9.2 Urban Design

An Urban Design Impact assessment was undertaken in July 2010 to assess the potential impacts the proposed substation would have on a proposed 22 storey mixed used development at 136-140 Walker Street.

The full urban design assessment is attached as Appendix E and a summary is presented below.

The assessment was undertaken to address the following:

- General urban design impacts that the proposed design for the substation has on the proposed development at 136-140 Walker Street.
- Urban design impacts in relation to *State Environmental Planning Policy No 65* (SEPP 65) principles for the proposed development at 136-140 Walker Street.
- Urban design impacts that would affect the approved development at 136-140 Walker Street if the substation site was developed with a building envelope that took into consideration NSDCP 2002.
- Urban design impacts on the eight west facing units (Level 5 to 8) at 136-140 Walker Street.

In addition, consent was granted on 19 July 2010 for a new eight storey mixed use development at 144-150 Walker Street. The urban design impacts of the proposed substation on 144-150 Walker Street are considered to be negligible as the recently approved development is not directly adjacent to the proposed substation site. Accordingly, the focus of the urban design assessment has been limited to the potential impacts on the proposed development at 136-140 Walker Street only.

Furthermore, the focus of the urban design assessment was on the proposed substation site and not the site of the existing substation.

9.2.1 Existing Environment

The proposed substation site is located on the eastern side of Ward Street between Harnett and Berry Streets. The site shares a common boundary with 136 and 138-140 Walker Street to the east, 76 Berry Street to the south-east, and the Wilson Parking car park in Ward Street to the north and west.

The site has an approximate area of 1,200 m^2 and is surrounded by a mix of commercial development to the northwest and residential development to the north east.

The proposed substation has an RL of 94.5 at Ward Street at the highest point of the roof. The substation has a total of five levels, with a building height of approximately 25 m at the southern end (Ward Street) and a building height of 29 m at the northern end (Harnett Street).

The proposed substation site abuts two residential/multi-unit properties to the immediate east, identified as 136, and 138-140 Walker Street. The two properties are proposed to be demolished as approval has been granted for a 22 storey mixed use development that would comprise 46 residential units (refer to Figure 9-20) across a parcel of land with a total area of 1,170 m^2 and a frontage of 28.8 m to Walker Street and a depth of 40.3 m. The approved development would have a height up to RL of 132.46 m and would have its primary street frontage to Walker Street and a pedestrian through site link from Harnett Street to Walker Street.

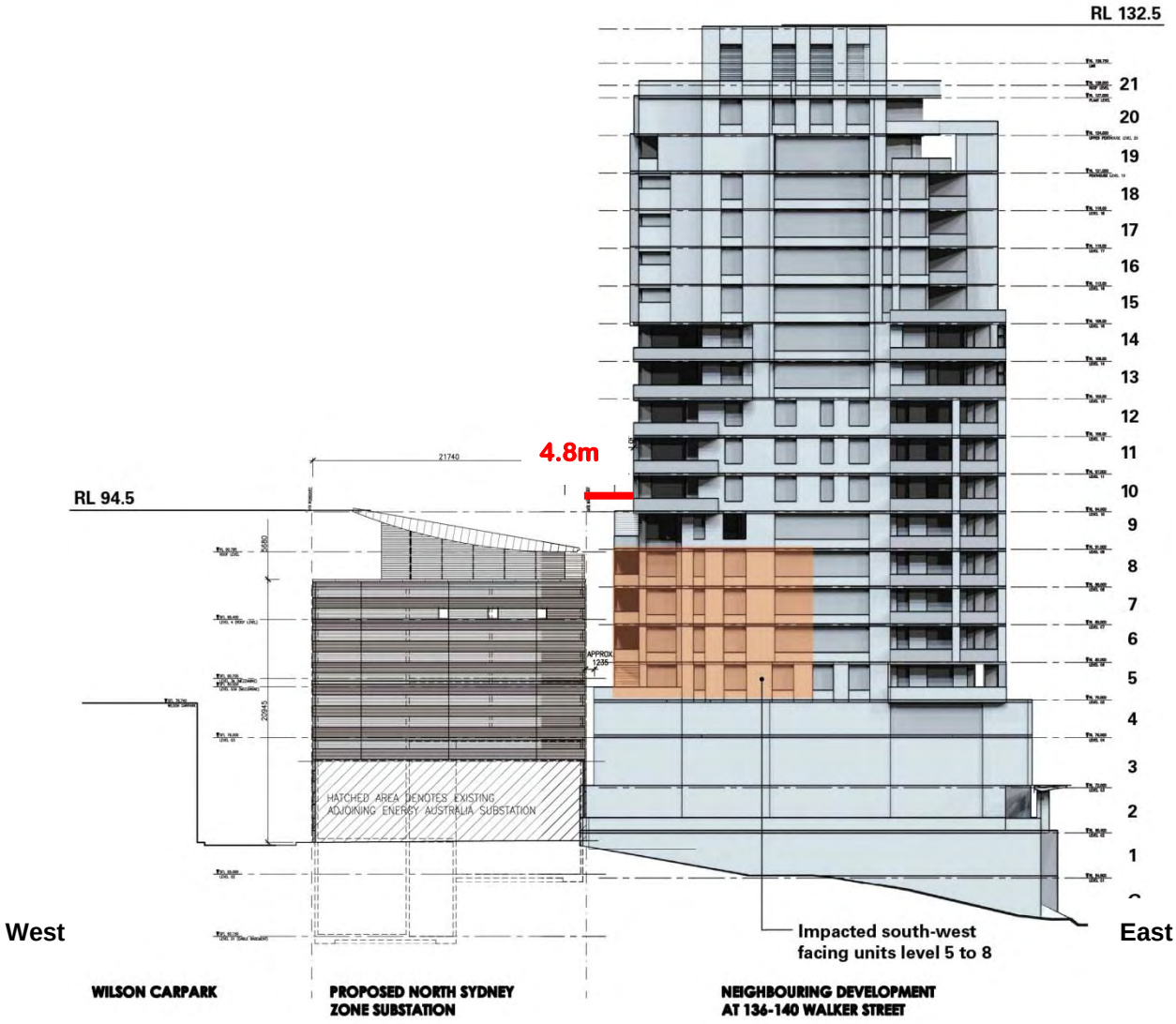
Figure 9-20 - Substation redevelopment site and surrounding land use

9.2.2 Potential Impacts

136-140 Walker Street

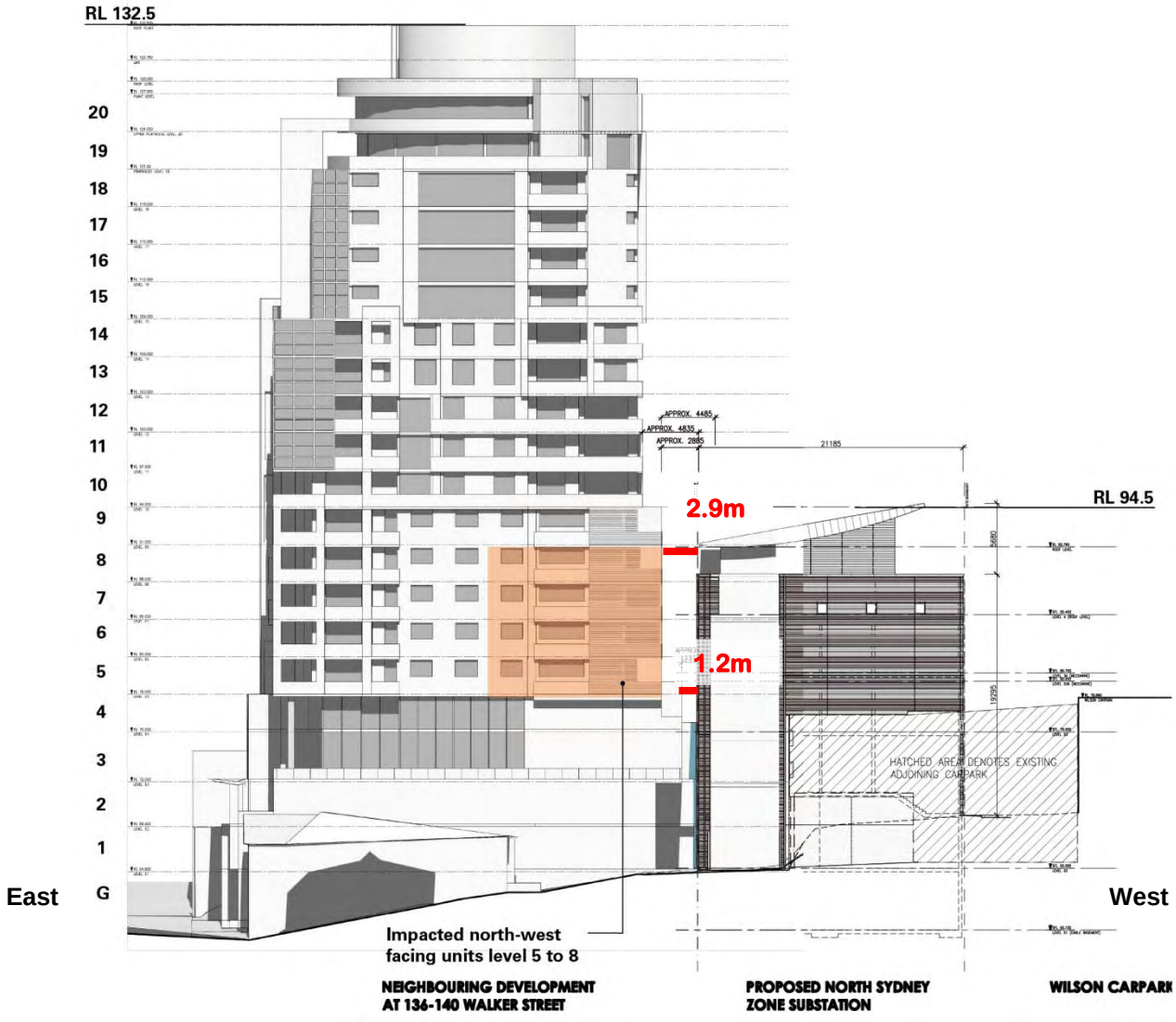
The proximity of the proposed substation's eastern wall to the proposed development at 136-140 Walker Street has the potential to create adverse impacts on the amenity of eight western facing units on Levels 5 to 8 as there is 4.8m between the facade wall of the units and the substation eastern wall (refer to Figure 9-21). The distance between the substation and the unit balconies is 1.2 m for unit 3 on Level 5 and 2.9 m for units on Levels 6 to 8 (refer Figure 9-22).

Figure 9-21 – Southern facade of 136-140 Walker Street and proposed substation



Source: Kann Finch, 2010

Figure 9-22 - Northern façade of 136-140 Walker Street and proposed substation



Source: Kann Finch, 2010

The proposed substation building potentially creates impacts in relation to SEPP 65 matters on the proposed development at 136-140 Walker Street. These impacts predominantly relate to amenity and include altered outlook and overshadowing.

The proximity of the proposed substation to the proposed development at 136-140 Walker Street would impact on the amenity of eight north western and south western units on Levels 5 to 8, including outlook. A photomontage showing a view from the south western facing unit on Level 7 of the proposed development is presented as Figure 9-23.

Figure 9-23 - Photomontage of the substation viewed from a south western facing unit (Level 7)

Source: Kann Finch Group, 2010

A series of shadow diagrams have been prepared to illustrate the overshadowing impacts of the proposed substation and existing development on the proposed development at 136-140 Walker Street. Plan and western elevation views of the overshadowing impacts on the proposed development at 136-140 Walker Street during the winter solstice are illustrated in Figure 9-24, Figure 9-25 and Figure 9-26.

Figure 9-24 – Plan view of overshadowing impact on 136-140 Walker Street from proposed substation for winter solstice

Source: Kann Finch Group, 2010

Figure 9-25 – Western elevation view of overshadowing impact on 136-140 Walker Street from proposed substation for winter solstice for 12pm (top figure) and 1pm (bottom figure) on June 21

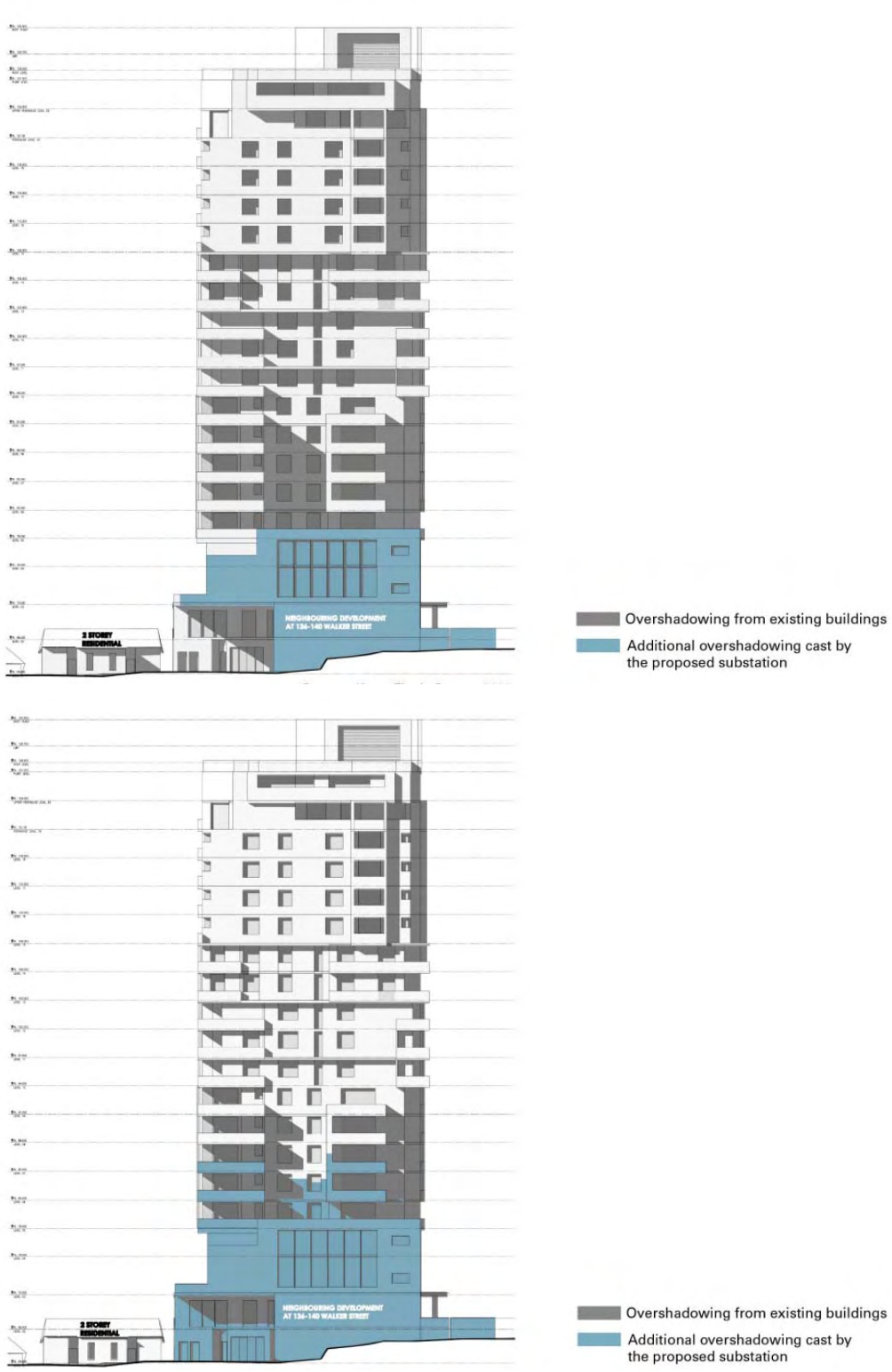


Figure 9-26 – Western elevation view of overshadowing impact on 136-140 Walker Street from proposed substation for winter solstice for 2pm (top figure) and 3pm (bottom figure) on June 21

The proposed substation overshadows a total of six western facing units at 136-140 Walker Street and reduces the sunlight access to less than two hours in mid winter for three of the units facing south west. A more detailed discussion of overshadowing impacts on136-140 Walker Street from the proposed substation is presented in Appendices D and E.

It is noted that a separation distance of 6.5m could have been achieved between the residential units and the eastern facade of the substation site if the NSDCP 2002 controls had been adopted for the approved development at 136-140 Walker Street.

It is considered that the overshadowing impacts are reasonable considering the urban density and high rise nature of the North Sydney CBD.

Overall, in excess of 85 per cent of the total 46 units at 136-140 Walker Street would receive more than three hours of sunlight in mid winter which meets the 70 per cent benchmark requirement outlined in the *Residential Flat Design Code* (DoP, 2002).

Envelope Controls at Proposed Substation Site

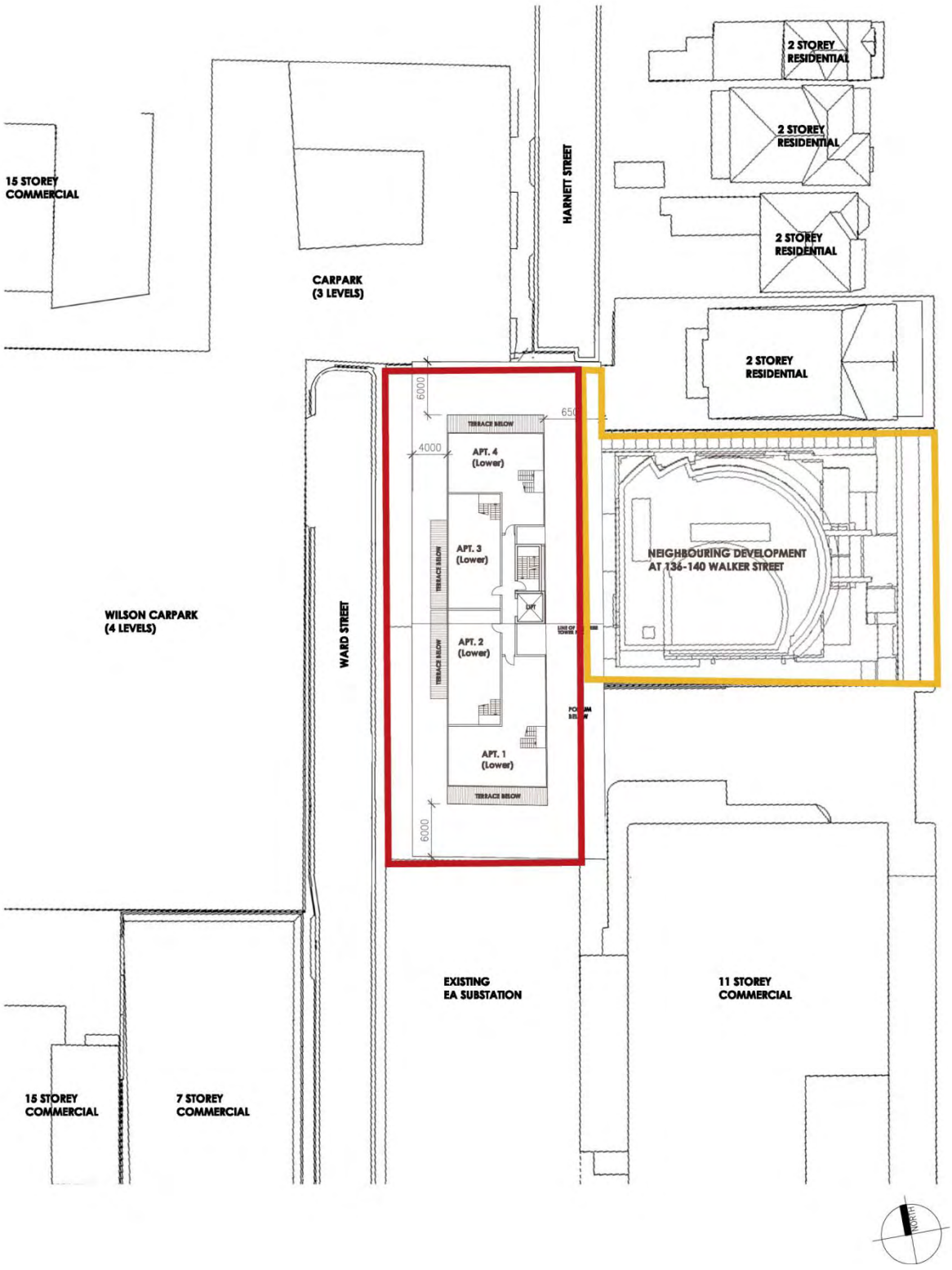
The proposed substation site (3-11 Ward Street) is located in the CBD character area as defined in the NSDCP 2002. The NSDCP 2002 sets out development controls for building in North Sydney and allows building in the proposed substation site to have heights up to RL111m (No. 3 and part of No. 5 Ward Street) and 125m (part of No. 5, and No. 7, 9 and 11 Ward Street). The building envelope controls for the character area that relate to 3-11 Ward Street include zero setback at ground level, and four metre setback above podium along Ward Street. The building envelope controls at 136-142 Walker Street include additional setbacks which are:

- 6.5m along the western boundary
- 7m along the eastern boundary
- 9m along the northern boundary and
- 6m along the southern boundary.

In 2007, the section of the NSDCP 2002 that relates to setbacks for 136-142 was declared to be invalid and ineffective following a court case in the Land and Environment Court (*Castle Constructions Pty Ltd v North Sydney Council* (2007)). In addition, despite no set back controls for 3-11 Ward Street, in 2007 North Sydney Council rejected a development application for a development on 3-11 Ward Street on the grounds that the site did not have sufficient depth to accommodate a viable building footprint.

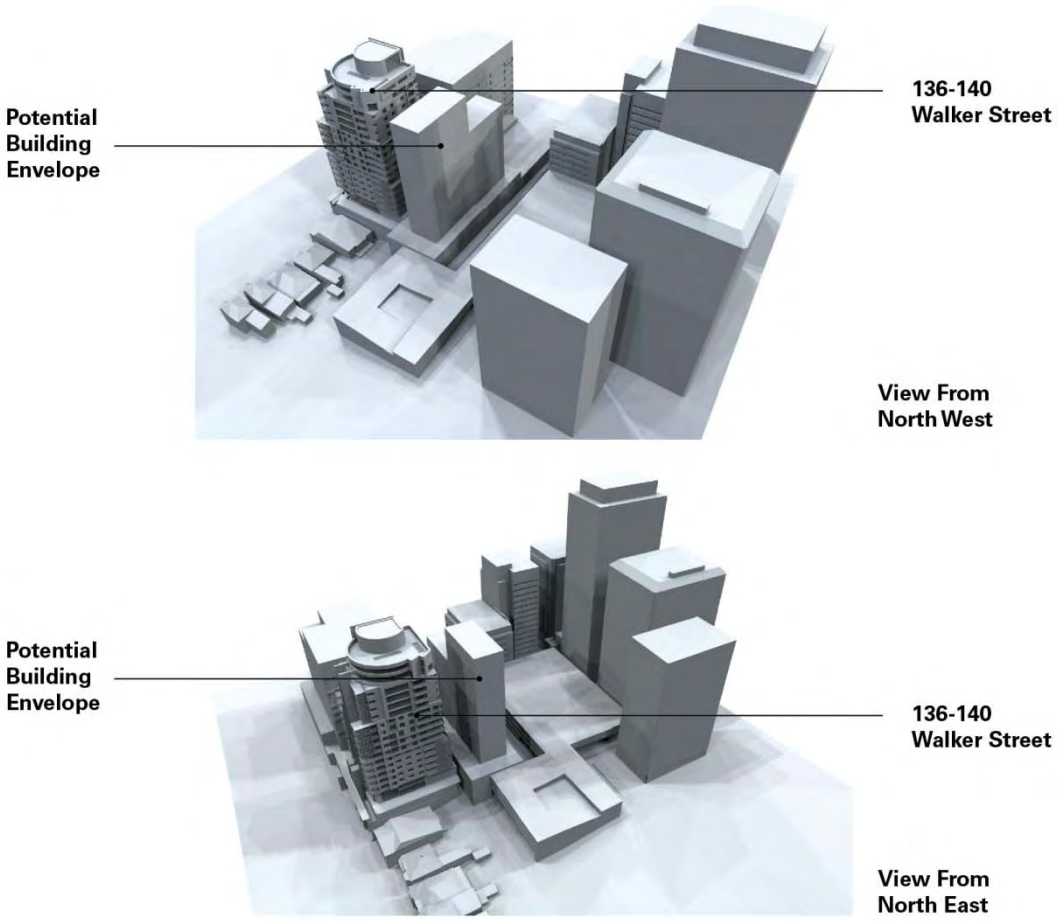
Despite this, Energy2U considers that 3-11 Ward Street should be given the same consideration for development as any other site in North Sydney regardless of the site width. To demonstrate this, Energy2U has developed a hypothetical mixed use development for 3-11 Ward Street and shown that such a development would satisfy the principles of SEPP65, even if the setbacks for the adjacent site are adopted. A hypothetical floor plan layout has been developed to demonstrate that residential units could be accommodated in a narrow site that uses the above outlined setbacks (refer to Figure 9-27). The layout consists of four duplex units on every second level that optimize orientation toward the east and north while being cross ventilated over the two internal levels. A 3D model of the building envelope for the potential development at 3-11 Ward Street is shown in Figure 9-28 and Figure 9-29. In principle the indicative layouts would meet SEPP 65 principles and the *Residential Flat Design Code* requirements including those related to amenity, density and scale as shown in Figure 9-27 (refer to Appendix E for a more detailed discussion). This hypothetical development has been included to demonstrate Energy2U's line of reasoning for a development in lieu of the proposed substation and its affect on the adjacent development, and is not part of the project description. The planned substation would not be enlarged in the future to incorporate a high rise development.

Figure 9-27 – Indicative layout for potential (hypothetical) development at 3-11 Ward Street



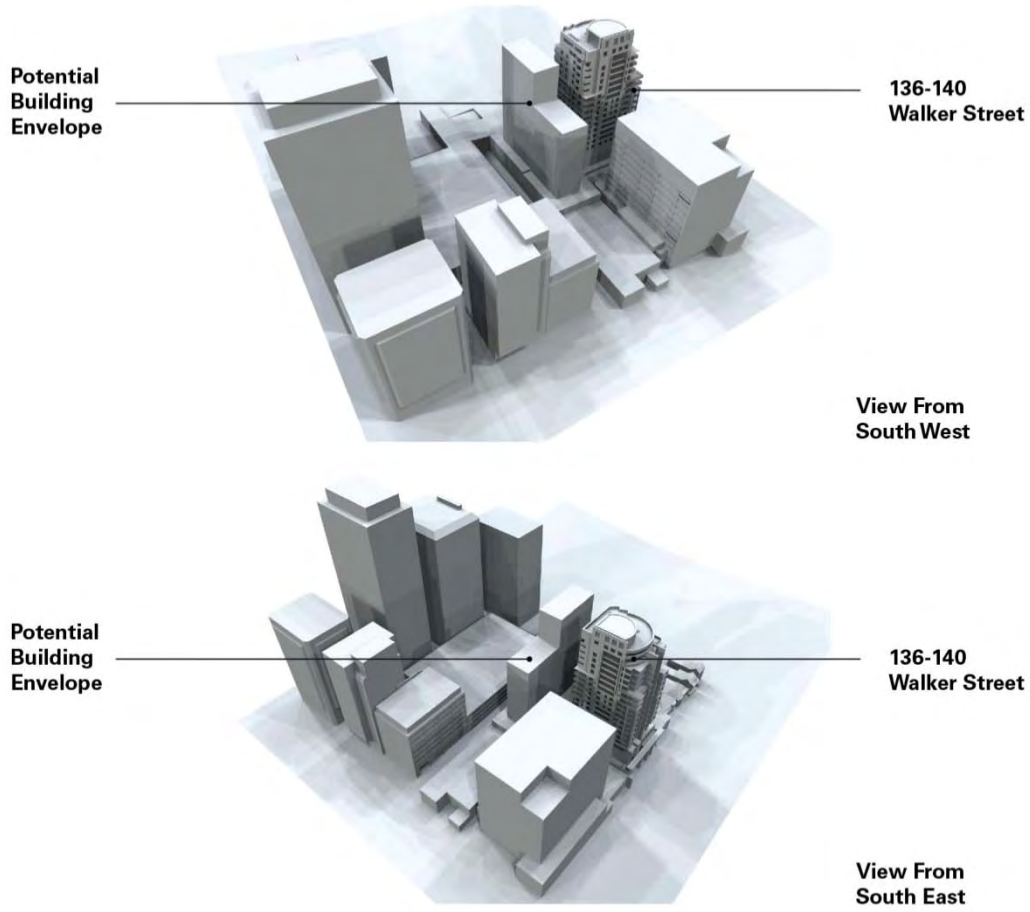
Source: Kann Finch Group, 2010

Figure 9-28 – Proposed development at 136-140 Walker Street and potential (hypothetical) building envelope at 3-11 Ward Street – view from north west and north east



Source: Kann Finch Group, 2010

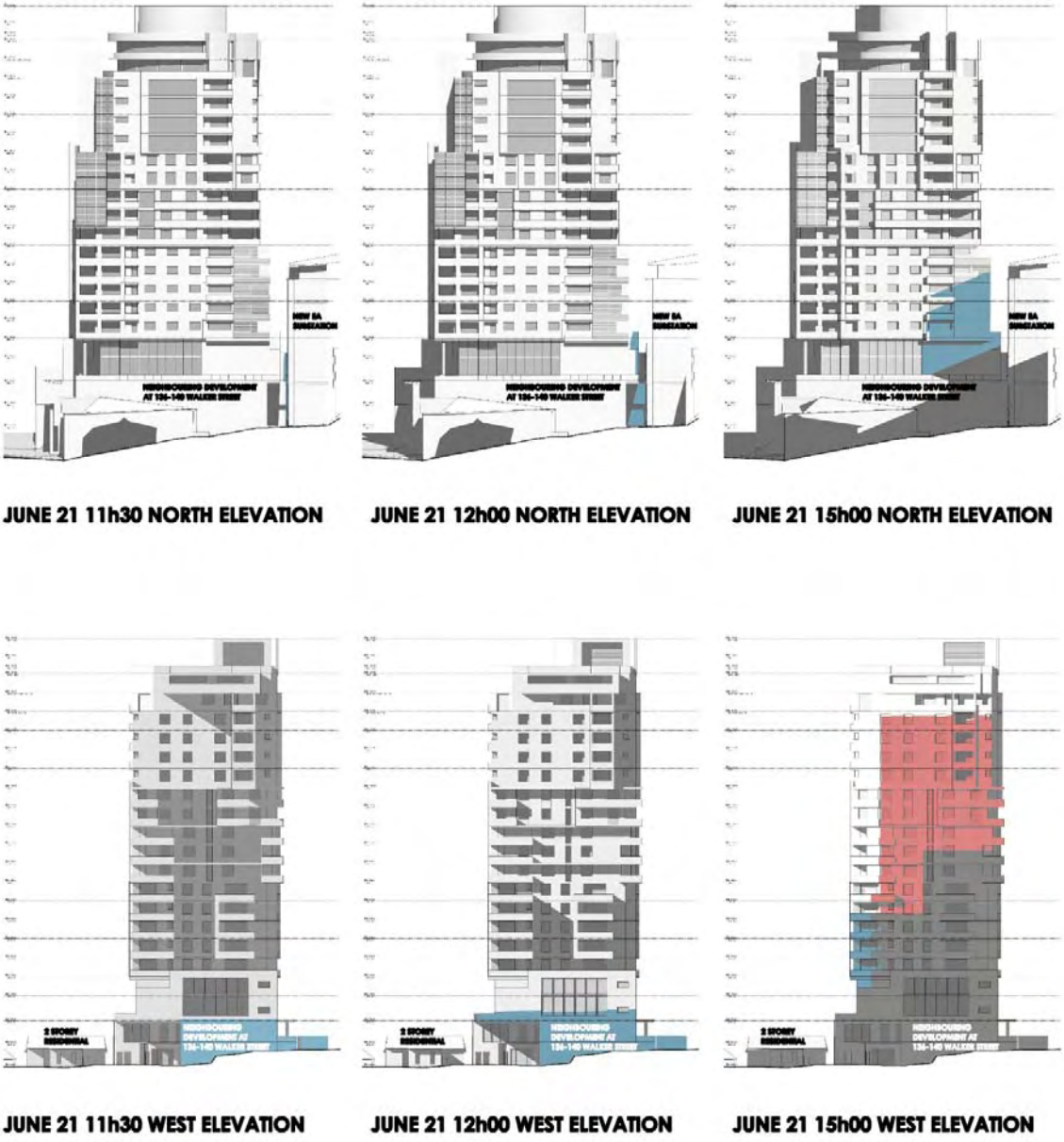
Figure 9-29 – Proposed development at 136-140 Walker Street and potential (hypothetical) building envelope at 3-11 Ward Street – view from south west and south east



Source: Kann Finch Group, 2010

A suite of shadow diagrams has been prepared to illustrate the additional shadowing impact of a potential building envelope (for a hypothetical mixed use development) at 3-11 Ward Street on the proposed development at 136-140 and how this compares with the predicted overshadowing from the proposed substation. Overshadowing impacts for northern and western elevations including a potential (hypothetical) building envelope are presented in Figure 9-30.

Figure 9-30 – Overshadowing impacts for northern and western elevations



Overshadowing cast by existing buildings

Additional overshadowing cast by the proposed substation

Additional overshadowing from a potential (hypothetical) building envelope at the proposed subject site

These figures demonstrate the following:

- The potential (hypothetical) building envelope would have overshadowed approximately 40 per cent more of the western elevation of the approved development. As such, it is considered that

the proposed substation may be regarded as an under development of the site, creating less of an impact on the approved development at 136-140 Walker Street and the surrounding land uses than could occur within the applicable design guidelines.

- The overshadowing impacts of the proposed substation to six of the western units is minor considering the high rise nature of the North Sydney CBD and a potential (hypothetical) building envelope at 3-11 Ward Street.

SEPP 65 Review

A review of the performance of the approved proposed development at 136-140 Walker Street in relation to the relevant design principles outlined in SEPP 65 has been undertaken. A full copy is provided in Appendix E and an excerpt presented in Table 9-1 below. This SEPP 65 review was undertaken to determine whether the amenity impacts of the proposed substation design on the neighbouring proposed development at 136-140 Walker Street are considered reasonable and acceptable.

Table 9-1 – Excerpt of SEPP 65 Review

SEPP 65 PRINCIPLE	IMPACT OF PROPOSED SUBSTATION ON 136-140 WALKER STREET
Context	
Good design responds and contributes to its context. Context can be defined as the key natural and built features of an area. *Responding to context involves identifying the desirable elements of a location's current character or, in the case of precincts undergoing a transition, the desired future character as stated in planning and design policies. New buildings will thereby contribute to the quality and identity of the area.*	The subject site and the proposed development site are located within the North Sydney CBD which is characterised by high rise buildings. The proposed substation has a height of 29 m above Ward Street (RL 94.5) which is substantially lower than the permissible RL of 111 m to RL 125 m for 3-11 Ward Street. As demonstrated in the VIA, the proposed substation would fit within the existing streetscape character of Ward Street and Harnett Streets. In order to mitigate the impact the building has been designed with horizontal pattern of light and dark brick bands that visually modulates the wall. It is considered that there are sufficient mitigation measures to minimise the impact of a large wall towards 136-140 Walker Street and that the building responds to its context.
Scale	
Good design provides an appropriate scale in terms of the bulk and height that suits the scale of the street and the surrounding buildings. *Establishing an appropriate scale requires a considered response to the scale of existing development. In precincts undergoing a transition, proposed bulk and height needs to achieve the scale identified for the desired future character of the area.*	The scale of the proposed substation design is modest compared to the scale of a building enveloped allowed in NSDCP 2002. The scale and bulk of the proposed substation is consistent with that of other buildings within Ward Street, Berry Street and the western side of Harnett Street. The scale of the building towards 136-140 Walker Street is mitigated with a skillion roof that slopes towards the common boundary.

Built Form	
Good design achieves an appropriate built form for a site and the building's purpose, in terms of building alignments, proportions, building type and the manipulation of building elements. *Appropriate built form defines the public domain, contributes to the character of streetscapes and parks, including their views and vistas, and provides internal amenity and outlook.*	The proposed substation has been designed to be built to all boundaries in order to house its specific technical requirements. Mitigation measures to address Ward Street, Harnett Street and 136-140 Walker Street include a modulated facade, a skillion roof and a mix of materials that includes two shades of coloured bricks and metal louvres. The eastern facade, adjacent to the approval development at 136-140 Walker Street continues the horizontal rhythm of the light and dark brick bands. The building has been designed to complement the low rise residential style characteristic to the lower North Shore area, and the previous dwellings which occupied the site. The masonry finish combined with louvred panels and window/opening details generally conform to similar low level developments in the area and effectively conceal its function.
Landscape	
Good design recognises that together landscape and buildings operate as an integrated and sustainable system, resulting in greater aesthetic quality and amenity for both occupants and the adjoining public domain. *Landscape design builds on the existing site's natural and cultural features in responsible and creative ways. It enhances the development's natural environmental performance by co-ordinating water and soil management, solar access, microclimate, tree canopy and habitat values. It contributes*	Construction of the proposed substation would have minimal impacts on landscaping for the approved development at 136-140 Walker Street as public area landscaping is proposed for the eastern and southern boundaries of the mixed use development only. Although the substation would overshadow the private open spaces on Levels 5 to 7 these would still be used for private landscaping and be able to be planted with plants that tolerate low light. In summary, there would be acceptable and reasonable impacts on the landscape amenity of the development as a whole including the six west facing units on Levels 5 to 7.

to the positive image and contextual fit of development through respect for streetscape and neighbourhood character, or desired future character. *Landscape design should optimise usability, privacy and social opportunity, equitable access and respect for neighbours' amenity, and provide for practical establishment and long term management.*	
Amenity	
Good design provides amenity through the physical, spatial and environmental quality of a development. *Optimising amenity requires appropriate room dimensions and shapes, access to sunlight, natural ventilation, visual and acoustic privacy, storage, indoor and outdoor space, efficient layouts and service areas, outlook and ease of access for all age groups and degrees of mobility.*	North Sydney CBD is a high density environment where amenity can be compromised by the proximity of high rise buildings. 136-140 Walker Street was approved with a reduced setback on the western boundary of 4.8 metres which is 25 per cent less than the recommended in the NSDCP 2002 (6.5 m). **Access to natural sunlight** As demonstrated in the shadow diagrams the proposed substation overshadows a small portion of the western and northern facades of the proposed development at 136-140 Walker Street. In excess of 85 per cent of the units would meet the *Residential Flat Design Code* requirements for three hours of sunlight in mid winter. Three units on the south western side of the Levels 5 to 7 would receive less than two hours of sunlight in mid winter. The units would be impacted by the high rise buildings in Miller Street from 2pm onwards. In addition, the high rise nature of North Sydney CBD and the permissible controls in the NSDCP 2002 would mean that the three impacted south western units would have been impacted by any development at 3-11 Ward Street above the podium level.

	Visual privacy The proposed substation does not provide any openings on the eastern elevation. Accordingly, there is no potential to overlook the approved development's living areas or balconies located on its western elevation. Therefore there are no impacts in relation to visual privacy. **Ventilation** The proximity of the proposed substation would not impact the ventilation of the units between Levels 5 and 7 as all these units would still be cross ventilated. **Outlook** The eight western units between Levels 5 and 8 would be impacted by the proximity of the proposed substation building. This separation could have been 6.5 m if the NSDCP 2002 had been adopted. The proposed building mitigates this impact by adding visual interest to the wall through bands of light and cream bricks and a skillion metal roof that can be seen form Levels 8 and above. **Acoustic privacy** The proposed substation does not provide any habitable floor space and has been designed to situate all noise producing plants and transformers as far away from the eastern elevation as practicable. Therefore there are no acoustic privacy impacts on units in the approved development at 136-140 Walker Street.

Safety and Security	
Good design optimises safety and security, both internal to the development and for the public domain. *This is achieved by maximising overlooking of public and communal spaces while maintaining internal privacy, avoiding dark and non-visible areas, maximising activity on streets, providing clear, safe access points, providing quality public spaces that cater for desired recreational uses, providing lighting appropriate to the location and desired activities, and clear definition between public and private spaces.*	The lack of active uses and low visual interest along Harnett Street compromises the passive surveillance of this cul-de-sac. The proposed substation building would have the main vehicular access at the end of Harnett Street which would activate the streetscape. The building also has CCTV cameras along Ward Street and Harnett Street which provide additional surveillance.
Aesthetics	
Quality aesthetics require the appropriate composition of building elements, textures, materials and colours and reflect the use, internal design and structure of the development. Aesthetics should respond to the environment and context, particularly to desirable elements of the existing streetscape or, in precincts undergoing transition, contribute to the desired future character of the area.	The aesthetics of the proposed substation building has been considered to generate a building that has a commercial look and is sympathetic with the surrounding commercial and mixed use urban context. Its design includes: • A modulated built form with a strong vertical articulation along Ward Street. • Horizontal brick banding. • Mix of materials including two shades of bricks, metal louvers and opening frames. • Skillion roof form. In summary, the proposed substation building would fit within its context and would not alter the aesthetics of the development at 136-140 Walker Street.

The SEPP 65 review revealed that the approved development at 136-140 Walker Street would still meet all of the SEPP 65 urban design principles, if the substation design is approved for development.

9.2.3 Mitigation Measures

The substation design has incorporated appropriate design measures to respond to its context and blend into the existing character of the North Sydney CBD. Mitigation measures in the proposed design include:

- An articulated elevation towards Ward Street.
- A facade treatment that creates interest through a pattern of light and dark bricks.
- A skillion roof form that reduces the bulk towards it eastern boundary.

Overall it is considered that the impacts on the approved development are reasonable and acceptable considering the nature and character of the North Sydney CBD. A potential (hypothetical) building envelope at 3-11 Ward Street would have overshadowed 40 per cent of the western elevation of the proposed development compared with the proposed substation. The proposed substation building fits within its context and would not impact on the scale, built form or aesthetics of the North Sydney streetscape.

9.3 Noise and Vibration

A Noise and Vibration Assessment has been undertaken to assess the potential noise and vibration impacts associated with the substation redevelopment. A summary of the report is provided below and a full copy is presented in Appendix F.

9.3.1 Existing Environment

Sensitive Receivers

A number of sensitive receivers are located within close proximity to the site, including residential properties and a restaurant at 76 Berry Street. As discussed in Section 2.1.1, surrounding residential properties are located on Walker Street and Berry Street. Residences in Walker Street are located approximately 10 to 15 m from the boundary of the site and residences in Berry Street are located approximately 40 m from the site. There is a commercial building adjacent to the site on the corner of Berry Street and Walker Street which contains a restaurant with an outdoor courtyard on the ground floor (76 Berry Street).

As it is likely that the neighbouring land use will change in the future, the noise and vibration assessment has considered approved proposed developments directly adjacent to the site, including the proposed mixed use development at 136-140 Walker Street. This proposed development would be the closest residential property to the proposed substation with the façade on Levels 5 to 8 being between approximately 4.8 m from the eastern wall of the substation.

Ambient Noise Levels

The background noise level is defined by the NSW Industrial Noise Policy (INP) as “the underlying level of noise present in ambient noise when all unusual extraneous noise is removed” and includes the following descriptors:

- $L_{A90,\ 15\ min}$ – the background noise level.
- L_{Aeq} – the ambient noise level which is the equivalent continuous sound level.
- RBL – Rating Background Level is a measure of the average minimum background sound level.

Both attended and unattended measurements were taken in order to quantify and qualify the noise sources in the area around the proposed substation. A noise logger alone is unable to qualify noise in the area and hence attended measurements were taken.

Background noise levels were monitored with an unattended noise logger for a five day period between 3 July and 9 July 2009 adjacent to the site to approximate the average ambient noise levels in the area. The unattended noise logger was located at the rear of 136 Walker Street, North Sydney (refer to Figure 9-31). The noise logger was deployed at the selected location in order to approximate the general ambient noise levels in the area in the absence of the noise source to be assessed (i.e. the proposed redevelopment of the substation including the existing substation). Table 9-2 shows the noise levels measured during this period.

Figure 9-31 - Location of Attended and Unattended Noise Monitoring

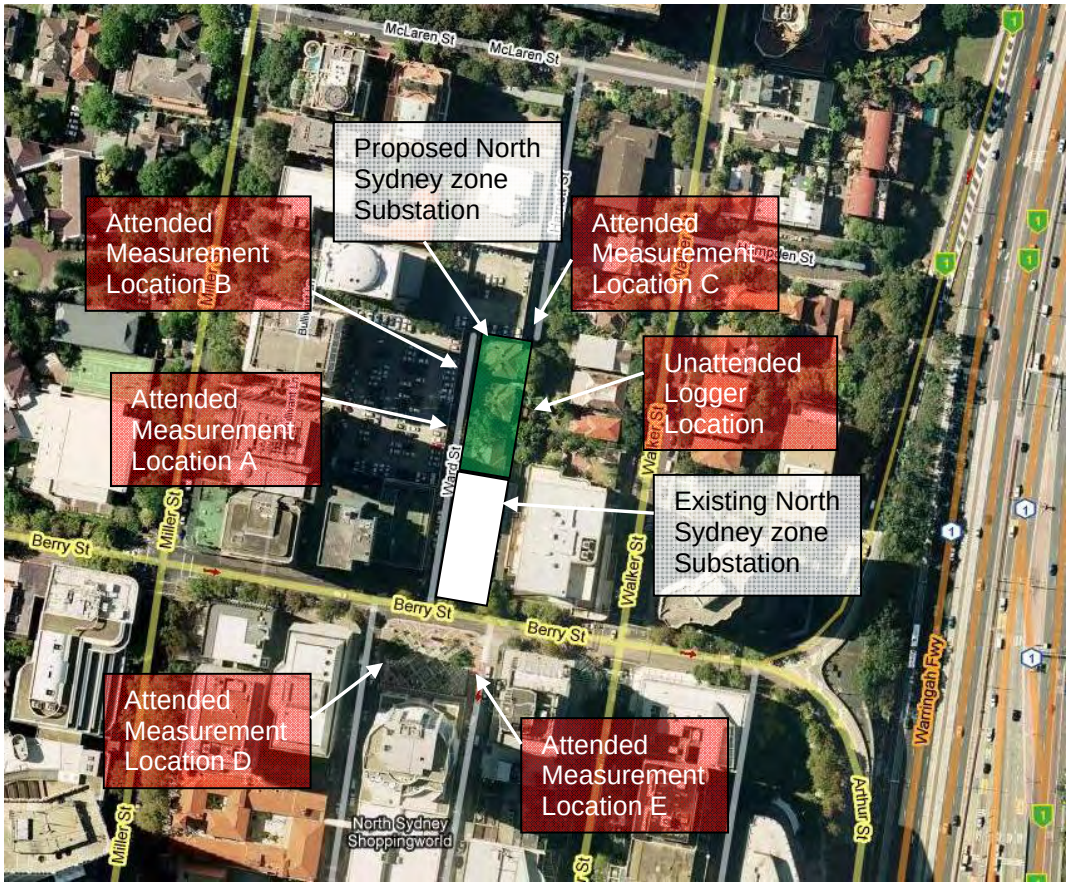


Table 9-2 – Existing Ambient Noise Levels Adjacent to the Project Site

DATE (2009)	L_{A90} BACKGROUND NOISE LEVELS dB(A)			L_{Aeq} AMBIENT NOISE LEVELS dB(A)		
	Day	Evening	Night	Day	Evening	Night
Friday 3 July	-	52	46	-	55	51
Saturday 4 July	52	51	46	55	55	51
Sunday 5 July	51	49	44	54	53	50
Monday 6 July	56	50	45	59	54	51
Tuesday 7 July	57	52	46	60	51	52
RBL	**54**	**51**	**46**	**-**	**-**	**-**
Log Average	**-**	**-**	**-**	**57**	**55**	**51**

Attended noise measurements were conducted during the early morning on 14 July 2009 at three locations within close proximity to the site (refer to Figure 9-31) and two additional locations on 10 August 2010. The purpose of these measurements was to qualify and quantify the noise environment in the vicinity of the proposed redevelopment and to confirm that the location of the unattended noise measurements was not affected by noise emanating from the existing substation. Table 9-3 shows the results of the attended noise monitoring. When the attended measurements were taken, it was observed that plant and equipment from a number of buildings adjacent to the site were audible, including those serving buildings to the west of Wilson Parking carpark, 76 Berry Street and buildings on Denison Street and Little Spring Street. No noise was audible from the existing substation.

Table 9-3 – Attended Noise Measurements on 14 July 2009

Location / Time / Date	Comments	Noise Levels	
		Descriptor	dB(A)
A / 2:08am / 14 Jul 2009	28 m from the end of Ward Street (towards Berry Street): - Mechanical plant and equipment serving nearby buildings located behind Wilson carpark clearly audible (approx 45 dB(A); - Traffic and trucks along Berry Street and distant clearly audible; - No tonal characteristics audible; and - No noise from existing substation audible. Plant ramped up to 48 dB(A) and aborted measurements at approx 10min in duration.	L_{A90} L_{Aeq}	46 48

B / 2:20am / 14 Jul 2009	At entrance to Wilson carpark with Wilson carpark shielding plant and equipment from building behind: - Dominated by distant traffic; - Mechanical plant and equipment serving nearby buildings located behind Wilson carpark could barely be heard at times being approximately 44 dB(A); - No tonal characteristics audible; and - No noise from existing substation audible Garbage truck idling on Berry Street and measurements aborted at approximately 10 min in duration.	L_{A90} L_{Aeq}	45 50
C / 2:36am / 14 Jul 2009	At the end of Harnett Street adjacent to proposed site (North): - Mechanical plant and equipment serving People Telecom building clearly audible at 42 – 44 dB(A); - Distant traffic clearly audible; and - No noise from existing substation audible.	L_{A90} L_{Aeq}	44 47
D / 3:45 am / 10 Aug 2010	In front of residential building across road from Ward Street (west side closest to Denison Street): - Dominated by hum of mechanical plant and equipment serving nearby buildings on Denison Street; - Distant traffic audible; - Limited amount of traffic along Berry Street; and - No noise from existing substation audible.	L_{A90} L_{Aeq}	51 59
E / 4:00 am / 10 Aug 2010	In front of residential building across road from Ward Street (east side closest to Little Spring Street): - Dominated by hum of mechanical plant and equipment serving building on Little Spring Street; - Distant traffic audible; - Limited amount of traffic along Berry Street; and - No noise from existing substation audible.	L_{A90} L_{Aeq}	51 55

9.3.2 Construction Noise Criteria

Construction Noise Management Levels

The construction noise assessment is based on DECCWs *Interim Construction Noise Guidelines* (ICNG). The ICNG states that noise management levels shall be set for the standard working hours and shall be complied with where reasonably practicable.

Construction work for the substation redevelopment would include earthworks, concrete pouring, building erection, building demolition and installation of mechanical and electrical equipment including cables. The construction noise goals for the project were determined using unattended measurements in Table 9-2 and the Noise Management Levels (NMLs) set out in Table 4-1 of the Noise and Vibration Assessment (refer to Appendix F) and are presented in Table 9-4.

Table 9-4 – Construction Noise Goals

LOCATION / LEVEL	NOISE MANAGEMENT LEVELS – dB(A)	
	Day	Night
RBL/ Log Average (from Table 9-2)	54	46
Residential ($L_{Aeq\ (15\ min)}$)	64[1]	51[2]
Office (L_{Aeq})	70	N/A
Café / Restaurant	55 (Internal) Refer to AS:2107[3]	N/A

1 RBL + 10 dB(A) (Table 4-1 of Appendix F) – standard hours.
2 RBL + 5 dB(A) (Table 4-1 of Appendix F) – outside standard hours.
3 Noise measurements inside the adjacent restaurant were measured to be 55 dB(A) when unoccupied (on 11 March 2010). This noise level was dominated by background music. It must be noted that typical noise levels in similar restaurants, when occupied by patrons, have previously been measured to be between 65 and 70 dB(A).

Sleep Disturbance at Residences

There are no specific sleep disturbance criteria outlined in the ICNG but it refers to the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999) for guidance. The ECTRN provides sleep arousal criteria to ensure that the amenity of sleeping areas is protected and that sleep arousal is avoided beyond reasonable limits.

The characteristics of a noise signal such as frequency, peak level of noise event and emergence of noise above the ambient noise are strongly related to sleep disturbance. For this project, we recommend that the maximum internal noise levels in a sleeping area are assessed against the following sleep arousal criteria:

- One or two noise events per night are permitted to exceed 55 dB(A) internally by up to 15 dB(A).
- The remaining construction noise events in the night period (10pm to 7am) should not exceed 55 dB(A) internally.

9.3.3 Construction Vibration Criteria

Ground-Borne Noise

Noise generated by activities such as underground rock breaking work is referred to as ground-borne noise or regenerated noise. The ICNG applies the following criteria for ground-borne noise during evening and night time periods:

- Evening (6pm to 10pm) – $L_{Aeq,\ 15\ min}$ 40 dB(A) (internal).
- Night (10pm to 7am) – $L_{Aeq,\ 15\ min}$ 35 dB(A) (internal).

These criteria are only applicable when ground-borne noise levels are higher than air-borne noise levels.

Vibration – Human Comfort

The vibration assessment involved an assessment of human comfort during the construction period and has been prepared in accordance with *Assessing Vibration: A Technical Guideline* (DECCW, 2006).

Vibration and its associated effects are generally classified as follows:

- Continuous vibration – machinery, steady road traffic and continuous construction activity such as tunnel boring.
- Impulsive vibration – infrequent activities that create up to three distinct vibration events, for example, occasional dropping of heavy equipment and occasional loading and unloading.
- Intermittent vibration – trains, nearby intermittent construction activity, impact pile driving and jack hammers.

There are three axes used to reference the position of the human body when assessing the impact of vibration, the x-axis (back to chest), y-axis (right side to left side) and z-axis (foot to head). In this way, different vibration limits can be imposed based on the different positions of the human body, for example, while lying down the limit would be based on the y- and z-axis and while standing the limit would be based on the x- and y-axis). Where the orientation of the occupant is unknown or may vary, then the most conservative approach should be adopted.

Preferred and maximum allowable magnitudes for continuous exposure to building vibration with respect to the position of the human body are displayed in Table 9-5. Vibration is generally measured as a velocity, which is a measurement of the frequency of vibration waves in millimetres per second (mm/s).

Table 9-5 – Human Comfort Vibration Limits for Continuous Vibration

TYPE OF SPACE OCCUPANCY	TIME OF DAY	PREFERRED VELOCITY (mm/s)		MAXIMUM VELOCITY (mm/s)	
		z-axis	x-and y-axis	z-axis	x-and y-axis
Residential	Day	0.01	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools	Day/Night	0.020	0.014	0.040	0.028

Disturbance caused by vibration depends on its duration as well as its magnitude. The Vibration Dose Value (VDV) is calculated to evaluate the cumulative effects of bursts of intermittent vibration. The VDV may also be used to assess the likelihood of complaints from intermittent vibration.

The VDV is a calculation which is measured as metres per second1.75 (m/s1.75) and represents the amount of vibration which accumulates over the assessment period. VDV criteria are presented in Table 9-6.

Table 9-6 – Acceptable VDV Limits for Intermittent Vibration ($m/s^{1.75}$)

TYPE OF SPACE OCCUPANCY	TIME	LOW PROBABILITY OF ADVERSE COMMENT
Residential	Day (16 hours)	0.2 – 0.4
	Night (8 hours)	0.13 – 0.26
Offices / Restaurant	Day / Night	0.4 – 0.8

Vibration – Structural Damage

Ground vibration criteria provide vibration levels at which the risk of damage to buildings and structures would be avoided.

Table 9-7 provides the vibration limits as set out in *British Standard BS7385-Part 2: 1993 – Evaluation and Measurement for Vibration in Buildings* which have been adopted as the structural damage vibration limits for this project.

Table 9-7 – Structural Damage Vibration Limits

TYPE OF BUILDING	PEAK COMPONENT PARTICLE VELOCITY IN FREQUENCY RANGE IF PREDOMINANT PULSE	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures, industrial and heavy commercial buildings.	50 mm/s at 4 Hz and above	
Dwellings and buildings of similar design and/or use.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

9.3.4 Operational Noise and Vibration Criteria

The noise emission goals during operation of the proposed substation were developed in accordance with guidelines in the INP. The INP sets out two criteria that are used to assess potential off-site noise levels; intrusive noise criteria and amenity noise criteria. The former aims to control intrusive short-term noise levels for residences (intrusive criterion), while the latter aims to maintain the long term amenity of particular land uses (amenity criterion). The amenity criteria, the more conservative of the two limits, have been established as the project specific operational noise goals. Details are presented in Table 9-8 below, based on the background noise measurements. A discussion of amenity and intrusive criteria is presented in Section 3 of the Noise and Vibration Assessment in Appendix F.

Table 9-8 – Operational Noise Goals

PERIOD	INTRUSIVENESS CRITERIA $L_{Aeq, 15min}$ dB(A)	AMBIENT $L_{Aeq, period}$ dB(A)	AMENITY CRITERION $L_{Aeq, period}$ dB(A)
Day (7am to 6pm)	59	57	57
Evening (6pm-10pm)	56	55	45
Night (10pm to 7am)	51	51	41

Sleep Disturbance Criteria

The INP recommends that sleep disturbance is assessed based on the criteria that the $L_{A1\ (1\ minute)}$ noise limit should not exceed the $L_{A90\ (15\ minute)}$ noise level by more than 15 dB(A). This means that a short noise event during the night should not exceed the background noise level by more than 15 dB(A). The night-time noise emissions from the substation would generally be associated with relatively constant activities. Therefore no significant peak noise events would be expected.

Vibration Criteria

Operational vibration criteria would be equivalent to the construction vibration criteria presented in Section 9.3.3 as both the operational and construction vibration criteria are based on *Assessing Vibration: A Technical Guideline* (DECCW, 2006) and *British Standard BS7385-Part 2: 1993 – Evaluation and Measurement for Vibration in Buildings*. The design of the new substation has been developed to incorporate measures to isolate vibration and therefore comply with these criteria.

9.3.5 Potential Impacts

The assessment of the construction and operational noise and vibration impacts was undertaken in accordance with relevant standards and DECCW guidelines.

Construction Noise Impact Assessment

Preliminary calculations have been conducted for the equipment expected to be used during the construction of the proposed substation. Noise Management Levels (NML's) have been determined based on the criteria determined in Table 9-4. These NML's have then been compared to the calculated noise levels expected to be produced by the construction equipment (assuming that no noise control measures are in place) and exceedances of these NML's have been determined.

Table 9-6 shows the predicted noise levels and exceedances at the nearest sensitive residential receivers during the daytime for the different types of equipment.

Table 9-9 – Estimated Construction and Demolition Noise Levels at Residential Receivers – Daytime Only

PLANT AND EQUIPMENT IN OPERATION	L_{Aeq} NOISE LEVEL – dB(A)		
	No Noise Controls	Exceedance of the NML's	NML's (refer Table 9-3)
Crane	69	2	Day: 64
Truck and trailer	68	1	
25T concrete mixer	78	11	
Concrete pump	76	9	
Jackhammer	84	17	

Noise emissions at residential receivers during the construction and demolition phases of the project are predicted to exceed the daytime NML's by 1 to 17 dB(A).

Table 9-10 shows the predicted noise levels for the likely equipment that will be used and exceedances at the nearby restaurant and offices during the construction of the substation (daytime only).

Table 9-10 – Estimated Construction and Demolition Noise Levels at Restaurant and Offices – Daytime Only

PLANT AND EQUIPMENT IN OPERATION	L_{Aeq} NOISE LEVEL – DB(A)				
	No Noise Controls	Exceedance of the NML's		NML's (refer Table 9-3)	
		Restaurant	Office	Restaurant	Office
Jackhammer	84	19	14	Day: 65[1] (external)	Day: 70 (external)
Crane	69	4	-		
Truck and Trailer	68	3	-		
25T Concrete Mixer	78	13	8		
Concrete pump	76	11	6		

1 The DECCW's ICNG recommends that a conservative difference between external and internal noise levels is 10 dB with windows open (for adequate natural ventilation) – for the purposes of a quantitative assessment

Table 9-10 shows that the predicted noise impacts during construction of the proposed substation and demolition of the existing substation would be between 3 and 19 dB(A) above the NML's at the adjacent restaurant and office building.

Bulk excavations have been completed on the proposed substation site (as part of a separate approval). Minor excavation would still be required for the construction of the cable vault and trenches in Berry, Ward and Harnett Streets. The excavation and construction of the cable vault and trenches would occur during the night. Table 9-11 presents the estimated construction noise levels at the nearest sensitive receivers during the night from equipment used during the construction of the cable vault.

Table 9-11 – Estimated Construction Noise Levels at Residences during Construction of the Cable Vault on Berry Street – Night Time Only

PLANT AND EQUIPMENT IN OPERATION	L_{Aeq} NOISE LEVEL – dB(A)		
	No Noise Controls	Exceedance of the NML's	NML's (refer Table 9-3)
Jackhammer	75	24	Night: 51
Bulldozer	70	19	
Rock breaker / hydraulic	80	29	

PLANT AND EQUIPMENT IN OPERATION	L_{Aeq} NOISE LEVEL – dB(A)		
	No Noise Controls	Exceedance of the NML's	NML's (refer Table 9-3)
Crane	70	19	
Stone saw	76	25	
Rotary and percussive rock drill (127mm diameter)	65	14	
Excavator mounted hydraulic rock hammer	79	28	
Truck and trailer	69	18	
25T concrete mixer	69	18	
Concrete pump	67	16	

Table 9-11 shows that exceedances of NML's during the night time work associated with the construction of the cable vault and trenches would be between 14 and 29 dB(A).

The construction phase would be relatively short term in comparison with the life of the development. During construction, exceedances of the criteria would be likely to occur during night works required on Berry, Ward and Harnett Streets, and construction of the substation and demolition of the existing substation. The night works would be limited to approximately six months and the program of activity would be scheduled to minimise impacts as much as possible. The noisiest activities (associated with rockbreaking) would be restricted to a maximum of five nights per week and would take approximately two to three months to complete.

These exceedances would be managed through the implementation of the mitigation measures provided in Section 9.3.6 and the Construction Noise and Vibration Management Plan (CNVMP).

During construction of the cable vault, up to 10 trucks would visit the site during each night shift. This would equate to a maximum of 1 truck per hour and approximately 50 dB(A), therefore complying with the ECRTN criteria presented in Section 4.3of the Noise and Vibration Assessment (Appendix F).

During construction and demolition of the substations it is expected that around 10 trucks would be visiting the site during the day which equates to less than one truck per hour. During concrete pours, 25 trucks per day would be visiting the site to make deliveries which is an increase to less than 2 trucks per hour. This would equate to a maximum of 2 trucks per hour and approximately 53 dB(A), therefore complying with the ECRTN criteria presented in Section 4.3 of Appendix F during the daytime on a local road.

Construction Vibration Impact Assessment

It is recommended that minimum buffer distances be used between vibration equipment and sensitive receivers to avoid human discomfort. Table 6-5 of the Noise and Vibration Assessment (refer to Appendix F) provides the minimum required buffer distances. The restaurant and office building at 76 Berry Street as well as the existing and proposed residential developments in Walker Street would be closer to the construction works than the stated buffer distances. According to DECCW's *Assessing Vibration: A Technical Guideline* (2006), situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration. This would include vibration events during construction and excavation works.

Where vibration buffer distances cannot be met, engineering and management measures would be required to control vibration, particularly during night works. Mitigation measures in Section 9.3.6 would be implemented to reduce the potential impact of vibration on adjacent sensitive receivers during the construction and demolition phases of the project.

Operational Noise Impact Assessment

The substation is proposed to operate on a 24-hour per day, seven days a week basis, operating with three 132/11 kV 50 MVA transformers (consisting of two operational transformers and one stand-by transformer). Of the equipment to be installed at the site, the transformers and mechanical equipment such as exhaust fans are expected to be the only notable source of noise.

The nearest sensitive receivers are residences located at 136 and 138-140 Walker Street and future occupants of the proposed 22 storey mixed use development at 136-140 Walker Street once it is constructed. Given the proximity of this proposed development to the substation, should noise criteria be met for this development it would be expected that criteria would also be met for other surrounding residential developments located further from the site, including an approved eight storey mixed use development at 144-150 Walker Street.

Estimated operational noise emission from the proposed substation at the nearest affected properties (existing and proposed) would be 36 dB(A) at the boundary. As there would be a tonality penalty of 5 dB (due to the tonal nature of the proposed transformers) imposed on the redevelopment, the equivalent noise level would be 41 dB(A) at peak load times. The predicted operational noise level for the proposed substation is within the project specific noise limits for day, evening and night.

9.3.6 Mitigation Measures

Construction and operational noise and vibration impacts associated with the proposed substation and demolition of the existing substation would generally be managed by noise and vibration engineering control and management techniques which are outlined below.

Construction Noise and Vibration

A CNVMP would be prepared as part of the CEMP for the construction of the proposed substation, cable vault and cable trenches. A DMP would be prepared and would include measures to manage noise impacts during the demolition of the existing substation. The CNVMP and DMP would include reasonable and feasible methods for reducing the impact of noise on the surrounding sensitive receivers. They would also include appropriate complaints registration and handling procedures. Mitigation measures that would form part of these plans are discussed below.

Where an exceedance of criteria is predicted, the ICNG advises that the proponent should apply all reasonable and feasible work practices to minimise the noise impact.

The following measures would be implemented to minimise noise impacts during construction:

- Portable barriers and hoardings would be considered where reasonable and feasible. The use of semi-permanent barriers during the construction of the cable vault would not be feasible as the road needs to be reopened to daytime traffic after each shift, requiring all equipment to be completely removed from the work location each morning.
- Maximising the offset distance between noisy plant items and nearby noise sensitive receivers.
- Avoiding the coincidence of noisy plant and equipment working simultaneously close together and adjacent to sensitive receivers would be avoided, where practicable.
- Where possible, equipment with directional noise emissions would be orientated away from sensitive receivers.
- Locate noisy plant away from potentially noise affected neighbours or behind barriers, such as sheds or walls.
- Loading and unloading would be carried out away from sensitive receivers, where practicable.
- The selection of site access points would take into account the proximity of noise sensitive receivers.
- Maintenance work on construction plants with the potential to generate noise impacts would be carried out away from noise sensitive receivers and confined to standard daytime construction hours, where possible.
- Minimising consecutive works in the same locality, where practicable.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.
- Turn off plant that is not being used.
- Examine, and implement where feasible and reasonable, alternative work practices which generate less noise – for example, use electric equipment instead of diesel or petrol powered equipment.
- Examine, and implement where feasible and reasonable, the use of silenced equipment and noise shielding around stationary plant (such as generators), subject to manufacturers' design requirements.
- Ensure plant is regularly maintained, and repair or replace equipment that becomes noisy.
- Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant.
- Where practicable, reversing beepers on trucks would be replaced with low pitch tonal beepers (quackers) after 10 pm.
- Alternative construction methodologies would be considered where noise levels exceed the noise management levels. If no reasonable and feasible options can be found, community consultation measures would be undertaken. It should be noted that alternative construction methods to rock breaking, such as the use of rock splitting (or penetrating cone fracture) have been already considered. However, these methods are likely to impact on (reduce) the integrity of the highly sensitive existing high voltage cables and optic fibre which must remain in operation during the construction of the cable vault. As a result, these methods have been deemed unfeasible.
- Mobile plant such as excavators and other diesel operated machinery would be fitted with silencing equipment, where practicable, if works are planned out of standard operating hours.
- Low noise machinery would be selected where practicable (e.g. electric instead of internal combustion, vibratory piling instead of impact).
- Plant and equipment would be operated and maintained in an efficient and proper manner.
- Dropping materials from a height, either into or out of trucks, trays or bins would be avoided.
- Vehicle speeds would be restricted on, or near, the work site.

- Intermittently used machinery would be shut down or throttled down when not in operation.
- Rowdy behaviour would be avoided on work sites, such as shouting, radios and inappropriate vehicle use.
- Plant or machinery would not be 'warmed up' before the nominated working hours.
- All construction vehicles would enter and leave the site in accordance with site entry controls.
- Noise monitoring at selected receivers would be considered to investigate complaints regarding noise impacts. Contractors and workforce would be informed of noise sensitive neighbours.
- Noisy activities would be conducted in as short a time period as possible with minimum delays.
- Construction works for the proposed substation would generally be undertaken during the following standard operating hours: Monday to Friday from 7am to 6pm and Saturday from 8am to 4pm. No work would occur on Sundays or Public Holidays. Works may be undertaken outside of standard operating hours if the both of the following criteria are satisfied:
  - The works cannot be undertaken during standard operating hours e.g. RTA requirements for road works within Berry and Ward Streets; and
  - Any potentially affected residents are given prior notice of work times and reasons.

  For works that are planned out of standard operating hours, the noisiest works, such as rockbreaking, would be scheduled so they are completed before 10 pm, where practicable;
- Construction works for the proposed cable vault and cable excavations would generally be undertaken during the following hours:
  - Sunday – Wednesday 8:00pm to 5:00am
  - Thursday 8:30pm to 5:00am
  - Friday 8:30pm to 7:00am
  - Saturday 8:00am to 5:00pm
  - Sunday 8:00am to 5:00pm

  Night work would be undertaken for a maximum of 5 nights per week, with works carried out during the daytime on Saturday and Sunday. Two nights of respite (Friday, Saturday or Sunday nights) would be implemented each week.
- Work for the cable vault and substation building would generally not be carried out simultaneously (as the vault would be constructed at night and on weekends, whereas the building work would generally be carried out during daytime hours). The cable vault construction period would run parallel with the construction period for the substation building. However, as excavation for the substation building has been completed, the noise generated by the construction of the substation building with construction plant such as cranes, trucks and power tools, will have different, less annoying characteristics than percussive noise from rock hammering. In addition as the construction of the substation building progresses further acoustic shielding would be provided to receivers on Berry Street.

  It should be noted that whilst it is unlikely that noisy activities would be able to be restricted to certain times of the day, continuous work would enable the works to be completed quicker, minimising the length of time residents are subjected to construction noise.

Respite periods

- The proposal involves activities which could generate noise levels above L_{Aeq} 75 dB(A) or activities likely to generate noise with intermittent, impulsive, tonal or low-frequency characteristics which have the potential to affect the amenity of adjacent noise receivers. In the case that high impact noise activities or activities likely to generate noise with intermittent, impulsive, tonal or low-frequency characteristics are required, respite periods would be implemented.

Community notification

- Potentially noise affected neighbours would be contacted at the earliest possible time before any site work begins. Affected properties would be suitably notified in relation to hours of works and anticipated duration of noisy activities. This notification would include approaching in person and letterbox drops.
- For residential properties where noise levels from the construction works are likely to exceed the noise management levels, it is recommended that letterbox drops as a minimum be considered. Letter box drops should occur a minimum of seven days ahead of proposed construction works.
- An information display may also be erected in the foyer of 77-81 Berry Street and other information posted in prominent locations in the building.
- Register all community and stakeholder enquiries and complaints in a community and stakeholder database and address as required. The community relations hotline number would be provided to the community and stakeholders who would potentially be directly impacted by construction at least 48 hours prior to commencement of construction activities. A complaints procedure would be detailed in order to address any complaints.
- Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking.
- Describe any noise controls, such as walls to be built first that would reduce noise, temporary noise walls, or use of silenced equipment.
- Provide contact details on a site board at the front of the site, and maintain a complaints' register suited to the scale of works.
- Provide a copy of the noise management plan, if available, to potentially noise affected neighbours.

Noise and vibration complaints

- Any noise or vibration complaints would be addressed in a timely manner, in accordance with the Incidents and Complaints Management Procedure.

Construction Vibration

Vibration impacts would be most likely to occur during the excavation of the cable vault and trenches. Continuous rockbreaking close to affected receivers may raise complaints and would require management measures prior to commencement of excavation. The vibration dose values and regenerated noise levels experienced at affected receivers would be controlled by:

- Source controls
  - Use of less noise and vibration intensive equipment (e.g. sawing of trenches prior to rockbreaking, rotary cutting and reducing the size of the rockbreaker).
  - Negotiating (as per Section 7.2.2 of the ICNG) respite periods and adhering to these predetermined periods.
- Management methods
  - Community consultation.
  - Complaint response.
  - Site layout.
  - Avoiding work during sensitive time periods (e.g. night work).
  - Noise and vibration logging and attended measurements.
  - Training.
- Path controls
  - Noise enclosures.

- Avoid vibration intensive works in a concentrated area and try to work over a large area in order to reduce maximum vibration dose values, i.e. changing the location of excavation such as working opposite corners/edges.

General mitigation measures to reduce potential vibration impacts associated with the proposed substation redevelopment would include:

- All construction vehicles entering and leaving the site in accordance with site entry controls.
- Condition surveys at affected receivers (residential receivers in Walker Street and the restaurant at 76 Berry Street).
- Continuously monitoring of the ground vibration levels at selected receivers for the entire duration of the excavation/construction works.

Any damage to buildings or structures attributable to vibration from construction activities would be rectified within a reasonable period, at no cost to the property owners

Operational Noise and Vibration

The proposed substation has been designed to address issues identified during the operational noise assessment. These design measures include all electrical installations being fully contained within the substation building, the type of material used for the walls of the transformer bays and the use of acoustic insulation in the ventilation stacks of all three transformers.

The predicted operational noise levels would comply with project specific noise criteria and therefore no additional mitigation measures would be required.

9.4 Electric and Magnetic Fields

9.4.1 Introduction

Electric and magnetic fields

EMF are produced by the natural environment (e.g. static magnetic field of the earth's magnetic core and varying electric fields during thunderstorms) and flow of electricity through a material. The electric field associated with electrical equipment is associated with the voltage of the equipment and the magnetic field is associated with the current (amperage). In combination, these fields cause energy to be transferred along electric wires.

Electric fields are strongest close to their source and their strength diminishes rapidly with distance from the source. Many common materials such as brickwork or metal block electric fields so they are readily shielded and do not penetrate buildings.

A magnetic field is a region where magnetic materials experience an invisible force produced by the flow of electricity (known as electric current and measured in Amperes). Magnetic fields are related to current rather than voltage and therefore they are produced by a variety of equipment in everyday life such as appliances in the home and workplace and electrical machinery.

The strength of a magnetic field resulting from an electrical installation varies continually with time and is dependent on a range of factors including:

- The total electrical load.
- The size and nature of the equipment.
- The design of the equipment.
- The layout and electrical configuration of the equipment and its interaction with other equipment.

The layout of a substation can have a significant effect on the external magnetic fields.

EMF and human health

The issue of EMF and human health has been the subject of extensive research throughout the world over the past three to four decades. To date, adverse health effects have not been established, but the possibility that they may exist has not been ruled out. The first studies on EMF were focused on the effects of electric fields, however the focus later shifted to magnetic fields as more study findings were revealed.

It is well accepted by scientists that no study considered in isolation will provide a meaningful answer to the question of whether or not EMFs can contribute to adverse health effects. Research into electric and magnetic fields is a complex area involving many scientific disciplines from biology, physics and chemistry to medicine, biophysics and epidemiology. In order to make an informed conclusion from all of the research it is necessary to consider the science in its totality. Over the years, governments and regulatory agencies around the world have commissioned independent scientific review panels to provide overall assessments.

The most recent scientific reviews by authoritative bodies are reassuring for most potential health issues. However, statistical associations between prolonged exposure to elevated magnetic fields and childhood leukaemia have persisted. Despite over two decades of laboratory research, no mechanism for an effect has been established which lends weight to the possibility that the observed statistical associations reflect some factor other than a causal relationship.

Overall, it is generally accepted that adverse health effects from long term low level human exposure to EMF have not been established but the possibility of such effects cannot be ruled out.

Health Standards

Until a few years ago, the relevant Australian health standard for electric and magnetic fields was the Interim Guidelines on Exposure to 50/60 Hz Electric and Magnetic Fields issued by the National Health and Medical Research Council. These guidelines have been replaced by draft standards produced by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

In 2006 ARPANSA issued a Draft Standard on Exposure Limits for Electric and Magnetic Fields (0Hz to 3kHz) for public comment. This standard proposed a 24 hour exposure limit for the general public of 1000 milligauss (mG). Although this draft standard is currently in the process of being finalised it is widely accepted as the current Australian standard.

In applying the ARPANSA draft standard it is important to recognise that the numerical limit of 1000mG is based on ‘established biological effects’ which occur at field levels much higher than those normally encountered in the vicinity of electrical equipment. The numerical exposure limits in the draft standard cannot be said to define safe limits for possible health effects, should these exist, from fields at levels normally encountered in the vicinity of electrical equipment. As such the approach of applying precautionary measures such as ‘prudent avoidance’ has arisen.

Prudent avoidance

Although compliance with the relevant magnetic field numerical guidelines is important, it does not imply a level of safety. The possibility of health effects has been comprehensively studied over several decades worldwide but there remains no clear understanding of whether or not electric or magnetic fields pose a threat to human health. There is presently no scientific basis to support exposure limits below the guidelines which presently exist as a prudent avoidance measure. As such a precautionary approach of prudent avoidance has developed and is widely adopted as common practice for new utility installations.

Prudent avoidance is commonly defined as doing what can be done at modest cost and without undue inconvenience to avoid a possible risk. This includes incorporating measures into the design of an electricity installation to reduce public exposure to electric and magnetic fields.

Given the inconclusive nature of the science, it is considered that a prudent approach continues to be the most appropriate response in the circumstances. Under this approach, subject to modest cost and reasonable convenience, power utilities should design their facilities to reduce the intensity of the fields they generate and locate them to minimise fields that people encounter over prolonged periods. While these measures are prudent it cannot be said that they are essential or that they will result in any benefit.

A practice of prudent avoidance has been adopted by EnergyAustralia for the proposed substation.

9.4.2 Electric and Magnetic Field Assessments

Two separate assessments have been undertaken to predict the electric and magnetic fields associated with the proposed substation development. The first assessment was undertaken by Energy2U in December 2009 and was based on the concept design of the proposed substation. The second assessment was undertaken by Aurecon in July 2010 and was based on the detailed design of the proposed substation.

A copy of each assessment is presented in Appendices G and H respectively and summaries for each provided in this section.

As the focus of the EMF assessment undertaken in December 2009 was to present a preliminary assessment and inform the design, the findings of the assessment are included in this introductory section only. The focus of the remainder of the section is on the findings of the recent and more comprehensive EMF assessment that was undertaken in July 2010.

EMF Assessment (December 2009)

An EMF assessment was undertaken in December 2009 as part of the REF assessment process. The purpose of the assessment was to undertake an assessment of the predicted EMF levels based on the concept design of the proposed substation. The report also outlined an EMF exposure management strategy that would be adopted by EnergyAustralia, which would comprise the following:

- A preliminary impact assessment to determine the maximum extent to which the public would be exposed to magnetic fields by the substation.
- Measurements of the ambient fields from the existing and proposed substation to determine if there are any changes in the field levels in the area.
- The definition of ‘low cost’ or ‘no cost’ design measures that can be implemented to mitigate EMF exposure.

The strategy was developed to achieve the objective that all EMF levels would be below the most conservative exposure limits as a minimum but would also consider design measures that would reduce the levels further. This has been achieved by designing the substation with consideration of the predicted levels from the study prepared in December 2009 and making further modifications to the detailed design in response to the findings of the recent and more comprehensive EMF study.

The EMF assessment calculated the worst case magnetic field levels along the boundaries of the proposed substation. The magnetic fields due to current flow in the 132kV and 11kV cables were calculated in accordance with the method recommended by CIGRE Joint Task force 36.01/21 as summarised in Technical Brochure 104- Magnetic field in HV Cable Systems 1/ Systems Without Ferromagnetic Component. This method of calculation was based on the preliminary design specifications available at the time and due to this a number of simplifications were required when modelling the cables, GIS bus and terminations, transformers and cable terminations, and capacitors and air-core reactors.

EMF levels were calculated around the perimeter and results are summarised in Table 9-12. The calculated fields at the boundaries showed EMF levels for the whole site are within the numerical health limits, and compliance with the numerical limit would be maintained during the life of the substation.

Table 9-12 – Calculated EMF levels for boundary of proposed substation (December 2009 study)

LOCATION	CALCULATED EMF LEVEL (mG)	NUMERICAL HEALTH STANDARD (mG)
Eastern boundary adjacent to proposed 22 storey mixed use development (136-140 Walker Street)	40	1000
South east corner adjacent to People Telecom building (76 Berry Street)	24	
Southern boundary once existing substation is decommissioned and demolished	25	
Western boundary adjacent to Wilson Parking carpark	26	
Western boundary on public footpath (on eastern side of Ward Street)	261	

The report identified design measures that were 'low cost' or 'no cost' that had already been incorporated in the concept design. These include:

- Equipment that produces high magnetic fields would be located furthest from sensitive sites. These include:
  - capacitor banks with air-core reactors would be located near the centre and roof of the building
  - air insulated busbars would be located on the third level away from residential properties
  - transformers with air-insulated terminations would be positioned near Ward Street, away from residential and commercial properties
- Lower voltage equipment would be located furthest away from sensitive sites since the current and magnetic fields surrounding this equipment are higher.
- GIS would be used where possible since the reduced phase spacing lowers magnetic field levels and the metal enclosure of the equipment would provide shielding of the magnetic fields.
- Metal-clad 11kV switchgear would be used so that no unshielded busbars or terminations would be present within the substation apart from those connections within the transformer rooms.
- Incoming and outgoing transformer connections which produce the highest magnetic field levels would be installed away from sensitive sites using the most compact construction possible.
- Cables would be arranged by feeder in a trefoil configuration to provide maximum magnetic field cancellation and thereby lower the magnetic field levels at the property boundaries.
- The same phases at the 11kV transformer terminal would terminate into three core cables with the shortest possible transition length to minimise magnetic fields near those locations.
- Lower voltage cables carrying large current would be positioned away from sensitive sites toward the centre of the building.
- Cable trays and reinforcing would be made electrically continuous so that it would provide some magnetic field shielding at the property boundaries.

- The 132kV and 11kV loads would be balanced.
- The largest sources of magnetic field at the property boundaries are the 11kV cable terminations in the transformer rooms and the 11kV cables connecting the transformer outputs to the 11kV switchgear. The cable terminations at the transformers would be positioned adjacent to Ward Street rather than near the residential or commercial properties. Eight of the cables between the transformers and the switchgear would be located in the central cable riser and the four cables in the eastern cable riser would be located as close to the centre of the building within that riser as is possible.

It was predicted that the magnetic field levels at the boundaries of the proposed substation would be within the numerical health standard and similar to levels measured in a typical household or office environment, with the exception of the eastern side of Ward Street where levels would be intermittently higher during times of peak load.

EMF Assessment (July 2010)

An EMF assessment was undertaken by Aurecon in July 2010 to support the application for Project Approval. The EMF assessment was developed to address the DGRs and the following specific objectives:

- Detailed assessment of EMF levels produced by the existing substation and its associated infrastructure (including cables and conduits) under current operating scenarios
- Detailed assessment of the predicted EMF levels that the proposed substation and its associated infrastructure (including cables and conduits) under likely future operational scenarios, at both commissioning (2011) and under ultimate loading conditions (2014), including the predicted levels at the boundary of adjacent property
- Assessment of the risks to human health from EMF with particular reference to the ARPANSA guidelines and standards and other international EMF guidelines
- Assessment of the proposed substation development against precautionary and principles of prudent avoidance in relation to EMF.

Aurecon visited the site in July 2010 to undertake magnetic field measurements and to view the project area. Measurements were undertaken along the site boundaries of the existing and proposed substation.

Based on the available design and loading information, the magnetic field contribution expected from the proposed substation and its underground feeders was modelled using the CDEGS software package. The results from the magnetic field modelling are presented in the form of surface contour plots for the project site and profiles along its boundaries.

In calculating the magnetic fields along the boundaries, it was necessary to select an appropriate height at which to perform these calculations. Accordingly, the magnetic field profiles along the northern and eastern boundaries were calculated at approximately 1m above Harnett Street (RL66.1) and along the western and southern boundaries at approximately 1m above Ward Street (RL68.8).

9.4.3 Existing Environment

The magnetic fields were measured along the western boundary of the existing substation in July 2010 as part of the recent assessment undertaken by Aurecon. Magnetic field measurements were taken along the site boundaries of the existing substation and the proposed substation. Measurements were also recorded in the vicinity of the cable vault to be installed on the corner of Ward and Berry Streets. The measurements were recorded with an Emdex 2 magnetic field metre in conjunction with an Enertech linear data acquisition system at a height of 0.9m above the ground as dictated by the guidelines for the equipment used. On an international level it is widely accepted that measurements should be recorded at a height of 1m however differences between the two would be immaterial.

Existing substation site

A full set of measurements along the eastern boundary of the existing substation was not possible due to limited access. To counteract this, full measurements were taken for the southern 10 m and spot measurements taken for the remainder of the boundary from accessible points within the adjacent building.

Approximately half the measurements around the existing substation were less than 20mG with the majority of the remainder being less than 80mG.

There were eight peaks ranging up to 240mG including a peak of 200mG towards the southern end of the eastern boundary (likely due to cables and connections to the substation) and a peak of 240mG midway along the western boundary (likely to be due to the 11kV underground cables in Ward Street).

Proposed substation site

The magnetic fields measured along the eastern and northern boundary of the proposed substation site were less than 4mG, while those measured along the western boundary were generally between 3mG and 5mG with a peak of 8mG near the north west corner.

Cable vault

Magnetic fields measured in the vicinity of the existing cable vault on the eastern side of Ward Street ranged up to 120mG while those on the western side and in Berry Street were generally less than 10mG. The measurements taken on the eastern side of Ward Street would be associated with the existing substation and cables.

9.4.4 Potential Impacts

Electric fields

As most of the electrical equipment associated with the substation would be located indoors, it would produce little or no electric field external to the equipment enclosure. The only unenclosed HV connections within the substation would be short sections within the transformer enclosures which would be accessible to authorised persons only.

On this basis, the electric fields in these areas directly under the connections based on typical equipment characteristics have been estimated to be within the relevant occupational limits.

No major source of electric field is expected beyond the substation boundary as all of the incoming and outgoing feeders are to be underground.

The EMF assessment has considered magnetic field levels only since there is no public exposure to electric fields from the substation and scientific research into the health effect of exposure to EMF has focussed on magnetic fields.

Magnetic fields

The magnetic fields from substation equipment depend on the loadings at a particular time. However, during a typical day the amount of load current passing through a substation will vary substantially between a daily minimum, generally late at night and in the early hours of the morning and a daily maximum at times of peak demand (middle of the day). Loadings also vary seasonally throughout the year. As such, it is necessary to make practical assumptions regarding the substation and feeder loadings. Epidemiological associations which underpin community interest regarding magnetic fields tend to relate to elevated average magnetic fields. Accordingly, the long term average load for North Sydney substation has been used in this assessment rather than the maximum capacity of the substation, which would present unrealistic results. The substation loading has been assumed to be at the 85th percentile of operation for this assessment i.e. that level which is exceeded for only 15 per cent of the year. In this regard the EMF study has assessed the worst case scenario.

Based on the available design and loading information, the magnetic field contribution expected from the proposed substation, cable vault and underground feeders has been modelled using the CDEGS software package. The results obtained from the magnetic field modelling are shown in the form of surface contour plots for the whole site. Two contour plots have been prepared, illustrating the predicted magnetic field contribution associated with the proposed substation 1m above Harnett Street level (refer Figure 9-32) and 1m above Ward Street (refer Figure 9-33).

Figure 9-32 – Predicted magnetic field contribution associated with proposed substation 1m above Harnett Street

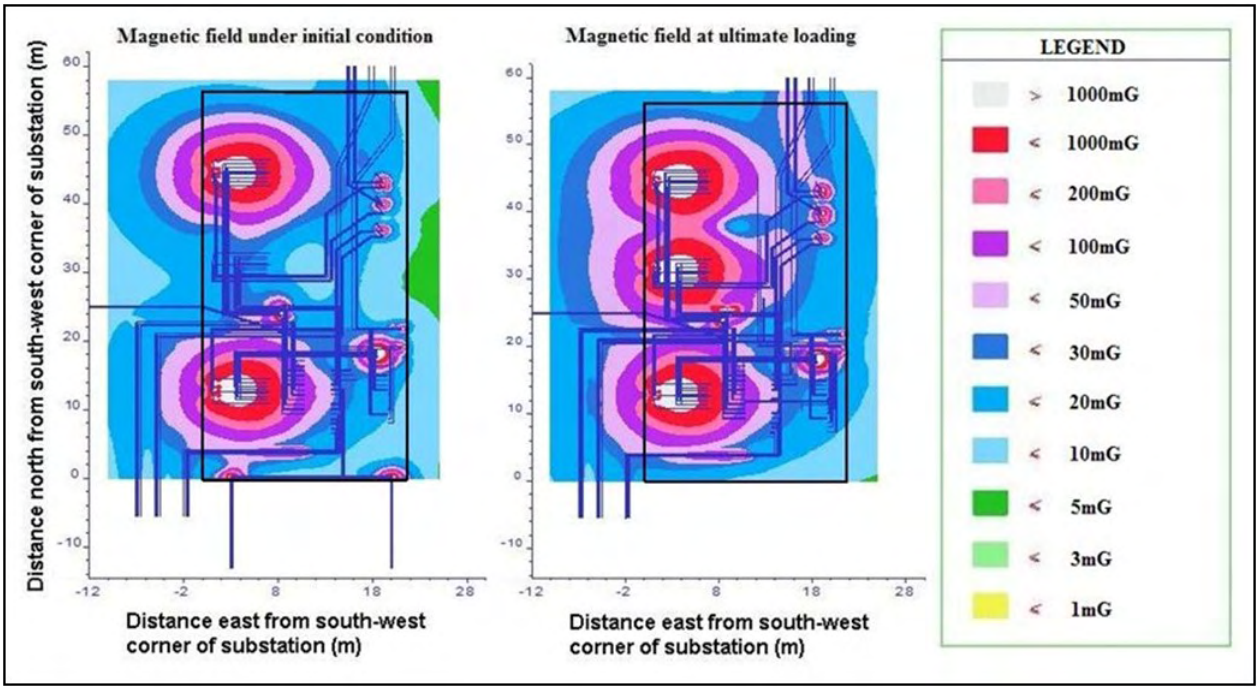
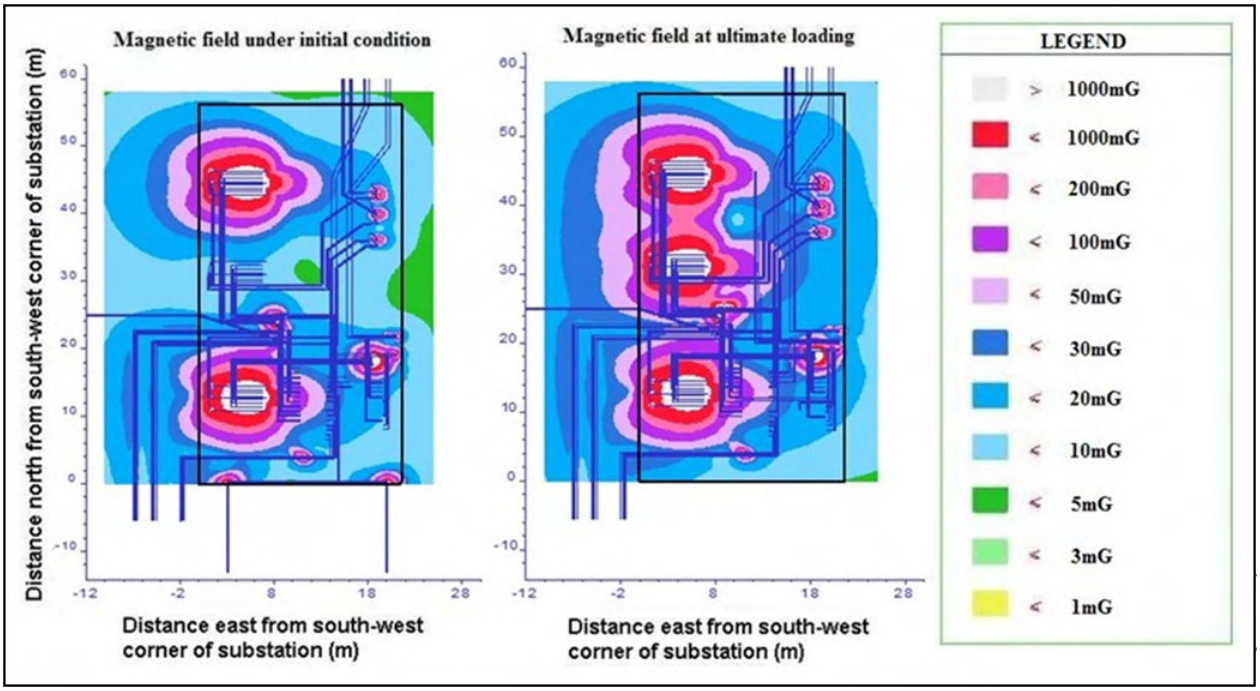


Figure 9-33 – Predicted magnetic field contribution associated with proposed substation 1m above Ward Street



The proposed substations contribution to the magnetic field levels along its boundaries is summarised below:

- Northern boundary is predicted to be in the range of 7mG to 20mG upon commissioning and 11mG to 32mG under ultimate conditions.

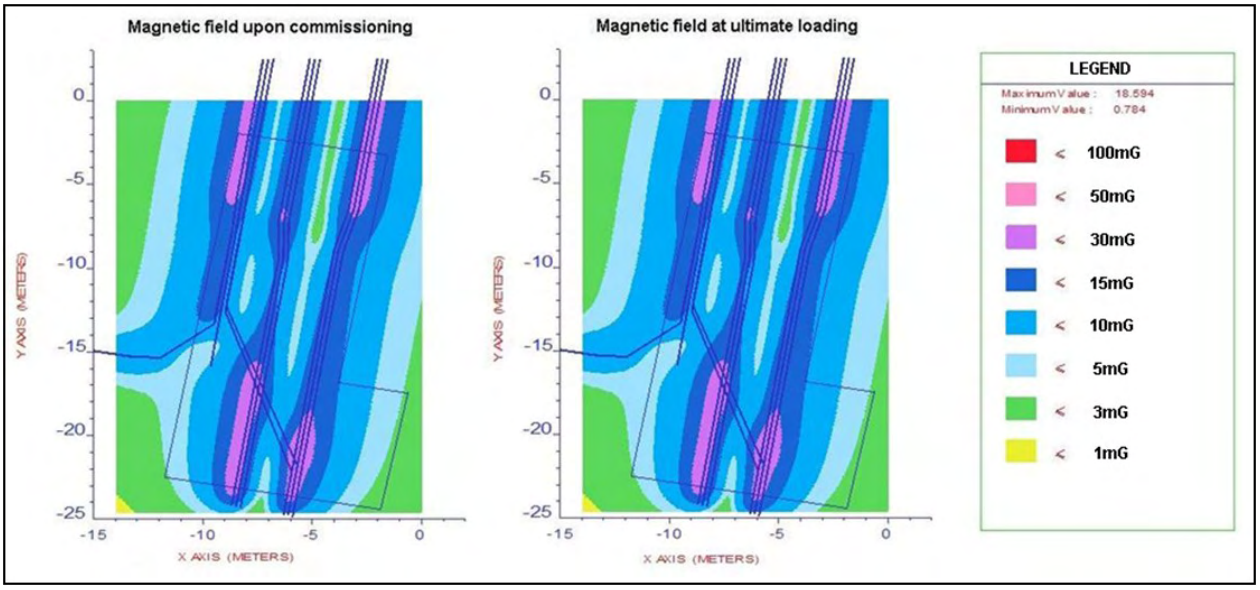
- Western boundary is predicted to be in the range of 20mG to 70mG with two peaks of up to 120mG upon commissioning and three peaks up to 130mG under ultimate conditions. The peaks would be associated with the transformer connections.
- Southern boundary is predicted to be in the range of 5mG to 17mG.
- Eastern boundary is predicted to be in the range of 6mG to 10mG and 5mG to 16mG under ultimate conditions. It is predicted there would be two peaks of up to 35mG upon commissioning and up to 41mG under ultimate conditions. The peaks would be associated with the eastern cable riser. For the initial condition it is predicted there would also be a peak of around 45mG near the southern end primarily due to the 11kV temporary cables.

In summary, the highest magnetic field levels at and beyond the substation boundary are predicted to occur along the western boundaries near the transformer connections. However, the highest calculated fields would still comply with the relevant health standard of 1000mG.

Proposed 11kV cable vault

The magnetic field levels associated with the 11kV cable vault that would be constructed below Ward Street are predicted to be comparable at initial commissioning and at ultimate loading. The peak magnetic field directly above the feeders is predicted to be approximately 18mG under initial loading and 19mG under ultimate loading condition. The cables would be installed at a depth of approximately 2m. The magnetic fields are expected to reduce to less than 10mG at a distance of 2m from the underground cables and less than 5mG at a distance of 5m. These predicted fields would comply with the relevant health standard of 1000mG.

Figure 9-34 – Predicted magnetic field contribution from the proposed 11kV cable vault



Approved proposed neighbouring development

Two residential properties are located on the eastern boundary of the proposed substation (136 and 138-140 Walker Street). The distance between the proposed substation and existing residential properties would mean that the magnetic fields predicted to be associated with the proposed substation would drop off to a low level at the façade of the existing properties. In addition, approval has been granted for a 22 storey mixed use development at 136-140 Walker Street and an 8 storey mixed use development at 144-150 Walker Street. The lower levels of the approved development at 136-140 Walker Street (i.e. to be used for commercial purposes) would abut the proposed substation while the balconies on Level 5 (residential) range between 1.2m and 2.8m from the substation eastern wall.

The dominant influence on the magnetic field environment of the 144-150 Walker Street site would be the 132kV cables traversing Harnett Street to the proposed substation. Assessment for the installation of the 132kV cables would be part of a separate approval and any EMF impact on 144-150 Walker Street associated with the 132kV cables would be assessed at that time. The substation redevelopment project would have negligible contribution and its influence on this site has not been assessed further.

The proposed substation is bound by a small portion of the south western corner of an existing residential property at 142 Walker Street. The magnetic field environment at the property would be influenced by the 132kV cables traversing down Harnett Street to connect with the proposed substation. Under the ultimate loading condtion, the magnetic field would be approximately 12mG at the property boundary and 3-4mG at the building facade.

Magnetic field profiles along the external surfaces of the western walls of the proposed mixed use development at 136-140 Walker Street have been calculated as follows:

- One metre above floor level on Level 2 (commercial)
- One metre above floor level on Level 3 (pool and amenities)
- One metre above floor level on Level 4 (commercial)
- One metre above floor level on Level 5 (residential)

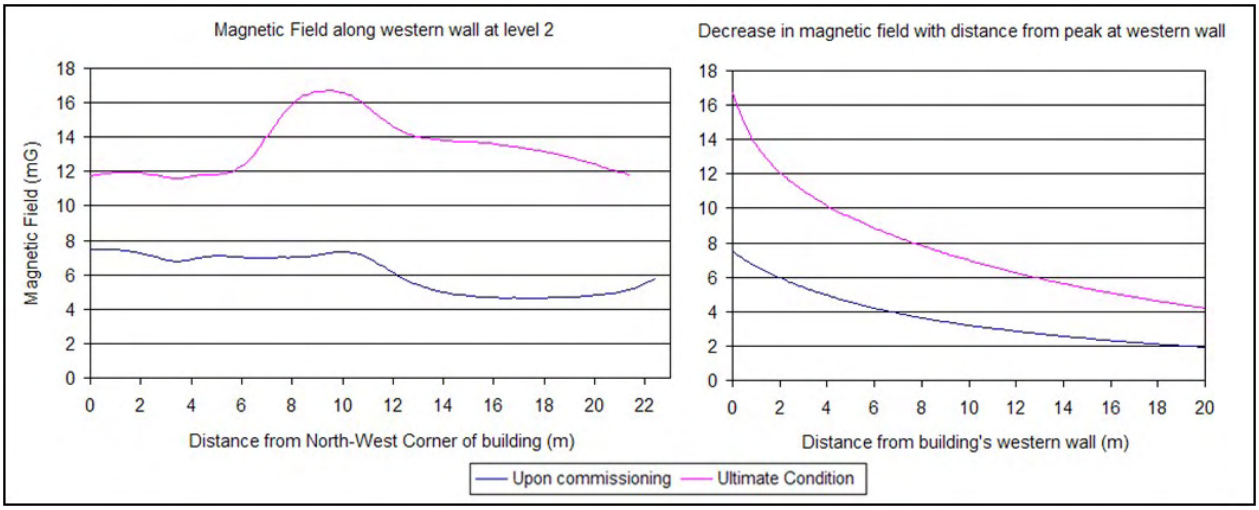
Magnetic field levels would continue to decrease with distance from the source and as such profiles have not been calculated above Level 5.

The highest magnetic field levels along the outside western wall of the proposed development are predicted to occur at Level 2 in the range of 4mG to 8mG at commissioning and between 11mG and 17mG at the ultimate loading condition.

The highest magnetic fields at the residential levels of the proposed development is predicted to be highest at Level 5 where the magnetic fields are predicted to be in the range of 3mG to 4mG under the initial condition and between 6mG and 9mG under the ultimate loading condition.

The contribution of the substation to the magnetic fields beyond the western wall of the proposed development (i.e. inside the development) would reduce with distance from the wall. At 10m from the western wall, the peak magnetic field is predicted to be 3mG under the initial condition and 7mG under the ultimate loading condition.

Figure 9-35 – Predicted magnetic field contribution at Level 2 of the proposed mixed use development (commercial level)



In summary, following commissioning and at ultimate loading there would be localised areas of higher magnetic field levels outside the substation boundary in the vicinity of the transformers (western boundary) and the underground feeders, and above the cable vault. However, these intermittent fields on the western boundary would be experienced for short periods of time when the substation is at peak load. As such the fields can be considered analogous to those we experience in everyday life. To put this into perspective, the Energy Networks Association has published a series of typical magnetic field levels associated with various household appliances at normal user distance. These are listed in Table 9-13. It can be seen that fields along most of the boundaries of the substation are predicted to be within the range normally encountered in everyday life. The highest calculated fields are predicted to be higher than this range, but still below the relevant health limits (1000mG). As such, the predicted magnetic field levels associated with the substation would comply with the numerical health standards.

Table 9-13 – Magnetic field levels associated with appliances

APPLIANCE	TYPICAL MEASUREMENT (mG)	RANGE OF MEASUREMENTS (mG)
Stove	6	2-30
Computer	5	2-20
Television	1	0.2-2
Electric blanket	20	5-30
Hair dryer	25	10-70
Refrigerator	2	2-5
Toaster	3	2-10
Kettle	3	2-10
Fan	1	0.2-2

9.4.5 *Mitigation Measures*

Prudent avoidance

Given the inconclusive nature of the science associated with electric and magnetic fields it is considered that an approach of prudent avoidance continues to be the most appropriate response. EnergyAustralia has considered and incorporated prudent avoidance measures in the design of the proposed substation to reduce the magnetic field levels at the property boundaries, including the following:

- Openly shared information regarding the EMF health issue and the proposed substation.
- Incorporating compact, indoor switch gear into the design, resulting in reduced magnetic fields when compared with larger but less expensive outdoor facilities.
- Reviewing the location of the 132kV cable risers and making design modifications following release of EMF study findings thus resulting in a significant reduction in the magnetic fields at the eastern boundary.
- Reviewing the location of the 11kV temporary cables (routed from the existing substation and in operation until the 33kV feeders into the substation are fully decommissioned) and making design modifications resulting in a significant reduction in the magnetic fields at the southern end of the eastern boundary.
- Reviewing the orientation of the transformers with a view to further reducing the EMF levels along the western boundary near the transformer connections. Following detailed review, the selected orientation was judged to represent the most practicable option, having regard to its impact on the positioning of other EMF sources and various space constraints.
- Positioning equipment that produces high magnetic field levels furthest from sensitive sites. This includes:
  - Capacitor banks with air-core reactors which are located near the centre and roof of the building.
  - Air insulated busbars which are located on the third level away from the residential properties.
  - Transformers with air insulated terminations which are positioned near Ward Street, away from residential and commercial properties.
  - High capacity 11 kV cables which are located in the cable riser at the centre of the building.
- Placing lower voltage equipment furthest from sensitive sites since the current and therefore magnetic fields surrounding the equipment are higher. The 132kV GIS bus, which produces low EMF levels has been located near the proposed mixed use development, while the 11kV switchgear and transformer terminations which produce high EMF levels are located near Ward Street.
- Arranging cables by feeder in a trefoil configuration to provide maximum magnetic field cancellation and thereby lower the magnetic field levels at the property boundaries.
- Based on the prudent avoidance measures outlined above the substation design is consistent with the principles of prudent avoidance.

9.5 Traffic and Access

9.5.1 Existing Environment

The Existing Road Network in North Sydney

The existing road network in the vicinity of the project site includes both State and local roads. Figure 1-1 and Figure 1-2 display the road network in the vicinity of the project site.

Berry Street is a one-way arterial road running east to west between the Pacific Highway and the Warringah Freeway on the southern side of the existing substation. It links the Pacific Highway to the Sydney Harbour Bridge (Bradfield Highway) and the Sydney Harbour Tunnel and is one of the main road thoroughfares between suburbs in Sydney's Lower North Shore and the CBD. It has two traffic lanes and two parking lanes (one on each side). Clearway restrictions exist during peak hours (6am to10am and 3pm to 7pm, Monday to Friday). There is a speed limit of 40 km/h due to high pedestrian activity. Berry Street is classified as a State road between the Pacific Highway and Warringah Freeway, meaning that the RTA has been delegated control, maintenance and management responsibility for the road.

Ward Street is a local road running north from Berry Street and forms the western boundary of the existing and proposed substations. It is a short two-way cul-de-sac of approximately 100 m in length that is closed at its northern end. Ward Street primarily provides access to the Council-owned carpark (leased by Wilson Parking) at 201 Miller Street. Pedestrians also utilise Ward Street to access the carpark and commercial properties located to the north of the carpark.

Harnett Street is a short two-way cul-de-sac that is closed at its southern end and is approximately six metres wide. Harnett Street provides access to the carpark of the commercial building on the corner of McLaren and Harnett Streets on the western side and two residential properties on the eastern side. It would provide the sole vehicle access and egress point during the operation of the proposed substation. Metered parking is installed on the western side while the eastern side is signposted as "No Parking".

Harnett Street intersects McLaren Street at its northern end. McLaren Street is a local road that connects the Pacific Highway and Walker Street. It is approximately 11 m wide and has two traffic lanes and two parking lanes (one on each side). The speed limit is 40km/h. Parking restrictions (metered parking) exist on both sides of the street. McLaren Street forms a T-intersection with both Harnett Street and with Walker Street. McLaren Street also provides pedestrian facilities with sealed footpaths on both sides of the road.

Walker Street forms a T-intersection with McLaren Street and has a speed limit is 40km/h. South of McLaren Street it has two traffic lanes and one parking lane. Parking is restricted to one hour or two hours metered parking.

Ward, McLaren, Harnett and Walker Streets are under the care, control and management of North Sydney Council.

Traffic Volumes in North Sydney

North Sydney is a residential and commercial hub with high density residential and commercial office buildings. There are approximately 51,000 workers and 62,000 residents in the North Sydney region who travel to and from, and around the area per day.

The most recent traffic data that is available from the RTA for the study area was collected in 2005. This data shows that the Annual Average Daily Traffic (AADT) was 16,517 vehicles per day at the intersection of Berry Street and Miller Street (RTA, 2005). CFE Information Technologies collected traffic data on Berry Street in November 2008. This data shows that the AADT in 2008 had increased to 19,234 vehicles per day on Berry Street between Miller Street and the Warringah Freeway (CFE, 2008). This equates to an increase of approximately 16 per cent.

Peak morning traffic movements occur between 6am and 10am with the afternoon peak volume occurring between 3pm and 7pm. Any impacts to the road network in the study area are quickly amplified with the high volumes of traffic which utilise the road network daily.

Peak hour vehicular traffic volumes in North Sydney were collected by the RTA in 2002. Table 9-14 shows combined morning and afternoon peak hour traffic volumes along Miller, Walker and Berry Streets in 2002.

Table 9-14 – Peak Hour Traffic Volumes

STREET AND SECTION	TOTAL TRAFFIC VOLUME (COMBINED MORNING AND AFTERNOON PEAK)
Miller Street	
Between Pacific Highway and Berry Street	1,320
Between Berry Street and McLaren Street	1,355
Walker Street	
Between Pacific Highway and Mount Street	1,170
Between Mount Street and Berry Street	1,090
Between Berry Street and McLaren Street	760
Berry Street	
Between Pacific Highway and Miller Street	1,520
Between Miller Street and Walker Street	1,750
Between Walker Street and Arthur Street	2,365

Source: URaP – TTW, 2005

Peak hour traffic volumes were also collected by CFE Information Technologies in November 2008. Combined morning and afternoon peak hour traffic volumes increased to 2650 on Berry Street between Miller Street and the Warringah Freeway (CFE, 2008). This equates to an increase of approximately 12 per cent from 2002 to 2008.

Berry Street carries the largest number of vehicles of the roads in the vicinity of the project with traffic continually increasing between the Pacific Highway and Arthur Street. All traffic from Berry Street flows onto Arthur Street which provides access between Berry Street and the Warringah Freeway. Traffic volumes on Miller Street are fairly consistent between the Pacific Highway and McLaren Street. Traffic volumes on Walker Street are higher between the Pacific Highway and Berry Street and decrease between Berry Street and McLaren Street. This is consistent with traffic volumes on Berry Street and shows that approximately 30 per cent of vehicles travelling along Walker Street turn on to Berry Street to access the Warringah Freeway.

9.5.2 Potential Impacts

Potential traffic and access impacts may arise during the construction, demolition and operational phases of the project. Impacts may be associated with additional heavy and light vehicles travelling to and from the project site, with road closures during construction and installation of the cable vault and conduits. There would also be potential temporary impacts to pedestrians, cyclists and public transport as a result of changed traffic conditions associated with the project.

Vehicular Access to the Project Site during Construction

The construction and demolition phases of the project may impact on the existing traffic flows on roads in close proximity to the project site such as Harnett, McLaren and Walker Streets. In order to minimise this impact, work areas would be isolated, work would be scheduled to keep road user delays to a minimum and access to businesses and residences would be maintained.

Both heavy and light vehicles would need to access the area to transport materials, equipment and people to and from the site. During peak construction, the workforce on-site would be a maximum of 60 workers per day which would equate to a maximum of 100-120 work trips per day. However, given the proximity of the site to both rail and bus transport and the general lack of affordable parking, the majority of the site labour force would use public transport to get to and from the site which would greatly reduce the number of vehicles generated daily. Therefore, the impact on existing traffic flows associated with construction personnel accessing the site in North Sydney would be low.

Construction Vehicle Access to the Proposed Substation Site

During the construction of the new substation, approximately 25 delivery vehicles per day would access the site via Harnett Street. Trucks travelling from the north towards the project site would utilise the Warringah Freeway (southbound) and exit at either Falcon Street or Alfred Street. From Falcon Street trucks would turn left onto Miller Street, left into McLaren Street and right onto Harnett Street. From Alfred Street trucks would go around the Alfred Street roundabout turn right onto High Street then merge into the Pacific Highway. From the highway they would turn right into Walker Street, left into McLaren Street and then left into Harnett Street.

Trucks approaching the site from the south would utilise the Warringah Freeway (northbound) and exit at the Pacific Highway. From the Pacific Highway they would turn right into Miller Street or Walker Street. From Miller Street trucks would turn right into McLaren Street and right into Harnett Street. From Walker Street trucks would turn left into McLaren Street and left into Harnett Street.

As Harnett Street is narrow and the width of the project site is limited, trucks would not be able to turn around on the site. It is therefore necessary for trucks approaching the site via McLaren Street to reverse into Harnett Street which would allow them to exit the site in a forward direction.

Trucks exiting the site to the north would turn left onto McLaren Street, left onto Miller Street, left onto Berry Street and left onto the Warringah Freeway. Trucks exiting the site to the south would turn left onto McLaren Street, left into Miller Street, left into Berry Street and right onto the Warringah Freeway.

The largest impact to traffic flow would be likely to occur on Walker Street and Miller Street. However, given that there would be an average of 50 trips per day spread across both of these streets, the number of construction vehicles accessing these streets in comparison to the average traffic volumes displayed in Table 9-14 would be low.

Construction Vehicle Access to the Cable Vault and Cable Trenches

During excavation and construction of the cable vault, approximately 10 vehicles per night would access the site via Berry and Ward Streets. Trucks approaching from the north would utilise the Warringah Freeway (southbound) and exit at Falcon Street. They would turn left onto the Pacific Highway, left into Berry Street and left into Ward Street. Trucks approaching from the south would utilise the Warringah Freeway (northbound) and exit at the Pacific Highway. They would then turn right onto Berry Street and left into Ward Street.

Trucks exiting the site would turn left into Berry Street from Ward Street and at the end of Berry Street would turn left onto the Warringah Freeway to head north and right onto the Warringah Freeway to head south.

Given that the cable vault works would occur during the night, the impact to traffic flow on Berry Street would be low. As discussed below, night time work is required as the construction of the cable vault would require the partial closure of Berry Street and Ward Street.

Construction Vehicle Access during Demolition of the Existing Substation

During the demolition of the existing substation, approximately 10 vehicles per day would access the project site via Berry Street. Trucks would likely approach and exit the site via the same routes as those approaching the cable vault site. Trucks would utilise the internal driveway of the existing substation for loading and unloading.

While Berry Street has a higher traffic volume that Walker Street and Miller Street, the impact would be lower given that there would only be 20 construction vehicle trips per day utilising Berry Street during the demolition. This small number of vehicles would have very little impact on the existing traffic volume on Berry Street and therefore the impact on traffic flow would be minimal.

In summary, during the excavation, construction and demolition phases of the project, there may be a small impact on local traffic flow due to light and heavy delivery vehicle movements, particularly if these vehicles and trucks were to access the site during morning and afternoon peak periods. However, the potential number of trucks that would be generated during the construction works would be low compared to the total volume of traffic in North Sydney. Therefore the impact of the project on traffic operation in North Sydney would be low.

Vehicular Access to the Proposed Substation during Operation

Once the substation is operational, EnergyAustralia technicians and contractors would access the site when required for maintenance and servicing purposes. There would be approximately 550 operation and maintenance visits to the site per year. This equates to less than two visits to the substation per day. Therefore, once operational, the impact of the substation on local traffic flow would be minimal.

During operation, access to the substation would be via a locked roller door accessed from Harnett Street, leading to the concrete transformer roadway on Level 2 of the substation building. No regular deliveries would be expected, however access for maintenance vehicles would be required. Given the operation and maintenance vehicles would park within the substation, access impacts to Harnett Street would be low and it is unlikely that existing parking arrangements would be affected.

Road Closures

A portion of the road corridor at the intersection of Berry Street and Ward Street would need to be excavated for the construction of the cable vault. It is expected that a 17 m by 8 m by 3 m deep excavation would be required for this construction. This would equate to the closure of two lanes on the northern side of Berry Street and one lane in Ward Street.

The installation of conduits in Ward Street would occur in three separate trenches across the width of the street. The excavation of these trenches and installation of the conduits would require the closure of Ward Street, limiting access to the Wilson Parking carpark. The excavation and installation would be undertaken in a progressive manner and would occur in six to 12 m sections to minimise disruption to traffic.

Due to the high traffic volumes that utilise Berry Street and the potentially significant delays that this work would cause if undertaken during peak periods, night and weekend work would be necessary for this aspect of the work. This work would be undertaken over a period of approximately six months.

Night and weekend work would ensure that construction of the cable vault and conduits would not compromise road capacity or disturb traffic flows. It would also enable access to Ward Street, the Wilson Parking carpark and the loading dock at 66 Berry Street to be maintained during day time hours. Any loss of access during night works would be negotiated with Wilson Parking and 66 Berry Street. Access to residential properties would be maintained at all times. Specific mitigation measures would be included within the relevant traffic management plans and would include a team of licensed traffic controllers directing and controlling traffic movements, where required. Skid resistant road plates would be placed over the cable vault and trenches outside of the permitted working hours to enable traffic to flow unimpeded.

Impacts on Pedestrians, Cyclists and Public Transport

The North Sydney CBD has high pedestrian activity on the footpath and on pedestrian crossings across the road network. Bicycle facilities in the North Sydney CBD predominantly consist of on-road cycle paths.

The existing pedestrian facilities and access for residents in Harnett Street would be maintained. Where access to pedestrian facilities would be disrupted during construction, such as in Ward Street and on the northern side of Berry Street, traffic and pedestrian management measures would be implemented. Ward Street would become a shared zone throughout the construction. The footpath on the northern side of Berry Street would require closure between Miller Street and Walker Street during times when works are being carried out. Pedestrians would be directed by signage to use the footpath on the southern side of the street. Pedestrian and cyclist access to Berry Street, Ward Street and Harnett Street would be reinstated once the new substation is operational.

There are no bus stops located within areas where traffic control would be required and it is therefore unlikely that bus routes would be affected.

9.5.3 Mitigation Measures

Construction and demolition activities have been sequenced to maximise the safety of workers and road users, maintain the existing capacity of the road network, minimise road user delays and avoid major in-road activities during peak periods.

Traffic management and road works would be carried out in accordance with RTA requirements, including limiting road occupancy to specific hours and days. Various plans and documents would be prepared and submitted to the RTA including a Road Occupancy Licence (for the works in Berry Street), TMPs, and the relevant TCPs for specific traffic control measures. TMPs would be provided to North Sydney Council for work in Ward and Harnett Streets.

TMPs would be prepared as part of the CEMP for the construction of the substation and the excavation and construction of the cable vault and trenches.

TCPs would be developed as part of the TMPs prepared for the project. They would be prepared in accordance with AS1742.3 and the RTA's *Traffic Control at Worksites* manual and aim to:

- Warn drivers of changes to road conditions,
- Inform drivers about changed conditions,
- Guide drivers through the work site, and
- Maintain safety for workers, motorists, pedestrians and cyclists.

TCPs would be prepared for:

- Traffic management for construction access via Harnett Street.
- Traffic management during construction of the cable vault at the intersection of Ward and Berry Streets.

The TCP for Harnett Street would relate to trucks reversing into Harnett Street from McLaren Street and includes the following management measures:

- Accredited traffic controllers (one for each direction) would stop traffic in both directions in McLaren Street when a truck is entering or exiting Harnett Street.
- When a truck is reversing into Harnett Street, barrier boards would be used to close the footpath on the southern side of McLaren Street and on both sides of Harnett Street to control pedestrian movements.
- A spotter would be located at the exit of the driveway to 41 McLaren Street in order to provide guidance to exiting vehicles with regards to when a truck is reversing into Harnett Street.

The TCP for Berry and Ward Streets would provide management measures during road closures and for trucks accessing Ward Street. These measures would include:

- Accredited traffic controllers would direct traffic into and out of Ward Street.
- Accredited traffic controllers would direct traffic adjacent to the closed section of Berry Street when a truck is required to reverse into Ward Street.
- Advanced warning signs would be installed in Berry Street and Miller Street (on both the northern and southern approaches to Berry Street) to warn drivers of changed traffic conditions.
- Pedestrian warning signs would be installed on the northern footpath at the intersections of Berry Street and both Miller Street and Walker Street to warn pedestrians of the footpath closure. Both of these intersections are signalised and pedestrians would be directed to cross to the footpath on the southern side.

The TMPs would also include provision for contingency plans, environmental controls and consultation and communications.

Contingency plans would be developed for all traffic control operations and would be incorporated into the various Safe Work Method Statements (SWMS). Incidents may include:

- Excessive traffic congestion.
- Late finishing road work.
- Equipment breakdown.

- Poor weather conditions.
- Unplanned incidents.

Consultation and communications procedures would include:

- Residents and commercial organisations would be notified via a letter box drop of upcoming works, including any road works.
- The RTA and key stakeholders would be consulted prior to the implementation of changed traffic conditions, and roadwork information would be disseminated to the community so they can plan their journeys.
- A minimum of two days notice would be provided to any affected residents and businesses regarding changes to property access, parking arrangements or traffic arrangements during the construction period. All community and stakeholder enquiries and complaints would be registered in a community and stakeholder database and would be addressed as required.

Following the completion of all construction and demolition activities:

- All temporary traffic signs would be removed and new permanent signs would be installed, where required.
- Temporary roadways or detour arrangements would be removed and the area would be restored to a condition equivalent to that which existed prior to the commencement of construction.
- Condition reports would be prepared for any public footpaths, kerbs, gutters prior to the commencement of construction and excavation work. Any damage during the works would be restored to the satisfaction of the relevant authority at the contractor's expense.
- Road pavement excavated during the works would be reinstated to the satisfaction of the relevant authority at the contractor's expense.

The implementation of mitigation measures outlined within this chapter would ensure that the risk of impacts and disruptions to traffic and access within North Sydney would be low during the construction and demolition phases of the project. No mitigation measures are proposed for the operational phase of the proposed substation as vehicle movements generated during this phase would be negligible (i.e. limited to approximately two visits per day from operational and maintenance personnel).

9.6 Land Use

An assessment of the land use and property impacts associated with the project has been undertaken and is presented below. The land use impact assessment has been largely informed by the findings of the assessments for the key issues associated with the proposed redevelopment, including those undertaken for urban design, EMF and visual impact.

9.6.1 Existing Environment

The subject site is located within the North Sydney CBD and is within 500m of North Sydney Rail Station and Greenwood Plaza, a major shopping centre in the area. There is a major pedestrian link from the station and Greenwood Plaza that runs from Denison Street to Berry Street, which emerges diagonally opposite Ward Street. North Sydney Oval is approximately 470m to the north of the subject site and Sydney CBD is approximately 4 kilometres to the south.

The subject site has frontages to Berry, Ward and Harnett Streets. Berry Street east provides a one-way access link between the Pacific Highway and the Warringah Freeway, and as such conveys high volumes of vehicular traffic. Ward Street is a small cul-de-sac that intersects with Berry Street east. Ward Street's primary function is to convey vehicular traffic from Berry Street to the Wilson Parking carpark at the end of Ward Street. Visually, Ward Street is seen from Berry Street as a narrow, treeless laneway, terminating in the Wilson Parking carpark building façade. Harnett Street is a small laneway that services a number of residential allotments that address Walker Street, an undercroft carpark on the western side of the street and terminates at the subject site.

Existing North Sydney Zone Substation Site

The existing substation site is legally described as Lots 6, 6A, 7, 7A and 8 in DP 24474 and commonly referred to as 70-74 Berry Street, North Sydney, and has a site area of approximately 969sqm. The site is generally rectangular in shape and is located at the intersection of Berry and Ward Streets, North Sydney. The existing substation site has an approximate frontage of 22m to Berry Street and an approximate frontage of 44 m to Ward Street with an existing vehicle cross-over on Berry Street. The site is located on the northern side of Berry Street, between Walker Street to the east and Ward Street to the west (refer to Figure 9-36). The existing substation was commissioned in 1968 and is considered to be a neutral to detracting structure in relation to the Berry Street streetscape character.

Under NSLEP 2001, the existing substation site is currently zoned as *Special Use – Substation.* The site is surrounded by land located in the Mixed Use Zone, with the exception of land that is directly to the south of the existing substation. Land immediately adjoining the existing substation to the north is 3-11 Ward Street, and a 10 storey commercial building adjoins the land to the east. Immediately to the west of the existing substation site is Ward Street, with another seven storey commercial building and Wilson Parking on the opposite side of Ward Street. The south of the site addresses Berry Street and the land further south is characterised by multi-storey mixed use and commercial development (refer to Figure 9-37).

Figure 9-36 – Existing Substation Site in its Current State

Source: Energy2U, 2010

Figure 9-37 – Surrounding Development Looking South from the Roof of Wilson Parking Carpark

Source: Energy2U, 2010

Proposed North Sydney Zone Substation Site

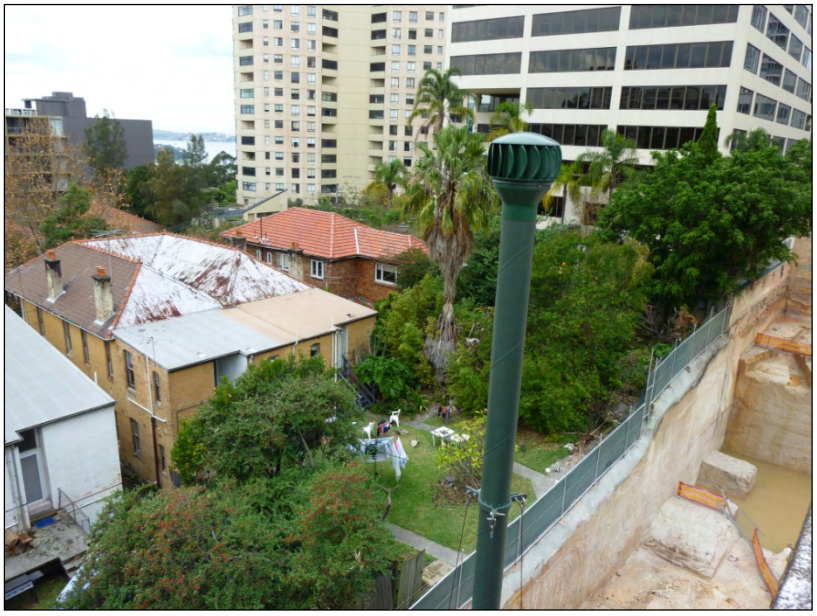
The proposed substation site is legally described as Lots 1, 1A, 2, 2A, 4, 4A and 5 in DP 24474, Lot 5A in DP 225770 and Lot 1 in DP 5933976. It is commonly referred to as 3-11 Ward Street, North Sydney and has an approximate site area of 1200sqm. The site is generally rectangular in shape with an approximate frontage of 55m to Ward Street (west) and an approximate frontage of 6m to Harnett Street (north). The proposed development would limit vehicular access to Harnett Street only. The site is located on the eastern side of Ward Street, between Walker Street to the east and Bullivant Lane and Miller Street to the west. The site is currently vacant (and excavated) as illustrated in Figure 9-38.

Figure 9-38 – View of the Proposed Substation and Existing Substation Sites in the Foreground Surrounded by North Sydney Development Looking South

Source: Energy2U, 2010

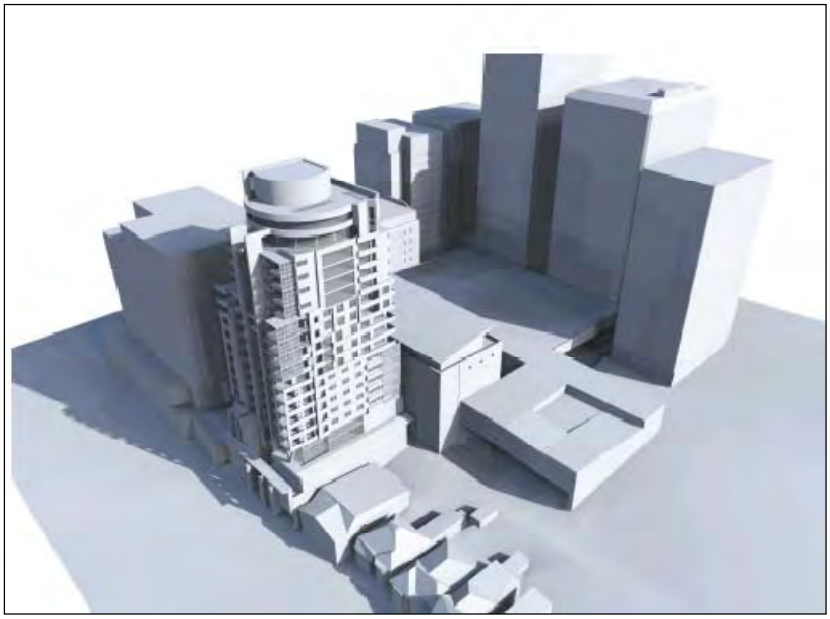
The proposed substation site is located within the North Sydney CBD and as such the site's locality is predominantly characterised by multi-storey commercial and mixed use development (refer to Figure 9-37, Figure 9-38 and Figure 9-39). Under NSLEP 2001, the proposed substation site is currently zoned for Mixed Use purposes. Directly opposite the proposed substation site beyond Ward Street is a Council owned multi-level car park which flanks Ward Street on the western side and wraps around the end of Ward Street to share a common boundary with the proposed substation site. The multi-level car park is adjoined by three commercial buildings to the west (of 13, 23 and 17 storey construction respectively) and one commercial building to the northwest being of 15 storey construction. To the south, the proposed substation site is bounded by the existing substation and to the southeast the site shares a partial boundary with 76 Berry Street, a 10 storey commercial building (People Telecom). The northern section of 76 Berry Street incorporates a small paved courtyard garden and adjoining rooftop garden. Immediately to the east, the proposed substation site adjoins a number of residential properties, including four non-strata units at 136 Walker Street and two strata title blocks at 138-140 Walker Street, with single and two storey dwellings further to the north east. These buildings are currently used for residential purposes however, on 22 October 2008 approval was granted for the construction of a 22 storey mixed use development at 136-140 Walker Street (DA 195/08) (refer to Figure 9-40). On the northern boundary, the proposed substation site has a 6m frontage to Harnett Street and the remainder of the boundary is with the Wilson Parking carpark.

Figure 9-39 – Residential properties (136, 138-140 Walker Street) and commercial building (76 Berry Street) to the south



Source: Energy2U, 2010

Figure 9-40 – Massing Figure Showing the Approved Development at 136-140 Walker Street and Proposed Substation



Source: Energy2U, 2010

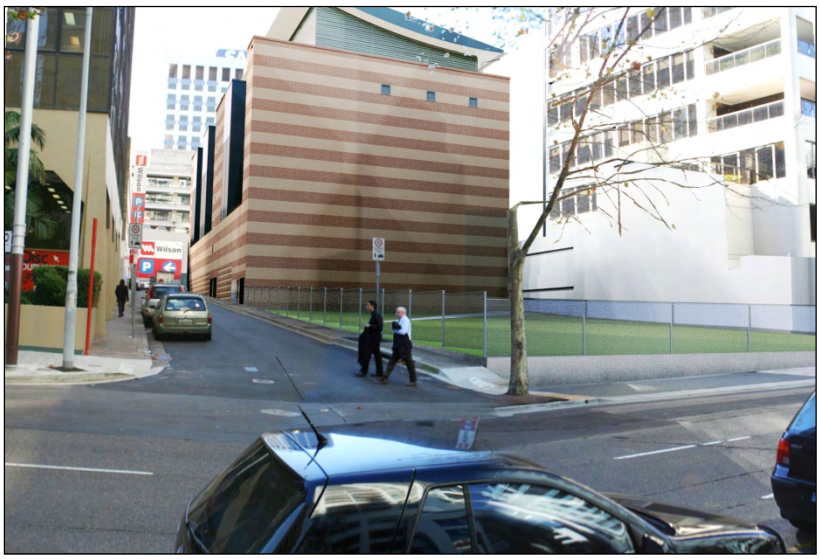
The proposed substation site has been excavated (as part of a separate approval), with the walls and floor of the excavation finished with concrete where required to prevent erosion. A fence runs around the site perimeter for safety and security purposes. Due to the excavation and concrete finishing the site is largely devoid of vegetation (refer to Figure 9-38 and Figure 9-39).

9.6.2 Proposal

Existing North Sydney Zone substation

The works proposed at 70-74 Berry Street are limited to the decommissioning and demolition of the existing substation as well as any requisite remediation works (refer to Section 10.5). Remediation works would be carried out in accordance with relevant Australian Standards (including AS 2601-1991 – The demolition of structures) and an approved RAP. The future use of this particular site has not yet been determined. Therefore, the only work proposed to this site following decommissioning, demolition and remediation is site stabilisation and the installation of fencing to prevent public access to the land (refer to Figure 9-41). In this regard, there would be a limited land use impact on adjoining and surrounding sites at this stage. In addition, the future redevelopment of the land, post 2015, would provide an opportunity to make a marked visual improvement to the Berry Street streetscape and local environs.

Figure 9-41 – Project Site Post Decommissioning, Demolition and Remediation



Source: Kann Finch Group, 2010

Proposed North Sydney Zone Substation

Approval is now sought for the construction and operation of a new North Sydney zone substation. The substation is to be constructed to RL 94.5, which equates to approximately 25 m high above Ward Street and approximately 29 m above Harnett Street at its highest point. The substation structure would be constructed to each boundary, with a minimal setback (approximately 200 mm) to allow the footings to remain within the site boundaries.

The substation has been designed to complement the Federation building style characteristic to the lower North Shore area and includes a horizontally banded cream and red brick facade complemented by anodized aluminium finished louvres and an oblique Colourbond roof (refer to Figure 9-42). The Ward Street elevation has been articulated through inset elements positioned over louvre vents to reduce the perceived bulk, scale and massing of the structure. Minimal external lighting would be provided as maintenance works, replacement of equipment and other essential operative activities would take place wholly inside the building. However, two recessed doorways on the Ward Street elevation would be illuminated at night to discourage antisocial behaviour as well as eliminate entrapment areas.

Figure 9-42 – Photomontage of the Proposed North Sydney Zone Substation (Northern and Western Elevations at the Top and Southern and Eastern elevation at the Bottom)

Source: Kann Finch Group, 2010

9.6.3 Land Use Issues

The proposed works have the potential to generate off-site impacts on surrounding land uses both during construction and operation of the proposed substation.

Land directly to the west of the proposed substation site contains Ward Street, with a Council owned multi-level car park located along the opposite side of Ward Street and wrapping around to the east to share a common boundary at the northern end of the proposed substation site. To the north west of the Council owned car park is a 15 storey commercial building. The location of Ward Street to the west and the car park to the north and west would ensure that land use impacts from the proposed substation are minimised.

The southern boundary of the proposed substation site is bounded by the existing substation at 70-74 Berry Street. The existing substation is to be demolished, with development not currently proposed for the site. Any potential impact on the land would be considered when future development is proposed.

The proposed substation site also shares a partial common boundary with 76 Berry Street, a 10 storey commercial building (People Telecom) to the south east, of which the northern section incorporates a paved courtyard garden and adjoining rooftop garden that extends across the northern boundary of the site, ranging in approximate width from 12 to 18 m. The garden would continue to receive solar access during the morning, with reduced sunlight during the middle of the day and afternoon. However, due to the commercial high rise nature of the area, which is zoned by NSLEP for mixed use, some overshadowing is expected and considered acceptable.

The proposed substation site adjoins four units at 136 Walker Street and two strata title blocks at 138-140 Walker Street immediately to the east. However, the land use to the east of the site is likely to increase significantly in density and scale as a result of approval granted for the construction of the proposed development at 136-140 Walker Street. There is the potential for the proposed substation development to result in impacts on the approved development at 136-140 Walker Street. These potential impacts are addressed below.

Visual Impact

A VIA has been prepared for the proposed substation that considered both visual impact and shadow. The VIA identified five observer locations surrounding the site from which to view the substation development. The locations include:

1. Public plaza, Berry Street (100 m to centre of site)
2. Corner of McLaren and Harnett Streets (120m to centre of site)
3. Middle of Harnett Street (60 m to centre of site)
4. Corner of existing car park, Ward Street (25 m to centre of site)
5. Units in the approved development at 136-140 Walker Street (25m to centre of site)

The observer locations and photomontages illustrating the potential view of the proposed substation are presented in Chapter 9 and Appendix D. The VIA considered that the visual impact from locations 1, 2 and 4 to be low (refer to Chapter 9 for further justification), with the visual impact from location 3 being moderate to high due to the height and proximity of the substation to the residencies at 136 to 140 Walker Street, which would lead to an increase in visual bulk within the streetscape and overshadowing. However, there are a number of mitigating factors including the visual scale of the proposal being in accordance with other low level commercial building in the vicinity, the low number of potential observers and the breaking up of the built form through the alternately coloured rows of bricks and low angled roof. Consequently, subject to mitigation measures implemented in conjunction with the land owners, such as planting, the visual impact is considered to be low to moderate for location 3.

The proposal has the potential to create a high level of impact on observer location 5, which contains the approved development at 136-140 Walker Street and specifically the units on Levels 5 to 7 in the south western corner of the building. However, there is a distinction between units in the north-west corner of the proposed building (unit 3 on each level), which would receive direct sunlight for more than half the day, and the units in the south-west corner (unit 4 on each level). Solar access to the units to the south west would be restricted to between 1 and 1.5 hours direct sunlight at the winter solstice (worst case scenario) (as illustrated by shadow diagrams located at Chapter 9 of this report and Appendix D) and are subject to a significant level of visual bulk due to the proximity of the rear wall of the proposed substation.

The shadow diagrams indicate that the proposed substation does not begin to cast shadow on the proposed neighbouring development at 136-140 Walker Street until 11.30am, at which time, only commercial components of the proposed development are affected, as these are located from Ground to Level 4, with residences located on Level 5 (RL 79) and above. The proposed substation casts shadows onto the residential component of the neighbouring development at 136-140 Walker Street between the hours of 12noon and 3pm. Units 3 and 4 on Levels 5 to 8 only are affected to differing degrees during this time.

The south-western facing units on Levels 8 and 9 are subject to considerably less visual impact than those on Levels 5 to 7 due to the larger substation setbacks and with the units on Level 9 being located above the proposed substation. These units would not therefore be impacted by overshadowing, and would have views beyond the roof to the North Sydney skyline.

In order to minimise impacts on the approved development a number of mitigation measures have been incorporated into the design through extensive discussion with the developer that have included input from North Sydney Council's Design Excellence Panel. Mitigation measures include the use of a visually modulated form through the banding of bricks and the use of metal louvres as well as a low angled roof to reduce bulk. Additionally, it is noted that the proposed substation development creates a significantly reduced bulk comparatively to a development constructed in accordance with the provisions of NSDCP 2002. Consequently, following detailed negotiations with the neighbouring landowner, and through consideration of North Sydney Council guidelines, the proposal's design has incorporated the full extent of mitigation measures that could potentially be utilised.

Mitigation Measures

Mitigation measures for observer location 3 would need to be undertaken in consultation with the property owners and include:

- Planting of a select suite of tree and shrub species to the rear garden spaces of 136-140 Walker Street has the potential to substantially reduce the visual impact of the proposed substation from these dwellings, through reduction in the visible area of the wall, and provision of an attractive detailed focal point within the rear garden space.
- Providing a replacement vegetation canopy cover, within the garden of 76 Berry Street that would be suited to the increased level of overshadowing from the proposed substation.

Electric and Magnetic Fields

The EMF contribution expected from the proposed substation and its underground feeders has been assessed (as part of the previous REF approval process) and verified by an independent study including modelling undertaken by Aurecon. The model illustrated that the highest levels of EMF (in excess of 1000mG) are confined to within the substation immediately adjacent to the transformers. The fields across the bulk of the remainder of the site under average load conditions are predicted to be less than 50mG with the exception of three locations along the western boundary, near each of the transformer connections that are predicted to be 120mG upon commissioning and 130mG under ultimate loading conditions. These peaks would drop off rapidly with distance.

The EMF levels at the boundary of the approved proposed development at 136-140 Walker Street were also plotted taking the location of residences into consideration (refer to Chapter 9 and Appendix H for details of model parameters). The contribution of the proposed substation to the magnetic fields in the development is predicted to be highest on Level 2 (commercial use). The peak EMF level at the outer wall of this level is predicted to be in the range of 4mG to 8mG under initial conditions and between 11mG and 17mG under the ultimate loading condition. The contribution of the proposed substation at the residential levels (5 and above) is predicted to be highest on level 5. At 1m above this level, the magnetic fields are predicted to be in the range of 3mG to 4mG under the initial condition and between 6mG and 9mG under the ultimate loading condition.

The EMF Assessment illustrates that there would be localised areas of higher EMF levels outside the substation boundary. However, the EMF under normal load conditions along most of the boundaries of the substation would be within the range normally encountered in everyday life as illustrated in Table 2 of the EMF Assessment located at Appendix H.

At the highest predicted level, EMF levels would be greater than encountered in day to day life, however, they are less than 15 per cent of the reference level in the relevant health guideline for the general public (refer to Chapter 9 for guideline details). Consequently, it is considered that the EMF levels generated by the substation would not significantly impact on surrounding land uses.

Mitigation Measures

The substation has been designed to incorporate a number of prudent avoidance measures to reduce the potential for magnetic fields. These include selection of compact indoor switchgear, and careful siting of the 132kV cable risers and temporary 11kV cables.

Residential amenity

A study to assess the urban design impacts of the proposed substation on 136-140 Walker Street has been prepared (refer Appendix E). The study assesses the potential urban design impacts in the context of:

- The SEPP 65 design principles; and
- A building constructed on the proposed substation site in accordance with the North Sydney DCP 2002 (NSDCP 2002).

The SEPP 65 assessment concluded that the proposal was consistent with the SEPP 65 provisions. However, the assessment did not consider future redevelopment of properties located at the proposed substation site and the subsequent impact on the approved development at 136-140 Walker Street, nor the resulting impact on the performance of the approved development under the provisions of SEPP 65.

The Urban Design study found the scale of the proposed substation design to be modest compared to the scale of a building enveloped allowed by NSDCP 2002 and at a height of RL 94.5m is substantially lower than the permissible RL 111m to RL 125m for the proposed substation site. The 3D model developed to illustrate the potential bulk and scale of a building demonstrated that a potential (hypothetical) building envelope consistent with the NSDCP 2002 would have overshadowed 40 per cent more of the approved development's western elevation than the proposed substation. Consequently, it is considered that the proposed substation may be regarded as an under development of the site, creating less of an impact on the approved development at 136-140 Walker Street and the surrounding land uses than could occur within the applicable design guidelines. Furthermore, despite the overshadowing impacts, the proposed mixed use development still complies with the requirement in the *Residential Flat Design Code* that at least 70 per cent of apartments in a development should receive a minimum of three hours direct sunlight between 9am and 3pm in mid winter (and two hours in dense urban areas).

The proposed substation would be constructed to the site boundary in order to satisfy the technical requirements and the configuration of the electrical equipment, which does not allow the eastern wall to be articulated. However, the impact of the bulk of the building on the remaining elevations is minimised through appropriate articulation.

In relation to visual privacy it is noted that the substation does not provide any openings on the eastern elevation. Accordingly, there is no potential to overlook the approved development's living areas or balconies located on its western elevation. Therefore there are no impacts in relation to visual privacy.

The eight west facing units between Levels 5 and 8 of the approved development would be impacted by way of visual bulk due to their proximity to the substation's eastern elevation. The potential visual bulk impact has been mitigated by adding visual interest to the wall through bands of light and cream bricks and a skillion metal roof that can be seen from Levels 8 and above. The impact of the substations bulk would have been further reduced if the approved development at 136-140 Walker Street had not been designed with a reduced western boundary setback of 4.835 m as opposed to the NSDCP requirement for a 6.5 m setback. The increased western boundary setback would have also assisted cross ventilation.

The substation design has incorporated appropriate design measures to respond to the site context and to help blend into the existing character of the North Sydney CBD and would not impact on streetscape character due to its appropriate scale, built form and aesthetics. The proposed substation does create some impacts on the approved development at 136-140 Walker Street in relation to SEPP 65 criteria including overshadowing and visual bulk. However, it is considered that the substation design is appropriate and with suitable mitigation measures as discussed above the proposed substation's minor urban design impacts to the approved development at 136-140 Walker Street are acceptable.

9.6.4 Conclusion

A number of specialist investigations have been undertaken to ascertain the extent if any of the construction and operational impacts of the proposed substation on surrounding land uses. The specialist investigations found that the urban design and visual impacts on land uses to the north, south and west were low. However, there were potential impacts to the east on both the rear of dwellings adjoining Harnett Street, the garden area in the northern section of 76 Berry Street and the approved development at 136-140 Walker Street.

The visual impact on the rear of dwellings on Harnett Street (location 3) would be low to moderate subject to mitigation measures implemented in conjunction with the land owners. Although, the proposal has the potential to create a higher level of impact on the approved development at 136-140 Walker Street and specifically the units on Levels 5 to 7 in the south western corner of the building. The VIA is supported by the Urban Design study, which concludes that overshadowing and visual bulk impacts would be created. However, the substation design is appropriate in the urban commercial and residential built environment in which it is located and the scale of the building is modest compared with the building envelope allowed by NSDCP 2002.

Other potential impacts including noise, EMF and traffic generation during construction and operation of the proposed substation have been assessed and are not considered to inhibit surrounding land uses through the implementation of appropriate mitigation measures as detailed in Chapter 9 of the EA. Based on the specialist investigations undertaken it is considered that while there would be some impact on the amenity of surrounding land uses, primarily the approved development at 136-140 Walker Street, the design limits impacts as far as possible. Consequently, the design ensures that the proposed substation is compatible with surrounding land uses and would not create a significant impact.