# CitiPower and Powercor

## Feasibility Study for Acoustic Treatments
## Substation Sites

December 2019

# Glossary of terms

| Abbreviation | Definition |
|---|---|
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| Ambient Noise | The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far. |
| AS | Australian Standard |
| AS/NZS | Australian / New Zealand Standard |
| Background Noise Level | For a day, evening or night period means the arithmetic average of the $L_{A90}$ levels for each hour of that period for which the commercial, industrial or trade premises under investigation normally operates. The background level shall include all noise sources except noise from commercial, industrial or trade premises which appear to be intrusive at the point where the background level is measured. |
| CAPEX | Capital Expenditure Budget |
| dB | Unit of measurement for Sound Pressure Level known as a decibel |
| dB(A) | 'A-weighted' decibel measurement, developed as a way to represent the sound frequency sensitivity of the human ear |
| Effective noise level | The level of noise emitted from the commercial, industrial or trade premises and adjusted if appropriate for character and duration |
| EMG | Executive Management Group |
| ENA | Energy Networks Association |
| EPA | Environment Protection Authority |
| GHD | GHD Pty Ltd |
| HV | High Voltage |
| IEEE | Institute of Electrical & Electronics Engineers |
| $L_{Aeq\ (Time)}$ | Equivalent sound pressure level is the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring. This is considered to represent ambient noise. |
| $L_{A90\ (Time)}$ | The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise. |
| $L_{A10\ (Time)}$ | The arithmetic average of the sound pressure level that is exceeded for 10 per cent of the time specified. This is considered representative of the average maximum noise. |
| $L_{Amax(Time)}$ | The maximum sound level recorded during a specified time interval |
| $L_{Amin(Time)}$ | The minimum sound level recorded during a specified time interval |
| LV | Low Voltage |
| MV | Medium Voltage |
| NIRV | EPA publication 1411 - *Noise from Industry in Regional Victoria* – October 2011 |

| Abbreviation | Definition |
| --- | --- |
| Refurbishment | Work on an asset which corrects a defect and/or normal deterioration and result in an extension to its expected end of life. |
| Repair / Maintain | Work on an asset which corrects a defect allowing the asset to operate to its expected end of life. |
| Sensitive Receiver,<br><br>Noise Sensitive Area | Sensitive receiver or noise sensitive area, as defined under the SEPP N-1 means:<br>• That part of the land within the apparent boundaries of any piece of land which is within a distance of 10 metres outside the external walls of any of the following buildings – Dwelling (except Caretaker's House) and Residential Building.<br>• That part of the land within the apparent boundaries of any piece of land on which is situated any of the following buildings which is within a distance of 10 metres outside the external walls of any dormitory, ward or bedroom of such buildings – Caretaker's House, Hospital, Hotel, Institutional Home, Motel, Reformative Institution, Tourist Establishment, Work Release Hostel. |
| SEPP N-1 | State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 |
| Sound Pressure Level (SPL) | The Sound Pressure Level is the change in air pressure above and below the average atmospheric pressure (amplitude) caused by a passing pressure wave; this is then converted to decibels and can be abbreviated as SPL or $L_p$. |
| Sound Power Level (SWL) | This is defined as the average rate at which sound energy is radiated from a sound source and is measured in watts (W). The Sound Power Level can be abbreviated as SWL or $L_w$. |
| TF | Transformer |
| ZSS | Zone Substation |

# Executive summary

GHD Pty Ltd (GHD) has been commissioned by CitiPower and Powercor (Powercor) to undertake a cost feasibility assessment for mitigating noise across various substations throughout Victoria (the Project) as part of an effort on Powercor's part to meet their GED requirements.

GHD has used a high-level desktop approach to review a number of potential mitigation options and costings that may be suitable across many of the substations within the CitiPower and Powercor substation network.

Powercor has supplied GHD with a list of substation sites to include in the assessment. GHD completed structural design and noise modelling to assess the feasibility of various noise mitigation solutions. GHD also engaged with an external quantity surveyor to obtain an understanding of indicative costs associated with each solution provided.

GHD has provided a range of noise mitigation solutions for each site, along with indicative decibel reduction and indicative associated costs for Powercor's consideration.

This report is subject to, and must be read in conjunction with, the limitations presented in Section 1.2 and the exclusions, assumptions and qualifications contained throughout the report.

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# 1. Introduction

Recent changes to environmental management for noise and other environmental parameters will come into effect on 1 July 2020 and impose a 'General Environmental Duty' (GED). This GED requires 'A person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution or waste must minimise those risks, so far as reasonably practicable'. Both criminal and civil sanctions will apply to a breach of the GED and officers of a corporation can be made directly liable for breaches under the new legislation.

The *Environment Protection Act 2017* and the *Environmental Protection (Amendment) Act 2018* (new EP Act) provide the new framework for environmental management in Victoria. Changes include new environmental duties, changes to how certain activities are approved, better access to environmental information and more effective investigation, enforcement and compliance.

Part 5.3 of the Draft Regulations address the matters relating to noise. The new regulations replace both the SEPP N-1, SEPP N-2 and also the *Environmental Protection (Residential Noise) Regulations 2018* (in conjunction with Environment Reference Standards (ERS)). They also establish a Noise Protocol which sets out how to determine noise limits, background levels, effective noise levels and alternative assessment criteria for an alternative assessment location.

GHD Pty Ltd (GHD) has been commissioned by CitiPower and Powercor (Powercor) to undertake a cost feasibility assessment for mitigating noise across various substations throughout Victoria (the Project) as part of an effort on Powercor's part to meet their GED requirements.

GHD has used a high-level desktop approach to review a number of potential mitigation options and costings that may be suitable across many of the substations within the CitiPower and Powercor substation network.

This report is subject to, and must be read in conjunction with, the limitations presented in Section 1.2 and the exclusions, assumptions and qualifications contained throughout the report.

## 1.1 Purpose of this report

The purpose of this Report is to provide a high level desktop assessment of potential noise mitigation methods across a number of selected CitiPower and Powercor substation facilities. The report also provides estimates of costs for several of the potential mitigation methods considered.

## 1.2 Disclaimer

*This report has been prepared by GHD for CitiPower and Powercor and may only be used and relied on by CitiPower and Powercor for the purpose agreed between GHD and the CitiPower and Powercor as set out in section 1.1 of this report.*

*GHD otherwise disclaims responsibility to any person other than CitiPower and Powercor arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in Appendix F and throughout the report. This report is based on assumptions made by GHD outlined in Appendix G and as outlined throughout this report. GHD disclaims liability arising from any of the assumptions being incorrect.*

# 2. Substations considered

A range of substations have been assessed across both the CitiPower and Powercor networks to capture a range of potential noise issues and likely mitigation options. This section outlines the substation types considered and a brief description of likely differences and noise challenges for each substation category. The assessed substation sites were chosen to cover a broad range of substations classified into the following three categories:

- Regional substations
- Metropolitan substations
- CBD Substations

The provided substations have indicative night time noise exceedances under the draft regulations. Indicative night time noise exceedance levels are noted for each site assessed in the following sections 2.1 through 2.3 and also in the site details Excel™ output in Appendix E.

## 2.1 Regional substations

For the purposes of deciding whether an area sits in regional or metropolitan boundaries, the following is used:

- SEPP-N1 Boundary
- Melbourne Urban Growth Boundary (MUGB)
- Planning Urban Growth Boundary (PUGB)
- Urban Centre Boundary (UCB)
- Major Urban Area Boundary (MUA)

An Urban Centre Boundary is defined by the Australian Bureau of Statistics as an urban centre with a population of greater than 7,000 people. A rural area covered by the NIRV is defined as land that is not within a MUA and includes land in cities or towns with populations below 7,000 and rural locations outside MUAs.

Powercor has several ‘Regional Substations’ in areas typically outside of metropolitan areas. The ‘Regional Substations’ are classified in this report as those that are located outside metropolitan areas with very low density residential receivers surrounding the substation.

The following Citipower and Powercor sites have been classified as Regional Substations and are assessed in this report:

- WPD, 25 Hams Road, Waurn Ponds (Figure 1)
  - Indicative night time noise exceedance 18 dB(A)
- KYM, 1-7 Allan Street, Kyabram (Figure 2)
  - Indicative night time noise exceedance 16 dB(A)

As the location of these substations is rural in nature, there are generally less neighbours that may be affected by substation noise and typically there may be larger distances between the likely noise sources on site and the noise sensitive receivers.

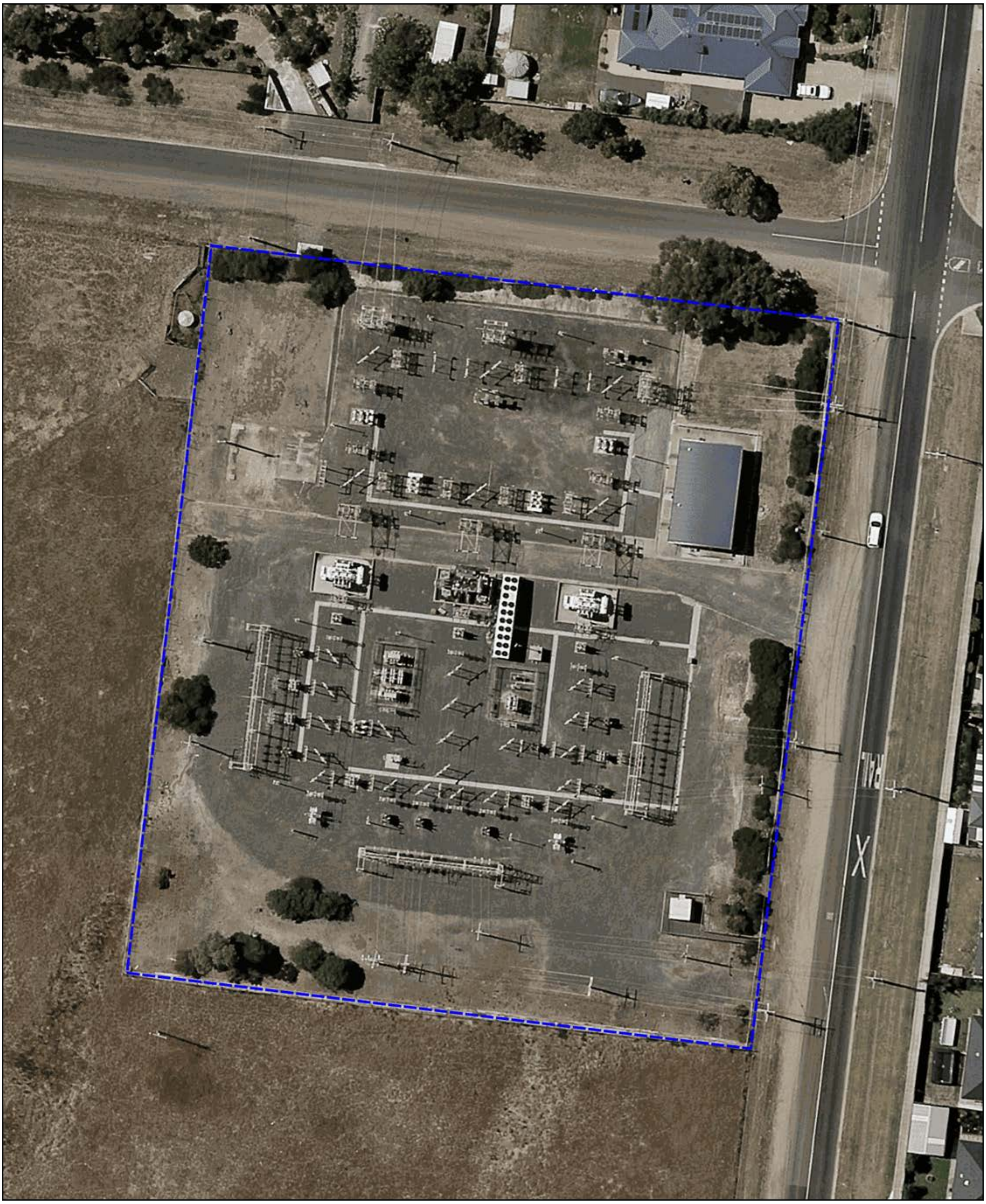
Noise control measures for regional substations may generally be considered easier to implement due to lower numbers of noise sensitive receivers likely to be impacted. However, noise control for such substation sites typically poses additional challenges due to very low background noise levels. Some of these include:

- Lower noise criteria compared to substations in metropolitan areas
- Likely increase in perceptible tonality impacts (noise characters)
- More sensitivity to noise within the community

Therefore, although in some cases the extent of noise mitigation solutions for regional substations may be reduced in cost and complexity, the criteria is likely to be more stringent and as such the most suitable solution may be very similar to that required in substations within metropolitan areas.

Detailed assessment of likely noise emissions from individual substation sites is outside the scope of this report, and therefore the proposed solutions presented by GHD are established based on a high level desktop review from aerial imagery across a number of CitiPower and Powercor substations and the proposed noise mitigation solutions where derived in consultation with the Powercor technical group, GHD's Civil, Acoustic, and Power groups and GHD's experience in assessment of substation noise emissions.

Site overviews for each regional substation considered in this report has been presented in Figure 1 through Figure 2.



Legend

Sites Boundary

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

**CitiPower and Powercor**
**Feasibility Study for Acoustic Treatments**

**Substations Considered**
**Regional Substations**
**WPD (25 Hams Road, Waurn Ponds)**

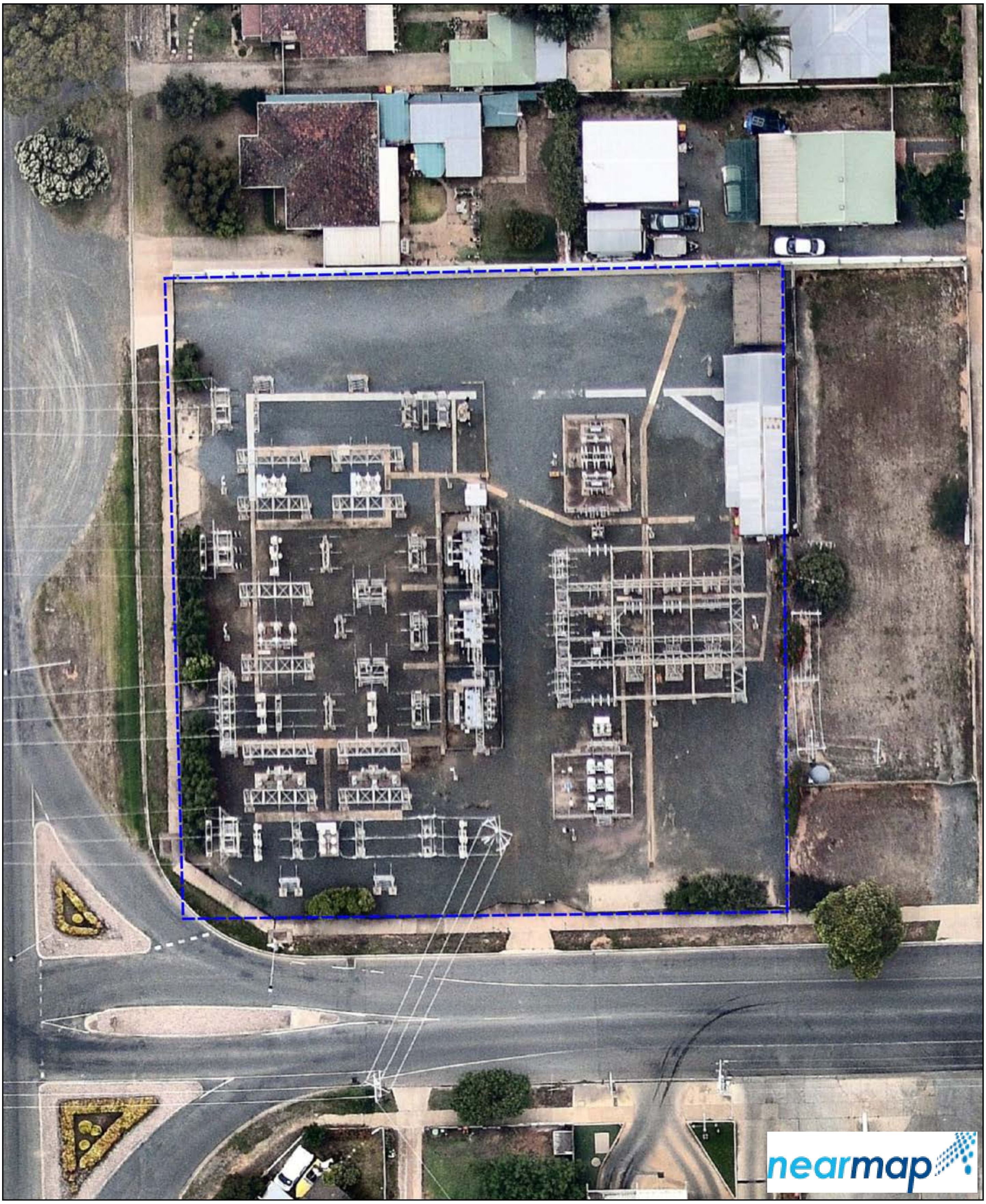
Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 1

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah




Legend

Sites Boundary

Paper Size ISO A4

0 6 12 18 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

**CitiPower and Powercor**
**Feasibility Study for Acoustic Treatments**

**Substations Considered**
**Regional Substations**
**KYM (1-7 Allan Street, Kyabram)**

Project No. **12515501**
Revision No.
Date. **11/11/2019**

FIGURE 2

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz

Data Source: Nearmap Created By: V. Alamshah

## 2.2 Metropolitan substations

The majority of Powercor substation sites considered within this report are located within metropolitan areas including Melbourne and Geelong Major Urban Areas.

Generally, these substations are in densely populated residential areas with noise sensitive receivers within close proximity to the substation site. Noise control solutions for these sites are typically challenging and costly to implement. Due to a larger number of noise sensitive receivers and increased density through multi-level dwellings and apartments, there are likely higher numbers of receivers potentially impacted from operations at the substation where an exceedance may be present. On the other hand, due to the metropolitan nature of the area, the relevant noise criteria may be slightly higher and in turn likely noise reductions required may be lower.

The following CitiPower and Powercor substation sites have been classified as Metropolitan Substations in this report:

- CW, 49 Easey St, Collingwood (Figure 3)
  - Indicative night time noise exceedance 12 dB(A)
- AR, 924 High Street, Armadale (Figure 4)
  - Indicative night time noise exceedance 12 dB(A)
- BC, 49 Hotham Street, St Kilda East (Figure 5)
  - Indicative night time noise exceedance 7-12 dB(A)
- NC, 21 Lennox Street, Northcote (Figure 6)
  - Indicative night time noise exceedance 6 dB(A)
- AP, 7 – 9 Howe Crescent, South Melbourne (Figure 7)
  - Indicative night time noise exceedance 5 dB(A)
- SK, 6 Waterloo Crescent, St Kilda (Figure 8)
  - Indicative night time noise exceedance 4 dB(A)
- Q, 15 – 17 Tennyson Street, Kew (Figure 9)
  - Indicative night time noise exceedance 2 dB(A)
- CL, 387 Riversdale Road, Hawthorn East (Figure 10)
  - Indicative night time noise exceedance 6 dB(A)
- GLE, 242 – 254 St Albans Road, Breakwater (Figure 11)
  - Indicative night time noise exceedance 12 dB(A)
- GL, 22 – 30 Ballarat Road, Hamlyn Heights, Geelong (Figure 12)
  - Indicative night time noise exceedance 18 dB(A)
- WBE, 178 Shaws Road, Werribee (Figure 13)
  - Indicative night time noise exceedance 4 dB(A)

Site overviews for each metropolitan substation considered in this report has been presented in Figure 3 through Figure 13.


Legend

Sites Boundary

Paper Size ISO A4

0 3 6 9 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

**CitiPower and Powercor**
**Feasibility Study for Acoustic Treatments**

**Substations Considered**
**Metropolitan Substations**
**CW (49 Easey St, Collingwood)**

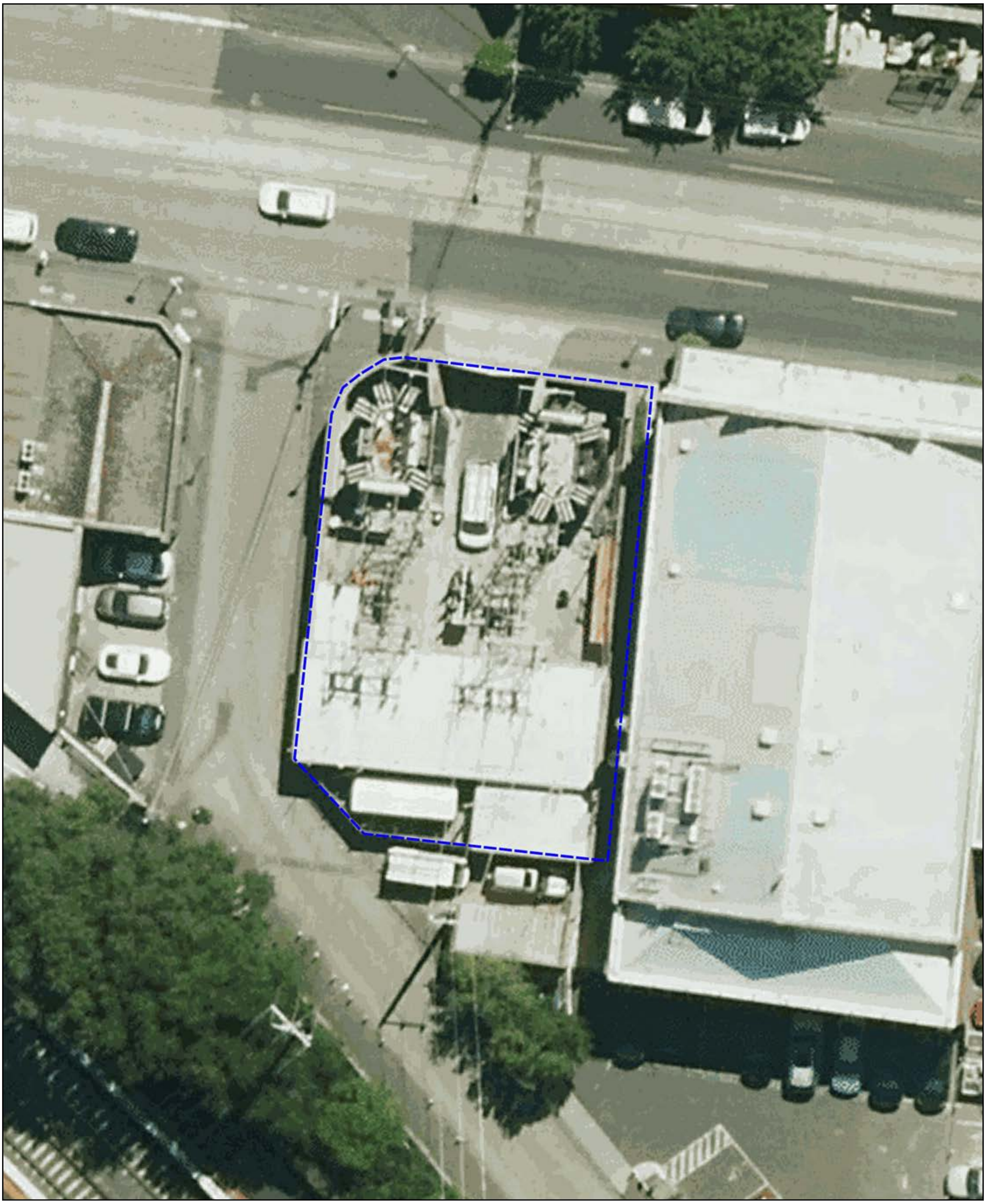
Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 3

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah



Legend

Sites Boundary

Paper Size ISO A4

0 3 6 9 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**AR (924 High Street, Armdale)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 4

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 5 10 15 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**BC (49 Hotham Street, St Kilda East)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 5

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 5 10 15 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**NC (21 Lennox Street, Northcote)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 6

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 3 6 9 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**AP (7 – 9 Howe Crescent, South Melbourne)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 7

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 4 8 12 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**SK (6 Waterloo Crescent, St Kilda)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 8

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 4 8 12 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**Q (15 – 17 Tennyson Street, Kew)**

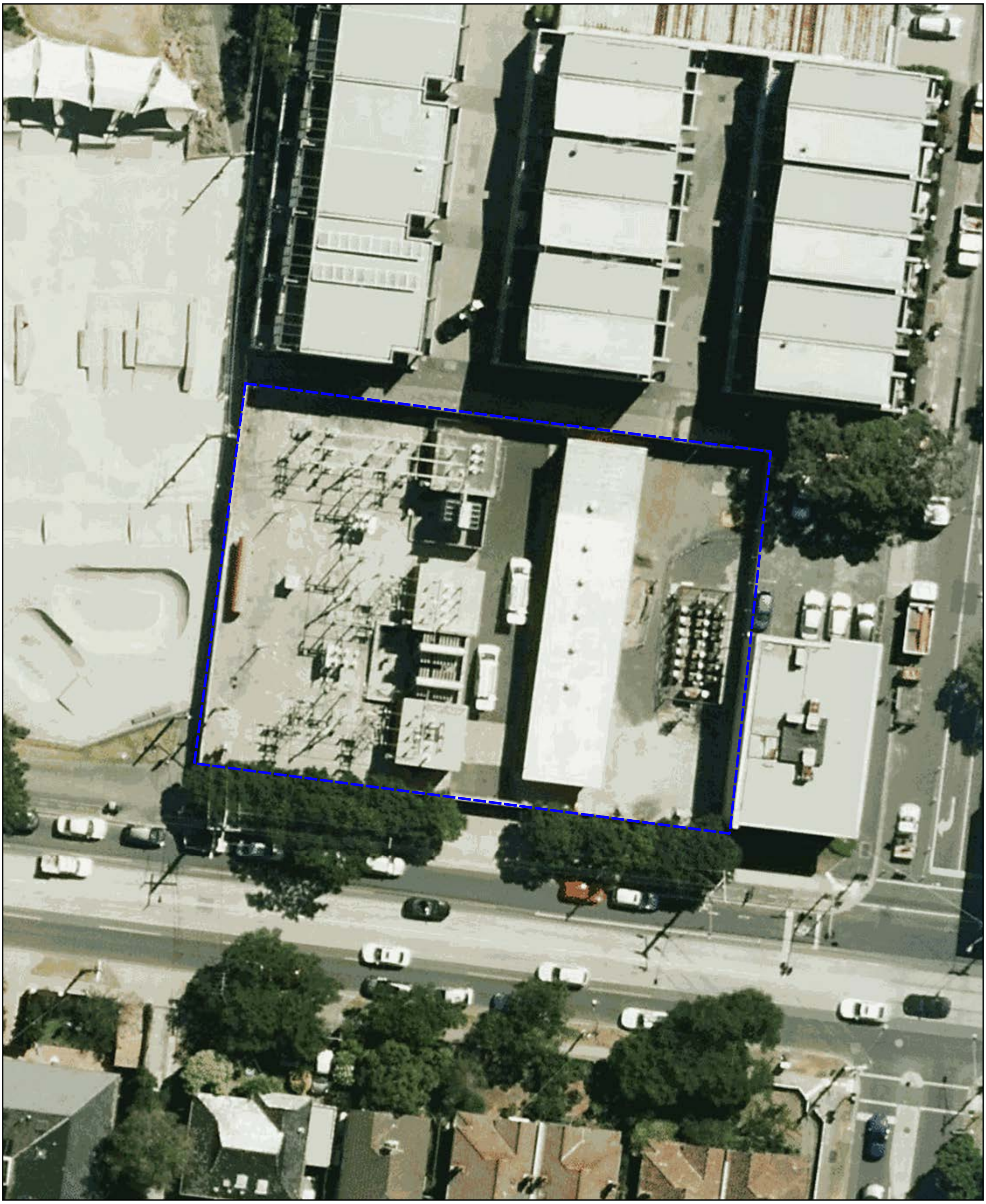
Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 9

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah



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Sites Boundary

Paper Size ISO A4

0 5 10 15 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

**CitiPower and Powercor**
**Feasibility Study for Acoustic Treatments**

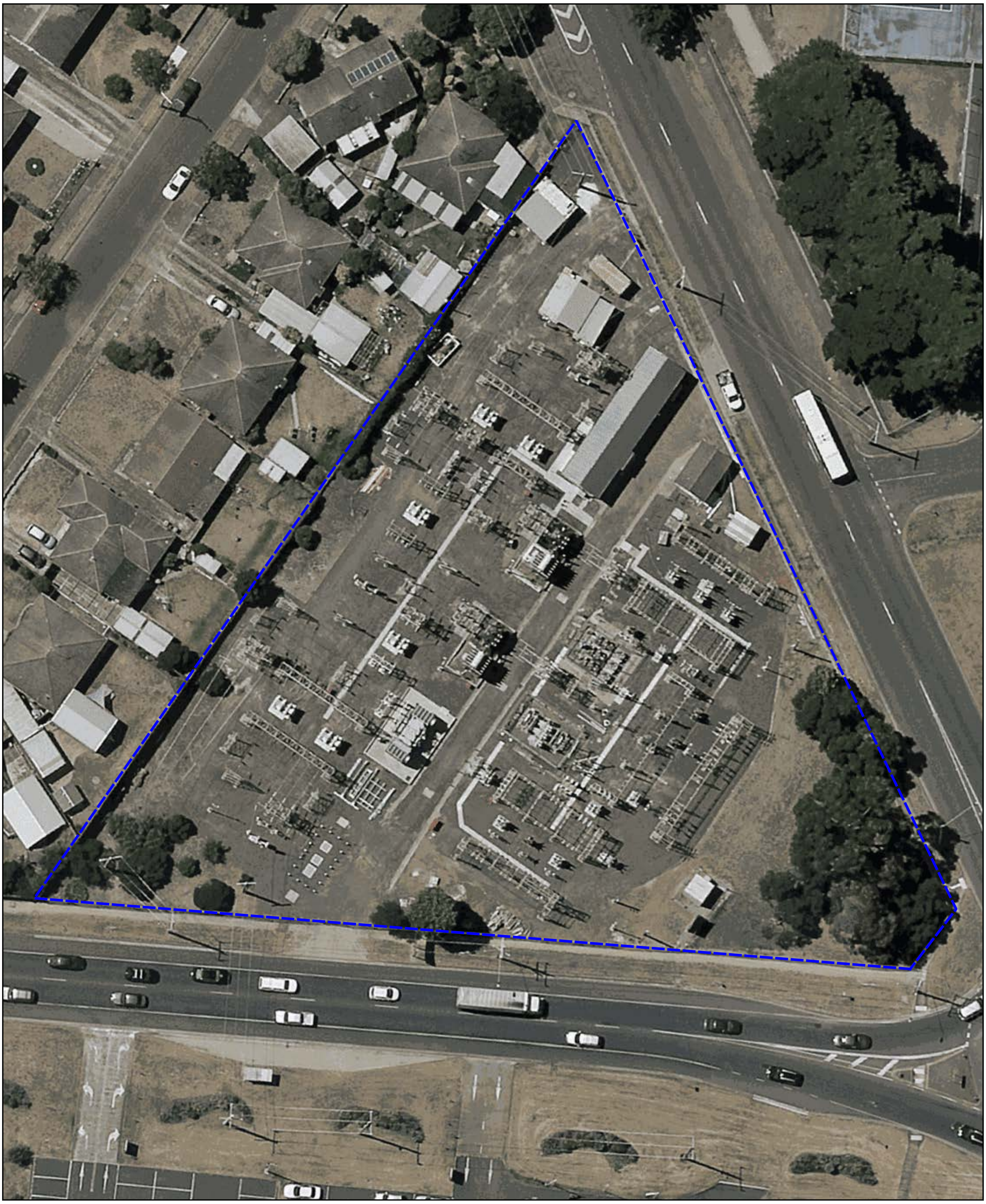
**Substations Considered**
**Metropolitan Substations**
**CL (387 Riversdale Road, Hawthorn East)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 10

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz

Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah



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Sites Boundary

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

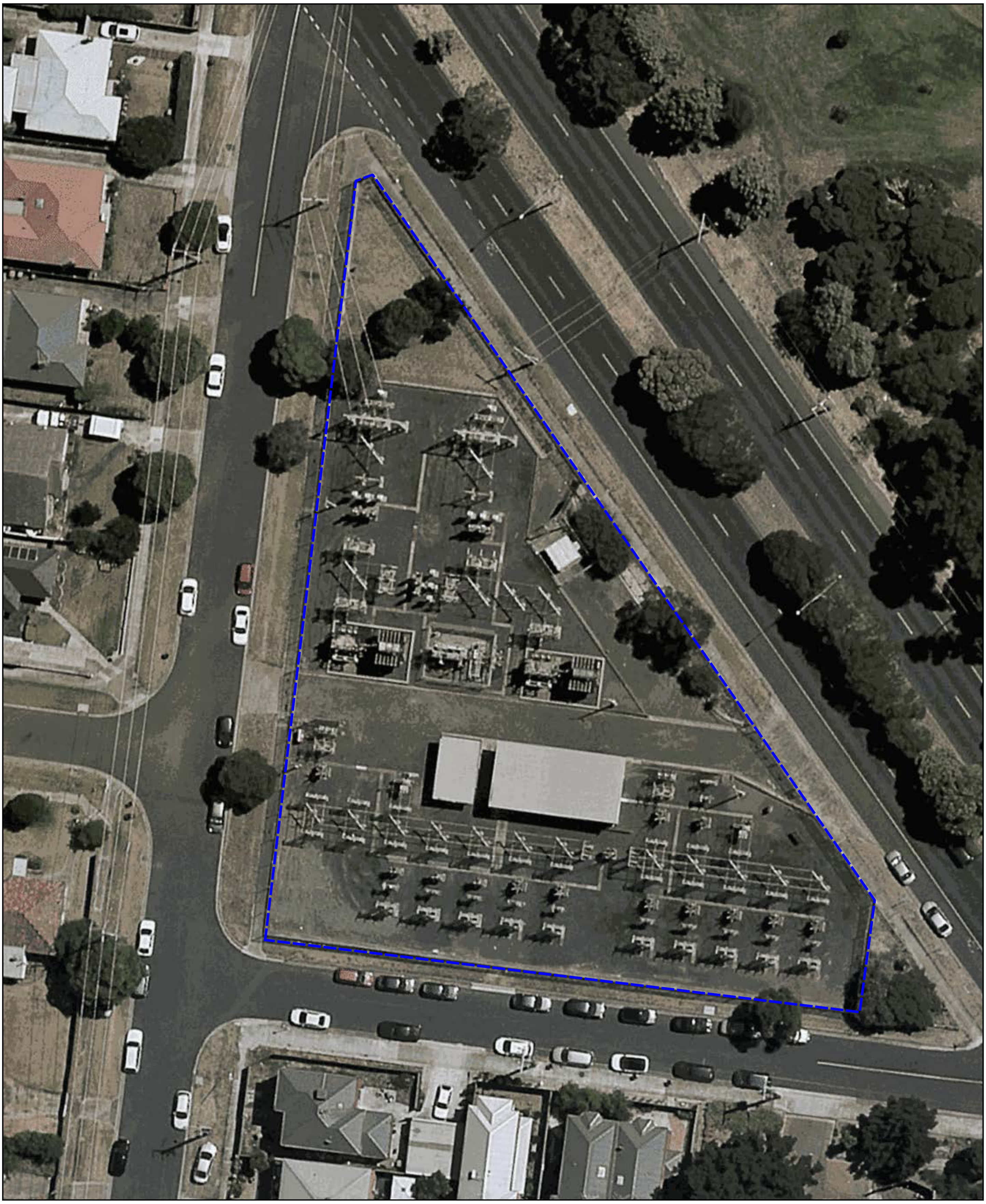
N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**GLE (242 – 254 St Albans Road, Breakwater)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 11



Legend

Sites Boundary

Paper Size ISO A4

0 6 12 18 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

**CitiPower and Powercor**
**Feasibility Study for Acoustic Treatments**

**Substations Considered**
**Metropolitan Substations**
**GL (22 – 30 Ballarat Road, Hamlyn Heights)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 12

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

Legend

Sites Boundary

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

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GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**Metropolitan Substations**
**WBE (178 Shaws Road, Werribee)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 13

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

## 2.3 CBD substations

Powercor has a number of substations that are within ‘CBD’ locations and are located completely indoors, adjoining various neighbouring buildings in densely populated and heavily utilised areas.

In such cases, the noise emissions from the substation would typically need to be contained within the internal boundary of the building due to the close proximity of other buildings and sensitive receptors. As a result significant noise mitigation measures may be required to contain potential noise issues. In addition to airborne noise, vibration transmission and structure borne noise is also typically a critical factor for such substations due to potentially shared façades or structures with adjoining receivers. Due to equipment being indoors and the close proximity to sensitive receivers, natural and passive ventilation of equipment may also not be possible introducing a requirement for forced air ventilation and/or air-conditioning adding to the noise level and noise reduction complexities from this type of substation.

One example of a Powercor/Citipower CBD substation includes:

- VM, 33 – 37 Walsh Street, West Melbourne (Figure 14)

Due to the unique nature of each CBD substation, GHD is not able to provide standardised solutions that will be suitable for multiple substations. It is anticipated that each substation which is currently affected by an acoustic or vibration issue will require a tailored solution specific to that substation. Therefore, while GHD outlines indicative suggestions for CBD substations within this report, costing is not undertaken for these indicative solutions due to the complexity of the likely issue and the need for case by case investigations at each site.

A site overview for the CBD substation provided as an example in this report has been presented in Figure 14.


Legend

Sites Boundary

Paper Size ISO A4

0 6 12 18 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**Substations Considered**
**CBD Substations**
**VM (33 – 37 Walsh St. West Melbourne)**

Project No. **12515501**
Revision No. **B**
Date. **11/11/2019**

FIGURE 14

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Aerial Imagery Source: Government of Victoria, DELWP VicMap. Street View Imagery Source: Google Imagery 2019
Created By: V. Alamshah

# 3. Acoustic mitigation options

## 3.1 Mitigation strategies

The noise mitigation strategies can generally be divided into four different areas, namely:

- Land use controls and planning (separating the location of noise-producing activities from sensitive areas)
- Control at source (reducing the noise output of the source to provide protection to the surrounding environment)
- Control of transmission path (reducing the noise level at the receiver but not necessarily to the environment surrounding the source, e.g. noise barrier, earth bund)
- Receiver control and mitigation (localised acoustic treatment at a sensitive receptor)

Land use, planning and source controls are at the top of noise mitigation hierarchy with control of sound transmission paths and receiver mitigation coming after. The most effective solution to reduce noise emissions is to eliminate or control the noise at the source. Controlling noise at the source allows for a consistent reduction of noise at all noise sensitive receivers and reduces likely extent and risk of underperformance of mitigation measures.

Other strategies such as control of the transmission path and receiver mitigation are considered when potential control of source measures are exhausted. Quiet often, the noise mitigation strategy for a specific site will include a mix of the above mitigation strategies. Receiver control and mitigation is however typically left as last resort where other reasonable and practical measures cannot be implemented. Control of noise at the receiver is typically more difficult and limited to specific noise sensitive receivers who gain treatment and this does not rectify the source of noise. Further control of noise at the sensitive receiver location generally means only the internal noise is (façade, window, and roof treatments) mitigated leaving the outside amenity still in non-compliance.

### 3.1.1 Land use control and planning

Land use control is typically a consideration of appropriate site location, relevant planning control measures and buffers that could be implemented during the early planning stages of a development. There are a number of strategies that could be implemented including:

- Setback strategy (e.g. open space design adjacent to noisy industries, busy roads and/or railway corridors to provide noise reduction through setback distances to residential uses).
- Setback distances (i.e. buffers) between the noise source and the noise sensitive receiver can reduce the noise exposure level experienced by the surrounding noise sensitive receivers. A setback strategy would also be effective in mitigating ground-borne vibration impacts from nearby vibration sources, which may be a consideration for CBD substation locations.
- Building locations and height controls: For example, high rise buildings (preferably not dwellings) could be located adjacent to primary noise sources to provide a noise shielding effect to residential uses and the overall precinct.
- Impose acoustic control planning conditions on new developments such as planning permit conditions for specific acoustic treatments for noise sensitive developments.

### 3.1.2 Source control

Source control measures typically include treatments to the noise source itself such that the noise emissions are reduced resulting in decreased noise levels at the noise sensitive receivers.

Examples of strategies that could be implemented to control noise at the source include:

- Operational restrictions such as reduced operational hours during sensitive periods
- Replacing and using quieter equipment
- Equipment maintenance to reduce noise emissions
- Incorporation of noise treatments to plant and equipment to reduce noise (examples include mufflers or modification to equipment design and enclosures)
- Use of efficient enclosures for noise sources
- Treatment to the building or enclosures housing the noise sources
- Active noise control, including noise cancelling technology

Due to nature of the substation environment and criticality the operation of substation, some of above strategies may not be possible.

### 3.1.3 Control of transmission path

The noise reduction strategy used to control noise in transmission generally involves the installation of noise barriers. Noise barriers may include an existing feature, such as:

- An elevated road or a natural slope (e.g. earth mound)
- A purpose designed feature such as a solid boundary fence
- A purpose designed feature of the building, such as a partially enclosed carport
- A purpose designed building which acts as a barrier block

Figure 15 and Figure 16 illustrate different noise barrier configurations, sourced from the NSW Department of Planning "*Development near Rail Corridors and Busy Roads – Interim Guideline*" (NSW DoP, 2008).

The barrier should be installed in a manner such that it covers the noise sources from direct line-of-sight to the sensitive receptors. In general, the barrier should provide sufficient screening to avoid direct line-of-sight between the shielded noise sources and the protected sensitive receivers.

Noise barriers would not be effective in reducing noise impacts if the line of sight from the noise source to the residence is not reduced. Hence, it may not be practical to install a noise barrier for elevated sensitive receptors such as that occurring at the Balaclava zone substation.

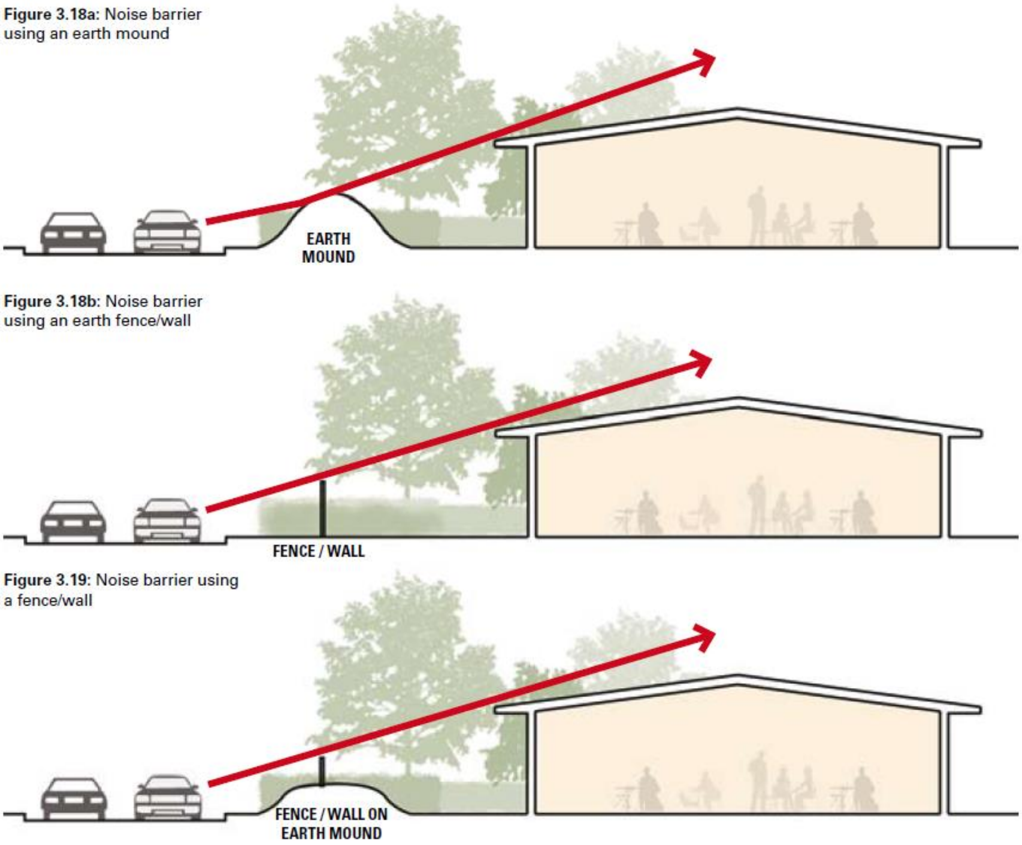



**Figure 15 Noise barrier features (NSW DoP, 2008)**

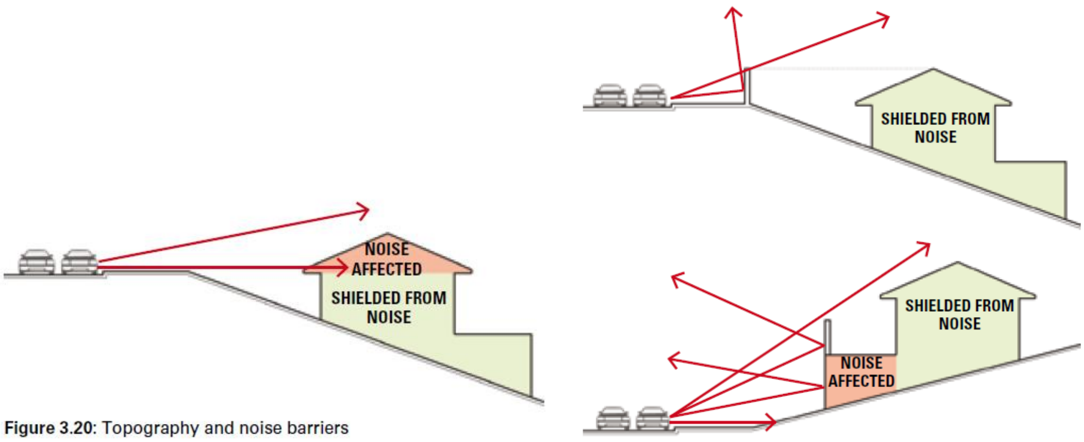



**Figure 16 Noise barrier topography and features (NSW DoP, 2008)**

### 3.1.4 Receiver control

There are several strategies that could be used to control noise at the receiver including:

- Building orientation
- Balustrade/balcony design/configuration
- Building façade acoustic treatment
- Roof or ceiling insulation
- Reducing flanking pathways into the building shell

The main receiver control strategy that could be implemented at existing sensitive receptors is building façade acoustic treatment. External noise intrusion due to different sources such as traffic, rail, aircraft, music or industrial noise is typically transmitted into the building via lightweight façade elements such as glass, doors, lightweight walls, lightweight roofs, as well as any grille openings. Subject to more detailed noise assessment of external noise intrusion, these light weight façade elements may need to be acoustically treated to preserve indoor amenity of the building occupants, such as:

- Minimise lightweight external wall construction facing the dominating noise sources
- Thicken glazing construction for the window façade
- Minimise window size and maximise masonry on the external wall construction
- Minimise the use of openable window construction
- Configure any discharge/intake duct grill layout (above ceiling level) facing away from the noise sources

The purpose of treating the building envelope is to reduce the internal noise. In principle, noise inside a building can be reduced if the building envelope has a high sound reduction. Heavy, dense materials such as masonry or brick walls are better for sound reduction. However, lightweight solutions can also be effective in reducing noise. These include double-stud, staggered-stud or resilient-stud systems that have external layers of cement sheet or similar and internal layers of plasterboard with acoustic insulation in the cavity.

Noise from external noise sources may enter a room through the roof, external walls, windows and external doors. Windows and doors are often the weakest point in sound insulation. Measures such as thicker glass, laminated glass or double glazing and acoustically sealed windows (permanent or openable) and doors are techniques for noise reduction. Louvre windows are less effective in noise reduction when compared to solid single and double glazed acoustically sealing windows. Depending on the noise reduction required, window size and effectiveness of acoustic seals, louvre windows can be considered as a construction component.

The internal noise design objectives in some cases can only be achieved when the windows remain closed. In such cases, to maintain internal design objectives at all times would require ventilation to rooms by means other than through openable windows. Alternative ventilation may include "borrowed" natural ventilation from other rooms with less exposure to external noise sources or a mechanically ventilated system.

Control of noise at the sensitive receiver location generally means only the internal noise is (façade, window, and roof treatments) mitigated leaving the outside amenity still in non-compliance.

## 3.2 Mitigation options

The following sections outline the acoustic mitigation options assessed in this report taking into consideration the strategies outlined in Section 3.1 above. It is noted that not all the noise mitigation options noted below are costed. Table 1 below summarises noise mitigation options considered in this assessment and provides an indication of those that are costed.

**Table 1 Noise mitigation options**

| Mitigation Option | Costed? | Comment |
|---|---|---|
| Do nothing approach | ✓ | An indicative cost is noted based on likely fine potential incurred by EPA enforcement action |
| Transformer Replacement | ✓ | An indicative cost provided by Powercor has been considered |
| New transformer enclosure | ✓ | Costed based on established indicative design |
| New radiator enclosure | ✓ | Costed based on established indicative design |
| Modification to transformer enclosure | ✓ | Costed based on established indicative design |
| Modification to radiator enclosure | ✓ | Costed based on established indicative design |
| Acoustic perimeter wall | ✓ | Costed based on established indicative design |
| Miscellaneous treatments | ✕ | Not costed as it varies case by case |
| Acoustic treatments at the receiver | ✕ | Not costed as it varies case by case |
| CBD substations treatment options | ✕ | Not costed due to complexity |
| Site retirement or relocation | ✕ | Not costed |

### 3.2.1 Do nothing approach

The option to not undertake any noise mitigation at substation sites which are known to have an exceedance has been considered (refer to indicative night time noise exceedance levels noted for each site in the sections 2.1 through 2.3 and also in the site details Excel™ output in Appendix E). Whilst on the face if it (*prima facie*) it would seem there is no cost related to this approach, there is in fact a significant risk of EPA enforcement action occurring.

The first stage of enforcement action is currently occurring at the Balaclava substation site, which due to residential complaints has had an EPA pollution Abatement Notice (PAN) placed on the site requiring this sites noise to be investigated and a proposed plan for noise reduction costed and provided to EPA by 11 December 2019.

Failing this CitiPower and Powercor may incur an infringement notice and subsequent to this should nothing be done to rectify the non-compliance to comply with local noise regulations, further legal action may be taken as follows:

- $8,060 initial fine (approximately, based on recent examples)[1]
- $390k max fine
- $195k/day ongoing fine

[1] https://www.epa.vic.gov.au/about-us/news-centre/news-and-updates/news/2019/april/10/yarra-trams-fined-for-noisy-substation
https://www.epa.vic.gov.au/about-us/news-centre/news-and-updates/news/2019/august/01/noisy-nightclub-changes-its-tune

### 3.2.2 Transformer replacement

As outlined in Section 3.1 elimination or reduction of noise at the source is the most effective noise mitigation strategy. New transformers typically have lower noise emissions compared to older transformers. Advances in technology and transformer design have allowed for better assessment of resonance frequencies and fine tuning of the transformer design to reduce noise and vibration. Reduced noise can be achieved by various optimised transformer design techniques such as:

- Enhanced material (i.e. steel with better magnetic orientation and lower magnetostriction)
- Control of core resonance frequencies by structural design
- Reduced lamination vibration through heavier grade lamination with greater stiffness
- Optimised winding design
- Optimised core design
- Optimised tank design
- Use of stiffeners or other means to reduce noise emissions

Depending on the likely exceedances at each site, transformer replacement and transformer selection could be considered to suit the noise emission requirements at each site. In addition to the noise reduction benefits that a new transformer replacement may provide, this option will also enable implementation of appropriate noise and vibration isolation mitigation measures within a purpose built sound enclosure. This option is generally expected to achieve a minimum reduction of 15 dB.

This option has not been costed by GHD, however an indicative cost per transformer of $3.7 million has been provided by Powercor based on previous transformer replacement projects with purpose built sound enclosures within the Powercor network.

### 3.2.3 New transformer enclosure

A new transformer enclosure may be built around the existing transformers that are located in an open area (not yet enclosed). Enclosures are a very effective noise mitigation for transformers when done correctly with adequate element isolation and is considered the most effective in situations where reduction in transformer noise itself is not possible.

Design of the transformer enclosure is critical due to the low frequency nature of transformer noise. Typically, to achieve a significant reduction, a transformer enclosure should have a heavy roof and walls and adequate sound attenuation through the access ways and ventilation paths.

For this assessment GHD has designed a new transformer enclosure which has been structurally designed up to 4.5 m tall, with an estimated footprint of 7.5 m x 7.5 m.

The new transformer enclosure (shown on SK003, Appendix A) is designed with prefabricated concrete precast walls, with one wall constructed of masonry and a precast concrete roof designed to support plant and equipment. The roof also includes removable Webforge Monowills handrails around the full perimeter for safe roof access when maintaining equipment. New louvres and a new acoustic/fire rated door has also been incorporated into the design.

Isolation/separation between the existing radiator slab and the new radiator enclosure footings has also been included to mitigate transfer of vibration between the two structures. The two structures are separated with 10 mm thick ableflex compressible fill material (separation thickness can be increased if vibration is found to be substantial on a site by site basis).

The new transformer is designed acoustically to achieve a nominal noise reduction of 20 ± 5 dB. An acoustic assessment and design of the transformer enclosure is further discussed in Section 4 (noise assessment).

### 3.2.4 New radiator enclosure

A new radiator enclosure may be built around the existing radiators where radiators are located outside. Depending on the cooling method, radiators could also be considered a significant noise emission source at a substation site. Cooling is typically achieved by:

- Natural convection at lower operating temperatures; or
- Forced convection via fans during hotter operating temperatures
- Forced circulation via oil pumps

Fans can also be somewhat noisy (64 dB(A) @1 m, BC-Substation) and have distinct noise characters resulting in annoyance at receivers. Oil pumps are significantly quieter and generally new oil pumps will emit noise at approximately 51 dB(A) @1 m (BC-Substation).

Often, transformer noise and vibration is also transmitted via the connection between the two structures resulting in noise emitted from the radiator fins.

The new enclosure around the radiator will contain noise emissions from the radiator at the source reducing the noise emissions at the noise sensitive receivers. This is a particularly effective noise mitigation option where noise sensitive receivers are within close proximity of the site or the site is surrounded by multi-storey sensitive receivers, such is seen at Balaclava (BC).

The new radiator enclosure option in this assessment has been structurally designed up to 6 m tall, with an estimated footprint of 7.5 m x 7.5 m. The new radiator enclosure (shown on SK002, Appendix A) is designed as prefabricated concrete precast panel walls supported by a Waler Beam and a strip footing around the full enclosure perimeter. New louvres and a new acoustic/fire rated door has also been incorporated into the design.

Isolation/separation between the existing radiator slab and the new radiator enclosure footings has also been included to mitigate transfer of vibrations between the two structures. The two structures are separated with 10 mm thick ableflex compressible fill material (separation thickness can be increased if vibration is found to be substantial on a site-by-site basis).

Appropriate ventilation remains an important aspect of the new enclosure to ensure the cooling requirements are maintained. GHD notes that a detailed assessment of such requirements has not been undertaken in this assessment and a detailed assessment of heat and air flow requirements would be needed. GHD has included ventilation louvres in the radiator design to allow for a cost estimate. Four (4) louvres have been allowed for, please refer to Appendix A.

### 3.2.5 Modifications to existing transformer enclosure

There are various substation sites where the transformer and/or the radiator are fully or partially enclosed. Generally, the transformers are enclosed within a brick building with either the radiator located outside unenclosed or within a partial enclosure (oil splash and fire barrier). In these cases it is generally expected that noise emissions are controlled by a number of paths including:

- Structural airborne noise transfer and structure borne noise due to insufficient isolation of the transformer from the structure
- Noise through the access doors
- Noise through ventilation paths

- Noise via penetrations and the like within the structure (flanking)
- Noise transfer into the radiator structure from the transformer

In this assessment all existing transformer structures (i.e. wall and roof) have been assumed to be brick or heavy masonry and hence airborne noise through existing structural elements is assumed to not be a controlling noise source. Therefore, acoustic mitigation for this option is more around the non-structural solutions addressing likely paths for noise flanking and transmission including access, ventilation, and penetrations.

All existing doors are suggested to be replaced with Acoustic/Fire rated Nap Silentflo doors with an acoustic performance rating of minimum $R_W$ 40 (or equivalent). All existing louvres are assumed to be replaced with higher performing acoustically rated intake louvres as per the louvre specification noted in the design sketches (SK001 and SK005, Appendix A).

Acoustic treatment to internal walls has been included using an acoustically absorptive internal wall finish as per the specification noted in the design sketches (SK001 and SK005, Appendix A). An absorptive finish was nominated as it will reduce noise build up within the enclosure and in return reduced noise emissions from each of the likely noise transmission paths or acoustic weaknesses within the enclosure.

Consideration is also provided for treatment of all penetrations, gaps and/or other acoustic weaknesses with appropriate acoustic sealant and heavy framing (low frequency intervention). Additionally, consideration is also given to isolation of transformer components from the structure or where possible the radiator to reduce potential structure borne noise. Implementation of resilient and vibration isolation hangers or pads are suggested to assist with control of structure borne noise.

Vibration isolation of pipework and/or transformer connections from the surrounding structure via resilient/vibration isolators is also considered for this option.

### 3.2.6 Modifications to existing radiator enclosure

There are a number of substations with existing radiator enclosures. Powercor has advised that typically these have a wall on two of their four sides (oil splash and fire barrier). Two new radiator acoustic walls may be built at these locations to enclose the radiator on all four sides. The new radiator enclosure has been structurally designed up to 6 m tall, with an estimated footprint of 7.5 m x 7.5 m. The existing wall may require removal and reinstallation should their overall heights not met the minimum acoustic requirements, however this would be assessed on a site-by-sites basis and therefore has not been costed in this assessment.

The new radiator enclosure (shown on SK004, Appendix A) is designed as prefabricated concrete precast walls supported by a Waler Beam and a strip footing around the full enclosure perimeter. The two new walls will require connections to the two existing walls around the radiator. Four (4) new louvres and two (2) new acoustic/fire rated doors have also been incorporated into the design along the new walls similar to that of the transformer enclosure modification.

Isolation/separation between the existing radiator slab and the new radiator enclosure footings has also been included to mitigate transfer of vibrations between the two structures. The two structures are separated with 10 mm thick ableflex compressible fill material (separation thickness can be increased if vibrations are found to be substantial on a site-by-site basis).

### 3.2.7 Acoustic perimeter wall

Acoustic barriers are one of the most effective solutions for control of noise transmission paths by reducing direct sound transmission between the source and receiver. However, the performance of the acoustic barriers is hugely dependent on the height of the barrier, and the distances of the source and noise receivers to the barrier. As noted in Section 3.1.3, the effectiveness of the barrier in reducing noise will depend on if the barrier is sufficiently blocking the direct line of sight between the noise source and the sensitive receiver. Therefore where elevated receivers such as double or multi-storey buildings exist at the site the barrier may not be an effective solution or may not provide the required noise reduction. An example of this is the Balaclava (49 Hotham St) substation where the adjoining noise sensitive receivers to the south are double storey units with direct line of site to the transformers. For this case, incorporation of a typical barrier will not be an effective noise mitigation strategy for these elevated sensitive receivers and a very high barrier would be needed to achieve any notable reduction.


**Figure 17 Example of reduced barrier performance**

The acoustic perimeter wall may be used either as an independent noise mitigation solution, or in addition to other solutions to assist with overall noise reduction from the substation site. The acoustic perimeter wall may be installed along the full perimeter of the substation boundary, or on selected sides, depending on each substation's unique requirements. As noise emission details for each site are not known, for the purpose of this report it is assumed that a full perimeter fence is required around each site.

Two acoustic perimeter wall construction types have been nominated including:

- Option A – Concrete wall
  - The acoustic perimeter wall 'Option A' consists of 200 mm thick precast concrete panels supported by vertical steel posts on piled footings with a 600 mm diameter, 3,000 mm deep (SK006, Appendix A). All concrete panel joints are also lined with full depth acoustic rated mastic (or equivalent) to prevent noise leakage.
- Option B – Steel perimeter wall
  - The acoustic perimeter wall 'Option B' (SK007, Appendix A) is an alternative type of construction offering a different architectural finish, and may be selected depending on the unique requirements of each individual substation. The acoustic perimeter wall option B consists of two steel sheets of cladding separated with a void. The Option B construction is comprised of:
    - Two(2) layers of 1 mm BMT sheeting separated by minimum a 100 mm void
    - Inclusion of a minimum 100 mm thick 120 kg/m$^3$ insulation[2] in the cavity
    - Inclusion of framing and capping
  - The metal sheeting will span between horizontal girt members, and will be supported by vertical steel posts on piled footings with a 600 mm diameter, 3,000 mm deep.

The acoustic perimeter walls (both alternatives) have been designed for a maximum height of 6,000 mm, however this can be reduced for individual sites as required.

Additional noise reduction from the acoustic wall may be achieved by lining the noise facing side with an acoustically absorptive finish internally (i.e. side facing the sources) as per the specification noted in the design sketches (SK001, Appendix A). This is also considered in the costing for this option.

An indicative transformer noise reduction of 5 – 15 dB is expected from an acoustic wall provided that the noise receiver is well shielded from the transformer (i.e. line of sight is completely blocked by the acoustic wall) and depending on the distance of the source and receiver with respect to the acoustic wall.

For substations with multiple transformers and other noise sources, the overall reduction achieved through an acoustic wall will also be dependent on the combined noise contributions from all sources on site. As these sources will have different distances, the acoustic performance of the barrier may vary for each individual path from each source to a given receiver resulting in a reduced overall performance. This often occurs in cases where sources (e.g. transformers) are dispersed over a large area of the substation.

The expected overall acoustic reduction performance of the acoustic wall option was assessed at a range of sites based on indicative high level noise modelling. Due to the large variation in the distance of the source and receiver with respect to the acoustic wall, and in particular the presence of elevated noise sensitive receivers (double storey buildings), generally a lower overall reduction at all receivers was predicted compared to the nominal 5 – 15 dB reduction expected. For example for sites where double storey receivers were present with no existing boundary fence, the designed 6 m high wall reduction in some cases was limited to a best case reduction of 6 dB. Where the site already had high boundary walls (3 – 4 m) the increase in the reduction by implementation of a 6 m acoustic wall was predicted to be between 2 – 5 dB depending on the site.

[2] http://www.rock-wool-insulation.com/sale-1524246-thickness-100mm-rockwool-flexi-insulation-blanket-rock-wool-felt.html, or similar

The above constraints were considered in the nomination of an acoustic wall as an independent solution for each relevant site. However, it should also be noted that acoustic wall or barriers could still be effectively implemented in addition to other types of mitigation to achieve the required overall reductions. Hence, where notable acoustic benefit was expected from the addition of an acoustic perimeter wall, this has been recommended in combination with other mitigation options already discussed.

### 3.2.8 Miscellaneous acoustic treatments

Miscellaneous treatments were not costed in this assessment. Generally, these treatments offer suitable reductions and are generally easily undertaken. Examples include:

- Rectify access doors with gaps and/or no seals
- Close any gaps and penetrations in the walls or roof that are not acoustically treated
- Tighten loose bolts and elements on transformers, covers and tops causing increased noise levels
- Mitigate noise due to excessive vibration of thin transformer elements
- Excessive equipment noise due to equipment requiring maintenance
- External miscellaneous equipment which may be causing minor exceedances
- Temporary fencing or enclosures such as Flexshield™ to reduce noise transmission

There are a number of more in-depth treatments that could be undertaken on a case-by-case basis and depending on the source of noise. These include:

- Replacing or adjusting door seals.
- Appropriate acoustic treatment and ensuring airtight seal for all penetrations.
- Local isolation of noisy equipment such as itemised enclosures around pumps.
- Additional acoustically absorptive finishes within the transformer enclosure or radiator enclosure to reduce the noise levels.
- Elastic damping material on transformer for reduced vibration and hence noise.
- Resilient absorbers such as cork-based polymers.
- Vibration isolation pads separating the transformer from the foundation slab. Replacement or installation of these isolation pads is a feasible solution however it is a significantly complex task and planning and pre works would need to be undertaken prior to this occurring and therefore has not been costed in this assessment.

The potential acoustic reduction from the above treatments will depend on numerous factors which are difficult to establish without detailed investigations. Assuming that noise emissions from the transformer are likely to originate from the above sources, then it is generally expected that the above mitigation treatments would result in a likely reduction of up to 5 dB.

### 3.2.9 Acoustic treatments at receiver

Acoustic treatment of noise at the sensitive receiver location is typically only considered where all other noise mitigation strategies including control at the source and along the transmission path are exhausted. This may include specific acoustic treatments to the property. Some of the typical treatments include:

- Upgrading of external building elements such as roof, glazing, and doors
- Upgrading of window and door seals
- Ventilation systems that meet BCA fresh air requirements to allow windows to remain closed
- Sealing of wall vents
- Sealing of underfloor paths (e.g. building perimeter skirting)
- Roof insulation
- Consideration of structures that provide shielding at the residence such as additional fencing, sheds as barrier shields, courtyard walls and the like
- Additional landscaping to provide visual screening and likely masking when windy (vegetation typically does not provide notable reduction in noise)

Generally for the architectural treatments to be effective, an alternative means of ventilation may need to be considered to enable windows to be closed at all times (or at least during night periods).

Noise controls at the receiver are typically expensive, particularly when many receivers require treatment, but may be an attractive and cost-effective solution where only a few receivers would be affected by noise and the alternatives at source controls are more expensive. The most extreme receiver control measure is property acquisition. Receiver treatments, including the extreme case of acquisition, are normally only applicable for isolated residences in rural areas.

### 3.2.10 CBD substations treatment options

As briefly discussed in Section 2.3, for substations which are fully indoors and their buildings adjoin other sensitive structure or buildings, there are additional challenges due to higher vibration and noise associated with the transformer operation.

Structure borne noise and vibration can be transmitted through shared building structures or through the ground if separation distances between the transformer and the sensitive receiver is insignificant. Potential noise and vibration sources associated with transformers include:

- Core transformer structure (including winding)
- Cooling fans and pumps
- Cooling pipes and radiators
- Tanks and wall shunts
- Adjacent supporting structure and enclosures

Noise and vibration from transformers in these cases can be transmitted by airborne paths and/or structural paths. Noise and vibration from transformers may have features that exacerbate the perception of air borne and structurally transmitted noise such as:

- Clear tone content that corresponds to 50 Hz and its multipliers (general transformer frequencies around operational frequencies)
- Low frequency content (below 200-250 Hz)

Typically, noise and vibration control measures should be incorporated into the standard design for transformer installations and operational/maintenance procedures. Indicative measures to mitigate airborne noise, and structural noise and vibration transmission may include:

- Ensure that structure of the transformer room provides sufficient air borne noise attenuation for dominant frequencies; i.e. where required additional acoustic treatment to external building elements may be required (enhanced façade elements)
- Acoustic treatment of ventilation paths
- Acoustically absorptive treatment to the transformer room to reduce noise build up
- Maintenance of transformer to ensure it is in good operational condition and coil windings are properly supported
- Confirm vibration of the transformer core does not exceed manufacturer specifications
- Service and maintain auxiliary equipment in accordance with manufacturer's specifications
- Transformer, pumps, air fans are installed on resilient mounts and the suspension provides sufficient attenuation for isolation of key excitation frequencies
- Confirm fans are balanced and do not exhibit excessive vibration
- Equipment should be level and installed without looseness and be operated within limits
- Appropriate vibration isolation used such as spring-mass or other dampers to reduce vibration of transformer and auxiliary equipment
- Use of suspended ballast blocks for auxiliary equipment if necessary
- Ensure that supporting structures/enclosures do not have structural resonances coinciding with main vibration components
- Use of flexible pipe and duct connections and ensure that pipes and cable penetrations are structurally isolated from floor, walls and ceiling
- Damping coating for transformer and/or consider suspended floor for transformer room
- Active vibration and noise control may be implemented if other structural noise and vibration reduction solutions are not practical

### 3.2.11 Site retirement or relocation

Decommissioning of the substation and/or relocation in rare cases where full noise reduction may not be possible or implementation of potential noise mitigation strategies may be very costly and/or the substation is close to the end of its lifecycle may be a consideration. Temporary noise mitigation measures may also be able to be implemented to reduce the potential impact of the substation during the de-commissioning phase.

### 3.2.12 Land acquisition

As discussed in Section 3.2.9 property acquisition is an extreme "mitigation" option and is normally only applicable for isolated residences in rural areas, but does create a buffer to other nearby receivers.

## 3.3 Mitigation scenarios

Depending on the site, different noise mitigation options as outlined in Section 3.2 may be feasible and applicable as an independent noise mitigation solution or in combination with other mitigation measures. Based on a high level review of the substation list provided to GHD, a number of noise mitigation scenarios have been established and are comprised of those options noted in Section 3.2. Table 2 summarises the established noise mitigation scenarios and indicative noise reduction range and the most suitable application. Note that the scenarios listed are sorted as per the recommended noise strategy hierarchy (i.e. source, transmission and receiver control), with the exception of Scenario 0 which is the do nothing approach.

### Table 2 Noise mitigation scenarios

| Noise Mitigation Scenario | Nominated mitigation options | Expected indicative reduction |
|---|---|---|
| **Scenario 0**<br>Do nothing approach | • Nil | Application: All cases<br>Reduction: Nil |
| **Scenario 1**<br>Transformer replacement | • Transformer replacement (Section 3.2.2) | Application: All cases<br>Reduction: Selection and design can likely be made to suit reduction required<br>(> 15 dB expected) |
| **Scenario 2**<br>New transformer and new radiator enclosures | • New transformer enclosure. (Section 3.2.4)<br>• New radiator enclosure (Section 3.2.4) | Application: Transformer and radiator both sitting in open<br>Reduction: 20 ± 5 dB |
| **Scenario 3**<br>Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | • Modification to existing transformer enclosure. (Section 3.2.5)<br>• New radiator enclosure (Section 3.2.4) | Application: Transformer in existing enclosure with radiator located externally in open<br>Reduction: 10 – 20 dB |
| **Scenario 4**<br>Modification to existing transformer & radiator enclosures | • Modification to existing transformer enclosure. (Section 3.2.5)<br>• Modification to existing radiator enclosure (Section 3.2.6) | Application: Both the transformer and radiator inside enclosures<br>Reduction: 10 – 20 dB |
| **Scenario 5**<br>Acoustic perimeter wall | • Acoustic Perimeter Wall (Section 3.2.7) | Application: All cases<br>Reduction: 2 – 15 dB |
| **Scenario 6**<br>Combination of Scenario 2 and 5 | • New transformer enclosure<br>• New radiator enclosure<br>• Acoustic Perimeter Wall | Application: Transformer and radiator both sitting in open and where there are likely isolated sources dispersed across site<br>Reduction: 23 ± 5 dB |
| **Scenario 7**<br>Combination of Scenario 3 and 5 | • Modification to existing transformer enclosure<br>• New radiator enclosure<br>• Acoustic Perimeter Wall | Application: Transformer in existing enclosure with radiator located externally in open and where there are likely isolated sources dispersed across site<br>Reduction: 15 – 23 dB |

| Noise Mitigation Scenario | Nominated mitigation options | Expected indicative reduction |
|---|---|---|
| **Scenario 8**<br>Combination of Scenario 4 and 5 | • Modification to existing transformer enclosure<br>• Modification to existing radiator enclosure<br>• Acoustic Perimeter Wall | Application: Both the transformer and radiator inside enclosures and where there are likely isolated sources dispersed across site<br>Reduction: 15 – 23 dB |
| **Scenario 9**<br>Miscellaneous treatments | • Miscellaneous Acoustic Treatments (Section 3.2.8) | Application: Existing enclosures<br>Reduction: Case by case (likely less than 5 dB) |
| **Scenario 10**<br>Receiver treatments | • Acoustic treatments at receiver (Section 3.2.9) | Application: All cases<br>Reduction: Case by case |

Note that the CBD substation treatment options discussed in Section 3.2.10 and site retirement or relocation options discussed in Section 3.2.11 are not included as scenarios in Table 2 as costing for CBD sites was too complex for a high level desktop assessment and would require detailed onsite investigations to determine cause and potential mitigation options.

Site retirement and or relocation can be applicable to all scenarios from a noise reduction perspective. However, it is not included as a solution scenario in the assessment due to the very specific nature of solution and complexity in determining site remediation, decommissioning, relocation, and rebuild costs at a site yet undetermined.

# 4. Noise assessment

Computational noise modelling was undertaken to assist with development of generic noise mitigation options and to help provide indicative treatment details to allow for costing of each main noise mitigation option. GHD has recently undertaken several noise measurements at the Balaclava Substation (ZSS) located at 49 Hotham Street. Transformer 1 internal noise levels were used as a generic transformer noise to allow for assessment of each option. This section outlines the details of simplified noise modelling to provide an indicative desktop noise assessment.

It is noted that the noise modelling outlined in this section is only undertaken for the purpose of development of generic noise solutions as part of this assessment and the results or conclusions made on this basis cannot be relied upon as a detailed noise assessment and/or solution for any of the substations in this assessment or for any other site and further detailed site specific measurement, modelling, and mitigation design would be required.

## 4.1 Modelling methodology

Noise modelling was undertaken using the environmental noise prediction package *Computer Aided Noise Abatement* (CadnaA) 2019 software package which incorporates the ISO 9613-2, "*Acoustics – Attenuation of sound during propagation outdoors"* noise prediction algorithm into its user interface.

The ISO 9613-2 algorithm was utilised for this noise impact assessment as the algorithm's propagation calculations take into account sound intensity losses due to distance attenuation, atmospheric absorption and ground absorption.

The ISO 9613-2 algorithm also takes into account the presence of a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm nights or 'downwind' conditions which are favourable to sound propagation. Taking into account a worst-case noise emission scenario.

## 4.2 Modelling assumptions

The following modelling assumptions and parameters were taken into consideration in the development of the high level noise modelling used in this assessment to predict the acoustic performance of the various noise options:

- A ground absorption coefficient of one representing an acoustically hard ground (conservative)
- Noise levels are assessed at 1.5 m and 4.5 m above ground level to represent single and double storey receivers
- Noise emissions from each substation are assumed to be only from transformer noise emissions
- The assessment is undertaken based on a measured transformer average noise level of 86 dB(A) within a fully reflective transformer enclosure at the Balaclava substation
- For the radiator, a sound power of 70 dB(A) is used for the noise modelling based on the noise measurements undertaken at Balaclava substation without fans in operation
- For assessment of acoustic perimeter walls, the transformer was modelled as point source located at 4 m above the ground
- The ISO 9613-2 noise prediction algorithm was used in this assessment

- An average temperature of 10°C and average humidity of 70% used for modelling purposes
- Existing fence heights were estimated based on the Google Street View imagery
- No assessment against any specific limits has been undertaken, in turn likely expected performance is assessed for each options

## 4.3 Modelling results

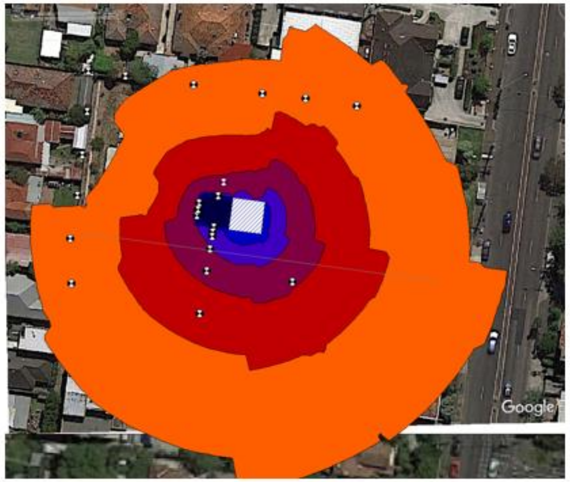
A selection of noise models were developed to inform the indicative acoustic mitigation options including:

- Indicative noise modelling of a new transformer and radiator enclosure
- Indicative noise modelling of a modified transformer and radiator enclosure
- Indicative noise modelling of an acoustic perimeter fence for a selected number of sites

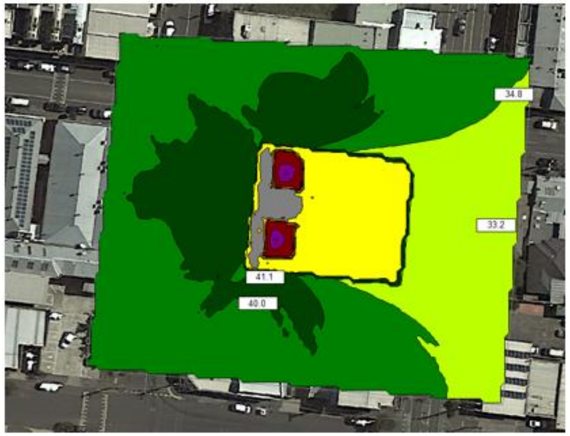
The results for each noise modelling scenario is presented in Table 3 and an example of the results presented in Figure 18. The detailed noise contours for each of the indicative noise models are shown in Appendix C.

### Table 3 Indicative results for generic noise model for mitigation options

| Model | Treatments | Site Code | Indicative noise reduction predicted |
|---|---|---|---|
| New transformer and radiator enclosure | Section 3.2.3<br>Section 3.2.4 | BC | 10 – 25 dB |
| Modified transformer and radiator enclosure | Section 3.2.5<br>Section 3.2.6 | BC | |
| Acoustic perimeter fence | Section 3.2.7 | CW | 2 – 15 dB<br>Variable depending on receiver location, height, fence height, and source distance to receiver |
| | | AR | |
| | | NC | |
| | | CL | |
| | | GLE | |
| | | WBE | |

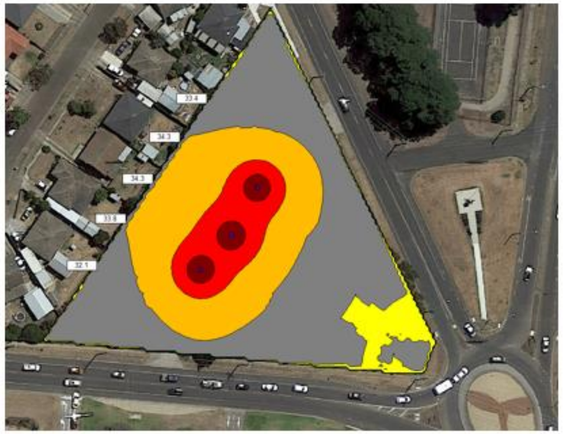


BC – new transformer and radiator enclosure



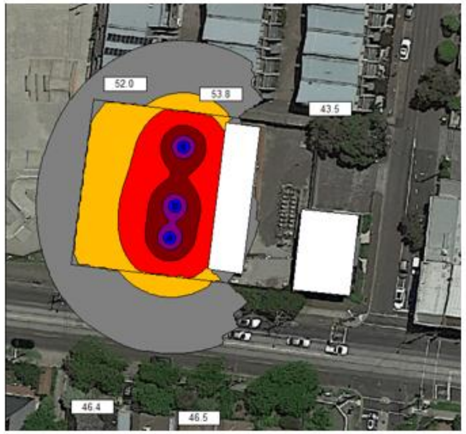
SW – Acoustic Perimeter Fence

NC – Acoustic Perimeter Fence



GLE – Acoustic Perimeter Fence

WBE – Acoustic Perimeter Fence



WBE – Acoustic Perimeter Fence

**Figure 18 Generic noise models undertaken for the purpose of this assessment**

# 5. Cost summary

## 5.1 Cost estimation

GHD has engaged Wilde and Woollard Quantity Surveyors (WWQS) to independently price the various acoustic treatments shown in the structural sketches SK001 to SK007 found in Appendix A. WWQS was provided the structural sketches by GHD and combined with a number of meetings have provided estimates with a cost accuracy of ± 30%.

## 5.2 Overall site cost

An approximate maximum cost for the different noise mitigation scenarios for each site have been calculated based on the Quantity Surveyors (WWQS) established unit costs relevant to each mitigation option. The overall site cost calculation is undertaken based on the following approaches to suit different scenarios:

- Scenarios 1 – 4, the overall cost per transformer/radiator for each relevant noise mitigation scenario, multiplied by the number of transformers/radiators on each specific site.
- Scenario 5, the cost per metre unit length of the acoustic perimeter wall multiplied by the perimeter length of each specific site.
- Scenarios 6 – 8 are a combination of two of the Scenarios 1 – 5. Hence the overall site cost is the arithmetic summation of the two relevant sub scenarios.

The summary of the overall site cost calculations are provided in Appendix C.

## 5.3 Site specific noise mitigation scenarios

A high level review of each substation site has been undertaken to identify applicable noise mitigation scenarios for each site from those outlined in Section 3.3. Following this a matrix of noise mitigation scenarios for the various substation sites has been developed listing key parameters being considered in site analysis as well as brief comments and/or justifications for each scenario. The developed noise mitigation scenario matrix is presented in the site details Excel™ output in Appendix E.

The following briefly summarises the approach undertaken for the high level site analysis:

- Site specific layout was assessed from aerial imagery and information provided to GHD.
- Site locality was analysed to assess likely noise receptors and their exposure to site noise.
- Noise mitigation scenarios which were suitable to the specific site arrangement were selected.
- Expected indicative noise reductions for each scenario were compared to indicative night time noise exceedances and suitable scenarios selected.
- Shortlisted noise mitigation scenarios were incorporated into the indicative noise models to assess the scenarios suitability with respect to site specific constraints such as receiver locations, perimeter walls, etc.

Following the above procedure, a list of appropriate noise mitigation scenarios were established for each site and presented in the following Section (Section 5.4) along with the corresponding overall cost estimate where applicable.

## 5.4 Cost summary table

Table 4 below outlines the potential options to mitigate noise at each substation site that were considered in this assessment, with a maximum indicative cost and indicative noise reduction for each option.

### Table 4 Cost summary table

| Noise Mitigation Options | Approximate Maximum Cost | Potential Noise Reduction, dB |
|---|---|---|
| **CW – 49 Easey St, Collingwood** (Figure 3), Indicative night time noise exceedance 12 dB | | |
| **Site arrangement:** 3 x TXs partially enclosed with open top. TX radiators directly next to TXs inside the enclosure. Site has high solid perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 4: Modification to existing transformer & radiator enclosures | $5.3 million | 10 – 20 dB |
| Scenario 8: Combination of Scenario 4 and 5.(refer to Section 3.3) | $8.9 million | 15 – 23 dB |
| **AR – 924 High Street, Armadale** (Figure 4), Indicative night time noise exceedance 12 dB | | |
| **Site arrangement:** 3 x TXs in open with radiators directly next to TXs. Site has high solid perimeter wall | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| **BC – 49 Hotham Street, St Kilda East** (Figure 5), Indicative night time noise exceedance 7 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed. Cooling radiator banks located outside of each enclosure against the enclosure wall. Site has solid perimeter wall. Some of the noise receivers are double storey overlooking the site. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 3: Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | $5.6 million | 10 – 20 dB |
| Scenario 7: Combination of Scenario 3 and 5 (refer to Section 3.3) | $12 million | 15 – 23 dB |

| Noise Mitigation Options | Approximate Maximum Cost | Potential Noise Reduction, dB |
|---|---|---|
| **NC – 21 Lennox Street, Northcote** (Figure 6), Indicative night time noise exceedance 6 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed. Cooling radiator banks located outside of each enclosure against the TX enclosure wall. Site has solid perimeter wall | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 3: Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | $5.6 million | 10 – 20 dB |
| Scenario 7: Combination of Scenario 3 and 5 (refer to Section 3.3) | $11.7 million | 15 – 23 dB |
| **AP – 7 – 9 Howe Crescent, South Melbourne** (Figure 7), Indicative night time noise exceedance 5 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed. Cooling radiator banks located outside of each enclosure against the enclosure wall. Some receivers are multi storey overlooking the site. Site has high solid perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 3: Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | $5.6 million | 10 – 20 dB |
| Scenario 7: Combination of Scenario 3 and 5 (refer to Section 3.3) | $10.1 million | 15 – 23 dB |
| **SK – 6 Waterloo Crescent, St Kilda** (Figure 8), Indicative night time noise exceedance 4 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed within a building. Cooling radiator banks located outside, each in a three wall alcove with a gate. Site is surrounded by multi storey residential premises overlooking the site. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 4: Modification to existing transformer & radiator enclosures | $5.3 million | 10 – 20 dB |
| Scenario 9: Miscellaneous Treatments | Not costed | Up to 5 dB |

| Noise Mitigation Options | Approximate Maximum Cost | Potential Noise Reduction, dB |
|---|---|---|
| **Q – 15 – 17 Tennyson Street, Kew** (Figure 9), Indicative night time noise exceedance 2 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed within a building. Cooling radiator banks located outside, each in a partial enclosure with open top. Site is surrounded by multi storey residential premises and has high perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 4: Modification to existing transformer & radiator enclosures | $5.3 million | 10 – 20 dB |
| Scenario 5: Acoustic Perimeter Wall | $6.6 million | 2 – 15 dB |
| Scenario 9: Miscellaneous Treatments | Not costed | Up to 5 dB |
| **CL – 387 Riversdale Road, Hawthorn East** (Figure 10), Indicative night time noise exceedance: 6 dB | | |
| **Site arrangement:** 3 x TXs fully enclosed. Cooling radiator banks located outside of each enclosure against the enclosure wall. Site has solid perimeter wall. Some of the noise receivers are double storey overlooking the site. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $11.1 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $6.6 million | 20 ± 5 dB |
| Scenario 3: Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | $5.6 million | 10 – 20 dB |
| Scenario 7: Combination of Scenario 3 and 5 (refer to Section 3.3) | $10.2 million | 15 – 23 dB |
| **GLE – 242 – 254 St Albans Road, Breakwater** (Figure 11), Indicative night time noise exceedance: 12 B | | |
| **Site arrangement:** 2 x TXs and cooling radiator banks located in open. Site has no perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $7.4 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $4.4 million | 20 ± 5 dB |
| **KYM – 1-7 Allan Street, Kyabram** (Figure 2), Indicative night time noise exceedance: 16 dB | | |
| **Site arrangement:** 2 x TXs and cooling radiator banks located in open. Site has no perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |

| Noise Mitigation Options | Approximate Maximum Cost | Potential Noise Reduction, dB |
|---|---|---|
| Scenario 1: Transformer Replacement | $7.4 million | > 15 dB |
| Scenario 2:  New transformer and radiator enclosures | $4.4 million | 20 ± 5 dB |
| **WPD – 25 Hams Road, Waurn Ponds** (Figure 1), Indicative night time noise exceedance: 18 dB | | |
| **Site arrangement:** 2 x TXs and cooling radiator banks located in open. Site has no perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $7.4 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $4.4 million | 20 ± 5 dB |
| **GL – 22 – 30 Ballarat Road, Hamlyn Heights, Geelong** (Figure 12), Noise exceedance: 9 dB | | |
| **Site arrangement:** 2 x TXs and cooling radiator banks located in open. Site has no perimeter wall. Some of the noise receivers are double storey overlooking the site. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $7.4 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $4.4 million | 20 ± 5 dB |
| **WBE – 178 Shaws Road, Werribee** (Figure 13), Indicative night time noise exceedance: 4 dB | | |
| **Site arrangement:** 2 x TXs and cooling radiator banks located in open. One transformer is enclosed with radiator located outside. Site has no perimeter wall. | | |
| Scenario 0: Do nothing approach (EPA Fines) | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | 0 dB |
| Scenario 1: Transformer Replacement | $7.4 million | > 15 dB |
| Scenario 2: New transformer and radiator enclosures | $4.4 million | 20 ± 5 dB |
| Scenario 3: Modification to existing transformer enclosure & new radiator enclosure (no existing radiator enclosure) | $3.8 million | 10 – 20 dB |
| Scenario 5: Acoustic Perimeter Wall | $10 million | 2 – 15 dB |
| Scenario 9: Miscellaneous Treatments | Not costed | Up to 5 dB |

# 6. Conclusion

GHD Pty Ltd (GHD) has been commissioned by CitiPower and Powercor (Powercor) to undertake a cost feasibility assessment for mitigating noise across various substations throughout Victoria (the Project) as part of an effort on Powercor's part to meet their GED requirements.

GHD has used a high-level desktop approach to review a number of potential mitigation options and costings that may be suitable across many of the substations within the Citipower and Powercor substation network.

Powercor has supplied GHD with a list of substation sites to include in the assessment. GHD has completed structural design and noise modelling to assess the feasibility of various noise mitigation solutions. GHD also engaged with an external quantity surveyor to obtain an understanding of indicative costs associated with each solution provided.

GHD has provided a range of noise mitigation solutions for each site, along with an indicative decibel reduction and indicative associated costs for Powercor's consideration.

This report is subject to, and must be read in conjunction with, the limitations presented in Section 1.2 and Appendix F and the exclusions, assumptions and qualifications contained in Appendix G and throughout this report.

# Appendices

# **Appendix A** – Structural design sketches

High level design sketches for the following:

- New radiator enclosure
- New transformer enclosure
- Modification to existing radiator enclosure
- Modification to existing transformer enclosure
- Acoustic perimeter fence Option A: Concrete Wall
- Acoustic perimeter fence Option B: Steel Perimeter Wall

**SPECIFICATION:**

1. DOOR SPECIFICATION:

- MINIMUM DOOR DEPTH 70MM (NAP SILENTFLO OR SIMILAR)
- MINIMUM DOOR CERTIFIED TO STC 41 (RW41) – (BC IS 50 MM BUT THIS IS ALSO A “QUIET” TRANSFORMER @ ~65DB(A))
- DOOR TO HAVE FITTED AND ADJUSTED FULL-PERIMETER ACOUSTIC SEALS TO MAINTAIN THE ACOUSTIC RATING OF THE DOOR

2. LOUVRE SPECIFICATION:

LOUVRE OPTIONS INCLUDE THE FOLLOWING:

- SBL2 WITH ACOUSTIC LINED DUCTING MAY BE REQUIRED TO PROVIDE ADDITIONAL INSERTION LOSS
- ACRAN CUSTOM ACOUSTIC LOUVRES
- QFS900 OR QFS1200 QUIET FLOW ACOUSTIC LOUVRES

VENTILATION REQUIREMENTS TBC BY POWERCOR TO ENSURE THE MITIGATION MEASURES DO NOT ADVERSELY AFFECT THE OPERATION OF THE TRANSFORMER

3. INSULATION SPECIFICATION:

- LINE INTERNAL SURFACES OF TX ENCLOSURE WALLS WITH INTERNAL ABSORPTIVE LININGS TO CONTROL REVERB AND MINIMISE REFLECTIONS E.G. OVERALL NRC 0.9 WITH AT LEAST 0.5 AT 125 HZ AND 0.7 AT 250HZ OCTAVE BANDS, I.E. VITEROLITE 900 OR SIMILAR.
- LINE INTERNAL SURFACES OF RADIATOR WALLS WITH INTERNAL ABSORPTIVE LININGS TO CONTROL REVERB AND MINIMISE REFLECTIONS E.G. OVERALL NRC 0.9 WITH AT LEAST 0.5 AT 125 HZ AND 0.7 AT 250HZ OCTAVE BANDS, I.E. VITEROLITE 900 OR SIMILAR.
- ALL ROOF TO WALL JOINTS TO BE FULL DEPTH SEALED
- ALL DOORS TO HAVE ACOUSTIC SEALS FITTED AND ADJUSTED FOR OPTIMAL PERFORMANCE
- OIL CONDUITS FROM TX TO RADIATOR AND VICE VERSA TO BE STRUCTURALLY ISOLATED USING COMPRESSIBLE FILL MATERIAL FROM THE ENCLOSURE WALLS AND FULL DEPTH ACOUSTIC SEALS THROUGH WALL.
- ROOF TOP BUSHINGS TO BE STRUCTURALLY ISOLATED USING COMPRESSIBLE FILL MATERIAL FROM THE ENCLOSURE WALLS AND FULL DEPTH ACOUSTIC SEALS THROUGH ROOF.
- ALL GAPS AND JOINTS WELL CAULKED AND SEALED WITH ACOUSTIC RATED MASTIC OR SIMILAR

4. WALL SPECIFICATION:

- LINE SENSITIVE RECEIVER FACING SURFACES OF YARD WALLS WITH AN ABSORPTIVE FACADE TO MINIMISE REFLECTIONS E.G. OVERALL NRC 0.9 WITH AT LEAST 0.5 AT 125 Hz AND 0.7 AT 250Hz OCTAVE BANDS, I.E. VITEROLITE 900 OR EQUIVALENT

**ASSUMPTIONS:**

1. SOIL CLASS ASSUMED TO BE H1 SOIL, REQUIRED TO BE CONFIRMED AT EACH INDIVIDUAL SITE

2. DESIGN IS BASED ON A MINIMUM SOIL BEARING CAPACITY OF 75 KPA

3. WIND CLASSIFICATION ASSUMED TO BE A5 (MELBOURNE), WITH AN IMPORTANCE LEVEL OF 2, DESIGN LIFE OF 50 YEARS AND TERRAIN CATEGORY OF 2. PARAMETERS REQUIRED TO BE CONFIRMED AT EACH INDIVIDUAL SITE.

4. TRANSFORMER ENCLOSURE ROOF SLAB DESIGNED FOR 5 KPA PLANT LOADING TO AS1170.

5. 7.5 M X 7.5 M FOOTPRINT OF BUILDING IS NOMINAL AND REQUIRED TO BE CONFIRMED FOR EACH INDIVIDUAL SITE, SUBJECT TO EXISTING TRANSFORMER SLAB FOOTPRINT

6. NO MECHANICAL VENTILATION CHECKS HAVE BEEN CONDUCTED AND ALLOWANCES FOR VENTILATION/LOUVRES ARE ASSUMED (NOMINAL).

7. OIL AND RAINWATER DRAINAGE (AND SUMPS) HAVE BEEN EXCLUDED FROM SKETCH. NOMINAL ALLOWANCE REQUIRED FOR COSTING

8. ASSUMES SINGLE DWELLING RESIDENTIAL RECEIVERS SURROUNDING SUBSTATION LOCATION

9. MASS ELEMENTS ARE ASSUMED TO CONTROL NOISE TRANSMISSION E.G. MIN RW55

10. INTERNAL ABSORPTIVE LININGS ARE ASSUMED TO CONTROL REVERB AND MINIMISE REFLECTIONS

11. STRUCTURAL VIBRATION IS ISOLATED AND STRUCTURE-BORNE NOISE IS ABLE TO BE MINIMISED

FOR COSTING

| rev | description | app'd | date |
|---|---|---|---|
| A | TRANSFORMER AND RADIATOR ENCLOSURE | CM | 26/09/19 |

POWERCOR
TRANSFORMER AND RADIATOR ENCLOSURE
SPECIFICATION AND ASSUMPTIONS

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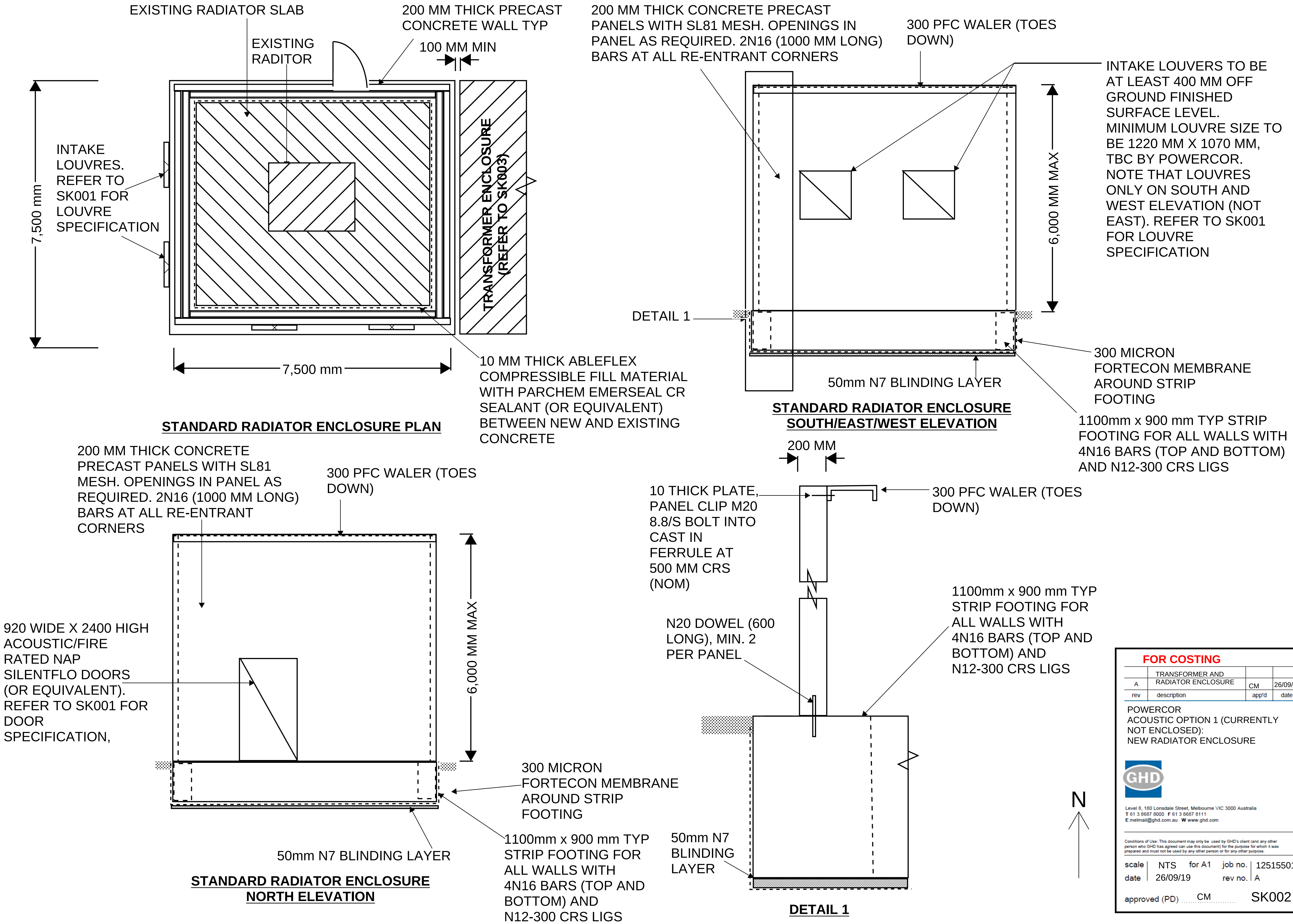


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POWERCOR
ACOUSTIC OPTION 1 (CURRENTLY NOT ENCLOSED):
NEW RADIATOR ENCLOSURE


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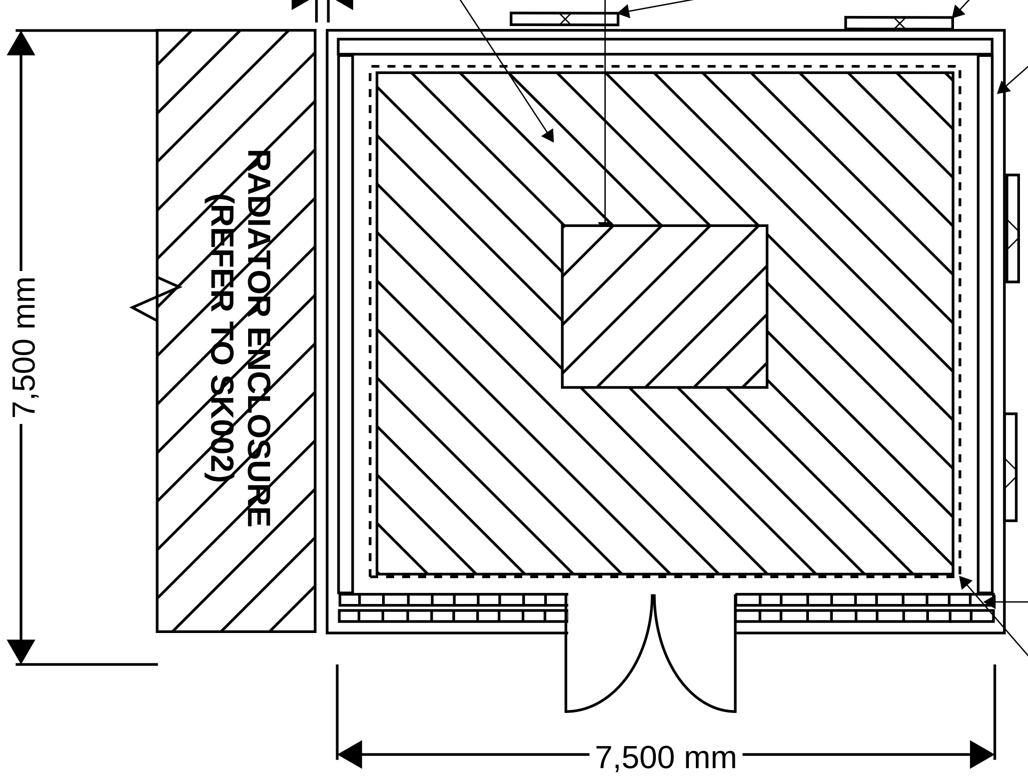
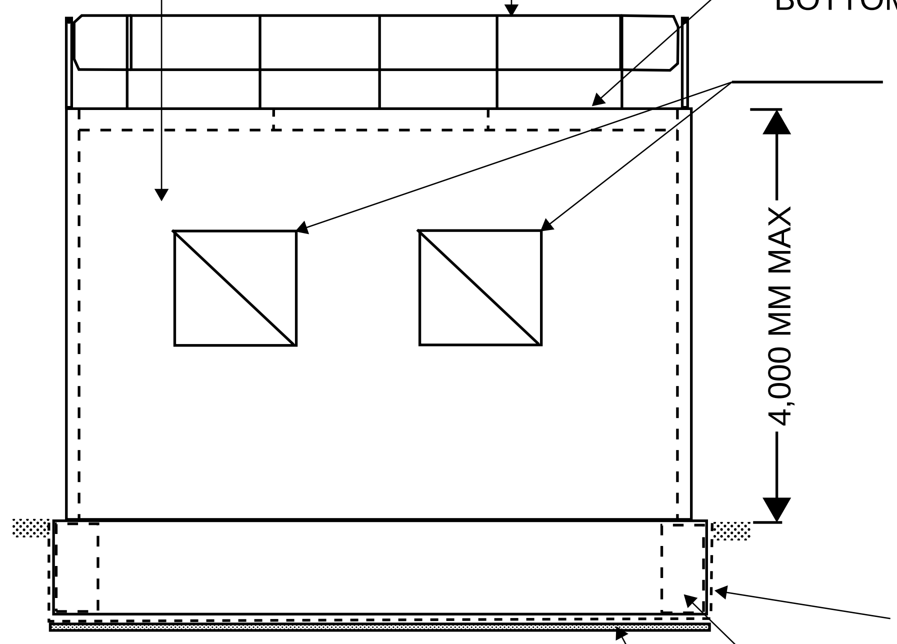
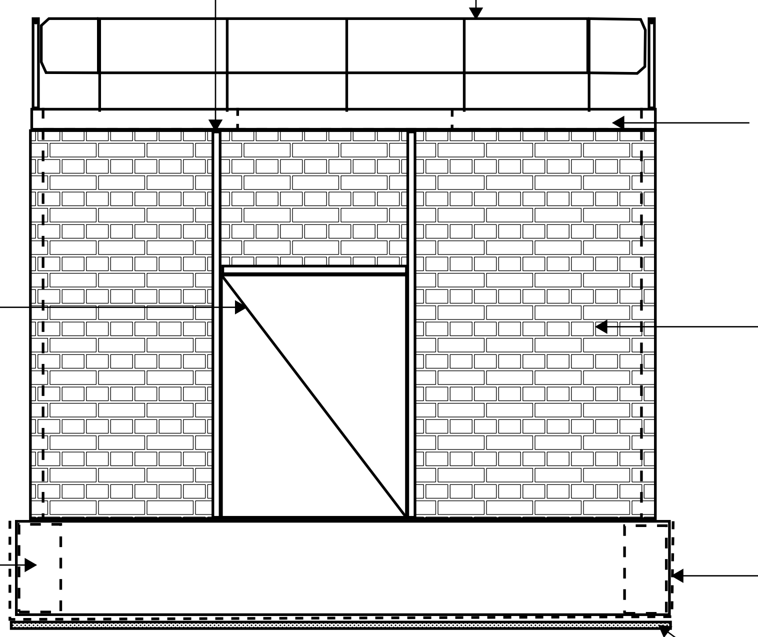



**STANDARD TRANSFORMER ENCLOSURE PLAN**

NOTE: ROOF SLAB NOT SHOWN FOR CLARITY




**STANDARD TRANSFORMER ENCLOSURE NORTH, EAST AND WEST ELEVATION**




**STANDARD TRANSFORMER ENCLOSURE SOUTH ELEVATION**

N

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|---|---|---|---|
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POWERCOR
ACOUSTIC OPTION 1 (CURRENTLY NOT ENCLOSED): NEW TRANSFORMER ENCLOSURE

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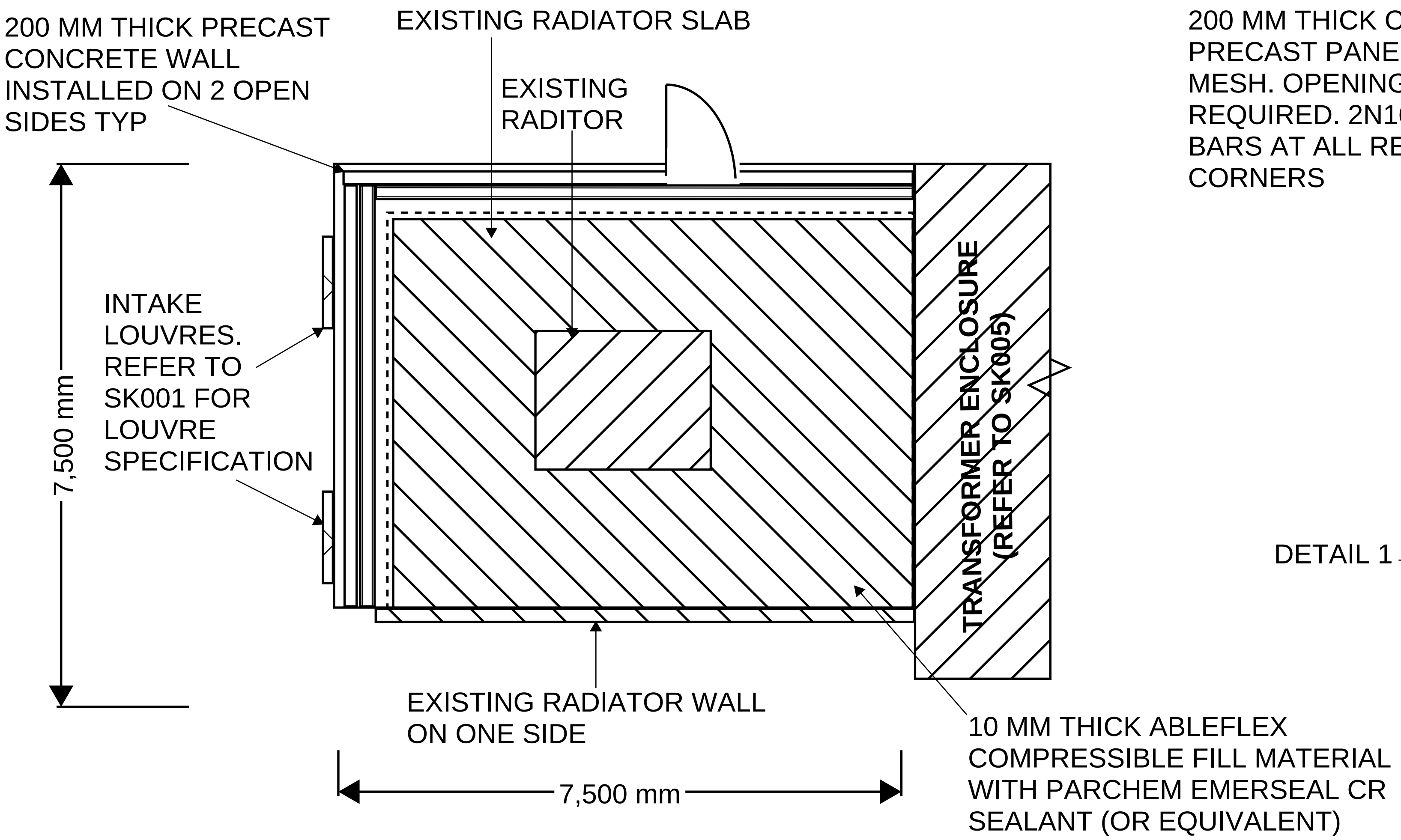
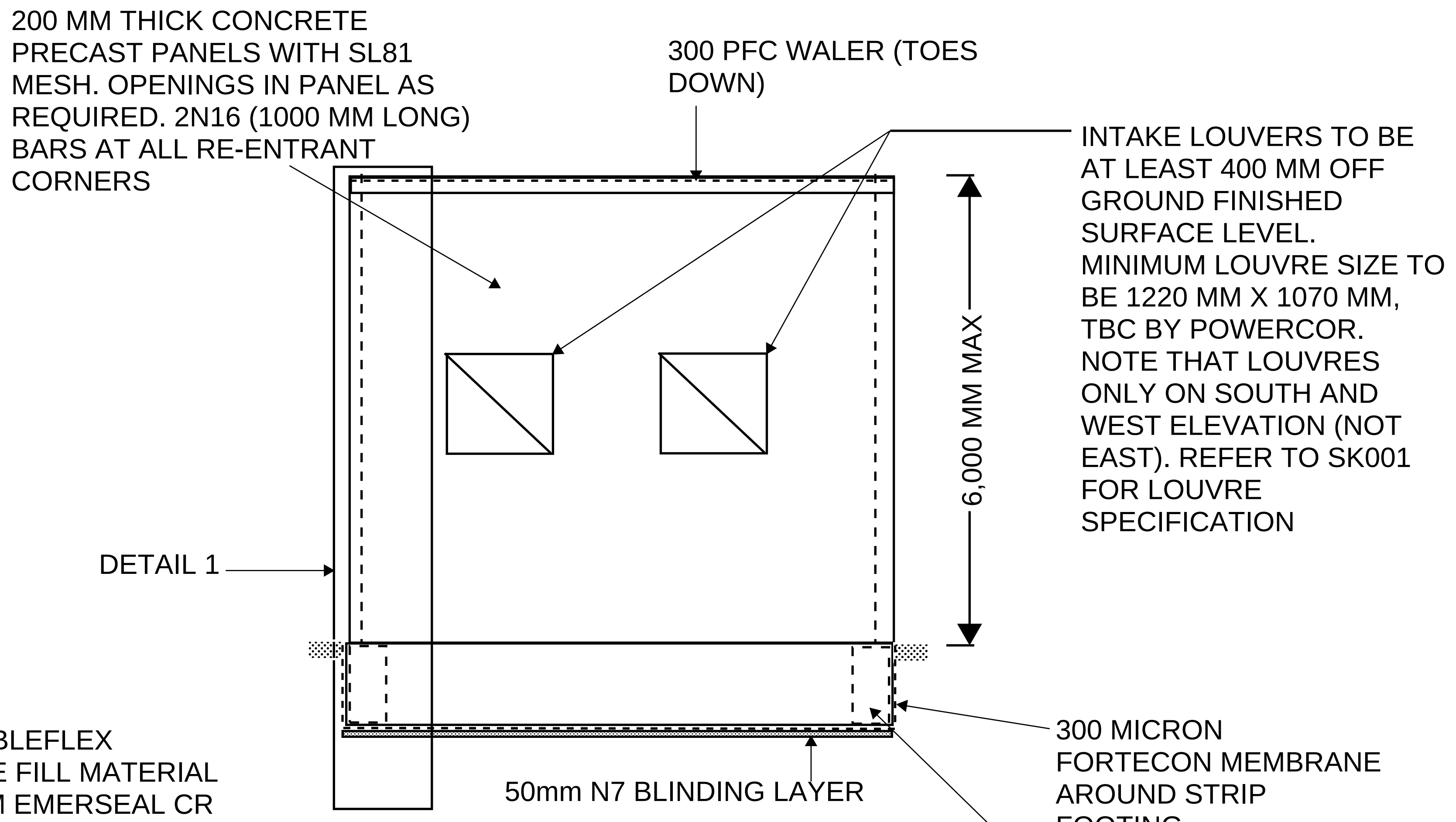
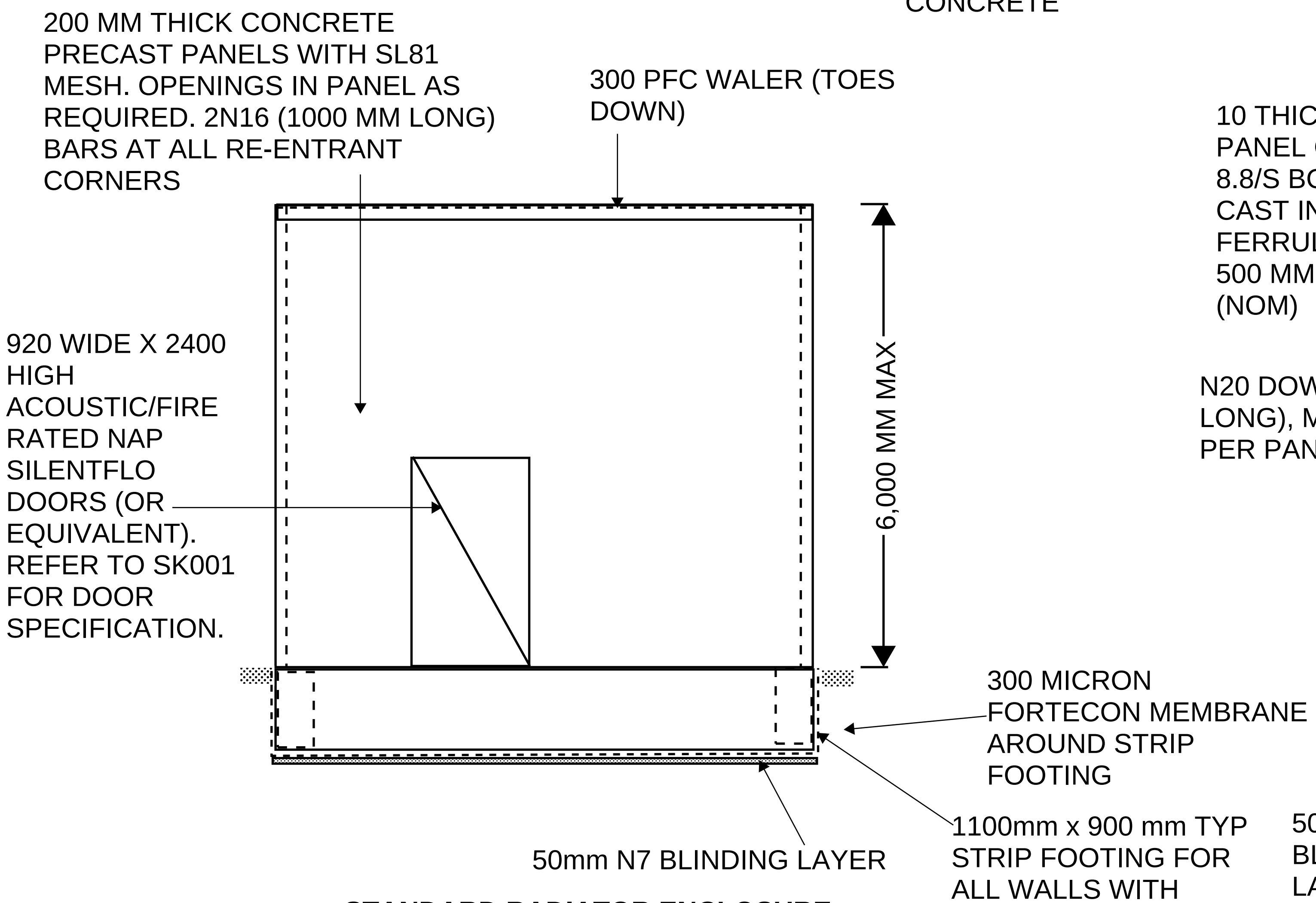


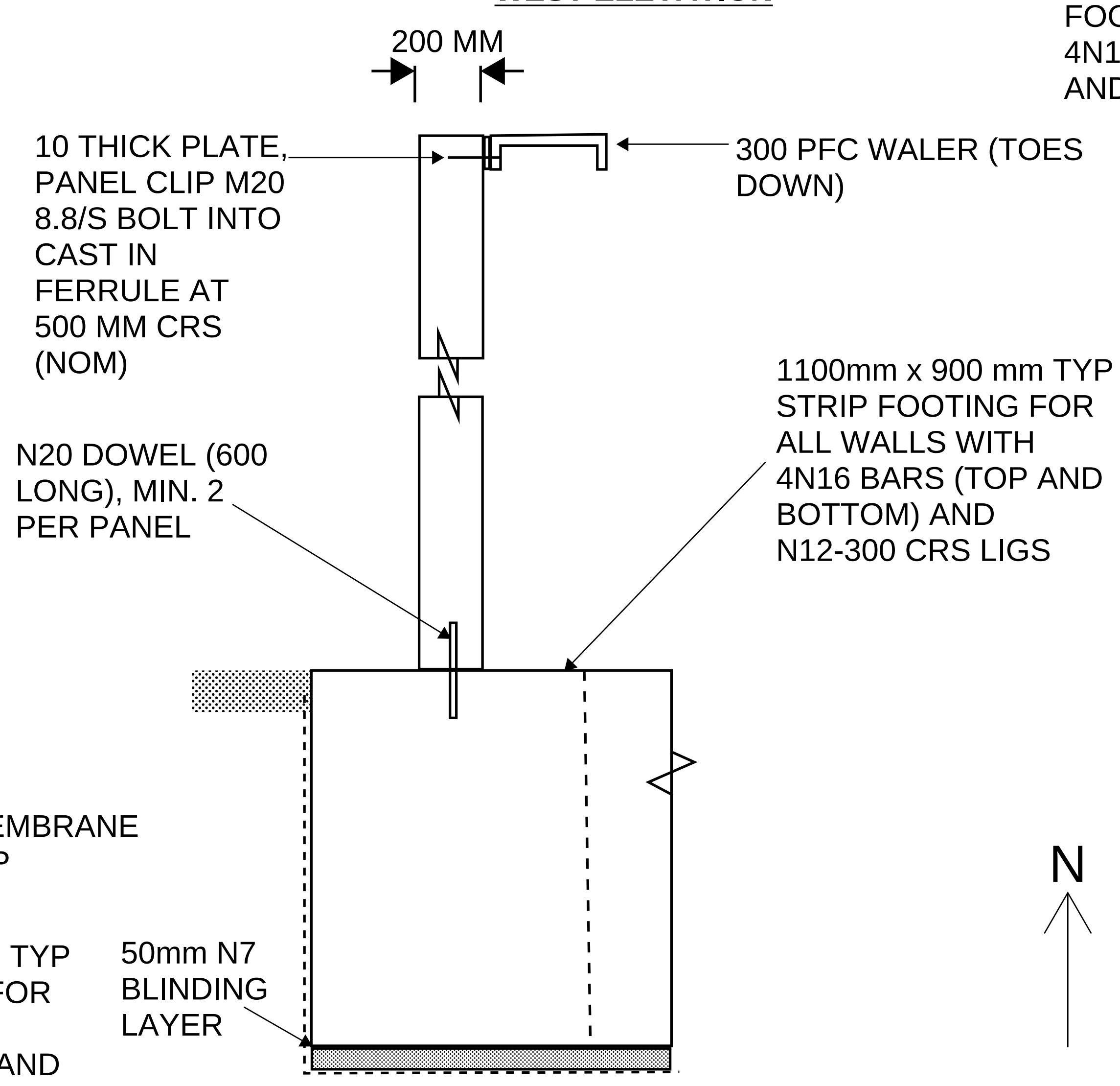

**STANDARD RADIATOR ENCLOSURE PLAN**




**STANDARD RADIATOR ENCLOSURE WEST ELEVATION**




**STANDARD RADIATOR ENCLOSURE NORTH ELEVATION**




**DETAIL 1**

NOTE:
1. LINE ALL RADIATOR WALLS (NEW AND EXISTING) WITH LININGS TO CONTROL REVERB AND MINIMISE REFLECTIONS (REFER TO SK001 FOR INSULATION SPECIFICATION)

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POWERCOR
ACOUSTIC OPTION 2 (PARTIALLY ENCLOSED): MODIFICATION TO EXISTING RADIATOR ENCLOSURE

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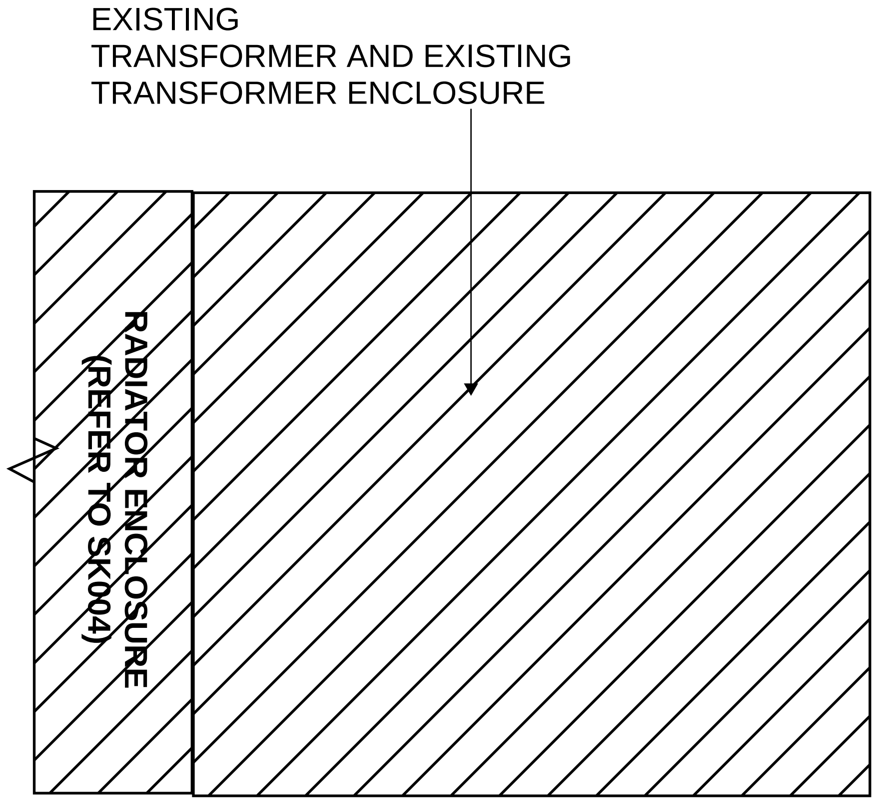
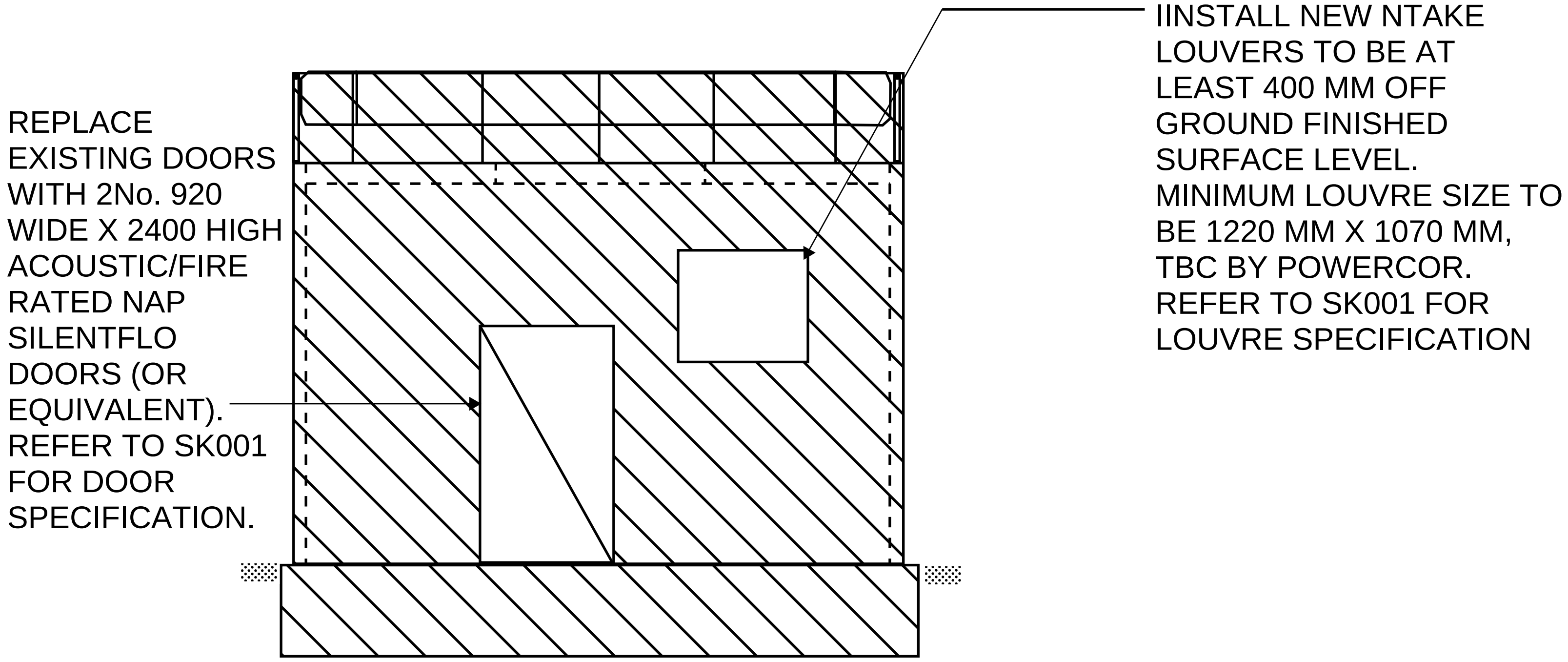


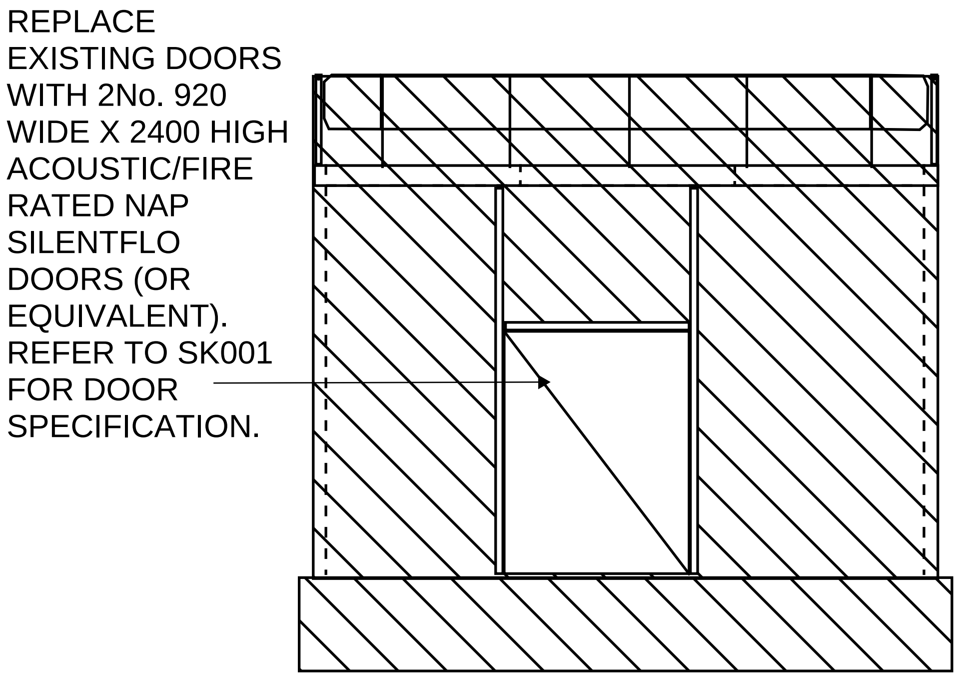

**EXISTING TRANSFORMER ENCLOSURE PLAN (EXAMPLE)**

NOTE: ROOF SLAB NOT SHOWN FOR CLARITY

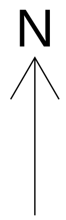



**EXISTING TRANSFORMER ENCLOSURE EAST, WEST AND NORTH ELEVATION (EXAMPLE)**

NOTE:
1. LINE ALL EXISTING TRANSFORMER BUILDING WALLS WITH LININGS TO CONTROL REVERB AND MINIMISE REFLECTIONS (REFER TO SK001 FOR INSULATION SPECIFICATION)




**EXISTING TRANSFORMER ENCLOSURE SOUTH ELEVATION (EXAMPLE)**

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POWERCOR
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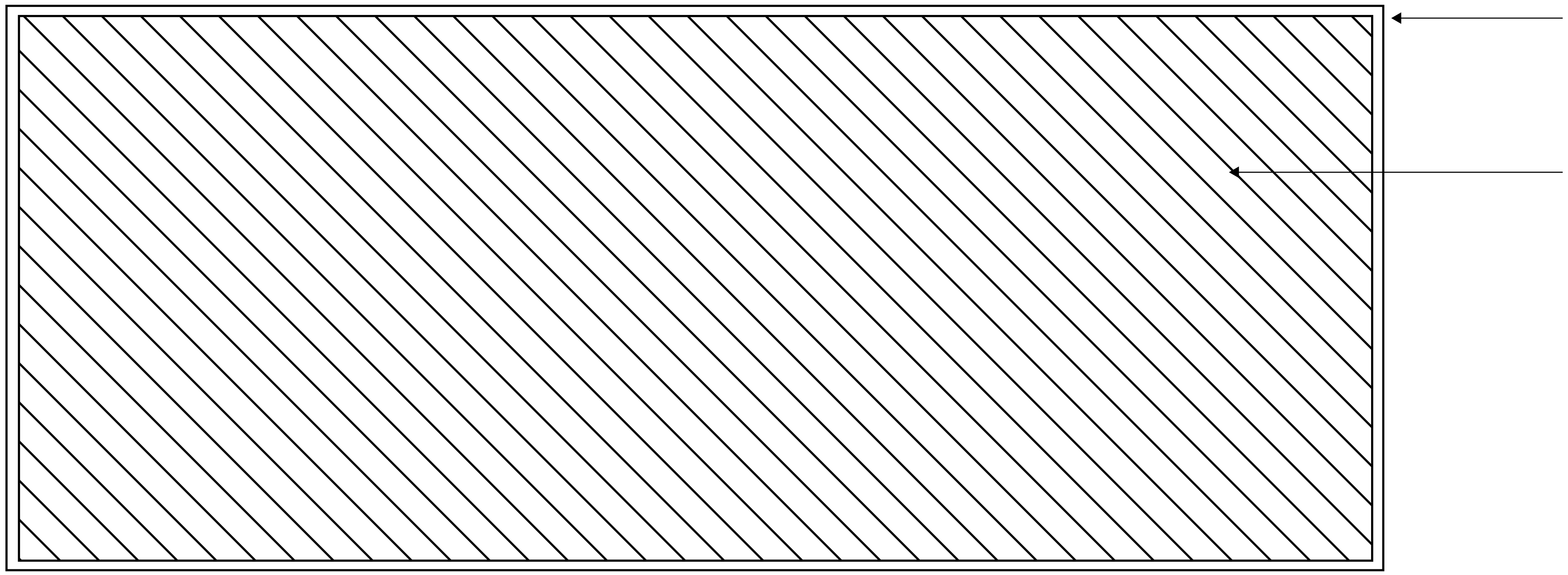
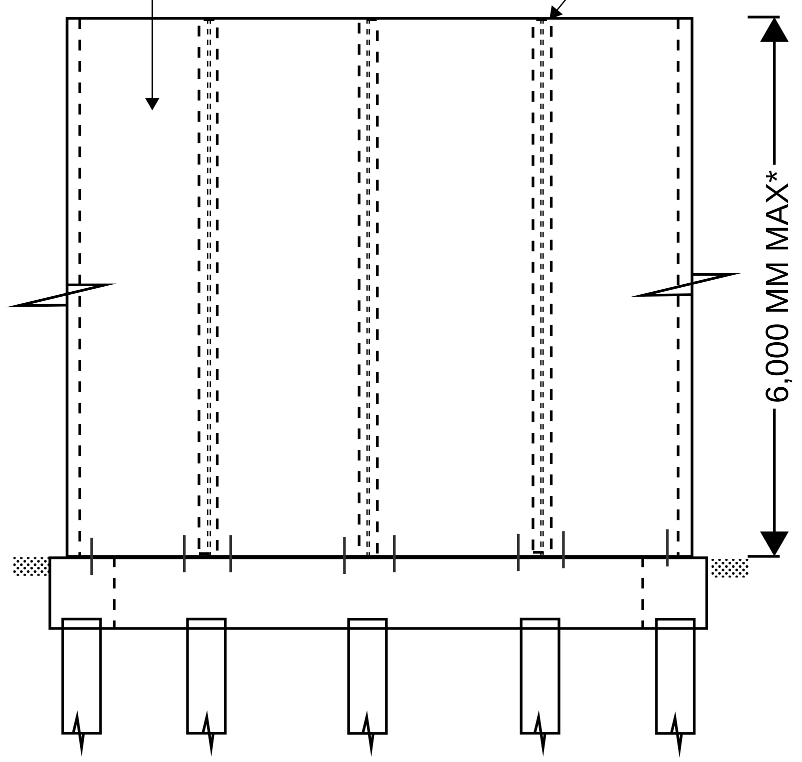
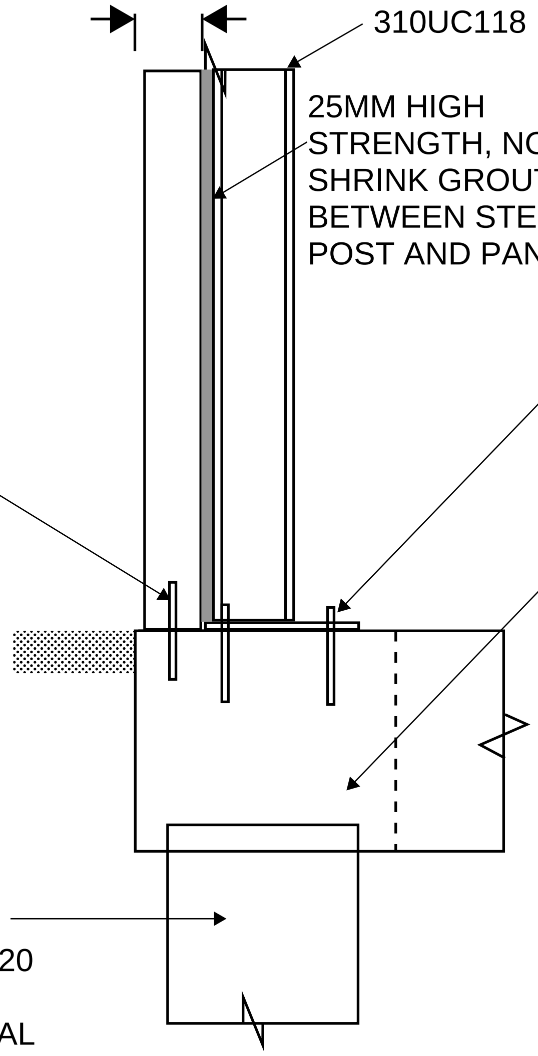
date 26/09/19 rev no. A
approved (PD) CM SK005




**STANDARD PERIMETER ACOUSTIC FENCE**




**STANDARD ACOUSTIC FENCE ELEVATION**




**DETAIL 1**

N

NOTE:
1. WALL HEIGHTS CAN VARY FOR EACH SITE I.E. 3M WALL, 4M WALL, 5M WALL AND 6M WALL (EACH WALL DESIGN AS SHOWN ON SK006).
2. LINE WALL ALONG FULL AREA WITH ABSORPTIVE LININGS TO MINIMISE NOISE REFLECTIONS (REFER TO WALL SPECIFICATION ON SK001)

**FOR COSTING**

| rev | description | app'd | date |
|---|---|---|---|
| A | TRANSFORMER AND RADIATOR ENCLOSURE | CM | 26/09/19 |

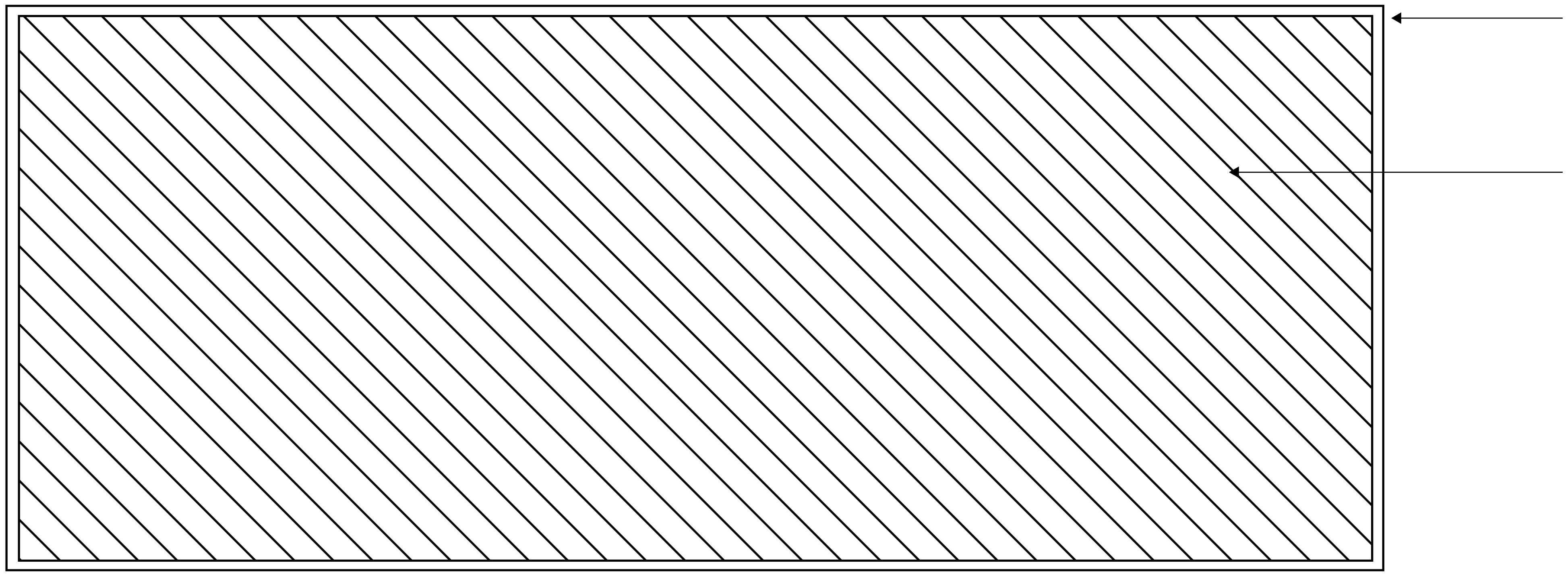
POWERCOR
ACOUSTIC OPTION 3:
ACOUSTIC PERIMETER FENCE

GHD

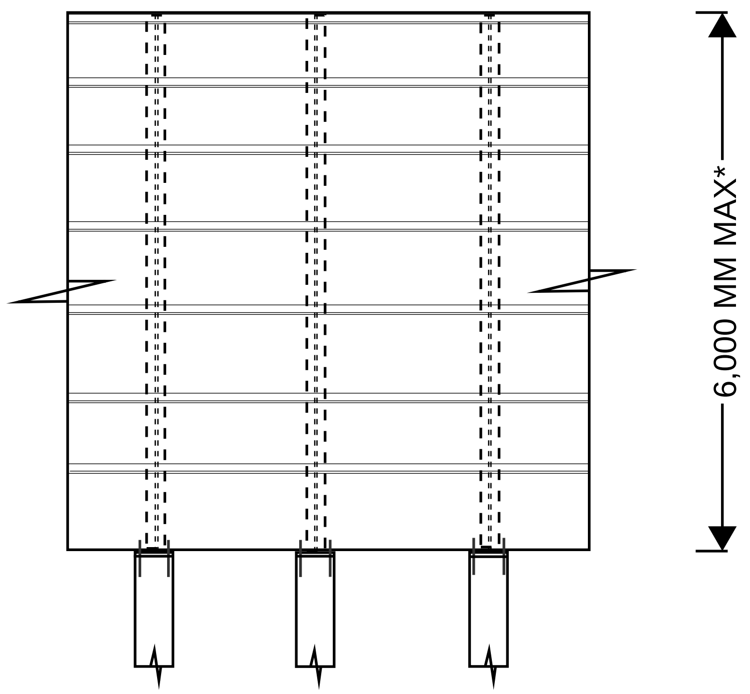

Level 8, 180 Lonsdale Street, Melbourne VIC 3000 Australia
T 61 3 8687 8000 F 61 3 8687 8111
E melmail@ghd.com.au W www.ghd.com



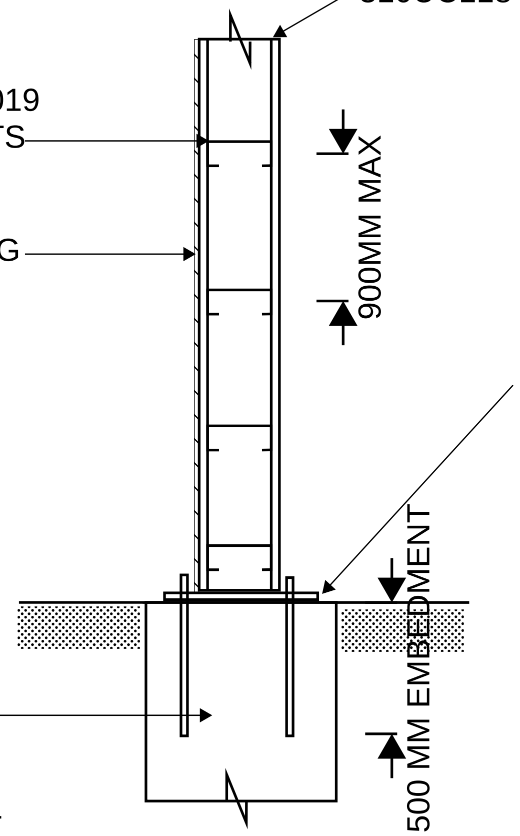

scale NTS for A1 job no. 12515501
date 26/09/19 rev no. A
approved (PD) CM SK006




**STANDARD PERIMETER ACOUSTIC FENCE**




**STANDARD ACOUSTIC FENCE ELEVATION**




**DETAIL 1**

NOTE:

1. WALL HEIGHTS CAN VARY FOR EACH SITE I.E. 3M WALL, 4M WALL, 5M WALL AND 6M WALL (EACH WALL DESIGN AS SHOWN ON SK006).
2. LINE WALL ALONG FULL AREA WITH ABSORPTIVE LININGS TO MINIMISE NOISE REFLECTIONS (REFER TO WALL SPECIFICATION ON SK001)

N

**FOR COSTING**

| rev | description | app'd | date |
|---|---|---|---|
| A | TRANSFORMER AND RADIATOR ENCLOSURE | CM | 26/09/19 |

POWERCOR
ACOUSTIC OPTION 3:
ALTERNATIVE ACOUSTIC PERIMETER FENCE


GHD
Level 8, 180 Lonsdale Street, Melbourne VIC 3000 Australia
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E melmail@ghd.com.au W www.ghd.com




scale NTS for A1 job no. 12515501
date 26/09/19 rev no. A
approved (PD) CM
SK007

# **Appendix B** – Acoustic treatment cost estimates

Cost estimates provided by Wilde and Woollard Quantity Surveyors:

No pre-existing enclosures:

- Powercor Acoustic Treatment - New Radiator Enclosure Feasibility Cost Plan
- Powercor Acoustic Treatment - New Transformer Enclosure Feasibility Cost Plan

Pre-existing enclosures:

- Powercor Acoustic Treatment - Existing Radiator Enclosure Feasibility Cost Plan
- Powercor Acoustic Treatment - Existing Transformer Enclosure Feasibility Cost Plan

Precast barrier fence:

- Powercor Acoustic Treatment - Precast Perimeter Fence (3 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Precast Perimeter Fence (4 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Precast Perimeter Fence (5 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Precast Perimeter Fence (6 m) Feasibility Cost Plan

Steel barrier fence (Alternative):

- Powercor Acoustic Treatment - Steel Perimeter Fence (3 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Steel Perimeter Fence (4 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Steel Perimeter Fence (5 m) Feasibility Cost Plan
- Powercor Acoustic Treatment - Steel Perimeter Fence (6 m) Feasibility Cost Plan

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**NEW RADIATOR ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | Allowance for remedial works to existing radiator slab | item | 1 | 15,000 | 15,000 | Provisional Sum |
| 3 | Allowance for isolation works to existing radiator slab | item | 1 | 30,000 | 30,000 | Provisional Sum - As advised by GHD |
| 4 | 900 Wide x 1100 deep strip footing including excavation, 50 thick N7 blinding layer, 4N16 bars top and bottom, N12-300 cts ligs and membrane | m | 30 | 600 | 18,000 | Excludes formwork |
| 5 | 10 Thick acoustic expansion joint between new and existing concrete | m | 30 | 25 | 750 | |
| | **Sub-Total** | | | | **63,750** | |
| | **External Walls** | | | | | |
| 6 | 200 Thick plain grey precast concrete wall including SL81 mesh, re-entrant bars, acoustic seals and paint finish | m2 | 180 | 450 | 81,000 | Assumed 6000 high |
| 7 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new walls including adhesion | m2 | 180 | 475 | 85,500 | Assumed 6000 high |
| 8 | 600 Long N20 dowel bars | no | 32 | 50 | 1,600 | Assumed 16 panels |
| 9 | 300 PFC waler beam to perimeter including hot dip galvanising and fixing | m | 30 | 350 | 10,500 | |
| 10 | 1250 x 1250 Fantech sound bar louvre (SBL2) | no | 4 | 4,000 | 16,000 | |
| 11 | Allow to acoustically seal wall penetrations for conduits between transformer and radiatior | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **196,600** | |
| | **External Doors** | | | | | |
| 12 | 920 Wide x 2400 high acoustic / fire rated door including frame, acoustic seals and hardware | no | 2 | 7,500 | 15,000 | |
| | **Sub-Total** | | | | **15,000** | |
| | **External Services** | | | | | |
| 13 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 14 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 15 | *Rounding* | | | | *650* | |
| | **Sub-Total** | | | | **65,650** | |
| | **Sub-Total Construction Cost** | **m2** | **56** | **6,446** | **$ 361,000** | |
| 16 | Allow for builder's preliminaries | | *15%* | | 55,000 | Running Costs |
| 17 | Extra over for limited access | | *20%* | | 84,000 | Provisonal Sum |
| 18 | Allow for works within a live HV substation | | *25%* | | 125,000 | Provisonal Sum |
| 19 | Allow for staging | | *10%* | | 63,000 | Provisonal Sum |
| 20 | Design contingency | | *5%* | | 35,000 | |
| | **Sub-Total Expected Tender** | **m2** | **56** | **12,911** | **$ 723,000** | |
| 21 | Contract Contingency | | *5%* | | 37,000 | Variations |
| 22 | Regional locality allowance | | *5%* | | 38,000 | Allow average rate |
| 23 | Cost Escalation to Tender | | *3%* | | 24,000 | 12 Months |
| | **Total Construction Costs** | **m2** | **56** | **14,679** | **$ 822,000** | |
| | **Other Project Costs** | | | | | |
| 24 | Professional fees | item | | | 150,000 | As advised by GHD |
| 25 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 26 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 27 | Project Contingency | | *2%* | | 20,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m2** | **56** | **18,125** | **$ 1,015,000** | |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**NEW RADIATOR ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Areas** | | | | | |
| Standard Radiator Enclosure | m2 | 56 | | | |
| **Total GFA** | **m2** | **56** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK002 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes 6m high enclosure
d Assumes industry standard lump sum contract completed in a single stage
e Average rate of 5% for regional locality allowance has been allowed. This will vary depending on site location
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Diversion / upgrade of existing services
b Cost escalation past a date of 12 months from the date of this estimate
c Out of hours works
d Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**NEW TRANSFORMER ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | Allowance for remedial works to existing transformer slab | item | 1 | 15,000 | 15,000 | Provisional Sum |
| 3 | Allowance for isolation works to existing radiator slab | item | 1 | 30,000 | 30,000 | Provisional Sum - As advised by GHD |
| 4 | 900 Wide x 1100 deep strip footing including excavation, 50 thick N7 blinding layer, 4N16 bars top and bottom, N12-300 ligs and membrane | m | 30 | 600 | 18,000 | |
| 5 | 10 Thick acoustic expansion joint between new and existing concrete | m | 30 | 25 | 750 | |
| | **Sub-Total** | | | | **63,750** | |
| | **Roof** | | | | | |
| 6 | 250 Thick plain grey precast concrete roof including N16-200 bars top and bottom and acoustic sealant | m2 | 56 | 550 | 30,800 | |
| 7 | Pyrotek Viterolite 900 non-combustible sound absorber to existing roof including adhesion | m2 | 56 | 500 | 28,000 | Assumed 7500 x 7500 x 4000 high enclosure |
| 8 | Allow for waterproofing to roof slab | m2 | 56 | 75 | 4,200 | |
| 9 | Allow for rainwater goods including, downpipes, sumps, guttering, etc. | m2 | 56 | 50 | 2,800 | |
| 10 | Allow for site drainage | item | 1 | 20,000 | 20,000 | Provisional Sum |
| 11 | Removable monowills tubular handrails to roof perimeter | m | 30 | 600 | 18,000 | |
| 12 | Allow to acoustically seal roof penetrations | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **105,800** | |
| | **External Walls** | | | | | |
| 13 | 200 Thick plain grey precast concrete wall including SL81 mesh, re-entrant bars, acoustic seals and paint finish | m2 | 90 | 450 | 40,500 | Assumed 4000 high |
| 14 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new walls including adhesion | m2 | 120 | 475 | 57,000 | Assumed 4000 high |
| 15 | 600 Long N20 dowel bars | no | 32 | 50 | 1,600 | Assumed 16 panels |
| 16 | Double brick skin wall including heavy duty masonry ties | m2 | 30 | 600 | 18,000 | Assumed 4000 high Excluding brick patterns |
| 17 | 1250 x 1250 Fantech sound bar louvre (SBL2) | no | 4 | 4,000 | 16,000 | |
| 18 | Allow to acoustically seal wall penetrations for conduits between transformer and radiatior | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **135,100** | |
| | **External Doors** | | | | | |
| 19 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| 20 | 200x100x6 RHS welded door frame | m | 20 | 400 | 8,000 | |
| | **Sub-Total** | | | | **33,000** | |
| | **External Services** | | | | | |
| 21 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 22 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 23 | *Rounding* | | | | *350* | |
| | **Sub-Total** | | | | **65,350** | |
| | **Sub-Total Construction Cost** | **m2** | **56** | **7,554** | **$ 423,000** | |
| 24 | Allow for builder's preliminaries | | *15%* | | 64,000 | Running Costs |
| 25 | Extra over for limited access | | *20%* | | 98,000 | Provisonal Sum |
| 26 | Allow for works within a live HV substation | | *25%* | | 147,000 | Provisonal Sum |
| 27 | Allow for staging | | *10%* | | 74,000 | Provisonal Sum |
| 28 | Design contingency | | *5%* | | 41,000 | |
| | **Sub-Total Expected Tender** | **m2** | **56** | **15,125** | **$ 847,000** | |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**NEW TRANSFORMER ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2** **10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| 29 | Contract Contingency | | *5%* | | 43,000 | Variations |
| 30 | Regional locality allowance | | *5%* | | 45,000 | Allow average rate |
| 31 | Cost Escalation to Tender | | *3%* | | 29,000 | 12 Months |
| | **Total Construction Costs** | **m2** | **56** | **17,214** | **$ 964,000** | |
| | **Other Project Costs** | | | | | |
| 32 | Professional fees | item | | | 150,000 | As advised by GHD |
| 33 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 34 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 35 | Project Contingency | | *2%* | | 23,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m2** | **56** | **20,714** | **$ 1,160,000** | |
| | **Areas** | | | | | |
| | Standard Transformer Enclosure | m2 | 56 | | | |
| | **Total GFA** | **m2** | **56** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK003 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes 4m high enclosure
d Assumes industry standard lump sum contract completed in a single stage
e Average rate of 5% for regional locality allowance has been allowed. This will vary depending on site location
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Diversion / upgrade of existing services
b Cost escalation past a date of 12 months from the date of this estimate
c Out of hours works
d Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**MODIFICATION TO EXISTING RADIATOR ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2** **10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | Allowance for remedial works to existing radiator slab | item | 1 | 15,000 | 15,000 | Provisional Sum |
| 3 | Allowance for isolation works to existing radiator slab | item | 1 | 30,000 | 30,000 | Provisional Sum - As advised by GHD |
| 4 | 900 Wide x 1100 deep strip footing including excavation, 50 thick N7 blinding layer, 4N16 bars top and bottom, N12-300 cts ligs and membrane | m | 15 | 600 | 9,000 | |
| 5 | 10 Thick acoustic expansion joint between new and existing concrete | m | 15 | 25 | 375 | |
| | **Sub-Total** | | | | **54,375** | |
| | **External Walls** | | | | | |
| 6 | Allowance for remedial works to existing radiator walls | item | 1 | 20,000 | 20,000 | Provisional Sum |
| 7 | 200 Thick plain grey precast concrete wall including SL81 mesh, re-entrant bars, acoustic seals and paint finish | m2 | 90 | 450 | 40,500 | Assumed 6000 high |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new and existing walls including adhesion | m2 | 180 | 475 | 85,500 | Assumed 6000 high |
| 9 | 600 Long N20 dowel bars | no | 16 | 50 | 800 | Assumed 8 panels |
| 10 | 300 PFC waler beam to perimeter including hot dip galvanising and fixing | m | 30 | 350 | 10,500 | |
| 11 | 1250 x 1250 Fantech sound bar louvre (SBL2) | no | 4 | 4,000 | 16,000 | |
| 12 | Allow to acoustically seal wall penetrations for conduits between transformer and radiatior | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **175,300** | |
| | **External Doors** | | | | | |
| 13 | 920 Wide x 2400 high acoustic / fire rated door including frame, acoustic seals and hardware | no | 2 | 7,500 | 15,000 | |
| | **Sub-Total** | | | | **15,000** | |
| | **External Services** | | | | | |
| 14 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 15 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 16 | *Rounding* | | | | *325* | |
| | **Sub-Total** | | | | **65,325** | |
| | **Sub-Total Construction Cost** | **m2** | **56** | **5,893** | **$ 330,000** | |
| | | | | | | |
| 17 | Allow for builder's preliminaries | | *15%* | | 50,000 | Running Costs |
| 18 | Extra over for limited access | | *20%* | | 76,000 | Provisonal Sum |
| 19 | Allow for works within a live HV substation | | *25%* | | 114,000 | Provisonal Sum |
| 20 | Allow for staging | | *10%* | | 57,000 | Provisonal Sum |
| 21 | Design contingency | | *5%* | | 32,000 | |
| | **Sub-Total Expected Tender** | **m2** | **56** | **11,768** | **$ 659,000** | |
| | | | | | | |
| 22 | Contract Contingency | | *5%* | | 33,000 | Variations |
| 23 | Regional locality allowance | | | | Excluded | |
| 24 | Cost Escalation to Tender | | *3%* | | 21,000 | 12 Months |
| | **Total Construction Costs** | **m2** | **56** | **12,732** | **$ 713,000** | |
| | | | | | | |
| | **Other Project Costs** | | | | | |
| 25 | Professional fees | item | | | 150,000 | As advised by GHD |
| 26 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 27 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 28 | Project Contingency | | *2%* | | 18,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m2** | **56** | **16,143** | **$ 904,000** | |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**MODIFICATION TO EXISTING RADIATOR ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Areas** | | | | | |
| Standard Radiator Enclosure | m2 | 56 | | | |
| **Total GFA** | **m2** | **56** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK004 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes 6m high enclosure
d Assumes industry standard lump sum contract completed in a single stage
e Assumes adequate access for cranage and other buildability issues
f Pricing accuracy within +-30%
g Provisional Sum allowances as stated above

***Exclusions***

a Diversion / upgrade of existing services
b Cost escalation past a date of 12 months from the date of this estimate
c Regional locality allowance
d Out of hours works
e Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**MODIFICATION TO EXISTING TRANSFORMER ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2**

WILDE AND WOOLLARD

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | Allowance for remedial works to existing transformer slab | item | 1 | 15,000 | 15,000 | Provisional Sum |
| 3 | Allowance for isolation works to existing radiator slab | item | 1 | 30,000 | 30,000 | Provisional Sum - As advised by GHD |
| | **Sub-Total** | | | | **45,000** | |
| | **Roof** | | | | | |
| 4 | Allowance for remedial works to existing transformer roof | item | 1 | 15,000 | 15,000 | Provisional Sum |
| 5 | Pyrotek Viterolite 900 non-combustible sound absorber to existing roof including adhesion | m2 | 56 | 500 | 28,000 | Assumed 7500 x 7500 x 4000 high enclosure |
| 6 | Allow to acoustically seal penetrations in existing roof | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **45,000** | |
| | **External Walls** | | | | | |
| 7 | Allowance for remedial works to existing transformer walls | item | 1 | 20,000 | 20,000 | Provisional Sum |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining existing walls including adhesion | m2 | 120 | 475 | 57,000 | Assumed 7500 x 7500 x 4000 high enclosure |
| 9 | Form opening in existing enclosure wall | item | 1 | 1,500 | 1,500 | Assumed at low level |
| 10 | 1250 x 1250 Fantech sound bar louvre (SBL2) | no | 4 | 4,000 | 16,000 | |
| 11 | Allow to acoustically seal wall penetrations for conduits between transformer and radiatior | item | 1 | 2,000 | 2,000 | |
| | **Sub-Total** | | | | **96,500** | |
| | **External Doors** | | | | | |
| 12 | Remove existing pair of doors including frame and hardware | no | 2 | 1,500 | 3,000 | |
| 13 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **28,000** | |
| | **External Services** | | | | | |
| 14 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 15 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 16 | *Rounding* | | | | *500* | |
| | **Sub-Total** | | | | **65,500** | |
| | **Sub-Total Construction Cost** | **m2** | **56** | **5,357** | **$ 300,000** | |
| 17 | Allow for builder's preliminaries | | *15%* | | 45,000 | Running Costs |
| 18 | Extra over for limited access | | *20%* | | 69,000 | Provisonal Sum |
| 19 | Allow for works within a live HV substation | | *25%* | | 104,000 | Provisonal Sum |
| 20 | Allow for staging | | *10%* | | 52,000 | Provisonal Sum |
| 21 | Design contingency | | *5%* | | 29,000 | |
| | **Sub-Total Expected Tender** | **m2** | **56** | **10,696** | **$ 599,000** | |
| 22 | Contract Contingency | | *5%* | | 30,000 | Variations |
| 23 | Regional locality allowance | | | | Excluded | |
| 24 | Cost Escalation to Tender | | *3%* | | 19,000 | 12 Months |
| | **Total Construction Costs** | **m2** | **56** | **11,571** | **$ 648,000** | |
| | **Other Project Costs** | | | | | |
| 25 | Professional fees | item | | | 150,000 | As advised by GHD |
| 26 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 27 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 28 | Project Contingency | | *2%* | | 17,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m2** | **56** | **14,964** | **$ 838,000** | |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**MODIFICATION TO EXISTING TRANSFORMER ENCLOSURE**

**FEASIBILITY COST PLAN - REV 2** **10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Areas** | | | | | |
| Standard Transformer Enclosure | m2 | 56 | | | |
| **Total GFA** | **m2** | **56** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK005 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes 7.5m x 7.5m x 4m high enclosure
d Assumes industry standard lump sum contract completed in a single stage
e Assumes existing doors are replaced with doors of the same size
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Stormwater drainage including connections
b Structural alterations
c Diversion / upgrade of existing services
d Cost escalation past a date of 12 months from the date of this estimate
e Regional locality allowance
f Out of hours works
g Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (3m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 900 x 900 pile capping beam including excavation, 4N16 bars top and bottom and N12-300 cts ligs | m | 40 | 500 | 20,000 | Assumed min. 10m x 10m fence enclosure |
| 4 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed piles at 2m centres |
| | **Sub-Total** | | | | **44,000** | |
| | **Columns** | | | | | |
| 5 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 2,900 | 58,000 | |
| 6 | Extra over 25 thick high strength grout between column and wall | no | 20 | 300 | 6,000 | |
| | **Sub-Total** | | | | **64,000** | |
| | **External Walls** | | | | | |
| 7 | 200 Thick plain grey precast concrete wall including SL81 mesh, acoustic seals and paint finish | m2 | 120 | 450 | 54,000 | |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new precast fence including adhesion | m2 | 120 | 475 | 57,000 | Assumed to full extent of fencing enclosure |
| 9 | 600 Long N20 dowel bars | no | 40 | 50 | 2,000 | Assumed 20 panels |
| | **Sub-Total** | | | | **113,000** | |
| | **External Doors** | | | | | |
| 10 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 11 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 12 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 13 | *Rounding* | | | | *0* | |
| | **Sub-Total** | | | | **65,000** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **8,275** | **$ 331,000** | |
| | | | | | | |
| 14 | Allow for builder's preliminaries | | *15%* | | 50,000 | Running Costs |
| 15 | Extra over for tight access | | *20%* | | 77,000 | Provisonal Sum |
| 16 | Allow for works within a live HV substation | | *25%* | | 115,000 | Provisonal Sum |
| 17 | Allow for staging | | *10%* | | 58,000 | Provisonal Sum |
| 18 | Design contingency | | *5%* | | 32,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **16,575** | **$ 663,000** | |
| | | | | | | |
| 19 | Contract Contingency | | *5%* | | 34,000 | Variations |
| 20 | Regional locality allowance | | | | Excluded | |
| 21 | Cost Escalation to Tender | | *3%* | | 21,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **17,950** | **$ 718,000** | |
| | | | | | | |
| | **Other Project Costs** | | | | | |
| 22 | Professional fees | item | | | 150,000 | As advised by GHD |
| 23 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 24 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 25 | Project Contingency | | *2%* | | 18,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **22,725** | **$ 909,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 23,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (3m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|
| **Lengths** | | | | | |
| Standard Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK006 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard lump sum contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (4m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 900 x 900 pile capping beam including excavation, 4N16 bars top and bottom and N12-300 cts ligs | m | 40 | 500 | 20,000 | Assumed min. 10m x 10m fence enclosure |
| 4 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed piles at 2m centres |
| | **Sub-Total** | | | | **44,000** | |
| | **Columns** | | | | | |
| 5 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 3,800 | 76,000 | |
| 6 | Extra over 25 thick high strength grout between column and wall | no | 20 | 400 | 8,000 | |
| | **Sub-Total** | | | | **84,000** | |
| | **External Walls** | | | | | |
| 7 | 200 Thick plain grey precast concrete wall including SL81 mesh, acoustic seals and paint finish | m2 | 160 | 450 | 72,000 | |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new precast fence including adhesion | m2 | 160 | 475 | 76,000 | Assumed to full extent of fencing enclosure |
| 9 | 600 Long N20 dowel bars | no | 40 | 50 | 2,000 | Assumed 20 panels |
| | **Sub-Total** | | | | **150,000** | |
| | **External Doors** | | | | | |
| 10 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 11 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 12 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 13 | *Rounding* | | | | *0* | |
| | **Sub-Total** | | | | **65,000** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **9,700** | **$ 388,000** | |
| | | | | | | |
| 14 | Allow for builder's preliminaries | | *15%* | | 59,000 | Running Costs |
| 15 | Extra over for tight access | | *20%* | | 90,000 | Provisonal Sum |
| 16 | Allow for works within a live HV substation | | *25%* | | 135,000 | Provisonal Sum |
| 17 | Allow for staging | | *10%* | | 68,000 | Provisonal Sum |
| 18 | Design contingency | | *5%* | | 37,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **19,425** | **$ 777,000** | |
| | | | | | | |
| 19 | Contract Contingency | | *5%* | | 39,000 | Variations |
| 20 | Regional locality allowance | | | | Excluded | |
| 21 | Cost Escalation to Tender | | *3%* | | 25,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **21,025** | **$ 841,000** | |
| | | | | | | |
| | **Other Project Costs** | | | | | |
| 22 | Professional fees | item | | | 150,000 | As advised by GHD |
| 23 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 24 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 25 | Project Contingency | | *2%* | | 21,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **25,875** | **$ 1,035,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 26,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (4m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|
| **Lengths** | | | | | |
| Standard Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK006 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard lump sum contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (5m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 900 x 900 pile capping beam including excavation, 4N16 bars top and bottom and N12-300 cts ligs | m | 40 | 500 | 20,000 | Assumed min. 10m x 10m fence enclosure |
| 4 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed piles at 2m centres |
| | **Sub-Total** | | | | **44,000** | |
| | **Columns** | | | | | |
| 5 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 4,800 | 96,000 | |
| 6 | Extra over 25 thick high strength grout between column and wall | no | 20 | 500 | 10,000 | |
| | **Sub-Total** | | | | **106,000** | |
| | **External Walls** | | | | | |
| 7 | 200 Thick plain grey precast concrete wall including SL81 mesh, acoustic seals and paint finish | m2 | 200 | 450 | 90,000 | |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new precast fence including adhesion | m2 | 200 | 475 | 95,000 | Assumed to full extent of fencing enclosure |
| 9 | 600 Long N20 dowel bars | no | 40 | 50 | 2,000 | Assumed 20 panels |
| | **Sub-Total** | | | | **187,000** | |
| | **External Doors** | | | | | |
| 10 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 11 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 12 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 13 | *Rounding* | | | | *0* | |
| | **Sub-Total** | | | | **65,000** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **11,175** | **$ 447,000** | |
| 14 | Allow for builder's preliminaries | | *15%* | | 68,000 | Running Costs |
| 15 | Extra over for tight access | | *20%* | | 103,000 | Provisonal Sum |
| 16 | Allow for works within a live HV substation | | *25%* | | 155,000 | Provisonal Sum |
| 17 | Allow for staging | | *10%* | | 78,000 | Provisonal Sum |
| 18 | Design contingency | | *5%* | | 43,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **22,350** | **$ 894,000** | |
| 19 | Contract Contingency | | *5%* | | 45,000 | Variations |
| 20 | Regional locality allowance | | | | Excluded | |
| 21 | Cost Escalation to Tender | | *3%* | | 29,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **24,200** | **$ 968,000** | |
| | **Other Project Costs** | | | | | |
| 22 | Professional fees | item | | | 150,000 | As advised by GHD |
| 23 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 24 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 25 | Project Contingency | | *2%* | | 23,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **29,100** | **$ 1,164,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 30,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (5m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK006 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard lump sum contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (6m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

WILDE AND WOOLLARD

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 900 x 900 pile capping beam including excavation, 4N16 bars top and bottom and N12-300 cts ligs | m | 40 | 500 | 20,000 | Assumed min. 10m x 10m fence enclosure |
| 4 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed piles at 2m centres |
| | **Sub-Total** | | | | **44,000** | |
| | **Columns** | | | | | |
| 5 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 5,700 | 114,000 | |
| 6 | Extra over 25 thick high strength grout between column and wall | no | 20 | 600 | 12,000 | |
| | **Sub-Total** | | | | **126,000** | |
| | **External Walls** | | | | | |
| 7 | 200 Thick plain grey precast concrete wall including SL81 mesh, acoustic seals and paint finish | m2 | 240 | 450 | 108,000 | |
| 8 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new precast fence including adhesion | m2 | 240 | 475 | 114,000 | Assumed to full extent of fencing enclosure |
| 9 | 600 Long N20 dowel bars | no | 40 | 50 | 2,000 | Assumed 20 panels |
| | **Sub-Total** | | | | **224,000** | |
| | **External Doors** | | | | | |
| 10 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 11 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 12 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 13 | *Rounding* | | | | *0* | |
| | **Sub-Total** | | | | **65,000** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **12,600** | **$ 504,000** | |
| 14 | Allow for builder's preliminaries | | *15%* | | 76,000 | Running Costs |
| 15 | Extra over for limited access | | *20%* | | 116,000 | Provisonal Sum |
| 16 | Allow for works within a live HV substation | | *25%* | | 174,000 | Provisonal Sum |
| 17 | Allow for staging | | *10%* | | 87,000 | Provisonal Sum |
| 18 | Design contingency | | *5%* | | 48,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **25,125** | **$ 1,005,000** | |
| 19 | Contract Contingency | | *5%* | | 51,000 | Variations |
| 20 | Regional locality allowance | | | | Excluded | |
| 21 | Cost Escalation to Tender | | *3%* | | 32,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **27,200** | **$ 1,088,000** | |
| | **Other Project Costs** | | | | | |
| 22 | Professional fees | item | | | 150,000 | As advised by GHD |
| 23 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 24 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 25 | Project Contingency | | *2%* | | 26,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **32,175** | **$ 1,287,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 33,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ACOUSTIC PERIMETER FENCE (6m HIGH)**
**OPTION A**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK006 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard lump sum contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (3m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|---|
| | | | | ($) | ($) | |
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed 10m x 10m enclosure Assumed piles at 2m centres |
| | **Sub-Total** | | | | **24,000** | |
| | **Columns** | | | | | |
| 4 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 3,200 | 64,000 | |
| | **Sub-Total** | | | | **64,000** | |
| | **External Walls** | | | | | |
| 5 | Steel sheet wall cladding comprising 2 layers of 1 BMT sheeting, C150 steel wall girts, 120kg/m3 insulation, sub framing and capping | m2 | 120 | 470 | 56,400 | |
| 6 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new steel fence including adhesion | m2 | 120 | 475 | 57,000 | Assumed to full extent of fencing enclosure |
| | **Sub-Total** | | | | **113,400** | |
| | **External Doors** | | | | | |
| 7 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 8 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 9 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 10 | *Rounding* | | | | *600* | |
| | **Sub-Total** | | | | **65,600** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **7,800** | **$ 312,000** | |
| 11 | Allow for builder's preliminaries | | *15%* | | 47,000 | Running Costs |
| 12 | Extra over for tight access | | *20%* | | 72,000 | Provisonal Sum |
| 13 | Allow for works within a live HV substation | | *25%* | | 108,000 | Provisonal Sum |
| 14 | Allow for staging | | *10%* | | 54,000 | Provisonal Sum |
| 15 | Design contingency | | *5%* | | 30,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **15,575** | **$ 623,000** | |
| 16 | Contract Contingency | | *5%* | | 32,000 | Variations |
| 17 | Regional locality allowance | | | | Excluded | |
| 18 | Cost Escalation to Tender | | *3%* | | 20,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **16,875** | **$ 675,000** | |
| | **Other Project Costs** | | | | | |
| 19 | Professional fees | item | | | 150,000 | As advised by GHD |
| 20 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 21 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 22 | Project Contingency | | *2%* | | 17,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **21,625** | **$ 865,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 22,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (3m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

WILDE AND WOOLLARD

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Alternative Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK007 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (4m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed 10m x 10m enclosure Assumed piles at 2m centres |
| | **Sub-Total** | | | | **24,000** | |
| | **Columns** | | | | | |
| 4 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 4,100 | 82,000 | |
| | **Sub-Total** | | | | **82,000** | |
| | **External Walls** | | | | | |
| 5 | Steel sheet wall cladding comprising 2 layers of 1 BMT sheeting, C150 steel wall girts, 120kg/m3 insulation, sub framing and capping | m2 | 160 | 470 | 75,200 | |
| 6 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new steel fence including adhesion | m2 | 160 | 475 | 76,000 | Assumed to full extent of fencing enclosure |
| | **Sub-Total** | | | | **151,200** | |
| | **External Doors** | | | | | |
| 7 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 8 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 9 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 10 | *Rounding* | | | | *800* | |
| | **Sub-Total** | | | | **65,800** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **9,200** | **$ 368,000** | |
| 11 | Allow for builder's preliminaries | | *15%* | | 56,000 | Running Costs |
| 12 | Extra over for tight access | | *20%* | | 85,000 | Provisonal Sum |
| 13 | Allow for works within a live HV substation | | *25%* | | 128,000 | Provisonal Sum |
| 14 | Allow for staging | | *10%* | | 64,000 | Provisonal Sum |
| 15 | Design contingency | | *5%* | | 36,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **18,425** | **$ 737,000** | |
| 16 | Contract Contingency | | *5%* | | 37,000 | Variations |
| 17 | Regional locality allowance | | | | Excluded | |
| 18 | Cost Escalation to Tender | | *3%* | | 24,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **19,950** | **$ 798,000** | |
| | **Other Project Costs** | | | | | |
| 19 | Professional fees | item | | | 150,000 | As advised by GHD |
| 20 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 21 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 22 | Project Contingency | | *2%* | | 20,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **24,775** | **$ 991,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 25,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (4m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Alternative Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK007 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (5m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed 10m x 10m enclosure Assumed piles at 2m centres |
| | **Sub-Total** | | | | **24,000** | |
| | **Columns** | | | | | |
| 4 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 5,100 | 102,000 | |
| | **Sub-Total** | | | | **102,000** | |
| | **External Walls** | | | | | |
| 5 | Steel sheet wall cladding comprising 2 layers of 1 BMT sheeting, C150 steel wall girts, 120kg/m3 insulation, sub framing and capping | m2 | 200 | 470 | 94,000 | |
| 6 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new steel fence including adhesion | m2 | 200 | 475 | 95,000 | Assumed to full extent of fencing enclosure |
| | **Sub-Total** | | | | **189,000** | |
| | **External Doors** | | | | | |
| 7 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 8 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 9 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 10 | *Rounding* | | | | *0* | |
| | **Sub-Total** | | | | **65,000** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **10,625** | **$ 425,000** | |
| | | | | | | |
| 11 | Allow for builder's preliminaries | | *15%* | | 64,000 | Running Costs |
| 12 | Extra over for tight access | | *20%* | | 98,000 | Provisonal Sum |
| 13 | Allow for works within a live HV substation | | *25%* | | 147,000 | Provisonal Sum |
| 14 | Allow for staging | | *10%* | | 74,000 | Provisonal Sum |
| 15 | Design contingency | | *5%* | | 41,000 | |
| | | | | | | |
| | **Sub-Total Expected Tender** | **m** | **40** | **21,225** | **$ 849,000** | |
| | | | | | | |
| 16 | Contract Contingency | | *5%* | | 43,000 | Variations |
| 17 | Regional locality allowance | | | | Excluded | |
| 18 | Cost Escalation to Tender | | *3%* | | 27,000 | 12 Months |
| | | | | | | |
| | **Total Construction Costs** | **m** | **40** | **22,975** | **$ 919,000** | |
| | | | | | | |
| | **Other Project Costs** | | | | | |
| 19 | Professional fees | item | | | 150,000 | As advised by GHD |
| 20 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 21 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 22 | Project Contingency | | *2%* | | 22,000 | |
| | | | | | | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **27,850** | **$ 1,114,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 28,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (5m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Alternative Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK007 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m  fencing enclosure
e Assumes industry standard contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (6m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

WILDE AND WOOLLARD

**10/10/2019**

| | Description of Work | Unit | Qty | Rate ($) | Total ($) | Comments |
|---|---|---|---|---|---|---|
| | **Hazardous Materials** | | | | | |
| 1 | Allowance for hazardous materials / contaminated soil removal | item | 1 | 20,000 | 20,000 | Provisional Sum |
| | **Sub-Total** | | | | **20,000** | |
| | **Substructure** | | | | | |
| 2 | No allowance for remedial works to existing substation | note | | | | |
| 3 | 600 Diameter pile x 3000 deep including 8N20 Bars and N12-150 helical reinforcement | no | 20 | 1,200 | 24,000 | Assumed 10m x 10m enclosure Assumed piles at 2m centres |
| | **Sub-Total** | | | | **24,000** | |
| | **Columns** | | | | | |
| 4 | 310 UC 118 Steel column including base place, grout, holding down bolts and connections | no | 20 | 6,000 | 120,000 | |
| | **Sub-Total** | | | | **120,000** | |
| | **External Walls** | | | | | |
| 5 | Steel sheet wall cladding comprising 2 layers of 1 BMT sheeting, C150 steel wall girts, 120kg/m3 insulation, sub framing and capping | m2 | 240 | 470 | 112,800 | |
| 6 | Pyrotek Viterolite 900 non-combustible sound absorber wall lining to new steel fence including adhesion | m2 | 240 | 475 | 114,000 | Assumed to full extent of fencing enclosure |
| | **Sub-Total** | | | | **226,800** | |
| | **External Doors** | | | | | |
| 7 | 1840 Wide x 2400 high pair of acoustic / fire rated doors including frame, acoustic seals and hardware | no | 2 | 12,500 | 25,000 | |
| | **Sub-Total** | | | | **25,000** | |
| | **External Services** | | | | | |
| 8 | Allow for connection to the existing substation earthing grid | item | 1 | 15,000 | 15,000 | Provisional Sum - As advised by GHD |
| 9 | Allow for isolation works between new / existing structure and equipment including resilient hangers, vibration pads, etc. | item | 1 | 50,000 | 50,000 | Provisional Sum |
| 10 | *Rounding* | | | | *200* | |
| | **Sub-Total** | | | | **65,200** | |
| | **Sub-Total Construction Cost** | **m** | **40** | **12,025** | **$ 481,000** | |
| 11 | Allow for builder's preliminaries | | *15%* | | 73,000 | Running Costs |
| 12 | Extra over for tight access | | *20%* | | 111,000 | Provisonal Sum |
| 13 | Allow for works within a live HV substation | | *25%* | | 167,000 | Provisonal Sum |
| 14 | Allow for staging | | *10%* | | 84,000 | Provisonal Sum |
| 15 | Design contingency | | *5%* | | 46,000 | |
| | **Sub-Total Expected Tender** | **m** | **40** | **24,050** | **$ 962,000** | |
| 16 | Contract Contingency | | *5%* | | 49,000 | Variations |
| 17 | Regional locality allowance | | | | Excluded | |
| 18 | Cost Escalation to Tender | | *3%* | | 31,000 | 12 Months |
| | **Total Construction Costs** | **m** | **40** | **26,050** | **$ 1,042,000** | |
| | **Other Project Costs** | | | | | |
| 19 | Professional fees | item | | | 150,000 | As advised by GHD |
| 20 | Allow for geotechnical site investigation | item | | | 18,000 | Provisional Sum |
| 21 | Allow for authority headworks and changes | item | | | 5,000 | Provisional Sum |
| 22 | Project Contingency | | *2%* | | 25,000 | |
| | **TOTAL CONSTRUCTION COST** (Excluding GST) | **m** | **40** | **31,000** | **$ 1,240,000** | |
| | **TOTAL CONSTRUCTION COST PER M** (Excluding GST) | **m** | | | **$ 31,000** | Average m rate allowing for minimum 10m x 10m fencing enclosure |

**POWERCOR - ACOUSTIC TREATMENT PROJECT**

**ALTERNATIVE ACOUSTIC PERIMETER FENCE (6m HIGH)**
**OPTION B**
**FEASIBILITY COST PLAN - REV 2**

**10/10/2019**

| Description of Work | Unit | Qty | Rate | Total | Comments |
|---|---|---|---|---|---|
| | | | ($) | ($) | |
| **Lengths** | | | | | |
| Standard Alternative Perimeter Acoustic Fence (Assumed) | m | 40 | | | |
| **Total Length** | **m** | **40** | | | |

***Assumptions***

a The above estimate is based on Sketches SK001, SK007 from GHD dated 26th September 2019
b The above estimate has been revised based on GHD comments received 9th October 2019
c Assumes footing system and structural steel does not require to be fixed to existing structure
d Assumes minimum 10m x 10m fencing enclosure
e Assumes industry standard contract completed in a single stage
f Assumes adequate access for cranage and other buildability issues
g Pricing accuracy within +-30%
h Provisional Sum allowances as stated above

***Exclusions***

a Upgrade of existing building structure
b Diversion / upgrade of existing services
c Cost escalation past a date of 12 months from the date of this estimate
d Regional locality allowance
e Out of hours works
f Goods and services tax (GST)

# **Appendix C** – Overall site cost calculations

## Table C-1 Cost per unit for different costed noise mitigated options

| Index | Noise mitigation option (NMO) | Unit cost type | Unit cost |
|---|---|---|---|
| NMO 1 | Transformer replacement | Cost per transformer | $3,700,000 (1) |
| NMO 2 | New transformer enclosure | Cost per transformer | $1,160,000 (2) |
| NMO 3 | New radiator enclosure | Cost per radiator enclosure | $1,015,000 (2) |
| NMO 4 | Modification to existing transformer enclosure | Cost per transformer enclosure | $838,000 (2) |
| NMO 5 | Modification to existing radiator enclosure | Cost per radiator enclosure | $904,000 (2) |
| NMO 6 | Acoustic perimeter wall | Cost per metre length | $22,000 - $33,000 (3), breakdown includes:<br>– 3 m high (4) , $22,000 – $23,000<br>– 4 m high (4), $25,000 - $26,000<br>– 5 m high (4), $28,000 - $30,000<br>– 6 m high (4), $31,000 - $33,000 |

Notes

1. Indicative cost provided by Powercor for transformer replacement and sound enclosure. Refer to Section 3.2.2 for further discussion.
2. For detailed cost breakdown, refer to the Quantity Surveyor’s cost estimates presented in Appendix B.
3. Cost estimate range represents costing for 3 – 6 m high acoustic perimeter wall constructed from steel or concrete.
4. Cost estimate range represents costing for a steel vs concrete perimeter wall. Refer to the detailed costing in Appendix B. Refer to Section 3.2.7 for details of the acoustic perimeter wall construction.

### Table C-2 Overall site cost calculation summary for sites CW to Q

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites [3] Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CW** | **AR** | **BC** | **NC** | **AP** | **SK** | **Q** |
| Number of transformers (TXs) | ---- | ---- | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Approximate site perimeter length | ---- | ---- | 138 m | 63 m | 244 m | 234 m | 174 m | 202 m | 197 m |
| Scenario 0 – Do Nothing Approach | *Nil* | *Nil* | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | | | | | | |
| Scenario 1 – Transformer Replacement | NMO 1 | $3,700,000 per transformer | $11,100,000 | $11,100,000 | $11,100,000 | $11,100,000 | $11,100,000 | $11,100,000 | $11,100,000 |
| Scenario 2 – New transformer and radiator enclosures | NMO 2<br>NMO 3 | $2,175,000 [1] per transformer | $6,525,000 | $6,525,000 | $6,525,000 | $6,525,000 | $6,525,000 | $6,525,000 | $6,525,000 |
| Scenario 3 – Modification to existing transformer enclosure & new radiator enclosure | NMO 4<br>NMO 3 | $1,853,000 [1] per transformer | $5,559,000 | $5,559,000 | $5,559,000 | $5,559,000 | $5,559,000 | $5,559,000 | $5,559,000 |
| Scenario 4 – Modification to existing transformer and radiator enclosures | NMO 4<br>NMO 5 | $1,742,000 [1] per transformer | $5,226,000 | $5,226,000 | $5,226,000 | $5,226,000 | $5,226,000 | $5,226,000 | $5,226,000 |
| Scenario 5 – Acoustic perimeter wall | NMO 6 | $33,000 per unit length | $4,554,000 | $2,079,000 | $8,052,000 | $7,722,000 | $5,742,000 | $6,666,000 | $6,501,000 |

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites (3) Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CW** | **AR** | **BC** | **NC** | **AP** | **SK** | **Q** |
| Number of transformers (TXs) | ---- | ---- | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Approximate site perimeter length | ---- | ---- | 138 m | 63 m | 244 m | 234 m | 174 m | 202 m | 197 m |
| Scenario 6 – Combination of scenarios 2 & 5 | NMO 2<br>NMO 3<br>NMO 6 | *Not relevant* (2) | $11,079,000 | $8,604,000 | $14,577,000 | $14,247,000 | $12,267,000 | $13,191,000 | $13,026,000 |
| Scenario 7 – Combination of scenarios 3 & 5 | NMO 4<br>NMO 3<br>NMO 6 | *Not relevant* (2) | $9,147,000 | $7,197,000 | $11,903,000 | $11,643,000 | $10,083,000 | $10,811,000 | $10,681,000 |
| Scenario 8 – Combination of scenarios 4 & 5 | NMO 4<br>NMO 5<br>NMO 6 | *Not relevant* (2) | $8,814,000 | $6,864,000 | $11,570,000 | $11,310,000 | $9,750,000 | $10,478,000 | $10,348,000 |
| Scenario 9 – Miscellaneous treatments | *Not relevant* | *Not relevant* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* |
| Scenario 10 – Receiver treatments | *Not relevant* | *Not relevant* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* |

Notes:

1. Maximum unit cost calculated is based on the summation of unit costs for each relevant NMOs. Refer to Table C-1 for unit cost for each NMO.
2. Estimated overall cost for this scenario is the arithmetic summation of estimated costs for each individual noted scenario. Hence unit cost is not relevant.
3. Example calculations are provided below representing site cost estimate calculations for all scenarios. The example calculations are for the CW site.
   - Scenario 1: $11,100,000 = 3 (no. transformers) x $3,700,000 (unit cost per transformer)
   - Scenario 2: $2,175,000 (maximum unit cost) = $1,160,000 (unit cost NMO 2) + $1,015,000 (unit cost NMO 3), then site cost estimate is $6,525,000 = 3 (no. transformers) x $2,175,000 (unit cost per transformer)

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites (3) Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CW** | **AR** | **BC** | **NC** | **AP** | **SK** | **Q** |
| Number of transformers (TXs) | ---- | ---- | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Approximate site perimeter length | ---- | ---- | 138 m | 63 m | 244 m | 234 m | 174 m | 202 m | 197 m |

- Scenario 5: $4,554,000 = 138 m (approximate site perimeter length) x $33,000 (unit cost per length)
- Scenario 6: $11,079,000 = $6,525,000 (site specific cost estimate for scenario 2) + $4,554,000 (site specific cost estimate for scenario 5)

## Table C-2 Overall site cost calculation summary for sites CL to WBE

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites (3) Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CL** | **GLE** | **KYM** | **WPD** | **GL** | **WBE** |
| Number of transformers (TXs) | ---- | ---- | 3 | 2 | 2 | 2 | 2 | 2 |
| Approximate site perimeter length | ---- | ---- | 176 m | 373 m | 284 m | 399 m | 294 m | 303 m |
| Scenario 0 – Do Nothing Approach | *Nil* | *Nil* | $8,000 initial<br>$390,000<br>$195,000 / day ongoing | | | | | |
| Scenario 1 – Transformer Replacement | NMO 1 | $3,700,000<br>per transformer | $11,100,000 | $7,400,000 | 7,400,000 | 7,400,000 | 7,400,000 | 7,400,000 |
| Scenario 2 – New transformer and radiator enclosures | NMO 2<br>NMO 3 | $2,175,000 (1)<br>per transformer | $6,525,000 | $4,350,000 | $4,350,000 | $4,350,000 | $4,350,000 | $4,350,000 |
| Scenario 3 – Modification to existing transformer enclosure & new radiator enclosure | NMO 4<br>NMO 3 | $1,853,000 (1)<br>per transformer | $5,559,000 | $3,706,000 | $3,706,000 | $3,706,000 | $3,706,000 | $3,706,000 |
| Scenario 4 – Modification to existing transformer and radiator enclosures | NMO 4<br>NMO 5 | $1,742,000 (1)<br>per transformer | $5,226,000 | $3,484,000 | $3,484,000 | $3,484,000 | $3,484,000 | $3,484,000 |
| Scenario 5 – Acoustic perimeter wall | NMO 6 | $33,000<br>per unit length | $5,808,000 | $12,309,000 | $9,372,000 | $13,167,000 | $9,702,000 | $9,999,000 |

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites (3) Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CL** | **GLE** | **KYM** | **WPD** | **GL** | **WBE** |
| Number of transformers (TXs) | ---- | ---- | 3 | 2 | 2 | 2 | 2 | 2 |
| Approximate site perimeter length | ---- | ---- | 176 m | 373 m | 284 m | 399 m | 294 m | 303 m |
| Scenario 6 – Combination of scenarios 2 & 5 | NMO 2<br>NMO 3<br>NMO 6 | *Not relevant* (2) | $12,333,000 | $16,659,000 | $13,722,000 | $17,517,000 | $14,052,000 | $14,349,000 |
| Scenario 7 – Combination of scenarios 3 & 5 | NMO 4<br>NMO 3<br>NMO 6 | *Not relevant* (2) | $10,135,000 | $13,404,000 | $11,090,000 | $14,080,000 | $11,350,000 | $11,584,000 |
| Scenario 8 – Combination of scenarios 4 & 5 | NMO 4<br>NMO 5<br>NMO 6 | *Not relevant* (2) | $9,802,000 | $13,182,000 | $10,868,000 | $13,858,000 | $11,128,000 | $11,362,000 |
| Scenario 9 – Miscellaneous treatments | *Not relevant* | *Not relevant* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* |
| Scenario 10 – Receiver treatments | *Not relevant* | *Not relevant* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* | *Not costed* |

Notes:

1. Maximum unit cost calculated is based on the summation of unit costs for each relevant NMOs. Refer to Table C-1 for unit cost for each NMO.
2. Estimated overall cost for this scenario is the arithmetic summation of estimated costs for each individual noted scenario. Hence unit cost is not relevant.
3. Example calculations are provided below representing site cost estimate calculations for all scenarios. The example calculations are for the CL site.
   - Scenario 1: $11,100,000 = 3 (no. transformers) x $3,700,000 (unit cost per transformer)
   - Scenario 2: $2,175,000 (maximum unit cost) = $1,160,000 (unit cost NMO 2) + $1,015,000 (unit cost NMO 3), then site cost estimate is $6,525,000 = 3 (no. transformers) x $2,175,000 (unit cost per transformer)

| Noise mitigation scenario | Noise Mitigation Options (NMOs) Table C-1 | Maximum unit cost | Overall noise mitigation scenario cost estimates for different substation sites (3) Highlighted cells indicate applicable scenarios for each site (refer to site matrix in Appendix E) | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Substation Sites** | ---- | ---- | **CL** | **GLE** | **KYM** | **WPD** | **GL** | **WBE** |
| Number of transformers (TXs) | ---- | ---- | 3 | 2 | 2 | 2 | 2 | 2 |
| Approximate site perimeter length | ---- | ---- | 176 m | 373 m | 284 m | 399 m | 294 m | 303 m |

- Scenario 5: $5,808,000 = 176 m (approximate site perimeter length) x $33,000 (unit cost per length)
- Scenario 6: $12,333,000 = $6,525,000 (site specific cost estimate for scenario 2) + $5,808,000 (site specific cost estimate for scenario 5)

# **Appendix D** – Noise modelling contours

Noise modelling contours for the following sites:

- BC, 49 Hotham Street, St Kilda East
- CW, 49 Easey St, Collingwood
- AR, 924 High Street, Armadale
- NC, 21 Lennox Street, Northcote
- CL, 387 Riversdale Road, Hawthorn East
- GLE, 242 – 254 St Albans Road, Breakwater
- WBE, 178 Shaws Road, Werribee


Legend

| | | | |
|---|---|---|---|
| New Transformer Enclosure | Noise Reduction | 12 - 14 dB(A) | 18 - 20 dB(A) |
| New Radiator Enclosure | 8 - 10 dB(A) | 14 - 16 dB(A) | 20 - 22 dB(A) |
| | 10 - 12 dB(A) | 16 - 18 dB(A) | 22 - 24 dB(A) |
| | | 24 - 26 dB(A) | 28 - 30 dB(A) |
| | | 26 - 28 dB(A) | |

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**New Transformer and Radiator Enclosure Noise Model**

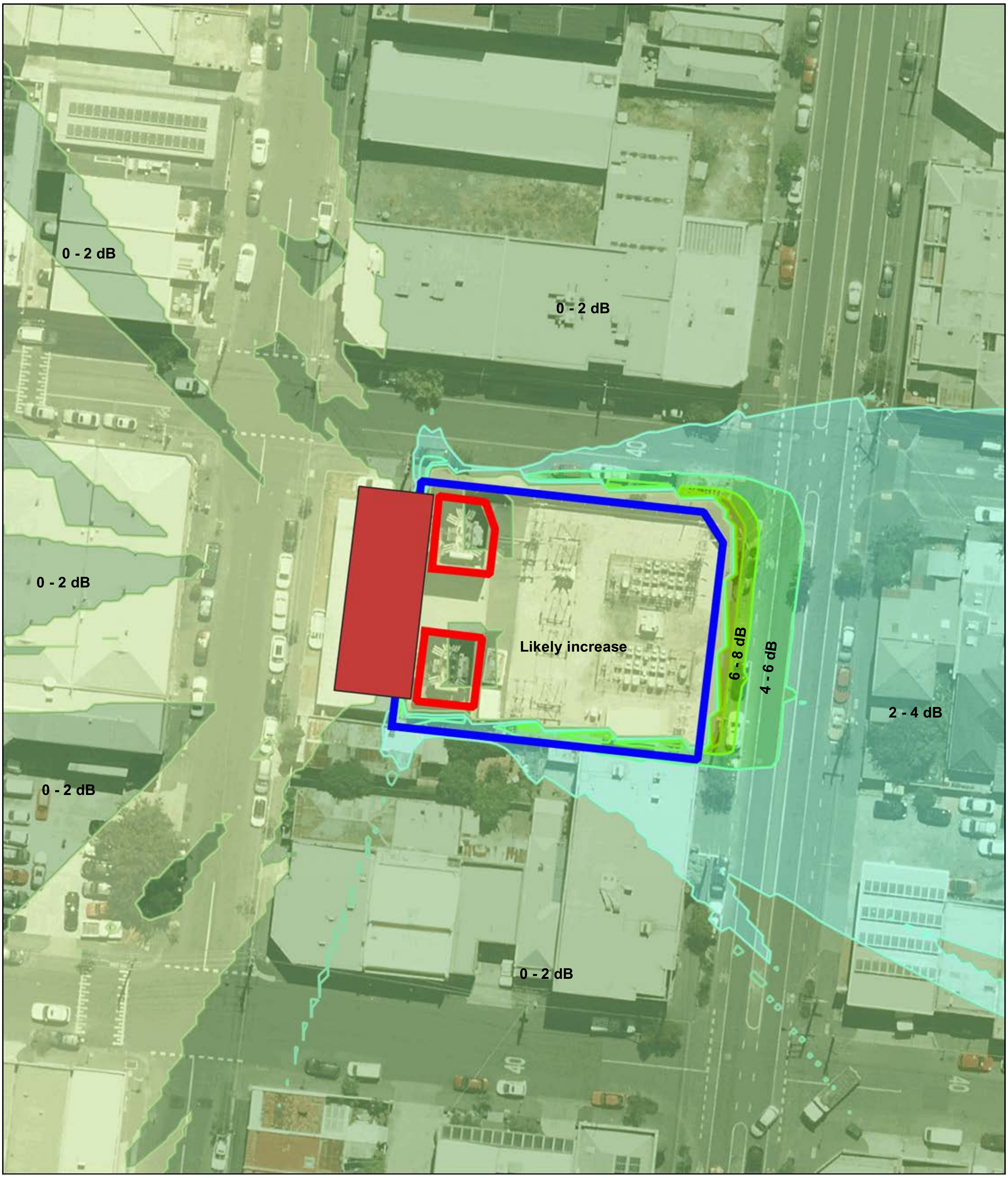
Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-1

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah




Legend

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Existing Enlosures | Noise Reduction | 2 - 4 dB(A) | 8 - 10 dB(A) | 14 - 16 dB(A) | 18 - 20 dB(A) |
| Acoustic Perimeter Wall | Likely increase | 4 - 6 dB(A) | 10 - 12 dB(A) | 16 - 18 dB(A) | |
| | 0 - 2 dB(A) | 6 - 8 dB(A) | 12 - 14 dB(A) | | |

Paper Size ISO A4

0 8 16 24 m

N

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**CW Substation**
**Acoustic Perimeter Wall**

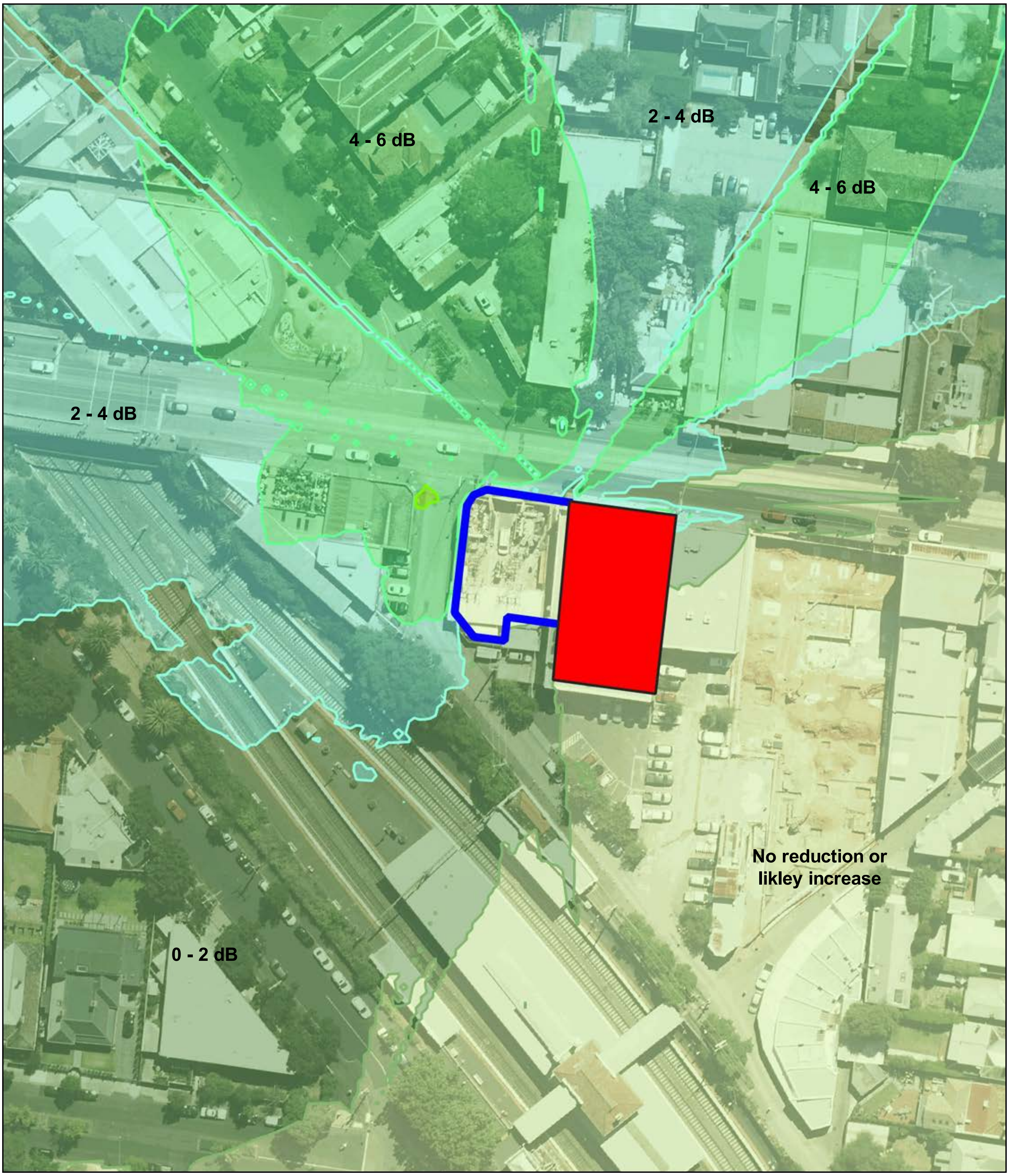
Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-2

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Google Imagery 2019 Created By: V. Alamshah




Legend

- Building
- Acoustic Perimeter Wall

Noise Reduction

- Likely increase
- 0 - 2 dB(A)
- 2 - 4 dB(A)
- 4 - 6 dB(A)
- 6 - 8 dB(A)
- 8 - 10 dB(A)
- 10 - 12 dB(A)
- 12 - 14 dB(A)
- 14 - 16 dB(A)
- 16 - 18 dB(A)
- 18 - 20 dB(A)
- 20 - 22 dB(A)
- 22 - 24 dB(A)

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**AR Substation**
**Acoustic Perimeter Wall**

Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-3

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah


Legend

| | | | | | |
|---|---|---|---|---|---|
| Acoustic Perimeter Wall | 0 - 2 dB(A) | 6 - 8 dB(A) | 12 - 14 dB(A) | 18 - 20 dB(A) | 22 - 24 dB(A) |
| Noise Reduction | 2 - 4 dB(A) | 8 - 10 dB(A) | 14 - 16 dB(A) | 20 - 22 dB(A) | |
| Likely increase | 4 - 6 dB(A) | 10 - 12 dB(A) | 16 - 18 dB(A) | | |

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**NC Substation**
**Acoustic Perimeter Wall**

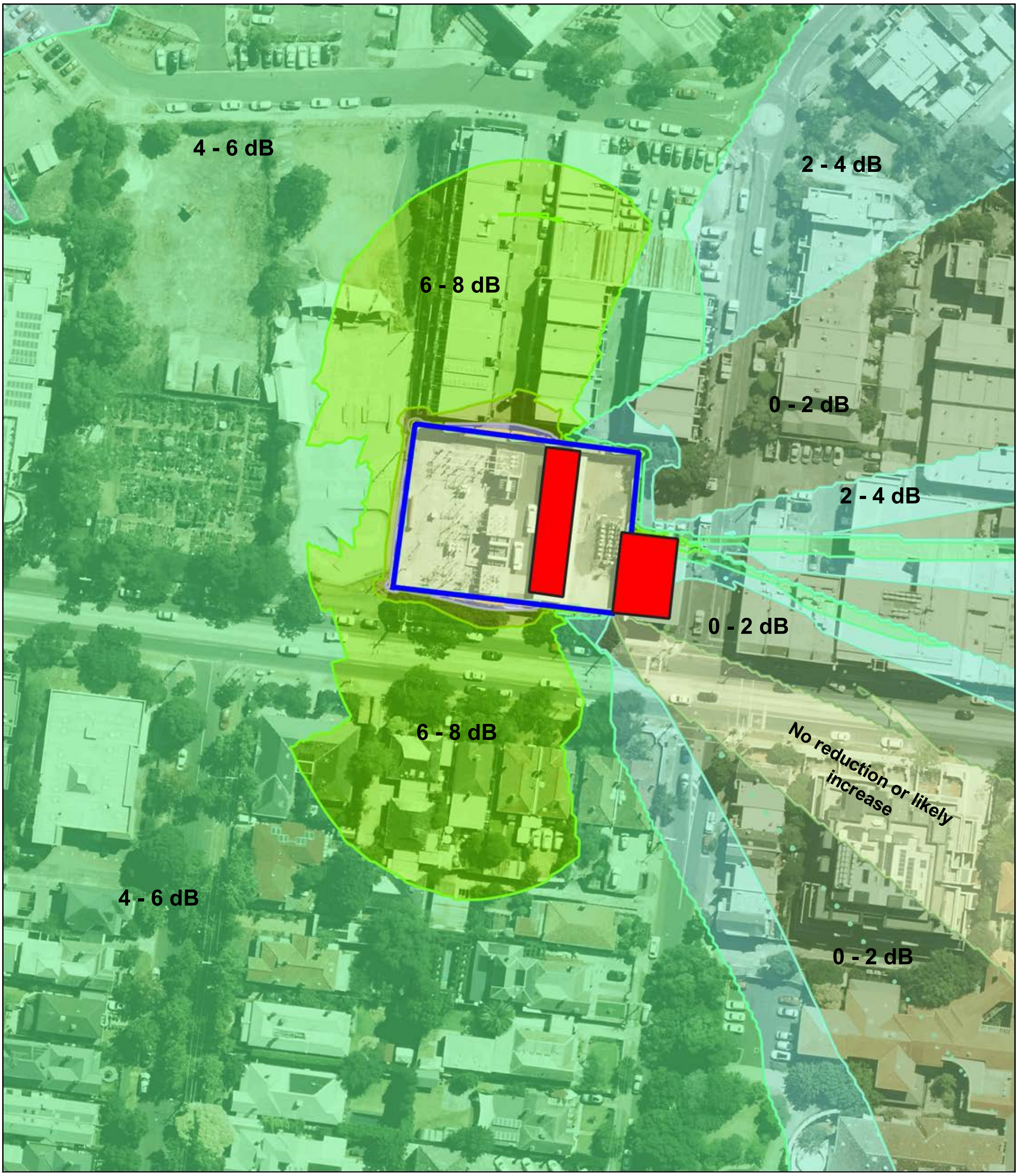
Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-4

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah




Legend

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| New Substation Building | Noise reduction | | 2 - 4 dB(A) | | 8 - 10 dB(A) | | 14 - 16 dB(A) | | 18 - 20 dB(A) |
| New Substation Barrier | | Likely increase | 4 - 6 dB(A) | | 10 - 12 dB(A) | | 16 - 18 dB(A) | | |
| | | 0 - 2 dB(A) | 6 - 8 dB(A) | | 12 - 14 dB(A) | | | | |

Paper Size ISO A4

0 8 16 24 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**CL Substation**
**Acoustic Perimeter Wall**

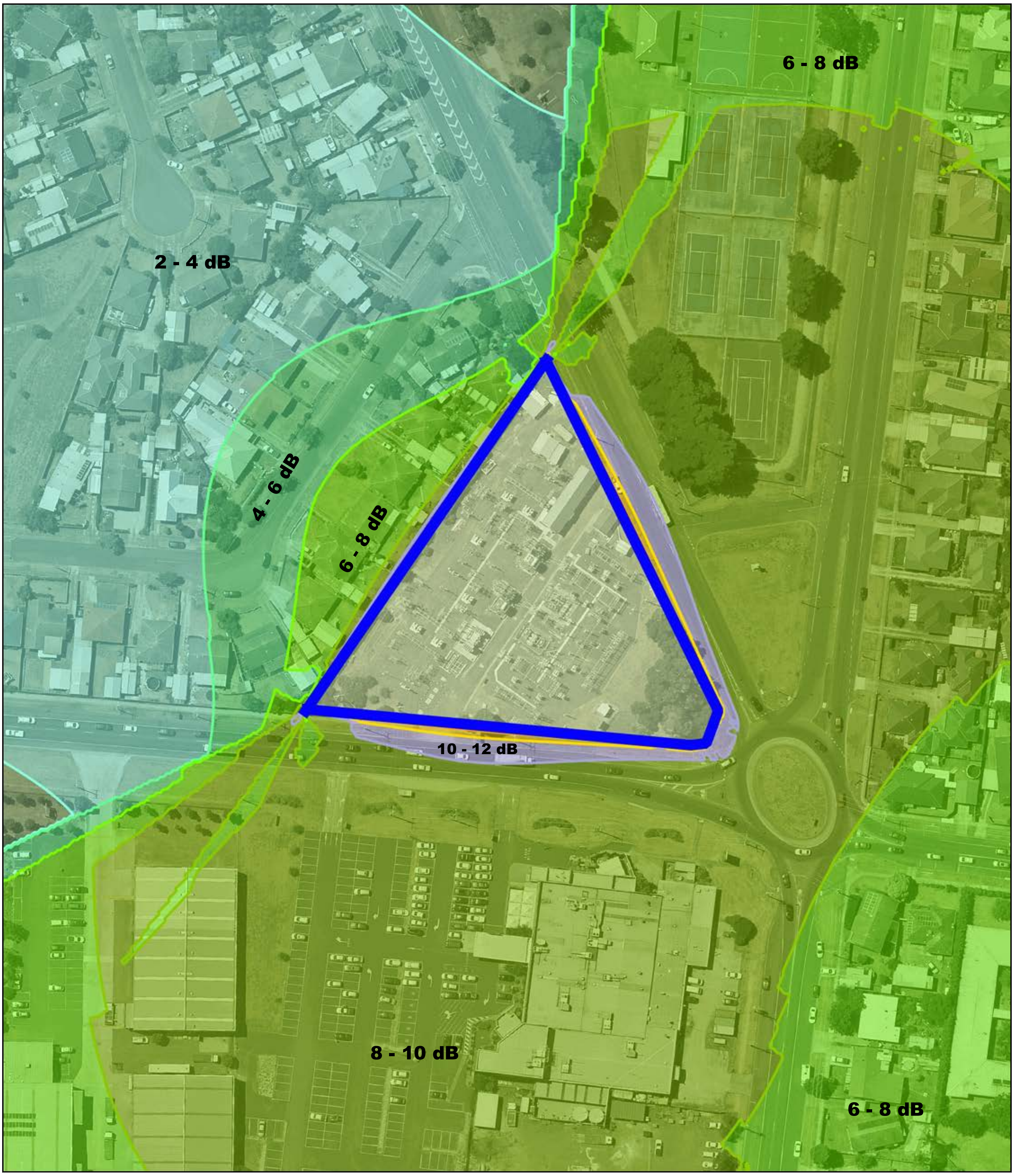
Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-5

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah




Legend

| | | | | |
|---|---|---|---|---|
| Acoustic Perimeter Wall | 0 - 2 dB(A) | 6 - 8 dB(A) | 12 - 14 dB(A) | 18 - 20 dB(A) |
| Noise Reduction | 2 - 4 dB(A) | 8 - 10 dB(A) | 14 - 16 dB(A) | |
| Likely increase | 4 - 6 dB(A) | 10 - 12 dB(A) | 16 - 18 dB(A) | |

Paper Size ISO A4

0 20 40 60 m

N

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**GLE Substation**
**Acoustic Perimeter Wall**

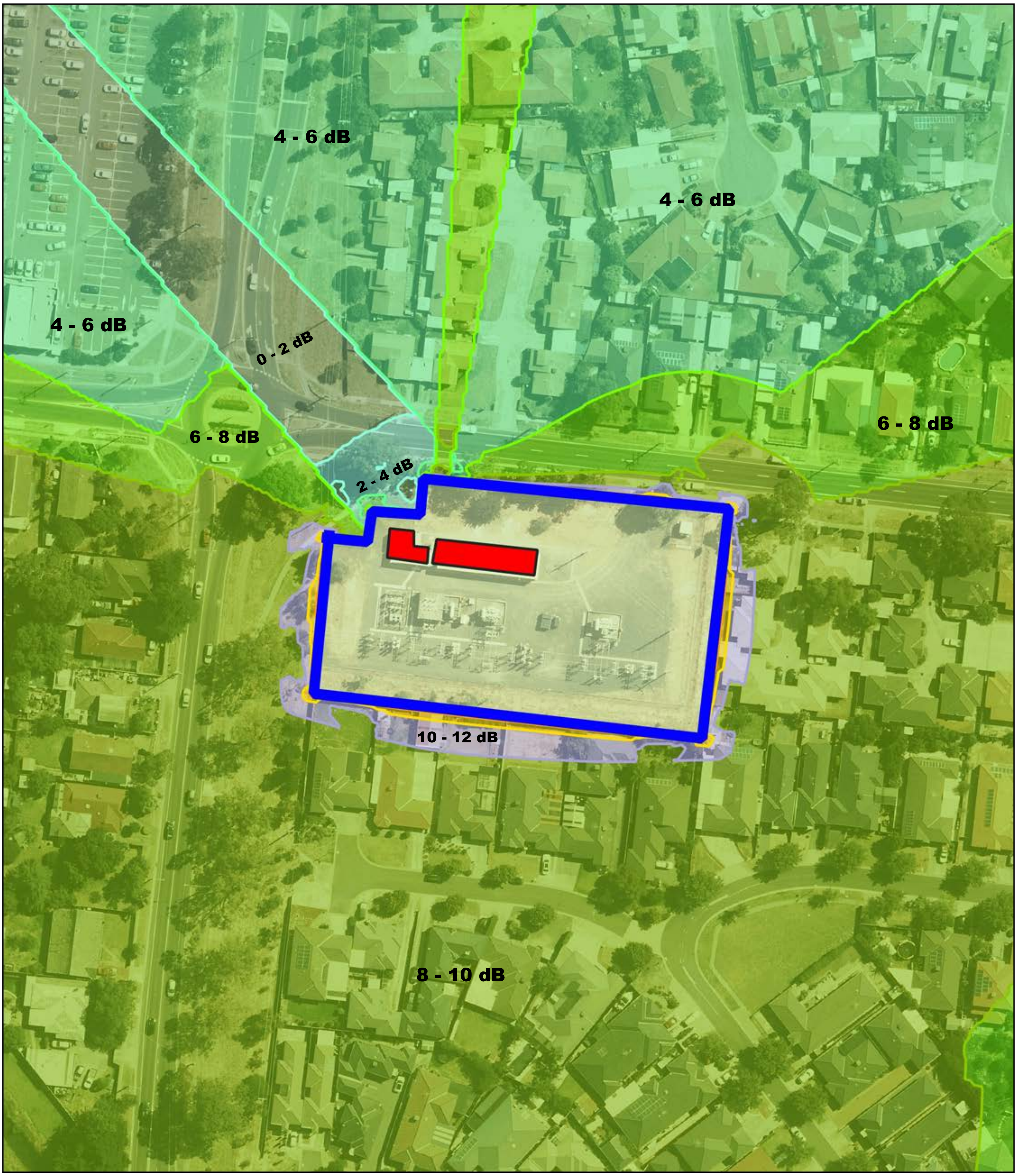
Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-6

Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz



Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah




Legend

| | | |
|---|---|---|
| Building | Noise Reduction | |
| Acoustic Perimeter Wall | Likely increase | |
| | 0 - 2 dB(A) | |
| 2 - 4 dB(A) | 8 - 10 dB(A) | 14 - 16 dB(A) |
| 4 - 6 dB(A) | 10 - 12 dB(A) | 16 - 18 dB(A) |
| 6 - 8 dB(A) | 12 - 14 dB(A) | 18 - 20 dB(A) |

Paper Size ISO A4

0 10 20 30 40 m

Map Projection: Mercator Auxillary Sphere
Horizontal Datum: WGS 1984
Grid: WGS 1984 Web Mercator Auxillary Sphere

N

GHD

CitiPower and Powercor
Feasibility Study for Acoustic Treatments

**WBE Substation**
**Acoustic Perimeter Wall**

Project No. **12515501**
Revision No. **C**
Date. **20/11/2019**

FIGURE D-7

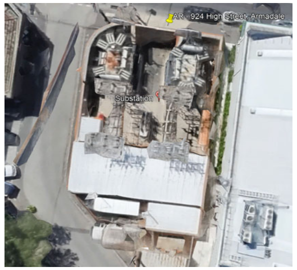
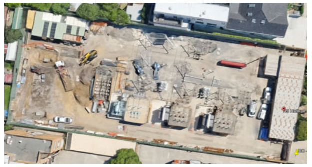
Document Path: G:\31\12515501\GIS\Maps\Working\Acoustics.qgz

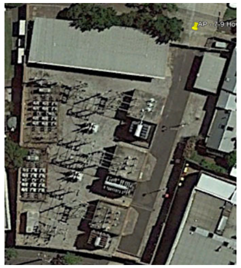
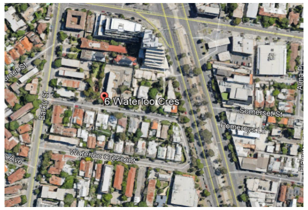
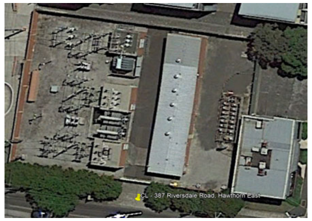


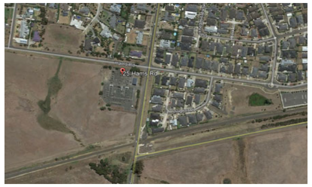
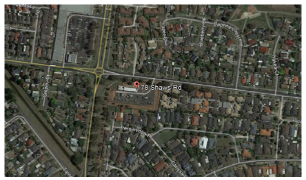
Data Source: Government of Victoria, DELWP VicMap. Created By: V. Alamshah

# **Appendix E** – Powercor site details Excel™

Powercor supplied Excel™ with sites for investigation updated by GHD

| Provided Information (from 'Input Data' tab) | | | | GHD Notes | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Code | Net | Number of TXs | Exceed. (dB) | General Notes | Radiator Notes | TX - No enclosure | TX - Some enclosure | TX - Inside building | Address | Close up image | Zoomed out image | Site classification | Noise sensitive receivers | Substation Zone | Noise sensitive Zone | Distance to receivers (m) |
| CW | CP | 3 | 12 | Only 2 TXs visible | Directly next to TX's, inside enclosure | - | YES, high walled brick enclosure, no roof | - | 49 Easey St, Corner Easey and Budo Streets, Collingwood |  |  | Metropolitan | 18 Budd St,<br>57 Easey St<br>64 Easey | Commercial | Commercial/Residential | 0 - 35 |
| AR | CP | 3 | 12 | Only 2 TXs visible | Directly next to TX's | No enclosure | - | - | 924 High Street, Armadale |  |  | Metropolitan | North - Residence along Northcote Road and Royal Crescent<br>West & South West - Residences along Cheel St | Commercial | Residential | 55 - 70 |
| BC | CP | 3 | 7 | 3 TXs | Outside each TX building, against west wall | - | - | YES, inside individual brick buildings | 49 Hotham Street, St Kilda East |  |  | Metropolitan | Adjoining residential premises to north, south and east. | Residential | Residential | 0 |
| NC | CP | 3 | 6 | only 2 TX's visible | Outside each TX building, against south wall | - | - | Yes, inside individual buildings | 21 Lennox Street, Northcote |  |  | Metropolitan | Adjoining southern and eastern residential premises. Educational facility to the north and east will also be cosidered a noise sensitive reciever under proposed new noise regulations. However higher criteria applies. | Residential | Residential | 0 |

| Provided Information (from 'Input Data' tab) | | | | GHD Notes | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Code | Net | Number of TXs | Exceed. (dB) | General Notes | Radiator Notes | TX - No enclosure | TX - Some enclosure | TX - Inside building | Address | Close up Image | Zoomed out image | Site classification | Noise sensitive receivers | Substation Zone | Noise sensitive Zone | Distance to receivers (m) |
| AP | CP | 3 | 5 | 3 TXs | Outside each TX building, against south wall | - | - | YES, inside individual brick buildings | 7-9 Howe Crescent, South Melbourne |  |  | Metropolitan | East - Adjoining , 10 Hower Cres.<br>North- Park Tower high rise<br>South - Residential along Martin St | Residential | Residential | 0 |
| SK | CP | 3 | 4 | 3 TXs | Outside building, each in a 3 wall alcove with gate | - | - | YES, inside single building | 6 Waterloo Crescent, St Kilda |  |   | Metropolitan/CBD | North - Adjoining multi storey<br>East - adjoining double storey<br>West - multi storey residential | Public Use Zone | Residential | 0 - 30 |
| Q | CP | 3 | 2 | 3 TXs | Outside building | - | - | YES, inside single building | 15-17 Tennyson Street, Kew |   |   | Metropolitan/CBD | Adjoining residential premises to north, south and west. Premises across Tennyson Street to the east. | Residential | Residential | 0 - 20 |
| CL | CP | 3 | 6 | 3 TXs | Outside buildings | - | - | YES, inside individual brick buildings | 387 Riversdale Road, Hawthorn East |  |  | Metropolitan | North - 26 Redfern Rd<br>South - Residential premises along Riversdale Rd | Commercial | Commercial/Residential | 0 - 20 |

| Provided Information (from 'Input Data' tab) | | | | GHD Notes | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site Code | Net | Number of TXs | Exceed. (dB) | General Notes | Radiator Notes | TX - No enclosure | TX - Some enclosure | TX - Inside building | Address | Close up image | Zoomed out image | Site classification | Noise sensitive receivers | Substation Zone | Noise sensitive Zone | Distance to receivers (m) |
| GLE | PAL | 2 | 12 | Appears to be 3 TXs | next to TXs | No enclosure. | - | - | 242-254 St Albans Road, Breakwater |  |  | Metropolitan | West - Residential premises along Woung Street<br>East - Residential premises along Boundary Road | Residential | Residential | 0 - 75 |
| KYM | PAL | 2 | 16 | Looks to be 3 TXs from street view. Unclear from satellite. | Next to TXs | No enclosure | - | - | 1-7 Allan Street, Kyabram |  |  | Regional | North - Adjoining residential premises<br>East - Residential premises along Crossthwaite St.<br>South - Residential premises along Allan St | Public Use Zone | Residential | 0 - 38 |
| WPD | PAL | 2 | 18 | 2 TXs | Next to TXs | No enclosure | - | - | 25 Hams Road, Waurn Ponds |  |  | Regional | North - 2 - 4 Hams Road<br>East - 1 - 13 Ghazeepore Road | Farming Zone | Residential | 26 - 29 |
| GL | PAL | 2 | 9 | 2 TXs | Next to TXs | No enclosure | - | - | 22-30 Ballarat Road, Hamlyn Heights, Geelong |  |  | Metropolitan | West - Residential premises along Ebden Street<br>South - Residential premises along Gibb Street | Residential | Residential | 13 - 20 |
| WBE | PAL | 2 | 4 | 2 TXs | next to TXs | No enclosure | - | - | 178 Shaws Road, Werribee |  |  | Metropolitan | Residential premises to north, west, east and south of the site | Residential | Residential | 3 - 50 |

| Site Code | Exceed. (dB) | Scenario 0<br>Do Nothing Approach<br>Ind. Noise reduction<br>0 dB | Scenario 1<br>Transformer Replacement<br>Ind. Noise reduction<br>15 dB > | Scenario 2<br>New Transformer & New Radiator Enclosure<br>Ind. Noise reduction<br>20 ± 5 dB | Scenario 3<br>Modification to transformer enclosure and new radiator enclosure<br>Ind. Noise reduction<br>10 – 20 dB | Scenario 4<br>Modification to existing transformer & existing radiator enclosure<br>Ind. Noise reduction<br>10 – 20 dB | Scenario 5<br>Acoustic Perimeter Wall<br>Ind. Noise reduction<br>2 – 15 dB | Scenario 6<br>Combination of Scenarios 2 & 5<br>Ind. Noise reduction<br>23 ± 5 dB | Scenario 7<br>Combination of Scenarios 3 & 5<br>Ind. Noise reduction<br>15 – 23 dB | Scenario 8<br>Combination of Scenarios 4 & 5<br>Ind. Noise reduction<br>15 – 23 dB | Scenario 9<br>Miscellaneous Treatments<br>Ind. Noise reduction<br>< 5 dB | Comments/Justification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CW | 12 | ✕ | ✓ | ✓ | ✕ | ✓ | ✕ | ✕ | ✕ | ✓ | ✕ | Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design likely sufficient, however may not be reasonable given transformers are partially enclosed.<br>Scenario 3 - Not relevant to this site as both Transformer and radiator in partial enclosure.<br>Scenario 4 - Modification to enclosure may be sufficient, however likely require additional mitigations such as combined options.<br>Scenario 5 - Acoustic Fence will not provide sufficient reduction by itself given the significant exceedance and location of receivers.<br>Scenario 6 - Not relevant as transformers are located in an existing enclosure<br>Scenario 7 - Not relevant as both the transformer and radiator are located in an existing enclosure<br>Scenario 8 - Modification to enclosure plus perimeter fence would be suitable. This option is technically preferred over Scenario 4, as it will reduce risk of likely noise from other sources on site.<br>Scenario 9 - Unlikely to achieve the reduction required without significant modifications and hence not reasonable. |
| AR | 12 | ✕ | ✓ | ✓ | ✕ | ✕ | ✕ | ✕ | ✕ | ✕ | ✕ | Site already has high perimeter fence providing reasonable reduction of noise. Further notable reduction of noise from site unlikely to be achievable without control at source.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure likely be most effective as it will treat noise at source.<br>Scenario 3 - Not relevant as no existing enclosures.<br>Scenario 4 - Not relevant as no existing enclosures.<br>Scenario 5 - Existing approx. 4 m perimeter fence. Increase of perimeter fence will not achieve the reduction required.<br>Scenario 6,7,8 - Site already has high perimeter fence, increase in height not expected to provide notable increase in noise reduction from site.<br>Scenario 9 - Miscellaneous treatments not predicted to achieve the reduction required. |
| BC | 7 | ✕ | ✓ | ✓ | ✓ | ✕ | ✕ | ✕ | ✓ | ✕ | ✕ | Transformer already have enclosures, however radiators are located outside. Some receivers are double storey overlooking the site hence noise transmission path strategy unlikely be practical by itself. Control of noise at source would be most effective solution or combination of the two strategies to address all receivers.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design not reasonable given transformers are already enclosed.<br>Scenario 3 - Likely to be most effective solution as it controls noise at source. However, additional treatment such as Scenario 5 may be required due to complexity of this site.<br>Scenario 4 - Not relevant as only transformer is enclosed.<br>Scenario 5 - Perimeter fence not likely to achieve the reduction given some receivers are double storey and would have major aesthetic ramifications.<br>Scenario 6 - Not relevant as transformers are located in an existing enclosure<br>Scenario 7 – Additional acoustic perimeter fence will reduce the risk of likely noise from other sources on site as well as assist with the overall reduction of noise from site given significant reduction required, close proximity of receivers and potential low ambient noise.<br>Scenario 8 - Not relevant as only transformer is enclosed.<br>Scenario 9 - Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| NC | 6 | ✕ | ✓ | ✓ | ✓ | ✕ | ✕ | ✕ | ✓ | ✕ | ✕ | Transformers already have enclosures, however radiators are located outside.<br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design not reasonable given transformers are already enclosed.<br>Scenario 3 - Likely to be most effective solution as it controls noise at source. However, additional treatment such as Scenario 5 may be required due to complexity of this site.<br>Scenario 4 - Not relevant as only transformer is enclosed.<br>Scenario 5 - Perimeter fence not likely to achieve the reduction given the distances from transformers to boundary. Increased boundary fence height may be required to achieve the reduction and reduce noise from other sources on site.<br>Scenario 6 - Not relevant as transformers are located in an existing enclosure<br>Scenario 7 - Additional acoustic perimeter fence will reduce the risk of likely noise from other sources on site as well as assist with the overall reduction of noise from site given significant reduction required, close proximity of receivers and dispersed sources on site.<br>Scenario 8 - Not relevant as only transformer is enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |

| Site Code | Exceed. (dB) | Scenario 0<br>Do Nothing Approach<br>Ind. Noise reduction<br>0 dB | Scenario 1<br>Transformer Replacement<br>Ind. Noise reduction<br>15 dB > | Scenario 2<br>New Transformer & New Radiator Enclosure<br>Ind. Noise reduction<br>20 ± 5 dB | Scenario 3<br>Modification to transformer enclosure and new radiator enclosure<br>Ind. Noise reduction<br>10 – 20 dB | Scenario 4<br>Modification to existing transformer & existing radiator enclosure<br>Ind. Noise reduction<br>10 – 20 dB | Scenario 5<br>Acoustic Perimeter Wall<br>Ind. Noise reduction<br>2 – 15 dB | Scenario 6<br>Combination of Scenarios 2 & 5<br>Ind. Noise reduction<br>23 ± 5 dB | Scenario 7<br>Combination of Scenarios 3 & 5<br>Ind. Noise reduction<br>15 – 23 dB | Scenario 8<br>Combination of Scenarios 4 & 5<br>Ind. Noise reduction<br>15 – 23 dB | Scenario 9<br>Miscellaneous Treatments<br>Ind. Noise reduction<br>< 5 dB | Comments/Justification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AP | 5 | ✕ | ✓ | ✓ | ✓ | ✕ | ✕ | ✕ | ✓ | ✕ | ✕ | Transformers already have enclosures, however radiators are located outside. Some receivers are multi storey overlooking the site hence noise transmission path strategy unlikely be practical by itself. Control of noise at source would be most effective solution or combination of the two strategies to address all receivers.<br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design not reasonable given transformers are already enclosed.<br>Scenario 3 - Likely to be most effective solution as it controls noise at source. However, additional treatment such as Scenario 5 may be required due to complexity of this site.<br>Scenario 4 - Not relevant as only transformer is enclosed.<br>Scenario 5 - Perimeter fence not likely to achieve the reduction given some receivers are double storey and would have major aesthetic ramifications.<br>Scenario 6 - Not relevant as transformers are located in an existing enclosure<br>Scenario 7 – Additional acoustic perimeter fence will reduce the risk of likely noise from other sources on site as well as assist with the overall reduction of noise from site given significant reduction required, close proximity of receivers and potential low ambient noise.<br>Scenario 8 - Not relevant as only transformer is enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| SK | 4 | ✕ | ✓ | ✓ | ✕ | ✓ | ✕ | ✕ | ✕ | ✕ | ✓ | Transformers within buildings and radiators within partial enclosures. Site is surrounded by multi storey residential premises overlooking the site hence noise transmission path strategy unlikely be practical by itself. Control of noise at source would be most effective solution.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design is not reasonable given transformers are already enclosed within building.<br>Scenario 3 - Not relevant as radiator is partially enclosed.<br>Scenario 4 - Likely most effective solution as it controls noise at source.<br>Scenario 5 - Will not be effective due to multiple sources overlooking site.<br>Scenarios 6,7,8 - Not suitable as increased perimeter fence unlikely to result in significant acoustic benefits due to height of noise receivers.<br>Scenario 9 - Miscellaneous treatments may achieve the reduction required. Although this option is feasible however not recommended as preferred solution without detailed site investigation. |
| Q | 2 | ✕ | ✕ | ✕ | ✕ | ✓ | ✓ | ✕ | ✕ | ✕ | ✓ | Transformers located within a building with radiators located outside in a partially open enclosure. The radiator enclosure appears to be louvered on the sides. Exceedance at this site is relatively minor.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design will likely achieve reduction, however not considered a cost effective solution given the small exceedance.<br>Scenario 2 - New enclosure design will achieve the reduction. However not a cost effective solution given minor exceedance.<br>Scenario 3 - Modification to existing radiator enclosure will likely be enough to achieve the reduction.<br>Scenario 4 - Likely most effective solution as it controls noise at source.<br>Scenario 5 – Perimeter fence expected to achieve the reduction required.<br>Scenario 6,7,8 - Not expected to be required as individual Scenarios 3,4 and 5 are expected to be satisfactory without the additional acoustic perimeter wall.<br>Scenario 9 - Miscellaneous treatments may achieve the reduction required. Although this option is feasible however not recommended as preferred solution without detailed site investigation. |
| CL | 6 | ✕ | ✓ | ✓ | ✓ | ✕ | ✕ | ✕ | ✓ | ✕ | ✕ | Transformers already have enclosures, however radiators are located outside. Some receivers are double storey overlooking the site hence noise transmission path strategy unlikely to be sufficient by itself. Control of noise at source would be most effective solution or combination of the two strategies to address all receivers.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New enclosure design will be feasible and sufficient, however may not be reasonable given transformers are already enclosed.<br>Scenario 3 - Likely to be most effective solution as it controls noise at source. However, additional treatment such as Scenario 5 may be required due to complexity of this site.<br>Scenario 4 - Not relevant as only transformer is enclosed.<br>Scenario 5 - Perimeter fence is unlikely to achieve the reduction given some receivers are double storey.<br>Scenario 6 - Not relevant as transformers are located in an existing enclosure<br>Scenario 7 –Additional acoustic perimeter fence will reduce the risk of likely noise from other sources on site as well as assist with the overall reduction of noise from site given complexity, close proximity of receivers and potential low ambient noise.<br>Scenario 8 - Not relevant as only transformer is enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |

| Site Code | Exceed. (dB) | Scenario 0<br>Do Nothing Approach | Scenario 1<br>Transformer Replacement | Scenario 2<br>New Transformer & New Radiator Enclosure | Scenario 3<br>Modification to transformer enclosure and new radiator enclosure | Scenario 4<br>Modification to existing transformer & existing radiator enclosure | Scenario 5<br>Acoustic Perimeter Wall | Scenario 6<br>Combination of Scenarios 2 & 5 | Scenario 7<br>Combination of Scenarios 3 & 5 | Scenario 8<br>Combination of Scenarios 4 & 5 | Scenario 9<br>Miscellaneous Treatments | Comments/Justification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ind. Noise reduction<br>0 dB | Ind. Noise reduction<br>15 dB > | Ind. Noise reduction<br>20 ± 5 dB | Ind. Noise reduction<br>10 – 20 dB | Ind. Noise reduction<br>10 – 20 dB | Ind. Noise reduction<br>2 – 15 dB | Ind. Noise reduction<br>23 ± 5 dB | Ind. Noise reduction<br>15 – 23 dB | Ind. Noise reduction<br>15 – 23 dB | Ind. Noise reduction<br>< 5 dB | |
| GLE | 12 | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | Transformers are in open area with no enclosures and with minor shielding.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 -Transformer replacement and re-design likely sufficient<br>Scenario 2 - New transformer and radiator enclosure would be suitable.<br>Scenario 3 - Not relevant as no existing enclosures.<br>Scenario 4 - Not relevant as no existing enclosures.<br>Scenario 5 - Acoustic perimeter fence not expected to achieve the reduction required due to distance of the transformers to the perimeter.<br>Scenario 6 - Additional fence not likely to achieve significant acoustic benefit due to distance of the transformers to the perimeter.<br>Scenario 7 - Not relevant as transformers and radiators not enclosed.<br>Scenario 8 - Not relevant as transformers and radiators not enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| KYM | 16 | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | Transformers are in open area with no enclosures and with minor shielding.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 -Transformer replacement and re-design likely sufficient<br>Scenario 2 - New transformer and radiator enclosure would be suitable.<br>Scenario 3 - Not relevant as no existing enclosures.<br>Scenario 4 - Not relevant as no existing enclosures.<br>Scenario 5 - Acoustic perimeter fence not expected to achieve the reduction required due to distance of the transformers to the perimeter.<br>Scenario 6 - Additional fence not likely to achieve significant acoustic benefit due to distance of the transformers to the perimeter.<br>Scenario 7 - Not relevant as transformers and radiators not enclosed.<br>Scenario 8 - Not relevant as transformers and radiators not enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| WPD | 18 | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | Transformers are in open area with no enclosures and with minor shielding.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 -Transformer replacement and re-design likely sufficient<br>Scenario 2 - New transformer and radiator enclosure would be suitable.<br>Scenario 3 - Not relevant as no existing enclosures.<br>Scenario 4 - Not relevant as no existing enclosures.<br>Scenario 5 - Acoustic perimeter fence not expected to achieve the reduction required due to distance of the transformers to the perimeter.<br>Scenario 6 - Additional fence not likely to achieve significant acoustic benefit due to distance of the transformers to the perimeter.<br>Scenario 7 - Not relevant as transformers and radiators not enclosed.<br>Scenario 8 - Not relevant as transformers and radiators not enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| GL | 9 | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | Transformers are in open area with no enclosures and with minor shielding.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 -Transformer replacement and re-design likely sufficient<br>Scenario 2 - New transformer and radiator enclosure would be suitable.<br>Scenario 3 - Not relevant as no existing enclosures.<br>Scenario 4 - Not relevant as no existing enclosures.<br>Scenario 5 - Acoustic perimeter fence not expected to achieve the reduction required due to distance of the transformers to the perimeter.<br>Scenario 6 - Additional fence not likely to achieve significant acoustic benefit due to distance of the transformers to the perimeter.<br>Scenario 7 - Not relevant as transformers and radiators not enclosed.<br>Scenario 8 - Not relevant as transformers and radiators not enclosed.<br>Scenario 9 - Miscellaneous treatments not expected to achieve the reduction required given the significant exceedance. |
| WBE | 4 | ✗ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✓ | Two of the transformers are in open area with no enclosure and one transformer is enclosed. Residences only appear to be single storey and have 1.7 -1.8 m fence.<br><br>Scenario 0 - EPA fines (high risk)<br>Scenario 1 - Transformer replacement and re-design likely sufficient<br>Scenario 2 - New transformer and radiator enclosure would be for the two transformers located in open area.<br>Scenario 3 - Modification of the existing enclosure and new radiator enclosure would be required for the one transformer with enclosure This option however will need to be adopted with Scenario 2.<br>Scenario 4 - Not relevant to this site.<br>Scenario 5 - Acoustic perimeter fence not expected to achieve the reduction required at double storey receivers.<br>Scenarios 6,7,8 - Additional fence not likely to achieve significant acoustic benefit due to double storey receivers.<br>Scenario 9 - Miscellaneous treatments may achieve the reduction required. Although this option is feasible however not recommended as preferred solution without detailed site investigation. |

# **Appendix F** – Limitations

*This report has been prepared by GHD for CitiPower and Powercor and may only be used and relied on by CitiPower and Powercor for the purpose agreed between GHD and the CitiPower and Powercor as set out in section 1.1 of this report.*

*GHD otherwise disclaims responsibility to any person other than CitiPower and Powercor arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section(s) Appendix G and Section 4.2 and throughout this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

*GHD has prepared this report on the basis of information provided by CitiPower and Powercor and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*GHD has prepared the preliminary cost estimate set out in Section 5 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD including advice and costings from a third party quantity survey (Wilde & Woollard), estimates as provisional sums for unknown quantities such as remedial works required for any hazardous materials found onsite, radiator slab remediation, slab and other isolation works, connection and earthing costings, HV works, geotechnical investigations and other cost assumptions outlined throughout this report.*

*The Cost Estimate has been prepared for the purpose of supporting a business case by Powercor to apply to the AER for funding to enable noise reduction works across the CitiPower and Powercor substation network and must not be used for any other purpose.*

*The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the [works/project] can or will be undertaken at a cost which is the same or less than the Cost Estimate.*

*Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.*

*The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*

*Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.*

# **Appendix G** – Assumptions and qualifications

The following assumptions and qualifications were made as part of this assessment report.

### *General*

- The assessments and proposed indicative design solutions in this report are high level only and require further detailed investigations prior to construction.
- This report only considers acoustic and structural factors and other disciplines such as electrical, mechanical, and geotechnical have not been considered and as such these solutions should only be regarded as conceptual and require further detailed investigations and design using multi-disciplinary option assessments prior to construction.
- The indicative enclosure designs noted in this report, have not taken into consideration the site specific ventilation requirements at each substation facility.
- The indicative enclosure designs noted in this report, have not taken into consideration the site specific transformer and radiator requirements at each substation facility, including clearance and any site specific constraints.
- Existing transformer enclosures are assumed to be brick or heavy masonry with heavy roof. No modular or lightweight wall construction is assumed.

### *Client supplied information*

- As the scope of the exercise was limited to providing generic solutions, with no solution being specific for one particular site, a range of Powercor inputs and design assumptions were required and were relied on by GHD to provide the various design solutions. Inputs Provided by Powercor included:
  - Structural drawings of an example zone substation - BC (Balaclava)
  - An Excel file containing site names and indicative night time noise exceedance levels
  - Advice on the types of substation scenarios to consider:
    - Regional substations
    - Urban substations
    - CBD substations
  - Substation aerial imagery

### *Structural Design*

- The soil class at each Powercor site was assumed to be class H1 soil or better. The solutions provided may not be relevant for ‘Class P’ sites (problem site).
- The soil bearing capacity at each site was assumed to be 75 kPa or greater.
- All sites were assumed to be within 70 km of the Melbourne CBD allowing for an A5 wind classification, a design life of 50 years, and a terrain category 2 as per the Australian Standard AS1170.2 – Wind Design.
- All new transformer enclosure roof slabs were designed for a 5 kPa plant loading as per the Australian Standard AS1770.
- The footprint of new transformer and radiator enclosure designs were a nominal 7.5 m x 7.5 m however the final footprint will require confirmation for each site, and will be subject to the existing site specific footprint. GHD notes a number of substation sites in the assessment have differing enclosure dimensions to that considered in this high level assessment.

### *Acoustic Assessment*

- The acoustic assessment has been undertaken using an existing worst case scenario. Noise levels from the No. 1 Transformer at Balaclava (BC) were used to represent noise levels across all transformer locations where sites are known to currently be in exceedance of their site specific noise criteria.
- Details of the assessment are based on Powercor provided transformer specifications, layouts, and dimensions.
- Simplified noise modelling was undertaken based on indicative scenarios noted above (Regional, Metropolitan) with assumptions outlined in this section and Section 4.2. However no modelling has been undertaken for CBD sites as the detail required for a CBD type assessment was unavailable and would require a site inspection and specialised measurements.
- Proposed mitigation options were established based on a high level review of sites, consultation with Powercor, and GHD's experience on similar sites.
- A detailed noise assessment for each site including site visits and measurements has not been carried out for this desktop assessment and would be required in order to sufficiently characterise noise emissions from each site and allow for appropriate tailored solutions to be developed.
- This assessment provides indicative high level mitigation options that are reasonably expected to reduce noise from each relevant site. The indicative solutions outlined in this report shall not be construed as detailed mitigation options for incorporation at each site.
- This assessment was based on site details and existing exceedance levels provided by Powercor. GHD has not undertaken any site visits or any detailed assessment of the sites. GHD does not have site specific information on where the exceedance in noise level has been measured from or what receivers are currently affected at each location.
- For the purpose of this indicative assessment, GHD have assumed that noise levels from each site are controlled by Transformer and/or radiator noise emissions and therefore have provided options aimed at a reduction in noise level from these two noise sources.
- For existing transformer enclosures, walls and roofs are assumed heavy and have sufficient sound transmission loss and are therefore site noise is not assumed emitted from wall or roof elements.
- There are a number of substations with existing radiator enclosures. Powercor has advised that typically these have a wall on two of their four sides (oil splash and fire barrier). Two new radiator acoustic walls may be built at these locations to enclose the radiator on all four sides. The existing wall may require removal and reinstallation should their overall heights not met the minimum acoustic requirements, however this would be assessed on a site-by-sites basis and therefore has not been costed in this assessment.
- Vibration isolation pads separating the transformer from the foundation slab. Replacement or installation of these isolation pads is a feasible solution however it is a significantly complex task and planning and pre works would need to be undertaken prior to this occurring and therefore has not been costed in this assessment.

### *Cost estimation*

- The cost estimate for a modification of the existing enclosures, does not include associated costs for demolition and removal of existing services, labour cost and making good of the enclosure.
- A number of provisional sums have been included in the cost estimations for each type of mitigation option, see Sections 3.2.1 through 3.2.7. These provisional sums are based on Wilde and Woollard (Quantity Surveyors) and GHD's experience together with workshopped discussions with Powercor staff.

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