8 ENGINEERING, DESIGN, CONSTRUCTION AND RIGHT-OF-WAY ACQUISITION

8.1 Transmission Line Engineering and Operation Design

8.1.1 Transmission Structure Design and Right-of-Way Requirements

Transmission structure design and the ROW requirements are discussed in **Section 4.1.1**. A schematic of typical structures is provided in **Figure 4-2**.

8.1.2 Design Options to Accommodate Future Expansion

A portion of the Menahga Project is proposed to accommodate a future project in the area. The first 4.5 miles of the 115 kV transmission line between the existing Great River Energy Hubbard Substation west to CR 115 is proposed to be designed and built for a second 115 kV circuit. This circuit would be used for a planned Great River Energy project to the north that would address load-serving needs in the Osage area in the future. The future proposed circuit for the Osage area would terminate on a structure at the intersection of CR 111 (110th St. SW) and CR 115 (129th Ave), while the other circuit would continue to the proposed new Minnesota Power Straight River Substation and then on to the Red Eye Substation endpoint.

Great River Energy is requesting that the second circuit be permitted as part of the Menahga Project so that the conductor could be strung during construction of the Menahga Project, due to the following safety, environmental and cost concerns:

- An outage would not be possible on the circuit to the Minnesota Power Straight River Substation if the second circuit were to be installed at a later date. There would be safety risks to line construction personnel if they had to string the second circuit in close proximity to the energized circuit. Therefore from a safety perspective, it would be ideal to install both circuits at the same time.

- There are two water crossings and a half mile of wetlands that would have to be traversed a second time if the second circuit is not installed as part of the Menahga Project, resulting in increased environmental impacts.

- Mobilization of construction crews a second time would be more costly than installing both circuits at the same time.

8.2 Identification of Existing Utility and Public Rights-of-Way

The proposed transmission line alignment will parallel road ROW for the majority of its length. In areas where the line is not proposed to follow road ROW, the line will follow either

Minnesota Energy's natural gas pipeline, MPL's existing pipelines, or will replace Minnesota Power's existing 34.5 kV 522 feeder line.

The east-west section of the Project (approximately 7 miles) between the existing Great River Energy Hubbard Substation and the proposed Minnesota Power Straight River Substation will replace the existing Minnesota Power 34.5 kV 522 feeder line.

The generally north-south section of the Project (approximately 15.5 miles) between the Minnesota Power Straight River Substation and the Todd-Wadena Red Eye Substation parallels the existing MPL Line 4 pipeline for approximately 1.0 mile, the Minnesota Energy natural gas pipeline for approximately 2.25 miles in Red Eye and Blueberry Townships, and various roads (Hubbard Line Road, CR 156, Wadena Line Road, TH 87, 111th Ave., 350th St., 109th Ave., CSAH 13, and 139th Ave.) for approximately 12.25 miles.

The new transmission line poles will generally be placed with a 3- to 7-foot offset outside of road ROW. Additional setbacks may be utilized to incorporate requests from landowners and/or agencies. Transmission or distribution lines that are overtaken by Great River Energy may be temporarily leaned or moved to allow construction of the new line if they are to be removed once the Project is energized. Great River Energy will work with the owners of transmission or distribution lines that must remain intact after the Project is complete. These lines may be co-located with and/or underbuilt on the new transmission line poles or be placed underground.

8.3 Transmission Line Right-of-Way Acquisition Procedures

Great River Energy will obtain new easements for the entire length of the Project, although there may be existing easements held by Minnesota Power or Todd-Wadena in areas where transmission and distribution lines may be overtaken by the proposed line.

Should a route permit be issued by the Commission, land rights acquisition will commence subsequent to survey and preliminary determination of the transmission centerline. Land rights acquisition includes acquisition of a permanent easement for the transmission line. As a general practice, landowners will be contacted in-person or by U.S. mail with a request to meet to discuss and provide information on the easement and share the Project details with the property owner(s).

During the acquisition phase of the Project, landowners are given a copy of the route permit, the transmission line easement, offer of compensation, and information on the Project schedule, construction practices, vegetation removal, and damage settlement. Additional information may also be given to each landowner that shows preliminary pole placement (if available at that time), structure design or photos, and power line safety.

In addition to permanent easements necessary for the construction of the line, marshalling yard agreements may be obtained from certain landowners for temporary construction or staging areas for temporary storage of poles, vehicles, or other related items. Landowners will be notified in the event site access for soil boring is required to determine soil suitability in areas where certain soil characteristics may require special transmission structure design.

If a negotiated agreement to an easement cannot be reached, Great River Energy has the power of eminent domain to obtain the necessary easement by Minnesota Statutes Chapter 117. In eminent domain the landowner has the authority to have compensation for the easement determined by impartial commissioners through a court process that is initiated by Great River Energy.

8.4 Construction Procedures

Procedures to be used for construction of the transmission lines are discussed below.

After land rights have been secured, landowners will be notified prior to the start of the construction phase of the Project, including an update on the Project schedule and other related construction activities.

The first phase of construction activities will involve survey staking of the transmission line centerline and/or pole locations, followed by removal of trees and other vegetation from the ROW. As a general practice, low-growing brush or tree species are allowable at the outer limits of the easement area. Taller tree species that endanger the safe and reliable operation of the transmission facility will be removed. In developed areas and to the extent practical, existing low-growing vegetation that will not pose a threat to the transmission facility or impede construction or maintenance may remain in the easement area, as agreed to during easement negotiations.

The NESC states that "vegetation that may damage ungrounded supply conductors should be pruned or removed." Trees beyond the easement area that are in danger of falling into the energized transmission line ("danger trees") will be removed or trimmed to eliminate the hazard as shown in **Figure 8-1**, as allowed by the terms in the existing or the new easement that is acquired. Danger trees generally are those that are dead, diseased, weak or leaning towards the energized conductors. In special circumstances, tree trimming agreements may be possible to minimize tree removal based on negotiations with individual landowners.

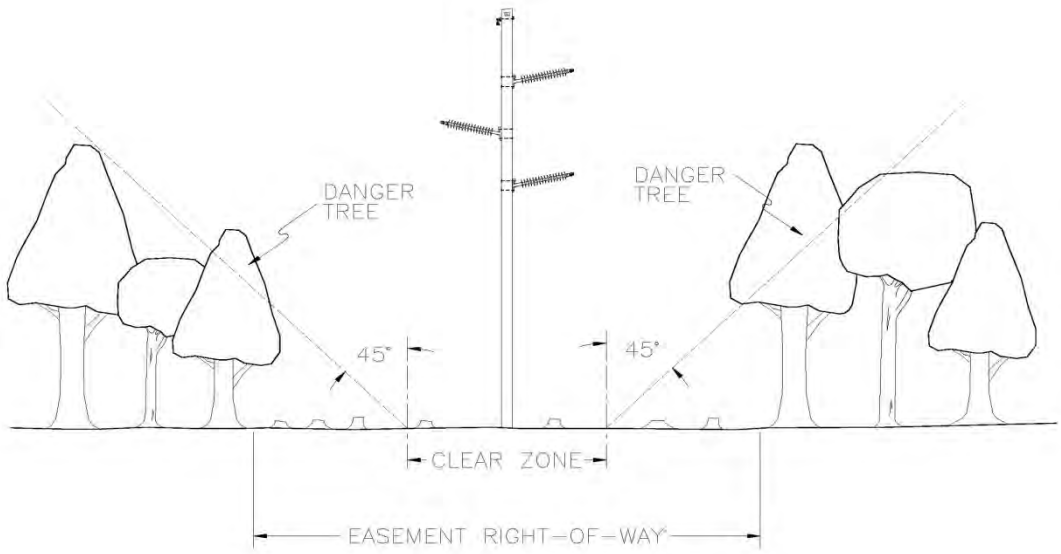
All materials resulting from the clearing operations will either be chipped on site and spread on the ROW, stacked in the ROW for use by the property owner, or removed and disposed of otherwise as agreed to with the property owner during easement negotiations.

The final survey staking of pole locations may again occur after the vegetation has been removed and just prior to structure installation.

The second phase of construction will involve structure installation and stringing of conductor wire. During this phase, underground utilities are identified through the required One Call process to minimize conflicts with existing utilities along the route.

If temporary removal or relocation of fences is necessary, installation of temporary or permanent gates would be coordinated with the landowner. The ROW agent may work with the property owner for early harvest of crops, where possible, with compensation to be paid for any actual crop losses. During the construction process, it may be necessary for the property owner to remove or relocate equipment and livestock from the ROW. Compensation related to these activities will be discussed with the landowner during easement negotiations.

Figure 8-1. Standard Tree Removal Practices



Transmission line structures are generally designed for installation at existing grades. Therefore, structure sites will not be graded or leveled unless it is necessary to provide a reasonably level area for construction access and activities. For example, if vehicle or installation equipment cannot safely access or perform construction operations properly near the structure, minor grading of the immediate terrain may be necessary.

Great River Energy will employ standard construction and mitigation practices that were developed from experience with past projects as well as industry-specific BMPs. BMPs address ROW clearing, erecting transmission line structures and stringing transmission lines. BMPs for each specific project are based on the proposed schedules for activities, prohibitions, maintenance guidelines, inspection procedures and other practices. In some cases these activities, such as schedules, are modified to incorporate BMP installation that will assist in minimizing impacts to sensitive environments. Any contractors involved in construction of the transmission line will be advised of these BMP requirements.

During construction of the first 7 miles of the Project between the Hubbard Substation and the Straight River Substation, the existing Minnesota Power 522 feeder line will have to remain energized. The 522 feeder line will therefore be leaned out of the way to accommodate the new construction and then removed when the new line is complete.

New structures are installed directly in the ground, by augering or excavating a hole typically 8 to 11 feet deep and 2 to 3 feet in diameter for each pole. Any excess soil from the excavation will be spread and leveled near the structure or removed from the site, if requested by the property

owner or regulatory agency. The new structures will then be set and the holes back-filled with the excavated material, native soil, or crushed rock. Based on typical soil types in Minnesota, it is anticipated that the average structure depth of a standard 70-foot long pole would be approximately 9 feet deep. In poor soil conditions, a galvanized steel culvert is sometimes installed vertically with the structure set inside. Concrete foundations may be necessary in special cases. Drilled pier foundations may vary from 4 to 8 feet in diameter. Concrete trucks are normally used to bring the concrete in from a local concrete batch plant.

After a number of new structures have been erected, Great River Energy will begin to install the new static wire by establishing stringing setup areas within the ROW. These stringing setup areas are usually located every two miles along a project route and occupy approximately 15,000 square feet of land. Conductor stringing operations require brief access to each structure to secure the conductor wire and shield wire once the final sag is established. Temporary guard or clearance structures are installed, as needed, over existing distribution or communication lines, streets, roads, highways, railways or other obstructions after any necessary notifications are made or permits obtained. This ensures that conductors will not obstruct traffic or contact existing energized conductors or other cables. In addition, the conductors are protected from damage.

Crossing of rivers, streams and wetlands will require particular attention during construction. The transmission lines will cross a number of wetlands and will span several waterways (Shell River, Blueberry River, Kettle Creek and Kitten Creek). Great River Energy will not allow construction equipment to be driven across waterways except under special circumstances and only after discussion with the appropriate resource agency. Where waterways must be crossed to pull in the new conductors and shield wires, workers may walk across, use boats, or drive equipment across ice in the winter. In areas where construction occurs close to waterways, BMPs help prevent soil erosion and ensure that equipment fueling and lubricating occur at a distance from waterways.

8.5 Restoration Procedures

During construction, limited ground disturbance at the structure sites will occur. Marshalling yard agreements will be obtained from property owner(s) or agency(ies) for temporary storage of materials and equipment. Typically, a previously-disturbed or developed area is used, and includes sufficient space to lay down material and pre-assemble some structural components or hardware and store construction equipment. Portions of the ROW or property immediately adjacent to the ROW may be used for structure laydown and framing prior to structure installation. Additionally, stringing setup areas are used to store conductors and equipment necessary for stringing operations. Disturbed areas are restored to their original condition to the maximum extent practicable, or as negotiated with the landowner.

Post-construction reclamation activities will include removing and disposing of debris, removing all temporary facilities (including staging and laydown areas), employing appropriate erosion control measures, reseeding areas disturbed by construction activities with vegetation similar to that which was removed with a seed mixture certified as free of noxious or invasive weeds, and restoring the areas to their original condition to the extent possible. In cases where soil

compaction has occurred, the construction crew or a restoration contractor uses various methods to alleviate the compaction, or as negotiated with landowners.

The ROW agent will contact landowners after construction is completed to determine if the cleanup measures have been to their satisfaction and if any other damage may have occurred. If damage has occurred to crops, fences or the property, Great River Energy will compensate the landowner. In some cases, an outside contractor may be hired to restore the damaged property as near as possible to its original condition.

8.6 Operation and Maintenance

Access to the ROW of a completed transmission line is required to perform periodic inspections, conduct maintenance and repair damage. Regular maintenance and inspections will be performed during the life of the transmission line to ensure its continued integrity. Generally, Great River Energy will inspect the transmission lines once per year. Inspections will be limited to the ROW and to areas where off-ROW access is required due to ROW obstructions or terrain impediments. If problems are found during inspection, repairs will be performed and property restoration will occur or the landowner will be provided reasonable compensation for any damage to the property.

The ROW will be managed to remove vegetation that interferes with the operation and maintenance of the transmission line. Native shrubs that will not interfere with the safe operation or accessing and traversing the ROW of the transmission line will be allowed to reestablish in the ROW. Great River Energy's practice generally provides for the inspection of 115 kV transmission lines every two years to determine if clearing is required. ROW clearing practices include a combination of mechanical and hand clearing, along with herbicide application (where allowed) to remove or control vegetation growth.

The estimated annual cost of ROW maintenance and operation and maintenance of Great River Energy's transmission lines (69 kV to 500 kV) in Minnesota currently average about $2,000 per mile. Actual transmission line specific maintenance costs will depend on the environmental setting, the amount of vegetation management necessary, storm damage occurrences, structure types, age of the line, etc. The Project facilities will primarily be routed along road ROW, which will minimize tree maintenance required.

8.7 Electric and Magnetic Fields (EMF)

As it pertains to the Project, the term "EMF" refers to the extremely low frequency (ELF) decoupled electric and magnetic fields that are present around any electrical device or conductor and can occur indoors or outdoors. Electric fields are the result of electric charge, or voltage, on a conductor. The intensity of an electric field is related to the magnitude of the voltage on the conductor. Magnetic fields are the result of the flow of electricity, or current, traveling through a conductor. The intensity of a magnetic field is related to magnitude of the current flow through the conductor. Electric and magnetic fields can be found in association with transmission lines, local distribution lines, substation transformers, household electrical wiring, and common household appliances.

8.7.1 Electric Fields

Voltage on a wire produces an electric field in the area surrounding the wire. The voltage on the conductors of a transmission line generates an electric field extending from the energized conductors. The intensity of transmission line electric fields is measured in kilovolts per meter (kV/m), and the magnitude of the electric field rapidly decreases with distance from the transmission line conductors. The presence of trees, buildings, or other solid structures in the path of the field can also significantly reduce the magnitude of the electric field. Because the magnitude of the voltage on a transmission line is near-constant (ideally within ±5 percent of nominal), the magnitude of the electric field will be near-constant for each of the proposed configurations, regardless of the power flowing on the line.

Although there is no state or federal standard for transmission line electric field exposures, the EQB developed a standard of a maximum electric field limit of 8 kV/m at one meter above ground. This standard has been adopted by the Commission. Applicants have calculated the approximate electric field for the Project's transmission configurations and estimate the peak magnitude of electric field density among all possible configurations to be well below the EQB standard at approximately 2.49 kV/m underneath the conductors, one meter (3.28 feet) above ground. **Table 8-1** summarizes the electric fields calculated for the proposed single and double circuit transmission lines on the Project. These electric field calculations are also shown graphically in **Figures 8-2 through 8-4**.

Table 8-1. Calculated Electric Fields (kV/M) for Proposed Transmission Line Designs (One meter (3.28 feet) above ground)

Scenario	Max. Operating Voltage (kV)	Distance to Proposed Centerline										
		-300'	-200'	-100'	-50'	-25'	Max.	25'	50'	100'	200'	300'
115/115 kV Double Circuit (**Figure 8-2**)	121/121	0.01	0.03	0.09	0.08	0.66	2.49	0.66	0.08	0.09	0.03	0.01
115 kV with 7.2 kV Underbuild (**Figure 8-3**)	121/8	0.01	0.02	0.06	0.20	0.36	0.70	0.49	0.18	0.06	0.02	0.01
115 kV Single Circuit (**Figure 8-4**)	121	0.01	0.02	0.06	0.21	0.49	1.40	0.65	0.19	0.07	0.02	0.01

Figure 8-2. 115/115 kV Double Circuit Line Electric Field Profile

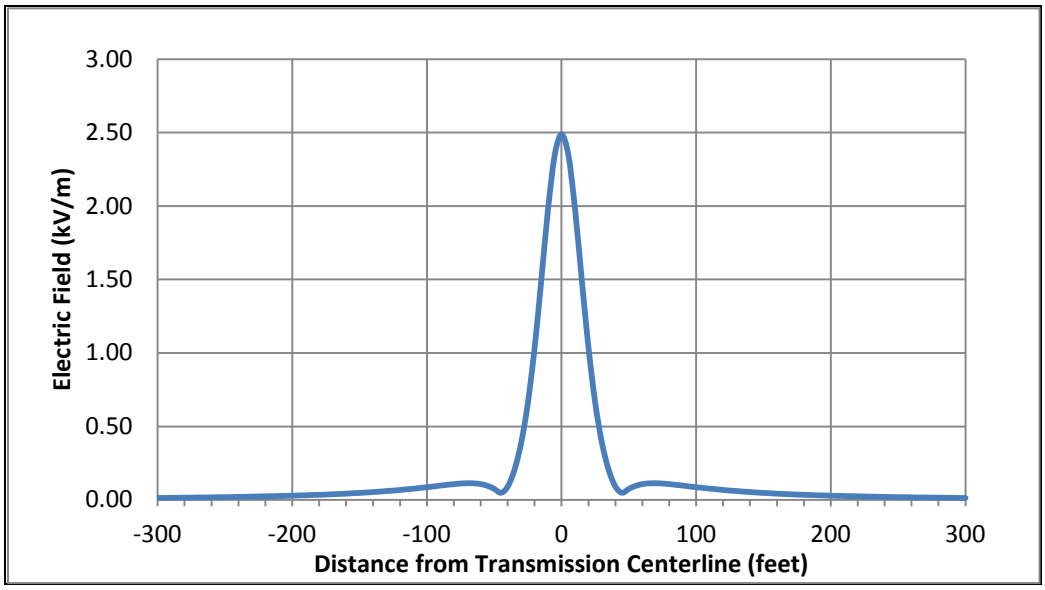


Figure 8-3. 115 kV with 7.2 kV Underbuild Line Electric Field Profile

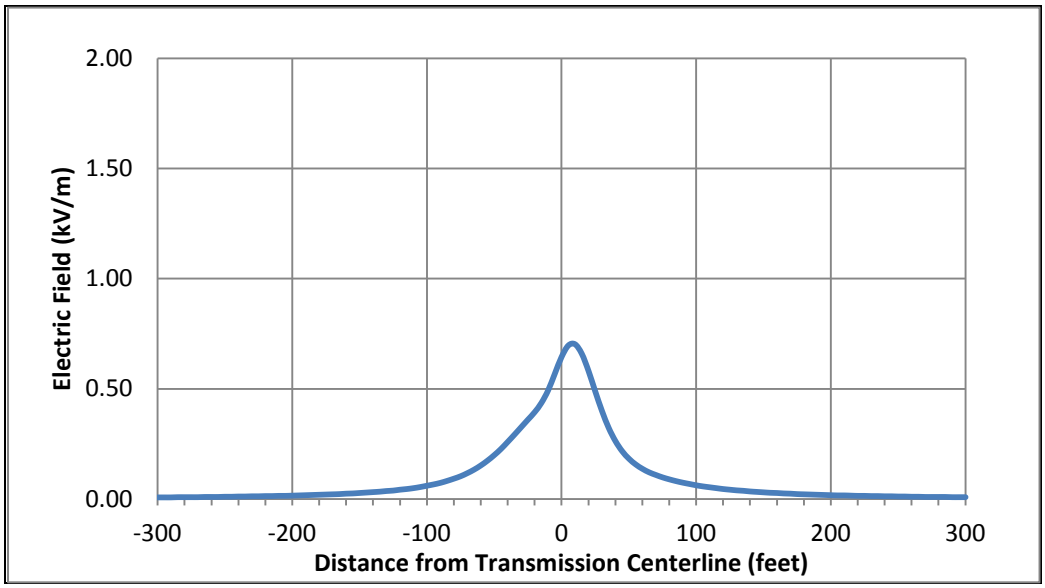
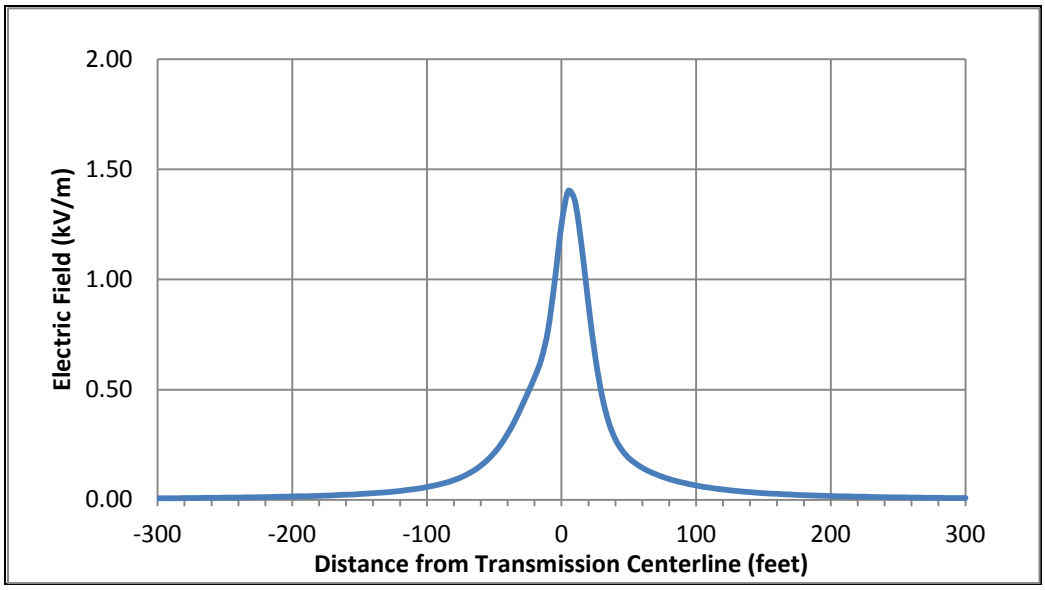


Figure 8-4. 115 kV Single Circuit Line Electric Field Profile



Induced Voltage

When an electric field reaches a nearby conductive object, such as a vehicle or a metal fence, it can induce a voltage on the object. The magnitude of this voltage is dependent on many factors, including the object's capacitance, shape, size, orientation and location, resistance with respect to ground, and the weather conditions. If the object is insulated or semi-insulated from the ground and a person touches it, a small current could pass through the person's body to the ground. This might be accompanied by a spark discharge and mild shock, similar to what can occur when a person walks across a carpet and touches an object or person.

The main concern with induced voltage is not the magnitude of the voltage induced, but the current that would flow through a person to the ground should the person touch the object. To ensure the safety of persons in the proximity of high voltage transmission lines, the NESC requires that any discharge be less than five (5) milliAmperes root mean square (mA rms). Applicants would ensure that any fixed conductive object in close proximity or parallel to the Project, such as a fence or other permanent conductive fixture, would be grounded so any discharge would be less than the 5 mA rms NESC limit.

Implantable Medical Devices

High intensity EMF can have adverse impacts on the operation of implantable medical devices (IMDs) such as pacemakers and defibrillators. While research has shown that the magnetic fields associated with high voltage transmission lines do not reach levels at which they could cause interference with such devices, it is possible that the electric fields associated with some high voltage transmission lines could reach levels high enough to induce sufficient body currents to cause interference. However, modern "bipolar" cardiac devices are much less susceptible to interactions with electric fields. Medtronic and Guidant, manufacturers of pacemakers and other

IMDs have indicated that electric fields below 6 kV/m are unlikely to cause interactions affecting operation of most of their devices. The older "unipolar" designs of cardiac devices are more susceptible to interference from electric fields. Research from the early 1990s indicates that the earliest evidence of interference with these types of IMDs could occur in electric fields ranging from 1.2 to 1.7 kV/meter. **Table 8-1** and **Figures 8-2 through 8-4** show that the electric fields for all of the Project's structure alternatives are well below levels at which modern bipolar devices are susceptible to interaction with the fields. For older style unipolar designs, the electric fields do exceed levels that research from the 1990s has indicated may produce interference. However, recent research conducted in 2005 concluded that the risk of interference to unipolar cardiac devices from high voltage power lines in everyday life is small. In 2007, Minnesota Power and Xcel Energy conducted studies with Medtronic, Inc. under 115 kV, 230 kV, 345 kV, and 500 kV transmission lines to confirm these 2005 findings. The analysis was based on real life public exposure levels under actual transmission lines in Minnesota and found no adverse interaction with pacemakers or IMDs. The analysis concluded that although interference may be possible in unique situations, device interference as a result of typical public exposure would be rare.[3]

In the unlikely event that a pacemaker is impacted, the effect is typically a temporary asynchronous pacing (commonly referred to as reversion mode or fixed rate pacing). The pacemaker would return to its normal operation when the person moves away from the source of the interference.

8.7.2 Magnetic Fields

Current passing through any conductor, including a wire, produces a magnetic field in the area around the wire. The current flowing through the conductors of a transmission line generates a magnetic field that, in similar fashion to the electric field, extends outward from the energized conductors. The intensity of the magnetic field associated with a transmission line is proportional to the amount of current flowing through the line's conductors, and the magnitude of the magnetic field rapidly decreases with the distance from the conductors. Unlike electric fields, magnetic fields are not significantly affected by the presence of trees, buildings, or other solid structures nearby. The value of the magnetic field density is expressed in the unit of gauss (G) or milligauss (mG).

There are no federal or Minnesota exposure standards for magnetic fields. The EQB and the Commission have recognized Florida (a 150-mG limit) and New York (a 200-mG limit) state standards. Both state standards are to be considered at the edge of ROW. Recent studies of the health effects from power frequency fields conclude that the evidence of health risk is weak.[4] The general standard is one of prudent avoidance.

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[3] 2007 Minnesota Power Systems Conference Proceedings (University of Minnesota), *Electromagnetic Compatibility of Active Implantable Medical Devices (AIMD) and Their Interaction with High Voltage Power Lines*, at 23.

[4] Minnesota Department of Health. *EMF White Paper on Electric and Magnetic Field* (EMF) Policy and Mitigation Options. 2002; National Research Council. *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*. 1997; www.niehs.nih.gov/health/topics/agents/emf/.

Magnetic field levels associated with some common electric appliances are provided in **Table 8-2.**

Table 8-2. Magnetic Fields of Common Electric Appliances (mG) [5]

Appliance	Distance from Source		
	6 inches	1 foot	2 feet
Hair Dryer	300	1	--
Electric Shaver	100	20	--
Can Opener	600	150	20
Electric Stove	30	8	2
Television	NA	7	2
Portable Heater	100	20	4
Vacuum Cleaner	300	60	10
Copy Machine	90	20	7
Computer	14	5	2

Table 8-3 summarizes the magnetic fields calculated for each of the Project's proposed transmission line configurations with power flow at peak loading and at the average loading. The magnetic field calculations are also shown graphically in **Figures 8-5 through 8-7.** Out of all the possible transmission line configurations, the maximum magnetic field under expected peak demand conditions is 28.52 mG, which is below most of the levels shown in **Table 8-2**.

Because the actual power flow on a transmission line could potentially vary widely throughout the day depending on electric demand, the actual magnetic field level could also vary widely from hour to hour. In any case, the typical magnitude of the magnetic field associated with the Project's transmission line is expected to be well below the calculated intensity at the expected peak loading.

[5] *EMF In Your Environment* (EPA 1992)

Table 8-3. Calculated Magnetic Fields (mG) for Proposed Transmission Line Designs(One meter (3.28 feet) above ground)

Scenario	Max. Operating Voltage (kV)	Line Current (Amps)	Distance to Proposed Centerline										
			-300’	-200’	-100’	-50’	-25’	Max.	25’	50’	100’	200’	300’
115/115 kV Double Circuit Peak Load (**Figure 8-5**)	121/121	115 kV: 110 115 kV: 138	0.28	0.62	2.36	7.64	17.33	28.52	16.62	7.38	2.31	0.62	0.28
115/115 kV Double Circuit Average Load (**Figure 8-5**)	121/121	115 kV: 80 115 kV: 82	0.18	0.41	1.53	4.92	11.11	18.61	11.06	4.90	1.52	0.41	0.18
115 kV with 7.2 kV Underbuild Peak Load (**Figure 8-6**)	121/8	115 kV: 110 7.2 kV: 26	0.55	0.84	1.94	4.76	9.36	17.11	12.35	6.54	2.63	1.05	0.65
115 with 7.2 kV Underbuild Average Load (**Figure 8-6**)	121/8	115 kV: 80 7.2 kV: 17	0.36	0.56	1.31	3.30	6.51	11.83	8.54	4.51	1.79	0.71	0.43
115 kV Single Circuit Line Peak Load (**Figure 8-7**)	121	110	0.13	0.29	1.08	3.45	7.92	15.88	9.38	3.94	1.17	0.31	0.14
115 kV Single Circuit Line Average Load (**Figure 8-7**)	121	80	0.10	0.21	0.79	2.51	5.76	11.55	6.82	2.86	0.85	0.22	0.10

Figure 8-5. 115/115 kV Double Circuit Line Magnetic Field Profile

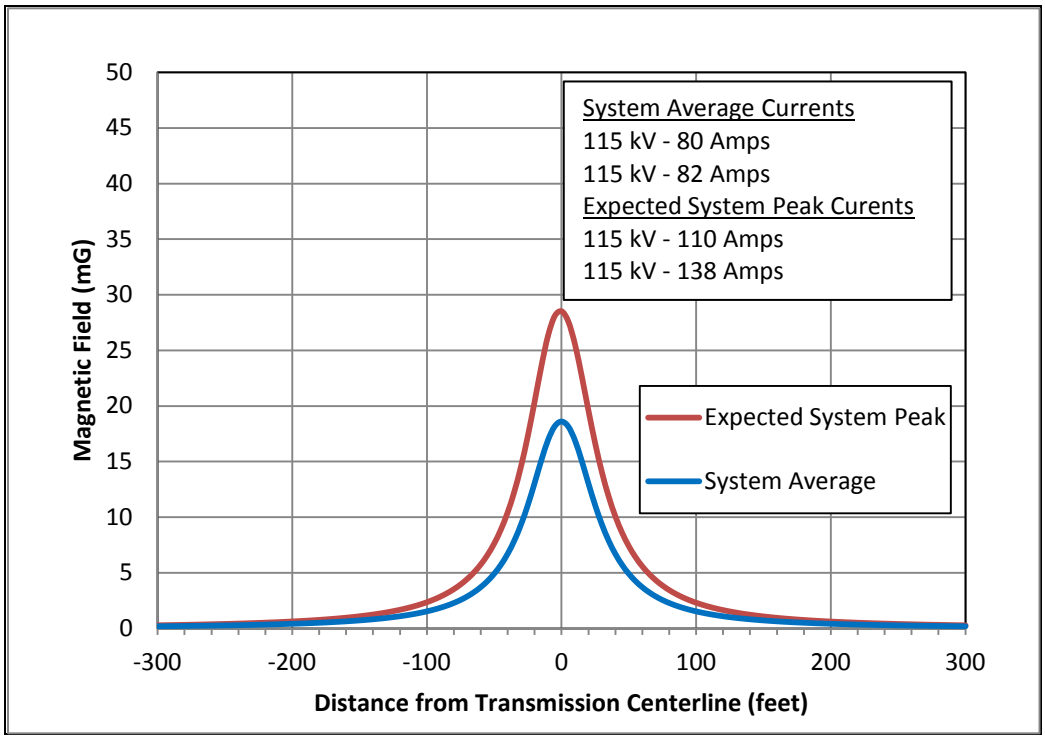


Figure 8-6. 115 kV with 7.2 kV Underbuild Line Magnetic Field Profile

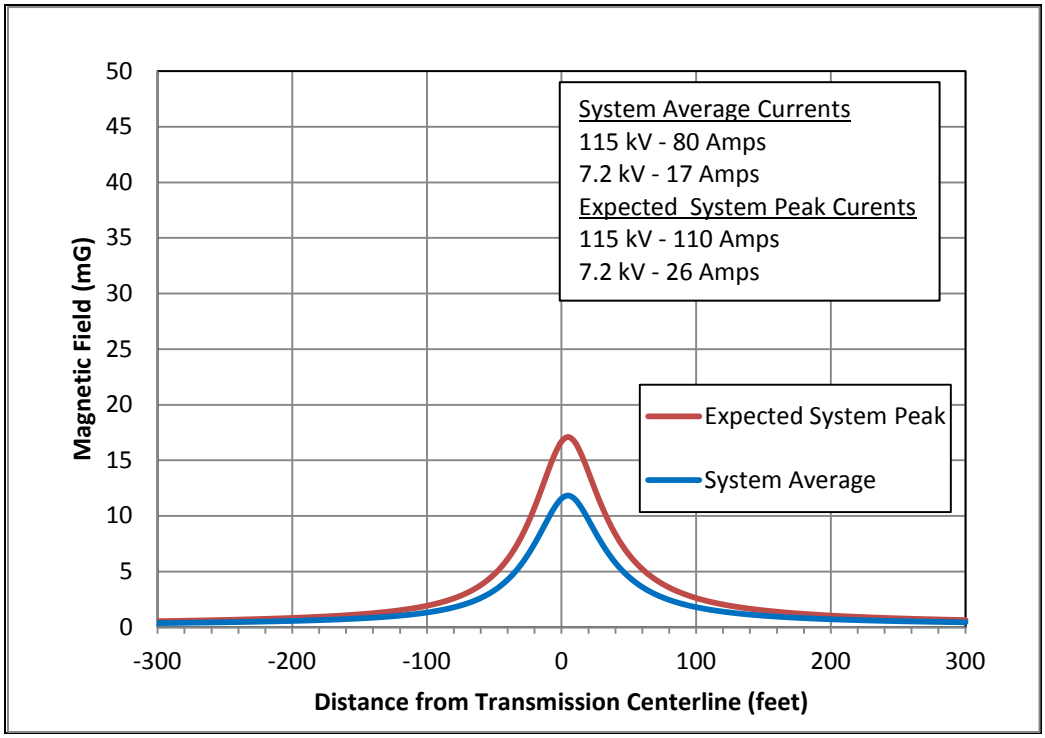
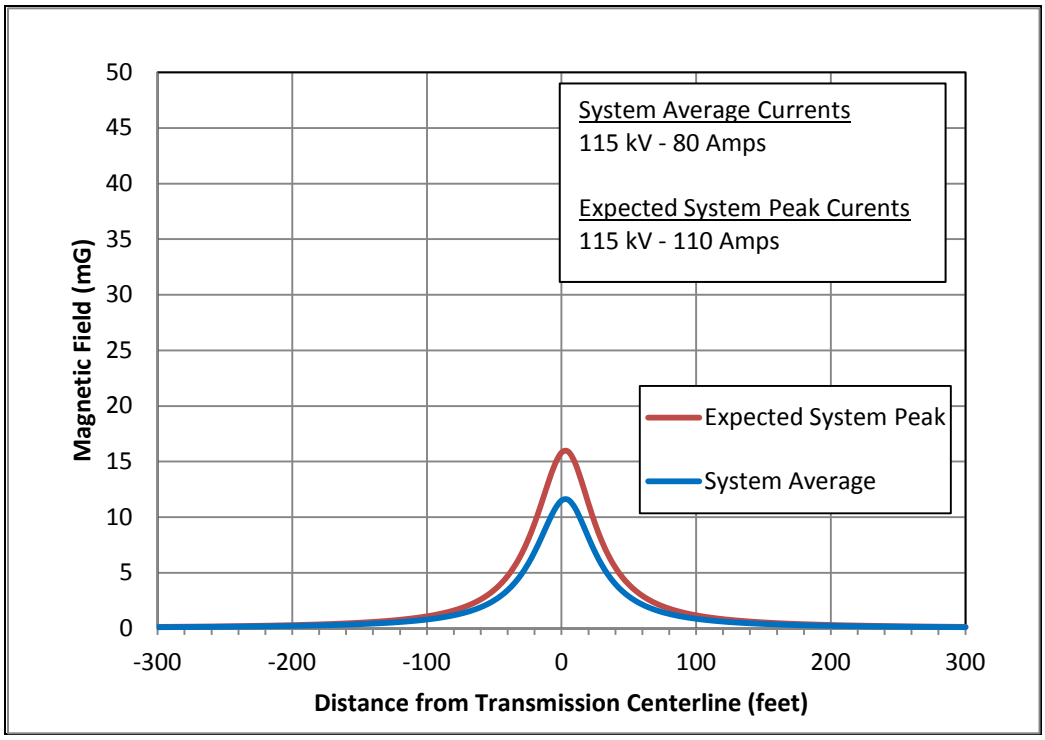


Figure 8-7. 115 kV Single Circuit Line Magnetic Field Profile



8.8 Stray Voltage

"Stray voltage" is a condition that can occur on the electric service entrances to structures from distribution lines. More precisely, stray voltage is a voltage that exists between the neutral wire of the service entrance and grounded objects in buildings such as barns and milking parlors.

Transmission lines do not, by themselves, create stray voltage because they do not connect to businesses and residences. Transmission lines can, however, induce a current on a distribution circuit that is parallel and immediately under the transmission line. Appropriate measures would be taken to mitigate problems associated with induced currents on distribution circuits when the proposed Project parallels or crosses distributions lines.

If a landowner has stray voltage concerns on their property, Applicants suggest they contact their electric service provider to discuss the situation with technical staff, including the possibility of an on-site investigation.

8.9 Corona

Under certain conditions, the localized electric fields near an energized transmission line conductor can produce small electric discharges, ionizing nearby air. This is commonly referred to as the "corona" effect. Most often, corona formation is related to some sort of irregularities on the conductor, such as scratches or nicks, dust buildup, or water droplets. The air ionization caused by corona discharges can result in the formation of audible noise and radio frequency

noise. If the discharges are excessive, the audible noise can reach annoyance levels and the radio frequency discharges can cause interference with radio and television reception. The potential for radio and television signal interference, however, is largely dependent on the magnitude of the corona-induced radio frequency noise *relative to* the strength of the broadcast signals.

Corona formation is a function of the conductor radius, surface condition, line geometry, weather condition, and most importantly, the line's operating voltage. Corona-induced audible noise and radio and television interference are typically not a concern for power lines with operating voltages below 161 kV, because the electric field intensity is too low to produce significant corona. The expected electric field intensity due to the Project's transmission lines is provided in **Section 8.7.1**.

8.9.1 Radio and Television Interference

Because the likelihood of significant corona formation on the Project's 115 kV lines is minimal, the likelihood of radio and television interference due to corona discharges associated with the Project's transmission is also minimal. Applicants are unaware of any complaints related to radio or television interference resulting from the operation of existing 115 kV facilities in the Project area and do not expect radio and television interference to be an issue along the proposed route.

8.9.2 Audible Noise

Transmission lines can cause audible noise due to corona discharges from the conductors. This noise, which resembles a crackling sound, is typically only within the threshold of human hearing during rainy or foggy conditions, and even then is largely imperceptible due to background noise. The impacts and mitigation of audible noise due to the Project are discussed further in **Section 9.2.3**.

8.9.3 Ozone and Nitrogen Oxide Emissions

In addition to potentially causing audible and radio frequency noise, corona can also produce ozone and oxides of nitrogen in the air surrounding the conductor. Ozone is a very reactive form of oxygen molecule that combines readily with other elements and compounds in the atmosphere, making it relatively short lived. Ozone forms naturally in the lower atmosphere from lightning discharges and from reactions between solar ultraviolet radiation and air pollutants such as hydrocarbons from auto emissions. The natural production rate of ozone is directly proportional to temperature and sunlight, and inversely proportional to humidity. Thus the conditions that are most likely to cause corona formation on a transmission line – humid, rainy, or foggy conditions – actually inhibit the production of ozone.

Like audible and radio frequency noise, corona-induced ozone and nitrogen oxides are typically not a concern for power lines with operating voltages below 161 kV, because the electric field intensity is too low to produce significant corona. Therefore, Applicants expects ozone and nitrogen oxide concentrations associated with the Project to be negligible, and well below all federal and state standards.

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