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(This is to replace the Report No. 210505)

Electromagnetic Field Survey Assessment of New Liverpool Public School

for

ADCO Construction
Level 2, 7-9 West Street, North Sydney NSW 2060

Dr. Yu Ji

PhD MSc (Elect) SMIEEE

Signed:  9th June 2021

Geoffrey Garrett *BE (Elect) Hons.*
Signatory of NATA Accredited Reports

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APPLICABLE DOCUMENTS

[1] International Commission on Non-Ionizing Radiation Protection (ICNIRP): Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz - 100 kHz). Published in: Health Physics 99(6):818-836; 2010.

[2] RHS30 (Radiation Health Series 30), Interim Guidelines on Limits of Exposure to 50/60 Hz Electric & Magnetic Fields (1989), Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Cancelled 2015.

[3] IEEE Std 644 (1994) - IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields From AC Power Lines. Reaffirmed 27 March 2008.

[4] Report of the NRPB Advisory Group on Non-Ionising Radiation. "Power Frequency Electromagnetic Fields and the Risk of Cancer" 6 March 2001.

*Note: * The finding by the UK NRPB is of a possible doubling of the risk of leukaemia in children when exposed to a power frequency magnetic field of greater than 0.4 microtesla. The NRPB (Doll) report concluded that from a review of studies conducted in a residential environment "the possibility remains that high and prolonged time-weighted average exposure to power frequency magnetic fields can increase the risk of leukaemia in children". The report considered studies based on residential exposure. This finding has yet to be scientifically replicated and cause and effect established.*

[5] RPS3 (Radiation Protection Standard 3), Maximum Exposure Levels to Radio-Frequency Fields – 3 kHz to 300 GHz (2002), National Health and Medical Research Council.

[6] AS/NZS 2772.2:2016 + Amt:2018 - Principles and methods of measurement – Radio frequency fields 3 kHz to 300 GHz.

[7] AS 2344:2016: Limits of electromagnetic interference from overhead A.C. powerlines and high voltage equipment installations in frequency range 0.15 MHz to 3000 MHz, 2016.

1. INTRODUCTION

New Liverpool Public School is proposed for development at the corner of Burnside Drive and Lachlan Street, Liverpool, NSW, where there is currently a large playing field for the Liverpool Boy's and Liverpool Girl's High Schools. The property for the new public school is located adjacent to the Sydney Trains railway line with nearby traction electrical substation, high voltage (HV) overhead (OH) powerline, and a radiocommunications tower (refer Figure 1, Photos 1 & 2 of the Appendix).

As the proposed public school is in proximity to the railway line with traction electrical substation, HV OH power line and radiocommunications tower, an electromagnetic field exposure assessment report is required for assuring health and safety of occupants within the proposed school development. The electromagnetic field impact will be assessed, in particular due to the adjacent railway lines with nearby traction substation, HV OH powerline, and radiocommunications tower, and also due to the power-frequency and radio-frequency emissions in the general area.

An electromagnetic field survey was conducted at the proposed school site to investigate the health and safety exposure concerns, and to assess the electromagnetic field environment. Compliance with the relevant OH&S & interference standards / requirements will be determined. This report includes the measurement results of the survey, assesses the impact of the electromagnetic field emissions, assesses for compliance and provides a recommendation.

2. REQUIREMENTS

The requirements of the electromagnetic field exposure assessment are described in the points below:

1) Review the provided building development plans for electromagnetic field issues.
2) Power-frequency electromagnetic field (EMF) level measurements will be taken at selected locations over the site, and with distance away from the railway line.
3) RF broadband electric field measurements of the accumulative field level in bandwidths of 100 kHz to 3 GHz, and 10 MHz to 60 GHz, will be taken at selected locations over the site, including with incremental height up to the level 2 floor building height.
4) RF narrowband measurements containing magnitude and frequency information will be recorded.
5) Conduct radio frequency (RF) measurements to AS/NZS 2344 (applicable to the railway overhead power lines, substation and catenary) with regard to the interference impact on wireless receiver equipment that may be used at the school.
6) Results of test indicating the measured levels and their status in relation to the applicable standards and regulations.
7) Predict by extrapolation of the measurements the maximum power-frequency magnetic field levels expected from the railway with increased power loading.
8) Establish the margin of compliance with the ELF EMF ICNIRP Guideline and the RPS 3 standard required by ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) and application of the precautionary principle / prudent avoidance (ALARA).
9) Establish the margin of compliance with the AS/NZS 61000.6.1 interference immunity limit applicable to general electronic equipment for use in residential / light industrial environments.
10) Establish the margin of compliance of the radiated emissions with the interference limits/requirements of AS/NZS 2344 applicable to wireless receivers.
11) Establish the boundary of any areas exceeding the above limits (if any).

3. APPLICABLE HUMAN EXPOSURE REFERENCE VALUES AND LIMITS

3.1 Reference Values of Exposure for Humans - Power Frequency Electromagnetic Fields

Recently an ICNIRP (International Commission on Non-Ionizing Radiation Protection) guideline [1] has replaced ARPANSA RHS 30 [2], and the power frequency electric and magnetic field exposure reference values set by ICNIRP applicable to human health are summarized in the table below:

Table 1. Reference Values of Human Exposure to 50/60 Hz Time-Varying Electric & Magnetic Fields

Exposure Type	**Applicable Standard**	**Electric Field** (kV/m rms)	**Magnetic Field** (μT rms)
Occupational (adequately inducted to access exposure area for whole working day)	ICNIRP	10	1000
General Public (up to 24hrs per day)	ICNIRP	5	200

Note: The Radiation Health Committee (RHC) agreed at its 24 June 2015 meeting that it would withdraw the existing National Health & Medical Research Council 's (NHMRC's) RHS 30 guideline on Extra Low Frequency (ELF) exposure. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has issued Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz -100 kHz) which are aimed at preventing the established health effects resulting from exposure to ELF EMF. The ICNIRP ELF guidelines are consistent with ARPANSA's and the RHC's understanding of the scientific basis for the protection of people from exposure to ELF EMF.

3.2 Human Exposure Limits – Radio Frequency Electromagnetic Fields

In February 1999 the Australian Communications Authority (ACA) mandated the limits of AS/NZS2772.1(Int) 1998. These limits were replaced on the 1st March 2003 by those of a new Standard RPS3, that was published by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). For regulatory purposes, the new limits became effective from the 1st June 2003.

The ARPANSA RPS3 human exposure limits [5], applicable to electromagnetic radiation, are summarized in the table below:

Table 2. Time Averaged Human Limits of Exposure – 100 kHz to 300 GHz Electric & Magnetic Fields

Exposure Activity	Frequency Range	Electric Field Strength (V/m rms)	Magnetic Field Strength (A/m rms)	Equivalent Plane Wave Power Flux Density (W/m²)
Occupational (whole working day)	100kHz-1MHz	614	1.63/f	-
	1MHz-10MHz	614/f	1.63/f	$1000/f^2$ (1)
	10MHz-400MHz	61.4	0.163	10 (1)
	400MHz-2GHz	$3.07\sqrt{f}$	$0.00814\sqrt{f}$	f/40
	2GHz-300GHz	137	0.364	50
General Public (up to 24hrs per day)	100kHz-150kHz	86.6	4.86	-
	150kHz-1MHz	86.6	0.729/f	-
	1MHz-10MHz	$86.6/\sqrt{f}$	0.729/f	-
	10MHz-400MHz	27.4	0.0729	2 (1)
	400MHz-2GHz	$1.37\sqrt{f}$	$0.00364\sqrt{f}$	f/200
	2GHz-300GHz	61.4	0.163	10

Note: 1. In the near field, both electric field and magnetic field limits are applicable rather than power flux density, which is applicable in the far field.
2. f is the frequency in MHz.

3.3 Protection of Receivers from Interference due to Overhead Power Lines and HV Electrical Equipment Installations

Australian Standard AS/NZS 2344:2016 "Limits of electromagnetic interference from overhead AC power lines and high voltage equipment installations in the frequency range 0.15 to 3000 MHz", establishes maximum limits for the radio frequency disturbances produced by overhead power lines to protect radio communications services operating in their vicinity. These limits apply to the H field over the frequency range 0.15 – 30 MHz and E field for frequencies between 30 MHz and 3 GHz.

3.4 Susceptibility of General Electronic Equipment to Magnetic Fields

If power frequency electromagnetic fields (EMF) or static magnetic fields are significant enough, they can interfere with electronics equipment, which may result in degradation of performance or operation, and may cause malfunction.

Electronic equipment is often manufactured to withstand power frequency (50 Hz) magnetic fields that may be encountered in everyday situations, and the applicable interference immunity limits are given in the table below:

Table 3. – Immunity of Electronic Equipment to 50 Hz Magnetic Fields

Electronic Equipment Type	Applicable Standard	Magnetic Field	
		(amps/metre)	(μT)
General	AS/NZS 61000.6.1	3.0 (50Hz)	3.77

Note: 1. There are no limits applying to static and slowly varying magnetic fields.
2. These interference immunity requirements are not mandatory.

These immunity requirements are not mandatory. Although equipment marketed in Australia is expected to comply with the above requirements.

4. MEASUREMENT METHODOLOGY & ACCURACY

4.1 Power Frequency Electromagnetic Fields

The magnetic field measurements were performed using IEEE Std 644 (1994) [3] methodology, as applicable.

The measurement duration was determined by the time required to obtain a stable repeatable reading indicative of the true rms value at that time.

Measurements were performed at 1 m above ground level (AGL) unless otherwise specified.

All magnetic fields measured are true root mean square (rms) values of the resultant (from the X, Y & Z planes) and recorded in a 5 Hz to 32 kHz bandwidth.

The uncertainty of the measurements performed is typically ± 3 decibels (dB) for magnetic fields, with a coverage factor of 2.0 and 95% of confidence level.

The calibration of the electromagnetic field analyser (EMC Services Plant No. 24) was current.

4.2 RF Broadband Electromagnetic Fields

An Electromagnetic Radiation Meter (plant no. 22) with a 100 kHz to 3 GHz and a 10 MHz to 60 GHz E-field Probes (plant nos. 22a and 22b), was used for the broadband measurements. The broadband measurements are recorded from 100 kHz to 3 GHz and 10 MHz to 60 GHz and provide magnitude only information.

Measurements were performed at 1.5 m AGL unless otherwise specified.

The RF broadband electric field measurements from 100 kHz to 60 GHz were performed using AS/NZS 2772.2:2016 Amt 2018 methodology [6].

The uncertainty of the electric field power flux density measurements performed was ± 5 dB, with a coverage factor of 2.0 and 95% confidence level. The calibration of the measurement equipment was current.

4.3 RF Narrowband Electromagnetic Fields

The RF narrowband spectrum measurements from 30 MHz to 1 GHz and 1 GHz to 6 GHz were performed using AS/NZS 2772.2:2016 Amt 2018 methodology [6]. The RF narrowband spectrum measurements from 150 kHz to 6 GHz use AS/NZS 2344:2016 methodology. These measurements have been performed using both peak and quasi-peak detectors.

The main equipment used for taking the narrowband measurements included a Rhode & Schwarz, HFH2-Z2 active loop antenna, a 30 MHz – 1 GHz bi-conical antenna (plant no. 83), a 1 - 18 GHz broadband horn antenna (plant no. 29), a R&S ESCS30 radio receiver, and a 100 Hz – 26 GHz spectrum analyser (plant no. 59a).

The uncertainty of the electric field narrowband measurements performed was ± 3 dB, with a coverage factor of 2.0 and 95% of confidence level. All correction factors are accounted for in the measurement results. The calibration of the measurement equipment was current.

Measurements are peak hold detector values performed at 1.5 m AGL unless otherwise specified.

5. RESULTS

The electromagnetic field survey was conducted adjacent to the eastern boundary of the property of the proposed school and also within the property, from 11:30 am to 5:00 pm, on Monday 31 May 2021. The weather was fine with a temperature around 18^{o}C. The test officers were Geoff Garrett and Dr. Yu Ji.

Measurements of broadband RF electromagnetic fields next to and along the eastern boundary of the proposed school, and within the property were conducted in the morning and afternoon, at 1.5 m above ground level (AGL) at the locations shown in Figure 2. A maximum field level of 0.0026 W/m^2 was recorded at location 7 where one of the proposed buildings is to be located next to the eastern boundary. A mast was employed to raise the RF field meter and probe at location 7 to a height of up to 9.5 m AGL which is approximately 1.5 m above the level 2 floor building height. The measurement results for these locations are listed in Table 4 of the Appendix.

The measurements of the power frequency electromagnetic fields were taken outside the property alongside the eastern boundary every 10 metres (m) between 12:30pm to 1pm. As the measured power-frequency magnetic fields were all found to be similarly low, measurement results at locations every 30 m were recorded as shown in Table 5.

Having conducted investigative measurements next to the traction electrical substation, the power-frequency magnetic field level was noted to significantly increase while a train was passing, the measured power-frequency magnetic field level was noted to significantly increased to a maximum of 1.5 μT (refer Table 5). Across the road along the eastern boundary of the school the measured power-frequency magnetic field levels are much lower and negligible mainly due to the 10 m separation distance between the boundary and the traction electrical substation. When taking into account that the maximum predicted power-frequency magnetic field levels along the eastern boundary are expected to be no more than a factor of 5 times the measured values, when the electrical power lines are under greater power loading from the traction electrical substation during peak hours, the predicted maximum field levels there are not of concern as they are a maximum of 0.18 μT.

Narrowband RF trace measurements for assessing the RF magnetic and electric field levels at frequencies from 150 kHz to 30 MHz, 30 MHz to 1 GHz and 1 GHz to 6 GHz, were performed at location 23 next to the eastern boundary of the proposed New Liverpool Public School and opposite the traction electrical substation. These narrowband RF trace measurement results are shown in Figures 3-1 to 5-2.

Narrowband RF trace measurements from 750 MHz to 6 GHz were also recorded at location 7 where the RF broadband measurements were found to be highest in the area of the proposed buildings. These narrowband RF trace measurement results are shown in Figures 6-1 and 6-2.

A nearby Sydney Trains radiocommunications tower was identified visually (refer Photo 3) and according to the ACMA Register of Radiocommunications Licences, four transmitting antennas in the directions of 10^{o} and 210^{o} with respect to north at a height of 27 m to 29 m were found there and these transmitting antennas operate at frequencies in the vicinity of 1.87 GHz.

A Telstra mobile phone base station tower was identified from the ACMA Register of Radiocommunications Licences at Liverpool Hospital, many mobile phone base stations were found there and these base stations contain many transmitting antennas operating within the frequency range 725 MHz to 3.605 GHz. The 3.605 GHz signal for 5 G communications was detected during the narrowband measurements as shown in Figures 5-1 to 6-2.

According to ACMA Register of Radiocommunications Licences, the locations of other sites which contain telecommunication transmitters are shown in Figure 7.

6. ASSESSMENT

6.1 Criterion

The assessment of compliance of the measurements and/or of the predictions by extrapolation of the measurements, with standards limits or guideline reference values, excludes the tolerance/s due to the measurement uncertainties given in Section 4.

6.2 Power Frequency Electromagnetic Fields

It was found that the measured power frequency magnetic field levels are consistently low along the eastern boundary of development site, with the measured maximum being 0.056 μT at location 21 next to the Sydney Trains traction substation when a train was passing (refer in Table 5). This field level and the predicted maximum field level of 0.18 μT are well below the ICNIRP Guideline reference value of 200 μT applicable to general public exposure (refer Table 1) that ARPANSA has adopted.

Although the present guideline reference values are relatively high, long-term exposure to a magnetic field level of 0.4 μT or more, is regarded by some experts to be associated with an increase in the number of recorded cases of childhood leukemia; the UK National Radiological Protection Board (NRPB) Advisory Group on Non-Ionising Radiation (AGNIR) reported their research findings in relation to this in 2001 [4]. However, as these research findings, of the UK NRPB are yet to be proven or adopted in standards, they currently only suggest that quasi-continuous exposure to low level power frequency magnetic fields, may increase the risk of leukemia in children.

As indicated in the ICNIRP guideline [1], a number of epidemiological studies have consistently found that everyday chronic low-intensity power frequency magnetic field exposure (to levels above 0.3– 0.4 μT) is associated with an increased risk of childhood leukemia. The International Agency for Research on Cancer (IARC) has classified such fields as possibly carcinogenic. However, a causal relationship between magnetic fields and childhood leukemia has not been established nor have any other long term effects been established. The absence of established causality means that this effect cannot be addressed in the ICNIRP basic restrictions (i.e. by limiting exposure within the field levels of Table 1).

As shown in Table 5, the measured and predicted maximum power-frequency magnetic field level along the eastern boundary of the proposed New Liverpool Public School, next to Sydney Trains railway lines and substation, is below the quasi-continuous precautionary reference value of 0.4 μT.

The maximum predicted magnetic fields at the proposed New Liverpool Public School are well below the 3.77 μT interference immunity limit applicable to general electronic equipment set down by AS/NZS 61000.6.1.

6.3 Radio Frequency Electromagnetic Fields

The RF broadband emission levels were measured along the eastern boundary of and within the proposed New Liverpool Public School, corresponding to a maximum average power density in these areas of less than 0.13% and 0.63% of the ARPANSA RPS3 exposure limit applicable to the General Public (refer Tables 3 and 4), at heights of 1m AGL and 9.5 m respectively, of which the latter height is equivalent to the level 2 floor space of the proposed school building. There were no significant fluctuations measured during the survey.

Looking at the narrowband measurements shown in Figures 3-1 to 6-2, which were conducted at location 23 and location 7 where the RF broadband electric field measurements were highest, the Sydney Trains radiocommunications tower emissions and the mobile phone emissions in the area are confirmed to be low and are mainly at frequencies in the vicinity of 725 MHz, 870 MHz, 950 MHz, 1.81 GHz, 1.86 GHz, 2.1 GHz, 2.6 GHz and 3.605 GHz. The main emissions were due to the FM radio and digital TV broadcasts over the greater area from the broadcast towers at Willoughby, Artarmon and Gore Hill. None of the detected signals were of concern of interference risk to WiFi operating in the 2.4 GHz and 5.8 GHz ISM bands.

The measured narrowband RF noise level in the AM radio band (500 kHz to 1.7 MHz) and MF band (500 kHz to 3 MHz) could be expected to increase by a factor of up to 5 (12 dB) when the traction substation is under greater load, such as during peak hours, though with a noise increase of this order the reception of AM broadcast and MF communications in the new school would likely remain acceptable due to a reduced signal-to-noise ratio in the order of 10 dB.

According to the ACMA Register of Radiocommunications Licences, Telstra holds a licence for the operation of 5 G mobile phone base station transmitting equipment at the nearby Liverpool Hospital. These antennas are Ericsson model Air 6468 B42 5G antennas and will operate at 3.605 GHz with up to 200 Watts (W) output power.

7. CONCLUSION & RECOMMENDATION

7.1 Health & Safety

At the proposed New Liverpool Public School, the measured and maximum predicted power-frequency magnetic field levels are well below the ICNIRP guideline reference value of 200 μT applicable to the general public that has been adopted by ARPANSA. Therefore, there should be no concern of risk to the health and safety of the general public or occupational personnel due to the power-frequency magnetic fields.

As the measured and maximum predicted power-frequency magnetic fields are below the precautionary reference value of 0.4 μT [1][4] applicable to the health of infants and children, precautionary mitigation of power-frequency magnetic fields is not recommended.

Within the development site of the New Liverpool Public School, the measured radio-frequency electric fields including from the nearby Sydney Trains radiocommunications tower and mobile phone communications in the general area, are well below the ARPANSA RPS3 exposure limits applicable to the general public, so there should be no concern of risk to the health and safety of occupants within the proposed school due to the radio-frequency electric field emissions there.

7.2 Interference

The reception of AM band radio (500 kHz to 1.7 MHz), MF band (500 kHz to 3 MHz) and FM radio broadcasts, and WiFi communications in the proposed New Liverpool Public School are considered to be at low risk of interference due to the impact of the existing Sydney Trains radiocommunications tower, traction substation, and OH HV powerline.

The interference risk to general electronic equipment used within the proposed school, due to the power frequency magnetic fields from the adjacent railway traction electrical substation, and OH HV powerline, is considered to be very low. There may be low risk of interference to cathode ray tube equipment, such as conventional TV or computer monitors which have largely been replaced by modern plasma, LCD or LED equivalents.

7.3 Future Survey

Should there be significant change to the electromagnetic field environment at the proposed New Liverpool Public School, such as due to change of the Sydney Trains radiocommunications tower, railway lines or traction substation, or installation of new electricity power substations and mobile phone base stations nearby the school then it is recommended to have the electromagnetic field environment re-assessed for health & safety and interference compliance and assurance.

8. APPENDIX

Table 4 - RF Measurements at the Proposed Development Site (12:30pm - 5:00pm)

Measurement Location (refer Figure 2)	**Measured Maximum Average Electric Field Power Density (100 kHz – 3 GHz) BW** $^{(1)\,(2)}$ W/m^2	**Measured Maximum Average Electric Field Power Density (10 MHz – 60 GHz) BW** $^{(1)\,(2)}$ W/m^2	**Calculated Maximum Power Density Exposure - % of ARPANSA RPS3 General Public Limit in (10 MHz – 60 GHz) BW or (100 kHz – 3 GHz) BW** $^{(3)}$
Within the proposed New Liverpool Public School			
1	-	0.0005	0.025
2	-	0.0011	0.055
3	-	0.0002	0.01
4	-	0.0002	0.01
5	-	0.0016	0.08
6	-	0.0000	0.00
7 (1 m AGL, GL)	-	0.0026	0.13
7 (3.5 m AGL, GL)	-	0.0027	0.135
7 (4.5 m AGL, L1)	-	0.0045	0.225
7 (6.5 m AGL, L1)	-	0.0070	0.35
7 (8.5 m AGL, L2)	-	0.0065	0.325
7 (9.5 m AGL, L2)	-	0.0126	0.63
8	-	0.0002	0.01
9	-	0.0007	0.035
10	-	0.0009	0.045
11	-	0.0026	0.13
12	-	0.0004	0.02
13	-	0.0002	0.01
14	-	0.0029	0.145
15	-	0.0010	0.05
16	-	0.0005	0.025
17	-	0.0014	0.07
18	-	0.0003	0.015
Along the eastern boundary of the proposed New Liverpool Public School			
19	0.0021	0.0006	0.105
20	0.0071	0.0019	0.355
21	0.0036	0.0017	0.18
22	0.0031	0.0019	0.155
23	0.0075	0.0048	0.375
24	0.0065	0.0077	0.325
25	0.0044	0.0015	0.22
26	0.0027	-	0.135

Note:

1. *"Watts per square Metre" – W/m^2 are the International (SI) and legal units of power flux density.*
2. *Time-averaged measurement.*
3. *Accumulative of the measured electric field expressed in power density as a percentage of the 2 W/m^2 limit in Table 2 (i.e. minimum limit within the frequency band).*
4. *Measurements are recorded at a height of 1.5 m AFL (i.e. the mean height of body mass), unless otherwise noted.*

Table 5 – Measured Power Frequency Magnetic Fields -
Along the Eastern Boundary of the Proposed New Liverpool Public School

Measurement Locations (refer Figure 2)	**Comments**	**Measured Maximum Average Magnetic Field (5 Hz – 32 kHz)** (μT rms)	**Predicted Maximum Magnetic Field (5Hz – 32kHz)** (1) (μT rms)
19	North-east corner	0.028	0.14
20	Eastern boundary	0.035	0.175
21	Next to northern side of the substation	0.056	0.28
22	Next to middle of the substation	0.021	0.105
23	Next to southern side of the substation	0.023	0.115
24	Eastern boundary	0.031	0.155
25	Eastern boundary	0.036	0.18
26	South-east corner	0.025	0.125

Note: 1. Based on a current loading of the Sydney Trains traction substation at the time of measurement of 20% of the rated load.

Figure 1. Proposed Development Site for New Liverpool Public School

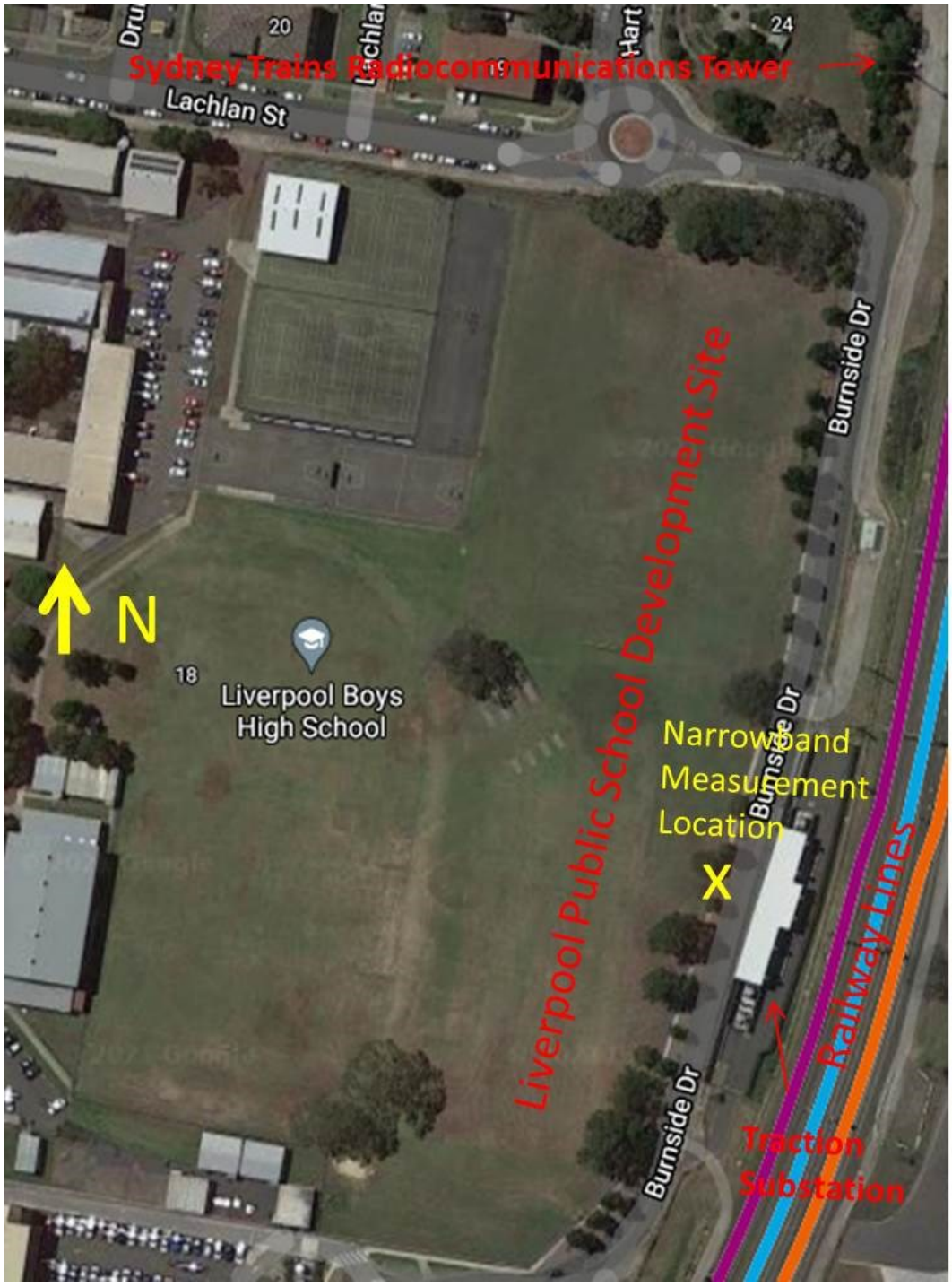


Figure 2. RF Electric Field and Power Frequency Magnetic Field Measurement Locations at the Proposed New Liverpool Public School

Note: 1. This figure is based on an original drawing provided by ADCO Constructions, that has been copied and marked-up for illustration purposes only, and is not to scale.

Figure 3-1. RF Narrowband Trace Measurement at Location 23 – 150 kHz to 30 MHz when the loop antenna was facing the substation

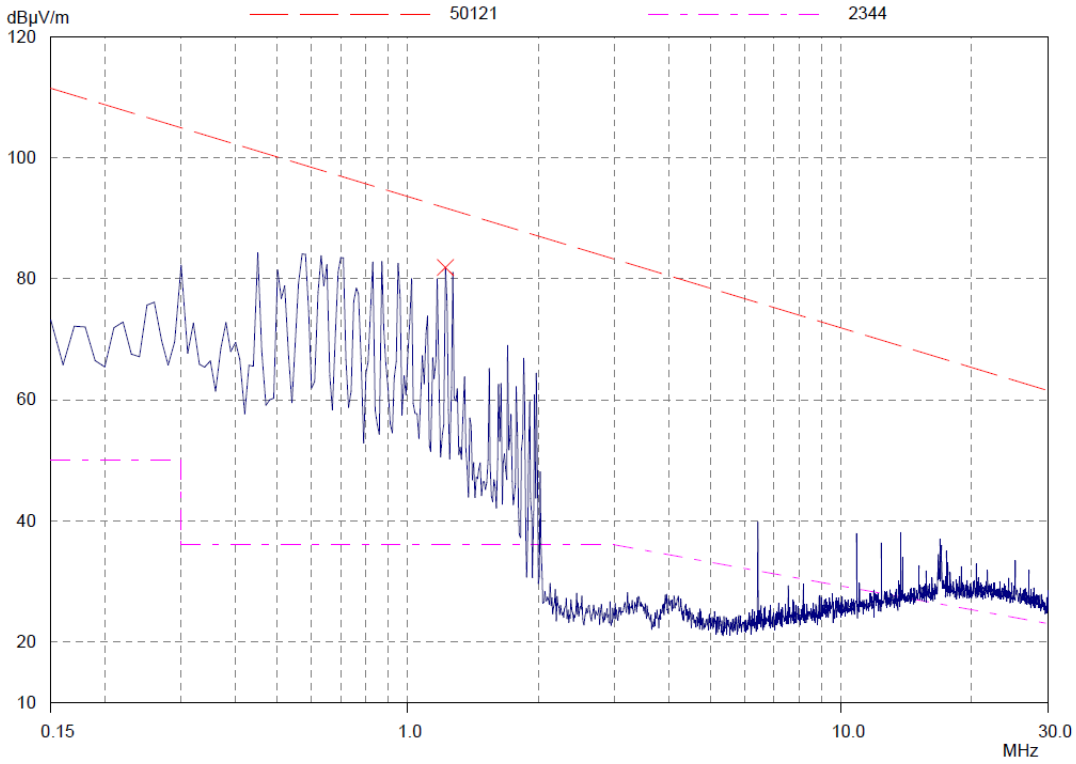


Figure 3-2. RF Narrowband Trace Measurement Location 23 – 150 kHz to 30 MHz when the loop antenna was perpendicular to the Substation

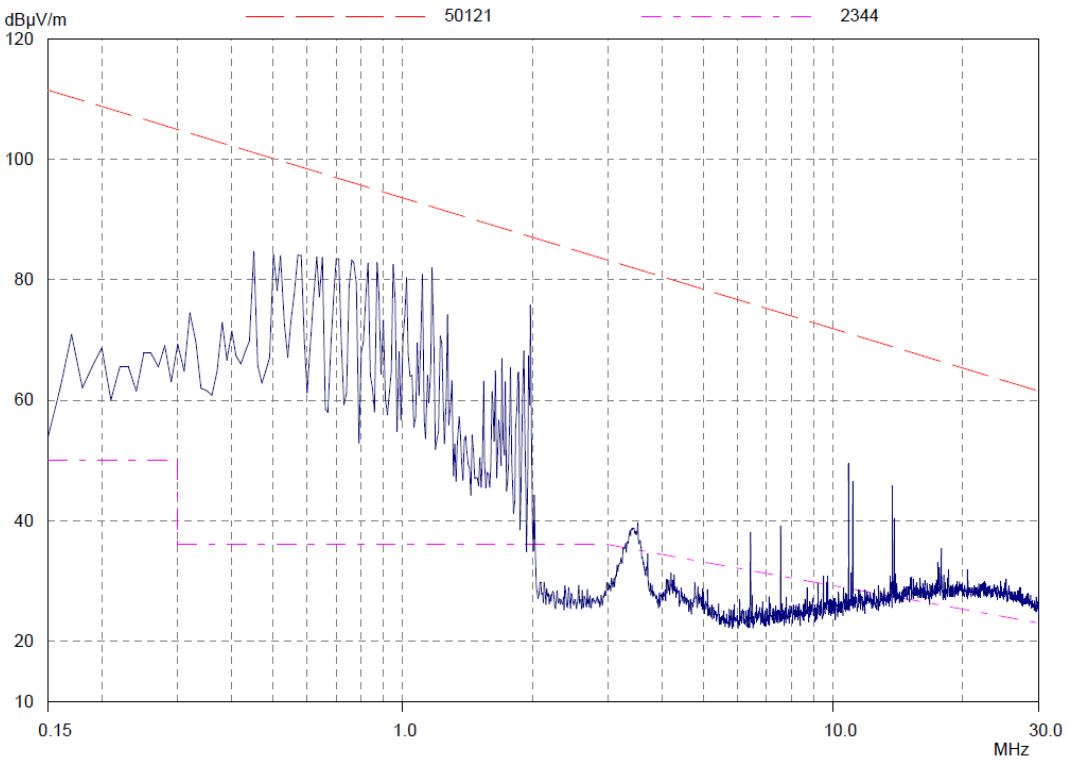


Figure 4-1. RF Narrowband Trace Measurement at Location 23 – 30 MHz to 1 GHz in Horizontal Polarization

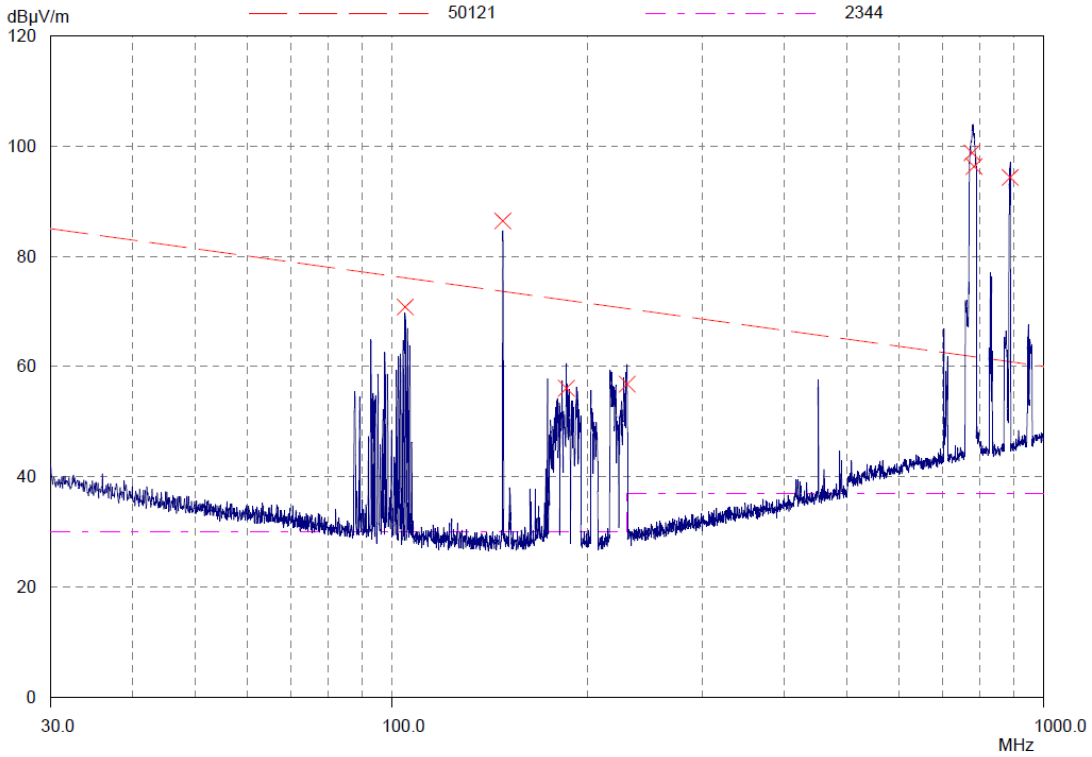


Figure 4-2. RF Narrowband Trace Measurement at Location 23 – 30 MHz to 1 GHz in Vertical Polarization

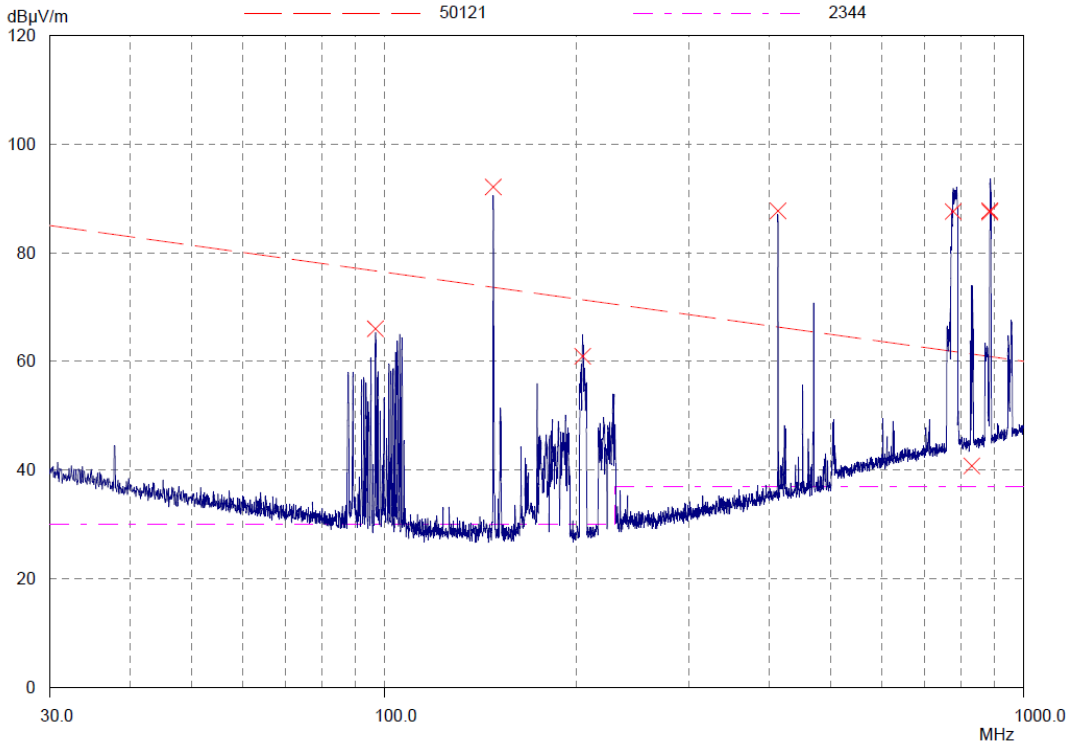


Figure 5-1. RF Narrowband Trace Measurement at Location 23 – 1 GHz to 6 GHz in Horizontal Polarization

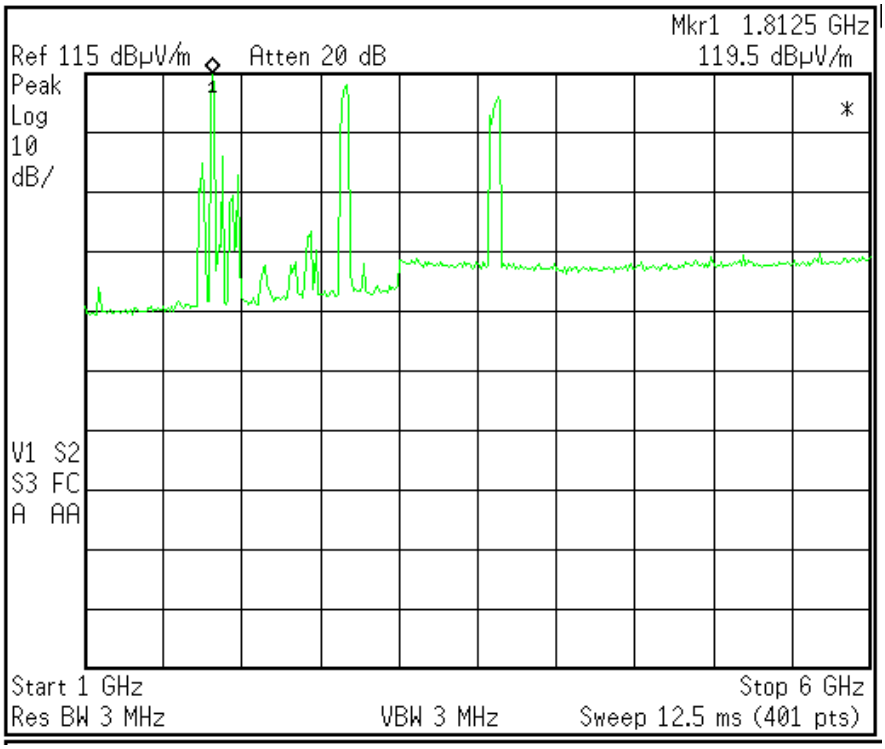


Figure 5-2. RF Narrowband Trace Measurement at Location 23 – 1 GHz to 6 GHz in Vertical Polarization

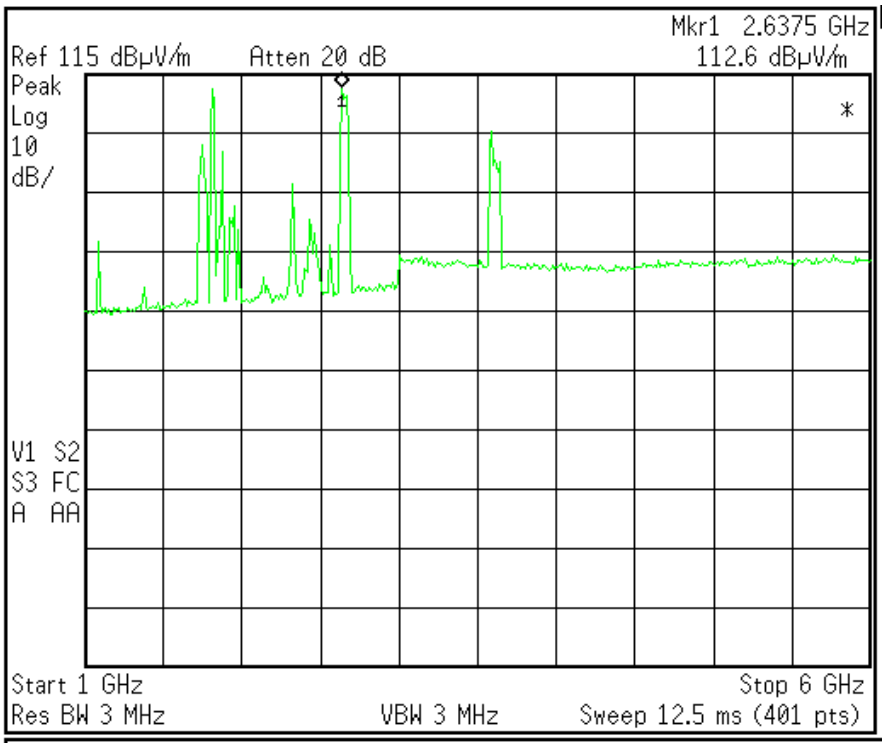


Figure 6-1. RF Narrowband Trace Measurement at Location 7 – 750 MHz to 6 GHz in Horizontal Polarization

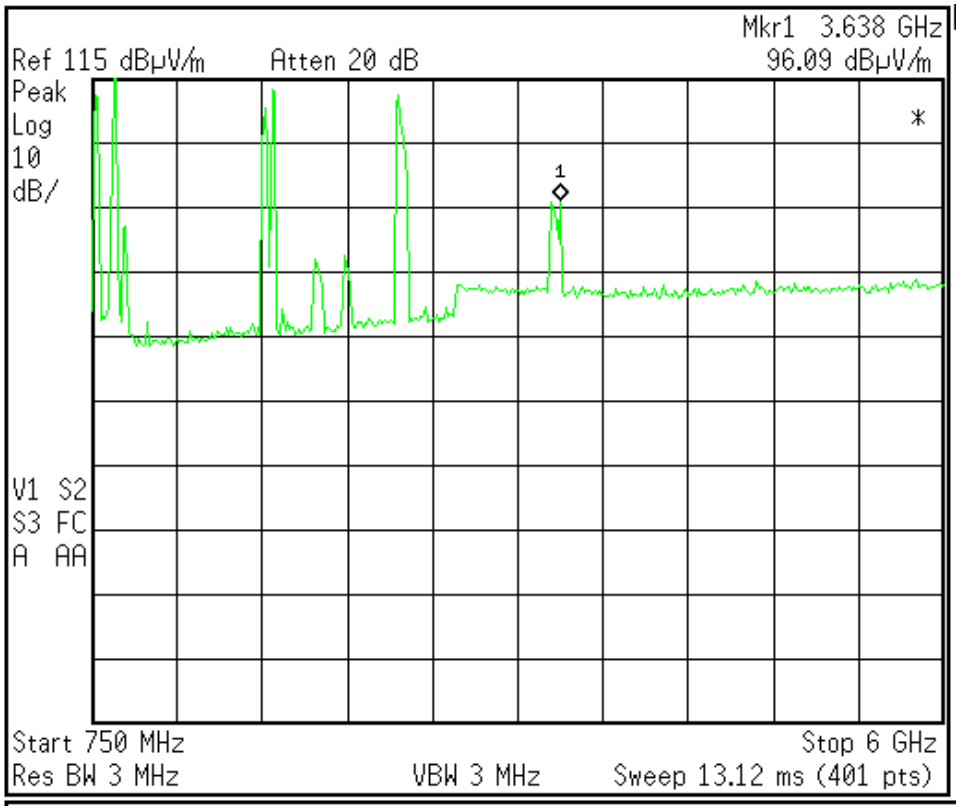


Figure 6-2. RF Narrowband Trace Measurement at Location 7 – 750 MHz to 6 GHz in Vertical Polarization

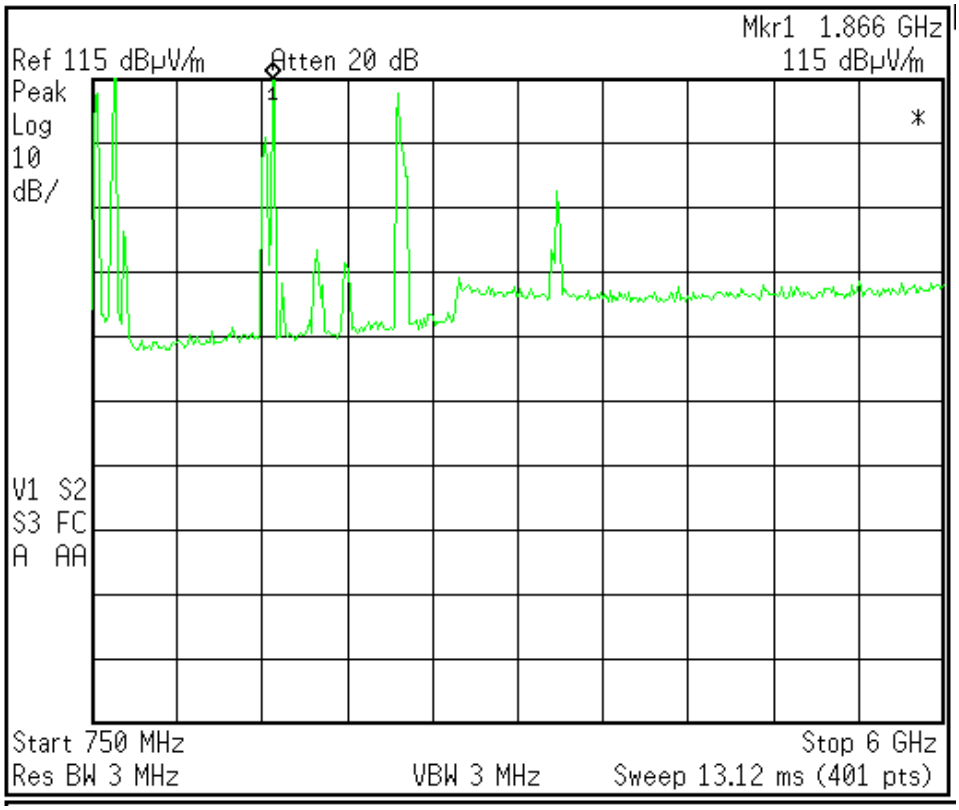
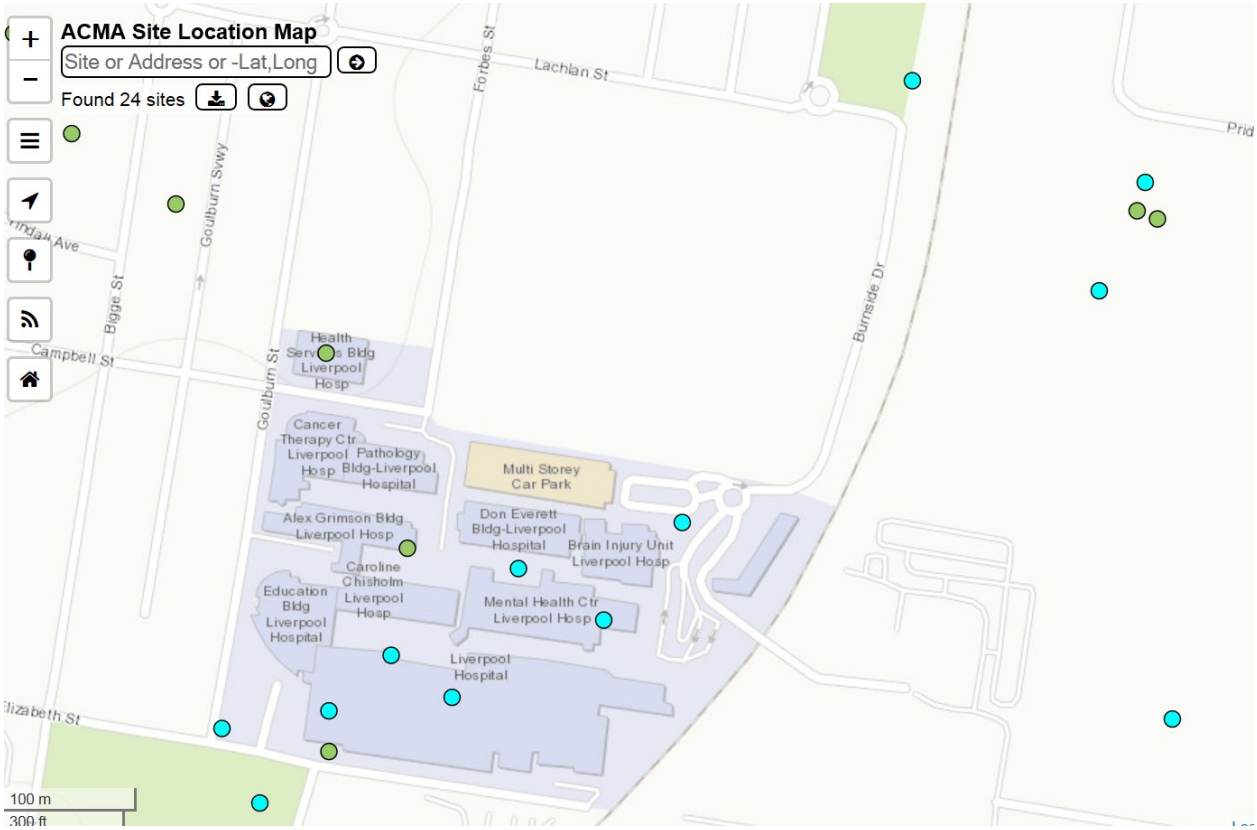


Figure 7. Radiocommunications / Telecommunication Sites next to the Proposed New Liverpool Public School



Note: Blue dots are active sites, and green dots are inactive sites.

Photo 1. Proposed New Liverpool Public School Site

Photo 2. Railway Lines, Overhead power Lines and Traction Substation next to the Proposed New Liverpool Public School

Photo 3. Sydney Trains Radiocommunications Tower next to the Proposed School

Photo 4. RF Electric Field Measurement Setup at Location 7 of the Proposed New Liverpool Public School

9. GLOSSARY

Broadband	In the context of an RF measurement, a broadband measurement measures the magnitude over a large (broad) frequency range. A broadband measurement is useful for providing the net magnitude of the emissions from multiple sources (eg. The combination of Radio, TV, WiFi, Mobile Phones, etc…) though does not provide the magnitude of individual frequency emissions.
Narrowband	In the context of an RF measurement, a narrowband measurement measures the magnitude over a small (narrow) frequency range. A narrowband measurement provides the magnitude of individual frequencies, and is useful for determining the emissions from the sources of interest (eg. WiFi only).
Power Frequency	A term typically used to describe mains power electromagnetic fields at 50 Hz, though extends to other frequencies such as the harmonics of 50 Hz, which may extend to approx. 3 kHz. Examples of sources that emit higher magnitudes of power-frequency electromagnetic fields include, power lines, electrical switch boards, electrical substations, electrical risers, high power electrical appliances, etc…
Radio Frequency (RF)	Radio Frequency is a term used for describing the range of oscillation of radio waves, which is generally from 3 kHz to 300 GHz. Some examples of radio waves are Radio & TV Broadcasts, Mobile Phone communications, WiFi, Bluetooth, etc..