Transpower's transmission network. TWZ is supplied off the 220 kV Twizel bus.

10.2 GXP Description

Similar to Tekapo, TWZ is supplied from a single source Transpower 33 kV CB feeder onto our short overhead line into its TWZ zone substation. We have an indoor 11 kV switchboard with two feeders supplying Twizel township and two additional feeders supplying the surrounding rural area.

Subdivision development is very popular and there is also potential for irrigation scheme development. However, we have not yet seen a lot of actual load growth from these initiatives. An embedded network operator is active in also providing supply to new developments in this area at two network supply points (NSP) at Manuka Terrace and Mackenzie Park.

Photograph 10.1 Twizel Village Zone Substation Maintenance—Transformer Swap–out Day

10.2.1 Critical Data

The critical GXP data shown in Table 10.1 below summarises the key physical attributes of the station, the voltages, the capacity, the security, and the power flow. We share the capacity at TWZ with Genesis Energy, Meridian Energy, and NWL.

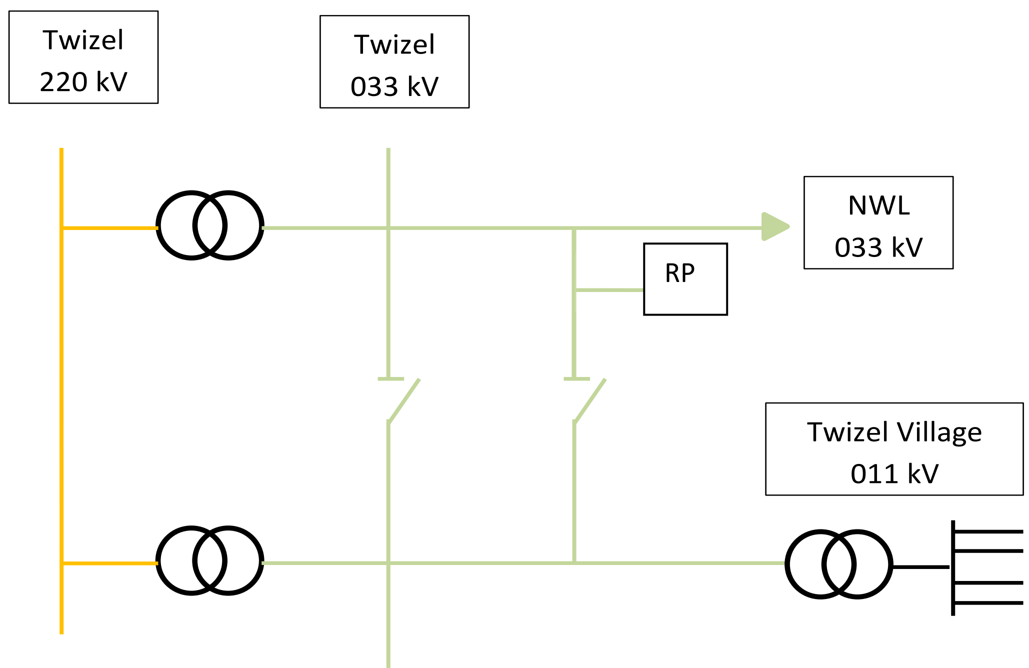
Table 10.1 Studholme Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N—1 Capacity	Demand 2014
TWZ	220 kV	33 kV	40 MVA[2]	20 MVA[3]	3.0 MW

10.3 Twizel GXP Network Information

Figure 10.1 shows the TWZ GXP area network.

Figure 10.1 Twizel GXP Area Network



10.3.1 Zone Substation Detail

Twizel is a service town that is also popular as a holiday and tourism centre, being the nearest town to Mt Cook.

At present there is a peak demand of 2.9 MVA on a 5/6.25 MVA OLTC transformer, and 1951 vintage 11 kV BTH switchgear (predominantly with Metro Vickers protection relays). The

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[2] *Note that others share the 20 MVA capacity at TWZ.*

site was handed over from the Ministry of Works toward the end of the Hydro project. All of our monitoring of the 11 kV switchgear shows it is still in serviceable condition. Some minor replacements of protection equipment were undertaken in late 2014.

The load growth that was evident before the 2009 recession has waned. We will watch the load for signs for growth resurgence before committing to any development plans for the substation.

Because a developer is interested in the land that the Twizel Village Zone Substation (TVS) is situated on, we agreed to plan conceptual redevelopment for 2014/15 with earliest possible construction in 2016. However, there are long standing issues with soil resistivity, so moving from this site with its meshed earth mat to the village ring (and possibly to Transpower's main substation) will present significant technical challenges.

We note the recent establishment of a major salmon processing plant in Washdyke instead of at Twizel.

Proposals for irrigation have been presented for the area; few on the Twizel side of the Waitaki River have proceeded, some to the south in NWL's area have been developed.

If irrigation prospects proceed, a mix of 11 kV and 33 kV supply options are available.

- Possible Pukaki Outlet 33/11 kV zone substation (estimated for 2016/17).
- Possible supply past Ohau C power station to Haldon.

Discussions with Transpower have been held to gain an additional 33 kV feeder.

Photograph 10.2 Twizel Ripple Plant

The zone substation and sub–transmission key data for Twizel shown in Table 10.2 details the major assets with respect to; rating, age, and general condition. The maximum demand at the various substations is provided. The table also details capacity constraints, the substation's communication systems back to Meadows Rd and the SCADA functions.

Table 10.2 Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
TWZ	1x 5/6.25 MVA T1 OLTC (1972) Good 1x 3 MVA (1964) Fair (off line spare)		1x 33 kV OCB (1960) Poor 8x 11 kV OCBs (1951) Fair	438 Hz Landis and Gyr (shared with NWL, but we have no effective access)

Sub–Transmission Line	Make Up	Limit at 6% p.d. (MVA)	Limit of Conductor at 50°C (MVA)	Limit of Cable (MVA)	Lowest Limit
TVS–TWZ	Dog	82.48	12.6		12.6

Area of Network with Constraint	Capacity Constraint	Description	Intended Remedy
Twizel GXP	None		
Twizel Village Sub (TVS)	None		

Communications	VHF	UHF Analogue	UHF Digital	Fibre Optic
TVS	VHF for voice traffic	TVS–MRC MRC–WDK		None

SCADA	Supervision	Control	Automation	Data Acquisition
TVS	Current, voltage and CB status at TVS. Security at TVS	TVS CB control. TVS pilot wire control.	Auto reclosing CB	Load data at TVS

TVS connects via radio systems detailed under communications in Table 10.2. A radio was being established at TVS–TWZ for ripple plant control, the project waned when the ripple plant was found to be unsuitable for both NWL and our use. For TVS SCADA consists of L&N C68 RTU equipment.

The legacy RTU and analogue UHF radio comms may be replaced in 2015 with more modern digital equipment when the same type of equipment at TEK is replaced as both TVS, and TEK substations use the same leased UHF radio link equipment at Mt Rollesby.

Table 10.3 lists the existing level of security at the substation and justifies any shortfall.

Table 10.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
Twizel CBD	N—0.5	N—0.5	No alternate supply to station. Limited 11 kV rings. Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.
Twizel Rural	N	N	Limited fault backup Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

The estimated demand listed in Table 10.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 10.5.

Table 10.4 TVS Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10 year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
TVS	3.3 (shoulder)	2.26% historic on TWZ Residential load, large scale subdivision, dairy and irrigation development.	4.2 (shoulder)	Possibly rebuild substation in conjunction with developer to free land. Extend 33 kV line to new irrigation development and install smaller dedicated substations.

10.4 Development of GXP and Substations

Figure 10.2 shows the TWZ load growth.

Figure 10.2 Load Growth for Twizel GXP

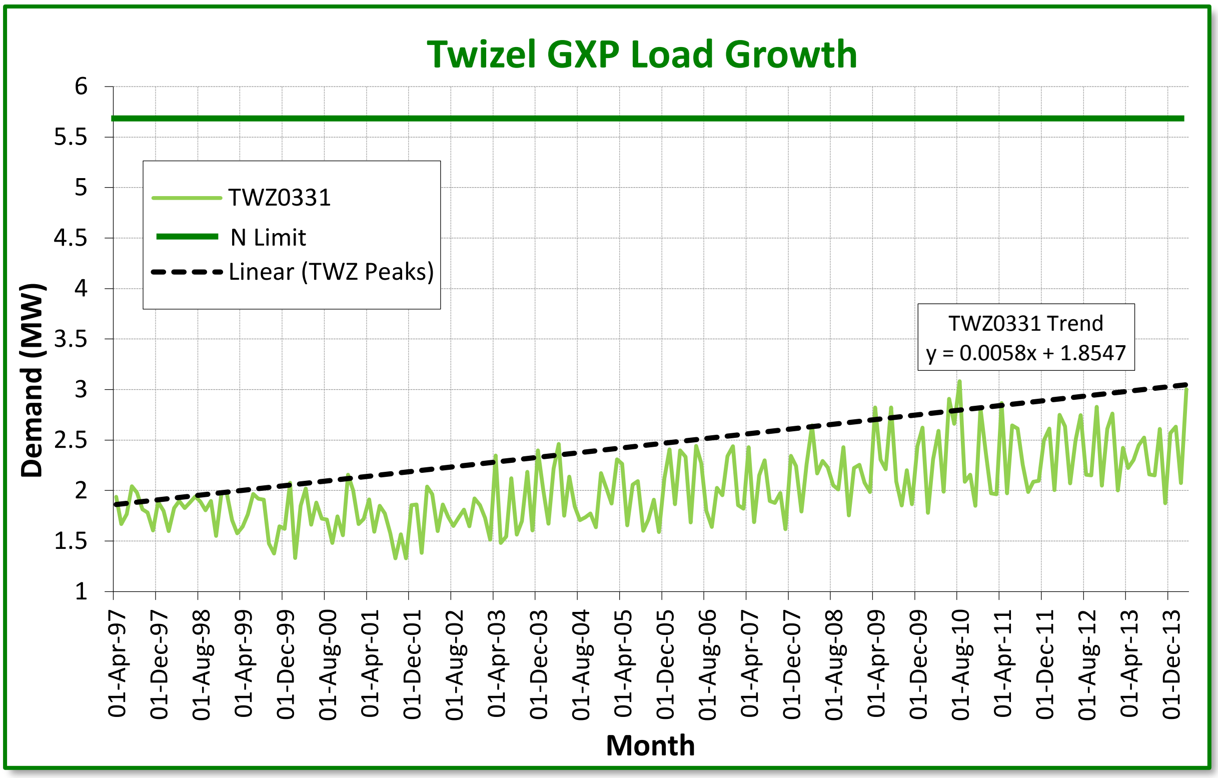


Table 10.5 shows the growth trend to the year 2025.

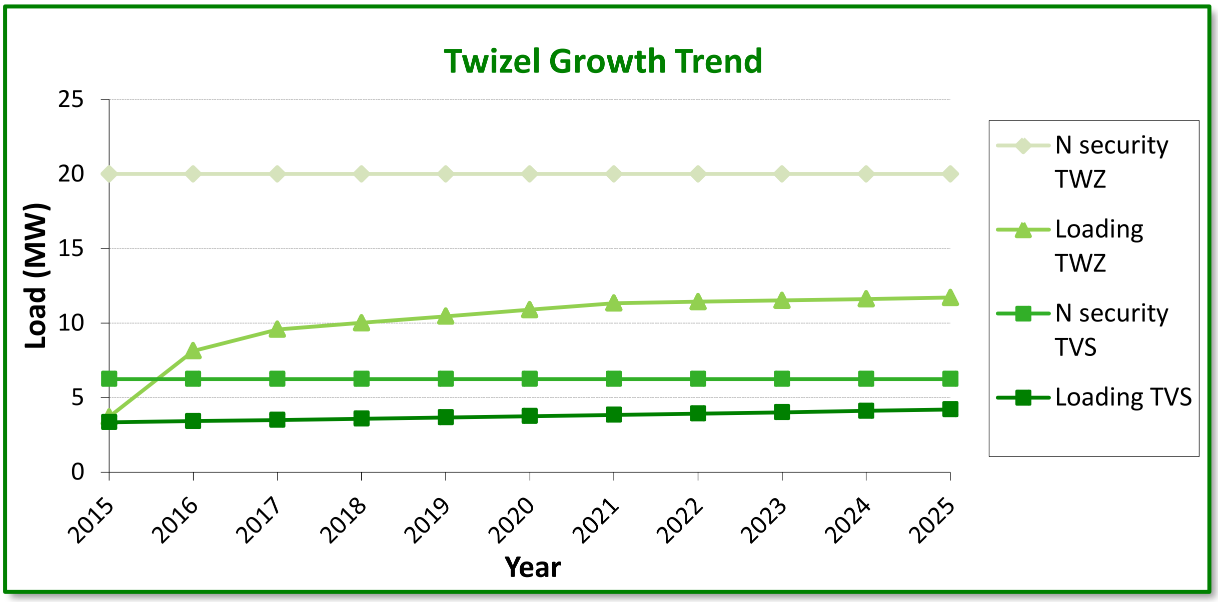
Table 10.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
TWZ Sum (Autumn/ Spring)	3.2	3.7	8.1	9.5	9.9	10.4	10.8	10.9	10.9	11.0	11.1
TVS Village	3.7	8.1	9.6	10.0	10.5	10.9	11.3	11.4	11.5	11.6	11.7
Irrigation on 33 kV	0.4	4.7	6.1	6.4	6.8	7.1	7.5	7.5	7.5	7.5	7.5

Note—the 20 MVA firm capacity is shared with Meridian Energy and NWL.

Figure 10.3 shows the TWZ area growth trend, security level and capacity.

Figure 10.3 Twizel Area Load Growth and Supply Security



Note—others share the 20 MVA capacity at TWZ.

The load growth in Twizel in the tourism sector has stagnated with a slight reduction in peak demand. The highest loads occur on the autumn and spring holiday weekends, dependent on the weather at the time.

There have been a couple of enquiries for irrigation but we are uncertain about their prospect of being established and as a result they have been pushed back to 2016. Indications so far would point toward these being remote from the TWZ substation so would need a new zone substation established for them. The 11 kV distribution would be too light to carry the load being indicated. The prospects are not firm enough yet to know what will be done with the fodder grown.

Salmon farms and processing have an impact on the load, however the Twizel based processing factory (Aoraki smokehouse, Hooker Crescent) has been closed down, and relocated to Christchurch. The new plant at Washdyke (Mt Cook Salmon) has now been completed.

TVS zone substation has a suitably rated transformer at 5/6.25 MVA. The transformer is fitted with an on–load tap changer (OLTC) which is important as the TWZ 33 kV bus swings with differing generation patterns.

10.4.1 Substation Growth Trend and Supply Security

The TWZ supply is made via a single 33 kV line, some tying ability to a NWL 33 kV line is available, and vice versa, to give some security of supply from the TWZ 33 kV bus. The installed capacity is shared with two other companies. We do not know fully about the other companies' intentions and assumes the supply capacity is secure for the planning period.

10.4.2 Rate and Nature of GXP Growth and Provisions Made

Table 10.6 describes the rate and nature of growth at the GXP level as well as provision for growth.

Table 10.6 Growth and Response

GXP	Rate and nature of growth	Provisions for growth
TWZ	Med—Rural and subdivision	GXP investment

10.4.3 Specific Developments

10.4.3.1 Twizel GXP Development

Transpower's TWZ 33 kV GXP bus is run split, and is fed from two 20 MVA OCTC 220/33 kV transformers. The 33 kV bus was originally split as the 33/11 kV construction transformers for the hydro were not able to withstand the full fault level. Transpower suggests the split avoids incidences on the 33 kV bus, causing instability on the 220 kV bus. There is no 33 kV bus coupler or bus bar protection so running the bus tied would be problematic during a fault.

Our supply is not as secure as a tied bus arrangement, but this has been of little concern as the outage rate is very low. If a supply transformer is lost or released Transpower can easily tie the two bus halves to the remaining transformer.

A sole 33 kV feeder is taken from the TWZ switching station to the TVS zone substation on the edge of Twizel. Preliminary discussions have been held with Transpower regarding the option of taking a second feeder.

The taking of a second feeder is not straight forward as the Transpower split of the 33 kV bus will inhibit either:

i) the ability for use to run a solid bus should supply be taken from either side of the Transpower bus, or
ii) bus tying in the zone substation as we may end up with a slightly less secure supply if both feeders are connected to the same side of the bus.

Transpower is in agreement that if we fit suitable protection at the far end of the feeders with back–feed protection then, a tie would be allowed in our zone substation.

More analysis is required to determine the best path forward for Twizel.

Prior to set off, a view on how quickly the loads may be growing will have to be established from both the residential and irrigation demands. Transpower has programmed to investigate moving the 33 kV outdoor switchgear indoors. At that time a second 33 kV feeder to TVS substation would also be evaluated.

Any project at Twizel will be funded via a new investment agreement with Transpower.

10.4.3.2 Twizel Zone Sub Development

Please refer to Zone Substation Detail on page 90.

10.4.3.3 Ripple Plant Upgrade

A shared ripple plant had been established at TWZ with NWL. Its frequency is equal to NWL's as it holds the larger population of ripple receivers. With the TWZ 33 kV bus being run split and NWL being on the 'other side' we have not been able to use the plant. This is because the plant does not have sufficient power to pass signal through T18 and T19. Future ripple plant development will in time allow time clocks at TWZ to be replaced with more reliable ripple relays and security for load control in the Waitaki area.

10.4.4 Issues Arising from Estimated Demand

We have an N security supply at TWZ with ability to tie to NWL's feeder or to provide a reciprocal connection in case of NWL loss.

Transpower can also tie its 33 kV bus to connect our feeder to the alternate GXP transformer.

Our attempt to gain a second feeder from Transpower proved uneconomic so will be reviewed when Transpower replaces the outdoor 33 kV switchgear with indoor.

Notes:

11 Waihao Grid Exit Point

11.1 Introduction

Figure 1.5 page 11, shows how the proposed Waihao (WHO) GXP would be configured on the ISL–LIV 220 kV Line.

11.2 GXP Description

WHO is proposed to allow supply to the increasing loads in the Waimate district. WHO would supply BPD, CNR and STU (Waimate). The net capacity off loaded from the grid at BPD, and STU will be requested to be supplied at STA (for details see chapter 5).

WHO's transformers will primarily drop 220 to 110 kV. These transformers have a stabilising winding which will be configured to 11 kV and supply a bus for local 11 kV distribution.

We had been working with NWL, and Transpower on an alternate supply into the Lower Waitaki Valley area; Transpower have offered a connection to the ISL–LIV 220 kV circuit with a limit of 50 to 70 MVA. This would not be until the OAI 220 kV bussing project is built, only then will more capacity be available. The loads that we envisage total more than the initial limit, so the timing of OAI's construction is important to enable the completion of certain projects within South Canterbury.

If we were to have shared the new Livingston GXP with NWL, both would have to agree on the same bus potential. With us focussing on 110 kV and NWL on 66 kV there is no commonality.

Another option was explored to establish the new shared GXP at Stone Wall; this became less attractive to NWL as it moved further from NWL's load centres. It also did not suit us to supply the burgeoning STU site due to long line lengths and volt drop issues.

Establishing a GXP in the Waihao area becomes more beneficial to us with it being more central to BPD, and STU. An initial study of the three options shows this to be the most cost efficient to us.

NWL have slowed up its need by some years for a new GXP at Livingston, as the WTK GXP is being reconfigured to offload NWL's existing asset to some degree.

11.2.1 Critical Data

The critical GXP data shown in Table 11.1 summarises the potential physical attributes of the station, the voltages, the capacity, the security, and the power flow.

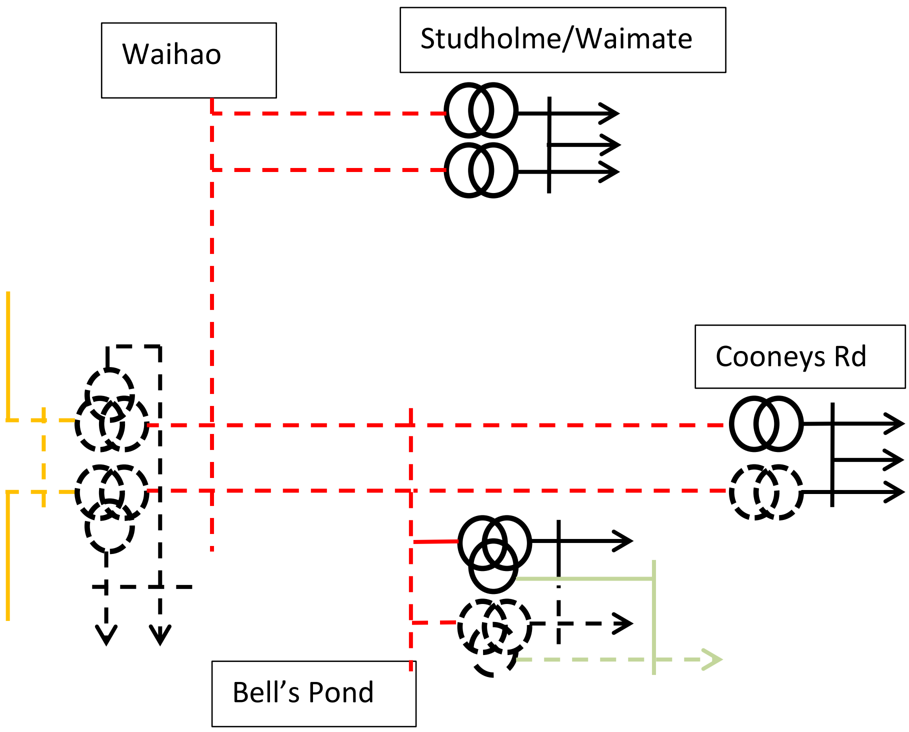
Table 11.1 Orari Zone Substation Key Data

GXP	GXP Transmission Potential	GXP Point Of Supply Potential	Capacity	N–1 Capacity	Demand 2015
WHO	220 kV	110 kV	Approx. 80 MVA	100 MVA	0 MW

11.3 Waihao GXP Network Information

Figure 11.1 shows the WHO GXP area key assets. The WHO GXP would deliver 110 kV sub–transmission and local 11 kV distribution.

Figure 11.1 Waihao GXP Area Network



11.3.1 Waihao Zone Substation Detail

The zone substation key data shown in Table 11.2 details the major assets to be established at WHO. The communication systems are also described.

Table 11.2 Waihao Zone Substation Key Data

Zone Substation Site	Transformer	Regulator	Switchgear	Ripple Plant
WHO			To be established	Zellweger 317 Hz to be established
Communications	**VHF**	**UHF Analogue**	**UHF Digital**	**Fibre Optic**
WHO	VHF for voice traffic	None	WHO–MEC MEC–CHC CHC–NST or WDK	TBA

WHO SCADA systems would adopt the technology of the time.

Table 11.3 lists the existing level of security at the substation and justifies any shortfall.

Table 11.3 Security Level

Security Level			
Zone Sub/Load Centre	**Actual**	**Target**	**Shortfall from Target**
BPD, CNR & STU	N–1	N–1	Encourage consumers to be self–sufficient for their essentials. As for CD emergencies.

The estimated demand listed in Table 11.4 shows the aggregated effect of substation demand growth for a 10 year horizon incorporating the anticipated step changes detailed in Table 11.5.

Table 11.4 Estimated Demand at Zone Substation Level

Estimated Demand				
Zone Sub Site	**2015 MW**	**10–year Rate and Nature of Growth**	**2025 MW**	**Provision for Growth**
WHO	0 (summer)	3.6% per year expected at Waihao as per present growth at STU and BPD.	76 (summer)	Build to suit 10 year forecast.

11.4 Development of GXP

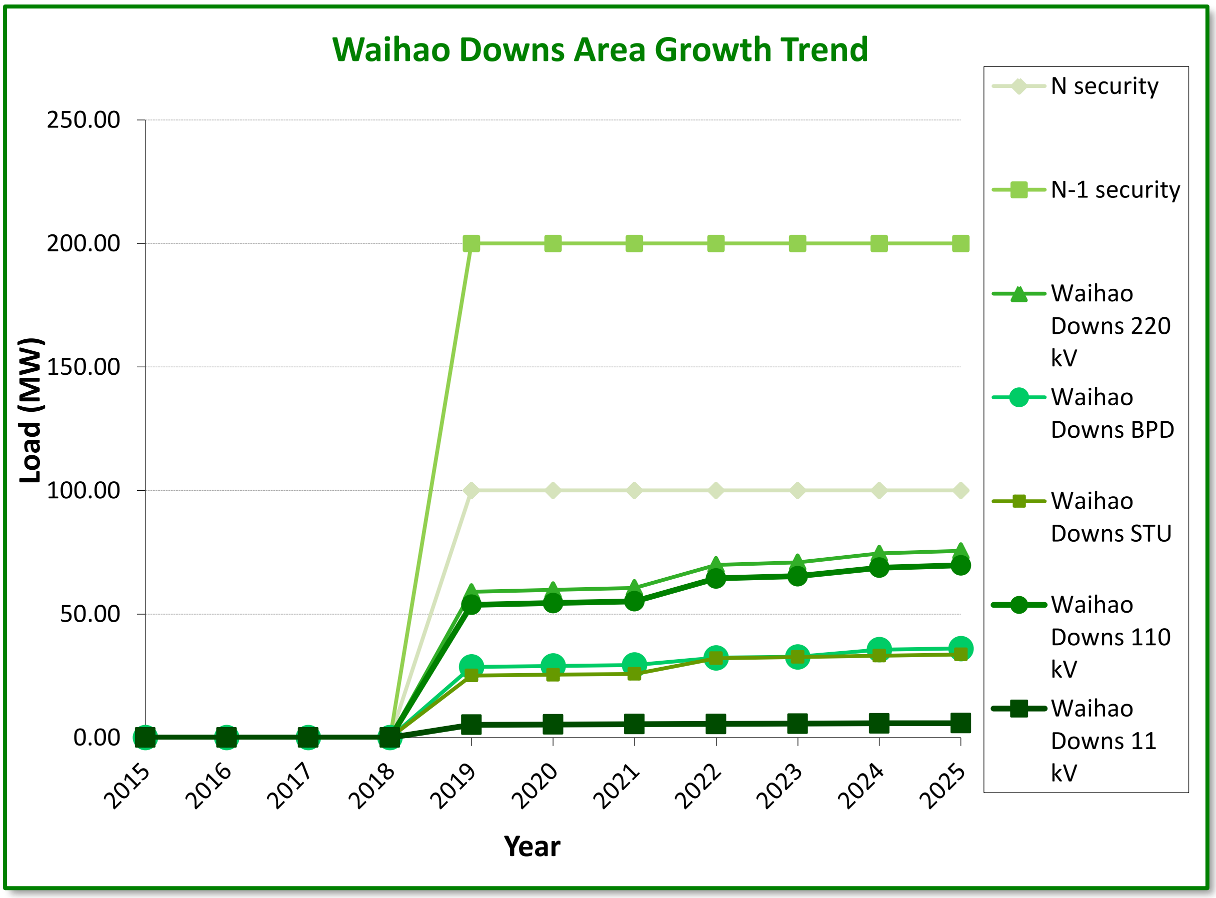
Table 11.5 shows the growth trend to the year 2025 at Waihao. The main load growth is as a result of the Hunter and Waihao Downs Irrigation schemes, and dairy factory load growth to be picked up by us.

Table 11.5 Substation Load Growth

GXP Substation (Season Peak)	Growth Trend (Total MW MD)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
WHO (Summer)	0.00	0.00	0.00	0.00	59.11	59.93	60.76	70.11	71.13	74.67	75.74

The date of introduction needs to be scheduled with load growth and demand need. Figure 11.2 plots the WHO load growth.

Figure 11.2 Waihao Growth Trend



12 Glossary

The following acronyms and abbreviations are used throughout the Major Network Asset Management Plan.

A	—	Ampere
ABY	—	Albury grid exit point/zone substation
AMP	—	Asset Management Plan
AVR	—	Automatic Voltage Regulator
BML	—	Balmoral zone substation
BPD	—	Bell's Pond grid exit point/zone substation
Bus	—	Bus Bars
CB	—	Circuit Breakers
CBD	—	Central Business District
cct	—	Circuit
CD	—	Civil Defence
CD1	—	Clandeboye No.1 substation
CD2	—	Clandeboye No.2 substation
CNR	—	Cooneys Road zone substation
CNL	—	Canal Road
CT	—	Current Transformer
Consumer	—	A person that consumes electricity from our network, or acquires electricity lines services
Customer	—	A body which we have a direct contractual relationship with, in the form of a user of supply agreement
Dyn11	—	Transformer Vector Group
FLE	—	Fairlie zone substation
GLD	—	Geraldine Downs zone substation
GRM	—	Grasmere
GTN	—	Glentanner zone substation
GWh	—	Giga Watt hours
GXP	—	Grid Exit Point
HDI	—	Hunter Downs Irrigation scheme

HLB	—	Haldon/Lilybank zone substation
HNT	—	Hunt Street zone substation
Hz	—	Hertz
IED	—	Intelligent Electronic Device
ISL–LIV	—	Islington Livingston
kV	—	kilo Volt
LOS	—	Loss of Supply
LV	—	Low Voltage
MDC	—	Mackenzie District Council
MVA	—	Mega Volt Ampere
MW	—	Mega Watt
NER	—	Neutral Earthing Resistor
NET	—	Neutral Earthing Transformer
NSP	—	Network Supply Points
NST	—	North Street zone substation
NWL	—	Network Waitaki Limited
N—1	—	Reliability measure, where N systems can lose one element and still function normally
OAI	—	Orari grid exit point
OAM	—	Oamaru
OCB	—	Oil Circuit Breaker
OCTC	—	Off Current Tap Changer
ODL	—	Oceania Dairy Limited
OLTC	—	On Load Tap Changer
OPU	—	Opuha Power Station
PAR	—	Pareora zone substation
p.d.	—	Potential Difference
PD	—	Partial Discharge
PILC	—	Paper Insulated Lead Cable
PILCSWA	—	Paper Insulated Lead Steel Wire Armoured Cable
PLP	—	Pleasant Point zone substation

POS	—	Point of Supply
RGA	—	Rangitata zone substation
RMU	—	Ring Main Unit
RTU	—	Remote Terminal Unit
SCADA	—	Supervisory Control and Data Acquisition
SEL	—	Schweitzer Engineering Laboratories
SSR	—	Solution Study Report
STA	—	St. Andrews grid exit point/zone substation
STU	—	Studholme grid exit point
TDC	—	Timaru District Council
TEK	—	Tekapo Village zone substation
TIM	—	Timaru grid exit point/step-up zone substation
TKA	—	Tekapo grid exit point
TMK	—	Temuka grid exit point/zone substation
TP	—	Transpower
TVS	—	Twizel Village zone substation
TWZ	—	Twizel grid exit point
UHF	—	Ultra High Frequency
UHT	—	Unwin Hut zone substation
V	—	Volts
VCB	—	Vacuum Circuit Breaker
VHF	—	Very High Frequency
W	—	Watts
WDC	—	Waimate District Council
WHO	—	Waihao grid exit point
WTE	—	Waimate zone substation
WTK	—	Waitaki
XLPE	—	Cross Linked Polyethylene Cable

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