

EXHIBIT I

This page intentionally left blank

EXHIBIT I: ANTICIPATED NOISE AND INTERFERENCE WITH COMMUNICATION SIGNALS

Describe the anticipated noise emission levels and any interference with communication signals which will emanate from the proposed facilities.

I.1 Corona and Audible Noise

Noise emanating from a transmission line is caused by corona. Corona is the electrical ionization of the air that occurs near the surface of the energized conductor and suspension hardware due to very high electric field strength. Certain electromagnetic effects are inherently associated with overhead transmission of electrical power at high voltage. These effects are produced by the electric and magnetic fields (EMF) of the transmission line with one of the primary effects being corona discharge. Corona effects are manifested as audible noise (AN), radio interference, and television interference. These particular effects will be minimized by line location, line design, and construction practices. Results presented in this exhibit are based on consideration of the various possible construction configurations along the alternative routes. Corona may result in AN being produced by a transmission line.

The amount of corona produced by a transmission line is a function of the voltage of the line, the diameter of the conductors, the locations of the conductors in relation to each other, the elevation of the line above sea level, the condition of the conductors and hardware, and the local weather conditions. Corona typically becomes a design concern for transmission lines at 345 kV and above and is less noticeable from lines that are operated at lower voltages, such as these proposed 138 kV transmission lines.

The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface; hence, lower corona than smaller conductors, everything else being equal. The conductors for the Project would be selected to have large diameters, and thus a reduced potential to create AN. Irregularities (such as nicks and scrapes on the conductor surface or sharp edges on suspension hardware) concentrate the electric field at these locations, increasing the electric field gradient and the resulting corona at these spots. Similarly, foreign objects on the conductor surface, such as dust or insects, can cause irregularities on the surface that are a source for corona.

Corona also increases at higher elevations where the density of the atmosphere is less than at sea level. AN varies with elevation with the relationship of $A/300$, where A is the elevation of the line above sea level measured in meters (EPRI 2005). AN at a 600-meter (1,968.5 feet) elevation would be twice the AN at 300 meters (984.25 feet), all other things being equal.

Raindrops, snow, fog, hoarfrost, and condensation accumulated on the conductor surface are also sources of surface irregularities that can increase corona. During fair weather, the number of these condensed water droplets or ice crystals is usually small, and the corona effect is also small. However, during wet weather, the number of these sources increases (e.g., due to rain drops standing on the conductor) and corona effects are therefore greater. During wet or foul weather conditions, the conductor would produce

the greatest amount of corona noise; yet noise generated by heavy rain hitting the ground would typically be greater than the noise generated by corona, thus masking the AN from the transmission line.

Corona produced on a transmission line can be reduced by the design of the transmission line and the selection of hardware and conductors used for the construction of the line; for instance, the use of conductor hangers that have rounded rather than sharp edges, and no protruding bolts with sharp edges would reduce corona. The conductors themselves can be made with larger diameters and handled so that they have smooth surfaces without nicks, burrs, or scrapes in the conductor strands.

The transmission lines proposed here will be designed to reduce corona generation. Baseline ambient noise levels were estimated using the relationship between population density and noise levels. The population of the area immediately adjacent to the proposed Project's facilities are rural, with a population density of 49 people per square mile. Ambient noise levels are around 30 A-weighted decibels (dBA). The proximity of the TIA (located 2.5 miles to the northwest) increases noise levels to 65 kBA when planes are approaching or taking off. Other sources of noise in the area are activities at the sand and gravel pit located on both sides of South Swan Road, both north and south of East Old Vail Connection Road, and training activities (including gun range) at the COT Police Academy. Sensitive noise receptors are limited to the residents in the community in the southern portion of the Project area.

Some level of noise will result from transmission line construction, operation, and maintenance. During construction, equipment used for assembly and erection of structures, and wire pulling and splicing activities will generate noise. Noise from construction activities would be audible, particularly to the closest residents. This construction noise, however, would not be considered to be a major impact because construction would occur during daytime hours when tolerance to noise is higher, and would be temporary, lasting only a few days at a time in any one location. Long-term noise impacts from transmission line operation and maintenance activities are expected to be minimal.

I.2 Radio Interference

Corona-generated radio interference is most likely to affect the amplitude modulation (AM) radio broadcast band (535 to 1,605 kilohertz); frequency modulation (FM) radio is rarely affected. Only AM receivers located very near to transmission lines that are tuned to a weak station have the potential to be affected by radio interference. An example is the humming noise on an AM radio that happens when the radio is near a power line, but diminishes as the radio moves away from the line. FM radio is rarely affected by transmission lines. FM radio receivers usually do not pick up interference from transmission lines, because corona-generated radio frequency noise currents decrease in magnitude with increasing frequency and are quite small in the FM broadcast band (88 to 108 megahertz). In addition, the excellent interference rejection properties inherent in FM radio systems make them virtually immune to amplitude-type disturbances.

Residential areas located in the vicinity of the Project's alternative alignments are in close proximity to other existing power lines; therefore, additional radio interference as a result of the Project's implementation is not expected. There is one active communications tower previously licensed by the Federal Communications Commission (FCC) within the Project's study area. It is located 1.1 miles south of East Old Vail Connection Road, on the west side of South Wilmot Road. TEP has notified this tower

owner and has not received a response at this time. No radio interference is anticipated from the Project. Potential impacts will be further assessed following design and any impacts mitigated as needed.

I.3 Television Interference

Interference with traditional television reception from the transmission line’s corona effects may occur during periods of bad weather, but is usually only a concern for transmission lines of 345 kV or greater and only for receivers within 500 feet of the line. Because the voltage would not exceed 138 kV, television interference is not expected.

I.4 Electric and Magnetic Field Effects

EMF are produced by power lines. These fields would induce voltages and currents on nearby conductive objects. Electric fields are produced whenever a conductor is connected to a source of electrical voltage. An example of this is the plugging of a lamp into a wall outlet in a home. When the lamp is plugged in, a voltage is induced in the cord to the lamp, which causes an electric field to be created around the cord. Magnetic fields are produced whenever an electrical current flows in a conductor. In the lamp example, if the lamp is turned on (allowing electricity to flow to the lamp), a magnetic field is created around the lamp cord in addition to the electric field. These fields exist around overhead and underground power lines, house wiring, computers, power tools, appliances, and anything that carries or uses electricity. Table 7 demonstrates examples of EMF levels from various electrical sources (see also Figure 1). This information was provided in both a poster and a handout available to the public at the Open House Meetings (see Exhibit J-3.3).

Both current and voltage are required to transmit electrical energy over a transmission line. The current, a flow of electrical charge, measured in amperes (A), creates a magnetic field. This can fluctuate with the amount of line loading at any given time. The voltage (force or pressure that causes the current to flow), measured in units of volts (V) or kV, creates an electric field. Though an electric field is present anytime a line is energized, even from one end, the magnetic field exists only when electricity flows. It is general practice to consider both fields together as EMF values in assessing the amount of effect at the outer edge of a transmission line’s right-of-way.

Table 7. EMF Strength of Various Electrical Sources at Various Distances

EMF Source ¹	Distance	Strength	Distance	Strength	Distance	Strength
Microwave Oven	0.5 feet	200 mG	1.0 feet	4 mG	4.0 feet	2 mG
Vacuum Cleaner	0.5 feet	300 mG	1.0 feet	60 mG	4.0 feet	1 mG
Hair Dryer	0.5 feet	300 mG	1.0 feet	1 mG	4.0 feet	0 mG
Electric Shaver	0.5 feet	100 mG	1.0 feet	20 mG	4.0 feet	0 mG
138-kV Transmission Line, vertical ²	0 feet	40 mG	50 feet	11 mG	300 feet	0.4 mG

¹ Appliance magnetic field strengths are median values in milliGauss (mG) for typical 60 Hz electrical current (source: USNIEHS 1999, DOE 1995)

² 138kV power line right-of-way is 100 feet wide; 0-feet values represent directly below the lines at lowest point of sag

EMF decreases in strength with increased distance from the source. In addition, electric fields are further weakened by obstacles such as walls, roofs, trees, and vegetation. However, magnetic fields are not easily shielded by most materials and are primarily reduced in strength by distance alone.

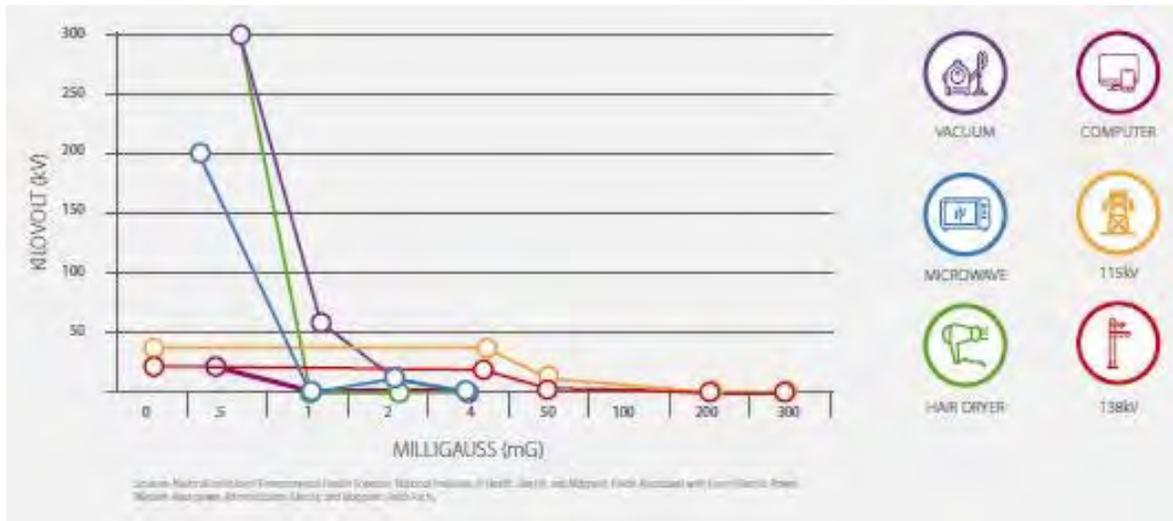


Figure 1. EMFs from Various Sources

The EMF values associated with this Project are expected to be comparable to other 138 kV transmission lines in the state, and are expected to be within generally accepted standards at the edge of the Project area (Figure 2 and Figure 3).

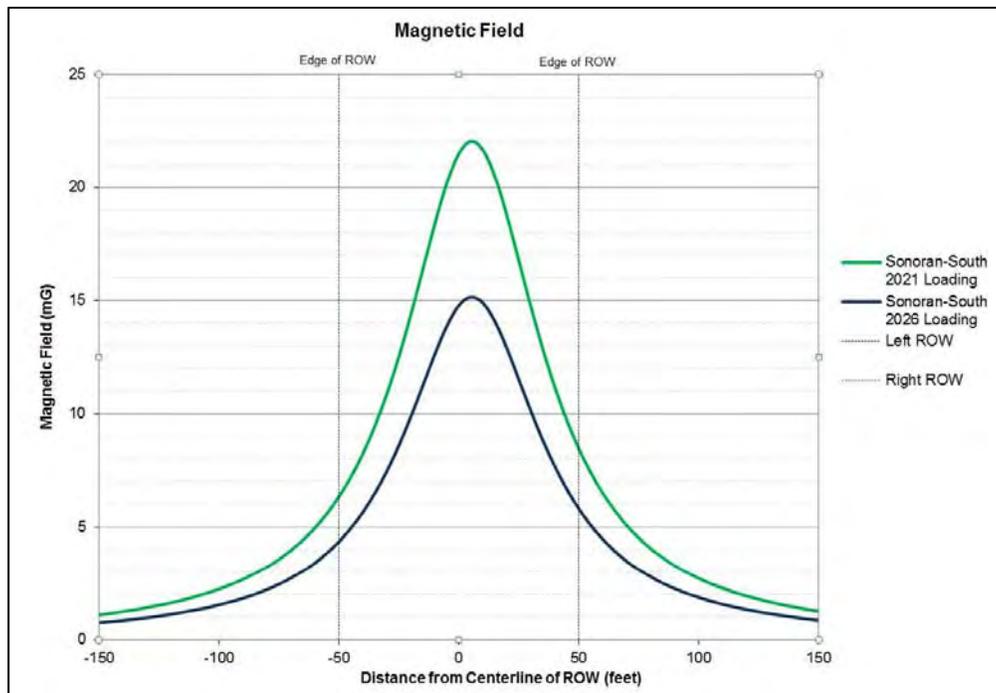


Figure 2. Magnetic Field at Distance from Centerline

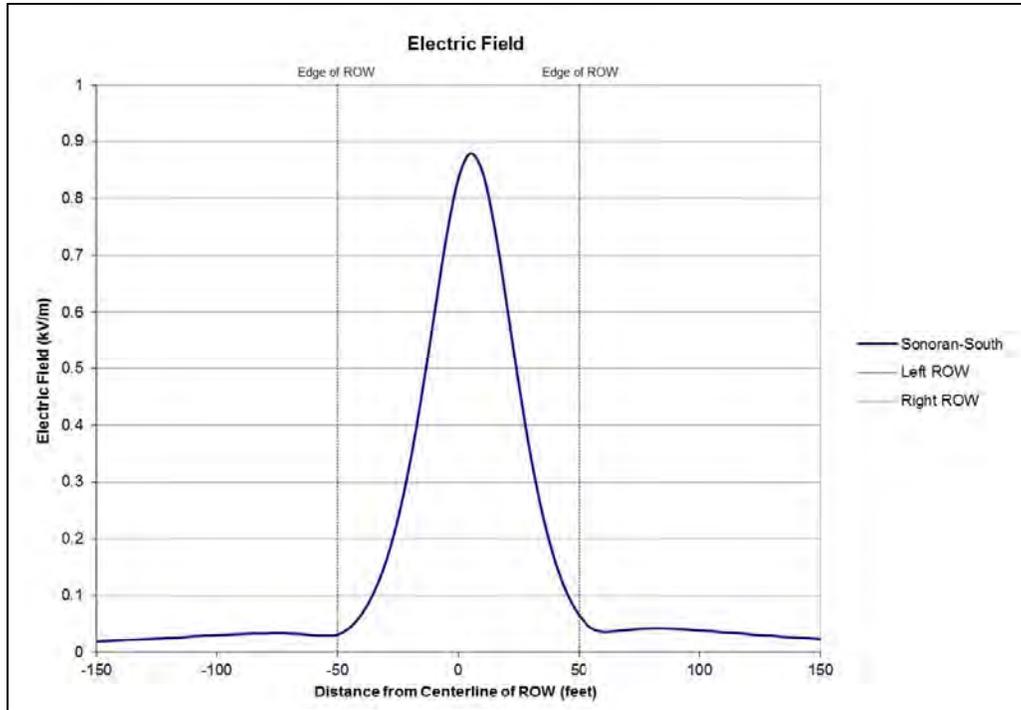


Figure 3. Electric Field at Distance from Centerline

I.5 References

IEEE/ANSI Standard C2-2007. National Electrical Safety Code.

National Academy of Sciences, 1977. Guidelines for Preparing Environmental Impact Statements on Noise. Washington D.C.

National Academy of Sciences, 1996. Possible Health Effects of Exposure to Residential Electric and Magnetic Fields. National Research Council.

National Institute of Environmental Health Sciences, 1999. Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields.

POWER Engineers, 2018. Tucson Electric Power, Sonoran – South Transmission Line EMF Analysis, Revision A. May 24, 2018.

Tucson International Airport. 2017. Public Airport Disclosure Map. Tucson, AZ.

This page intentionally left blank

May 24, 2018

TUCSON ELECTRIC POWER

Sonoran - South Transmission Line *EMF Analysis*

Revision A

PROJECT NUMBER:
152379

PROJECT CONTACT:
ROB SCHAERER
EMAIL:
ROB.SCHAERER@POWERENG.COM
PHONE:
858-810-5337



SONORAN-SOUTH EMF ANALYSIS

PREPARED FOR:
TUCSON ELECTRIC POWER

PREPARED BY:
DEBORAH F. SAWYER, P.E. – (858) 810-5396 – DEBORAH.SAWYER@POWERENG.COM
JOHN BRINSKO – (858) 810-5317 – JOHN.BRINSKO@POWERENG.COM

REVISION HISTORY						
REV.	ISSUE DATE	ISSUED FOR	PREP BY	CHKD BY	APPD BY	NOTES
A	05/24/18	Appvl	DFS	JCB	JAB	Issued for client's review and approval

"Issued For" Definitions:

- "Prelim" means this document is issued for preliminary review, not for implementation
- "Appvl" means this document is issued for review and approval, not for implementation
- "Impl" means this document is issued for implementation
- "Record" means this document is issued after project completion for project file

TABLE OF CONTENTS

INTRODUCTION	1
DATA.....	1
ANALYSIS.....	1
RESULTS.....	2
ELECTRIC FIELD	2
MAGNETIC FIELD.....	3
APPENDIX A – STRUCTURE DRAWING.....	A-1

INTRODUCTION

This study is to perform EMF calculations for a new Tucson Electric Power 138 kV line from Sonoran to South. The line consists of 138 kV vertical construction in a new corridor that is a double circuit for a portion of the line and single circuit for the rest. The 2026 case assumes a lower load value than 2021 case due to assumed generation online. POWER Engineers, Inc.'s (POWER) engineering service for this study was to perform calculations to determine the predicted electric and magnetic fields from the transmission line.

DATA

Electric and magnetic fields (EMF) from a transmission line are based on the electrical and physical characteristics of the transmission line. Specifically, these factors are driven by: the voltage and current loading of the line; the physical conductor characteristics; relationships of each phase conductor to the other phases and shield wires; and the heights of the conductors from the ground. As a result, several variable factors will affect results. The following data was used for the analysis. Should any of this data change, the results will also change.

- Though the line is on structures that are double circuit for a portion of its length, TEP requested we only consider the single circuit in this study. Thus, no double circuit conditions were considered. The area with double circuit may have fields that are significantly higher or lower than the results presented in this report. This is based on the phasing of the conductors of the parallel line as well as the direction of current flow in the parallel line.
- For the 138 kV line, a maximum operating voltage of 105% of nominal voltage (144.9 kV_{ll}) was used for electric and magnetic field analysis.
- A maximum loading of 409 amps per phase was assumed for the 138 kV line for the year 2021. This was based on load data provided of 97.1 MW and 11.4 MVAR.
- A maximum loading of 281 amps per phase was assumed for the 138 kV line for the year 2026. This was based on load data provided of 66.3 MW and 10.5 MVAR.
- A single 954 kcmil ACSS 45/7 Rail conductor was used for the 138 kV line in the analysis.
- The shield wire is ADSS 96 fiber optic cable #5-99-0352, which is 0.563 inches in diameter.
- The phasing arrangement and spacing was assumed as labeled on the structure drawings provided for reference in Appendix A.
- The right-of-way width is assumed to be 100 feet centered on the structure.
- The minimum conductor height was 33.42 feet for the lowest phase conductor.

ANALYSIS

The environmental field effects analysis was performed using the Bonneville Power Administration's (BPA) Corona and Field Effects Program (CAFEP) software (version 3) on the proposed transmission line structure configurations. CAFEP uses the electrical and physical characteristics of the transmission line to calculate resulting fields from the transmission lines.

The electric fields are driven by the maximum operating voltage of conductors. Magnetic fields are driven by the line current loading, which varies over time. Therefore, the magnetic fields calculations were performed at 100% of the maximum line loading for the two different future years provided.

The values of these effects are typically of concern at various points across the right-of-way. Therefore, values reported include the maximum values within the right-of-way for the given structures, the value at the edge of the right-of-way (the worse of the two edges), and the distance at which the value falls below 0.01 kV/m and 0.1 mG. Also included for reference are plots of the results for values across the entire width of the right-of-way and beyond the right-of-way.

For the analysis, electric and magnetic fields were analyzed at a minimum conductor height (mid-span, maximum sag), as this location will produce the worst case scenario.

RESULTS

Electric Field

The electric field strength is a measure of the force per unit charge at a given point in space relative to a charged object. It is typically measured in volts or kilovolts per meter (kV/m). Table 1 shows a summary of the values in the right-of-way for each tangent structure configuration and number of circuits. Values are calculated at the minimum conductor height (mid-span) at a height of one meter above the ground per IEEE Std 644-1994 (R2008).

TABLE 1: ELECTRIC FIELD RESULTS [kV/m]			
CASE	EDGE OF ROW	MAXIMUM IN ROW	DISTANCE (IN FT.) TO <0.01 kV/m
Sonoran-South	0.065	0.879	255

Figure 1 shows a plot of the electric field across the right-of-way for the single circuit configuration. As the electric field does not change with a change in loading, only one trendline is shown.

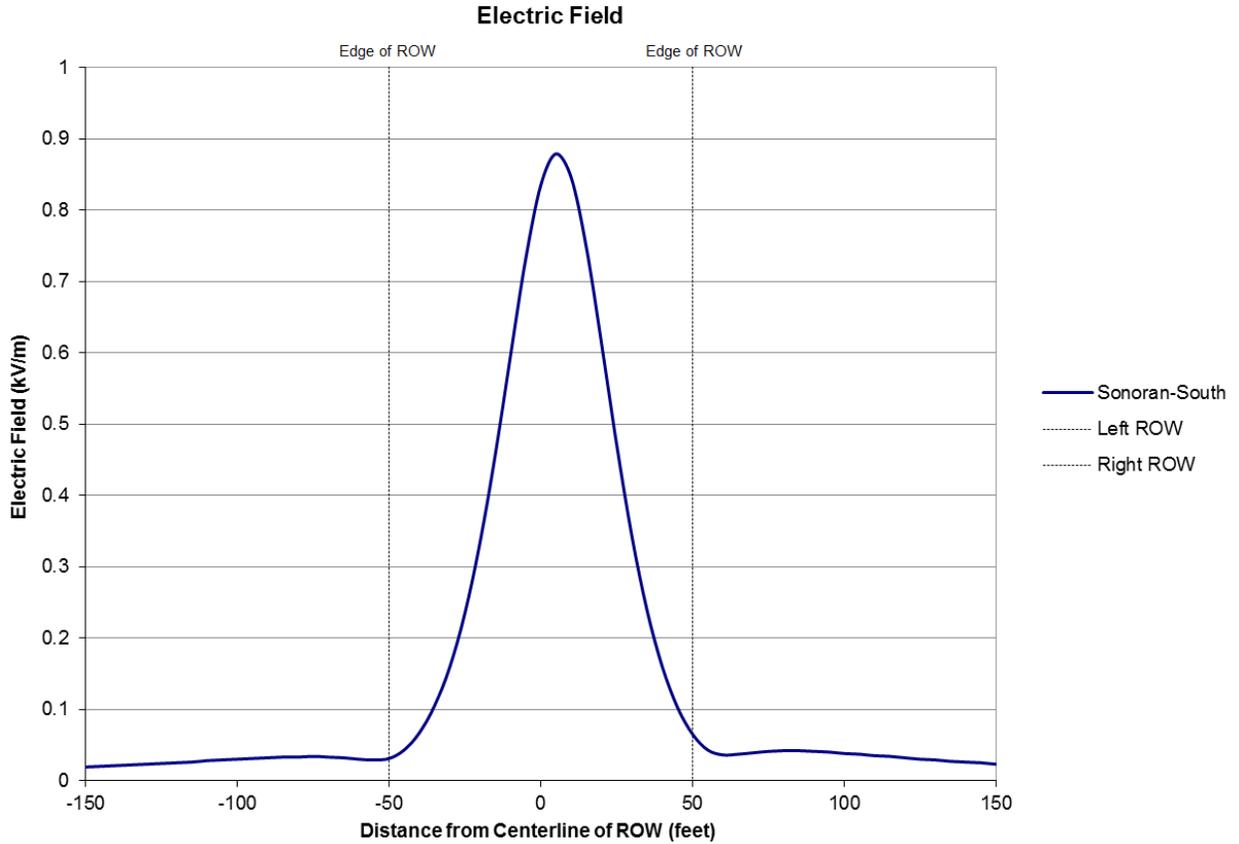


Figure 1: Electric Field Across Right-of-Way

Magnetic Field

The reported magnetic field values are the magnetic flux density at a given point in space. Magnetic flux density is measured in gauss or milligauss (mG) or in micro-Teslas (μT). These values can be easily converted as one tesla equals 10,000 gauss, or simply 10 mG equals 1 μT .

Table 2 shows a summary of the resulting values in the right-of-way, assuming maximum current loading. Values are calculated at the minimum conductor height (mid-span) at a height of one meter above the ground per IEEE Std 644-1994 (R2008).

TABLE 2: MAGNETIC FIELD RESULTS – 100% LOADING [mG]			
CASE	EDGE OF ROW	MAXIMUM IN ROW	DISTANCE (IN FT.) TO <0.1 mG
Sonoran-South – 2021 (409A)	8.47	22.05	550
Sonoran-South – 2026 (281A)	5.82	15.15	455

Figure 2 shows a plot of the magnetic field across the right-of-way at 100% loading for single circuit configuration for the two different load cases provided.

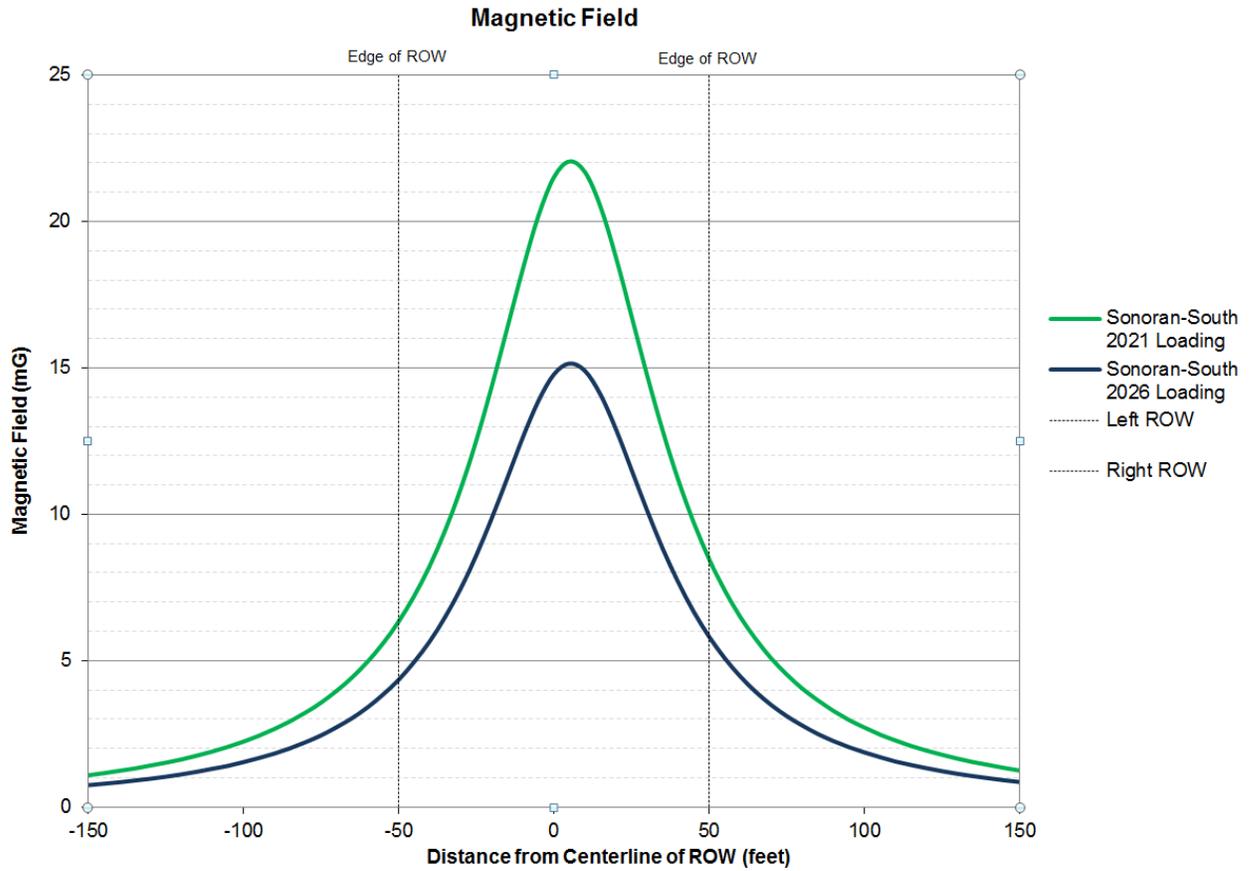
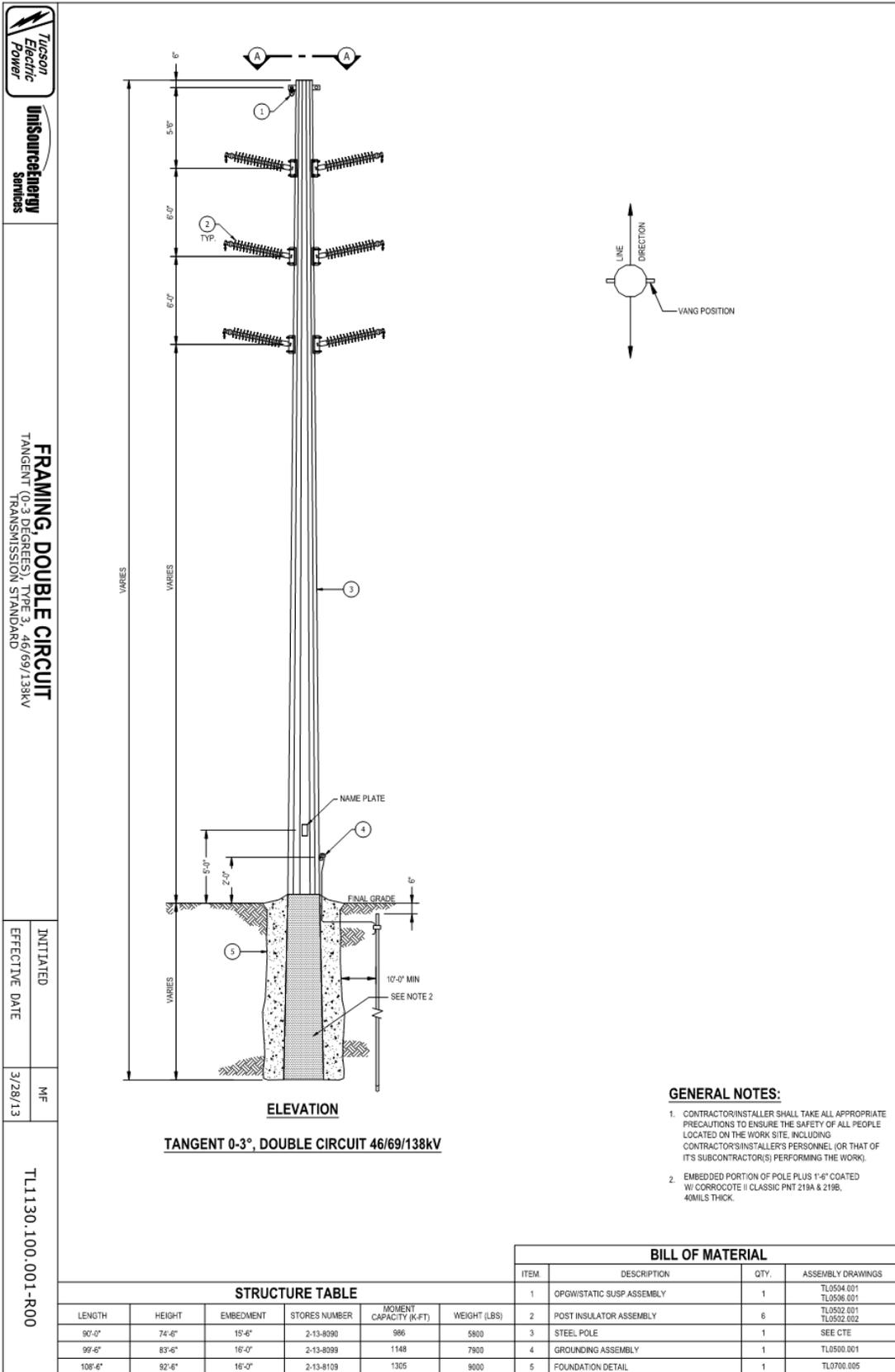


Figure 2: Circuit Magnetic Field Across Right-of-Way

APPENDIX A – STRUCTURE DRAWING



This page intentionally left blank