Regional Energy Transition Accelerator Tairāwhiti & Wairoa Electricity Capacity Availability

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Abbreviations

Abbreviation	Detail
AAC	All Aluminium Conductor
ACSR	Aluminium Conductor Steel Reinforced
AMP	Asset management plan
EECA	Energy Efficiency and Conservation Authority
FHL	Transpower Substation, Fernhill
GIP	Grid injection point (Transpower)
GXP	Grid exit point (Transpower)
NIPS	North Island Power System
RDF	Transpower Substation, Redclyffe
RETA	Regional Energy Transition Accelerator
SO	System Operator
TUI	Transpower Substation, Tuai

1 Executive Summary

This report provides an assessment of the electricity supply capacity in the Tairāwhiti and Wairoa Districts which includes the Firstlight Network, and the interface with the only grid exit point in the region, Tuai Substation, owned by Transpower.

The review, undertaken by ElectroNet engineers, with the support of asset management team members of Firstlight Network, was conducted during May and June 2023. Detailed assessments relating to specific load connections were completed in September and October 2023. Further to the direct support provided, publicly available information was referenced.

When considering load and limitation of circuits associated with temperatures during different seasons, and the Transpower special protection scheme, the results of the study show that there is a conservative maximum capacity of approximately 49 MW (N-1) available at the Tuai 110 kV bus, considering the 2023 load year forecast. This decreases over the projected 15-year period, where due to general growth within Hawke's Bay, no capacity is predicted to be available by 2037. Transpower is planning to increase capacity to mitigate this ahead of time.

In 2019, studies regarding load growth in the Tairāwhiti district were undertaken [2]. Conclusions provided state that the existing 110 kV Tuai to Gisborne circuits are at, or close to thermal capacity limits. This is the single most impactful constraint on the Firstlight Network for the entire Tairāwhiti district.

The report [2] presented options for potential upgrades, with the aim of catering for projected load growth in the area. The study concludes that the existing circuits to Wairoa Substation, from Tuai, are underutilised. These 110 kV circuits are suitable to cater for projected growth in the Wairoa district. Research undertaken in this project support the findings in respect of both Gisborne and Wairoa.

50 kV zone substation, Wairoa has > 9 MVA of N capacity available for all seasons but does not achieve N-1 security. 50 kV zone substation, Gisborne has between ~3 MVA (winter) and 19 MVA (summer) of N-1 capacity available.

The Wairoa district part of the network has a single circuit of 50 kV only, connecting Waihi generator (5 MW) site to Kiwi Zone Substation. The rest of this network is a mixture of 33 kV and 11 kV distribution.

There are three main parts to the 50 kV network from Gisborne zone substation (Island Ring, Urban Ring, Coast Spur), which supply the rest of the Tairāwhiti district zone substations. Under normal conditions the 50 kV network has capacity of greater than 8 MVA on all circuits in all seasons.

Most of the zone substations have some transformer capacity available. Substations such as Te Araroa and Tokomaru Bay to the north, and Puha, inland from Gisborne have the least capacity available, ranging from 1.2 MVA to 1.5 MVA (N) in winter, which is the period of the year with the highest demand.

A high-level review of capacity of 11 kV feeders across the region was reviewed for the winter period. A mixture of conclusions was drawn. In most cases, there is no capacity available for some parts of a circuit. In some cases, there is no capacity available anywhere on a circuit. Limitations established were related to both thermal rating of conductors, and the voltages across circuits.

Considering the above, connection options and -50/+100% cost estimation has been developed for the RETA demand side projects. In several cases, there is upstream limitation which will inhibit the ability to provide the desired capacity, or electrical security without further upgrade work by Firstlight. For some options, we have suggested that the most feasible option may be to establish a new zone substation, utilising the capacity on the 50 kV network. Irrespective of this, and as previously mentioned, the major constraint into the region, is the 110 kV capacity available, at least for the next few years before upgrades are complete.

2 Introduction

The Regional Energy Transition Accelerator (RETA) is a programme being run by the Energy Efficiency and Conservation Authority (EECA). The aim of the programme is assisting medium to large energy-using businesses and public sector organisations with potential solutions to reduce their carbon emissions [3].

EECA has led this initiative in the South Island, originally piloted in the Southland region. RETA is now continuing across the North Island.

This project focuses on the Tairāwhiti and Wairoa districts which includes the entirety of the Firstlight Network (formally known as Eastland Network). The extent of the Firstlight Network shared across the districts as shown below in Figure 1. There is one grid exit point at Transpowers' Tuai Substation, located within the Wairoa district.

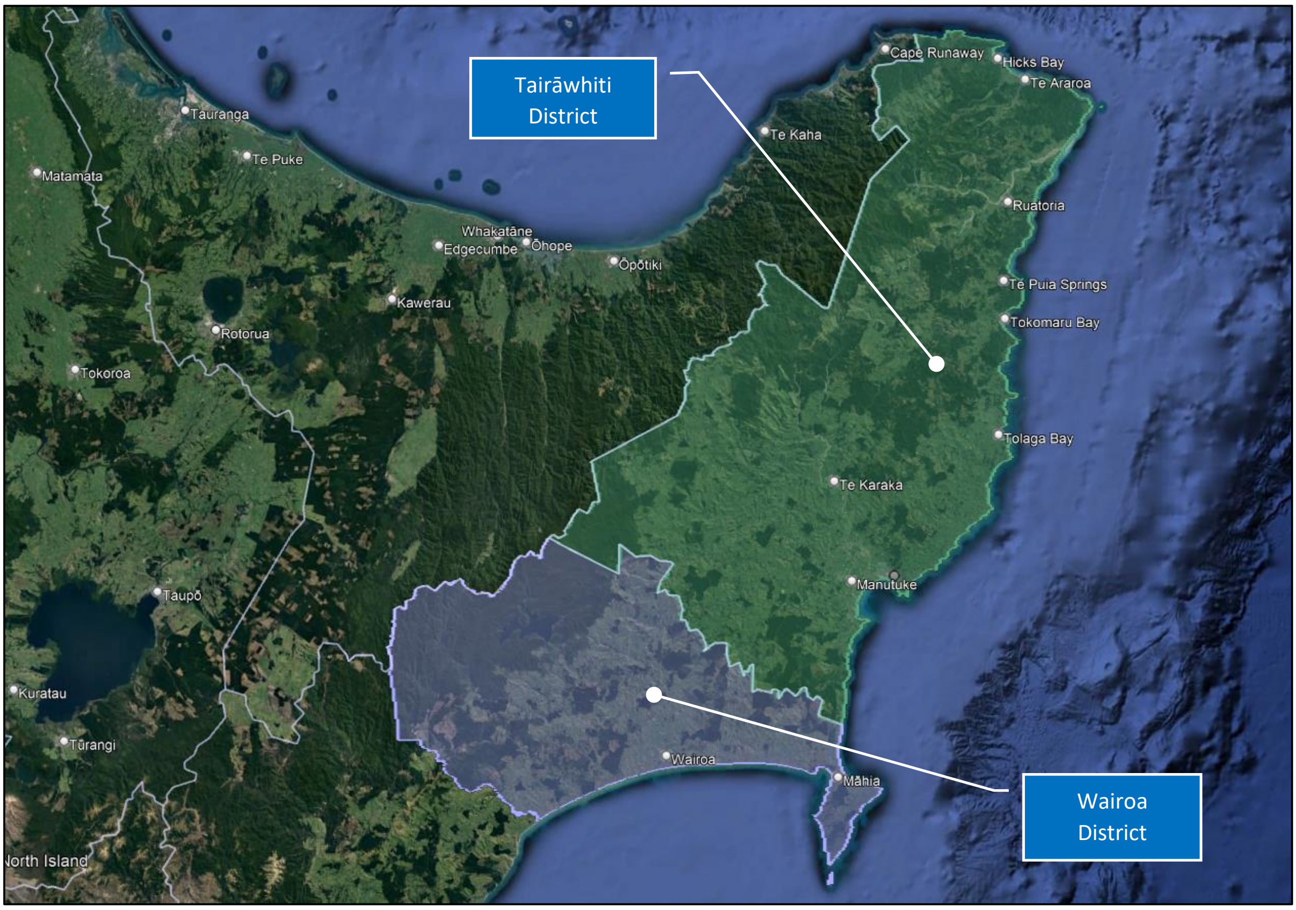

Figure 1: Tairāwhiti and Wairoa Districts

This report discusses our assessment of the electricity capacity availability in the Tairāwhiti and Wairoa Districts. The work was developed in parallel with scope by others to establish electrification load conversion opportunities.

Within the Tairāwhiti District, there are 16 Zone Substations. The northernmost near Te Araora (Te Araroa Substation) and the southernmost on Pehiri Road (Pehiri Substation). Several zone substations are in or surrounding the Gisborne area.

Within the Wairoa District, there are seven Firstlight Network zone substations. Tuai Substation is fed from the Transpower grid exit point (GXP), also called Tuai (TUI).

A list of the zone substations across the network is shown in Table 1.

Table 1: Firstlight Network Zone Substations

	Substation	District		Substation	District
1	Gisborne	Tairāwhiti	13	Ngātapa	Tairāwhiti
2	Te Araroa	Tairāwhiti	14	Puha	Tairāwhiti
3	Ruatoria	Tairāwhiti	15	JNL	Tairāwhiti
4	Tokomaru	Tairāwhiti	16	Matawhero	Tairāwhiti
5	Tolaga Bay	Tairāwhiti	17	Tuai	Wairoa
6	Kaitī	Tairāwhiti	18	Wairoa	Wairoa
7	Port	Tairāwhiti	19	Wairoa-Mahia	Wairoa
8	Carnarvon	Tairāwhiti	20	Kiwi	Wairoa
9	Parkinson	Tairāwhiti	21	Blacks Pad	Wairoa
10	Makaraka	Tairāwhiti	22	Tahaenui	Wairoa
11	Pātūtahi	Tairāwhiti	23	Waihi	Wairoa
12	Pehiri	Tairāwhiti			

3 Transmission Network and Grid Exit Point

At the time of writing this report, the regional transmission network shown within Figure 2 (Section 3.1.1) is operating in a non-standard arrangement temporarily, due to impacts of Cyclone Gabrielle, February 2023. We understand that the temporary network configuration will likely be remedied ahead of load conversion opportunities being implemented. Our assessment therefore assumes a pre Cyclone Gabrielle network configuration.

There is one GXP in the region. Transpower's Tuai Substation is located within the Wairoa District. This is the single interface between Transpower and the distribution network.

3.1 Methodology to Review Transmission Network Capacity

The Transpower North Island Power System model (NIPS v1.4.8 EMI) was referenced to allow us to review the seasonal transmission capacity available. The default study cases included within the model were used, along with two additional cases looking at an outage of the Waikaremoana generation scheme at peak and minimum load.

For each study case:

1. A dummy load was connected to the Tuai 110 kV bus.
2. The dummy load active power consumption was increased until any monitored component (lines and transformers) exceeded its thermal rating. This gave the N capacity limit.
3. This process was repeated for contingency (N-1) scenarios. This gave the N-1 capacity limit.

The following contingency scenarios were studied:

1. Loss of any single 220/110 kV interconnecting transformer in the Hawke's Bay region.
2. Loss of any single 110 kV circuit into Tuai.

3.1.1 Connection Arrangement

Transpower's transmission network extends to Tuai Substation (TUI) at 110 kV within the Wairoa district. There are two 110 kV transmission lines supplying TUI, one from Redclyffe (RDF), and one from Fernhill (FHL). These lines carry a total of three 110 kV transmission circuits, two from RDF and one (doubled bonded) from FHL. The 110 kV system is connected to the 220 kV system via the two 220/110 kV interconnecting transformers at RDF.

Refer to Figure 2 below [4, p. 230] for the normal connection arrangement.

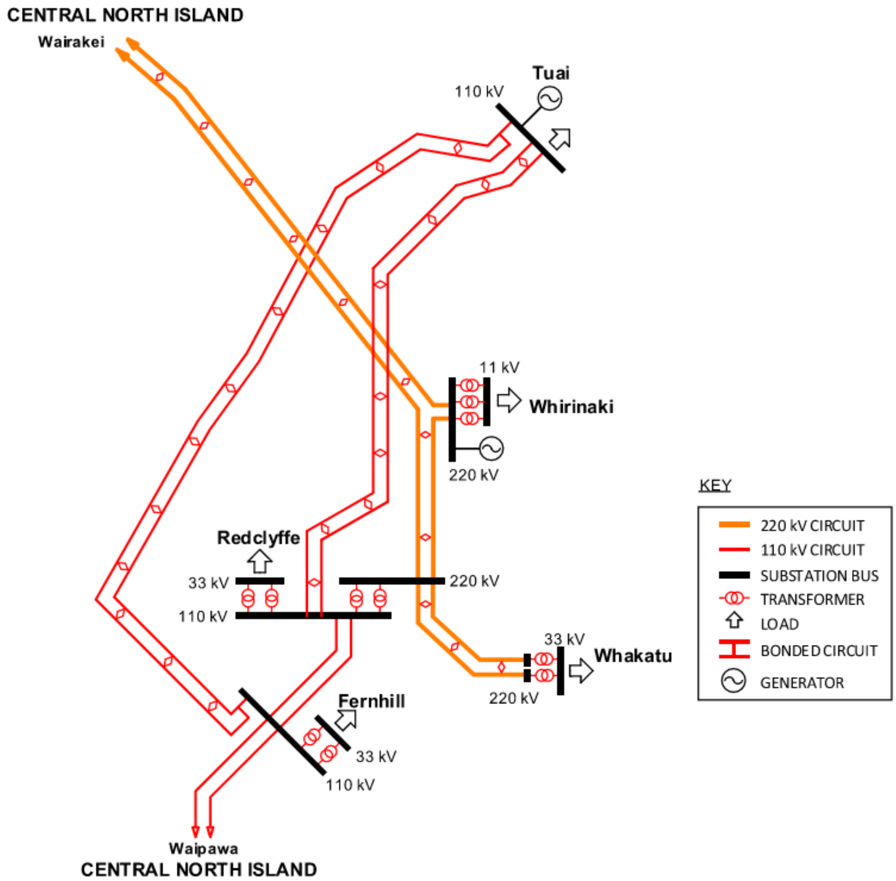

Figure 2: Hawke's Bay Region Transmission Schematic

3.1.2 Annual Peak Demand for the Region

The Transpower planning report refers to the annual peak demand in respect of the three substations noted in Section 3.1.

Table 2 shows the projected load growth for Tuai and related Hawkes Bay GXP substations to 2037 [4, p. 233].

Table 2: Forecast Annual Peak Demand (MW) at Hawke's Bay GXPs to 2037

		Peak Demand (MW)										
Grid Exit Point	**Power Factor**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2037**
Tuai	1.00	66	67	69	70	72	73	75	76	78	79	87
Fernhill	0.98	69	70	74	74	76	77	77	78	79	80	85
Redclyffe	0.99	67	69	71	72	74	75	75	76	77	78	81

Note:

1) 2022 source information is omitted from this table. Up to date loading has been obtained from NIPS.

Transpower refers to possible upgrades to the existing configuration as noted in Figure 2 in 2037 [4, p. 231] at Tuai and Fernhill. The upgrade considered, new assets, upgraded assets, and assets scheduled for replacement.

Tuai Substation is located at the northern end of Lake Whakamarino, within the Wairoa District. See Figure 3.

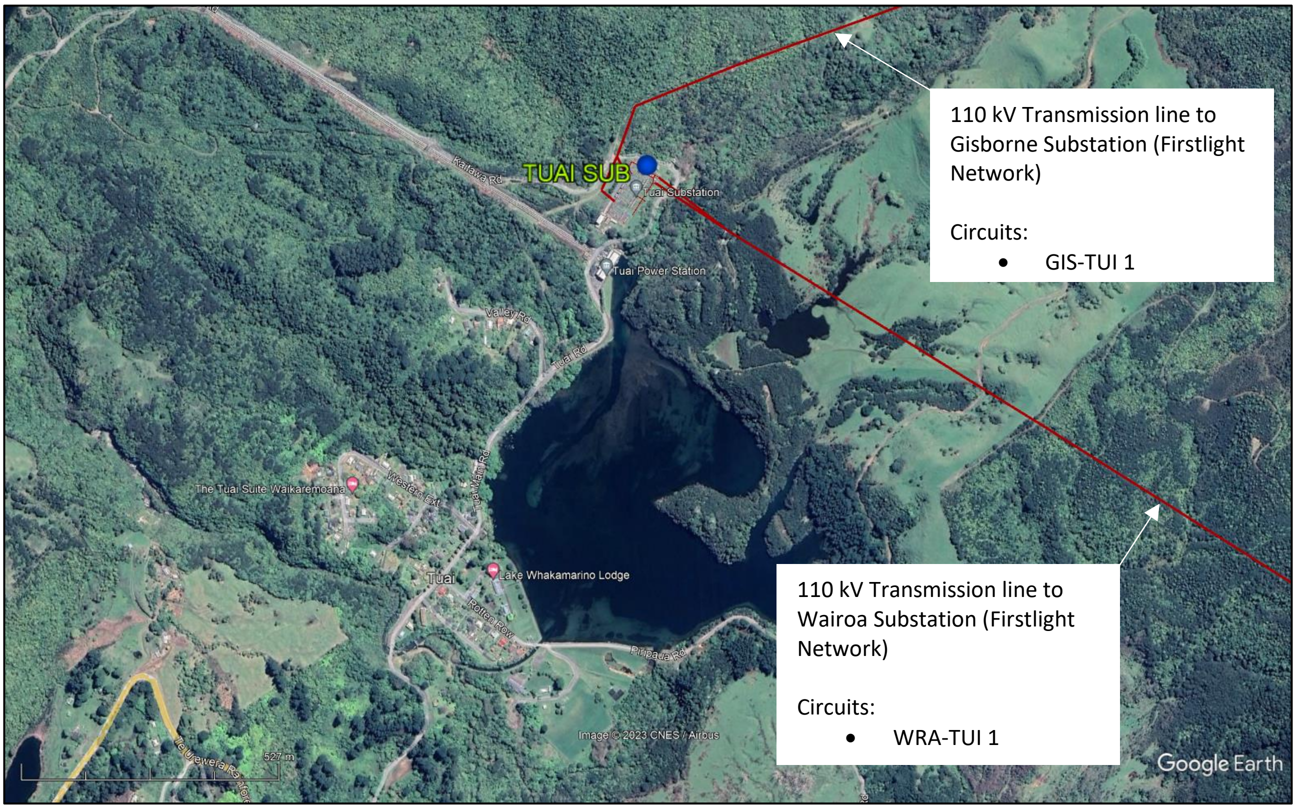

Figure 3: Tuai GXP Substation Location

Section 3.2 discusses the Firstlight Network.

3.1.3 Security of Supply Definitions

Transpower defines service levels within the Transpower Service Framework. These are presented below in Table 3 [5, p. 24].

Table 3: Transpower Security of Supply Definitions

Definition	Description
N Security Sites	A connection point that does not have redundancy in the event of a primary equipment (line, transformer) outage. Typically, these are smaller rural Points of Service.
N-1	A defined reliability standard whereby the failure of a major transmission component (circuit, transformer), does not interrupt supply to end consumers. Transpower's core transmission network is required to be operated to N-1.

3.2 Transmission Network Summary

3.2.1 Existing Capacity

Table 4 has been developed from output of the 2022 NIPS model. Study cases have been run per the following definitions:

Summer Light: load at regional trough, during summer months.
Summer Peak: load at regional peak, during summer months.
Winter Peak: load at regional peak, during winter months.

Table 4 provides the spare capacity presently available at Tuai grid exit point.

Table 4: TUI110 Additional Load Capacity Study Results for 2023

Study case	N available capacity (MW)	N Limiting components	N-1 available capacity (MW)	N-1 spare capacity available SPS active 2) (MW)	N-1 limiting components
Summer Light	101	RDF SO limit 1)	59	74	RDF-TF-T3 RDF-TF-T4
Summer Peak	49	RDF SO limit 1)	6	49	RDF-TF-T3 RDF-TF-T4
Winter Peak	79	RDF SO limit 1)	36	79	RDF-TF-T3 RDF-TF-T4

Note:

1) To avoid overloading RDF T3/T4, the System Operator (SO) constrains the total pre-contingency power flow through the transformers to 130 MW (RDF_T3 MW + RDF_T4 MW ≤ 130 MW). This becomes the limiting factor in N capacity.
2) The RDF T3/T4 TOPS SPS modelled in the EMI NIPS model varies slightly from the implementation described by Transpower. In actuality, the first stage is to request load management by Unison and Firstlight Network, then as a last resort after 5 minutes trip all RDF33 feeders. The model implementation immediately trips all RDF33 feeders.

The results of the study show that there is a conservative maximum capacity of approximately 49 MW available at the Tuai 110 kV bus, considering the 2023 load year forecast. This minimum of available capacity occurs during the Summer Peak case, because of a combination of reduced line/transformer ratings (due to higher ambient temperatures) and reduced availability of generation from the Waikaremoana scheme.

Under all N conditions, the limiting factor is the System Operator (SO) constraint imposed on the total loading of the Redclyffe interconnecting transformers, where the total MW power flow cannot exceed 130 MW.

Should there be a complete outage of the Waikaremoana generation scheme, the available capacity is zero. It is noted that in this case the existing total load would exceed the System Operator MW constraint, and load management would be required. Note that a complete outage is an unlikely event, given the number of generators within the scheme, and the ability to bypass stations to continue to supply. A complete outage would be considered at least an N-3G event, which is much more stringent that typical N-1 or N-G-1 security provisions. The System Operator will also constrain-on the generation to prevent a loss of supply during high load, low generation conditions.

Under light loading only, the available capacity is reduced significantly under N-1 conditions, where the limiting factor becomes a loss of an interconnecting transformer at Redclyffe, rather than the SO limit.

As the limiting factor is the Redclyffe interconnectors, any increase in 110 kV load in the Hawke's Bay region (including connections at Fernhill or Redclyffe) will also reduce the available capacity at Tuai. Table 5 shows the impact of projected demand growth on the available capacity.

Table 5: Three-yearly Forecast of Capacity Available (MW) at Tuai GXP to 2037

	2023	2026	2029	2032	2037
Total Hawkes Bay Demand [1)] (MW)	202	216	227	237	253
Growth in Hawkes Bay 110 network (MW)	0	14	25	35	51
N Spare Capacity at Tuai	49	35	24	14	0
N-1 Spare Capacity at Tuai	49	35	24	14	0

Note:

1) Aggregated from Table 2.
2) N and N-1 spare capacity are the same due to the system operator limit imposed under normal operating conditions, where the total loading of RDF must not exceed the post-contingency thermal limit of either RDF interconnector transformer. I.e., current peak load + available capacity < post-contingency single transformer limit.

Therefore, beyond 2037, upgrades at Redclyffe will be required to facilitate additional growth. This is discussed in Section 3.2.2.

3.2.2 Other Considerations Affecting Future Capacity

The upgrades mentioned in Section 3.1.2 for the Hawke's Bay part of the network include an additional transformer at Redclyffe Substation. Transpower States, "we will increase the Redclyffe 220/110 kV interconnecting transformer capacity by installing a third transformer at Redclyffe to remove the transformer constraint as a long-term solution" [4, p. 236]. However, there is now some uncertainty introduced by impacts from Cyclone Gabrielle in respect of Redclyffe Substation.

Transpower has confirmed that the third interconnector project at Redclyffe is committed. As any potential changes relating to future capacity or resilience are 2+ years away, the outcomes presented within this section focus on the data obtained from the NIPS model pre-cyclone.

It is noted that once the interconnectors are upgraded, the thermal limit will become the 110 kV transmission lines. Transpower is aware of this constraint and note that it does occur significantly beyond the interconnector transformer overload case.

4 Distribution Network and Zone Substations

4.1 Methodology to Review Distribution Network Capacity

Capacity of the network is established by reviewing a suite of information available including:

- The capacity of Tuai GXP, per Section 3 and as discussed within Section 3.2.
- Configuration of the network, from mimic diagrams provided.
- Thermal and voltage drop limitations of the 110 kV, 50 kV and 11 kV feeders.
- Physical open points in the network.
- Transformer capacity.
- Seasonal loading information.
- Forecast growth planning.

To assess the electricity capacity availability in the Tairāwhiti and Wairoa Districts, a mixture of publicly available reports and other information which was provided directly by either Transpower or Firstlight Network, were considered. The following sections discuss this evidence.

4.1.1 Connection Arrangement

The Firstlight Network owns and operates 23 Zone Substations across the two districts, Wairoa and Tairāwhiti. Refer to Figure 4 [1].

Figure 4: Firstlight Network's Region

As discussed in Section 3.1.1 the Transpower network supplies 110 kV to the TUI GXP. From the two 110 kV buses at TUI (Bus A and Bus B), four circuits distribute into the Firstlight Network, per the following:

1. Two circuits to Gisborne Zone Substation (Tairāwhiti District).
2. Two circuits to Wairoa Zone Substation (Wairoa District).

Voltage transformation occurs at both Gisborne and Wairoa Zone Substations.

Note that Figure 4 shows a 110 kV circuit between Gisborne and Tokomaru Bay. Historically, this circuit was operating at 110 kV, and was being utilised as a capacitor for a period of time to mitigate voltage issues in parts of the network. Recently, the circuit has been reinstated as an important part of the 50 kV system. Parts of this circuit are rated to 110 kV, and it is possible it could be upgraded to this operating voltage again in the future. The image (Figure 4), which originally came from the Firstlight AMP [1, p. 20] is due to be updated to reflect the true operating voltage of this part of the system.

4.1.1.1 Wairoa Zone Substation

Wairoa Zone Substation (Wairoa) has two 110 / 11 kV step-down transformers, T1 and T2. Each transformer is rated at 10 MVA continuously and 12/12 MVA (Summer/Winter) when operating on its own (post contingent event rating).

Wairoa connects to Kiwi Zone Substation over three 11 kV feeders, from Kiwi there is a step-up transformer and an interconnecting 50 kV sub transmission circuit to Waihi generation station.

Step-up transformer T3 (11 / 33 kV) at Wairoa allows for a 33 kV connection to Tahaenui. A radial 33 kV supply then continues to Blacks Pad Zone Substation. Blacks Pad Substation supports Mahia township and the rest of the peninsular via a 33 / 11 kV, 1.5 MVA transformer. A local generation site also supports this 11 kV network.

Refer to Appendix E.

4.1.1.2 Gisborne Zone Substation

Gisborne Zone Substation (Gisborne) has two 110 / 50 / 11 kV three-winding transformers, T3 and T4. Each transformer is rated at 60/60/60 MVA (Continuous/Summer post contingent/Winter post contingent).

These transformers support the 11 / 0.4 kV local service supplies at Gisborne, and the rest of the Firstlight network, consisting of 16 zone substations fed via 50 kV normally open ring circuits.

Refer to Appendix E.

4.1.2 Substation Demand

Firstlight Network provided 11 kV feeder load data of 30-minute intervals, with a data range from 1 January 2020 to 31 December 2022 across all four seasons [6][1]. Seasonal peak loading was compared for all three years.

- 35% of the zone substations have their peak loading in 2022.
- 30% of the zone substations have their peak loading in 2021.
- 10% (Parkinson and JNL zone substations) have peak loading in 2020.
- The remainder (25%), have either no change, or on par with the previous two years.

There were negligible differences (<0.5 MW) between peak loads year to year for all substations, except for Parkinson.

Fluctuations for Parkinson Zone Substation were more significant. There was a 9.9 MW peak in 2020, 9.6 MW in 2021, and 8.4 MW in 2022. This is a 15% decrease in 11 kV loading for Parkinson Substation over these three years. This analysis can be seen in Figure 5[2].

The matter was discussed with Firstlight, where it was explained that there had been some internal changes to the electrical configuration within the Cedenco Foods factory, supplied from Parkinson zone substation.

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1 Summer: 1 December to 28 February, Autumn: 1 March to 31 May, Winter: 1 June to 31 August, Spring: 1 September to 30 November.

[2] *The following substations, which are referenced elsewhere in this report, are not included in Figure 5:*

1. *Gisborne – (zone substation). No 11 kV loads. Dedicated to the 50 kV sub-transmission network.*
2. *Mahia – Refers to the generator at Mahia.*
3. *Waihi – (zone substation) Generation connected only.*

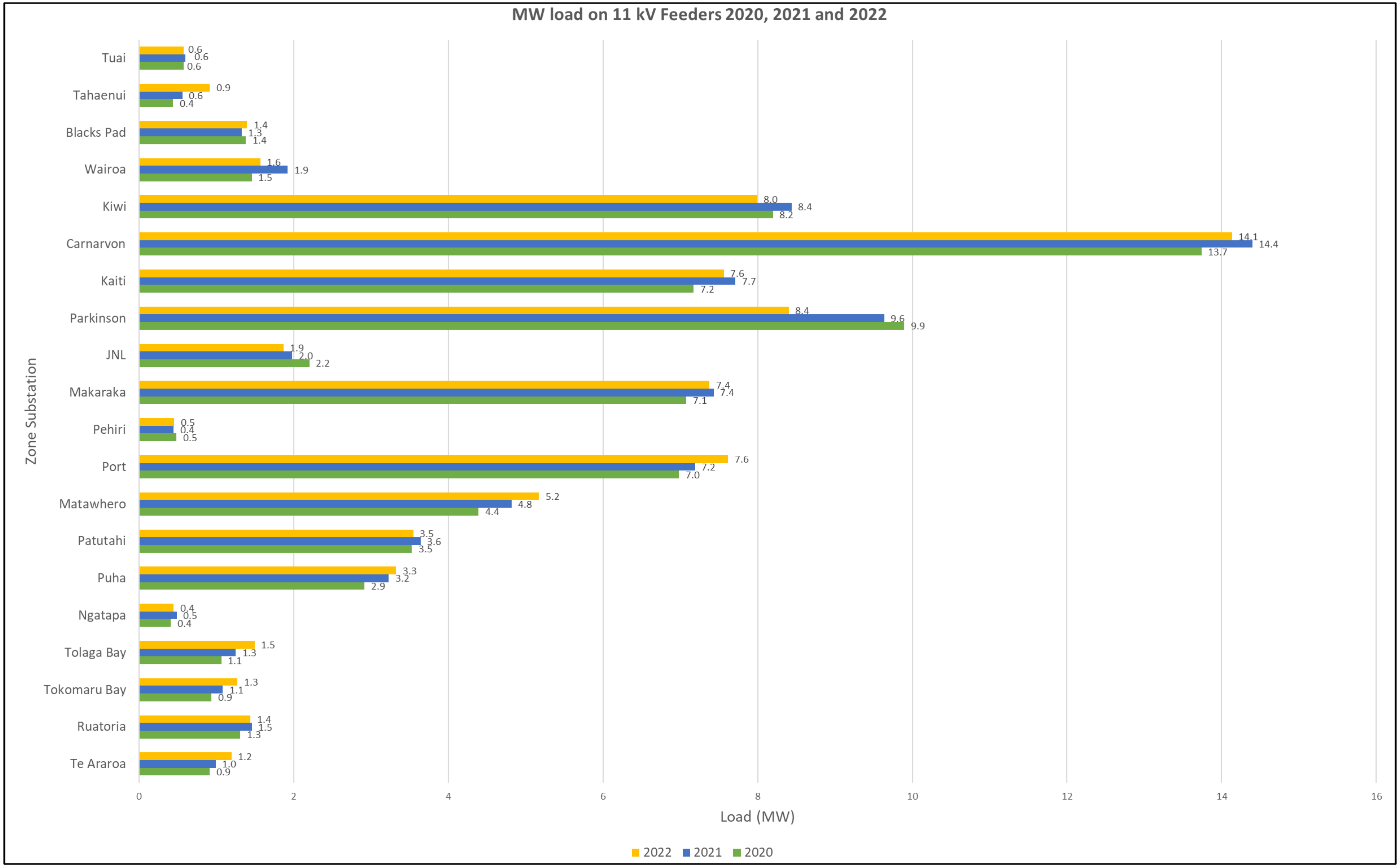

Figure 5: Comparison of Zone Substation Peak Loading – 11 kV

Further analysis of the peak demand on the Cedenco feeder (0704, Figure 6), shows that this is where the majority (> 90%) of the reduction has occurred. The peak load on the Cedenco Feeder (0704) was 2.4 MW in 2022, 3.6 MW in 2021, and 3.8 MW in 2020. This shows in total a 1.4 MW reduction across these three years.

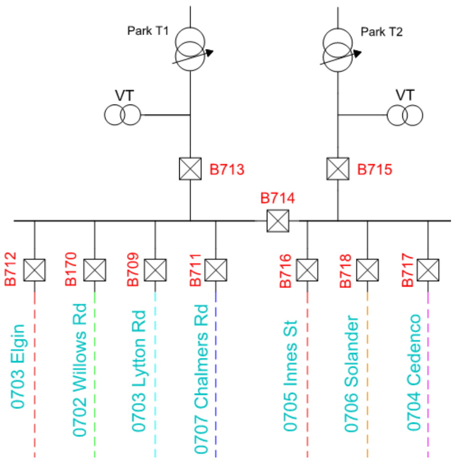

Figure 6: Parkinson Substation 11 kV Feeders

At the time of writing this report, we do not have visibility as to whether the Cedenco feeder load may come back online in the future, or if there if it is anticipated that the load will continue to decrease.

Based on discussions with Firstlight and per the discussion above, we have utilised 2022 load data within our analysis.

A summary of feeder and substation peak loading in 2022 by season is presented in Appendix A. 2022 data is also referenced in Table 6 and for discussions within Section 4.2.

Table 6: 2022 Maximum Coincidental Peak Demand (MW) – 11 kV

Gisborne		Wairoa	
Zone Substation	**Peak Demand**	**Zone Substation**	**Peak Demand**
Te Araroa	1.19	Wairoa	10.28
Ruatoria	1.44	Blacks Pad	1.40
Tokomaru Bay	1.27	Tahaenui	0.91
Tolaga Bay	1.49	Tuai	0.58
Ngātapa	0.45		
Puha	3.32		
Pātūtahi	3.55		
Matawhero	5.17		
Port	7.62		
Pehiri	0.45		
Makaraka	7.38		
JNL	1.87		
Parkinson	8.40		
Kaitī	7.56		
Carnarvon	14.13		

Key: Summer, Autumn, Winter, Spring

Anticipated growth on the network is discussed within Section 4.1.4.

4.1.3 Circuit Constraints

This section is provided to make some generic assumptions on the potential maximum capacity of circuits.

The two elements considered are:

1. Thermal capacity – the ability of conductors to meet load requirements without breaching the operational design criteria.
2. Voltage at the point of supply – the ability to supply distribution transformers without exceeding the tolerance limit set out within the Electricity (Safety) Regulations for the LV systems.

4.1.3.1 Thermal Capacity

As discussed within the overhead line design standard [7] other specific considerations are relevant in-situ. Examples of other considerations which impact current carrying capacity of the circuit are:

- Electrical requirements
- Mechanical requirements
- Environmental requirements
- Conductor construction

Confirmation of the overhead network conductors per, Table 7, and Table 8 were provided by personal communication.

110 kV Constraints

Firstlight Network owns and operates previous Transpower 110 kV line assets which interconnect Gisborne Substation to Tuai GXP, and Wairoa Substation to Tuai GXP.

In 2019, Tesla Consultants undertook a study with the purpose of reviewing the capacity of lines to Gisborne and Wairoa substations and provide investment recommendations for potential upgrades if required. The report, Eastland Network 110 kV Network Capacity Upgrade Study [2] has been referred to for aspects of the 110 kV supplies into the area.

Tesla Consultants determined through modelling “that the existing capacity of the GIS network can support a maximum peak load of 51 MW to maintain n-1 capacity (i.e. with one circuit Out Of Service) and transformer contingency (i.e. one transformer Out Of Service) rating.” [2, p. 17].

Table 7: Thermal Ratings of the 110 kV Conductor Network

Voltage	Description	Type	Thermal Rating
110 kV	Tuai to Wairoa: Double circuit line.	Wolf (ACSR)	53 MVA[1)]
110 kV	Tuai to Gisborne: Double circuit line.	Hyena (ACSR)	51 MVA[2)]

Notes:

1) Thermal capacity limit established from the Nexans data sheet [8, p. 5/13].
2) Thermal capacity limit established from modelling completed by Tesla Consultants [2, p. 17]. For consistency, this is stated as “51 MVA”, conservatively assuming a unity power factor.

Seasonal load on these circuits varies. Wairoa appears to have capacity, while the circuits to Gisborne appear to be more thermally constrained during peak seasons.

50 kV Constraints

The estimated thermal ratings for 50 kV circuits are shown below in Table 8.

Table 8: Thermal Ratings of the 50 kV Conductor Network

Description	Type	Thermal Rating
Rural areas: Includes the Coast Spur line and the ring feed through the country.	Dog (ACSR) Mink (ACSR)	210 A / 18 MVA 152 A / 13 MVA [8, p. 5/13]
Urban areas: Primarily the Gisborne town sub transmission.	Cockroach (AAC)	390 A / 34 MVA [8, p. 5/9]
Sub transmission circuits: 1. Waihi to Kiwi 2. Ngātapa to Puha 3. Puha to Hexton	Raccoon (ACSR)	175 A / 15 MVA [8, p. 5/13]

The 50 kV network is distributed from Gisborne Substation, apart from the single circuit between Waihi generation site, and Kiwi Substation, within the Wairoa District. This can be seen as Racoon conductor within Table 8, which has a thermal rating of 15 MVA.

11 kV Constraints

Constraints within the 11 kV network have been reviewed using the Firstlight Network Sincal Model, file name “PVEastland.sin” [9].

The approach to this involved:

1. Classifying individual nodes within the network under their respective feeders.
2. For each node in each feeder, a dummy load was connected, and its active power consumption varied until a thermal limit is encountered for any component within that feeder. Any voltage violations were noted.
3. This process was repeated for each node within the feeder.

The output of this is a large dataset consisting of the available capacity at each feeder node. These have been summarised to give the minimum, median and maximum available capacity on each feeder. Refer to Appendix C for full details.

The model [9] was reviewed for the winter peak period only. Our review was limited to this season due to the extensive time it took to run the model. This season is where most of the highest loads[3] on the network exist, and therefore is a conservative view of existing loading and available capacity. It provides for an initial “pass/fail” check for load conversion opportunities considered within Section 5.

[3] *Exception of Matawhero and Port substations per Table 6.*

4.1.3.2 Voltage at the Point of Supply

Voltage constraints for the 110 kV and 50 kV parts of the network have been ignored for the purposes of this review, as Firstlight Network can actively manage voltage throughout the system, to zone substation transformers as required.

The main consideration is the voltage available at the point of supply for any additional load which may be connected to an existing 11 kV feeder circuit.

Refer to Section 4.2.4.

4.1.4 Firstlight Network Growth Development Planning

Since disclosure of the AMP in 2021 some upgrade work around the network has been completed, including replacement of some transformers at zone substations. This has been considered within the conclusions of this report.

The Demand Forecasts section (10.4) of the Eastland Network (now Firstlight Network) 2021 asset management plan (AMP) [1] outlines factors for increase in future electricity demand. The following were considered to make load projections for growth development:

- Growth of future customer connections
- Improvements of energy efficiency
- Wood processing in the region
- Uptake of electric vehicles
- Solar PV and battery installations
- Impact of Covid-19
- Cyclone Gabrielle, February 2023[4]

As the most recent AMP disclosed is now out of date, new work has been completed for the purposes of this project to establish new load forecasts. Firstlight Network has used up to date data to forecast the growth of the existing network to the best of their knowledge. (M. Chakma, personal communication, June 1, 2023). Growth for each substation has been established as a percentage increase, per year, or stagnant in some cases, per the following:

Flat	±0.0%
Low	+0.2%
Medium	+0.5%
High	+1.0%
Very High	+2.0%

[4] *Note that Firstlight Network has confirmed that there are projects ongoing relating to reestablishment and mechanical strengthening of 11 kV components of the network. At the time of writing, it is understood that there are no plans to strengthen or remove electricity network assets due to the impacts of Cyclone Gabrielle.*

Table 9 shows the forecast demand for each of the zone substations, using the 2022 peak load as a baseline (Table 5).

Table 9: 2033 Forecast Annual Maximum Demand (MW) for Firstlight Substations – 11 kV

Zone Substation	Peak Demand (2022) [6], (Table 6)	Anticipated Growth Band	2033 Forecast Substation Peak Demand
Te Araroa	1.20	Low	1.23
Ruatoria	1.44	Low	1.47
Tokomaru Bay	1.27	Low	1.30
Tolaga Bay	1.49	Low	1.52
Ngātapa	0.45	Flat	0.45
Puha	3.32	Low	3.39
Pātūtahi	3.55	High	3.96
Matawhero	5.17	Very High	6.43
Port	7.62	Medium	8.05
Pehiri	0.45	Flat	0.45
Makaraka	7.38	Very High	9.18
JNL	1.87	Flat	1.87
Parkinson	8.40	Medium	8.87
Kaitī	7.56	High	8.43
Carnarvon	14.13	Medium	14.93
Wairoa	10.28	Low	10.51
Blacks Pad	1.40	High	1.56
Tahaenui	0.91	Low	0.93
Tuai	0.58	Flat	0.58

4.2 Distribution Network Summary

In determining the (N) and (N-1) available capacity for the distribution network, ElectroNet analysed the 30-minute interval sample data for 2022 loading on the 11 kV network feeders.

ElectroNet has reviewed and concluded available capacity for:

- 110 kV feeder circuits from Tuai (Transpower) to Gisborne and Wairoa GXPs (seasonal).
- The 50 kV sub transmission network (seasonal).
- Substation transformers (seasonal).
- 11 kV feeders from zone substations (conservative peak only).

4.2.1 110 kV Circuits

Figure 7 below shows the existing demand and available capacity to maintain N-1 security of supply for the circuits to Wairoa and Gisborne zone substations, from the Tuai GXP during peak winter loading. Note that the Gisborne circuit is at capacity.

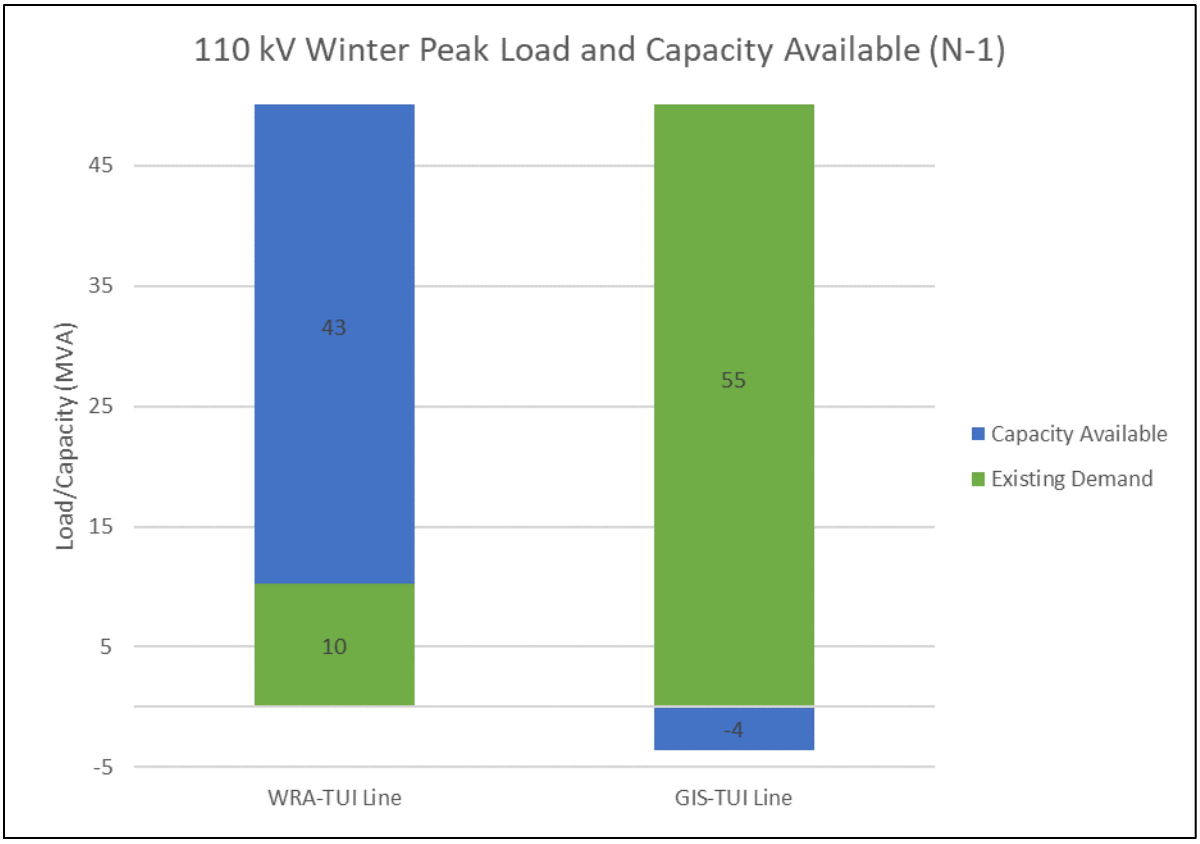

Figure 7: N-1 Security of Supply, Capacity Available for 110 kV Feeders

Wairoa

The Wolf conductors to Wairoa substation have a single thermal design rating of 53 MVA [8].

Peak loading occurs in Winter, and Summer is the lightest loading on the network.

During winter is appears as though the circuits are loaded to 20% of N-1 capacity only.

Refer to Appendix C, Table 35 for further information.

Gisborne

The circuits to Gisborne substation are both Hyena conductor, however GIS-TUI CCT 1 has two spans, approximately 600 m of Dog conductor. As the full length of the circuit is approximately 82.5 km, it is assumed that this short section will have negligible effect on the overall impedance. Therefore, for the purposes of this assessment, we assume that the current flow through the circuits will be balanced.

Hyena conductors to Gisborne substation have a single thermal design rating of 51 MVA [2]. Assessment for both circuits is based on this thermal limitation. As the sections of Dog are short in comparison to the full length of the circuit, we have not considered this a thermally limiting factor. This is because we assume that any potential additional sag associated with the current through this section will have been accounted for.

There is a mix of capacity available across the seasons. Winter loading is the highest, and summer is the lightest. **In Winter, there is no available capacity to maintain N-1 security of supply**, however, at N security further growth can occur. Approximately 12 MVA of capacity is available for full N-1 security of supply during the summer months.

A report [2] from a previous study has included options for upgrade of these circuits for future proof for anticipated load growth in the district.

As is seen here, there is an existing constraint for N-1 security. The security of supply requirements for additional load within the Gisborne district will need to be considered carefully. Upgrade of these circuits will be costly.

Refer to Appendix C, Table 35 for further information.

4.2.2 50 kV Circuits

Wairoa

There is one 50 kV (Racoon/15 MVA, Table 8) circuit within the Wairoa district, which runs from Waihi to Kiwi Zone Substation. Waihi has a 5 MW generator. The load flow on this 50 kV circuit is one-way only, due to no load being present at Waihi. As the rest of the network in the Waihi district is supported by this generator and by the connection to Tuai in parallel, we consider that anywhere along this feeder could effectively support an additional 15 MW load. Limitation of this would be the transformer, T1 at Kiwi Zone Substation, which has a 6.5 MVA rating.

Gisborne

The ring networks offer alternate configuration during fault scenarios which have not been considered for this review. The capacity of the 50 kV network is based on normal configuration only, per the open points as shown on the mimic diagram in Appendix E.

As expected, the bulk of the load is on the feeders which supply areas close to Gisborne. These are supplying substations:

- Port
- Carnarvon
- Makaraka
- Parkinson
- JNL

Winter coincidental peak loading is when the largest load occurs on all the 50 kV feeders.

The capacity available is >8 MVA on all feeders, during normal operational configuration in all seasons.

Refer to Appendix C, Table 36 for further information.

4.2.3 Zone substations

Based on loading from 2022, there is transformer capacity across the network.

Figure 8 below shows the existing demand and available capacity for N security for zone substation transformers during peak winter loading. Note that Gisborne zone substation has been left off the graph due to the large scale in comparison to the other substations. Winter demand at Gisborne is 57 MVA, and remaining available capacity (N) is 63 MVA.

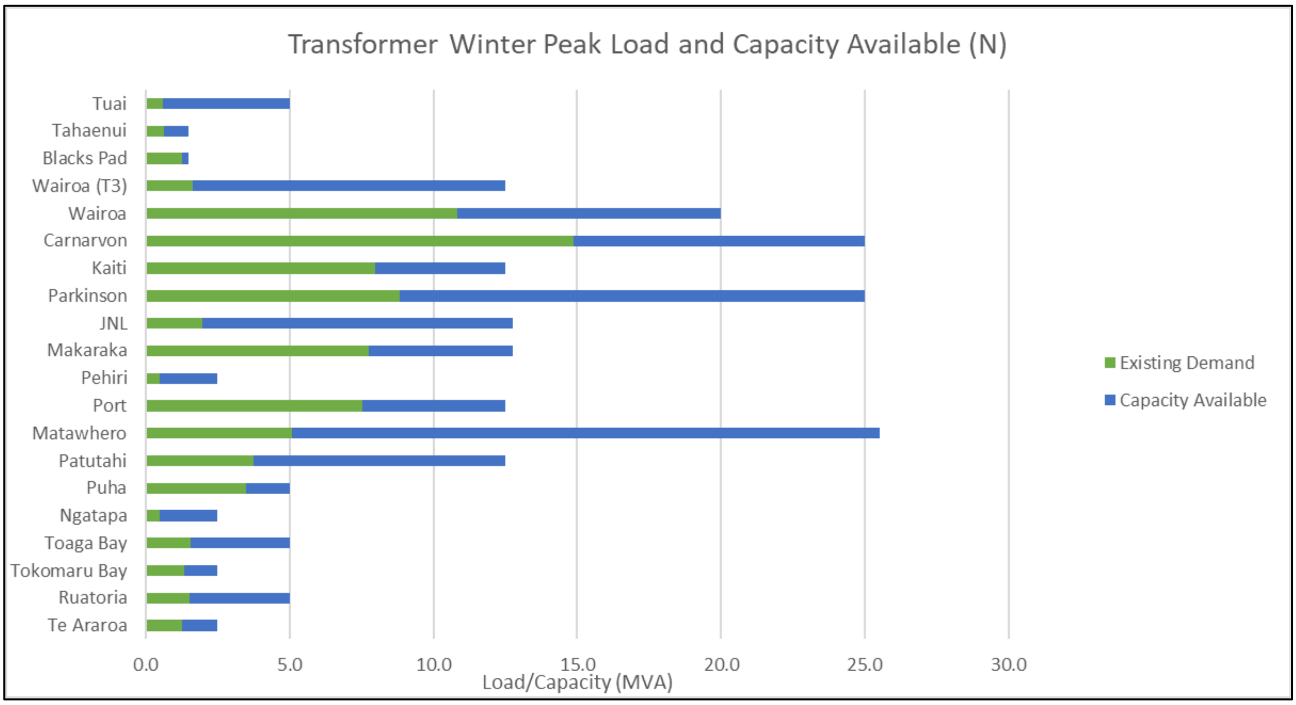

Figure 8: N Security of Supply, Capacity Available for Zone Substation Transformers

Figure 9 below shows substations with duplicate transformer arrangement allowing for an N-1 security of supply. The data for Figure 9 is captured from winter peak loading.

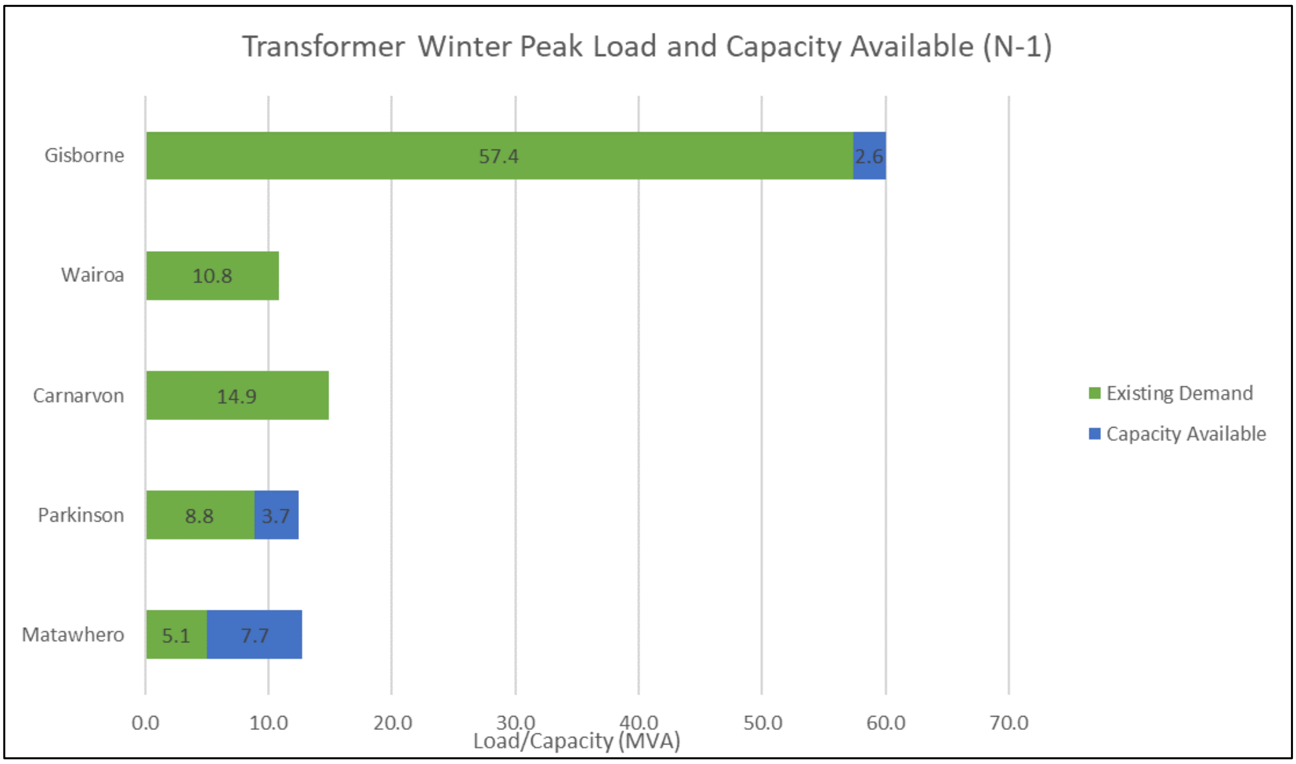

Figure 9: N-1 Security of Supply, Capacity Available for Zone Substation Transformers

N-1 security of supply is already compromised at Wairoa and Carnarvon substations.

In respect of the 10-year growth projections to 2033 from Table 9, there appears to be some violations. Upgrade of transformers at the following substations may need to be considered:

- Tokomaru Bay
- Puha
- Port
- Makaraka
- Kaitī
- Carnarvon
- Blacks Pad
- Tahaenui

Refer to Appendix B, Table 34 for further information.

4.2.4 11 kV feeders

Due to the complexity of the review, the available capacity for additional load for 11 kV feeders is based on winter peak loading only. Specific review of circuits was completed for specific load connection opportunities, and presented in Section 5 where relevant.

From the model, we have established the availability for additional load for each feeder in winter, based on the 2022 load data. Refer to Appendix C (Table 37 and Figure 20) for full details.

Each section of conductor was analysed, and voltage or thermal limitations were established. Based on this, we were able to determine the minimum and maximum opportunity for load to be connected to that part of the circuit in winter.

The summary in Appendix C summarises the capacity across the feeder. In some cases, the maximum opportunity is “0”, meaning that there is no available capacity at any segment along the circuit, in winter.

If the minimum opportunity is “0”, but the maximum opportunity is >0, there are some segments of the circuit that have capacity, and some that don’t. Generally, for radial feeders, the maximum capacity occurs at the start of the circuit and reduces further down. If a segment has zero capacity it can reasonably be assumed that all segments downstream have no capacity. For circuits with embedded generation, capacity may be available near the generator.

Where both the minimum and maximum opportunity are >0, all segments of the circuit have available capacity.

Section 5 includes which load connection opportunities may utilise existing 11 kV circuits.

5 Connection Options

5.1 Introduction

Section 5 discusses the nine potential demand side assessments, listed here:

1. Cedenco Foods, Gisborne
2. Ministry of Health, Gisborne Hospital
3. Pioneer Brand Seeds, Gisborne
4. Ovation NZ Ltd, Gisborne
5. Fulton Hogan, Gisborne Asphalt Plant
6. Ministry of Education, Lytton High School
7. Indevin, Gisborne
8. Ministry of Education, Gisborne Girls High School
9. Ministry of Education, Gisborne Boys High School

Further to these nine projects, we have been asked to provide concept and cost estimation for a potential Fulton Hogan crushing plant project at Matawai. This is detailed within Section 5.4.

Also, three potential forestry industry projects are presented within Section 5.5.

5.2 Methodology

Our approach to review the options for supplies to demand sites is from the bottom up. Initially, we assessed the request for connection, from existing infrastructure, and move to establishment of new assets as required, per the following:

- The existing supply to site and the capacity available. In some cases, the potential load requirements may be at typical low voltage.
- Nearby 11 kV feeders.
- Nearby zone substation.
- Nearby 50 kV feeders.
- New zone substation.

Each opportunity has been considered stand alone in this review.

It may be possible that some combinations could be considered as larger projects to reduce costs to individual organisations. For example, several opportunities rely on investment at the zone substation level. For one project this level of investment could be prohibitive, but zone substation upgrades may permit several opportunities to proceed in tandem and provide additional future capacity.

5.3 RETA Demand Site Assessments

5.3.1 TAI1 Cedenco Foods, Gisborne

Electrical Requirements

Anticipated Load	Electrode Boiler
Electrical Demand	3.7 MVA, 6 MVA and 16 MVA
Security of Supply Requested	N and N-1 security options

Feasibility and Concept Presentation

Cedenco Foods is approximately 700 m from Parkinson Zone Substation, where it is presently supplied from. There is interest in installing an electrode boiler, of up to 16 MVA.

EECA has requested that options are assessed for a 3.7 MVA connection at N-1, which will have cabling sized to accommodate 6 MVA. 185 mm^2 Al single core cabling has been used for costing purposes throughout this project where suitable. This cable will support a load of 349 A buried directly (approximately 6.65 MVA, at 11 kV) [8, p. 16].

Presently, there are limitations to the capacity which is immediately available at Parkinson Substation.

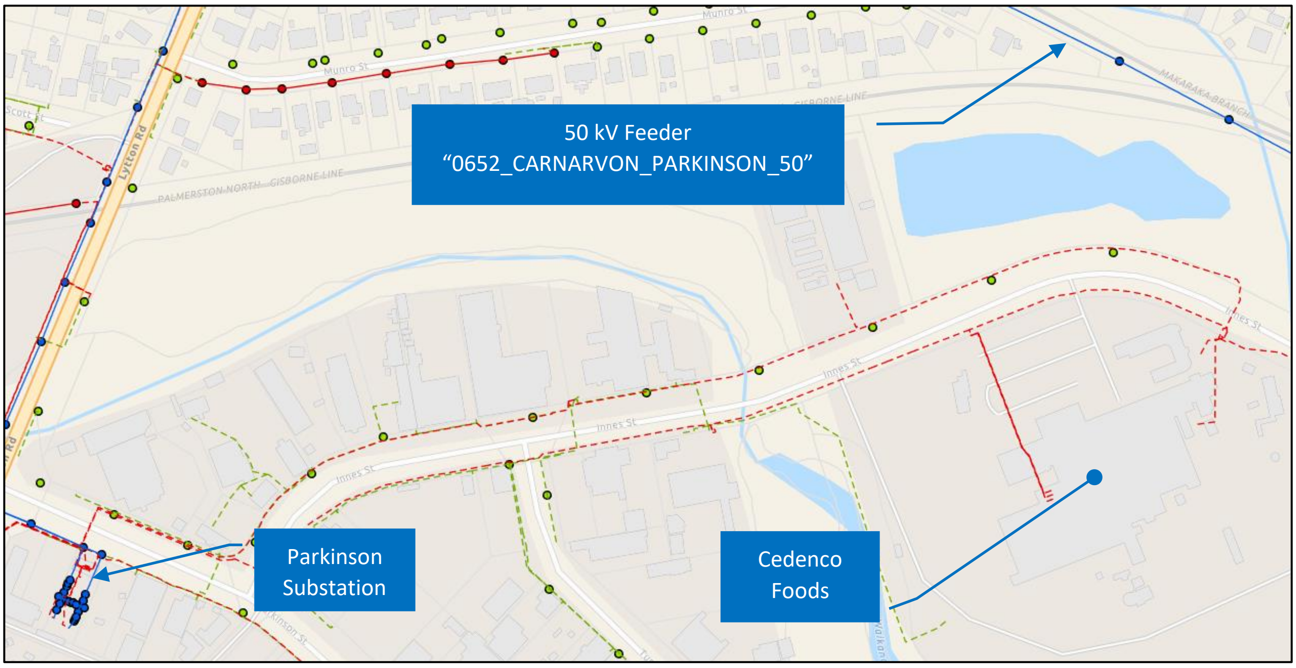

Figure 10: Cedenco Foods and Local Electricity Infrastructure

<u>Option 1 – Existing feeder to Cedenco</u>

Feeder 0704 (Figure 6) has a thermal capacity of approximately 8 MVA. The installed capacity of transformers at Cedenco is 6 MVA. This is an intentional contingency (75%) to allow for back feeding via an open ring point in the network, to Innes Street feeder (0705) also sourced at Parkinson Substation.

In 2022 the Cedenco 0704 feeder was loaded to 2.4 MW [6]. Based on this, Cedenco could load the existing transformers to capacity, or a new 11 kV radial tee could be connected to the existing 0704 feeder. If the 400 V system is not to be increased at Cedenco, it is estimated that loading could increase by approximately 3 MW on the existing 0704 feeder. However, this does not meet the additional 3.7 MVA, 6 MVA, or 16 MVA load requirement and is not considered further.

Option 2 – Installation of a new dedicated 11 kV feeder to Cedenco

Assuming that loading has not increased since 2022, electrically, Parkinson Substation should have sufficient capacity to support a new 16 MVA feeder (840 A @ 11 kV) to Cedenco on N security. However, it is understood that the assets at Parkinson Substation have been identified as being at end of life and the site is due for an upgrade, or replacement. Firstlight Network has confirmed that it is not physically possible to install new circuit breakers at the site, which means that an additional feeder will not be possible. This option is not considered any further.

Option 3 – Construction of a new dedicated zone substation

We consider that this is the only option to adequately achieve either a 3.7 MVA, 6 MVA or 16 MVA supply to Cedenco.

There is capacity on the local 50 kV network to support 16 MVA at N-1 security. To achieve this the following would be required:

1. Incoming 50 kV Supply from the "0652_CARNARVON_PARKINSON_50" feeder:
2. Zone Substation:
3. 11 kV cabling:

Cost Estimation for a new dedicated Zone Substation (Option 3)

Note that the following estimation includes the cost for installation.

$N_{6\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $4,400,000
	11 kV cable / trench (40 m)	= $20,000
		= $4,650,000
$N_{16\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,800,000
	11 kV cable / trench (40 m)	= $80,000
		= $6,110,000

Table 10: TAI1, Cedenco (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation	11 kV Distribution
N-1	N	N-1	N	N-1	N	N	N
×	✓	×	✓	✓	×		

$N\text{-}1_{6\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $6,100,000
	11 kV cable / trench (80 m)	= $40,000
		= $6,370,000
$N\text{-}1_{16\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $7,650,000
	11 kV cable / trench (80 m)	= $150,000
		= $8,030,000

Table 11: TAI1, Cedenco (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation	11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N-1
×	✓	×	✓	✓	×		

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 18 months.

Other Considerations

110 kV Limitations

While the establishment of a new zone substation at Cedenco is possible, which will provide N-1 security at distribution (11 kV) and subtransmission (50 kV) levels, it has been identified that there are limitations into the Gisborne Substation at 110 kV. N-1 security is not available to 16 MVA for any season on the 110 kV network. Refer to Table 35 for 110 kV availability.

24 MVA (conservatively assumed at unity power factor) is available as a worst case in the winter to provide N security. Refer to Table 35.

Replacement of Parkinson Substation

It was previously noted that the Parkinson Substation is due to be replaced. The authors of this report are not aware of the timeline for this project. It is expected that the development of this report may assist Firstlight Network in concluding the overall capacity to be built into a solution. It is possible that Cedenco and other demand side projects, could be collectively supported from a new Firstlight Substation, separate to the detail presented within this report.

5.3.2 TAI2 Ministry of Health, Gisborne Hospital

Electrical Requirements

Anticipated Load	Heat pumps and electrode boilers
Electrical Demand	0.92 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

EECA has requested that 0.92 MVA is established at site. Transformer C364P at Gisborne Hospital is fed from Makaraka Substation, approximately 3 km to the southwest of site. Refer to Figure 11.

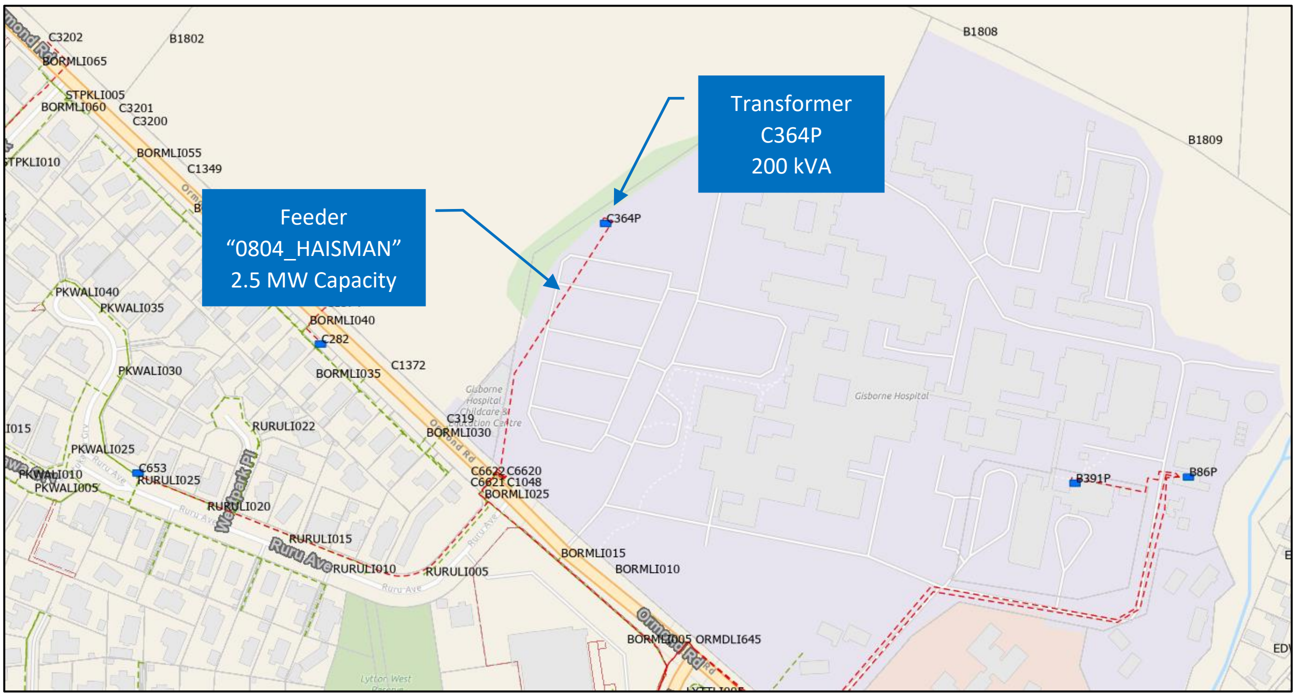

Figure 11: Gisborne Hospital and Local Electricity Infrastructure

N security capacity at Makaraka substation varies throughout the year. Most conservatively, 5 MVA is available in winter, with up to 7.3 MVA available in summer. N-1 security out of Makaraka is not available due to it being a single transformer zone substation.

The existing 0804 feeder ("Haisman") to site transformer C364 (200 kVA) has approximately 2.5 MVA of capacity available and will support the load request.

Establish an 11 kV Tee and cabling to load

A three-way CFC ring main unit (RMU) would be established near the existing 0804 "Haisman" feeder. The existing cable would be cut into and terminated onto the RMU. An 11 kV outgoing cable will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

Cost Estimation

Note that the following estimation includes the cost for installation:

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 12: TAI2, Gisborne Hospital (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	✓	×	✓	×	×	✓	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

5.3.3 TAI3 Pioneer Brand Seeds, Gisborne

Electrical Requirements

Anticipated Load	Electrode boiler
Electrical Demand	6 MVA
Security of Supply Requested	N and N-1 security options

Feasibility and Concept Presentation

EECA has requested a 6 MVA upgrade to the site and are interested in both N, and N-1 options. The site is presently supplied from Parkinson Substation via two feeders:

1. B703 (“Lytton Rd”) feeder.
2. B706 (“Solander”) feeder.

Supply to site may be established by several options. Refer to Figure 12.

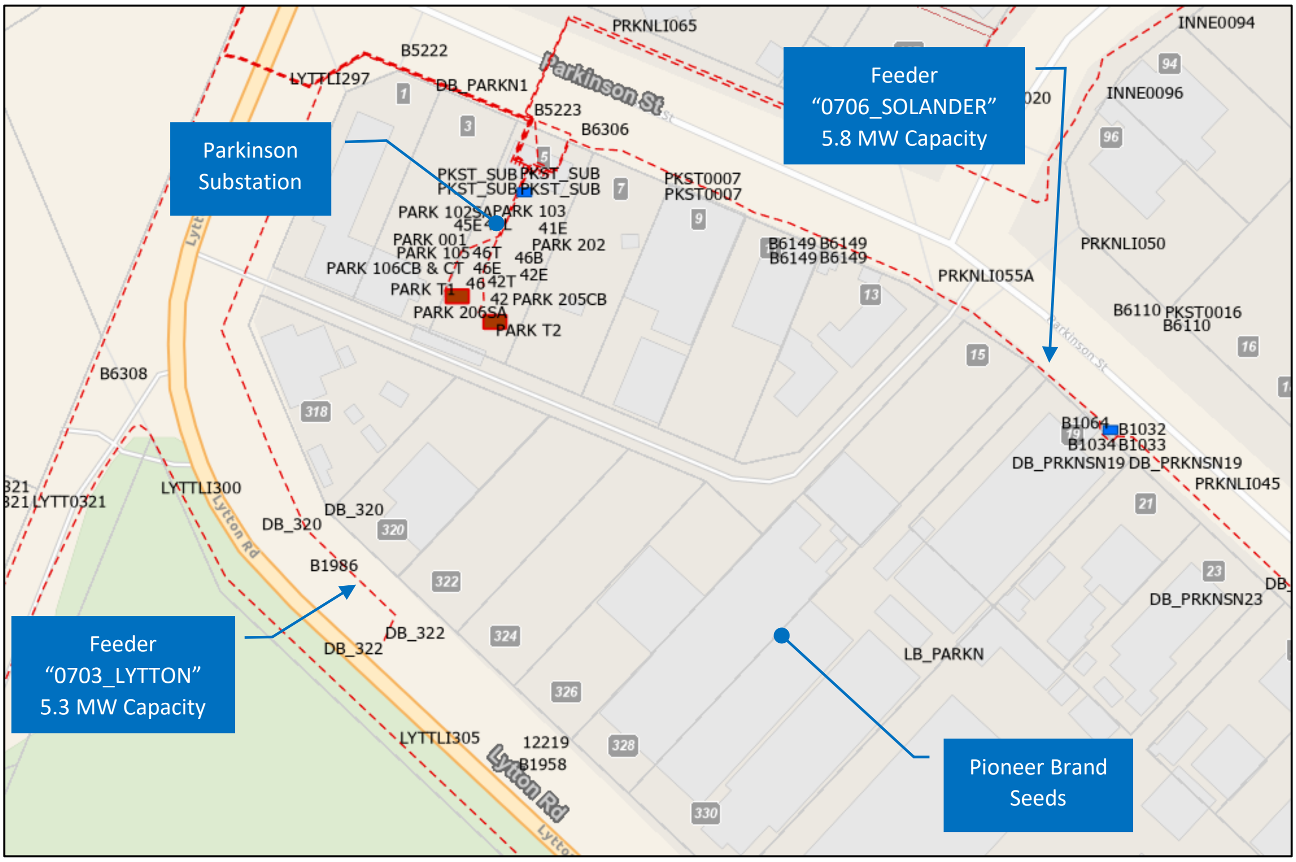

Figure 12: Pioneer Brand Seeds and Local Electricity Infrastructure

Based on the existing configuration, spare capacity at Parkinson substation varies throughout the year. The most conservative spare capacity values are through the winter months:

- N Security = ≥ 16.2 MVA
- N-1 security = ≥ 3.7 MVA

If a new substation were to be developed to support the Cedenco project (Section 5.3.1), these values would increase.

The load profile provided by EECA (Figure 13), shows that the demand is relevant from March to June only. During these periods, which we have defined as autumn, and running into the start of winter, Parkinson substation has the following capacity available, which again would increase if the Cedenco load was removed from Parkinson:

- N Security = ≥ 16.4 MVA
- N-1 security = ≥ 3.9 MVA

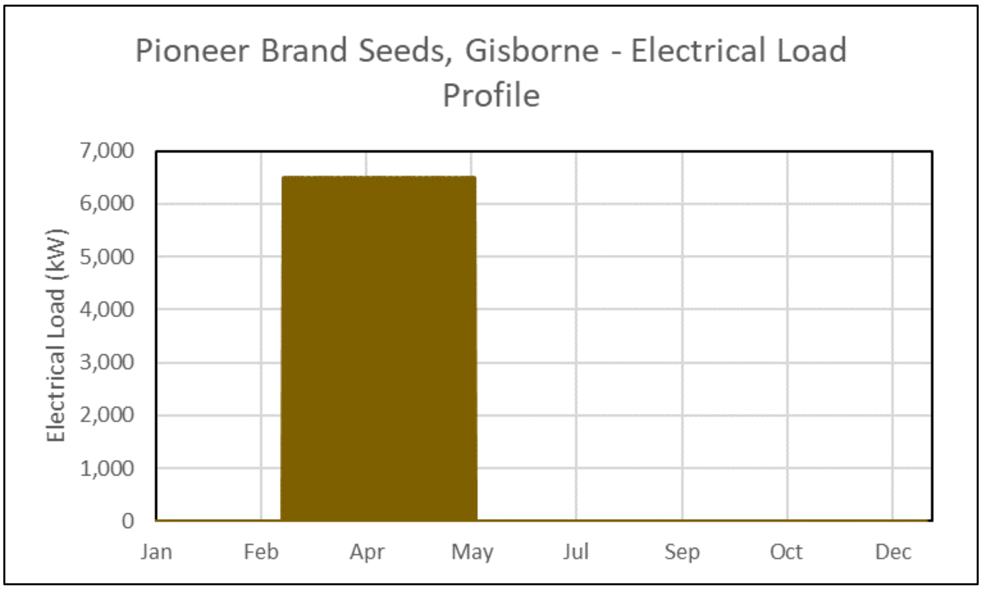

Figure 13: Pioneer Brand Seeds Load Profile

There are two feeders to site:

1. 0703 "Lytton", 5.3 MVA[5] of spare capacity available on the cabled section only[6].
2. 0706 "Solander", 5.8 MVA[5] of spare capacity available.

<u>Option 1 – Establish an 11 kV Tee and cabling to load, offering N Security</u>

A three-way CFC ring main unit (RMU) would be established near the existing 0706 "Solander" feeder. The existing cable would be cut into and terminated onto the RMU. An 11 kV outgoing cable will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

This option will offer 5.8 MVA[5] at N security.

<u>Option 2 – Establish two 11 kV Tees and cabling to load, offering N-1 Security</u>

Two three-way CFC ring main units (RMU) would be established near:

1. the existing 0706 "Solander" feeder.
2. the existing 0703 "Lytton" feeder.

Both RMUs would be cut into the existing underground cabling to establish the maximum capacity available. 11 kV outgoing cabling will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al per circuit has been allowed for in the cost estimation below.

[5] Conservatively assumes unity power factor.
[6] If a tee is established off the Lytton overhead, then less capacity is available. Possibly only 1.8 MW.

This option will offer 3.9 MVA (conservatively assumed at unity power factor) at N-1 security, however N security is available to 5.8 MVA per Option 1.

Cost Estimation

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 13: TAI3, Pioneer Brands Seeds 5.8 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	✓	×	✓	×	×	✓	

N-1	Ring Main Unit	= $80,000
	11 kV cabling	= $20,000
		= $100,000

Table 14: TAI3, Pioneer Brand Seeds 3.9 MVA Autumn Only (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
✓	×	✓	×	✓	×	✓	×	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

Other Considerations

<u>110 kV Limitations</u>

N-1 security to 5 MVA (autumn, Table 35) is available on the incoming 110 kV feeders only.

<u>Gisborne Substation</u>

While N-1 is shown as being available, per Table 14, this is relevant for the autumn months only. Available spare capacity at Gisborne substation drops to approximately 2.6 MVA in winter (Table 34).

<u>6 MVA Option – New Zone Substation</u>

A 6 MVA option was not provided per the original request, because it was possible to achieve close to the request by utilising existing infrastructure. If a 6 MVA supply is a necessity, then costing would be per the TAI1 solution for Cedenco Foods (Section 5.3.1), i.e.:

- N $4,650,000
- N-1 $6,370,000

5.3.4 TAI4 Ovation NZ Ltd, Gisborne

Electrical Requirements

Anticipated Load	Electrode boiler
Electrical Demand	0.15 MVA and 0.6 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

The site is presently supplied from Matawhero Substation via feeder 1408 (“Waipaoa”). Refer to Figure 14.

It is possible that 0.15 MVA (212 A at 400 V), may be supported at low voltage. We do not have technical details of the existing demand at site. We recommend that Ovation explore the possibility of supporting this opportunity with the existing infrastructure to site.

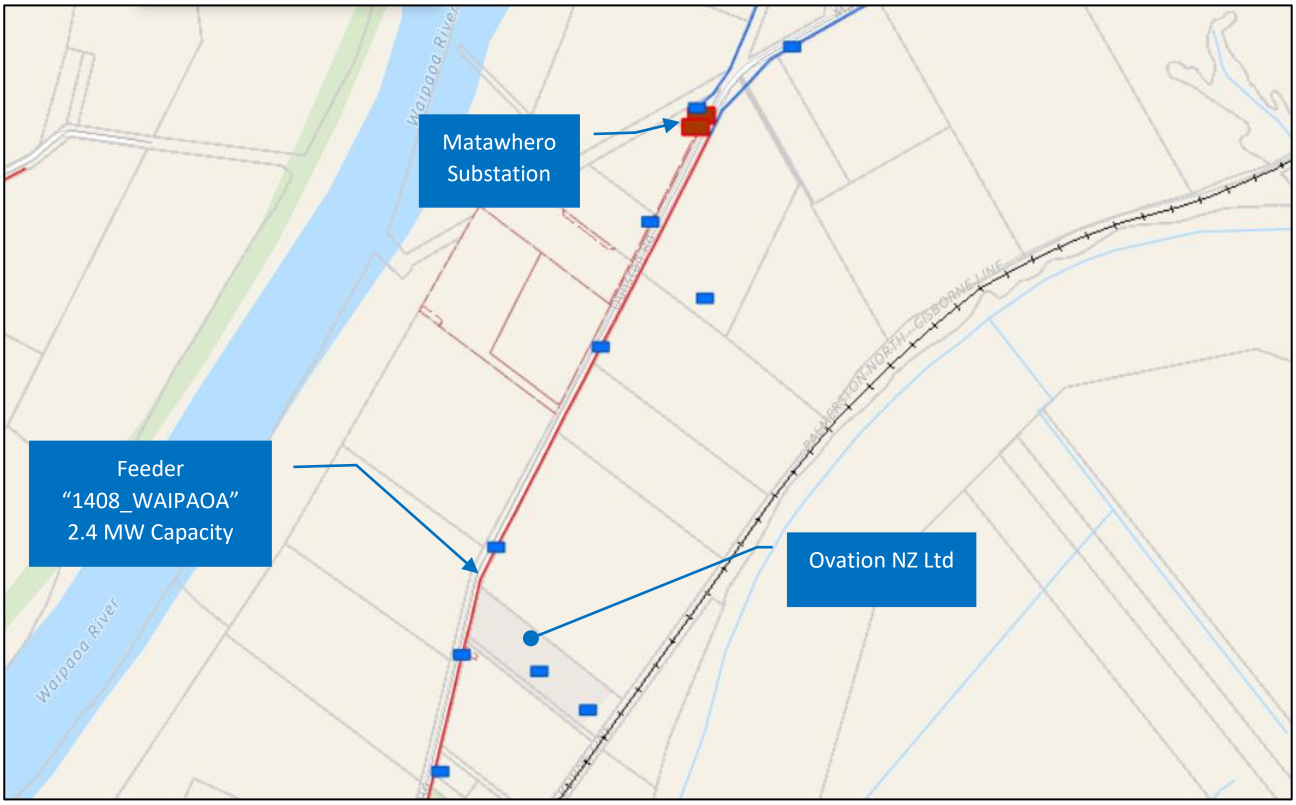

Figure 14: Ovation and Local Electricity Infrastructure

For a load connection of 0.6 MVA a new 11 kV tee will need to be established.

<u>Establish an 11 kV Tee and cabling to load</u>

The solution is to take a single radial supply only from existing infrastructure, offering N security only at 11 kV distribution level.

A three-way CFC ring main unit (RMU) would be established near the existing 1408 “Waipaoa” feeder. The existing cable would be cut into and terminated onto the RMU. An 11 kV outgoing cable will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

Cost Estimation

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 15: TAI4, Ovation N Security Cost Estimation

<table>
<tr><th colspan="2">110 kV Transmission</th><th colspan="2">110/50 kV Substation</th><th colspan="2">50 kV Sub-transmission</th><th colspan="2">50/11 kV Substation</th><th>11 kV Distribution</th></tr>
<tr><td>N-1</td><td>N</td><td>N-1</td><td>N</td><td>N-1</td><td>N</td><td>N-1</td><td>N</td><td rowspan="2">N</td></tr>
<tr><td>✗</td><td>✓</td><td>✓</td><td>✗</td><td>✓</td><td>✗</td><td>✓</td><td>✗</td></tr>
</table>

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

5.3.5 TAI5 Fulton Hogan, Gisborne Asphalt Plant

Electrical Requirements

Anticipated Load	Unknown
Electrical Demand	0.03 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

EECA has requested that 0.03 MVA is established at site.

It is assumed that 0.03 MVA (43 A at 400 V), can be supported at low voltage from the existing electrical installation. We recommend that Fulton Hogan explore this possibility.

We have not undertaken any further analysis relating to this opportunity.

5.3.6 TAI6 Ministry of Education, Lytton High School

Electrical Requirements

Anticipated Load	Heat pumps
Electrical Demand	0.23 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

EECA has requested a 0.23 MVA load increase to the Lytton High School. The school is supplied by Transformer “C254P”, which is rated to 300 kVA.

Given the relatively small scale of this request, we have developed a solution which is to take a single radial supply only from existing infrastructure, offering N security only at 11 kV distribution level. A new 11 kV tee will be established off feeder 0803 (“Nelson”) which is supplied from Makaraka Substation. Refer to Figure 15.

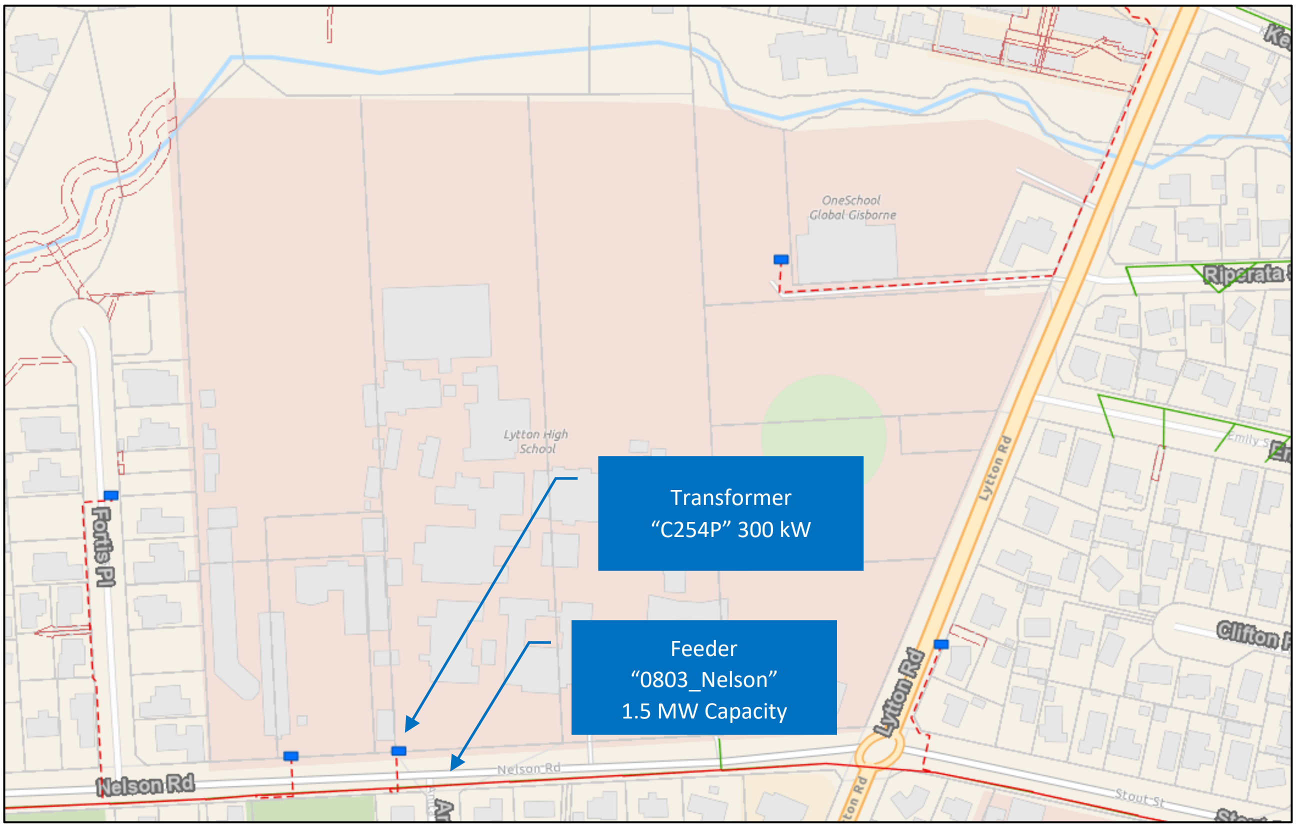

Figure 15: Lytton High School and Local Electricity Infrastructure

The existing cable to transformer C254P is 16 mm^2 Cu with a directly buried thermal rating of 2 MVA. Therefore, there is 1.5 MVA of spare capacity available on the HV side of the transformer.

Establish an 11 kV Tee and cabling to load

A three-way CFC ring main unit (RMU) would be established near the existing 0803 "Nelson" feeder. The same spare capacity is available if the tee is established, either at:

1. The cables on school property to Tx C254P. The existing cable would be cut into and terminated onto the RMU.
2. The overhead at the street. A new radial cable would be installed from the line to a newly established RMU at the boundary.

From the location of the RMU, a new 11 kV outgoing cable will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

Cost Estimation

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 16: TAI6, Gisborne Hospital (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	✓	×	✓	×	×	✓	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

5.3.7 TAI7 Indevin, Gisborne

Electrical Requirements

Anticipated Load	Unknown
Electrical Demand	0.46 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

Indevin has requested a 0.46 MVA load increase to their site.

A new 11 kV tee will be established off feeder 0706 (“Solander”) which is supplied from Parkinson Substation. Refer to Figure 16. Given the relatively small scale of this request, we have developed a solution which is to take a single radial supply only from existing infrastructure, offering N security only at 11 kV distribution level.

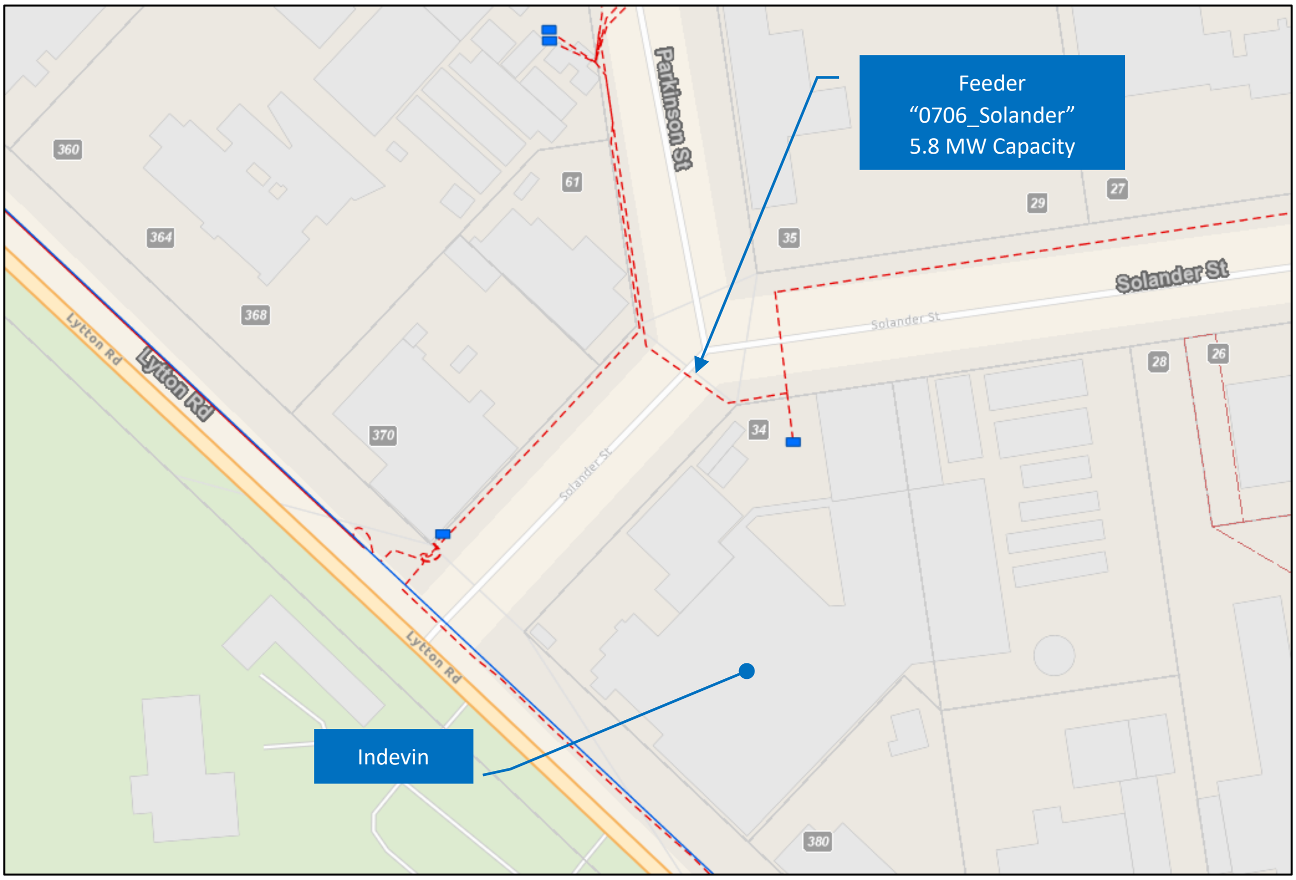

Figure 16: Indevin and Local Electricity Infrastructure

<u>Establish an 11 kV Tee and cabling to load</u>

There are two options to establish the new supply:

1. Cut into the existing cabling on the street and install a new CFC RMU.
2. Replace the existing RMU with a new CFCF (4-way) RMU.

From the location of the RMU, a new 11 kV outgoing cable will be terminated and run to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

Cost Estimation

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 17: TAI7, Indevin (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	✓	×	✓	×	✓	×	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

5.3.8 TAI8 Ministry of Education, Gisborne Girls' High School

Electrical Requirements

Anticipated Load	Heat pumps
Electrical Demand	0.09 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

It is assumed that 0.09 MVA (124 A at 400 V), may be supported at low voltage from the existing electrical installation. We recommend that the Ministry of Education explore this possibility.

We have not undertaken any further analysis relating to this opportunity.

5.3.9 TAI9 Ministry of Education, Gisborne Boys' High School

Electrical Requirements

Anticipated Load	Heat pumps
Electrical Demand	0.09 MVA
Security of Supply Requested	N-1 security

Feasibility and Concept Presentation

It is assumed that 0.09 MVA (124 A at 400 V), may be supported at low voltage from the existing electrical installation. We recommend that the Ministry of Education explore this possibility.

We have not undertaken any further analysis relating to this opportunity.

5.4 Fulton Hogan Crushing Plant, Mātāwai

Electrical Requirements

Anticipated Load	Quarry equipment	
Electrical Demand	Crushing plant:	330 kVA
	BEV charging:	844 kVA
	Crushing plant and BEV charging:	1,174 kVA
Security of Supply Requested	N-1 security	

Feasibility and Concept Presentation

It is unknown what diversity would be required for these items. To be conservative, it is assumed all will be required to run concurrently. We have assessed a requirement for a 1.2 MVA 11 kV supply.

There are potentially two options for this opportunity, which are detailed below.

<u>Option 1 – Complete a PSA study and correct the voltage constraint issues</u>

Capacity of a nearby 11 kV feeder (Puha - Matawai 1204) has been reviewed. Based on voltage constraints in the existing 11 kV network, we determine that there is presently no capacity available for additional connections. It may be possible to rectify this, however a detailed power systems analysis study would be required to determine the appropriate remedy. Assuming that the voltage constraint issues may be solved with the installation of voltage regulation equipment, the estimated cost to implement this type of solution, may be achieved for less than $1 M.

<u>Option 2 – Reinstate Historical 50 kV Circuit to Mātāwai</u>

There is an existing 50 kV rated feeder (1204_MATAWAI) which is currently being operated at 11 kV. The feeder begins at remote switch F423 and ends at F2134 and supplies the Mātāwai township. This circuit could be reinstated to 50 kV with some upgrade of insulators on 80 structures, which date back to the 1950's. On this line, there are also several poles which would need to be replaced.

A new 50/11 kV substation would be established on the southern side of Mātāwai township of which the local 11 kV circuits will be reconfigured to be supplied from. This will strengthen the 11 kV network in the area. The rating of this substation would be based on the requirements of this part of the network by Firstlight Network. As there is one existing line to be utilised for this option, we have assumed that a single transformer unit would be installed, offering N security only.

A detailed power systems analysis study would be required to determine the optimum configuration of the network, post upgrade. It may be possible to reconfigure or split existing 11 kV feeders to reduce loading on existing circuits and provide additional capacity within the 11 kV network. The area downstream of the proposed upgrade currently supplies around 0.5 MW of load (per modelling) and there seems to be reasonable thermal capacity. However, there appears to be voltage constraints which would prevent significant growth. Introduction of a 50 kV substation would likely alleviate these constraints. A power systems analysis study would be required to determine the options for circuit reconfiguration of the 11 kV network around Mātāwai.

Southern Generation Partnership Limited (SGLP) owns Mātāwai Power Station, a 2 MW hydro scheme [10] which tees into the existing 11 kV circuit, at pole F2324, approximately 12 km southeast of Mātāwai township. As the "1204_MATAWAI " circuit would be upgraded to 50 kV, this tee will need to be reconfigured. Some discussion with Firstlight has taken place around this solution and it is assumed that sufficient capacity is available on the other 11 kV circuit nearby, however some modelling is required to confirm. The tee would be disconnected, and the line lifted at this location. A new 11 kV span would be installed beneath the 50 kV circuit, and run approximately 90 m to the south, where the tee will be reestablished.

Cost estimation for this option is presented below.

N	Changing the switch connection at Otoko from 11 kV to 50 kV Installing a 50 kV circuit breaker and disconnector.	= $290,000
	Replace 80 insulator sets to 50 kV	= $500,000
	Transformer and substation at Mātāwai	= $4,025,000
	New connection across to 11 kV at pole F2324 for tee to Mātāwai Power Station	= $100,000
	Project and protection costs	= $250,000
	PSA study	= $100,000
		= $5,265,000

Table 18: Mātāwai Crushing Plant (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation	11 kV Distribution
N-1	N	N-1	N	N-1	N	N	N
×	✓	×	✓	×	✓		

Landowner negotiation and easement establishment has not been allowed for within our cost estimation for the 11 kV reconfiguration at the Mātāwai end of the circuit. This is because we understand that land owned by Firstlight Network has already been designated appropriate for a new zone substation and new easements should not be required.

5.5 Forestry Projects

Four potential forestry development projects are laid out within the following subsections. Options, in terms of what equipment, and the associated load may vary at the sites, per the following:

Electrical Requirements

Anticipated Load	Forestry processing equipment	
Electrical Demand	Pellet mill plant:	4 MVA
	Large sawmill:	10 MVA
Security of Supply Requested	N and N-1 security options	

There are various demands to consider, the pellet mills require up to 4 MVA, and a large sawmill could be up to 10 MVA. A sawmill and pellet plant could be installed at one location, so up to 14 MVA could be used. However, the size of the plant could be constrained based on electrical availability.

Based on the above, the following connection options are considered for each of the four sites:

1. The MVA point at which more investment is required.
2. 4 MVA
3. 14 MVA

5.5.1 Ruatoria

Feasibility and Concept Presentation

N-1 security is not available from Ruatoria substation, as there is only a single transformer. Table 34 states that there is less than 4.0 MVA available for three seasons, however due to this connection opportunity, more accurate, specific modelling was undertaken. We have determined that 2.7 MVA only is available before the Ruatoria transformer will overload.

The proposed site at Ruatoria is approximately 1.4 km from Ruatoria Substation, on the opposing, north side of the river. Refer to Figure 17.

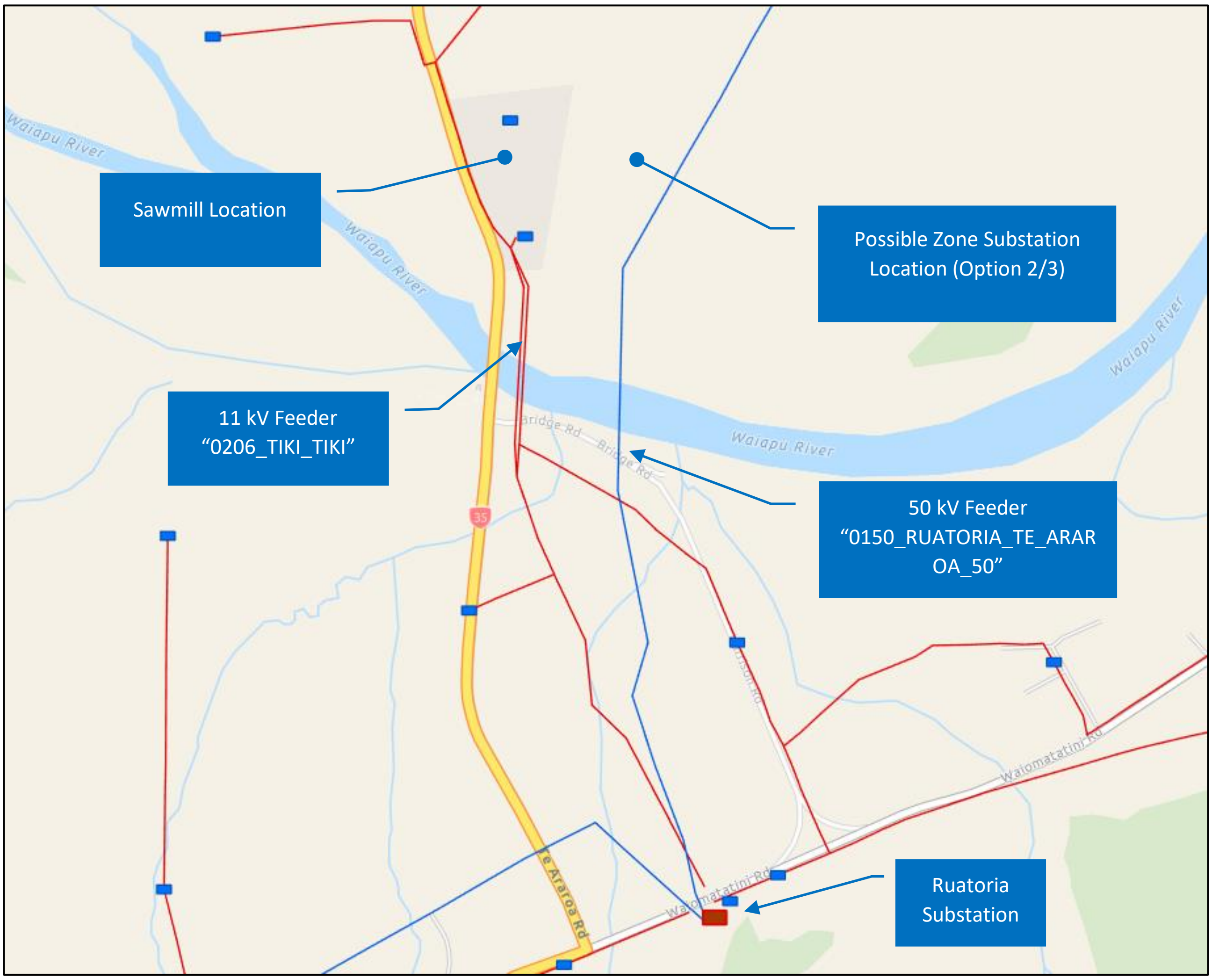

Figure 17: Ruatoria Greenfield and Local Electricity Infrastructure

<u>Option 1 – Supply limited by existing infrastructure</u>

As discussed above, there is 2.7 MVA available before the transformer at Ruatoria will overload. The existing 11 kV feeder 0206 "Tiki Tiki" will support this.

A new three-way CFC ring main unit (RMU) would be established near the existing 0206 "Tiki Tiki" feeder. A new radial cable would be installed from the line to a newly established RMU at the boundary. From here, an 11 kV cable would be installed to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

Gisborne zone substation can support this development at N-1 security for all parts of the year, apart from during the winter months. At that period, N-1 security is available up to 2.6 MVA.

This option will offer 2.7 MVA at N security.

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 19: Ruatoria Existing Infrastructure (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	✓	×	✓	×	×	✓	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

<u>Option 2 – 4 MVA for pellet mill only</u>

A new zone substation would need to be established for a 4 MVA, N or N-1 supply. We have assumed that this may be installed in relatively close proximity to the load site. Refer to Figure 17.

Note that the following estimation includes the cost for installation.

$N_{4\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $4,800,000
	11 kV cabling (20 m)	= $10,000
		= $5,040,000

Table 20: Ruatoria Forestry 4 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	×	✓	✓	×	×	✓	

$N\text{-}1_{4\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,900,000
	11 kV cabling (40 m)	= $20,000
		= $6,150,000

Table 21: Ruatoria Forestry 4 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
×	✓	×	✓	✓	×	✓	×	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 18 months.

Option 3 – 14 MVA for pellet mill and sawmill

The proposed solution to support 14 MVA at site is the same as for Option 2, above. The only difference is the size of the transformers to be installed at the new zone substation.

Note that the following estimation includes the cost for installation.

$N_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,600,000
	11 kV cable / trench (20 m)	= $40,000
		= $5,870,000

Table 22: Ruatoria Forestry 14 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	×	✓	✓	×	×	✓	

$N\text{-}1_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $7,650,000
	11 kV cable / trench (40 m)	= $80,000
		= $7,960,000

Table 23: Ruatoria Forestry 14 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
×	✓	×	✓	✓	×	✓	×	

5.5.2 Tolaga Bay

Feasibility and Concept Presentation

N-1 security is not available from Tolaga Bay substation, as there is only a single transformer. The seasonal capacity, per Table 34 states that there is less than 4.0 MVA available for three seasons. In summer 4.3 MVA is available.

The proposed site is approximately 4.5 km south of Tolaga Bay Substation, off to the true left of state highway 35. Refer to Figure 18.

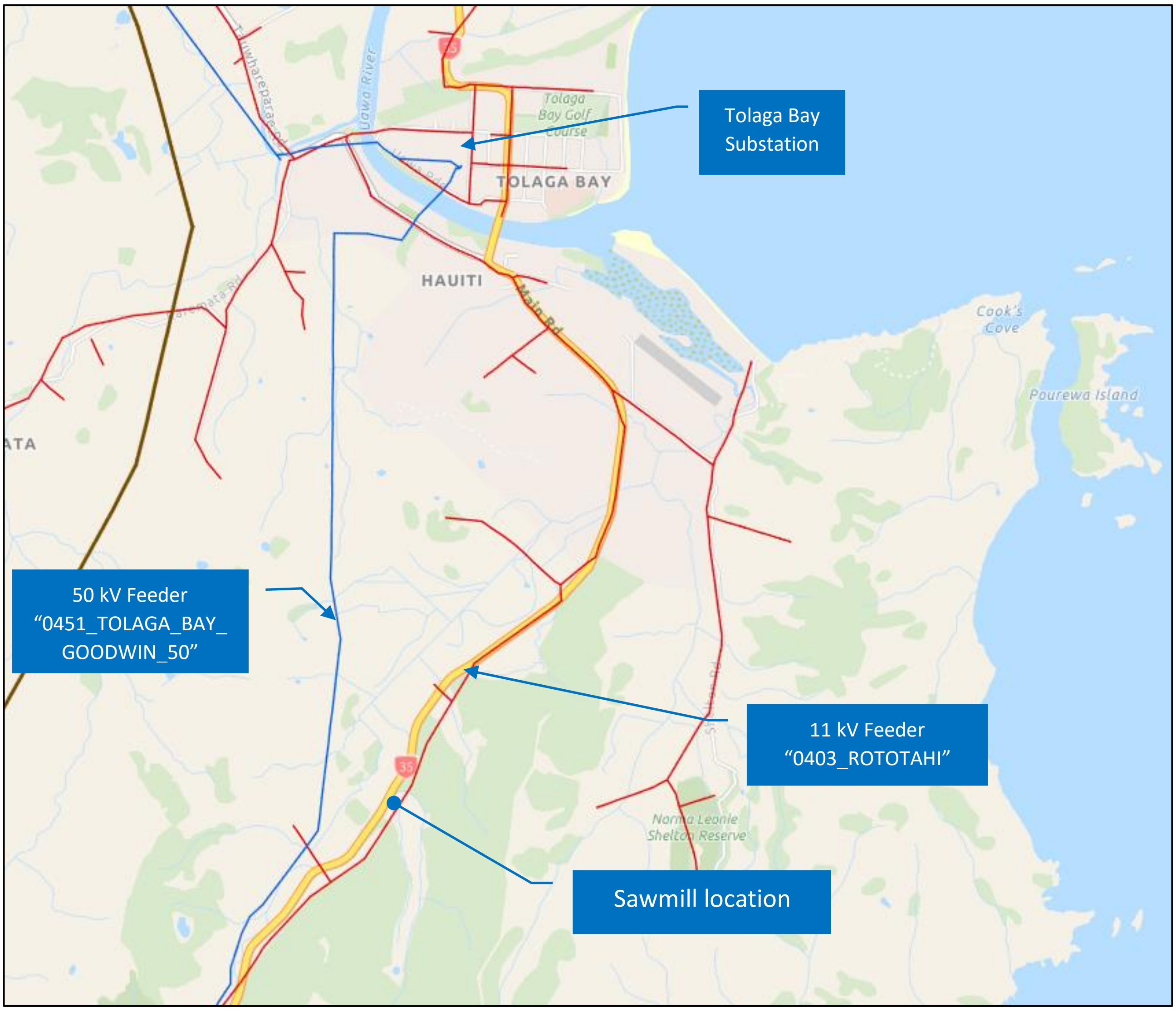

Figure 18: Tolaga Bay Greenfield and Local Electricity Infrastructure

There is approximately 2.1 MVA available on the existing nearby 11 kV feeder (0403 “Rototahi”) before an upstream segment overloads. To achieve any more than this on site, a new 50 kV connection and zone substation would be required.

<u>Option 1 – Supply limited by existing infrastructure</u>

A new three-way CFC ring main unit (RMU) would be established near the overhead feeder. A new radial cable would be installed from the line to a newly established RMU at the boundary. From here, an 11 kV cable would be installed to the load location. An estimated 20 m 185 mm^2 Al has been allowed for in the cost estimation below.

This option will offer 2.1 MVA at N security.

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling	= $10,000
		= $50,000

Table 24: Tolaga Bay Existing Infrastructure (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
✗	✓	✓	✗	✓	✗	✗	✓	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

<u>Option 2 – 4 MVA for pellet mill only</u>

A new zone substation would need to be established for a 4 MVA, N or N-1 supply. We have assumed that this may be installed in relatively close proximity to the load site. Refer to Figure 18.

Gisborne zone substation can support this development at N-1 security for all parts of the year, apart from during the winter months. At that period, N-1 security is available up to 2.6 MVA.

Note that the following estimation includes the cost for installation.

$N_{4\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $4,800,000
	11 kV cabling (20 m)	= $10,000
		= $5,040,000

Table 25: Tolaga Bay Forestry 4 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
✗	✓	✗	✓	✓	✗	✗	✓	

$N\text{-}1_{4\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,900,000
	11 kV cabling (40 m)	= $20,000
		= $6,150,000

Table 26: Tolaga Bay Forestry 4 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
✗	✓	✗	✓	✓	✗	✓	✗	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 18 months.

Option 3 – 14 MVA for pellet mill and sawmill

The proposed solution to support 14 MVA at site is the same as for Option 2, above. The only difference is the size of the transformers to be installed at the new zone substation.

Note that the following estimation includes the cost for installation.

$N_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,600,000
	11 kV cable / trench (20 m)	= $40,000
		= $5,870,000

Table 27: Tolaga Bay Forestry 14 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	×	✓	✓	×	×	✓	

$N\text{-}1_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $7,650,000
	11 kV cable / trench (40 m)	= $80,000
		= $7,960,000

Table 28: Tolaga Bay Forestry 14 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
×	✓	×	✓	✓	×	✓	×	

5.5.3 Gisborne

Feasibility and Concept Presentation

Matawhero substation has N-1 security to 7.7 MVA in the winter, and up to 8.7 in the summer. At N security, over 20 MVA is available all year around.

The proposed site is approximately 1.8 km south of Matawhero Substation. Refer to Figure 19.

Figure 19: Gisborne Greenfield and Local Electricity Infrastructure

The existing feeder 11 kV Feeder ("1403_DUNSTAN") splits north of the site, closer to the substation. Both a cable and overhead section come down toward the sawmill location. These have the following capacity available:

- Cable = 3.8 MW
- Overhead line = 4.9 MW

Connection to either will be cost comparable and will achieve N security to either 3.8 MW or 4.9 MW respectfully.

The whole feeder could be upgraded from the substation to achieve the required 14 MW all year around at N security. Beyond this, a third transformer could be installed at Matawhero zone substation to achieve further security. However, it is unknown if this is a practical option.

A new zone substation could be established, similar to previous options discussed. This is referred to as "Option 3", below.

Option 1 – Supply limited by existing infrastructure

A new three-way CFC ring main unit (RMU) would be established near the overhead feeder. A new radial cable would be installed from the line to a newly established RMU at the boundary. From here, an 11 kV cable would be installed to the load location.

Gisborne zone substation can support this development at N-1 security for all parts of the year, apart from during the winter months. At that period, N-1 security is available up to 2.6 MVA.

This option will offer 4.9 MVA at N security.

Note that the following estimation includes the cost for installation.

N	Ring Main Unit	= $40,000
	11 kV cabling (250 m)	= $110,000
		= $150,000

Table 29: Gisborne Forestry Existing Infrastructure (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	×	✓	✓	×	✓	×	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 3 to 6 months.

Option 2 – Install an additional feeder to achieve N-1 for the 4 MVA for pellet mill only

This option would firstly utilise the existing overhead feeder for Option 1 as discussed above, for one supply.

Additionally, a new circuit breaker would be installed at Matawhero zone substation, and new cabling installed to the site. This 11 kV cabling would terminate to the RMU (option 1), offering N-1 security to that point. A radial cable could then be installed to the load.

Total cabling for both supplies of 2,000 m is allowed for in the cost estimation below.

Note that the following estimation includes the cost for installation.

N-1	Option 1	= $150,000
	Works at Matawhero	= $180,000
	11 kV cabling (2000 m)	= $870,000
		= $1,200,000

Table 30: Gisborne Forestry 4 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
×	✓	×	✓	✓	×	✓	×	

Without considering the time impacts of consenting, A typical timeline for the development of this type of project is approximately 6 to 12 months.

Option 3 – 14 MVA for pellet mill and sawmill

For the installation of a dedicated zone substation, similar to what has been presented previously within Section 5.3, the cost estimation is as follows.

Note that the following estimation includes the cost for installation.

$N_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $5,600,000
	11 kV cable / trench (20 m)	= $40,000
		= $5,870,000

Table 31: Gisborne Forestry 14 MVA (N) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N
×	✓	×	✓	✓	×	×	✓	

$N\text{-}1_{14\ MVA}$	50 kV connection	= $230,000
	Zone substation	= $7,650,000
	11 kV cable / trench (80 m)	= $150,000
		= $8,030,000

Table 32: Gisborne Forestry 14 MVA (N-1) System Security Matrix

110 kV Transmission		110/50 kV Substation		50 kV Sub-transmission		50/11 kV Substation		11 kV Distribution
N-1	N	N-1	N	N-1	N	N-1	N	N-1
×	✓	×	✓	✓	×	✓	×	

6 References

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Appendix A
Zone Substation Peak Seasonal Loading – 11 kV

Table 33 shows the peak load on each feeder per season, based on data provided for 2022. The maximum load for each season considers the peak coincidental load[7] for that season.

Note that Waihi, Gisborne, Kiwi, and Mahia are not included in this list as they do not have any 11 kV feeders.

Table 33: Feeder and Substation Seasonal Coincidental Peak Loading (2022)

Feeder / Zone Substation	Autumn (MW)	Spring (MW)	Summer (MW)	Winter (MW)
Max of Awatere	0.45	0.47	0.11	0.56
Max of Hicks Bay	0.49	0.45	0.41	0.45
Max of Te Araroa	0.19	0.26	0.17	0.26
Te Araroa ZS	**0.86**	**0.93**	**0.58**	**1.20**
Max of Ruatoria	0.63	0.71	0.47	0.75
Max of Makarika	0.37	0.34	0.30	0.54
Max of Tikitiki	0.71	0.52	0.39	0.84
Ruatoria ZS	**1.31**	**1.42**	**0.90**	**1.44**
Max of Inland	0.30	0.34	0.24	0.88
Max of Seaside	0.43	0.37	0.39	0.21
Max of Mata	0.34	0.39	0.32	0.41
Tokomaru Bay ZS	**0.73**	**0.84**	**0.67**	**1.27**
Max of Toko-Tie	0.49	0.39	0.26	0.71
Max of Town	0.35	0.35	0.41	0.45
Max of Rototahi	0.39	0.45	0.32	0.54
Max of Tauwhareparae	0.22	0.26	0.17	0.28
Tolaga Bay ZS	**1.03**	**1.18**	**0.69**	**1.49**
Max of Ngātapa	0.13	0.15	0.09	0.22
Max of Tahora	0.24	0.26	0.21	0.28
Max of Totangi	0.06	0.04	0.06	0.13
Ngātapa ZS	**0.35**	**0.39**	**0.30**	**0.45**
Max of Whatatutu	0.41	0.49	0.32	0.45
Max of Kanakanaia	0.78	0.75	0.82	0.73
Max of Te Karaka	0.43	0.37	0.28	0.56
Max of Matawai	2.04	2.11	1.87	2.11
Puha ZS	**2.67**	**2.99**	**2.33**	**3.32**
Max of Lavenham	0.91	0.90	0.88	1.08
Max of Waimata	1.19	1.31	1.53	1.40
Max of Muriwai	0.73	0.88	0.54	0.82
Max of Te Arai	0.50	0.54	0.43	0.54
Pātūtahi ZS	**3.04**	**3.34**	**2.63**	**3.55**
Max of Dunstan	1.61	1.89	1.36	1.76
Max of JNL_A	1.23	0.58	2.20	1.85
Max of Waipoa	1.85	2.05	2.11	1.94
Max of Bell	0.97	1.66	1.70	1.77

[7] *30-minute samples periods were provided.*

Feeder / Zone Substation	Autumn (MW)	Spring (MW)	Summer (MW)	Winter (MW)
Matawhero ZS	**4.13**	**3.85**	**5.17**	**4.82**
Max of Port	2.61	2.69	1.94	3.66
Max of Crawford	4.63	1.83	1.06	1.98
Max of Esplanade	1.53	1.68	2.24	1.76
Max of Harris	1.74	1.68	1.06	1.83
Port ZS	**7.62**	**6.33**	**5.02**	**7.17**
Max of W-O-Kuri	0.36	0.28	0.23	0.32
Max of Parikanapa	0.31	0.19	0.01	0.19
Max of Tiniroto	0.18	0.19	0.13	0.19
Max of Tahunga	0.10	0.09	0.07	0.09
Pehiri ZS	**0.45**	**0.39**	**0.33**	**0.45**
Max of Campion	2.35	2.17	1.25	2.46
Max of Nelson	2.37	2.32	2.18	2.76
Max of Haisman	2.13	2.15	1.57	2.32
Max of Bushmere	1.33	1.27	1.25	1.98
Makaraka ZS	**6.12**	**6.50**	**5.19**	**7.38**
Max of JNL	1.79	1.85	1.77	1.87
JNL ZS	**1.79**	**1.85**	**1.77**	**1.87**
Max of Lytton	1.55	1.48	1.89	1.62
Max of Willows	0.78	0.84	1.90	0.90
Max of Elgin	1.57	1.70	2.15	1.94
Max of Cedenco	2.37	1.01	2.04	1.61
Max of Chalmers	2.09	1.87	1.94	3.12
Max of Solander	1.55	0.86	1.19	1.06
Max of Innes	0.62	0.47	2.18	0.52
Parkinson ZS	**8.18**	**6.37**	**7.04**	**8.40**
Max of Herschell	0.35	0.41	0.24	0.41
Max of Dalton	1.77	1.74	1.05	1.79
Max of Tamarau	2.48	2.37	1.31	2.46
Max of Wainui	1.57	2.82	0.88	1.59
Max of Whangara	1.70	2.11	1.21	2.41
Kaitī ZS	**6.16**	**7.02**	**4.18**	**7.56**
Max of Kahutia	0.77	1.70	0.82	0.84
Max of City	1.16	2.37	1.40	1.21
Max of Reads Quay	2.00	1.40	1.70	2.54
Max of Anzac	0.49	0.52	0.43	0.56
Max of Childers	1.74	2.04	1.29	2.17
Max of Awapuni	1.23	1.51	1.27	1.94
Max of Gladstone	2.48	2.78	2.43	2.97
Max of Aberdeen	2.39	2.91	1.85	2.88
Max of Palmerston	1.66	2.78	1.76	2.00
Carnarvon ZS	**11.20**	**13.61**	**11.97**	**14.13**
Max of Affco	3.44	3.51	4.18	3.21
Max of Borough One	2.73	2.89	1.74	3.01
Max of Borough Two	1.85	2.02	1.76	2.02
Max of Brickworks	0.41	0.80	0.78	0.49
Max of Nuhaka	0.39	0.41	0.86	0.54

Feeder / Zone Substation	Autumn (MW)	Spring (MW)	Summer (MW)	Winter (MW)
Max of Frasertown	0.86	0.77	0.71	0.82
Max of Raupunga	0.62	0.73	0.49	0.86
Wairoa ZS	**9.58**	**9.16**	**8.56**	**10.28**
Max of Mahia	1.28	1.40	1.31	1.19
Blacks Pad ZS	**1.28**	**1.40**	**1.31**	**1.19**
Max of Morere	0.42	0.91	0.74	0.60
Tahaenui ZS	**0.42**	**0.91**	**0.74**	**0.60**
Max of Village	0.00	0.00	0.00	0.00
Max of Lake	0.26	0.30	0.21	0.28
Max of Ruakituri	0.32	0.34	0.26	0.34
Tuai ZS	**0.56**	**0.58**	**0.41**	**0.56**

Appendix B
Substation Capacity Available

Summer
Autumn
Winter
Spring

Table 34: Zone Substation Capacity Available (2022 All Seasons)

Substation	Required security level	Transformer Capacity (MVA)	Supply Capacity (MVA)	Coincidental Seasonal Peak Load (MVA)				Seasonal Capacity (N) MVA				Seasonal Capacity (N-1) MVA			
				S	S	A	W	S	S	A	W	S	S	A	W
Te Araroa	C3	1 × 2.5	2.5	1.0	0.6	0.9	1.3	1.5	1.9	1.6	1.2				
Ruatoria	C3	1 × 5.0/7.5	5	1.5	0.9	1.4	1.5	3.5	4.1	3.6	3.5				
Tokomaru Bay	C3	1 × 2.5	2.5	0.9	0.7	0.8	1.3	1.6	1.8	1.7	1.2				
Tolaga Bay	C3	1 × 5	5	1.6	0.7	1.1	1.6	3.4	4.3	3.9	3.4				
Ngātapa	C3	1 × 2.5	2.5	1.2	0.3	0.4	0.5	1.3	2.2	2.1	2.0				
Puha	C2	1 × 5	5	3.1	2.5	2.8	3.5	1.9	2.5	2.2	1.5				
Pātūtahi	C1	1 × 12.5	12.5	3.5	2.8	3.2	3.7	9.0	9.7	9.3	8.8				
Matawhero	B	2 × 12.75	25.5	4.0	5.4	4.3	5.1	21.5	20.1	21.2	20.4	8.7	7.3	8.4	7.7
Port	C1	1 × 12.5	12.5	6.7	5.3	8.0	7.5	5.8	7.2	4.5	5.0				
Pehiri	C3	1 × 2.5	2.5	0.4	0.3	0.5	0.5	2.1	2.2	2.0	2.0				
Makaraka	C1	1 × 12.75	12.75	6.8	5.5	6.4	7.8	5.9	7.3	6.3	5.0				
JNL	C1	1 × 12.75	12.75	1.9	1.9	1.9	2.0	10.8	10.9	10.9	10.8				
Parkinson	B	2 × 12.5	25	6.7	7.4	8.6	8.8	18.3	17.6	16.4	16.2	5.8	5.1	3.9	3.7
Kaitī	C1	1 × 12.5	12.5	7.4	4.4	6.5	8.0	5.1	8.1	6.0	4.5				
Carnarvon	B	2 × 12.5	25	14.3	12.6	11.8	14.9	10.7	12.4	13.2	10.1	-1.8	-0.1	0.7	-2.4
Wairoa	B	2 × 1 ph 10	20	9.6	9.0	10.1	10.8	10.4	11.0	9.9	9.2	-1.8	-0.1	0.7	-2.4
Wairoa (T3)	-	1 × 12.5	12.5	1.8	1.6	1.7	1.6	10.7	10.9	10.8	10.9				
Blacks Pad	C3	1 × 1.5 (33/11)	1.5	1.5	1.4	1.4	1.3	0.0	0.1	0.1	0.2				

				Coincidental Seasonal Peak Load (MVA)				Seasonal Capacity (N) MVA				Seasonal Capacity (N-1) MVA			
Substation	Required security level	Transformer Capacity (MVA)	Supply Capacity (MVA)	S	S	A	W	S	S	A	W	S	S	A	W
Tahaenui	C3	1 × 1.5 (33/11)	1.5	1.0	0.8	0.4	0.6	0.5	0.7	1.1	0.9				
Tuai	D	1 × 5	5	0.6	0.4	0.6	0.6	4.4	4.6	4.4	4.4				
Gisborne	A	2 × 60	120	52.0	41.4	48.4	57.4	110.4	78.6	71.6	62.6	8.0	18.6	11.6	2.6

Note:

1) To calculate load and capacity in MVA, we have assumed a system power factor of 0.95.
2) The available capacity populated within this table has been established from a spreadsheet of peak loads. It should be used as a guide only. For any specific connection opportunities, specific modelling and more accurate analysis would be necessary.

Appendix C
Feeder Capacity Available

Summer
Autumn
Winter
Spring

Table 35: 110 kV Feeder Capacity (2022 All Seasons)

Feeder	Conductor		Diverse Seasonal Load				Seasonal Available Capacity (N)				Seasonal Available Capacity (N-1)			
	Type	Thermal Rating (MVA)	S	S	A	W	S	S	A	W	S	S	A	W
Supplies Wairoa Substation:														
WRA-TUI 1	Wolf (ACSR)	53	5	4	5	5	48	49	48	48	44	44	43	43
WRA-TUI 2	Wolf (ACSR)	53	5	4	5	5	48	49	48	48	44	44	43	43
Supplies Gisborne Substation:														
GIS-TUI 1	Hyena (ACSR)	51	25	20	23	27	26	31	28	24	2	12	5	-4
GIS-TUI 2	Hyena (ACSR)	51	25	20	23	27	26	31	28	24	2	12	5	-4

Table 36: 50 kV Feeder Capacity (2022 All Seasons)

Circuit Breaker Reference	Substations supplied (Normal Conditions)	Conductor		Diverse Seasonal Load				Seasonal Available Capacity			
		Type	Thermal Rating (MVA)	S	S	A	W	S	S	A	W
CB82	Port Carnarvon	Cockroach (AAC)	34	19	16	17	21	15	17	17	13
CB92	Tolaga Bay	Mink (ACSR)	13	1	1	1	1	12	12	12	12
CB122	Kaitī	Cockroach (AAC)	34	7	4	6	8	27	30	28	26
CB152	Tokomaru Bay Ruatoria Te Araroa	Dog (ACSR)	18	3	2	3	3	15	16	16	15
CB172	Puha Matawhero Pātūtahi Peheri Ngātapa	Mixture (based on Mink)[1)]	18	9	8	8	10	9	10	10	8
CB182	Makaraka Parkinson JNL	Cockroach (AAC)	34	14	13	13	15	20	21	20	18

Note:

1) This circuit has a mixture of different conductor, ranging from Mink to Dog and Cockroach. Mink conductor has been referenced for simplicity. This is the lowest rated and therefore most conservative approach. Capacity of >8 MVA is available for all seasons.

Table 37: 11 kV Feeder Capacity (2022 Winter Peak)

	2022 Capacity Available (MW)		
Feeder	**Minimum Available**	**Median Available**	**Maximum Available [8)]**
Blacks - Mahia	0.0	3.0	5.5
Carnarvon - Aberdeen 0609	0.0	0.0	0.5
Carnarvon - Anzac 0604	0.0	5.0	8.5
Carnarvon - Awapuni 0606	0.0	4.0	6.0
Carnarvon - Childers 0605	3.0	5.0	7.0
Carnarvon - City 0602	3.0	3.5	9.5
Carnarvon - Gladstone 0607	0.0	4.5	8.0
Carnarvon - Kahutia A 0601	5.5	5.5	8.5
Carnarvon - Kahutia B 0601	2.5	4.5	7.0
Carnarvon - Palmerston 0608	0.0	5.3	9.5
Carnarvon - Reads Quay 0603	3.0	6.0	10.0
JNL - JNL 1601	3.0	3.0	10.0
Kaitī - Dalton 0502	0.0	0.0	10.0
Kaitī - Herchell 0501	4.0	7.0	10.0
Kaitī - Tamarau 0503	0.0	3.0	7.5
Kaitī - Wainui 0504	0.0	5.0	10.0
Kaitī - Whangara 0506	0.0	0.5	10.0
Kiwi - Affco	0.5	4.0	10.0
Kiwi - Borough One	0.0	0.0	0.0
Kiwi - Borough Two	0.5	3.5	9.0
Kiwi - Brickworks	0.0	1.5	10.0
Kiwi - Nuhaka	0.0	1.0	10.0
Makaraka - Bushmere 0805	0.0	4.0	10.0
Makaraka - Campion 0802	0.0	3.5	10.0
Makaraka - Haisman 0804	0.0	3.5	10.0
Makaraka - Nelson 0803	0.0	5.0	10.0
Matawhero - Bell Rd 1406	0.0	1.5	10.0
Matawhero - Dunstan Rd 1403	0.0	7.3	10.0
Matawhero - JNL-A 1405	0.0	3.5	10.0
Matawhero - Waipaoa 1408	0.0	7.5	10.0
Ngātapa - Ngātapa 1102	0.5	0.5	1.0
Ngātapa - Tahora 1103	0.5	0.5	1.0
Ngātapa - Totangi 1101	0.5	2.5	3.0
Parkinson - Cedenco 0704	0.0	3.5	10.0
Parkinson - Chalmers Rd 0707	0.0	5.0	10.0
Parkinson - Elgin 0703	0.0	4.5	10.0
Parkinson - Innes St 0705	3.0	4.5	6.5
Parkinson - Lytton Rd 0703	0.0	4.0	10.0
Parkinson - Solander 0706	0.0	4.3	10.0
Parkinson - Willows Rd 0702	0.0	0.5	10.0

[8] Note that a cap of 10 MW was used to reduce the analysis time required. Where the maximum capacity is 10 MW, additional capacity may be available, though a case-by-case assessment is required.

	2022 Capacity Available (MW)		
Feeder	Minimum Available	Median Available	Maximum Available [8)]
Pātūtahi - Lavenham 0902	0.0	0.0	0.0
Pātūtahi - Muriwai 0905	0.5	3.5	4.0
Pātūtahi - Te Arai 0906	0.5	0.5	1.0
Pātūtahi - Waimata 0903	0.0	0.0	0.0
Pehiri - Parikanapa 1002	0.0	0.5	1.0
Pehiri - Tahunga 1004	0.0	1.0	1.0
Pehiri - Tiniroto 1003	0.0	0.5	10.0
Pehiri - Waerenga O Kuri 1001	0.0	0.5	10.0
Port - Crawford	3.0	3.8	10.0
Port - Esplanade 1503	3.0	5.0	9.5
Port - Harris 1502	2.5	3.8	10.0
Port - Port 1501	3.0	5.0	7.5
Puha - Kanakania 1202	0.5	0.5	1.0
Puha - Matawai 1204	0.0	0.0	0.0
Puha - Te Karaka 1203	0.5	0.5	1.0
Puha - Whatatutu 1201	0.5	0.5	1.0
Ruatoria - Makarika 0204	0.0	1.5	10.0
Ruatoria - Ruatoria 0201	0.5	3.5	6.5
Ruatoria - Tikitiki 0206	0.5	0.5	2.0
Tahaenui - Morere	0.5	1.0	1.5
Te Araroa - Awatere 0101	0.5	0.5	1.0
Te Araroa - Hicks Bay 0102	0.5	0.5	1.0
Te Araroa - Te Araroa 0103	0.0	0.0	0.0
Tokomaru Bay - Inland	0.5	0.5	1.0
Tokomaru Bay - Mata	0.5	0.5	1.0
Tokomaru Bay - Seaside	1.0	2.5	3.0
Tolaga Bay - Rototahi 0403	0.5	1.5	1.5
Tolaga Bay - Tauwhareparae 0404	0.5	0.5	1.0
Tolaga Bay - Toko Tie 0401	0.5	0.5	1.0
Tolaga Bay - Town 0402	0.5	0.5	1.0
Tuai - Lake	0.5	0.5	1.0
Tuai - Ruakituri	0.0	0.0	0.0
Tuai - Village	7.0	7.0	7.0
Wairoa - Frasertown	0.5	1.0	6.0
Wairoa - Raupunga	0.5	0.5	1.5

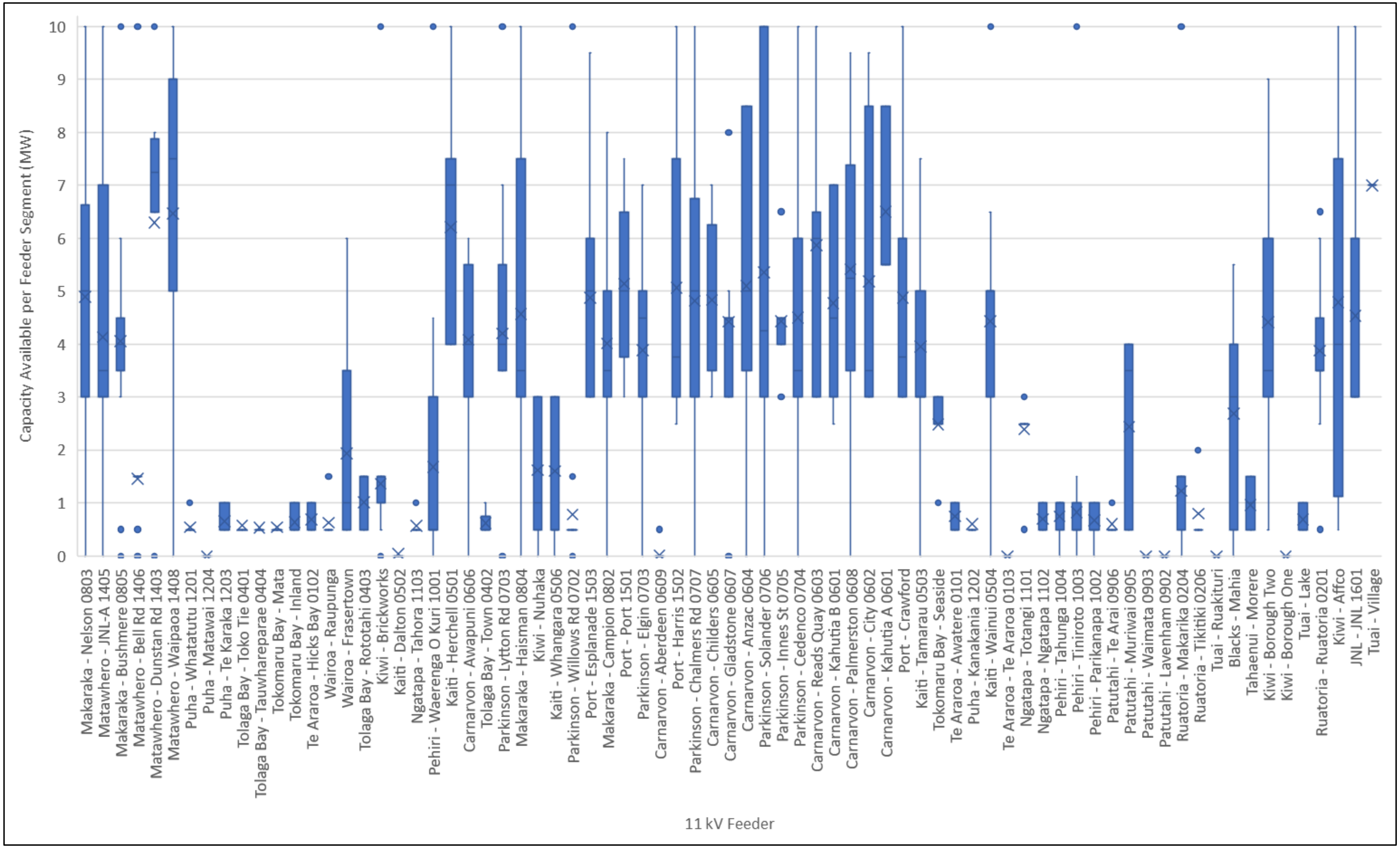


Figure 20: 11 kV Feeder Capacity Available Per Circuit Segment – Winter

Appendix D
Firstlight Network Security of Supply Definitions

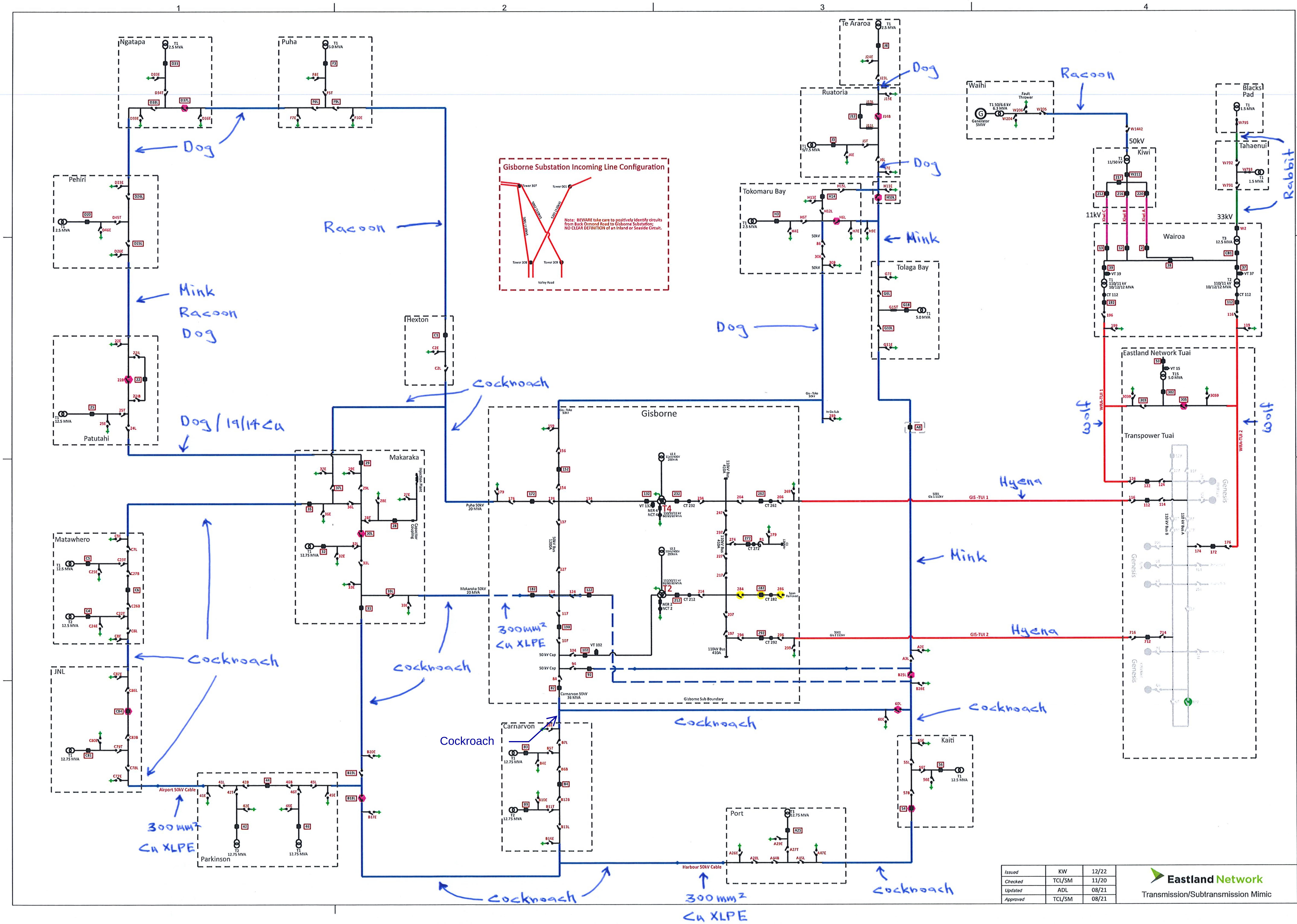
Table 36 of the 2021 AMP outlines the security standards for the network.

Table 38 is duplicated from the AMP for reference [1, p. 81].

Table 38: Firstlight Network Security of Supply Standards

Class	Range of group peak demand (GPD) MVA	No. Customers	Security level	Contingent capacity	Time to restore after event
A	More than 25 MVA i.e., transmission, or sub-transmission rings.	> 15,000	N-1	100%	Repair time.
B	Between 12 and 25 MVA i.e., small GXP, primary CBD & urban substations.	7,000 to 15,000	N-1	100%	Restore 90% of GDP within 3 hours and remaining 10% in time to repair.
C1	Between 6 and 12 MVA i.e., primary urban or industrial substations.	3,500 to 7,000	N	100%	Restore 90% of GDP within 3 hours. Repair time 100%.
C2	Between 3 and 6 MVA i.e., single transformer substations and urban meshed feeders.	1,750 to 3,500	N	80%	Restore 100% in time to repair.
C3	Between 1 and 3 MVA i.e., rural zone substation, meshed feeders.	500 to 1,650	N	67%	Restore 100% in time to repair.
D	Less than 1 MVA i.e., rural feeders, urban spurs, distribution transformers.	< 500	N	Restore 100% in time to repair.	Restore 100% in time to repair.

Appendix E
Firstlight Network Mimic Diagram



Ngatapa
Puha
Pehiri
Patutahi
Hexton
Makaraka
Matawhero
JNL
Parkinson
Carnarvon
Gisborne
Port
Kaiti
Te Araroa
Ruatoria
Tokomaru Bay
Tolaga Bay
Waihi
Kiwi
Blacks Pad
Tahaenui
Wairoa
Eastland Network Tuai
Transpower Tuai
Genesis
Gisborne Substation Incoming Line Configuration
Valley Road
Puha 50kV 20 MVA
Makaraka 50kV 20 MVA
Carnarvon 50kV 36 MVA
Gisborne Sub Boundary
Airport 50kV Cable
Harbour 50kV Cable
GIS-TUI 1
GIS-TUI 2
WRA-TUI 1
WRA-TUI 2
50kV
11kV
33kV
Dog
Racoon
Mink
Dog / 19/14 Cu
Cockroach
Hyena
Wolf
Rabbit 33kV
300 mm² Cu XLPE
Issued KW 12/22
Checked TCL/SM 11/20
Updated ADL 08/21
Approved TCL/SM 08/21
Eastland Network
Transmission/Subtransmission Mimic