Magshield Products (Aust.) International Pty. Ltd.
A. C. N. 082 413 125 A. B. N 441 1968 8614

Unit 6, 1 Edinburgh Street
P.O. Box 9
Hampton, Victoria 3188
Australia

Phone: (03) 9521 6068
Fax: (03) 9598 0328
Intern. Fax:+61 3 9598 0328
Web: www.magshield.com.au

Powerlink Project

Redlynch to Woree 132kV Cable Link

Electromagnetic Field Assessment for Underground Cables

Early morning In Melbourne

5 June 2024

Contents

1. BACKGROUND INFORMATION

Powerlink Queensland (Powerlink) are looking to replace existing overhead (OH) 132 kV Feeders 7141 and 7142 between Woree and Kamerunga Substations and as such, require an assessment of a suitable corridor and potential alignment. Powerlink has advised that the Project will be split into two projects, namely an overhead (OH) section from Kamerunga to Redlynch, and an underground (UG) section from Redlynch to Woree. The section between Kamerunga and Redlynch is being addressed under a separate scope of work and as such this report is specific to the section between the Redlynch Transition Site and the existing Woree Substation only (herein referred to as the 'project')

The existing 132kV overhead feeders 7141 and 7142 between Woree and Kamerunga Substations were constructed in 1963. Due to advanced corrosion some sections of overhead line were upgraded in 2014.

Due to its age, corrosion damage and the load growth in the area, Powerlink decided to replace the powerline by 2026.

The new transmission line will be established from Woree to the existing Redlynch site, and Redlynch to Kamerunga.

The easement requirements for the transmission line section between Redlynch and Kamerunga Substation are being already addressed. The easement requirements between Redlynch and Woree Substation are included in the new scope of work.

The objective of this phase of the project is to establish the optimum line route for the underground cable section, between the Woree and Redlynch part of the Woree to Kamerunga 132kV double circuit transmission line, and secure all approvals and permits necessary to for construction to commence, by June 2025.

Approval for the Project is being sought via the Ministerial Infrastructure Designation (MID) Process under the Queensland Planning Act 2016. A detailed design process will be undertaken as part of the post-MID construction project, which will be undertaken under a Design / Procure / Construct (DPC) Contract. This is a normal process for underground cables.

As part of the approval process, and to support the MID Proposal, it was necessary to carry out the electromagnetic field (EMF) study for the new underground cable line and to demonstrate that the new line will be designed and constructed in compliance with existing standards and guidelines for safe health exposure to general public and for interference free operation of electronic devices in proximity of the cable line.

As part of the environmental assessment, it is required to produce a comprehensive EMF assessment Report covering technical analysis and assessment of the impacts and recommend any necessary mitigation measures that might be required to comply with EMF standards and guidelines.

The technical requirements for the EMF report are as follows:

- EMF assessment of several representative cable layouts such as;
  - double circuit trefoil, both with a single phase uppermost (see details in Figure 1a)
  - double circuit trefoil, one trefoil inverted. This cable arrangement was originally developed by Magshield in 2013 for the Ausgrid's Northshore 132kV cable project (for details see Figure 1b)
  - flattened arrangement with all conduits in the one horizontal plane (for details see Figure 1c)
  - flattened arrangement across cable joining bay (for details see Figure 1d)
  - the impact of varying conductor depth for the case where all conduits arranged in one horizontal plane;
  - encompassed undercrossing showing the impact of varying conductor depth.

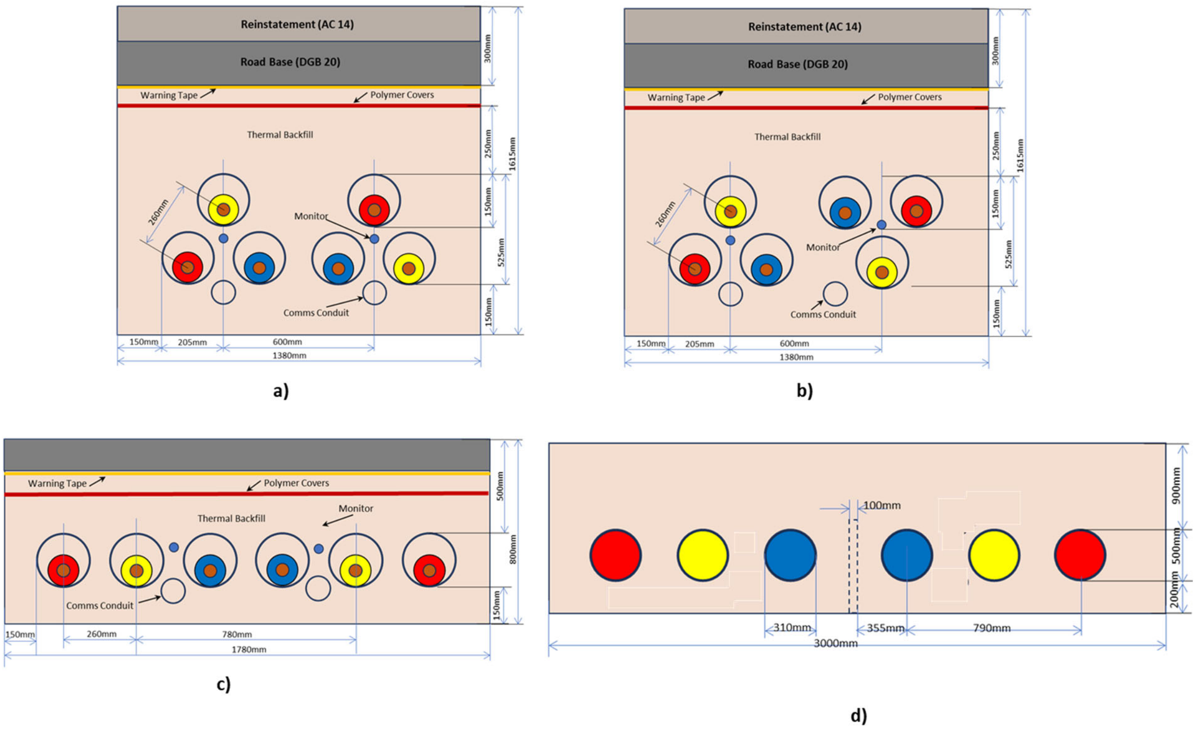


Figure 1 Several representative cable layouts

- Impact assessments such as:
  - typical exposure levels for representative locations, such as roads, open space and cycleways;
  - Time Weighted Average (TWA) for representative locations;
  - Commentary and critical analysis of ongoing TWA EMF for the length of the proposed alignment.

In addition to the above listed arrangements of the 132kV underground cables there were several others included in the EMF assessment.

Installation details for the 132kV cables were provided in the Feasibility Report prepared and submitted to Powerlink by Stockton Drilling Services (document No. J092-FR-0001). Based on this report, we identified the following cable configuration cases for the EMF study that were also included in the EMF study and presented in this report.

1) Typical trench cross section (page 37 of Stockton document)

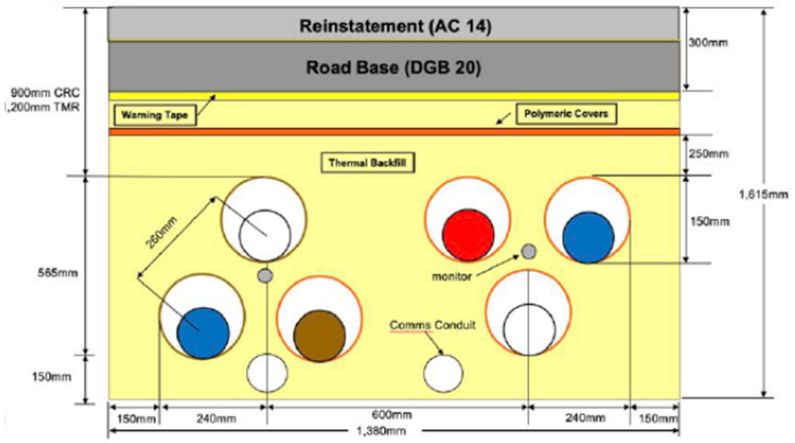


Figure 18.1 Typical Trench Cross Section

2) Individual bores. There are a total of 15 trenchless crossings. The depths of such crossings vary from approximately 2m, 4m, 4m-5m, 5m, 5m-6m, 6m, 6m-7m, 7m-8m and 6m-15m. The majority of the trenchless bore crossings will be as shown in Figure 18.2 However, in accordance with Powerlink advise the EMF calculations were performed only at 2m and 5m depths. These considered to be adequate as at deeper installation of cables the EMF on the surface above the cables will be smaller.

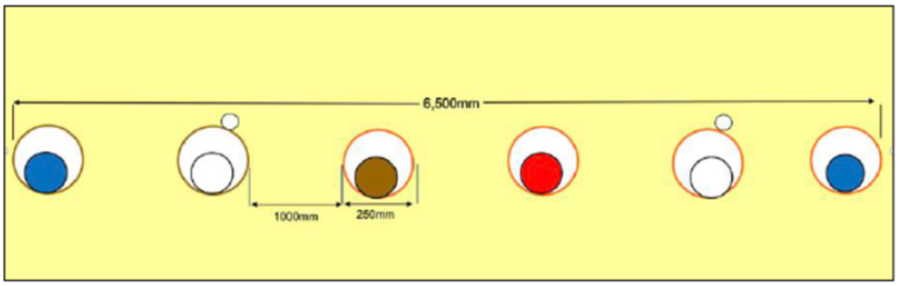


Figure 18.2 Individual Bores in Flat Formation

3) Where there is a requirement for reduced working width

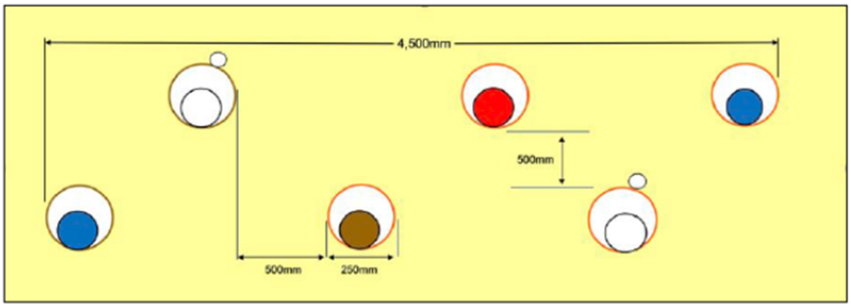


Figure 18.3 Individual Bores in Trefoil Formation

4) Bundle direct bury

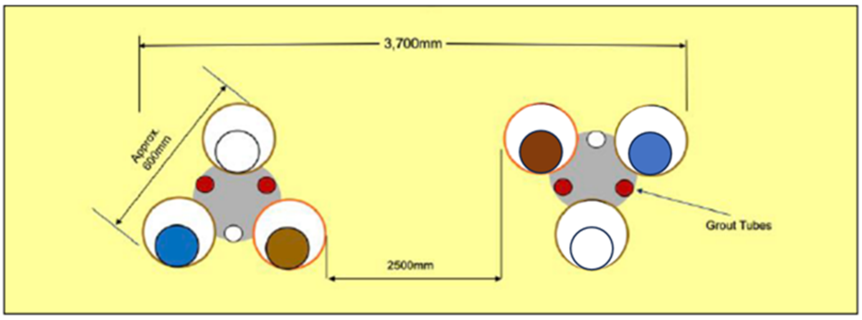


Figure 18.4 Conduit Bundles in Trefoil Formation

5) Bundle with outer casting

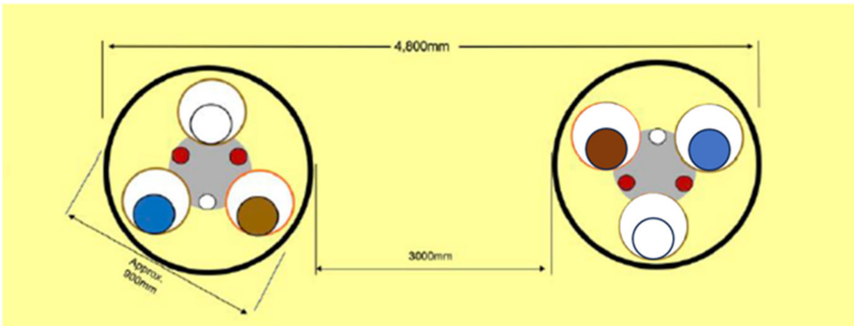


Figure 18.5 Conduit Bundles within Enveloper

The conduit configurations presented above are approximate and may be impacted by other requirements other than drilling accuracies and tolerances, including ground conditions, cable ratings and requirements of third parties.

The map presented in Figure 2 shows the existing overhead line and a section of the proposed underground cable alignment for the new phase of the project.

The proposed route for the underground cables was selected to minimize its proximity to the existing residential and commercial properties. In such areas it is intended to restrict the cable route to be located in the carriageways.

The map presented in Figure 2 shows the existing overhead line and a section of the proposed underground cable alignment for the new phase of the project.

The proposed route for the underground cables was selected to minimize its proximity to the existing residential and commercial properties. In such areas it is intended to restrict the cable route to be located in the carriageways.

Figure 2 Map showing the existing overhead powerline and proposed underground cable

2. EMF AND HEALTH

2.1 IRPA Guidelines

In 1989, the International Radiation Protection Association (IRPA) approved interim EMF human exposure guidelines prepared by its International Non-Ionising Radiation Committee. In the same year these guidelines were adopted as interim guidelines by the National Health and Medical Research Council of Australia (NHMRC). The guidelines recommended the following limits:

Exposure	Magnetic Flux Density
Occupational	
Whole working day	**0.5 mT (=5,000 mG)**
Short term	**5.0 mT (= 50,000 mG)**
For limbs	**25.0 mT (=250,0000 mG)**
General public	
Up to 24 hours per day	**0.1 mT (=1,000 mG)**
Few hours per day	**1.0 mT (=10,000 mG)**

Notes:

a) IRPA guidelines were developed *"primarily on established or predicted health effects produced by currents induced in the body by external [EMFs]".*

b) The guidelines were based on limiting current densities induced in the head and trunk from continuous exposure to 50/60 Hz electric and magnetic field to no more than 10 mA/m^2.

c) Immediately observable minor biological effects have been reported in human studies in respect to induced current densities between 1 and 10 mA/m^2

The NHMRC guidelines state that: *"The occupationally exposed population consists of adults exposed under controlled conditions in the course of their duties, who should be trained to be aware of potential risks and to take appropriate precautions".* Based on this definition, the occupational exposure limits should only be applicable to skilled and trained workers who are directly involved with operation and maintenance of EMF emitting equipment and installations and who know how to limit the severity and duration of exposure to the power frequency electric and magnetic fields.

Concerns about inadequacies of IRPA guidelines were summarised in Gibbs Report in 1991:

> *Since the guidelines proceed on the basis that "adverse human health effects from exposure to ELF electric fields at strengths normally encountered in the environment or the workplace have not been established", it is apparent that they are not intended to provide protection against any adverse health effect that may be caused by such exposure, and they would not do so. The levels of exposure recommended are many times greater than the levels at which it has been suggested that the fields may create a risk.*

2.2 ICNIRP Guidelines

In 2010 the International Commission on Non-Ionising Radiation Protection (ICNERP) published the new "Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (from 1 Hz to 100 kHz)". The new document replaced the last version of the guidelines previously published in 1998.

The principal limitation of the guidelines is stated in the "BASIS FOR LIMITING EXPOSURE" section as follows:

Induction of cancer from long-term EMF exposure was not considered to be established, and so these guidelines are based on short-term immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EMF.

The guidelines state that:

Epidemiological studies have found that everyday chronic low intensity power frequency magnetic field exposure is associated with an increased risk of childhood leukaemia. However, laboratory studies have not supported this association and a causal relationship between magnetic fields and childhood leukaemia or any other long term effect has not been established. The absence of established causality is the reason why the epidemiological results have not been addressed in the basic restrictions. ICNIRP is well aware that these epidemiological results have triggered concern within the population in many countries. It is ICNIRP's view that this concern is best addressed within the national risk management framework.

Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values).

Frequency range	E-field strength E (kV m^{-1})	Magnetic field strength H (A m^{-1})	Magnetic flux density B (T)
1 Hz − 8 Hz	5	$3.2 \times 10^4/f^2$	$4 \times 10^{-2}/f^2$
8 Hz – 25 Hz	5	3.2 x 103/f	$4 \times 10^{-3}/f$
25 Hz – 50 Hz	5	1.6×10^2	2×10^{-4}
50 Hz – 400 Hz	$2.5 \times 10^2/f$	1.6×10^2	2×10^{-4}
400 Hz – 3 kHz	$2.5 \times 10^2/f$	$6.4 \times 10^4/f$	$8 \times 10^{-2}/f$
3 kHz – 10 MHz	2.5×10^2	21	2.7×10^{-5}

Reference levels for occupational exposure to time varying electric and magnetic fields (unperturbed rms values).

Frequency range	E-field strength E (kV m^{-1})	Magnetic field strength H (A m^{-1})	Magnetic flux density B (T)
1 Hz − 8 Hz	20	$1.63 \times 10^5/f^2$	$0.2/f^2$
8 Hz – 25 Hz	20	$2 \times 10^4/f$	$2.5 \times 10^{-2}/f$
25 Hz – 300 Hz	$5 \times 10^2/f$	8×10^2	1×10^{-3}
300 Hz – 3 kHz	$5 \times 10^2/f$	$2.4 \times 10^5/f$	0.3/f
3 kHz – 10 MHz	1.7×10^{-1}	80	1×10^{-4}

Notes:
- f in Hz.
- 1μT = 10 mG
- See separate sections below for advice on non sinusoidal and multiple frequency exposure.
- To prevent indirect effects especially in high electric fields see chapter on "Protective measures."
- In the frequency range above 100 kHz, RF specific reference levels need to be considered additionally.

From the ICNIRP table the maximum EMF exposure limit at the power frequency of 50Hz for the general public is 200μT or 2000 mG. For the occupational exposure the safe exposure limit is 1 mT or 10,000 mG.

A number of publications have been prepared nationally and internationally on a possible adverse health effect from prolonged EMF exposure at much lower level. This information and some policy measures used in other countries is summarised in Appendix A.

2.3 AUSTRALIAN POWER SUPPLY INDUSTRY POSITION

The Energy Networks Association (ENA) is the peak national body for Australia's energy networks. ENA represents gas and electricity distribution, and electricity transmission businesses in Australia on a range national energy policy issues.

ENA's position on EMF is that adverse health effects from EMFs have not been established, and there remains a lack of scientific consensus about whether they can occur. ENA nonetheless recognises that some members of the public continue to have concerns about EMFs and is committed to addressing it by the implementation of appropriate policies and practices.

The ENA Policy statement includes recommending to its members that they design and operate their electricity systems in compliance with recognised international EMF exposure guidelines and to continue following an approach consistent with the concept of prudent avoidance.

Prudent avoidance has been defined in an Australian context by the former Chief Justice of the High Court of Australia, Sir Harry Gibbs as doing what can be done without undue inconvenience and at modest expense to avert the possible risk to health from exposure to new high voltage transmission facilities. This finding has been supported by subsequent Australian government inquiries.

2.4 PRECAUTION – WORLD HEALTH ORGANIZATION

In 2007, the WHO published their Extremely Low Frequency [ELF] Fields – Environmental Health Criteria Monograph No. 238. In relation to overall guidance to member states, WHO Organisation has addressed the notion of prudence or precaution on several occasions, including in its 2007 publication Extremely Low Frequency Fields, which states:

> *….. the use of precautionary approaches is warranted. However, it is not recommended that the limit values in exposure guidelines be reduced to some arbitrary level in the name of precaution. Such practice undermines the scientific foundation on which the limits are based and is likely to be an expensive and not necessarily effective way of providing protection."*

The Monograph further emphasises that:

> *Even when allowing for the legitimate desire of society to err on the side of safety, it is likely that it will be difficult to justify more than very low-cost measures to reduce exposure to ELF fields.*

For most practical purposes, precaution as defined by WHO is consistent with the industry's long standing policy of prudent avoidance.

2.4.1 PRUDENT AVOIDANCE / PRECAUTION PRINCIPLES

Considering the industry's long standing position of prudent avoidance and recommendations from WHO, the following key guiding principles can be applied to prudent avoidance / precaution in relation to EMF:

- Prudent avoidance / precaution involves monitoring research; reviewing policies in the light of the most up to date research findings (with particular emphasis on the findings of credible scientific review panels); providing awareness training for electricity supply business employees and keeping them informed and sharing information freely with the community.

- Measures to reduce exposure should be used if they can be implemented at 'no cost' or 'very low cost' and provided they do not unduly compromise other issues.

- Prudent avoidance / precaution does not operate in isolation but rather is one of many issues that need to be given due consideration.

- There is no reliable scientific basis for the adoption of arbitrary low exposure limits, setbacks or for a specific level at which precaution applies.

- Where exposure is consistent with typical background levels1, the potential for further reductions is limited.

- Due to the large additional cost, undergrounding powerlines for reasons of EMF alone is clearly outside the scope of prudent avoidance / precaution. It cannot be said that the above measures will result in a demonstrable health benefit.

3. EMF AND INTERFERENCE

3.1 Interference with Electronic Devices

Electromagnetic immunity levels for electronic devices used in residential, commercial and light industry are specified in the Australian Standard AS/NZS 61000.6.1:2006 "Electromagnetic compatibility (EMC), Part 6.1: Generic standards—Immunity for residential, commercial and light industrial environments (formerly AS/NZS 4251.1 "Electromagnetic Compatibility-Generic Immunity Standard", Part 1: Residential, commercial and light industry. 1:1994). The standard is technically equivalent to the European standard IEC 61000.6.1:2005.

The immunity limits specified in the standards for the low frequency EMF are summarised in the table below.

Device type	**Residential / commercial environment**
CRT displays	1.25 uT (12.5 mG)
Other equipment	3.75 uT (37.5 mG)

Cathode-ray-tube (CRT) based computer monitors which are commonly used in homes and offices are susceptible to EMF interference. The threshold level of sensitivity to the EMF for most 14" and 15" CRT based computer monitors is 10 mG. Monitors with 17" screens can be affected by the magnetic field less than 7 mG, while monitors with 20"-21" screens can be affected by the magnetic fields less than 5mG.

The jittery screen of the EMF affected computer monitors could also be a source of adverse health effect through causing eye strain and headache for computer users.

3.2. Transmitted Voltages to Telecommunication Network

Voltages transmitted to a Telecommunications Network from external sources, either by induction or conduction, should not exceed the limits for Telecommunications Network Voltages (TNV), as specified in AS/NZS 60950.1

3.3 Power Frequency Transients

Transient EMFs can be generated during a short circuit condition. Such EMFs can cause damage to sensitive electronic and bio-electronic devices, interfere with data communication lines and corrupt magnetic data storage media.

Currently there is no Australian standard that sets the electromagnetic field emission limits for interference with electronics and communication devices and equipment due to the transient voltage and current surges in the low voltage power supply.

The single-core 132kV cables proposed to be used on this project will be designed and constructed with metallic sheaths that substantially suppress such transient EMFs.

4. EMF MODELLING AND CALCULATIONS

In order to demonstrate that the proposed 132kV underground cables that might be installed in residential or commercial areas comply with EMF health exposure and also EMF interference requirements it is necessary to carry out the electromagnetic field modelling and calculations. To do this it is necessary to know the cable details, installation geometry and the electrical loading data.

This assessment is only related to the magnetic field emission from the cables. Due to metallic sheath of cables and also by the effect of soil, the electric field from underground cables is effectively shielded and is immeasurable in the space above buried cables. Therefore, this assessment is only related to the extremely low frequency magnetic field emitted by buried cables.

The following design data for the proposed 132kV underground cables was provided by Powerlink:

1. The 132kV dual circuit cable line will be constructed using the single-core XLPE insulated 800mm^2 copper cables. The overall diameter of the cable is 95mm. The cable construction details are shown in Figure 1;
2. The combined ultimate power rating of the dual circuit cable line is 150 MWA.

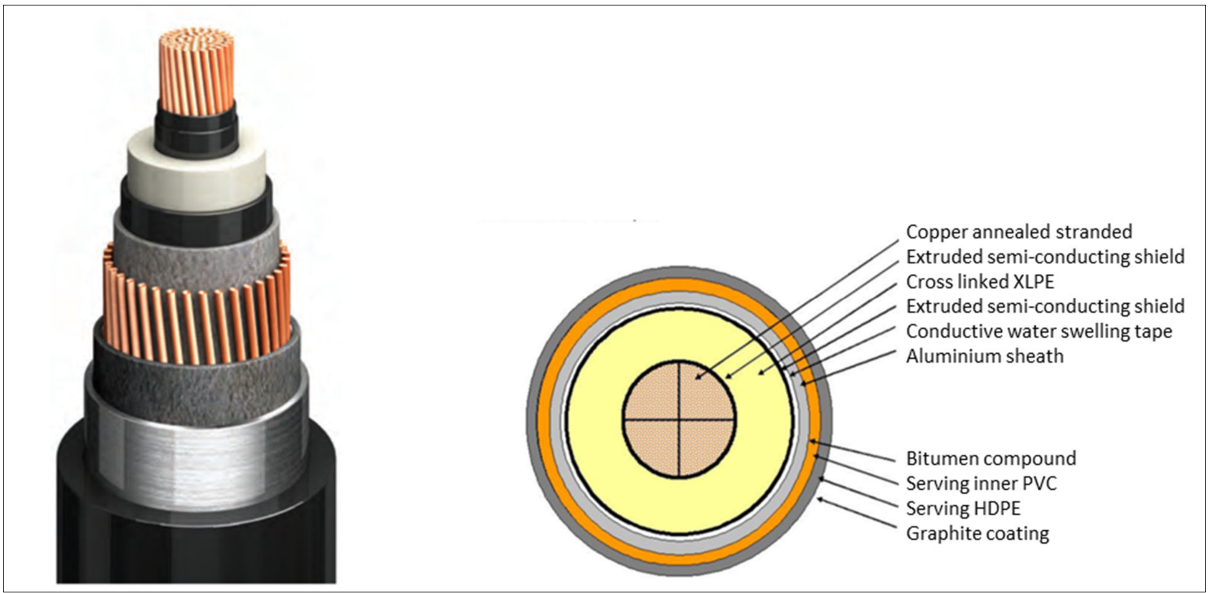


Figure 3 Construction detail of typical 132kV, XLPE Insulated copper cable

In addition, it is necessary to consider the followings important technical conditions:

- Zero sequence current in each 132kV circuit consisting of three single-core cables is negligibly small and, hence, was not included in the model.
- The phase shift between the currents in two adjacent 132kV circuit is equal to zero.
- The sheaths of the single-core 132kV cables will be divided into three equally long sections, electrically cross-bonded and earthed at both ends of each cable core. As a result, the voltage

induced in the three equally long sections of the sheath of each cable core will be balanced and, at 120 electrical degrees to each other. This results in zero current flowing in the cable sheaths (see Figure 4).

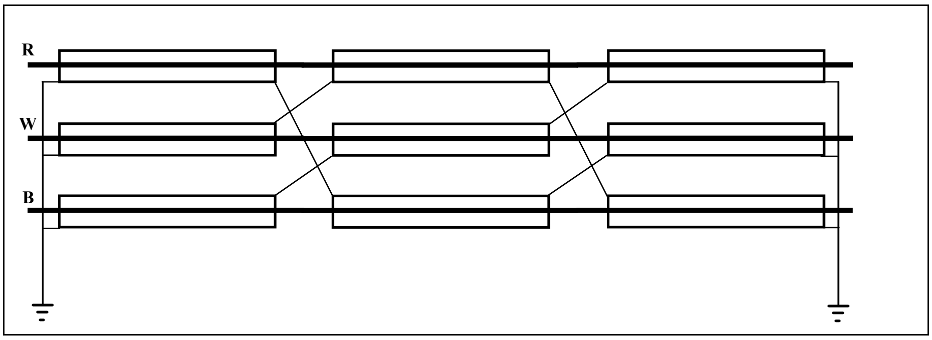


Figure 4 ***Cross-bonding and transposition of cable sheaths***

- The power factor of the load current in the two circuits is assumed to be 1.0
- The 85th percentile and time-weighted average electrical loading detail for both circuits
- EMF contribution from the existing sources which might be found along the proposed cable routes were excluded from this assessment.

The magnetic field from any electrical equipment is directly proportional to the electrical current passing through the equipment. The amount of electrical current passing though the equipment may substantially vary in time. Such fluctuation of current can be rapid with switching ON and OFF of various equipment connected to a low voltage suburban power line or they can be changing much slower in transmission and sub-transmission lines that feed large area with numerous residential, industrial and commercial customers. Nevertheless, the load current in such powerlines or cables might vary substantially during a typical weekday with daily maximum and minimum and have somewhat different pattern during a weekend.

The electrical load current can vary seasonally reaching its maximum either during a hot summer period or during the cold winter days. Such varying nature of the electrical current and the magnetic field it generates makes it difficult to determine if its health impact should be assessed on the basis of the highest current over a short duration or the average current over a very long, practically continuous, time. Epidemiological association between the EMF and its possible health effect is related to the exposure over a long period of time. Therefore, it is most appropriate to use in the calculations the long-term average annual load current. However, for more conservative exposure assessment the ENA in its 2006 document for “Standard basis for quoting transmission line magnetic fields” recommends to use the 85th percentile loading level determined from the load duration curve. Therefore, in assessing the magnetic field exposure level the ENA recommends to use the load current which exceeds for only 15% time of the year. This is now considered as the standard EMF calculation methodology in reference to the transmission and sub-transmission overhead powerline and underground cable projects.

However, for the present study Powerlink requested even more conservative modelling approach. Powerlink requested that the EMF modelling and calculations were carried out on the basis of a worst-case continuous power rating of 150 MVA or the current of 656 A per phase or 328 A per set of 3 cables to supply two 75MVA transformers. Powerlink also recommended modelling for the worst-case cable installation formation where the cables are installed in a shallow trench with reduced soil cover of 500mm. Such conditions might exist in situations where the cables are crossing other services.

In the study the required loading condition were applied to the following cases:

a) Both 132kV cable circuits are in service and they're equally sharing 656 A current
   i. Two normal trefoils as shown in Figure 1a
   ii. One normal and one inverted trefoil as shown in Figure 1b
   iii. Flat configuration as shown in Figure 1c
   iv. Cable joint bay with two circuits in service as shown in Figure 1d.

The results of computer modelling and EMF calculations for the four different formations of two sets of cables, where both cables are equally loaded with 328 A per phase are presented in graphical forms as four EMF profiles in Figure 5.

As per the standard assessment of the EMF exposure the EMF was calculated at 1m above the ground.

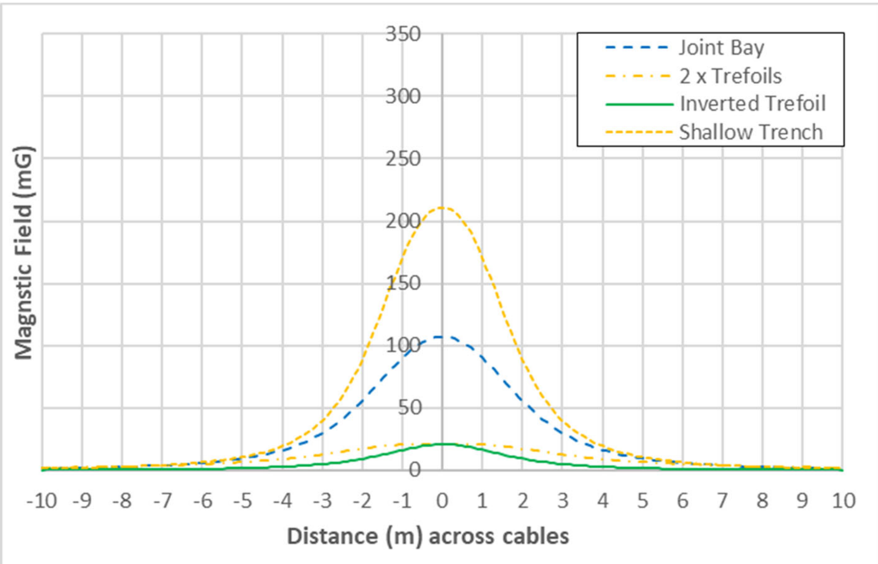


Figure 5a ***EMF profiles for four different formations of 2 sets of 132kV cables where both sets are electrically loaded equally to the half of their rated capacity***

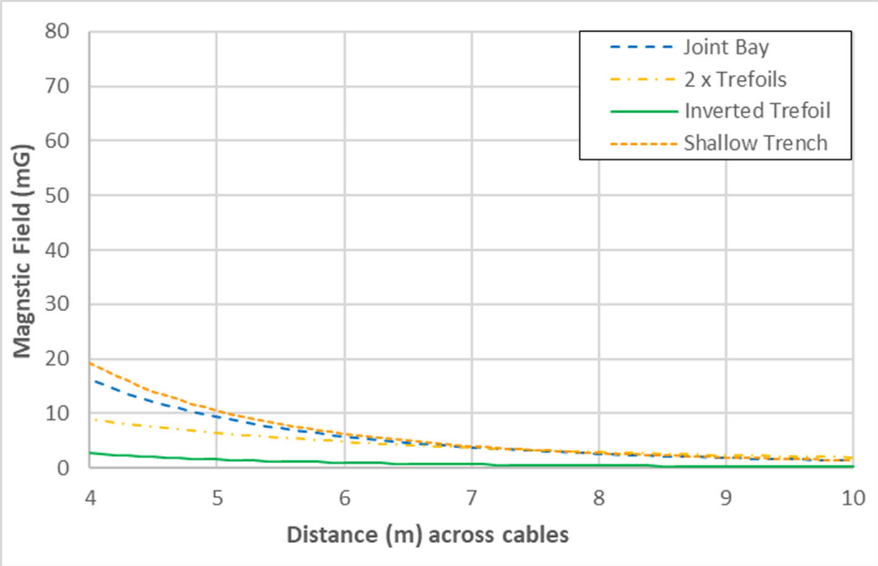


Figure 5b ***Same as Figure 5a with expanded vertical scale to show the effect of four different formations of cables at distances away from cables along the route.***

As can be concluded from the EMF profiles presented in Figures 5a and 5b, the most effective cable arrangement in respect to the lowest EMF in the space directly above the cable trench and at lateral distances away from the trench is for inverted trefoil case. In this arrangement one set of 3 x 1-core cables is installed in a normal trefoil formation and the other set of 3 x 1-core cables is installed in inverted trefoil formation and both sets of cables are electrically loaded with the same current per phase equal to 328 A.

As should be expected, the worst-case in respect to the EMF emission in the space above the cable trench and at lateral distances away from the trench is when the cables are installed in a shallow trench.

The results of EMF calculations for different distances away from the centre of the cable trench or the cable joint bay are presented in tabular form in Table 1.

Table 1

	Both 132kV Cable Circuits are in Service			
Distance	Joint Bay	2 x trefoils	1 trefoil & 1 inv trefoil	shallow trench
(m)	mG	mG	mG	mG
-10	1.38	1.95	0.24	1.42
-9.5	1.59	2.15	0.28	1.65
-9	1.86	2.37	0.33	1.93
-8.5	2.19	2.63	0.38	2.29
-8	2.61	2.94	0.45	2.73
-7.5	3.13	3.29	0.54	3.30
-7	3.79	3.72	0.65	4.03
-6.5	4.65	4.22	0.80	5.00

-6	5.78	4.83	0.98	6.29
-5.5	7.29	5.57	1.23	8.05
-5	9.35	6.47	1.57	10.52
-4.5	12.19	7.57	2.02	14.08
-4	16.17	8.92	2.66	19.33
-3.5	21.82	10.56	3.56	27.32
-3	29.86	12.54	4.83	39.77
-2.5	41.04	14.81	6.64	59.31
-2	55.79	17.20	9.14	88.97
-1.5	73.17	19.29	12.41	128.92
-1	90.15	20.49	16.13	170.90
-0.5	102.48	20.57	19.36	200.80
0	106.94	20.34	20.74	210.95
0.5	102.48	20.57	19.51	200.80
1	90.15	20.49	16.33	170.90
1.5	73.17	19.29	12.58	128.92
2	55.79	17.20	9.25	88.97
2.5	41.04	14.81	6.70	59.31
3	29.86	12.54	4.87	39.77
3.5	21.82	10.56	3.58	27.32
4	16.17	8.92	2.67	19.33
4.5	12.19	7.57	2.03	14.08
5	9.35	6.47	1.57	10.52
5.5	7.29	5.57	1.24	8.05
6	5.78	4.83	0.99	6.29
6.5	4.65	4.22	0.80	5.00
7	3.79	3.72	0.65	4.03
7.5	3.13	3.29	0.54	3.30
8	2.61	2.94	0.45	2.73
8.5	2.19	2.63	0.38	2.29
9	1.86	2.37	0.33	1.93
9.5	1.59	2.15	0.28	1.65
10	1.38	1.95	0.24	1.42

As can be seen from the data provided in Table 1 the EMF calculated at the maximum rated capacity of the proposed 132kV cables assessed in different configurations are well below the health exposure limit provided in ICNIRP Guidelines.

In additional, the EMF levels at lateral distances of 10m or grater from the proposed 132kV cables (at the property boundary lines) in its worst installation settings, such as in the cable joint bay or in a shallow trench, and at the worst loading condition, such as one set is our of service and all the electrical load current is flowing through the remaining set of 3 x 1-core cables, the EMF is below the limit for 50Hz interference as recommended in the Australian Standard AS/NZS 61000.6.1:2006.

It should be noted that, as a general rule, the EMF from 3-phase overhead power line or underground cable is inversely proportional to the square of the distance away from them. This means that the depth of cable installation has much more significant effect on the EMF in the space directly above the cables as compared to its values at horizontal distances away from them.

The following four sets of EMF profiles presented in Figures 6 to 9 represent EMF profiles calculated for the four cable installation cases presented by Stockton Drilling Services (document No. J092-FR-0001) and included on pages 5 and 6 of this report.

The EMF profiles presented below were calculated for the following 3 service conditions:

1) At the commissioning stage when the cables will be loaded to 188 A per circuit;
2) At the planning stage 10 year into future with steady annual load growth when the cables will be loaded to 223 A per circuit;
3) At the ultimate capacity of the for the Woree to Kamerunga powerline equal to 150 MVA or 328 A per circuit.

It should be noted that for the above listed loading conditions the EMF modeling and calculations were performed taking into consideration the time-weighted average level of electrical load. This approach was recommended by the Electricity Network Accusation for the EMF modelling and calculations assuming that the average long-term load of the powerline will conservatively be equal to the 85% of the maximum predicted load.

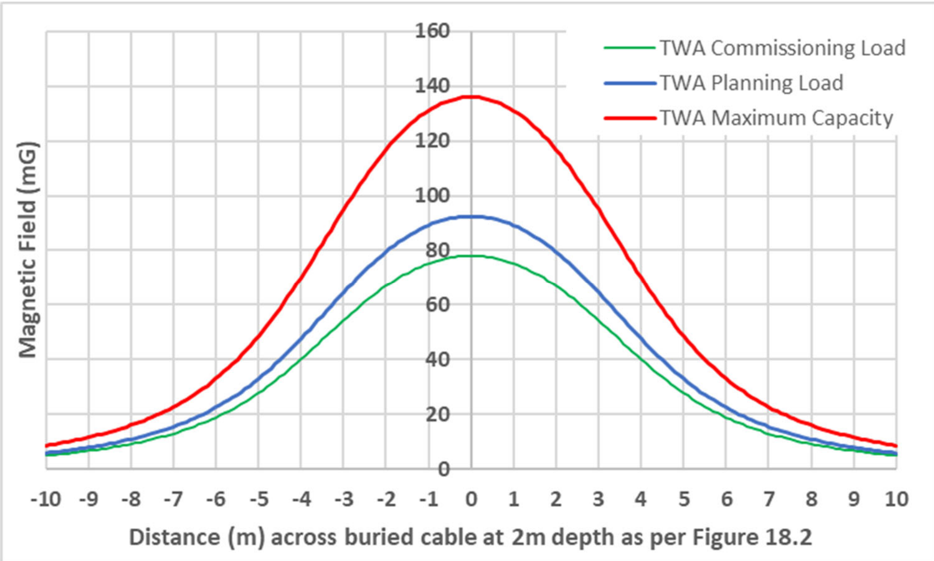


Figure 6a *EMF profiles calculated at 1m above ground across cables buried at 2m below ground and arranged as per Fig. 18.2 of Stockton Drilling Services report (see page 5 of this report).*

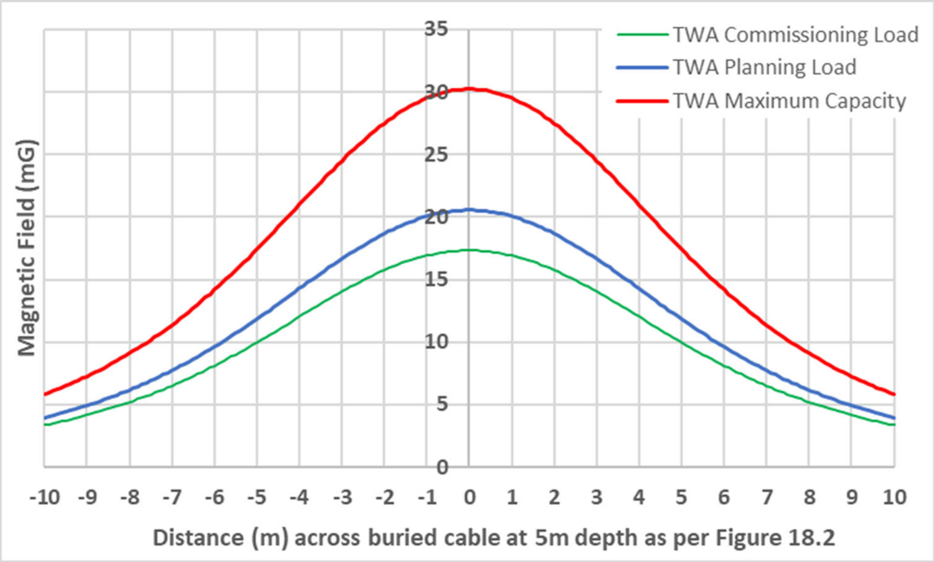


Figure 6b *The same as per Figure 6a but cables are buried at 5m depth.*

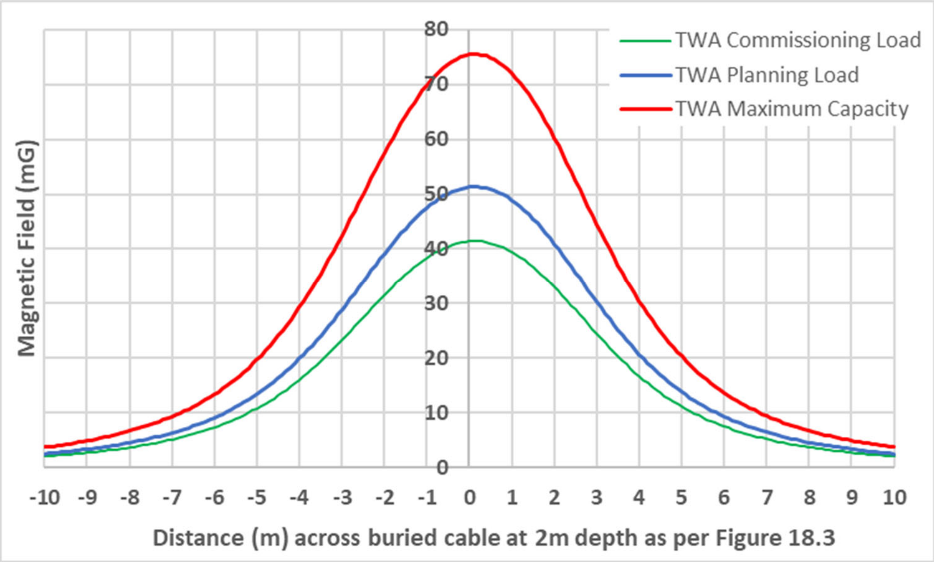


Figure 7a *EMF profiles calculated at 1m above ground across cables buried at 2m below ground and arranged as per Fig. 18.3 of Stockton Drilling Services report (see page 5 of this report).*

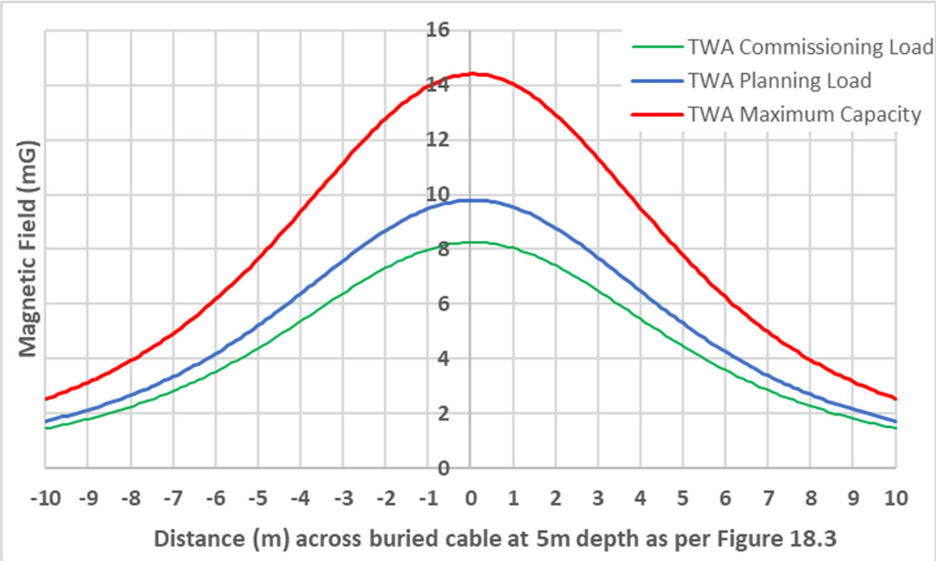


Figure 7b *The same as per Figure 7a but cables are buried at 5m depth.*

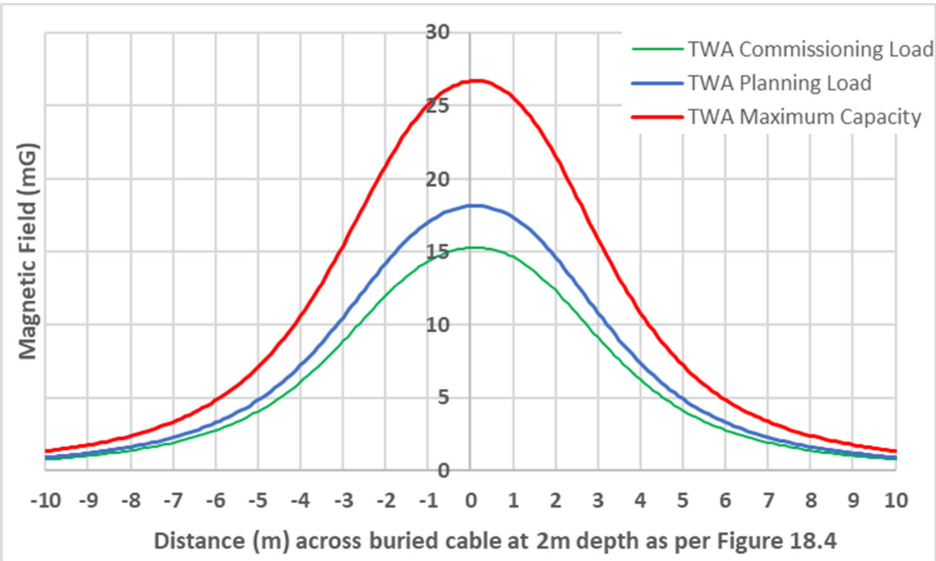


Figure 8a *EMF profiles calculated at 1m above ground across cables buried at 2m below ground and arranged as per Fig. 18.4 of Stockton Drilling Services report (see page 5 of this report).*

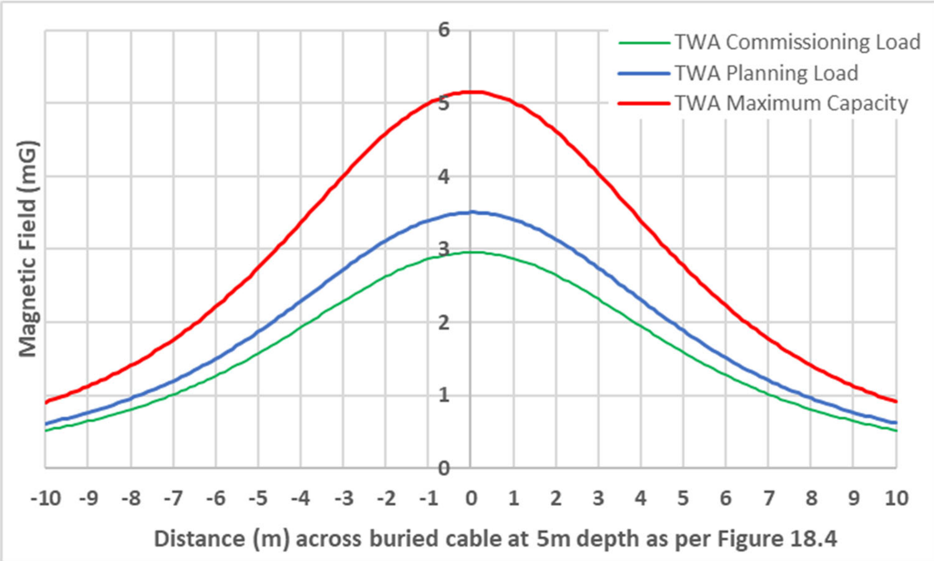


Figure 8b *The same as per Figure 8a but cables are buried at 5m depth.*

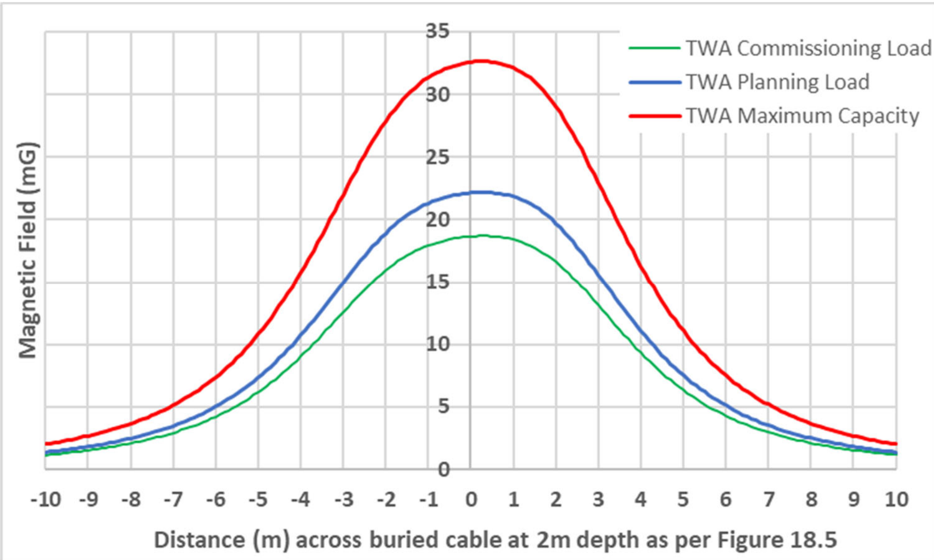


Figure 9a *EMF profiles calculated at 1m above ground across cables buried at 2m below ground and arranged as per Fig. 18.5 of Stockton Drilling Services report (see page 6 of this report).*

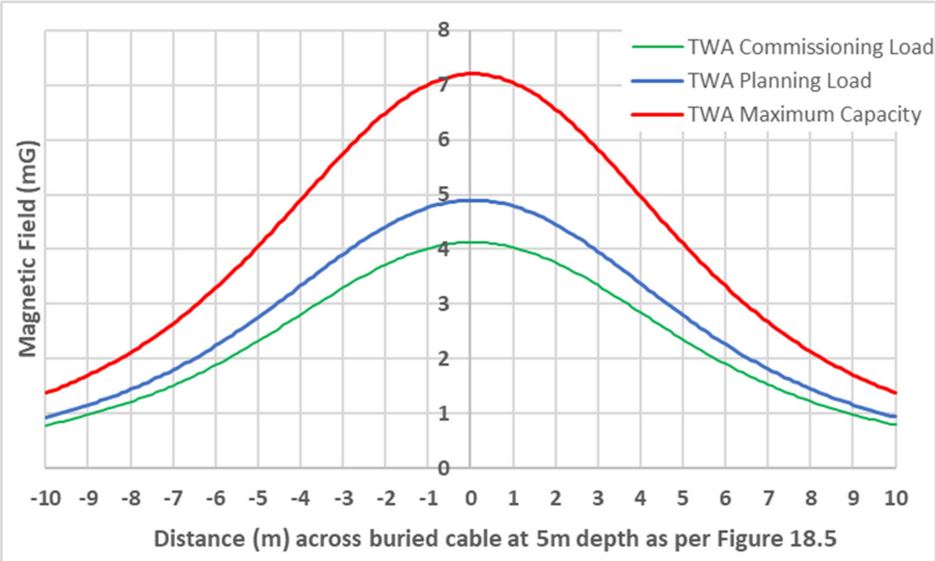


Figure 9b The same as per Figure 9a but cables are buried at 5m depth.

As can be noted from the profiles presented in Figures 6 to 9 the EMF reduces slower with lateral distances away from the cable as compared with cable installation in the standard trench as shown in Figure 1b and associated EMF profile in Figure 5a.

4.1 Application of Prudent Avoidance Measures

Based on the design data supplied by Powerlink for the study, it is evident that the prudent avoidance approach in respect to the EMF emission was at the core of the project. Such approach is evident from the following design information:

- The overhead power line will be replaced by underground cables. This measure is substantially more expensive but results in complete elimination of the low frequency electrical field produced by overhead power lines and in substantial reduction of magnetic field.
- The proposed cable route for the underground cables was considered so as to avoid placement of the 132kV cables in heavily populated areas and areas fitted with commercial properties.
- Where practical, it is intended to construct the cable trench and cable join bays in the middle of roadways and, hence, at considerable distance away from residential and commercial properties.
- The 132kV overhead power line will be replaced by two sets of 132kV underground cables. Dividing the total electrical load current between the two sets of cables when the cables will be installed with favorable configuration and phase sequence substantially reduces EMF in the space directly above the cables and at lateral distances away from them.
- Application of innovative cable configuration, where one set of 3 single core cables will be installed with conventional trefoil arrangement while the second set in inverted trefoil arrangement, will result in substantial minimization of the EMF in the space directly above the cables and at lateral distances away from them.
- Application of the low EMF phase sequencing between two sets of 3 single-core cable when installed in flat formation at crossings with other services and in cable joint bays.

References:

1. ENA, 2014, Policy Statement on Electric and Magnetic Fields (EMF).
2. Gibbs, Sir Harry (1991). Inquiry into community needs and high voltage transmission line development. Report to the NSW Minister for Minerals and Energy. Sydney, NSW: Department of Minerals and Energy, February 1991.
3. Parliament of the Commonwealth of Australia - Senate Economics References Committee 1995, EASTLINK, The Interconnection of NSW and Queensland Electricity Grids with a High Voltage Powerlink.
4. Peach H.G., Bonwick W.J. and Wyse T. (1992). Report of the Panel on Electromagnetic Fields and Health to the Victorian Government (Peach Panel Report). Melbourne, Victoria: September, 1992. 2 volumes: Report; Appendices.
5. WHO 2007, Electromagnetic fields and public health – Exposure to extremely low frequency fields. Fact Sheet 322 of June 2007.
6. WHO 2007, Extremely Low Frequency Fields – Environmental Health Criteria, Monograph No. 238 March 2007.
7. Melik G, "Magnetic Field Mitigation to Reduce VDU Interference", book published by Electricity Supply Association of Australia in July 1996.
8. "Mitigation Techniques of Power-Frequency Magnetic Fields Originated from Electric Power Systems", CIGRE Technical Brochure No: 373 prepared by WG C4.204, February 2009.
9. Hart J & Melik G "Ausgrid's North Shore 132kV Cables Project – Learnings on Route Selection, EMF Mitigation and Stakeholder Engagement" CIGRE 2016, paper No: C3-202.
10. ENA EMF Handbook, 2016.

Appendix A Additional Information on EMF and Health Exposure

On the 18th of December 1995 the Senate Economics References Committee released its report to the Senate on the proposed Eastlink transmission line project linking the electricity grids of New South Wales and Queensland. The committee's findings on the electromagnetic fields and their health effects are similar to those of the 1991 Gibbs Report. The Committee's Report states:

> *"In the light of... conflicting evidence, and because it is not possible scientifically to prove a negative, the Committee is unable to totally dismiss that there may be adverse (health) effect. Similarly, the Committee is unable to conclude that a definite link between power lines and adverse effects on human health exists and thus that any new policy recommendations need to be made. However, the Committee is able to conclude that simply the fear of detrimental health effects, whether real or imaginary, is in itself having an impact on lives of some individuals. The Committee takes a similar stand to that of Gibbs Report. The Committee agrees that, as a minimum policy or until evidence suggests otherwise, the concept of 'prudent avoidance' should continue to be practised by government and power authorities..."*

There have been a number of reported cases around the world where power transmission and distribution companies relocated or modified their existing electrical installations on the basis of perceived health risk associated with exposure to the power frequency magnetic fields, even though the levels were much smaller than the safe exposure limits recommended by the NHMRC and ICNIRP. Notwithstanding this, the level at which such relocations or modifications are warranted is not established and consideration should be given to the net potential benefit that may be gained from such actions.

Over the last forty years there have been many magnetic field surveys conducted within commercial and residential buildings in Australia and overseas. As a result of these surveys it can be concluded that the background level of magnetic field in a typical office or home environments is generally within the range of 0.5 – 3 mG. The EMF levels that can be measured along the streets in residential areas typically ranging between 0.5 mG and 18 mG.

Some household electrical appliances can produce the EMF in the range of 5 mG to 70 mG. For example, an average electric hair dryer can typically emit the EMF of 25 mG, while an electric stove may emit the field in the range of 2 mG to 30 mG and a personal desk-top computer can emit the EMF in the range of 2 mG to 20 mG.

There is no irrefutable scientific evidence of the adverse health effect from power frequency magnetic fields. Nor is there evidence to categorically dismiss any adverse health effects. It has not yet been established if a cumulative effect of relatively low field strengths may have some biological effects. It is also not yet known whether an intermittent exposure to the EMF may cause adverse health effects and, therefore, should be avoided.

In May 1999, the Director of the US National Institute of Environmental Health Sciences (NIEHS) tabled a report to the US Congress on “Health Effects from Exposure to Power-line Frequency Electric and Magnetic Fields".

A conclusion of the NIEHS report was:

“that ELF-EMF exposure cannot be recognised at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In my opinion, the conclusion of this report is insufficient to warrant aggressive regulatory concerns. However, because everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposure.

“While the support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of a small, increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia”.

“mechanistic studies and the animal toxicology literature, failed to demonstrate any consistent pattern across studies although sporadic findings of biological effects have been recorded. No indication of increased leukemias in experimental animals has been observed.”

In February 1, 2000, the Swiss Bundesrat (Upper House) enacted an "Ordinance Concerning Protection from Non-Ionising Radiation (NISV)" which sets a 10 mG exposure limit for power lines and other exposure sources affecting "sensitive use locations", including any room in a building which is "regularly occupied for significant period of time" and children's playgrounds.

An Explanatory Report issued by the Swiss Federal Office for the Environment, Forestry and Agriculture explains that these "precautionary" measures are needed because biological effects have been documented from EMF exposures below the ICNIRP limits, and because there is uncertainty about the possible harmful consequences of lower level exposures. The Report specifically points to the NIEHS Working Group recommendation that power frequency EMF be considered as "possible carcinogenic."

Early in 2001 the Advisory Group on Non-Ionising Radiation (AGNIR) to the UK National Radiological Protection Board published a report on power frequency electromagnetic fields and the risk of cancer.

In assessing the results of all Residential Exposure studies conducted around the world the report states that:

> *"… relatively heavy average exposure of 0.4 μT* (4 mG) *or more are associated with doubling of the risk of leukaemia in children under 15 years of age. The evidence, however, is not conclusive."*

The main conclusion of the report is:

> *“Laboratory experiments have provided <u>no good evidence</u> that extremely low frequency electromagnetic fields are capable of producing cancer, nor do human epidemiological studies suggest that they cause cancer in general. There is, however, some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukaemia in children. In practice, such levels of exposure are seldom encountered by the general public in the UK. In the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the epidemiological evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children. Unless, however, further research indicates that the finding is due to chance or some currently unrecognised artefact, the possibility remains that intense and prolonged exposure to magnetic fields can increase the risk of leukaemia in children.”*

In 2002 the International Agency for Research on Cancer (IARC) classified the power frequency magnetic fields as a *possible carcinogen*. [Ref.: (IARC), I.A.f.R.o.C. (2002). *Non-ionizing radiation, Part 1: static and extremely low-frequency (ELF) electric and magnetic fields.* Vol. 80. IARC Monogr Eval Carcinog Risks Hum.]

US study on the effect of magnetic fields on the risk of miscarriage resulted in the following conclusion:

> *"…prenatal maximum magnetic field exposure above a certain level (possibly around 16 mG) may be associated with miscarriage risk. The association was stronger for early miscarriages (<10 weeks of gestation) and among "susceptible" women with multiple prior foetal losses or subfertility."* [Re: Epidemiology 2002 January;13(1):9-20].

In 2010 the British Journal of Cancer published the following paper: *"Pooled analysis of recent studies on magnetic fields and childhood leukaemia"* (authors: L Kheifets, A Ahlbom, C M Crespi, G Draper, J Hagihara, R M Lowenthal, G Mezei, S Oksuzyan, J Schüz, J Swanson, A Tittarelli, M Vinceti and V Wunsch Filho). The main conclusion of the paper was as follows:

> *"Our results are in line with previous pooled analyses showing an association between magnetic fields and childhood leukaemia. Overall, the association is weaker in the most recently conducted studies, but these studies are small and lack methodological improvements needed to resolve the apparent association. We conclude that recent studies on magnetic fields and childhood leukaemia do not alter the previous assessment that <u>magnetic fields are possibly carcinogenic.</u>"*

In 2002 the Planning and Environment Court of Queensland imposed a magnetic field exposure limit of 0.4 µT (4 mG) on a new electricity substation development at Tanah Merah. This decision follows an appeal by the power company Energex Ltd, against an earlier decision of the court. The case was officially closed on the18th March 2002. The judgement was based on the findings of the NRPB AGNIR Report of April 2001 that exposure to magnetic fields above 0.4 µT is associated with a doubling of the risk of childhood leukaemia. The court accepted that while there was no absolute proof that exposure to magnetic fields cause an increased risk of childhood leukaemia the policy of "prudent avoidance" should apply.

In 2003 The Italian President of the Council of Ministers adopted a law which sets the following EMF exposure limits for general population [Ref.: "DECREE OF THE PRESIDENT OF THE COUNCIL OF MINISTERS 8 JULY 2003 - Establishment of exposure limits, attention values, and quality goals to protect the population against power frequency (50 Hz) electric and magnetic fields generated by power lines"]:

<u>Art. 3 Exposure limits and attention values</u>

1. *In case of exposure to electric and magnetic fields generated by power lines, the following exposure limits must not be exceeded: 100 µT* (1000 mG) *for the magnetic flux density and 5 kV/m for the electric field, both expressed as rms values.*
2. *As a cautionary measure to protect against any possible long-term effects that might be related to power frequency (50 Hz) magnetic fields, an attention value of 10 µT* (100 mG) *is adopted in children's playgrounds, residential dwellings, school premises, and in areas where people are staying for 4 hours or more per day. The attention value is the median of values recorded over 24 hours, under normal operational conditions.*

<u>Art. 4 Quality goals</u>

1. *In designing new power lines in the neighbourhood of children's playgrounds, residential dwellings, school premises, and in areas where people are staying for 4 hours or more per day, as well as in planning developments in the proximity of existing electric power lines and*

installations, including the categories mentioned above, a quality goal of 3 µT (30 mG) *is adopted for the purpose of the progressively minimising exposures to electric and magnetic fields generated by 50-Hz power lines. The quality goal is the median of values recorded over 24 hours, under normal operational conditions.*

<u>In Sweden:</u> The policy was set out in a 1996 Statement:

"If measures to reduce exposure can be taken at reasonable expense and with reasonable consequences in all other aspects, an effort should be made to reduce fields radically deviating from what could be deemed normal in the environment. Where new electrical installations and buildings are concerned, efforts should be made already at the planning stage to design and position them in such way that exposure will be limited. "

The following section considers *"what is meant by a normal magnetic field level?"* and states that the median value for homes and day nurseries in major towns or cities is approximately 0.1 µT, with 10% of homes having at least one room with a magnetic field exceeding 0.2 µT. It therefore suggests, without being explicit, that *"radically deviating from normal"* should be understood in relation to these figures.

<u>In Denmark and Norway:</u> Both countries have introduced the concept of an *"investigation"* level of an annual average of 0.4 µT (Norway in 2007 as a national policy, and Denmark in 2009 as a voluntary measure jointly by electricity companies and local authorities - Denmark has had a precautionary policy since 1993). If a new installation (such as a power line) or a new home would exceed this, an investigation is made of possible ways of reducing the field. But measures are only adopted if they are reasonable in terms of cost-benefit, safety, security of supply etc. Typical measures that might be adopted include optimal phasing.

<u>In Netherlands:</u> In November 2005, the Government issued a recommendation to local authorities that they should no longer give permission for new homes to be built in the "0.4 µT zone" of power lines. The policy was confirmed in a letter of November 4th, 2008. This also clarifies that a "long stay" is taken to be at least 14-18 hours a day during one year, that the "sensitive objects" where the policy applies are dwellings, schools, and crèches, and that not only the house but also the garden is part of the sensitive object.

<u>In Poland:</u> The current exposure limits in residential areas are:

- Electric field is 1 kV/m
- Magnetic field is 48 µT

<u>In Russian Federation:</u> The Russian Federal Law was introduced in August 2007 that limits the permissible population exposure to the 50Hz magnetic field to the following levels:

a. In all type of residential buildings, childcare centres, schools, tertiary institutions and other teaching organisations, hospital and medical clinics the magnetic field should not exceed 5 µT.

b. In unoccupied areas of residential buildings, in all administrative and commercial buildings, in populated areas designated for residential and commercial development, and in public parks and gardens the magnetic field should not exceed 10 µT.

c. In populated areas outside residential zones and within the zones occupied by overhead power lines or underground cables of voltages greater than 1kV the magnetic field should not exceed 20 µT.

d. In unpopulated areas and areas with difficult terrain that can be rarely visited by people the magnetic field should not exceed 100 µT.

In Slovenia: Exposure limits are 500 V/m and 10 µT for new facilities and in designated areas.

In Israel: Measures to be taken to reduce fields above level of suggested health effects; no measures needed below 0.2 µT.

In United Kingdom: For public exposure, the UK policy is to comply with the 1998 ICNIRP guidelines in the terms of the 1999 EU Recommendation. In 2010, ICNIRP produced new guidelines. But these do not automatically take effect in the UK. The UK policy remains based on 1998 ICNIRP until Government decide otherwise.

In June 2005 a paper on one epidemiological study published in the British Medical Journal and entitled *"Childhood cancer in relation to distance from high voltage power lines in England and Wales: a case-control study"* (authors: Gerald Draper, Tim Vincent, Mary E Kroll, John Swanson) reported an elevated risk of leukaemia in children living in proximity to high voltage power lines. The main results of the study are: Compared with those who lived > 600 m from a line at birth, children who lived within 200 m had a relative risk of leukaemia of 1.69 (95% confidence interval 1.13 to 2.53); those born between 200 and 600 m had a relative risk of 1.23 (1.02 to 1.49). There was a significant ($P < 0.01$) trend in risk in relation to the reciprocal of distance from the line. No excess risk in relation to proximity to lines was found for other childhood cancers.

The results of another epidemiological study carried out in Japan and published in February 2006 in the International Journal of Cancer under the title *"Childhood leukemia and magnetic fields in Japan: A case-control study of childhood leukemia and residential power-frequency magnetic fields in Japan"*, provided additional evidence that the exposure to the time-weighted average power frequency magnetic field above 0.4µT (4 mG) was associated with a higher risk of childhood leukemia. The study included children whose mothers were exposed to high magnetic fields in residential settings while being pregnant. The outcome of this study is in agreement with conclusion of an earlier study carried out in Canada and reported in scientific literature in 2003 (Infante-Rivard C, Deadman JE. "Maternal occupational exposure to extremely low frequency magnetic fields during pregnancy and childhood leukaemia.", *Epidemiology* 2003; 14: 437–441). This study concluded that:

> *Occupational exposure of mothers to high levels of magnetic fields during pregnancy has been associated with childhood leukaemia.*

In February 2006 an Independent Advisory Group on Non-Ionising Radiation produced a report for the National Radiation Protection Board of UK under the title of: *"Power Frequency Electromagnetic Fields, Melatonin and the Risk of Breast Cancer".* The following was stated in the summary section of the report:

> *"Investigations using cells, animals and humans have not given consistent or convincing evidence that EMF exposure affects melatonin production or action. However, there are deficiencies in the existing research, which leave open the possibility of an effect.*
>
> *There is stronger evidence that melatonin can inhibit the growth of cancer cells in laboratory culture and in animals. Data on the possible relation of melatonin levels to risk of subsequent breast cancer in humans are limited and inconclusive. Studies investigating the effect of light exposure (which affects*

melatonin) on breast cancer risk in humans have given some evidence for an association, but left it unclear whether, if there is an association, it is causal in nature.

There is no consistent evidence, from research using cells, animals and humans, that EMF exposure is a cause of breast cancer, nor has any mechanism for such an association been demonstrated."

The French Geocap case–control study reported in 2013 in the British Journal of Cancer supported the hypothesis that living <50m from a 225kV or 400 kV high voltage overhead lines (HVOL) may be associated with an increased incidence of childhood acute leukaemia (AL). No increase in risk was observed further from those lines and no increase in childhood AL risk was detected within 50m of the 63–150 kV HVOL. *(C Sermage-Faure, C Demoury, J Rudant, S Goujon-Bellec, A Guyot-Goubin, F Deschamps, D Hemon and J Clavel "Childhood leukaemia close to high-voltage power lines – the Geocap study, 2002–2007". British Journal of Cancer (2013) 108, 1899-1906)*.

The following conclusion was made in the 2018 paper published in the British Journal of Cancer under the title:

> "Proximity to overhead power lines and childhood leukaemia: an international pooled analysis": *In conclusion, we found a small, imprecise association between childhood leukaemia and residence located within 50 m of 200 + kV lines, which was stronger for younger children, in our individual-data pooled analysis of 11 studies.*

Other possible adverse health effect of the EMF is interference with operation of medical devices such as, cardiac pacemakers and defibrillators, neurostimulators, cochlear implants, metallic prosthesis and other bio-electronic devices and implants.

The magnetic field measurements conducted in the case where a person was fitted with a neurostimulator showed some effect at the EMF level above 0.05 µT (5 mG) and that it becomes painful above 0.5 µT (50 mG).

A common practice in the Australian construction industry is to limit the maximum EMF exposure to 10mG or less in all areas that can be regularly occupied by people for a significant period of time. This practice first emerged in the late 1980s on the basis of our finding that such EMF is below the level of interference with 14" and 15" computer monitors fitted with Cathode Ray Tubes.

We've also been able to equate the previous practice of limiting the EMF exposure to 10 mG in all commercial buildings to the new requirements of containing the EMF exposure to within the time-weighted average limit of 4 mG. This is demonstrated in the following example.

If a child in a childcare centre or an expecting mother at work are exposed to 10 mG during 8 hours a day, then their time weighted average exposure level (TWA) over the entire week is less than 4 mG. This is calculated on the basis that statistically the average EMF exposure level for the majority of urbane population is less than 2 mG.

$$EMF_{TWA} = \frac{(10mG \times 8hours + 2mG \times 16hours) \times 5days + 2mG \times 24hours \times 2days}{24hours \times 7days} = 3.9mG$$

CP.01489 Kamerunga to Redlynch Easement Acquisition Project

Electromagnetic Field Calculations for Kamerunga to Redlynch 132kV Transmission line

Table 1: Magnetic Field Values at Easement Sections 1 and 2

Overhead Line Status	Easement Section	Maximum Level (mG)	At Edge of Easement (mG)	ICNIRP Guideline Reference Limit (mG)
Existing	Section 1	31.0	14.3	2000
New	Section 1	62.1	27.5	2000
Existing	Section 2	12.4	7.5	2000
New	Section 2	22.6	0.4	2000

Table 2: Electric Field Values at Easement Sections 1 and 2

Overhead Line Statue	Easement Section	Maximum Level (V/m)	At Edge of Easement (V/m)	ICNIRP Guideline Reference Limit (V/m)
Existing	Section 1	1030	630	5000
New	Section 1	1200	700	5000
Existing	Section 2	470	380	5000
New	Section 2	500	10	5000

In easement section 2, the significant decrease of the values at the edge of easement between the existing and new lines is due to the width of the easement increasing from 20m to 40m.

Easement Section 1 (1252-STR-1525 to Kamerunga Beam)

Section 1 - Existing 132kV Overhead Line

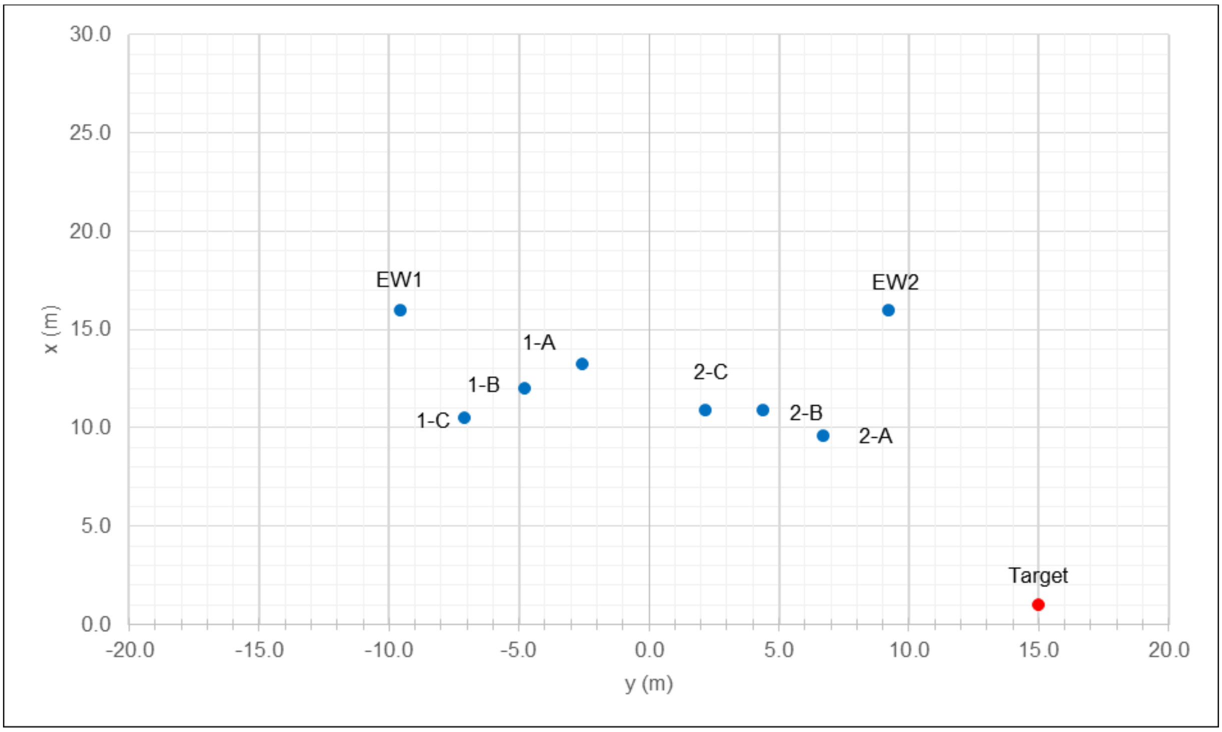


Figure 1: Section 1 – Approximate Location of Existing Wires at Mid-span

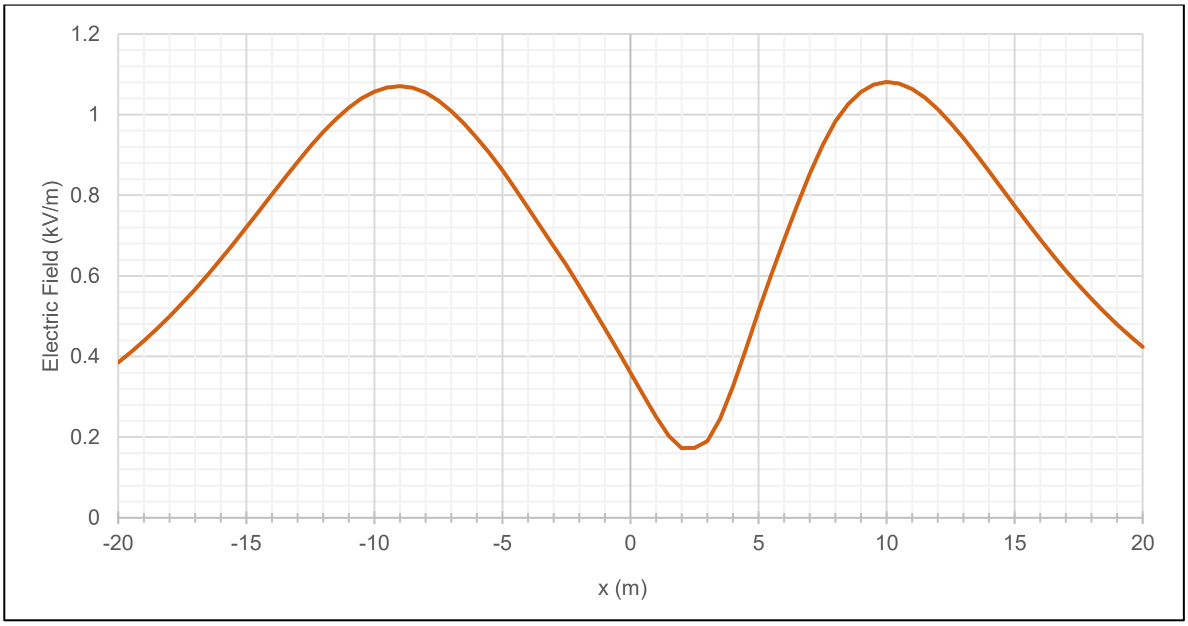


Figure 2: Section 1 - Electric Field of Existing Feeders at Mid-span

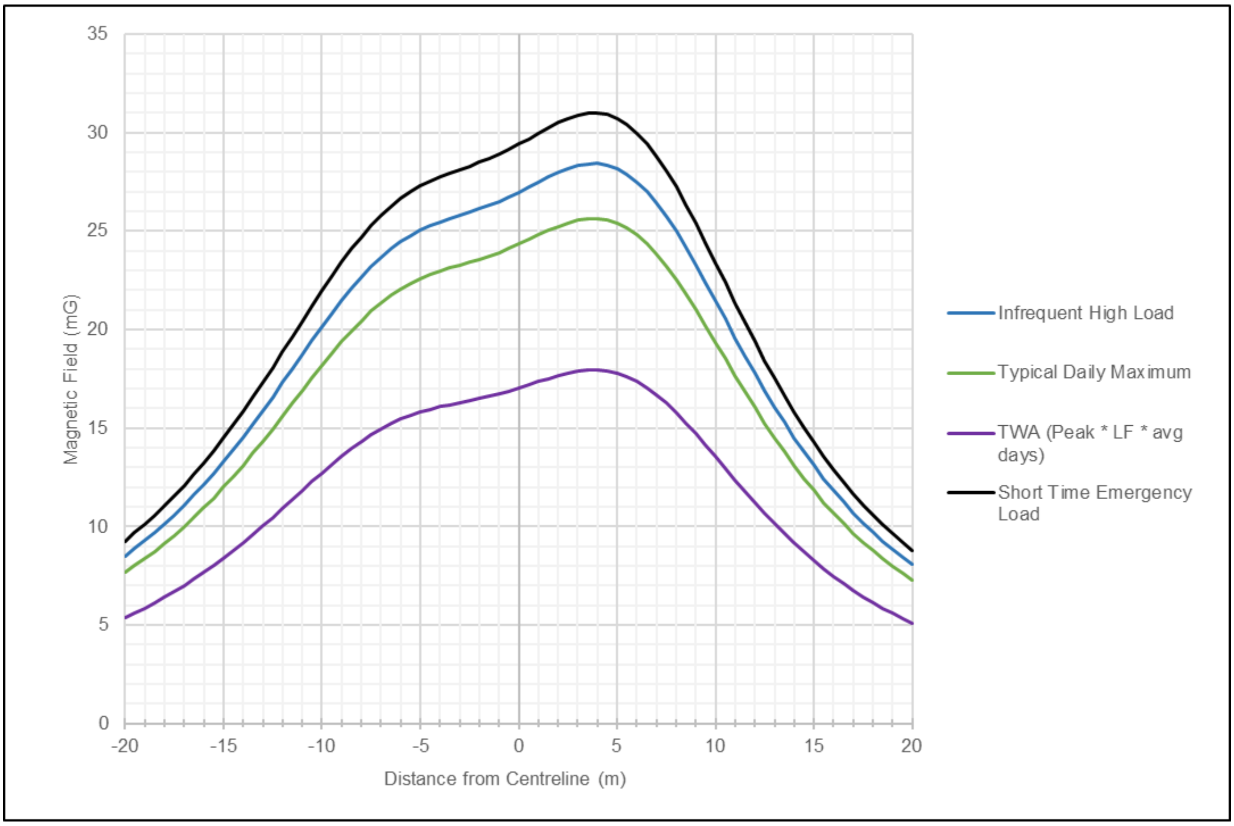


Figure 3: Section 1- Magnetic Field of Existing Feeders at Mid-span

Section 1 - New 132kV Overhead Line

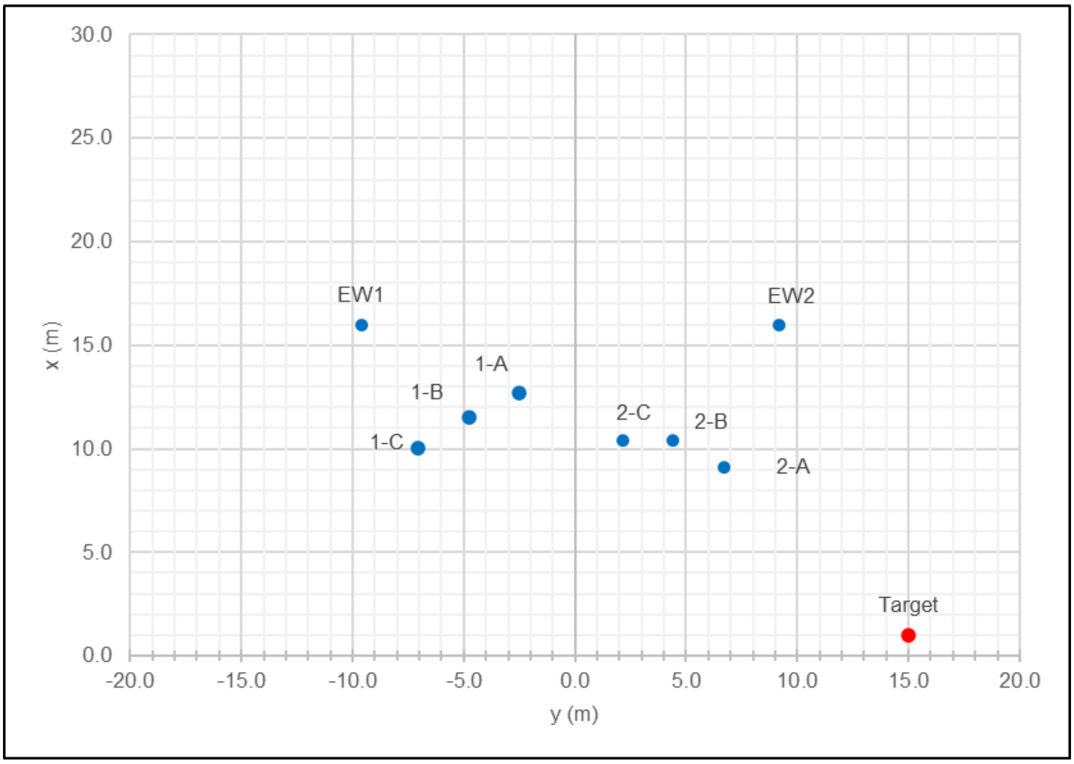


Figure 4: Section 1 – Approximate Location of New Wires at Mid-span

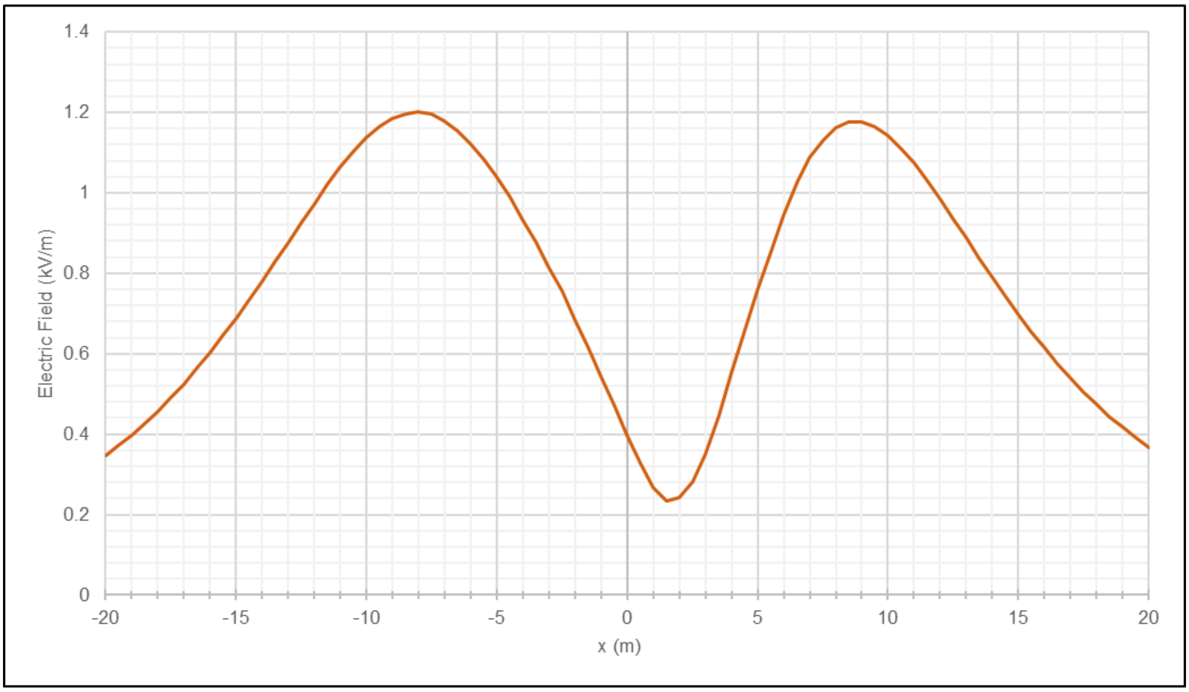


Figure 5: Section 1 - Electric Field of New Feeders at Mid-span

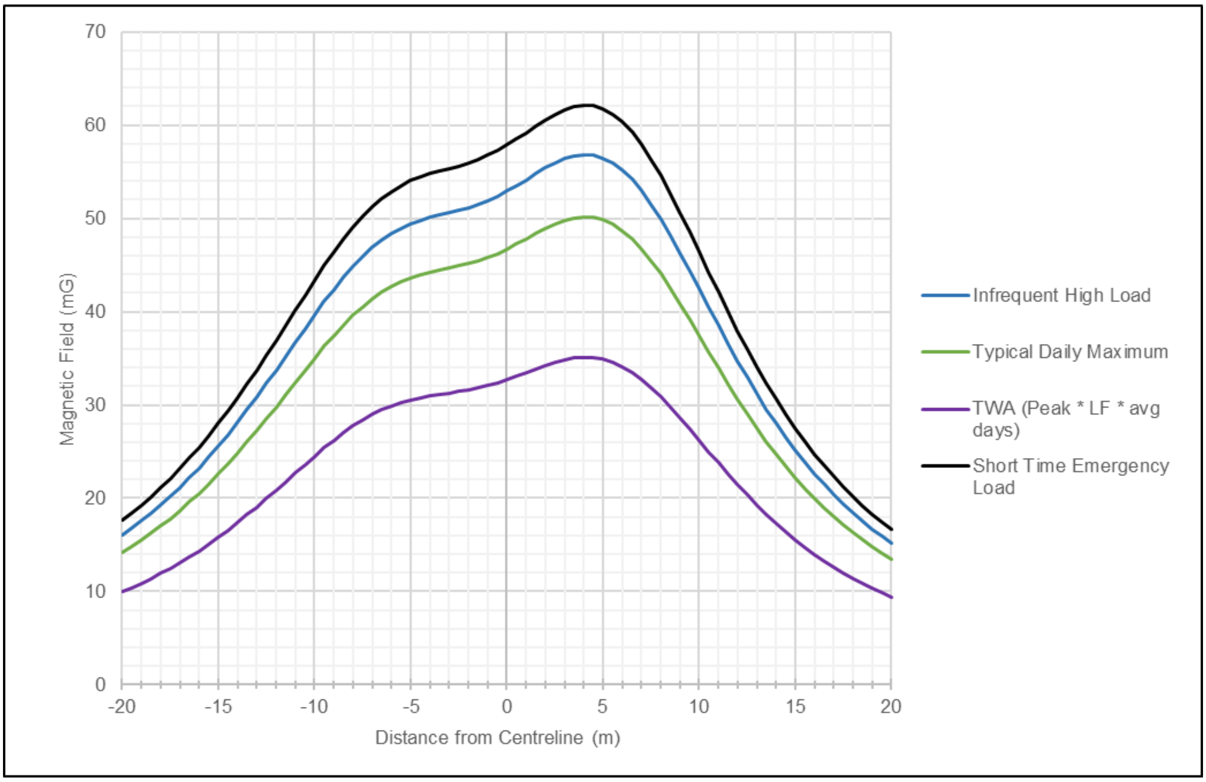


Figure 6: Section 1- Magnetic Field of New Feeders at Mid-span

Easement Section 2 (1252-STR-1531 to 1252-STR-1532)

Section 2 - Existing 132kV Overhead Line

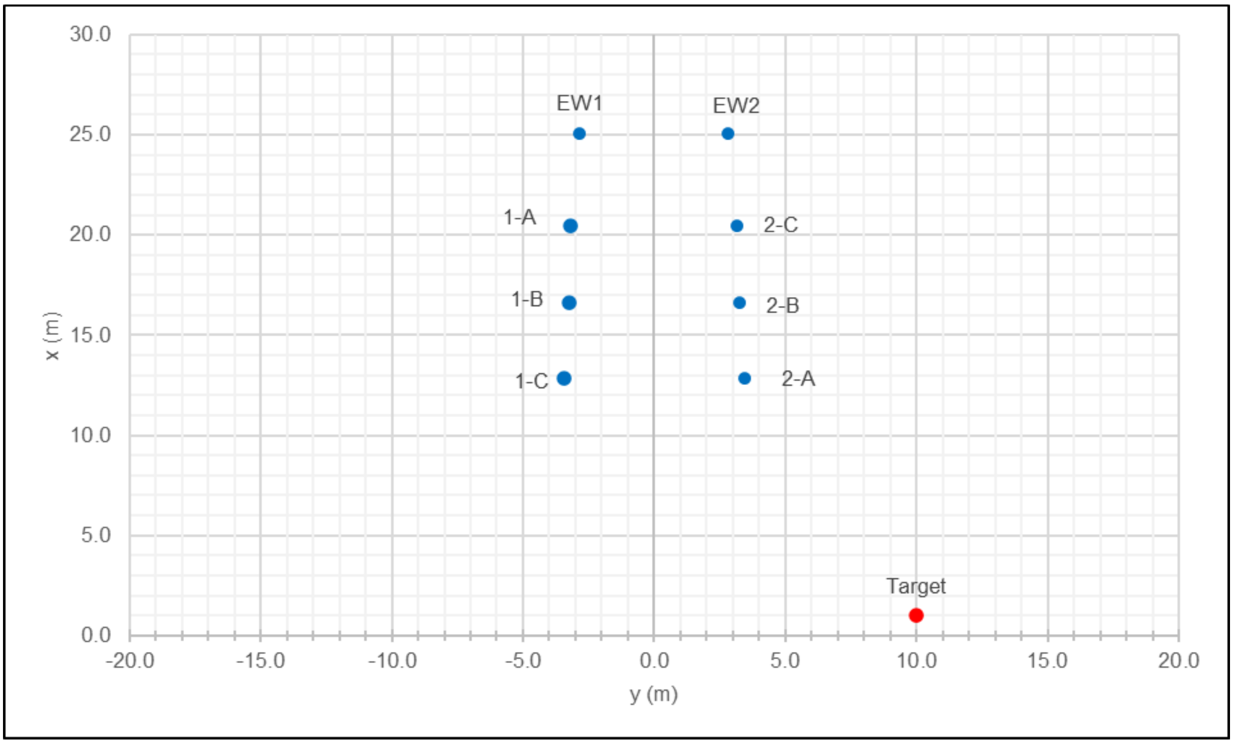


Figure 7: Section 2 – Approximate Location of Existing Wires at Mid-span

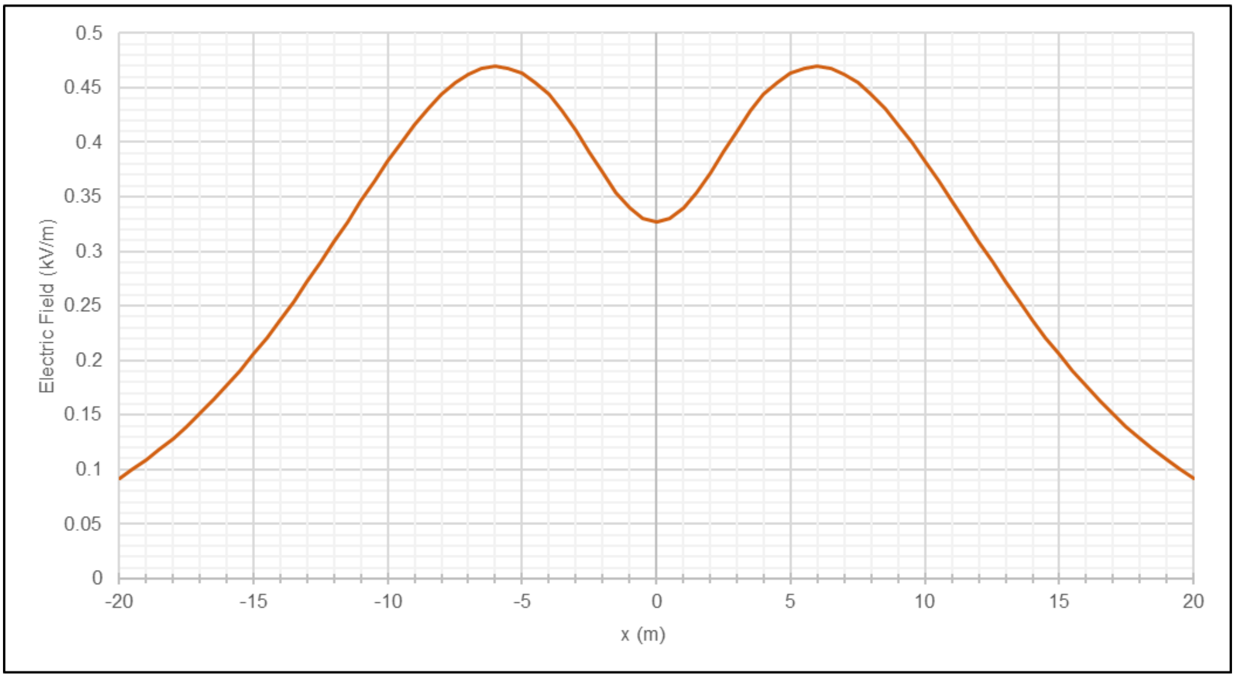


Figure 8: Section 2 - Electric Field of Existing Feeders at Mid-span

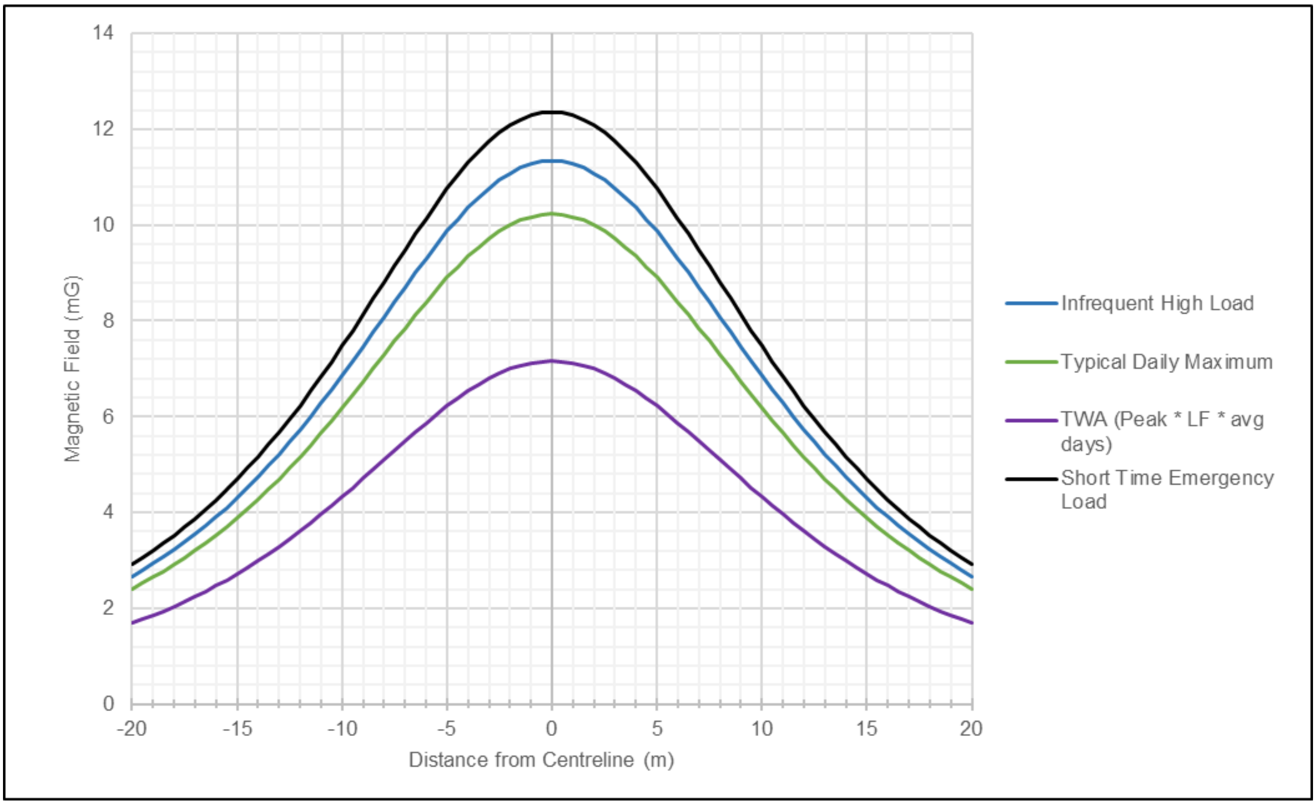


Figure 9: Section 2 - Magnetic Field of Existing Feeders at Mid-span

Section 2 - New 132kV Overhead Line

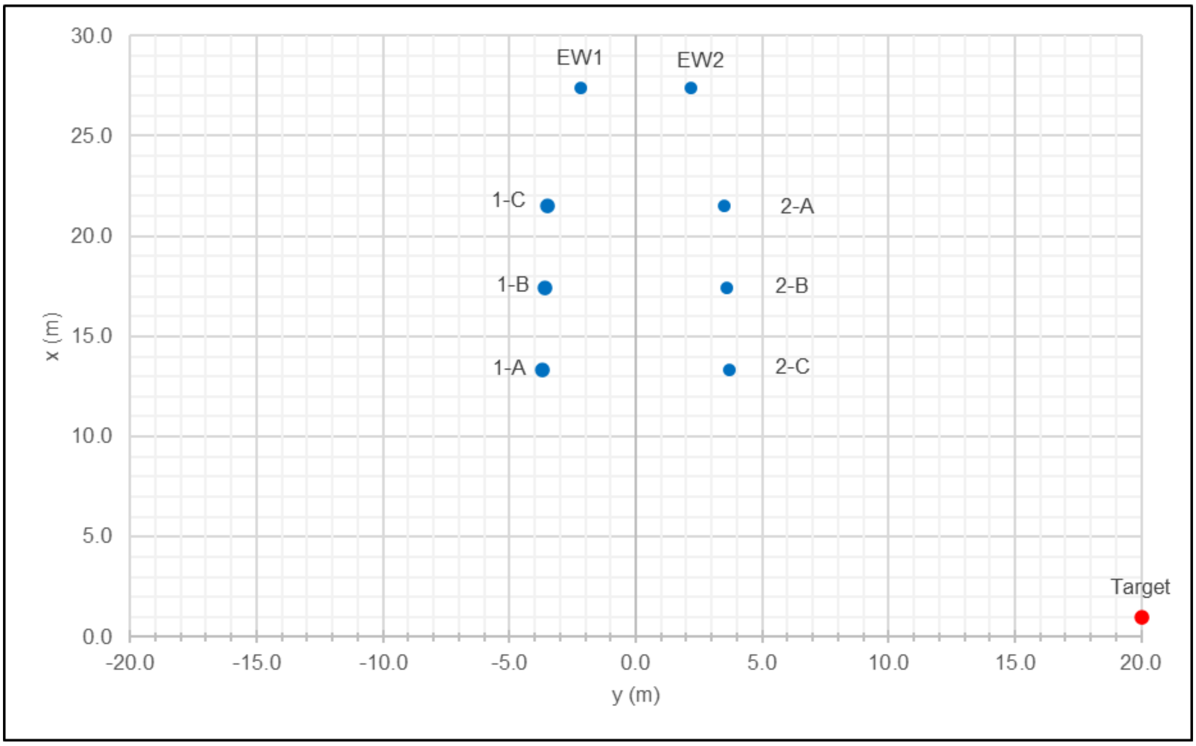


Figure 10: Section 2 – Approximate Location of New Wires at Mid-span

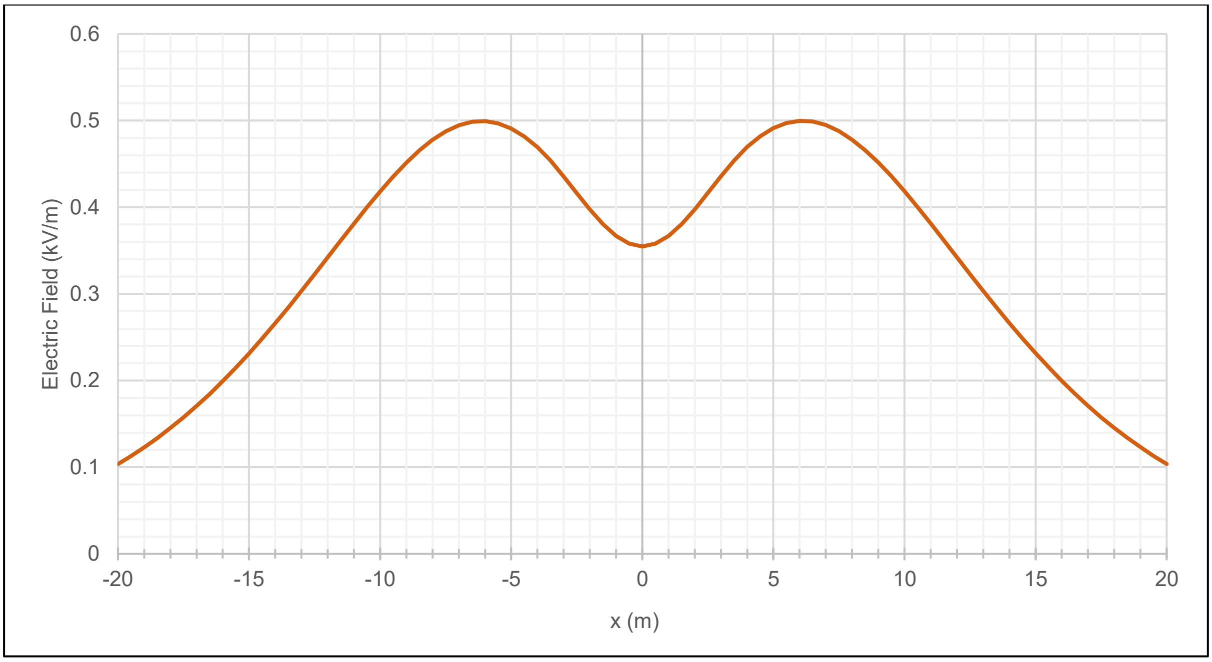


Figure 11: Section 2 - Electric Field of New Feeders at Mid-span

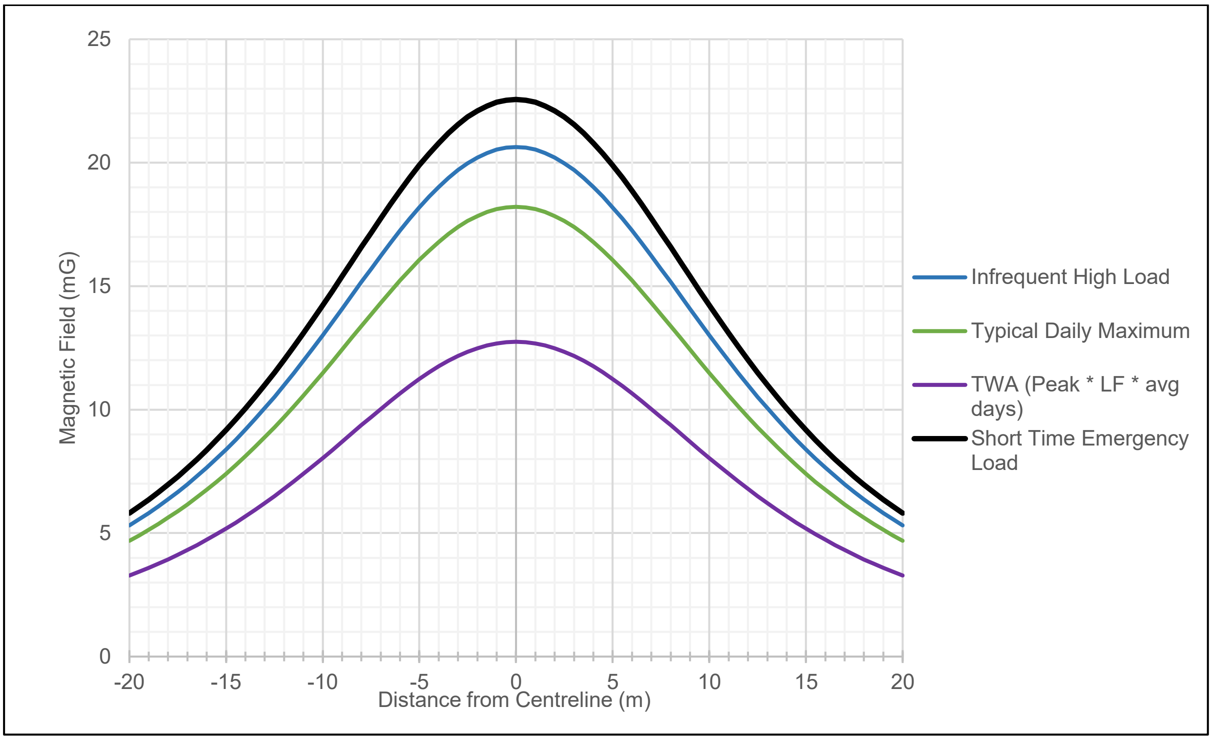


Figure 12: Section 2 - Magnetic Field of New Feeders at Mid-span

Studies Area

This report investigates the EMF levels for both the existing line and proposed line at these two locations:

1. Section 1 – Kamerunga Villas between structures 1252-STR-T053 and 1252-STR-1525
2. Section 2 – Sugar Cane Fields between structures 1252-STR-1531 and 1252-STR-1532.

The proposed new line will have similar structure locations and span lengths meaning that the same sections can be investigated for both proposed and new lines.

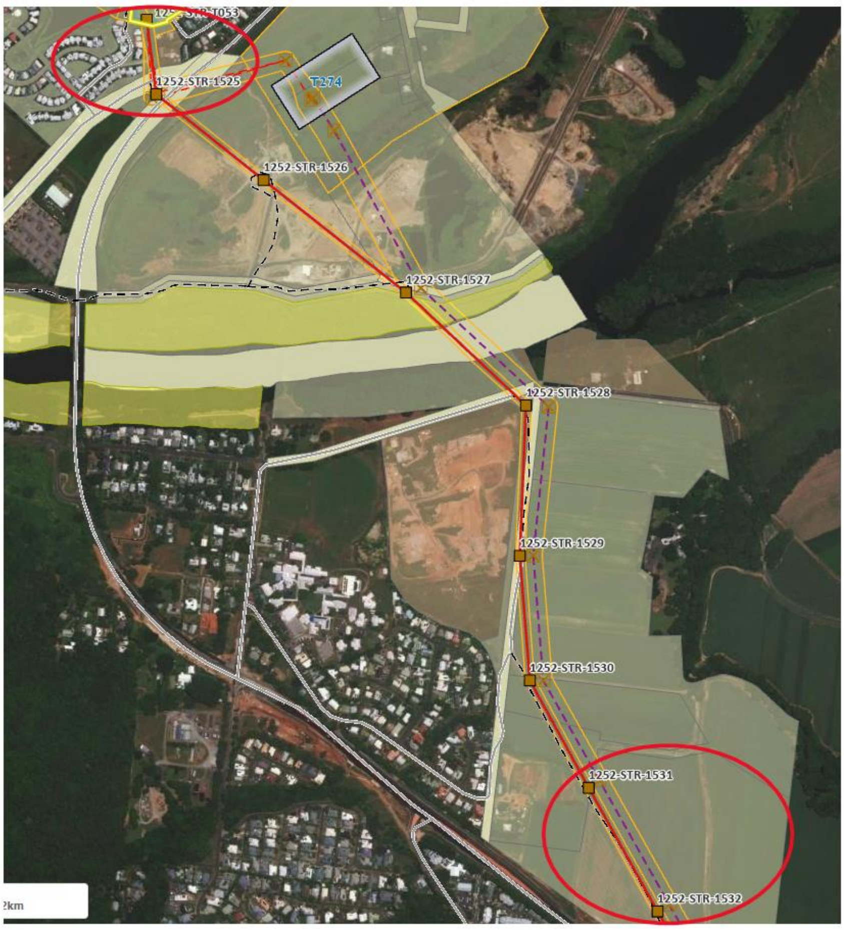
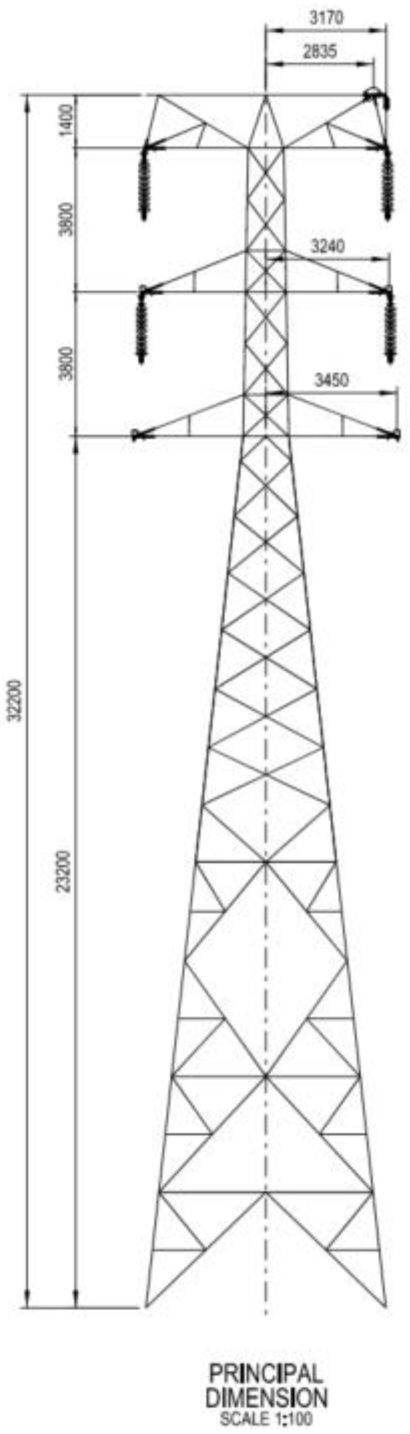


Figure 1: Study Areas

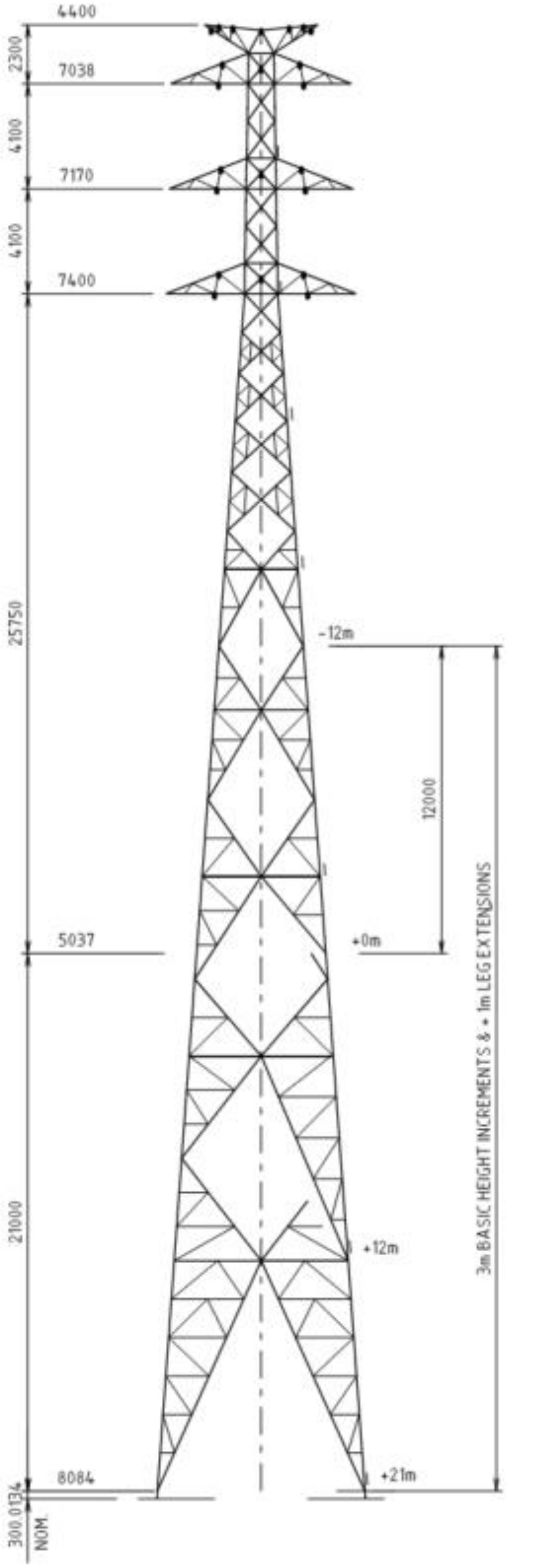
Feeder Load Data

Description	**Existing Feeders 7141/7142**	**New Feeders**
Conductor Name	Tiger	Phosphorus
Climate Zone	A	A
Conductor Temp (deg C)	55.8	57.4
Load Factor	0.7	0.7
Summer Normal Peak	184.7	327.7
Winter Normal Peak	220.2	406.7
Shoulder Normal Peak	205.0	373.2
Summer Emergency Peak	203.2	363.9
Winter Emergency Peak	240.1	444.7
Infrequent High Load	220.2	406.7
Typical Daily Maximum	199	359
TWA (Peak * LF * avg days)	139	251
Short Time Emergency Load	240.1	444.7

Appendix B: Structure Type CC2 Structure Geometry (Existing)



Appendix C: Structure Type D1S0E2 Structure Geometry (New)



PRINCIPAL STRUCTURE DIMENSIONS

Tower 1252-STR-1526 (Similar to model)

1252—STR-1525