SECTION 5

Transmission System Engineering

5.1 Introduction

The City of Vernon (City) proposes to develop a power plant (VPP) on a 13.7-acre property at the southeast corner of Fruitland and Boyle avenues. The VPP will be a 914-megawatt (MW) net (at 65 degrees Fahrenheit [°F] with duct burners and evaporative cooling)/943-MW (gross) combined-cycle generating facility configured using three natural-gas-fired combustion turbines and one steam turbine. Two transmission line options are being considered to connect the plant to Southern California Edison's (SCE) Laguna Bell Substation. Natural gas for the facility will be delivered via approximately 2,300 feet of new 24-inch pipeline that will connect to Southern California Gas Company's (SoCalGas) existing gas transmission line (Line 765). Potable water for drinking, safety showers, fire protection, service water, and sanitary uses will be served from the City's potable water system through two 10-inch pipelines connecting to the City's water mains. One would connect in Boyle Avenue and the other in Fruitland Avenue. Recycled water for industrial purposes will be provided by the Central Basin Municipal Water District (CBMWD) through a nominal 16-inch carbon steel (or if using high density polyethylene [HDPE], a 20-inch) water line connecting to its recycled water line in Boyle Avenue, adjacent to the plant site. The blowdown will be sent to Sanitation Districts of Los Angeles County (LACSD) via a new 2,400-foot section of City sanitary sewer line.

Section 5 discusses the transmission interconnection between the VPP and the existing electrical grid and the anticipated impacts that operation of the facility will have on the flow of electrical power in this region of California. To better understand the impacts of the proposed power plant on the regional transmission system and power flows, an analysis of the existing electrical transmission system in the immediate area of the VPP; the proposed electrical interconnection between the VPP and the electrical grid; and the proposed interconnecting transmission line route or alignment is presented. This section also examines the impacts of the electrical interconnection on the existing electrical transmission grid. Alternatives to the proposed interconnection and line alignments are discussed and the anticipated system impacts of the proposed interconnection to the Southern California Edison (SCE) transmission system are described. Additional discussions include potential nuisances (electrical, magnetic, audible noise, and corona effects), and safety of the interconnection.

The site for VPP was selected, in part, for its proximity to the anticipated load, existing transmission corridors, and potential interconnection substations. Los Angles Department of Water and Power (LADWP) and SCE both have extensive transmission/distribution lines and substations in the vicinity of the proposed facility site. The LADWP maintains the Century-Velasco 230-kV (double-circuit) transmission line that passes approximately 800 feet east of the site, and SCE shares ownership with the City of Vernon on several 66-kV circuits that occupy Randolph Street several blocks south of the proposed plant site. Figure 5.1-1 identifies the proposed VPP site in relation to relevant transmission resources in the immediate area. The proposed preferred interconnection is to the California Independent System Operator Controlled Grid (CAISO grid) at SCE's Laguna Bell Substation. However, an alternative connection to LADWP has been developed and is also presented. The alternative connection to LADWP does not meet the commercial objectives of the project and may result in undesirable transmission impacts. These objectives include economical service to the City of Vernon and the ability to provide economic power to the grid operated by CAISO. The alternative connection to LADWP could be used if connection to SCE is not feasible.

The initial examination of the local transmission system concentrated on the anticipated VPP power flows, the capacity and location of existing transmission lines, the availability of substation capacities, and the physical distances involved with the anticipated electrical interconnection. The interconnection feasibility analysis considered directly connecting VPP to the CAISO grid at SCE's Laguna Bell Substation, approximately 4.4 (via direct line) miles southeast of the proposed plant site and also looping one or both circuits of LADWP's Century-Velasco 230-kV line into the VPP switchyard. Due to the size of the proposed VPP (nominal 914 MW) and the commercial requirements for the plant, system analyses concentrated on connecting the facility to SCE's Laguna Bell 230-kV substation.

As proposed, the electrical interconnection connects the VPP to the regional power grid by directly connecting the plant to the CAISO grid at SCE's Laguna Bell Substation (Figure 5.1-1). The connection involves a new, double-circuit 230-kV line on common double-circuit steel-pole structures. To protect against a significant problem in one of the routes to Laguna Bell, two options will be permitted. One is referred to as the "River Route" because it follows the Los Angeles River for a significant distance. The other is referred to as the "Randolph Route" because most of the route follows Randolph Street.

The main alternative, would involve looping in both circuits of LADWP's Century-Velasco, 230-kV double-circuit line passing east of the plant site into the VPP switchyard. This configuration would connect the VPP switchyard to the existing Century-Velasco lines and the LADWP system. The looping of both circuits would effectively create two new Velasco to VPP and Century to VPP 230-kV lines in place of the existing Century-Velasco lines.

Figure 5.1-1 illustrates the two proposed optional interconnections (i.e., River Route and Randolph Route) to the CAISO grid via the SCE system at Laguna Bell Substation. In the figure the features of the electrical system are superimposed on an aerial photograph that allows a comparison of the proposed components (plant site, interconnection corridors, and substation locations) with geographic features and recent commercial development of the area.

The proximity of transmission assets of two electrical utilities to the VPP allowed different conceptual interconnections to be considered with respect to their feasibility and anticipated impact on the existing transmission system and power flows. Primary consideration in the analysis was given to the ability of the existing transmission lines to carry the anticipated VPP output. Additional aspects considered included: environmental effects of building and maintaining the new interconnecting transmission line, right-of-way modification(s) and/or acquisition, engineering requirements, and costs. Alternative interconnection options were identified after analyses of these data and review of the LADWP and SCE system maps and one-line diagrams for their respective service areas. From these alternatives the two proposed transmission line alignments, the interconnection configuration, and construction techniques were selected.

To assist in the routing process of the interconnection, a series of routing links were selected and reviewed to evaluate their potential for the interconnection alignment. Links typically extend between two geographic points (nodes), each of which has two or more additional links connected to the same point. Once identified, links are numbered for ease of discussion. This system of analysis recognizes that various transmission alignments may have various sections in common with other alignments. The identification of links and the resulting analysis creates an array of links from which transmission corridor alternatives can be selected and compared. This process was used to select transmission alignments for both the proposed options and the alternative interconnection of the VPP.

5.2 Transmission Interconnection Engineering

Preliminary engineering of the proposed transmission interconnection was based on the results of the interconnection feasibility studies performed. This section discusses the existing transmission facilities in the vicinity of the proposed VPP and other potentially impacted transmission resources.

5.2.1 Existing Transmission Facilities (including system map)

The proposed VPP site is located in south-central Vernon on a 13.7-acre parcel southeast of the intersection of Fruitland and Boyle avenues (Figure 5.1-1). The site is located approximately 2,300 feet east-southeast of the existing Malburg Generating Station (MGS) site, which is owned by the City of Vernon. The proposed plant site is in close proximity to transmission resources necessary to interconnect the VPP to either the LADWP or SCE transmission systems. The Century-Velasco corridor, owned by LADWP, passes approximately 800 feet east of the site. The Laguna Bell Substation (on Randolph Street), in the City of Commerce, is owned by SCE. The substation is approximately four miles east-southeast of the proposed VPP site via established transmission corridors (Figure 5.1-1).

An inventory and assessment of the transmission facilities in the immediate geographic area of the VPP project were conducted. The regional transmission line assessment focused on the number of electrical transmission lines, the rating of each line, existing loads, and the ability of the existing transmission grid to safely and reliably transmit the anticipated maximum nominal capability (914 MW) of VPP. All these factors were reviewed during the system analyses. The results coupled with the physical location of the transmission resources to the VPP site aided in the selection of the proposed interconnection and selected alternatives.

5.2.2 Proposed Transmission Interconnection

The proposed interconnection between VPP and the SCE/CAISO transmission system consists of the following major facilities:

- New double-circuit 230-kV overhead transmission line extending either approximately 4.3 or 4.85 miles from the VPP switchyard to Laguna Bell Substation (Figure 5.1-1), depending on the routing option selected.
- A new 230-kV onsite switchyard at VPP using a breaker-and-a-half bus configuration

- Modifications in the Laguna Bell Substation to use the two existing bays at the 230-kV bus

5.2.2.1 Vernon Power Plant 230-kV Switchyard Characteristics

The proposed VPP 230-kV switchyard consists of nine 230-kV gas-insulated circuit breakers. A breaker-and-a-half bus arrangement would be used in the switchyard to obtain a high level of service reliability. An electrical one-line schematic of the proposed VPP switchyard arrangement employing the interconnection to the CAISO/SCE system is presented in Figure 5.2-1.

The switchyard and all equipment will be designed for a 63-kiloampere (kA) interrupting capacity. The main buses, as well as the bays, will be designed for 3,000 amperes (A) continuous current. As depicted in Figure 5.2-1, each generator will be provided with an independent tie to the switchyard. The VPP breaker-and-a-half bus would be connected to the existing transmission grid through double-circuit connections to the 230-kV buses in the Laguna Bell substation. The connection would require two additional bays at the Laguna Bell substation. Redundant 15/13.8-kV Unit Auxiliary Transformers connected between the combustion turbine generators (CTG) and their respective step-up transformers will provide power to all auxiliary loads within the VPP facility. Startup and standby power would be supplied through the generator step-up transformer and auxiliary transformer. Alternately, startup and standby power might be provided by a 230/13.8/4.16-kV step-down transformer. Auxiliary controls and protective relay systems for the 230-kV switchyard will be located in a control building or the GIS building separate from the power plant.

5.2.2.2 Overhead Transmission Line Characteristics

The proposed interconnecting transmission circuits will be engineered to carry 230 kV in a double-circuit configuration, each supported by steel-pole structures at appropriate intervals. Both proposed circuits will employ the same conductor. The recommended conductor type is two-bundle 1033-kcmil “Curlew.” This conductor is a standard SCE type rated so that each circuit can carry the entire plant output in an emergency.

The proposed line will exit the VPP switchyard in a slack span configuration from the pull-off structures, approximately 40 feet in height, located in the switchyard adjacent to the east side of the VPP GIS building (Figure 5.1-1). The exit span will vary in length to accommodate the route option selected and will connect the pull-off structures to a new steel-pole, double-circuit, heavy-angle structure. The heavy-angle structure will be constructed to accommodate the turn necessitated by the selected option.

The steel-pole structures will be tangent-type design and will be spaced based on engineering criteria. Figure 5.2-2 illustrates the conceptual design of a typical double-circuit steel-pole structure proposed for the interconnection. A “family” of structures based on this design will be developed to address the physical parameters of routing the line along the corridor. Each structure will be approximately 95 feet tall.

5.2.2.3 Option 1: The River Route

The River Route exits the site to the east between 5151 and 5233 Alcoa Street, crosses Alcoa, and approaches the LADWP right-of-way through the parking lot at 5208 Alcoa. It continues by crossing the LADWP right-of-way and turning north on an easement on the east side of the LADWP right-of-way. The route would turns north on this new easement along the LADWP right-of-way and then proceeds to the south side of the Leonis Substation. From there the route would turn east between the south side of the Leonis Substation and the north side of the City of Vernon Fire Station to the west side of Downey Road. Once at Downey the route turns north to District Boulevard. The route crosses Downey Avenue to the northeastern corner of District Boulevard and continues east on the north side of District Boulevard, turning northeast (toward the Los Angeles River) between the properties at 4713 and 4717 District Boulevard. The route then crosses the railroad facilities and then the Los Angles River. Along the eastern bank of the Los Angles River the route turns south and follows the river to Randolph Street and the junction of the right-of-way currently occupied by two 66-kV circuits (Laguna Bell-Leonis #2 and Laguna Bell-Ybarra). Both these circuits currently serve the City of Vernon. Finally, the route turns east along the north side of Randolph Street, crosses the 710 Freeway, and proceeds to the Laguna Bell Substation. The interconnection, along this section Randolph Street, will occupy the right-of- way currently occupied by the Laguna Bell-Container-Pulpgen-Vernon and the Laguna Bell-Leonis-Vernon circuits (66 kV). Figure 5.1-1 illustrates this option.

The 66-kV lines currently in this location would be replaced by Vernon's reserve circuit and a currently idle SCE circuit or by burying them. The Vernon Reserve circuit is an existing circuit formerly described as "Laguna Bell-Pole Switch 20-Pole Switch 38" 66-kV, which runs parallel to the Laguna Bell-Federal Gen-Fruitland 66-kV circuit. The SCE Idle Circuit is the former Laguna Bell-Pole Switch 33 circuit that is currently open at Fruitland and Loma Vista Avenue in Vernon. This option would allow for the following changes:

- Replace Laguna Bell-Leonis #2 circuit with the Vernon-Laguna Bell-Leonis reserve circuit
- Replace the Laguna Bell-Ybarra circuit with the SCE idle circuit
- East of the Los Angles River between the river and Laguna Bell, move the Laguna Bell-Leonis-Vernon and the Laguna Bell-Container-Pulp Gen Vernon 69-kV circuits to the positions vacated by the Laguna Bell-Leonis #2 and Laguna Bell-Ybarra 69-kV circuits currently on the four circuit steel structure.

For this option a new 66-kV section would be added to the SCE Idle Circuit between Fruitland and 44th Street to complete the connection to Ybarra.

5.2.2.3 Option 2: The Randolph Street Route

The Randolph Street route exits the site to the east between properties located 5233 and 5383 Alcoa Avenue. From there it crosses Alcoa Avenue and continues south along the eastside of Alcoa on right- of-way currently occupied by the Laguna Bell-Leonis-Vernon 66-kV circuit to Randolph Street. The route continues east, crosses the Century to Velasco 230-kV LADWP transmission line, and proceeds towards the Laguna Bell Substation along north side of the Randolph Street corridor on right-of-way currently occupied by the Laguna Bell-Container-Pulpgen-Vernon and the Laguna Bell-Leonis-Vernon circuits. The route continues east and crosses the Los Angles River, the LADWP 230-kV circuits from Haynes, and the 710 Freeway, and proceeds to Laguna Bell. Figure 5.1-1 illustrates this option.

The 66-kV lines currently in this location would be replaced by Vernon's reserve circuit and an idle SCE circuit or by burying them. The Vernon Reserve circuit is an existing circuit formerly described as "Laguna Bell-Pole Switch 20-Pole Switch 38" 66-kV which runs parallel to the Laguna Bell-Federal Gen-Fruitland 66-kV circuit. The SCE Idle Circuit is the former Laguna Bell-Pole Switch 33 circuit that is currently open at Fruitland and Loma Vista Avenue in Vernon. For this route, the assumption is that the 230-kV will replace the 66-kV for the entire route. This option would allow for the following changes:

- Replace the Laguna Bell-Container-Pulpgen-Vernon 66-kV circuit with the Vernon reserve line. The Vernon reserve would be attached to a section of the existing Laguna Bell-Leonis-Vernon 66-kV circuit at Downey Road. By adding a short section of 66-kV line on Slauson Avenue between Alcoa and Boyle avenues, the circuit to the remaining portion of the old circuit can be completed.
- The Laguna Bell-Leonis-Vernon 66-kV circuit would be replaced by the SCE idle 66-kV Laguna Bell to Fruitland circuit that follows Fruitland Avenue, Loma Vista Avenue, and 56th Street. The SCE idle circuit would be connected to the remainder of the existing circuit near the intersection of Downey Road and Fruitland Avenue.

For this option a new 66-kV section would be added to the Vernon Reserve circuit between Alcoa and Boyle.

5.2.2.4 Modifications at Laguna Bell

Changes at the Laguna Bell Substation to accommodate the direct connect of VPP would include the addition of two 230-kV circuit breakers to be attached to the 230-kV bus in the switchyard. Based on analysis of aerial photography and limited documentation, at least one spare bay exists, and there appears to be ample space and opportunity to complete the needed interconnection. During initial discussions, SCE has provided an additional alternative they believe feasible. Details involving necessary modifications at the Laguna Bell Substation will be worked out in the engineering-design phase of the project.

5.3 Transmission Interconnection Alternatives

As discussed in Section 5.1, the VPP site is situated near the electrical transmission systems of both LADWP and SCE. One of the results of the transmission resource analysis was the development of several additional conceptual transmission interconnection alternatives. Factors considered in the development and selection of the proposed transmission interconnection and alternatives were: (a) the ability of the existing transmission resources to carry the power generated by VPP, (b) environmental consequences, (c) ability to secure any additional rights-of-way (if needed), and (d) engineering considerations and constraints. In light of the above factors it is apparent that this location has a plethora of interconnection options that might all be feasible.

Several alternatives were identified, analyzed, and discounted due to subjective differences with the proposed transmission interconnection and the meeting of project goals. These alternatives are presented below. Other alternatives, not discussed herein, were delineated, assessed, and rejected as clearly inferior. The discussion below lays out several options to interconnect the VPP to the SCE electrical grid.

5.3.1 Primary Alternative: Connection to the LADWP System

The alternative connection to LADWP does not meet the commercial objectives of the project and may result in undesirable transmission impacts. These objectives include economical service to the City of Vernon and the ability to provide economic power to the grid operated by CAISO. The alternative connection to LADWP could be used if connection to SCE is deemed not feasible. The alternative connection consists of the following major transmission facilities:

- New double-circuit 230-kV overhead transmission line extending approximately 1,000 feet from the VPP switchyard east to the existing LADWP Century-Velasco right-of-way, configured to loop both existing circuits of Century-Velasco 230-kV transmission line into the VPP switchyard.
- A new 230-kV onsite switchyard at VPP using a breaker-and-a-half bus configuration
- Modifications in the Velasco and Century substations to add protective control devices to ensure reliability

The relative close proximity of the Century-Velasco transmission line corridor to the VPP site, allowed for the review of several alignment options. The proposed alignment was based on distance; physical space available along the corridor; adjoining properties and structures; environmental concerns; and other engineering requirements.

The two new interconnecting circuits would employ the same conductor, 2,500 kcmil (91-strand) “Lupine.” This is the conductor type used by LADWP on the two existing Century-to-Velasco 230-kV circuits. The proposed interconnecting transmission circuits would be built on a single overhead quad-circuit 230-kV pole (four 230-kV lines in total) between the VPP switchyard and the Century-Velasco right-of-way. The proposed line would exit the VPP switchyard in a slack span configuration from the pull-off structures, approximately 108 feet in height, located near the southeast corner of the VPP site (Figure 5.1-1).

The first span would be approximately 550 feet in length and would connect the pull-off structures to a new steel pole, quad-circuit, heavy angle structure to be constructed on the west side of Alcoa Avenue. The heavy-angle structure would be constructed to accommodate an approximate 30 degree turn of both 230-kV double-circuit lines. The next span would cross Alcoa Avenue to a second steel pole, heavy-angle structure located on the east side of Alcoa Avenue along the western edge of a parcel of land that includes a parking lot adjoining the Century-Velasco right-of-way. The placement of the second heavy-angle structure would create an approximate 150-foot span across Alcoa Avenue. This second quad-circuit heavy-angle structure would also accommodate a second 30 degree turn of both 230-kV double-circuits. Each heavy-angle structure would be approximately 150 feet tall. The existing 66-kV circuit along the east side of Alcoa would need to be abandoned or modified.

A dead-end, quad-circuit steel pole structure would be placed in the Century-Velasco right-of-way to accommodate looping the two existing 230-kV double-circuits to the VPP switchyard. The structure would accommodate a 90 degree angle where the interconnection enters and leaves the right-of-way. The structures would also be approximately 150 feet tall. The insertion of the two, dead-end, double-circuit structures in the Century-Velasco right-of-way would alter the spans in the existing Century-Velasco lines. Presently, a 900-foot span passes the point where the line is being proposed to be looped into VPP. The placing of the new structures would create a span of approximately 700 feet north of this point and a span of approximately 200 feet to the south.

Additional quad-circuit tangent structures may be needed in the new interconnection portion of the Century-Velasco 230-kV quad-circuit line. Final engineering will determine tower type and placement. These determinations will be based on code requirements and other engineering constraints.

5.3.2 Alternatives: Direct Connection to the SCE System (CAISO Grid) through the Laguna Bell Substation

Figure 5.2-1 illustrates the VPP switchyard one-line schematic with an interconnection to the SCE transmission system. The switchyard for the alternative connections to the CAISO Grid at SEC's Laguna Bell Substation will be exactly the same as the two primary options. The alternative interconnections between VPP and the SCE transmission system also consist of the same major facilities as the two primary interconnection options.

5.3.2.1 Alternative 1: Connection to the CAISO Grid at SCE's Laguna Bell Substation (Century-Velasco Right-of-way to Randolph Street)

This alternative would also have the same major features as discussed above and differs from Option 2 by using the Century to Velasco 230-kV right-of-way to reach Randolph Street instead of using Alcoa Avenue.

This alternative would use the Randolph Street corridor employed in the proposed interconnection discussed in Subsection 5.2.2.3. However, once at Alcoa Avenue, the line would proceed to the east edge of the Century to Velasco 230-kV right-of-way by crossing the existing double-circuit Century-Velasco line. From there, the line would occupy the eastern sector of the right-of-way and the Century-Velasco line would occupy the western sector of the right-of-way. From this access point south to Randolph Street (approximately 6,000 feet), the two lines will be placed on separate double-circuit steel-pole structures. This alternative will result in the removal of approximately 7 existing lattice steel towers (approximately 800-foot spans) and replacing them with the steel-pole structures for each of the lines. These structures will use an approximate span of 400 feet. It is anticipated that 15 such structures will span the distance from the right-of-way access point to Randolph Street.

Once to Randolph the line route would turn east and share the Randolph Street corridor with the Union Pacific Railroad and several existing 66-kV transmission lines. For this alternative, one double-circuit 66-kV line will be removed along Randolph Street.

5.3.2.2 Alternative 2: Connection to the CAISO Grid using Underground

Placing the interconnection underground along each of the above potential routes was considered as an alternative to the preferred overhead construction configuration. The underground option alternative was rejected because it is environmentally inferior, inconsistent with SCE practice,[1] and difficult to implement in already congested corridors,

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[1] E-mail from Teri Kondo to Stephen S. Miller, Abraham Alemu, et al, dated 10/11/2005 with the subject "Response to City of Vernon's request for SCE's Transmission Preferences and Practices"

particularly those found within the City of Vernon.[2] While overhead construction will result in only minor local disturbance of the vegetation along the existing right-of-way, underground construction would require that the vegetation be removed. Directly over the underground installation, future replacement of the vegetation would be limited to certain low growing/shallow-rooted plants compatible with such an installation.

5.4 Transmission Interconnection System Impact Studies

Due to its location in a heavy load area, a unique attribute of this project is that it has many potential feasible interconnections that will have minimum system impacts. VPP has initiated the interconnection procedure with both LADWP and SCE/CAISO. Direct interconnection to the SCE/CAISO grid at Laguna Bell has been selected as the preferred interconnection option for this project because connection to LADWP does not meet the commercial objectives of the project and it may result in undesirable transmission impacts. Project objectives include economical service to the City of Vernon and the ability to provide economic power to the grid operated by CAISO. The alternative connection to LADWP could be used if preferred connection to SCE proves not feasible.

VPP has active requests under the Large Generator Interconnection Procedure (LGIP) for interconnection to the SCE/CAISO grid of the entire proposed 914-MW net output of the VPP. These interconnection requests are in the form of two separate actions. The first is for 610-MW net and the second is for a 304-MW net expansion.

The 610-MW System Impact Study (SIS) is completed except for review by CAISO. Review by CAISO has been delayed at CAISO's request. Vernon review and comment will follow once CAISO review has been completed. A copy of the completed draft study is provided as Appendix 5A. Based on this study; there are no grid impacts that require environmental remediation for the 610-MW interconnection. VPP has elected to complete a facilities study for this application and is in the process of initiating this investigation.

The 304-MW SIS has been initiated and, according to the LGIP, will be completed in early fall of 2006. A draft interconnection study of an 890-MW net interconnection for a similarly located project is available and has been provided as Appendix 5B. While the study was never completed and the queue has changed since the draft was completed, no transmission impacts were identified that would have significant environmental consequences.

Both the 610-MW and the 890-MW system impact studies analyze the system with and without the project under stressed peak and off-peak conditions. The conditions studied included normal conditions and Category B and C contingencies. Power flow, short circuit and transient stability simulations were made. Applicable reliability and planning criteria were used to determine criteria violations and appropriate tables and diagrams have been provided. Major study assumptions such as imports, exports, major generation queue and major transmission path flows are outlined in both the study plans and the reports. Data cases are available.

[2] E-mail from Ali Nour to Stephen S. Miller, dated 10/26/2005 with the subject "Alternatives to LADWP Right-of-way for Connection to SCE." This e-mail indicates that none of the alternative corridors have underground corridors more than 25 feet wide.

VPP's interconnection proposal has been reviewed by its independent engineering consultant. It is impossible to define the transmission facilities that will be required for a particular interconnection until an Interconnection Agreement has been signed. However, based on the review of the studies completed to date and proper application of published, NERC, WECC, CAISO procedures and the LGIP, it is the consultants opinion that interconnection of VPP will not require system modifications beyond changes to terminal equipment located in existing substations. Terminal equipment changes already identified include breaker upgrades and wave traps. In the event that system changes are necessary, it is the consultant's opinion that these are likely to be minor cases that can be addressed by upgrading conductors or small changes to system configuration. In any event, the environmental impact of these changes will be insignificant or easily mitigated to insignificance.

5.5 Transmission Interconnection Safety and Nuisances

This section discusses safety and nuisance issues associated with the proposed electrical interconnection of VPP with the electrical grid. Construction and operation of the proposed overhead transmission line will be undertaken in a manner that ensures the safety of the public, as well as maintenance and right-of-way crews, while supplying power with minimal electrical interference.

5.5.1 Electrical Clearances

Typical high-voltage overhead transmission lines are composed of bare conductors connected to supporting structures by means of porcelain, glass, or plastic insulators. The air surrounding the energized conductor acts as the insulating medium. Maintaining sufficient clearances, or air space, around the conductors to protect the public and utility workers is paramount to safe operation of the line. The safety clearance required around the conductors is determined by normal operating voltages, conductor temperatures, short-term abnormal voltages, wind-blown swinging conductors, contamination of the insulators, clearances for workers, and clearances for public safety. Minimum clearances are specified in the National Electric Safety Code (NESC). Electric utilities, state regulators, and local ordinances may specify additional (more restrictive) clearances. Typically, clearances are specified for:

- Distance between the energized conductors themselves
- Distance between the energized conductors and the supporting structure
- Distance between the energized conductors and other power or communication wires on the same supporting structure, or between other power or communication wires above or below the conductors
- Distance from the energized conductors to the ground and features such as roadways, railroads, driveways, parking lots, navigable waterways, airports, etc.
- Distance from the energized conductors to buildings and signs
- Distance from the energized conductors to other parallel power lines

The proposed VPP transmission interconnection will be designed to meet all national, state, and local code clearance requirements. Since the designer must take into consideration many different situations, the generalized dimensions provided in the figures of this section should be regarded only as reference for the electric and magnetic field calculations, and not absolute. The minimum ground clearance for 230-kV transmission line per the NESC is 22.4 feet, based on the road-crossing minimum. These are the design clearances for the maximum operating temperature of the line. Under normal conditions, the line operates well below maximum conductor temperature, and thus, the average clearance is much greater than the minimum. The electrical effects calculations are based on a 50-foot clearance for 230-kV lines per SCE "EMF Design Guidelines for Electrical Facilities." The final design value will be consistent with General Order 95 (GO-95) of the California Public Utilities Commission and SCE's guidelines for electric and magnetic field (EMF) reduction.

5.5.2 Electrical Effects

The electrical effects of high-voltage transmission lines fall into two broad categories: corona effects and field effects. Corona is the ionization of the air that occurs at the surface of the energized conductor and suspension hardware due to very high electric field strength at the surface of the metal during certain conditions. Corona may result in radio and television reception interference, audible noise, light, and production of ozone. Corona is a function of the voltage of the line, the diameter of the conductor (or bundle of conductors), and the condition of the conductor and hardware. Field effects are the voltages and currents that may be induced in nearby conducting objects. The transmission line's 60-hertz (Hz) electric and magnetic fields cause these effects.

5.5.2.1 Electric and Magnetic Fields

Operating power lines, like the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce electric and magnetic fields, commonly referred to as EMF. The EMF produced by the alternating current electrical power system in the United States has a frequency of 60 Hz, meaning that the intensity and orientation of the field changes 60 times per second.

The 60-Hz power line fields are considered to be extremely low frequency. Other common frequencies are AM radio, which operates up to 1,600,000 Hz (1,600 kHz); television, 890,000,000 Hz (890 MHz); cellular telephones, 900,000,000 Hz (900 MHz); microwave ovens, 2,450,000,000 Hz (2.4 GHz); and X-rays, about 1 billion billion (10^{18}) Hz. Higher frequency fields have shorter wavelengths and greater energy in the field. Microwave wavelengths are a few inches long and have enough energy to cause heating in conducting objects. High frequencies, such as X-rays, have enough energy to cause ionization (breaking of atomic or molecular bonds). At the 60-Hz frequency associated with electric power transmission, the electric and magnetic fields have a wavelength of 3,100 miles and have very low energy that does not cause heating or ionization. The 60-Hz fields do not radiate, unlike radio-frequency fields.

Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field. The electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains practically steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow, measured in terms of amperes, through the conductors. The magnetic field strength is also directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors. Thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss (mG). The amperes and, therefore, the magnetic field around a transmission line, fluctuate daily and seasonally as the usage of electricity varies.

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful or not. In the absence of conclusive or evocative evidence, some states, California in particular, have chosen not to specify maximum acceptable levels of EMF. Instead, these states mandate a program of prudent avoidance whereby EMF exposure to the public would be minimized by encouraging electric utilities to use low-cost techniques to reduce the levels of EMF.

Additional information on EMF is provided in Appendix 5C.

5.5.2.2 Audible Noise

Corona is a function of the voltage of the line, the diameter of the conductor, and the condition of the conductor and suspension hardware. The electric field gradient is the rate at which the electric field changes and is directly related to the line voltage. The electric field gradient is greatest at the surface of the conductor. Large-diameter conductors have lower electric field gradients at the conductor surface and, hence, lower corona than smaller conductors, everything else being equal. Irregularities (such as nicks and scrapes on the conductor surface) or sharp edges on suspension hardware concentrate the electric field at these locations and, thus, increase corona at these spots. Similarly, contamination on the conductor surface, such as dust or insects, can cause irregularities that are a source for corona. Raindrops, snow, fog, and condensation are also sources of irregularities. Corona typically becomes a design concern for transmission lines having voltages of 345 kV and above.

5.5.2.3 EMF and Audible Noise Assumptions

It is important that any discussion of EMF and audible noise include the assumptions used to calculate these values and to remember that EMF and audible noise in the vicinity of the power lines vary with regard to line design, line loading, distance from the line, and other factors. Both the electric field and audible noise depend upon line voltage, which remains nearly constant for a transmission line during normal operation. A worst-case voltage of 69 kV (66 kV + 5 percent) will be used in the calculations for the 66-kV lines and 242 kV (230 kV + 5 percent) will be used in the calculations for the 230-kV lines.

The magnetic field is proportional to line loading (amperes), which varies as power plant generation is changed by the system operators to meet increases or decreases in electrical demand. Line loading values assumed for the EMF and audible noise studies were based on the 2008 Summer Peak Transmission Assessment Case provided by LADWP for the Preliminary Study. The VPP plant is assumed to be operating at a nominal 800 MW for the EMF studies. The power will be transmitted away from the power plant. A power flow study was conducted, as described in Subsection 5.5.2.3.1, to calculate how the power is expected to distribute over the circuits. The calculated power flow values are tabulated in Subsection 5.5.2.3.1 and are used in the EMF and audible noise calculations.

Peak line loading of SCE's 66-kV lines was provided by SCE. Circuit loading used for the EMF study are presented in Table 5.5-1.

TABLE 5.5-1
Normal Flows in the Vicinity of the Vernon Power Plant (VPP)
2008 Summer Peak Transmission Assessment Case provided by LADWP

Line	Normal Rating (Amps)	Heavy Summer	
		Line Flow Without VPP (Amps)	**Line Flow With VPP (Amps)**
Velasco-Century 230-kV #1 & #2	1,599/1,200	330	330
VPP-Laguna Bell 230-kV #1 & #2	1,986	NA	1078
Laguna Bell-Fruitland 66-kV	920	211	211
Laguna Bell-Fruitland-Randolph 66-kV	920	147	147
Laguna Bell-Randolph #1 66-kV	920	172	172
Laguna Bell-Ybarra 66-kV	920	198	0
Laguna Bell-Container-Vernon 66-kV	920	99	99
Laguna Bell-Leonis-Vernon 66-kV	920	143	143
Laguna Bell-Leonis #2	920	145	0
SCE Idle Circuit	920	0	172
Vernon Reserve	920	0	172
Haynes-Velasco 230-kV	1,599/1,200	574	574
Haynes-River 230-kV	1,599/1,200	504	504
Haynes-Atwater 230-kV	1,599/1,200	260	260
Haynes-St John 230-kV	1,599/1,200	424	424
Laguna Bell-Velasco 230-kV	861	0	0

Another important parameter for these studies is the phase arrangement of the lines, both existing and after the interconnection is made. The phasing (i.e., relative location of A, B, and C phases) on a multi-circuit structure may offer some field cancellation, which results in reduced magnetic field values at the right-of-way edge. Studies have shown that cross-phasing double-circuit lines provides magnetic field reduction when both circuits are carrying power in the same direction. In cross-phasing, the circuit on one side of the structure is configured, for example, with phases A, B, and C arranged from top to bottom, while the other circuit is configured C, B, A from top to bottom. For this study, where phasing information was not available, cross phasing on each double-circuit structure was assumed with current flowing in the same direction.

The following assumptions, commonly used by SCE, were adopted for this study.

- The line will be considered loaded at 75 percent of forecasted load
- Magnetic field strength is calculated at 3 feet aboveground
- Resultant magnetic fields are being used
- All line loadings are considered as balanced
- Dominant power flow directions are being used

The data and assumptions used for the EMF and audible noise studies can be noted from the discussions contained in the following paragraphs and the figures included in the following pages.

Figure 5.1-1 illustrates the plan view of the two interconnection alignments. EMF and audible noise studies were calculated at specific transmission lines represented by the fourteen cross-sections (A thru N). Cross-sections D, F, and H depict the existing transmission corridor along the Los Angeles River route (Option #1). Cross-sections A, E, G, and I show the same route with the proposed 230-kV lines.

Cross-sections B, H, J, K, and M are representative of the existing transmission corridor for the Randolph Street route (Option #2). Cross-sections A, I, L, and N have the new 230-kV lines for this route.

Cross-section A is illustrated in Figure 5.5-1 and displays the proposed 230-kV double-circuit line. The transmission corridor represented by this cross-section include the Power Plant exit, Leonis and District Boulevards, and along Alcoa Avenue. The phasing, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-2 shows Cross-section B, and represents the existing LADWP Century to Velasco 230-kV lines. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section C is depicted in Figure 5.5-3 and represents the Velasco-to-Century corridor with the proposed 230-kV double-circuit line. The new line is located just outside the existing LADWP right-of-way and is parallel to the Velasco-Century Line. This is an alternate route from the plant to Randolph Street. The phasing, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-4 is Cross-section D and represents the existing transmission corridor along Downey Avenue. There is a double-circuit 66-kV wood pole line with one circuit connecting SCE’s Fruitland substation to SCE’s Laguna Bell substation as viewed looking north. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section E, as shown in Figure 5.5-5, represents the transmission corridor along Downey Avenue with the VPP connected. The proposed 230-kV double-circuit steel pole line now parallels the existing 66-kV line. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-6 is Cross-section F and represents the existing LADWP steel lattice towers that carry five Haynes 230-kV circuits parallel to a double-circuit 66-kV wood pole line as viewed looking south. The phasing configuration, conductor and shield wire used, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section G is illustrated in Figure 5.5-7 and represents the Los Angeles River Corridor with the new 230-kV double-circuit line replacing the 66-kV double circuit wood pole line. The phasing, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-8 is Cross-section H and represents the existing transmission corridor along Randolph Street at Colmar. There are two double-circuit 66-kV wood pole lines that run parallel to a steel lattice tower carrying four 66-kV circuits as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section I, as depicted in Figure 5.5-9, shows the transmission corridor along Randolph Street at Colmar with the VPP connected. A 66-kV wood pole double-circuit line is replaced with the proposed 230-kV double-circuit steel pole line as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-10 is Cross-section J and represents the existing transmission corridor along Alcoa Avenue. There is a double-circuit 66-kV wood pole line with one circuit connecting SCE's Leonis substation to SCE's Laguna Bell substation as viewed looking north. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section K is shown in Figure 5.5-11 and represents the existing transmission corridor along Randolph Street at Maywood. There are two double-circuit 66-kV wood pole lines connecting to SCE's Laguna Bell substation as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-12 is Cross-section L and shows the transmission corridor along Randolph Street at Maywood with the VPP. A 66-kV wood pole double-circuit line is replaced with the proposed 230-kV double-circuit steel pole line as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Cross-section M, as depicted in Figure 5.5-13, shows the transmission corridor along Randolph Street at Atlantic. Two wood pole double-circuit 66-kV lines run parallel to a steel lattice double-circuit 66-kV line as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

Figure 5.5-14 shows Cross-section N, and represents the transmission corridor along Randolph Street at Atlantic with the VPP connected. A 66-kV wood pole double-circuit line is replaced with the proposed 230-kV double-circuit steel pole line as viewed looking west. The phasing configuration, conductor and shield wire, and dimensions assumed for the EMF and audible noise studies are pictured.

These calculations are based on the preliminary conceptual design of the interconnection facilities. Estimates for these values will change based on the final design, which may include efforts directed at changing or reducing EMF.

5.5.2.3.1 EMF Calculations

EMFs were calculated at one meter above flat terrain using the Transmission Line Parameters and Electric Gradient (TRALIN) module of the Current Distribution, Electromagnetic Interference, Grounding and Soil Structure Analysis (CDEGS) program developed by the Safe Engineering Services & Technologies, Ltd. Measurements for electric and magnetic fields at one meter above the ground surface are in accordance with the Institute of Electrical and Electronic Engineers (IEEE) standards. TRALIN calculates the electric fields expressed as kilovolts per meter (kV/m) and the magnetic fields expressed in milligauss (mG). The various inputs for the calculations include voltage, current load (amps), current angle (i.e., phasing), conductor type and spacing, number of subconductors, subconductor bundle symmetry, spatial coordinates of the conductors and shield wire, various labeling parameters, and other specifics. The field level is calculated perpendicular to the line and at mid-span where the overhead line sags closest to the ground (calculation point). The mid-span location, therefore, provides the maximum value for the field.

Also using a TRALIN mathematical model, audible noise is calculated at a 5-foot microphone height above flat terrain with information concerning rain, snow, and fog rates for daytime and nighttime hours as input. Audible noise is expressed as “A-weighted” in decibels (dBA). The “A-weighted” scale approximates the response of the human ear. Graphs contained in this report were produced by importing TRALIN data into Microsoft Excel.

A power flow model was developed from a 2008 Western Electricity Coordinating Council (WECC) Summer Peak transmission assessment case provided by LADWP for this study. SCE provided data for the 66-kV flows. Three scenarios were calculated for comparison:

- Without the proposed VPP operating (Base Case)
- With the proposed VPP nominal generation of 800 MW added with a connection to CAISO grid

Variations in the power flow for the studied cross-sections are tabulated in Table 5.5-1.

5.5.2.3.2 Results of EMF and Audible Noise Calculations

Electric Field and Audible Noise

Line voltage and arrangement of the phases determine the electric field.

Cross-section A represents the corridor with only the new 230-kV double-circuit line. These include the Power Plant exit, Leonis and District Boulevards, and Alcoa Avenue. The electric field and audible noise levels are similar to those of the existing 230-kV transmission lines. The highest levels of corona and, hence, audible noise will occur during heavy rain when the line conductors are wet.[3] For these conditions, the conductor will produce a small amount of corona. The calculated surface gradient for dry conductor conditions for the proposed line is approximately 22 kV/cm (peak). The peak electric field level is 0.95 kV/m and the peak audible noise level during heavy rain is about 53 dBA.

The existing LADWP Century to Velasco 230-kV lines are represented by Cross-section B while Cross-section C has the new Vernon 230-kV double circuit line parallel just outside the existing edge of right-of-way. With this scenario the peak electric field increases from 0.75 to 1.09 kV/m and the peak audible noise level during heavy rain is increased from 45 to 54 dBA.

Cross-section F depicts the existing LADWP steel lattice towers that carry five Haynes 230-kV double-circuit lines parallel to a double-circuit 66-kV wood pole line which is replaced by the new 230-kV double circuit line (Cross-section G). The peak electric field level remains the same at 1.25 kV/m and peak audible noise would change from 47 dBA to 53 dBA.

Cross-sections D, H, J, K and M represent existing corridors of 66-kV lines along Alcoa Avenue, Downey Avenue and Randolph Street. The peak electric field levels are 0.4 kV/m or less and there is not any detectable audible noise. Cross-sections E, I, A, L and N represent the same location with the proposed 230-kV double-circuit line. Electric field levels have a peak value 0.95 kV/m and peak heavy rain audible noise would be about 53 dBA.

Graphical views of electric field profiles are shown in Figures 5.5-15 through 5.5-21. Figures 5.5-22 through 5.5-28 display the calculated audible noise levels during heavy rain, wet conductor and fair weather conditions.

Magnetic Field

Line current and arrangement of the phases determine the magnetic field. Graphical views are given in Figures 5.5-29 through 35. Table 5.5-2 summarizes calculated values for the magnetic field. For each cross-section, the peak magnetic field and values at ±50 feet and ±100 feet from centerline are presented “with VPP” and “without VPP.” For each cross-section, the distance is given where the maximum field value was located.

TABLE 5.5-2
Magnetic Field (mG), Calculated Field at Mid-span Perpendicular to Transmission Centerline

	Distance from Cross-section Centerline (feet) Given Below				
Profile	**-100**	**-50**	**Maximum Value**	**50**	**100**
Cross-section A	**West of Centerline**			**East of Centerline**	
With VPP Plant	2.0	6.9	16.3 at -38 ft	6.7	1.9
Cross-sections B, C	**West of Centerline**			**East of Centerline**	
Without VPP Plant	1.1	3.5	7.3 at 0 ft	3.4	1.1
With VPP Plant	1.7	4.4	15.0 at 60 ft	14.1	8.1

[3] However, during heavy rain the ambient noise generated by the rain will be higher than that generated by corona. Perception of noise may be worse when the conductor is wet but there is no rain.

TABLE 5.5-2
Magnetic Field (mG), Calculated Field at Mid-span Perpendicular to Transmission Centerline

Profile	Distance from Cross-section Centerline (feet) Given Below				
	-100	-50	Maximum Value	50	100
Cross-sections D, E	**West of Centerline**			**East of Centerline**	
Without VPP Plant	2.6	5.6	5.9 at -38 ft	1.7	0.8
With VPP Plant	4.2	12.8	14.7 at -32 ft	1.8	0.6
Cross-sections F, G	**West of Centerline**			**East of Centerline**	
Without VPP Plant	12.7	27.4	29.1 at -87 ft	7.9	5.2
With VPP Plant	21.0	32.3	47.3 at -8 ft	46.1	41.9
Cross-sections H, I	**South of Centerline**			**North of Centerline**	
Without VPP Plant	0.7	1.4	3.6 at 72 ft	2.0	2.9
With VPP Plant	1.5	2.1	18.6 at 0 ft	18.6	9.3
Cross-section J	**West of Centerline**			**East of Centerline**	
Without VPP Plant	2.4	5.1	5.4 at -38 ft	1.5	0.8
Cross-sections K, L	**South of Centerline**			**North of Centerline**	
Without VPP Plant	2.5	6.0	6.7 at -83 ft	1.6	3.1
With VPP Plant	0.4	1.8	16.4 at 80 ft	3.0	11.2
Cross-sections M, N	**South of Centerline**			**North of Centerline**	
Without VPP Plant	0.6	1.3	4.7 at 72 ft	0.6	3.8
With VPP Plant	1.0	0.3	16.4 at 24 ft	12.7	12.7

5.5.2.3.3 Transmission Line EMF Reduction

While the State of California does not set a statutory limit for electric and magnetic field levels, the California Public Utilities Commission (CPUC), which regulates electric transmission lines, mandates EMF reduction as a practicable design criterion for new and upgraded electrical facilities. As a result of this mandate, the regulated electric utilities have developed their own design guidelines to reduce EMF at each new facility. The California Energy Commission (CEC), which regulates transmission lines to the point of connection, requires independent power producers (IPP) to follow the existing guidelines that are in use by local electric utilities or transmission-system owners.

In keeping with the goal of EMF reduction, the interconnection of the VPP will be designed and constructed using the principles outlined in the SCE publication, “EMF Design Guidelines for Electrical Facilities.” These guidelines explicitly incorporate the directives of the CPUC by developing design procedures compliant with Decision 93-11-013 and General Orders 95, 128, and 131-D. That is, when the transmission line structures, conductors, and rights-of-way are designed and routed according to the SCE guidelines, the transmission line is consistent with the CPUC mandate.

From page 37 of the SCE guidelines, the primary techniques for reducing EMF anywhere along the line are to:

1. Increase the pole height for overhead design
2. Use compact pole-head configuration
3. Minimize the current on the line
4. Optimize the configuration of the phases (A, B, C)

Anticipated EMF levels have been calculated for the VPP interconnection as preliminarily designed. The CEC requires actual measurements of pre-interconnection background EMF for comparison with measurements of post-interconnection EMF levels. If required, the pre- and post-interconnection verification measurements will be made consistent with IEEE guidelines and will provide sample readings of EMF at the edge of right-of-way. Additional measurements will be made upon request for locations of particular concern.

5.5.2.3.4 Conclusion on EMF and Audible Noise

The connection to CAISO grid has between approximately 4.3 and 4.85 miles of new 230-kV double-circuit transmission with each circuit carrying approximately 1,078 amps per phase under full plant output. A portion of the proposed route currently has either no lines or a single 66-kV line. This include the power plant exit, Alcoa Avenue, Downey Aveue, and Leonis and District Boulevards (Cross-sections A and E). Electric field from the proposed 230-kV transmission line will be less than 1 kV/m. while audible noise will be very slight and probably only audible during certain wet conductor conditions, if at all. Magnetic field levels for this portion of the route are typical for a 230-kV double-circuit transmission line with a peak magnetic field of 16.3 mG.

The proposed 230-kV line will parallel an existing five 230-kV circuit line in the Los Angeles river corridor (Cross-section G). There is no change from the existing lines' electric field level of 1.25kV/m, as there is no change to the voltage or line configurations. The audio noise level increased slightly to 53 dBA during heavy rain, because the new line is using a bundled conductor. There is an increase, though, of magnetic field levels to a peak of 47.3 mG because of increased current load.

The proposed transmission corridor along Randolph Street represented by Cross-sections L, N, and I will see increases in electric field and audible noise levels due to the increase in voltage when replacing a 66-kV double-circuit line with 230-kV double-circuit line. Despite the increases, the values remain at acceptable levels with peak audible noise of 53 dBA during heavy rain and peak electric field less than 1 kV/m. The proposed 230-kV double-circuit line will carry 1,078 amps/phase, which will substantially increase the magnetic field. Also a currently unused 66-kV circuit will now carry power. The peak magnetic field in this corridor increases from 6.7 mG to 16.4 mG.

5.5.2.4 Induced Current and Voltages

A conducting object such as a vehicle or person in an electric field will have induced voltages and currents. The strength of the induced current will depend upon the electric field strength, the size and shape of the conducting object, and the object-to-ground resistance. Examples of measured induced currents in a 1-kV/m electric field are about 0.016 mA for a person, about 0.41 mA for a large school bus, and about 0.63 mA for a large trailer truck.

When a conducting object is isolated from the ground and a grounded person touches the object, a perceptible current or shock may occur as the current flows to ground. Shocks are classified as below perception, above perception, secondary, and primary. The mean perception level is 1.0 mA for a 180-pound man and 0.7 mA for a 120-pound woman. Secondary shocks cause no direct physiological harm, but may annoy a person and cause involuntary muscle contraction. The lower average secondary-shock level for an average-sized man is about 2 mA.

Primary shocks can be harmful. Their lower level is described as the current at which 99.5 percent of subjects can still voluntarily “let go” of the shocking electrode. For the 180-pound man this is 9 mA; for the 120-pound woman, 6 mA; and for children, 5 mA. The NESC specifies 5 mA as the maximum allowable short-circuit current to ground from vehicles, trucks, and equipment near transmission lines.

The mitigation for hazardous and nuisance shocks is to ensure that metallic objects on or near the right-of-way are grounded and that sufficient clearances are provided at roadways and parking lots to keep electric fields at these locations sufficiently low to prevent vehicle short-circuit currents from exceeding 5 mA.

Magnetic fields can also induce voltages and currents in conducting objects. Typically, this requires a long metallic object, such as a wire fence or aboveground pipeline that is grounded at only one location. A person who closes an electrical loop by grounding the object at a different location will experience a shock similar to that described above for an ungrounded object. Mitigation for this problem is to ensure multiple grounds on fences or pipelines, especially those that are oriented parallel to the transmission line.

Where railroads are crossed or are parallel to the transmission line, coordination is required with the railroad company to ensure that the magnetically-induced voltages and currents in the rails do not interfere with railroad signal and communications circuits, which are often transmitted through the rails. An approximate 3.3 mile section of the 230-kV double-circuit line connecting VPP with the Laguna Bell Substation would run in parallel with the UPRR and the LA Junction railroad. Upon final design for the location and various other specifics of the line, a study of any possible electrical interference will be conducted if requested. The proposed routing of the 230-kV lines will be constructed in conformance with GO-52.

The proposed 230-kV transmission interconnection will be constructed in conformance with GO-95 and Title 8 California Code of Regulations Section 2700 (8 CCR 2700) requirements. Therefore, hazardous shocks are unlikely to occur as a result of project construction or operation.

5.5.2.5 Communications (Radio/TV) Interference

The calculated quasi-peak radio noise at 1,000 kHz is 70 to 74 dB (relative to 1 microvolt/ meter) during heavy rain conditions and 45 to 49 dB during fair weather. The amount of AM radio interference caused by the transmission line depends upon the relative signal strength of the radio signal and other sources of ambient radio noise. Figures 5.5-36 through 5.5-42 display the calculated radio noise levels during heavy rain, wet conductor and fair weather conditions.

The North American Regional Broadcasting Agreement recognizes a 54 dB signal level as the outer boundary of an AM radio station's primary service territory. The Federal Communications Commission recommends the following minimum signals as necessary to reliably serve a primary service area: Business City Area 80 to 94 dB, Residential City Area 66 to 80 dB, and Rural Area 40 to 54 dB. The requirements for higher signal strengths in city areas takes into consideration the higher level of ambient noise levels typically found in the city as compared to a rural location.

Good radio reception is typically based on a signal strength 26 dB greater than ambient noise. This 26 dB signal-to-noise ratio is applied to the fair weather ambient noise level. A commonly accepted level of transmission radio noise is 40 to 45 dB at the edge of right-of-way for fair weather conditions. A 40-dB noise level and 26-dB signal-to-noise ratio would imply signal strength of 66 dB, which agrees with recommended signal strength as listed above for residential city area.

In conclusion, the expected peak fair weather radio noise from the 230-kV lines is calculated as 45 to 49 dB and is lower at the edge of right-of-way. The line is located in an urban area that would be expected to have high levels of ambient radio noise. The low radio noise of the 230-kV lines is not expected to be a problem to AM radio reception.

FM radio is immune to corona type radio noise and, therefore, is not considered in evaluation of transmission radio interference. TV audio is also an FM signal that is not affected by transmission line radio noise. TV video is an AM signal that is subject to interference from transmission lines. However, the frequency spectrum for fair weather corona noise follows an inverse law. The transmission noise attenuates at a rate of 20 dB per frequency decade. In addition to attenuation for frequency, an adjustment is made for the different bandwidth of the TV signal versus AM radio. When the frequency and bandwidth adjustments are made, the net correction is 10 dB. The expected noise at TV frequencies is 10 dB less than for AM radio.

For the proposed 230-kV transmission lines, the expected TV noise during fair weather is not expected to be a problem.

FCC regulations require that incidental radiation devices (such as transmission lines) be operated so that no harmful radio or TV interference is produced. The FCC regulations require that the operators of these devices eliminate such interference. Where an interference problem is created by a transmission line, the typical practice to alleviate the problem is to deal with each situation individually. Usually, the corrective measure includes moving or improving the receiving antenna or connecting to a cable TV system.

5.5.3 Aviation Safety

Federal Aviation Administration (FAA) Regulations, Title 14 of the Code of Federal Regulations (CFR), Part 77 establishes standards for determining obstructions in navigable airspace in the vicinity of airports that are available for public use and are listed in the Airport Directory of the current Airman's Information Manual. These regulations set forth requirements for notification of proposed obstruction that extend above the earth's surface. FAA notification is required for any potential obstruction structure erected over 200 feet in height above ground level. Also, notification is required if the obstruction is greater than specified heights and falls within any restricted airspace in the approach to airports. For airports with runways longer than 3,200 feet, the restricted space extends 20,000 feet (3.3 nautical miles) from the runway with no obstruction greater than a 100:1 ratio of the distance from the runway. For airports with runways measuring 3,200 feet or less, the restricted space extends 10,000 feet (1.7 nautical miles) with a 50:1 ratio of the distance from the runway. For heliports, the restricted space extends 5,000 feet (0.8 nautical miles) with a 25:1 ratio.

There are no airports (public or private) within 20,000 feet of the proposed VPP site. The three closest airports are Compton/Woodley Airport (40,000 feet), Hawthorne Municipal Airport (44,300 feet), and Los Angles International Airport (60,000 feet). All are open to public use, but beyond the 20,000-foot envelope. Only one heliport is located inside the 5,000-foot envelope established for these types of facilities. The SFI-Vernon Heliport is located approximately 1,650 feet to the north of the proposed VPP at 4700 South Boyle Street. As a result of the alignments of the two proposed interconnecting corridors, the closest transmission structure will be approximately 2,000 feet south-southeast of the heliport. This structure will be the first structure outside the VPP switchyard. From the switchyard all other structures will be further afield from the SFI-Vernon Heliport. The heliport sets atop the SFE Corporation Building at an elevation of 231 feet above mean sea level (msl). Boyle Avenue elevation at the heliport is 190 feet msl. This places the heliport approximately 41 feet above the surface of the street. Anticipated structure heights of 95 to 100 feet place their tops approximately 55 to 60 feet above the heliport but approximately 2,000 feet to the south. This facility is not available for public use, and thus not included in, or regulated by, Part 77 of the FAA regulations.

While it may be necessary to notify the FAA due to other tall elements of the project, the height of the transmission structures (95 to 100 feet) and their placement in the navigable airspace will not trigger an agency review. As a result of their location and height in relation to the existing public-use airports and the private-use SFI-Vernon Heliport, the structures of the either preferred electrical transmission interconnection will pose no deterrent to aviation safety as defined and regulated in 14 CFR Part 77 of the FAA regulations.

5.5.4 Fire Hazards

The proposed 230-kV double-circuit interconnecting transmission line built along either alignment to SCE’s Laguna Bell Substation will be designed, constructed, and maintained in accordance with California Public Utilities Commission’s General Order 95 (GO-95). GO-95 establishes clearances from other man-made and natural structures as well as tree-trimming requirements to mitigate fire hazards. The two interconnection alignments to the substation may have trees that would present a fire hazard, especially along Randolph Street or other surface streets. If this situation arises, the trees will be trimmed or removed to ensure mitigation of these hazards. However, it is unlikely that any vegetation management will be required because the entire proposed route is over areas that have existing transmission and distribution lines. The City of Vernon or their designate will maintain the interconnection corridor in accordance with accepted industry practices. This will include identification and abatement of any fire hazards to ensure safe operation of the line.

5.6 Applicable Laws, Ordinances, Regulations, and Standards (LORS)

This section provides a list of applicable laws, ordinances, regulations, and standards (LORS) that apply to the proposed interconnecting transmission line, switchyard/ substation and engineering during the construction and operations phases of the project. The following compilation of LORS is in response to Section (h), of Appendix B attached to Article 6, of Chapter 6, of Title 20 of the California Code of Regulations. Inclusion of these data is further outlined in the CEC's publication entitled "Rules of Practice and Procedure & Power Plant Site Certification Regulations."

5.6.1 Design and Construction

Table 5.6-1 lists the applicable LORS for the design and construction of the proposed transmission line and substations.

TABLE 5.6-1
Design and Construction LORS

LORS	Applicability	AFC Reference
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction"	California Public Utility Commission (CPUC) rule covers required clearances, grounding techniques, maintenance, and inspection requirements.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3
Title 8 California Code of Regulations (CCR), Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation, and maintenance of electrical installation and equipment to provide practical safety and freedom from danger.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3
General Order 128 (GO-128), CPUC, "Rules for Construction of Underground Electric Supply and Communications Systems"	Establishes requirements and minimum standards to be used for the underground installation of AC power and communications circuits.	Subsection 5.2.2.1
General Order 52 (GO-52), CPUC, "Construction and Operation of Power and Communication Lines"	Applies to the design of facilities to provide or mitigate inductive interference.	Subsection 5.2.2.2 Subsection 5.5.2.1 Subsection 5.5.2.2 Subsection 5.5.2.3.3 Subsection 5.5.2.4
ANSI/IEEE 693 "IEEE Recommended Practices for Seismic Design of Substations"	Provides recommended design and construction practices.	Subsection 5.2.2.1 Subsection 5.2.2.2
IEEE 1119 "IEEE Guide for Fence Safety Clearances in Electric-Supply Stations"	Provides recommended clearance practices to protect persons outside the facility from electric shock.	Subsection 5.2.2 Subsection 5.5.1
IEEE 998 "Direct Lightning Stroke Shielding of Substations"	Provides recommendations to protect electrical system from direct lightning strokes.	Subsection 5.2.2.1 Subsection 5.2.2.2
IEEE 980 "Containment of Oil Spills for Substations"	Provides recommendations to prevent release of fluids into the environment.	Subsection 5.2.2.1 Subsection 5.2.2.2
Suggestive Practices for Raptor Protection on Power lines, April 1996	Provides guidelines to avoid or reduce raptor collision and electrocution	Subsection 5.2.2.3

5.6.2 Electric and Magnetic Fields (EMF)

The applicable LORS pertaining to electric and magnetic field interference are tabulated in Table 5.6-2.

TABLE 5.6-2
Electric and Magnetic Field LORS

LORS	Applicability	AFC Reference
Decision 93-11-013 of the CPUC	CPUC position on EMF reduction.	Subsection 5.5.2 Subsection 5.5.2.3.3
General Order 131-D (GO-131), CPUC, Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities in California	CPUC construction-application requirements, including requirements related to EMF reduction.	Subsection 5.2.2 Subsection 5.5.1 Subsection 5.5.2
EMF Design Guidelines for Electrical Facilities, Southern California Edison Company, EMF Research and Education, 6090 Irwindale Avenue, Irwindale, California 91702, (626) 812-7545, September 2004	Large local electric utility's guidelines for EMF reduction through structure design, conductor configuration, circuit phasing, and load balancing. (In keeping with CPUC D.93-11-013 and GO-131)	Subsection 5.2.2 Subsection 5.5.2
ANSI/IEEE 644-1994 "Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines"	Standard procedure for measuring EMF from an electric line that is in service	Subsection 5.5.2

5.6.3 Hazardous Shock

Table 5.6-3 lists the LORS regarding hazardous shock protection for the project.

TABLE 5.6-3
Hazardous Shock LORS

LORS	Applicability	AFC Reference
Title 8 CCR Section 2700 et seq. "High Voltage Electrical Safety Orders"	Establishes essential requirements and minimum standards for installation, operation and maintenance of electrical equipment to provide practical safety and freedom from danger.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3 Subsection 5.5.1
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.5.1
National Electrical Safety Code (NESC), ANSI C2, Section 9, Article 92, Paragraph E; Article 93, Paragraph C.	Covers grounding methods for electrical supply and communications facilities.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3 Subsection 5.5.2.1 Subsection 5.5.2.2

5.6.4 Communication Interference

The applicable LORS pertaining to communication interference are tabulated in Table 5.6-4.

TABLE 5.6-4
Communications Interference LORS

LORS	Applicability	AFC Reference
Title 47 CFR Section 15.25, "Operating Requirements, Incidental Radiation"	Prohibits operations of any device emitting incidental radiation that causes interference to communications. The regulation also requires mitigation for any device that causes interference.	Subsection 5.2.2 Subsection 5.5.2.1 Subsection 5.5.2.2 Subsection 5.5.2.3.3 Subsection 5.5.2.4
General Order 52 (GO-52), CPUC	Covers all aspects of the construction, operation, and maintenance of power and communication lines and specifically applies to the prevention or mitigation of inductive interference.	Subsection 5.2.2 Subsection 5.2.2.1 Subsection 5.5.2.2 Subsection 5.5.2.4
CEC staff, Radio Interference and Television Interference (RI-TVI) Criteria (Kern River Cogeneration) Project 82-AFC-2, Final Decision, Compliance Plan 13-7	Prescribes the CEC's RI-TVI mitigation requirements, developed and adopted by the CEC in past siting cases.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.5.2.2

5.6.5 Aviation Safety

Table 5.6-5 lists the aviation safety LORS that may apply to the proposed construction and operation of the VPP.

TABLE 5.6-5
Aviation Safety LORS

LORS	Applicability	AFC Reference
Title 14 CFR Part 77 "Objects Affecting Navigable Airspace"	Describes the criteria used to determine whether a "Notice of Proposed Construction or Alteration" (NPCA, FAA Form 7460-1) is required for potential obstruction hazards in navigable airspace.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3 Subsection 5.5.3
FAA Advisory Circular No. 70/7460-1G, "Obstruction Marking and Lighting"	Describes the FAA standards for marking and lighting of obstructions as identified by Federal Aviation Regulations Part 77.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3 Subsection 5.5.3
Public Utilities Code (PUC), Sections 21656-21660	Discusses the permit requirements for construction of possible obstructions in the vicinity of aircraft landing areas, in navigable airspace, and near the boundary of airports.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.2.2.3 Subsection 5.5.3

5.6.6 Fire Hazard

Table 5.6-6 tabulates the LORS governing fire hazard protection for the VPP project.

TABLE 5.6-6
Fire Hazard LORS

LORS	Applicability	AFC Reference
Title 14 CCR Sections 1250-1258, "Fire Prevention Standards for Electric Utilities"	Provides specific exemptions from electric pole and tower firebreak and electric conductor clearance standards, and specifies when and where standards apply.	Subsection 5.2.2.2 Subsection 5.5.4
ANSI/IEEE 80 "IEEE Guide for Safety in AC Substation Grounding"	Presents guidelines for assuring safety through proper grounding of AC outdoor substations.	Subsection 5.2.2.1 Subsection 5.2.2.2 Subsection 5.5.4
General Order 95 (GO-95), CPUC, "Rules for Overhead Electric Line Construction" Section 35	CPUC rule covers all aspects of design, construction, operation, and maintenance of electrical transmission line and fire safety (hazards).	Subsection 5.2.2 Subsection 5.5.4

5.6.7 Jurisdiction

Table 5.6-7 identifies national, state, and local agencies with jurisdiction to issue permits or approvals, conduct inspections, and/or enforce the above referenced LORS. Table 5.6-7 also identifies the associated responsibilities of these agencies as they relate to the construction and operation of VPP.

TABLE 5.6-7
Jurisdiction

Agency or Jurisdiction	Responsibility
California Energy Commission (CEC)	Jurisdiction over new transmission lines associated with thermal power plants that are 50 MW or more. (PRC 25500)
CEC	Jurisdiction of lines out of a thermal power plant to the interconnection point to the utility grid. (PRC 25107)
CEC	Jurisdiction over modifications of existing facilities that increase peak operating voltage or peak kilowatt capacity 25 percent. (PRC 25123)
CPUC	Regulates construction and operation of overhead transmission lines. (General Order No. 95 and 131-D) (those not regulated by the CEC)
CPUC	Regulates construction and operation of power and communications lines for the prevention of inductive interference. (General Order No. 52)
Federal Aviation Administration (FAA)	Establishes regulations for marking and lighting of obstructions in navigable airspace. (AC No. 70/7460-1G)
California Independent System Operator (Cal-ISO)	Provides Final Interconnection Approval
City of Vernon	Establishes and enforces zoning regulations for specific land uses. Issues variances in accordance with zoning ordinances. Jurisdiction over safety inspection of electrical installations that connect to the supply of electricity. (NFPA 70) Issues and enforces certain ordinances and regulations concerning fire prevention and electrical inspection

5.7 References

California Public Service Commission, Decision 93-11-013.

California Public Service Commission, General Order 128-Rules for Construction of Underground Electric Supply and Communications Systems.

California Public Service Commission, General Order 131D-Rules for Planning and Construction of Electric Generation, Line, and Substation Facilities.

California Public Service Commission, General Order 52-Construction and Operation of Power and Communication Lines

California Public Service Commission, General Order 95-Rules for Overhead Electric Line Construction.

Electric Power Research Institute. 1975. Transmission Line Reference Book, 345-kV and Above. Palo Alto, California.

Electric Power Research Institute. 1978. Transmission Line Reference Book, 115-138-kV Compact Line Design. Palo Alto, California.

EMF Research and Education. 2004. EMF Design Guidelines for Electrical Facilities, Southern California Edison Company. Irwindale, California. September.

IEEE Power Engineering Society. 1985. Corona and Field Effects of AC Overhead Transmission Lines, Information for Decision Makers. July.

National Electrical Safety Code, ANSI C2.

PG&E. 1998. PG&E Interconnection Handbook. December 15.

Power flow cases obtained from WECC

Power flow cases used for the Feasibility Study as supplied by LADWP

Power flow cases used for the LGIP “System Impact Study” provided by SCE

SCE and LADWP Federal Energy Regulatory Commission (FERC) Form 715

Southwire. Overhead Conductor Manual.

U.S. Department of Energy. 1989. Electrical and Biological Effects of Transmission Lines, A Review. Bonneville Power Administration, Portland, Oregon. June.

United States of America, 14CFR1250-1258-Fire Prevention Standards for Electric Utilities.

United States of America, 15CFR77-Objects Affecting Navigable Airspace.

United States of America, 47CFR15.25-Operating Requirements, Incidental Radiation.

	Ratings	
	normal	emergency
Mesa - Lighthipe	956	956
Mesa - Redando	797	797
Laguna Bell - Goodrich	899	1135
Laguna Bell - Rio Hondo	988	1135
Laguna Bell - Del Amo	988	1135
Laguna Bell - La Fresa	1287	1478

	Ratings	
	normal	emergency
Circuit 1	637	637
Circuit 2	478	478

- Proposed Interconnection Route Segment
- Proposed Power Plant/Switchyard Site
- Existing 287 kV Transmission Line
- Existing 230 kV Transmission Line
- Existing 66 kV Transmission Line Serving Vernon
- Existing 66 kV Transmission Line Serving SCE
- City of Vernon Boundary
- Existing Substation/Generation Plant Site

Scale: 1" = 1,000' (1:12,000)

Datum: North American Datum of 1983 (NAD 83).
Coordinate System: California State Plane.
FIPS: 0405. Zone: 5. Units: US Feet.
Projection: Lambert Conformal Conic.
Spheroid: GRS 1980.

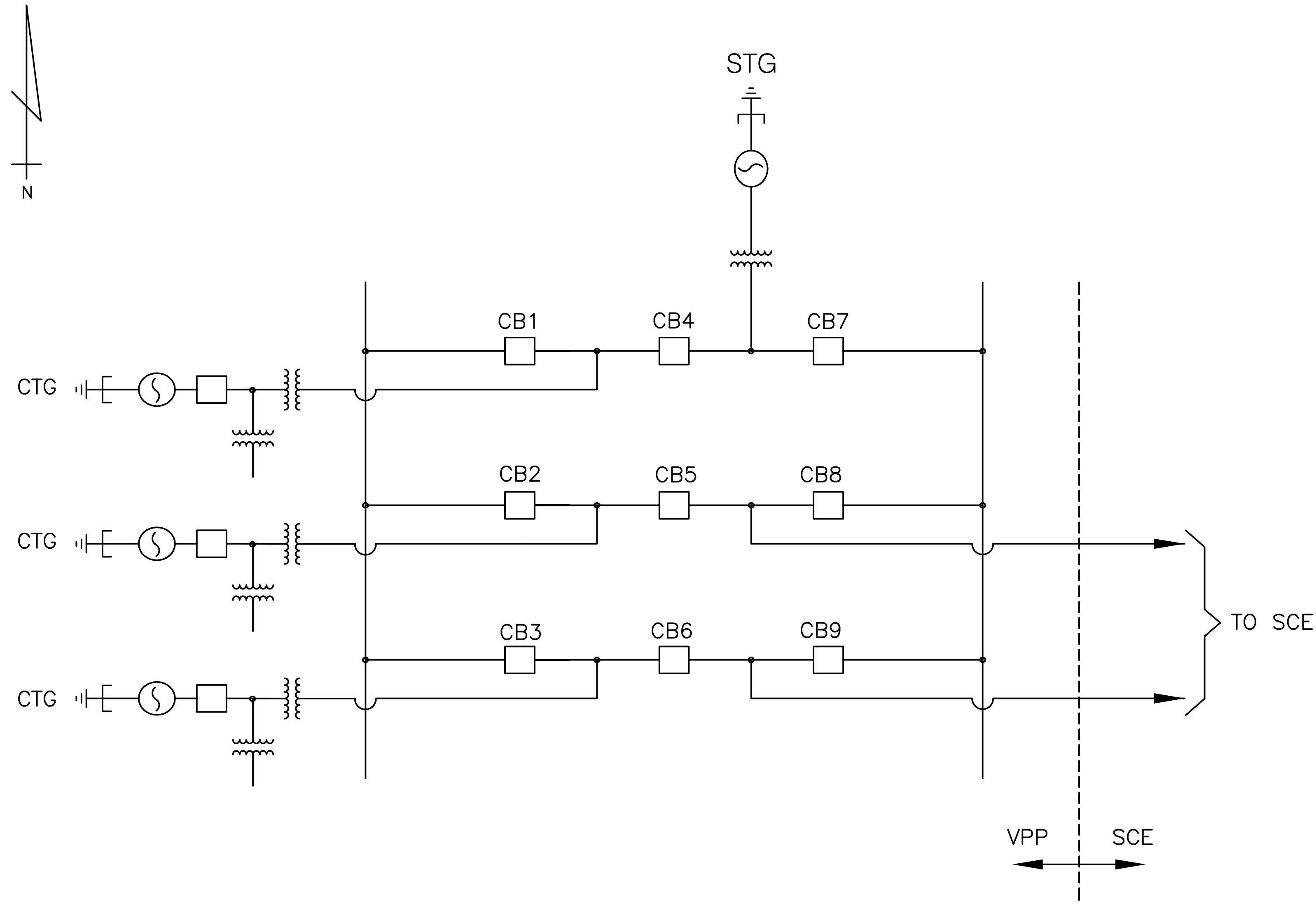
Base Map Source: State of California, The California Spatial Information Library - 1996 black & white digital orthophoto quarter quads (DOQQs). City of Vernon - 2005 digital orthophotography.

Figure 5.1-1. Selected Regional Transmission Assets and Interconnection Routes for the Proposed Vernon Power Plant

Vernon Power Plant

City of Vernon

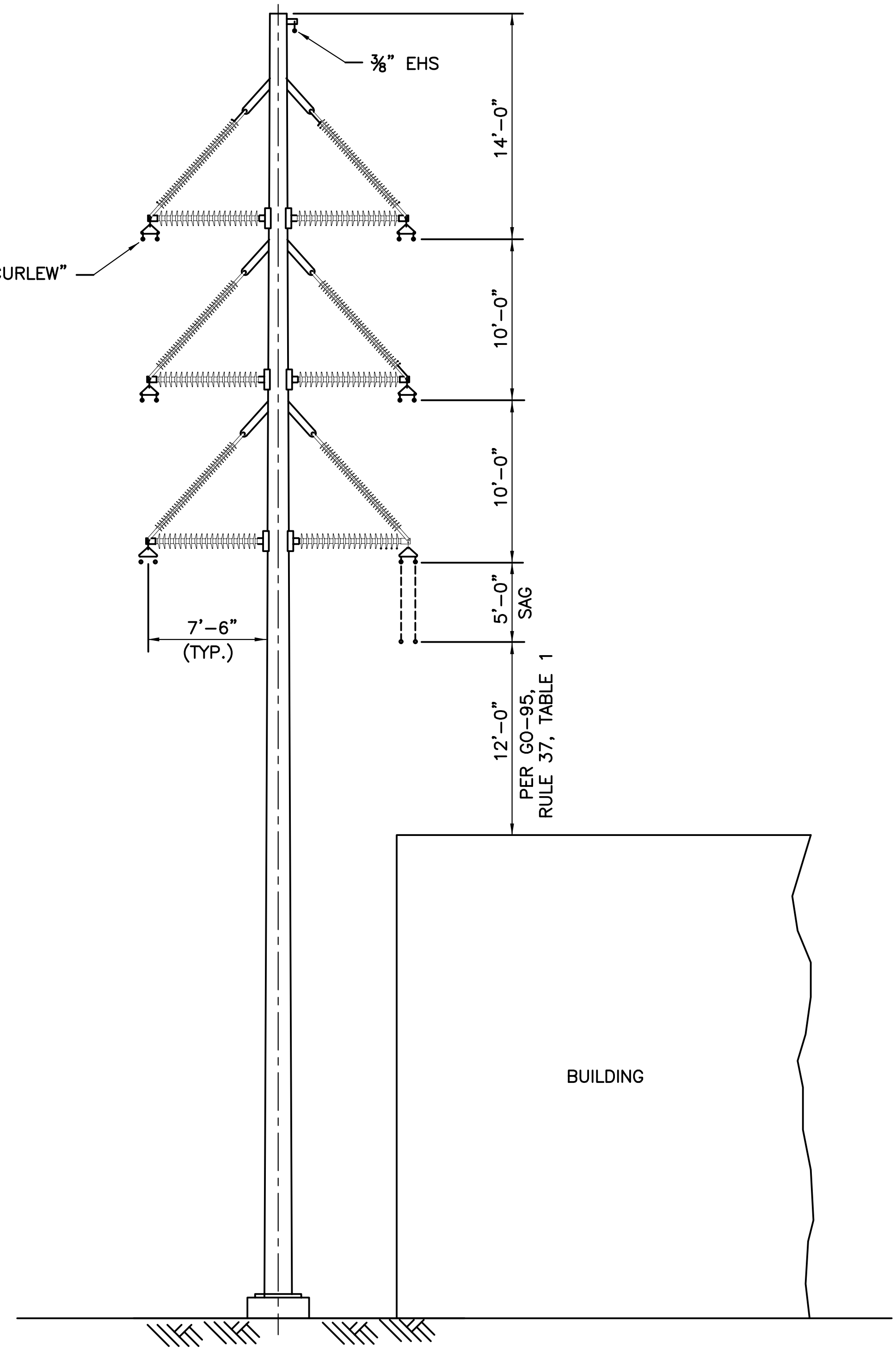
Commonwealth Associates, Inc.
engineers • consultants • construction managers



Source: Commonwealth Associates Inc., 06/09/06.

FIGURE 5.2-1
ONE-LINE SCHEMATIC OF THE CONCEPTUAL SWITCHYARD TO SCE
VERNON POWER PLANT
CITY OF VERNON, CALIFORNIA

CH2MHILL



230kV Horizontal-V Structure, Short Span (150')

NOT TO SCALE

VERNON POWER PLANT INTERCONNECTION
TYPICAL CROSS SECTION

Figure 5.2-2

Vernon Power Plant
City of Vernon

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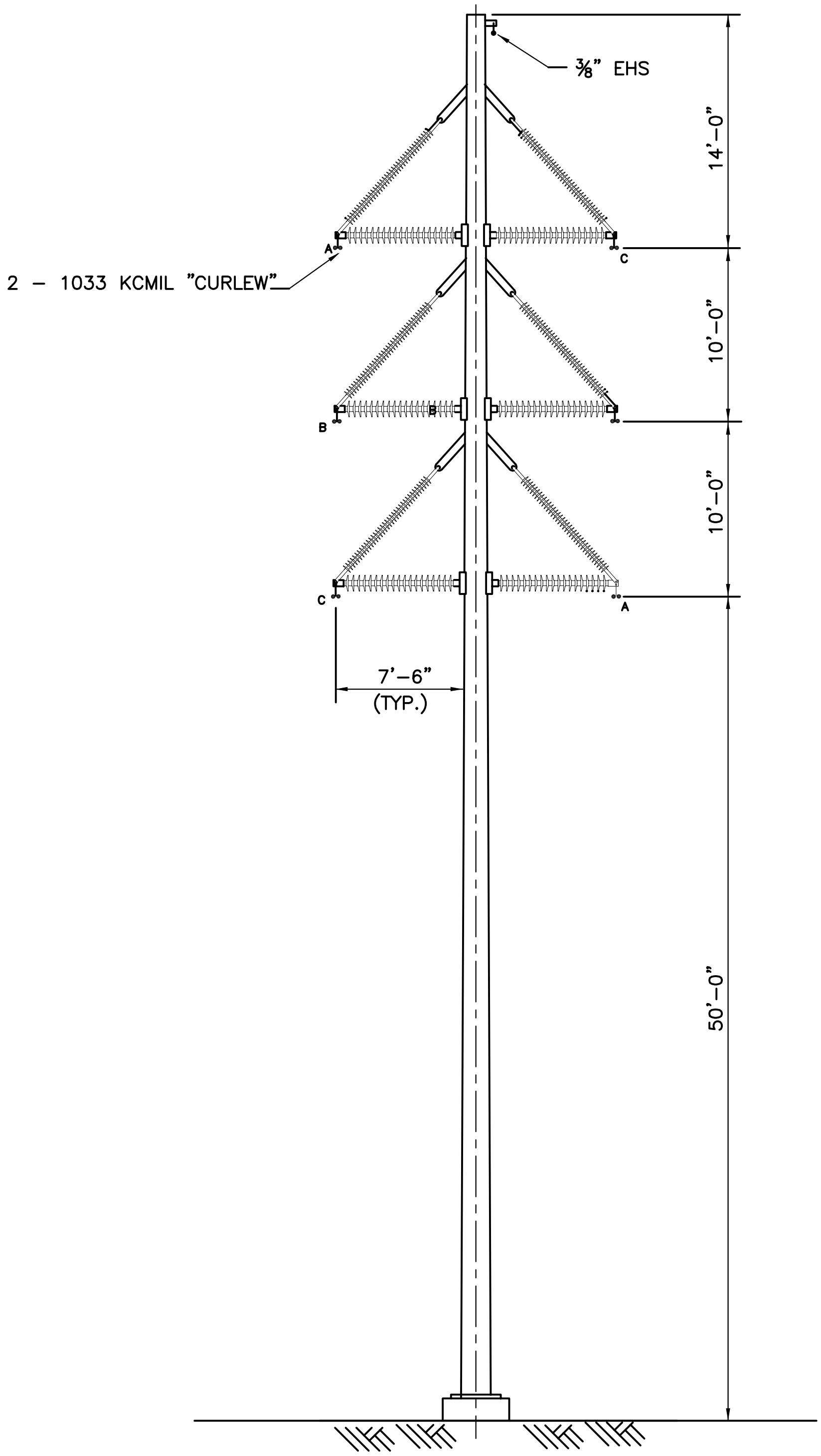
Engineers Consultants Construction Managers

06/09/06



230kV Horizontal–V Structure, Short Span

NOT TO SCALE

CROSS SECTION A

FIGURE 5.5-1

Vernon Power Plant
City of Vernon

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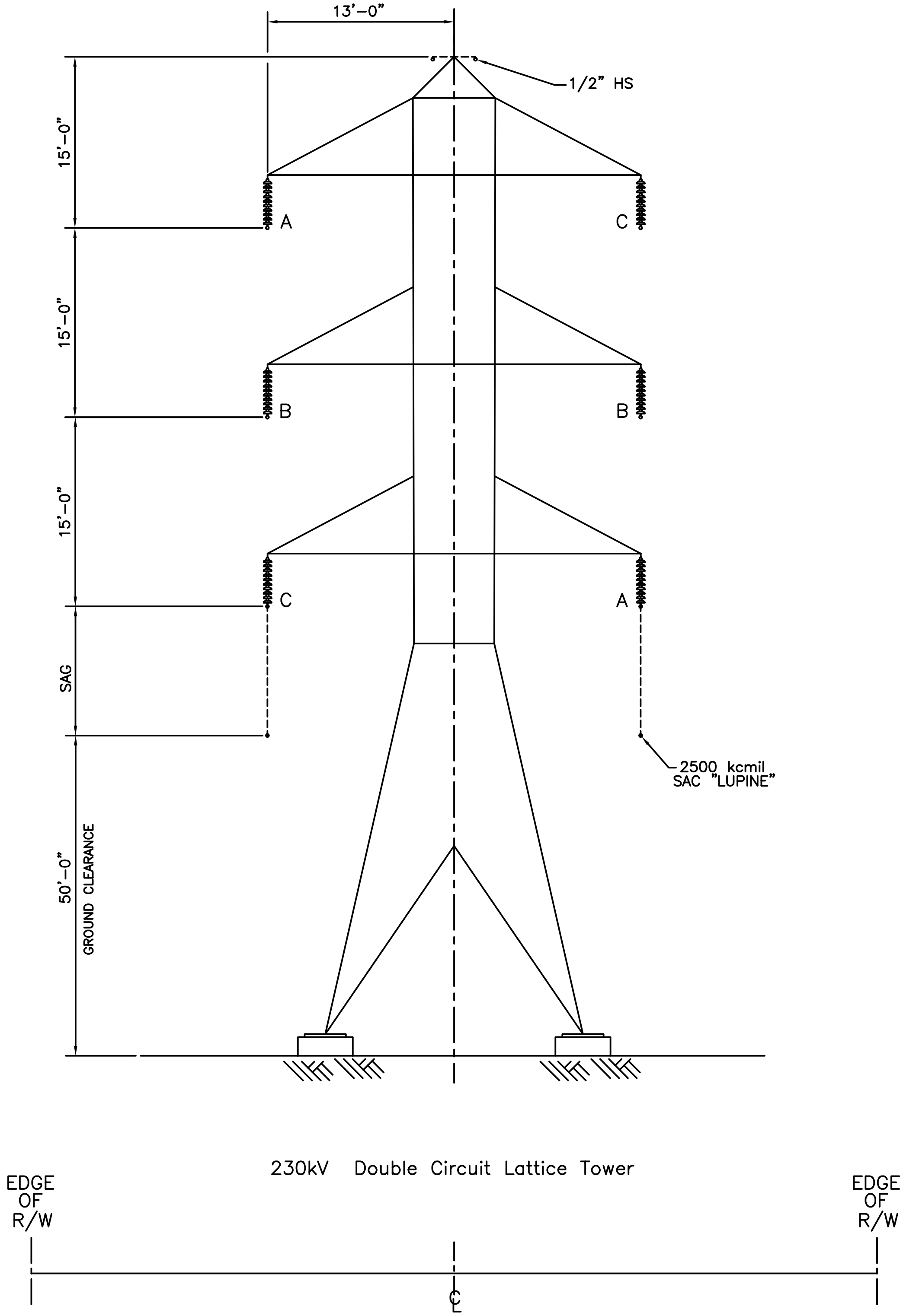

NOT TO SCALE

Cross Section B
LADWP Century To Velasco

FIGURE 5.5-2

Vernon Power Plant
City of Vernon

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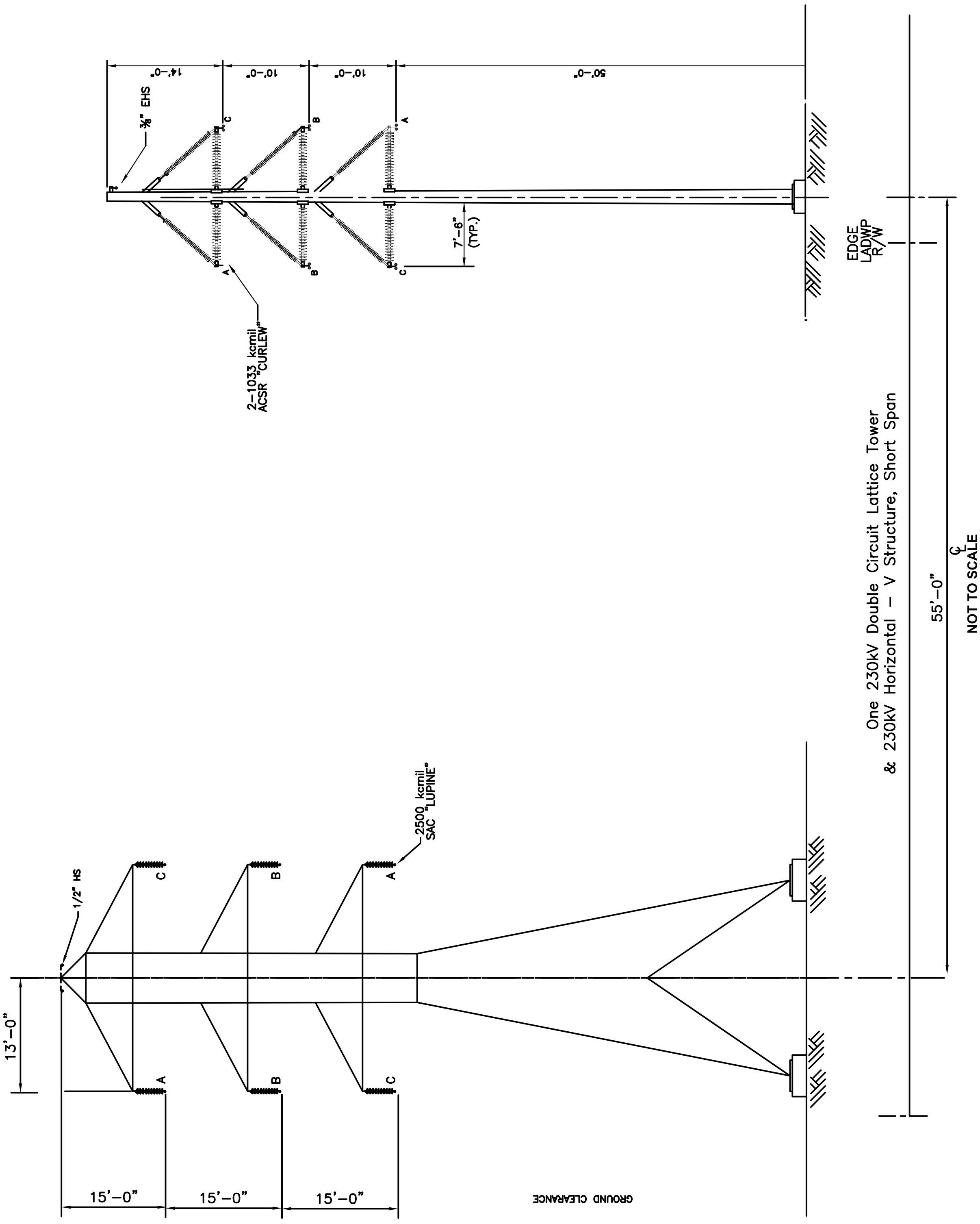

Cross Section C
Parallel to LADWP Century-Velasco - New

FIGURE 5.5-3

Vernon Power Project
City of Vernon

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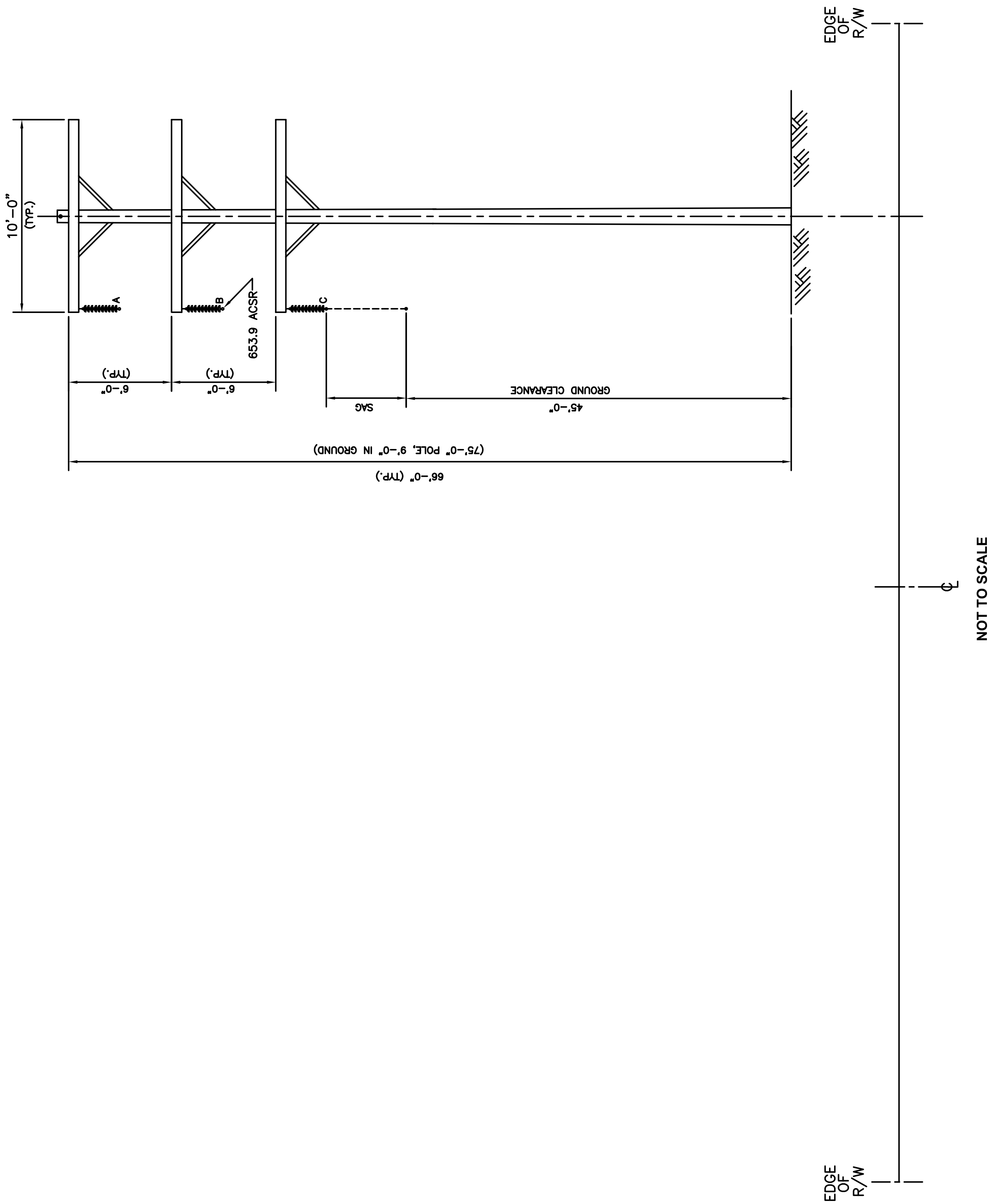

Cross Section D
Downey Ave. - Existing

FIGURE 5.5-4

Vernon Power Plant
City of Vernon

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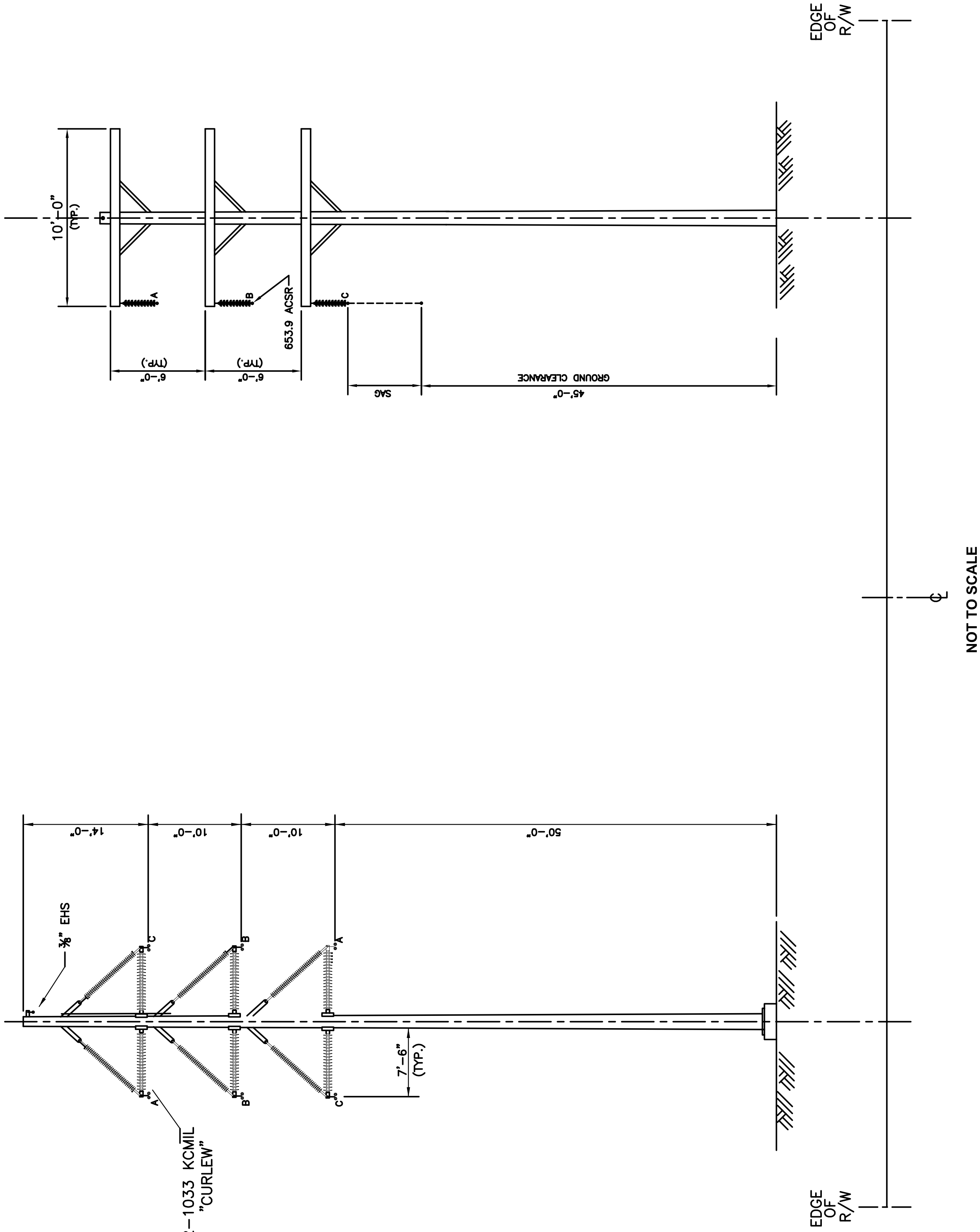

Cross Section E
Downey Ave. - New

FIGURE 5.5-5

Vernon Power Plant
City of Vernon

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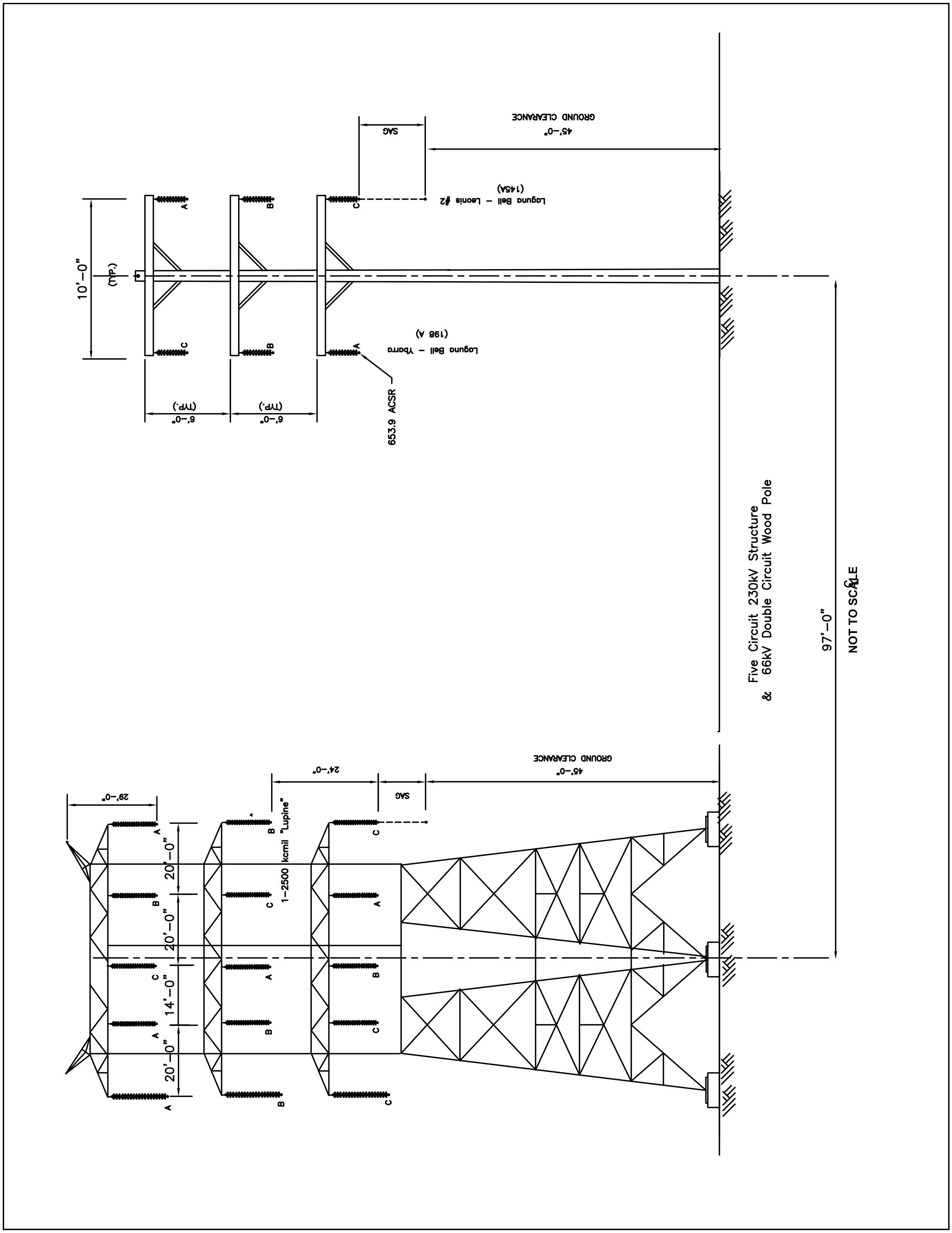

Cross Section F
Los Angles River Corridor - Existing

FIGURE 5.5-6

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City of Vernon

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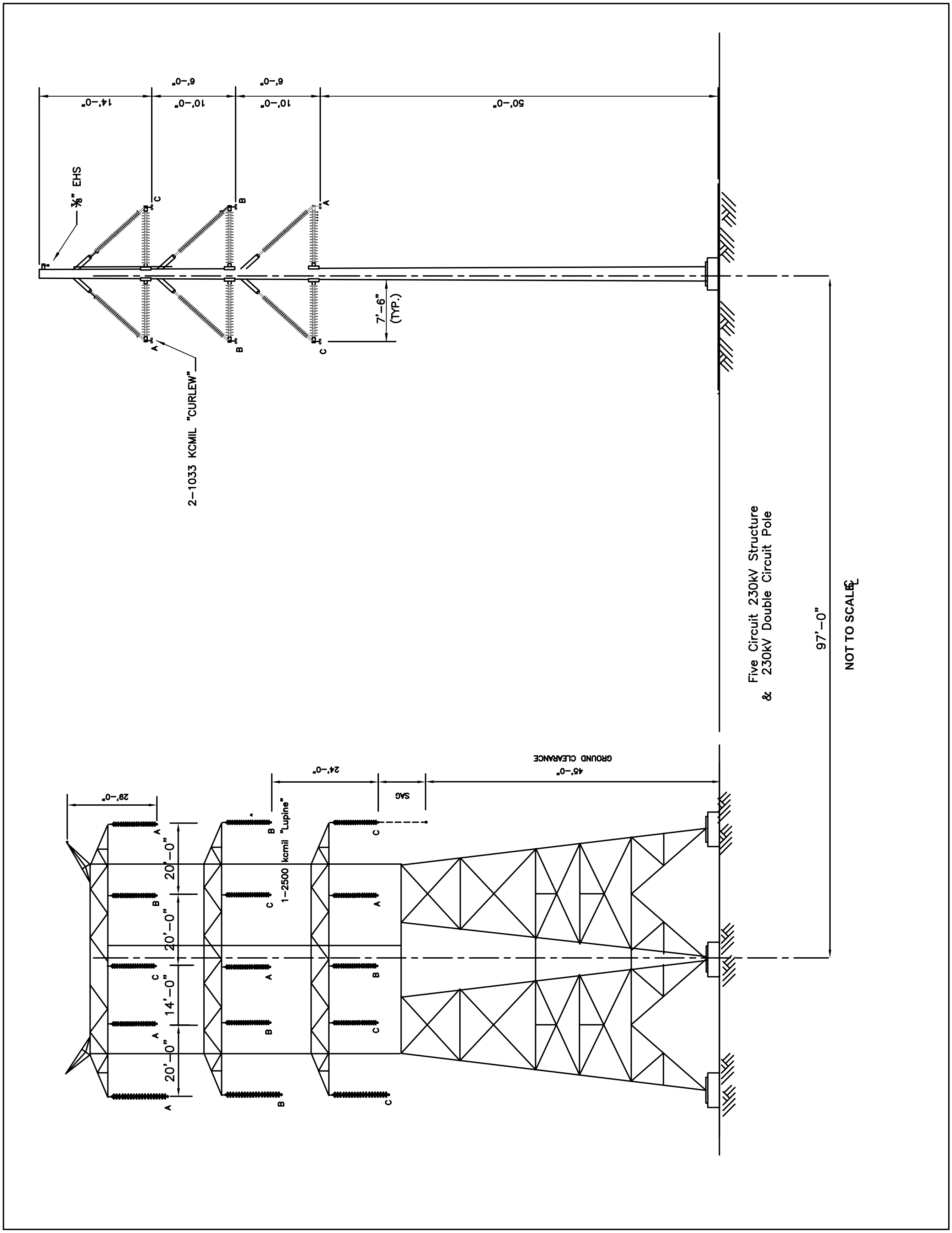

Cross Section G
Los Angles River Corridor - New

FIGURE 5.5-7

Vernon Power Project
City of Vernon

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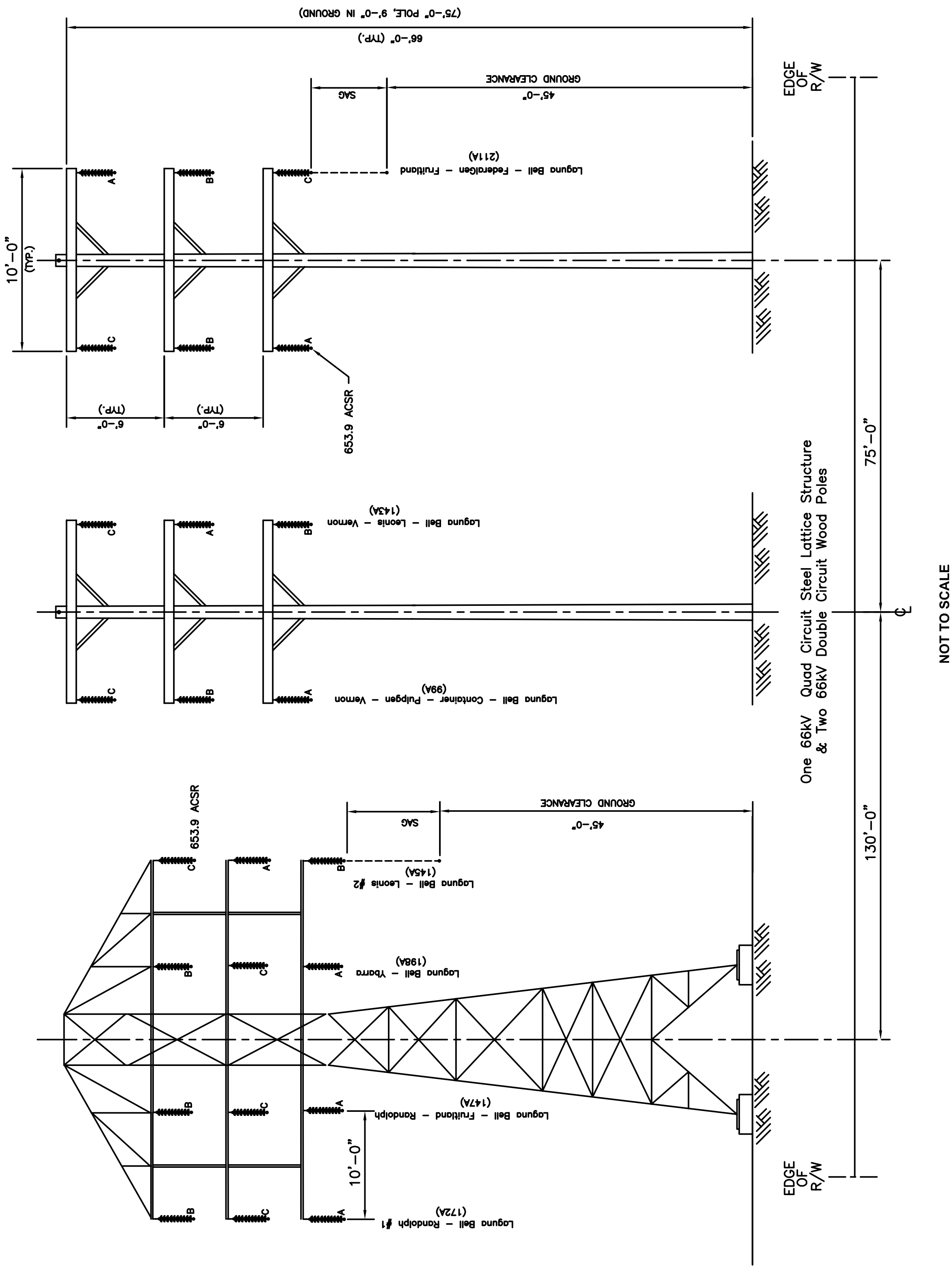

Cross Section H
Randolph At Colmar - Existing

FIGURE 5.5-8

Vernon Power Project
City of Vernon

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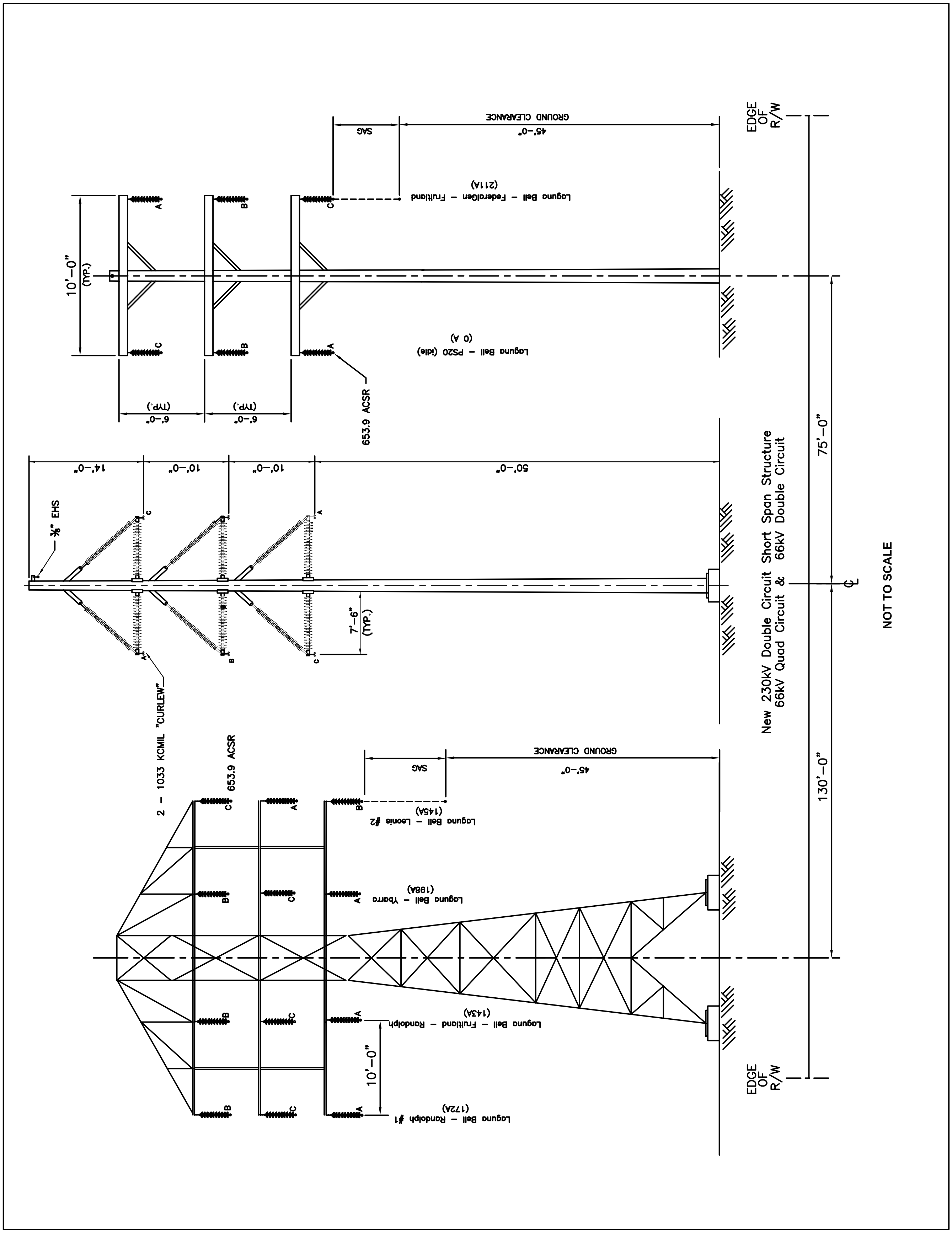

Cross Section I
Randolph At Colmar - New

FIGURE 5.5-9

Vernon Power Project
City of Vernon

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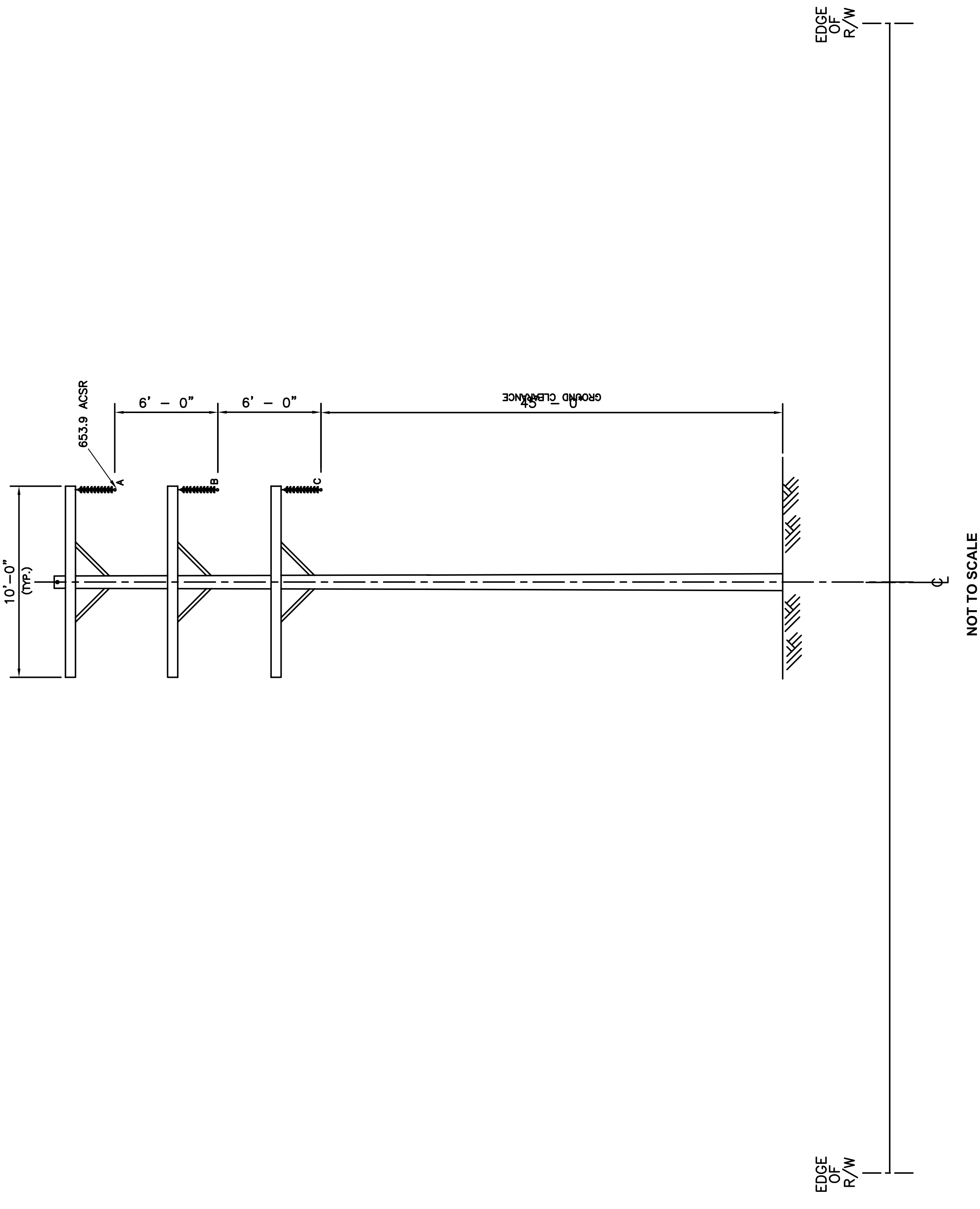

Cross Section J
Alcoa Ave. - Existing

FIGURE 5.5-10

Vernon Power Plant
City of Vernon

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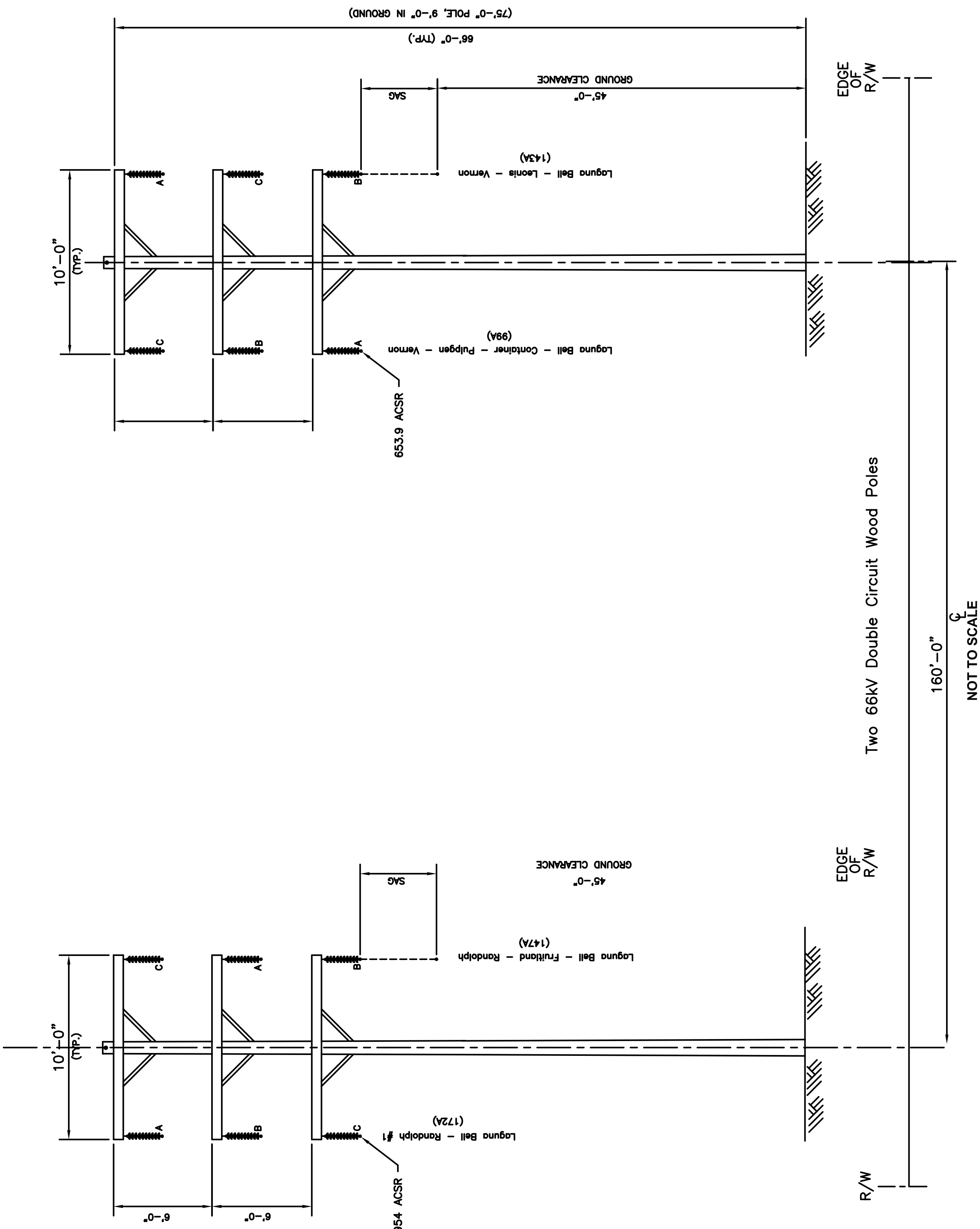

Cross Section K
Randolph At Maywood - Existing

FIGURE 5.5-11

Vernon Power Project
City of Vernon

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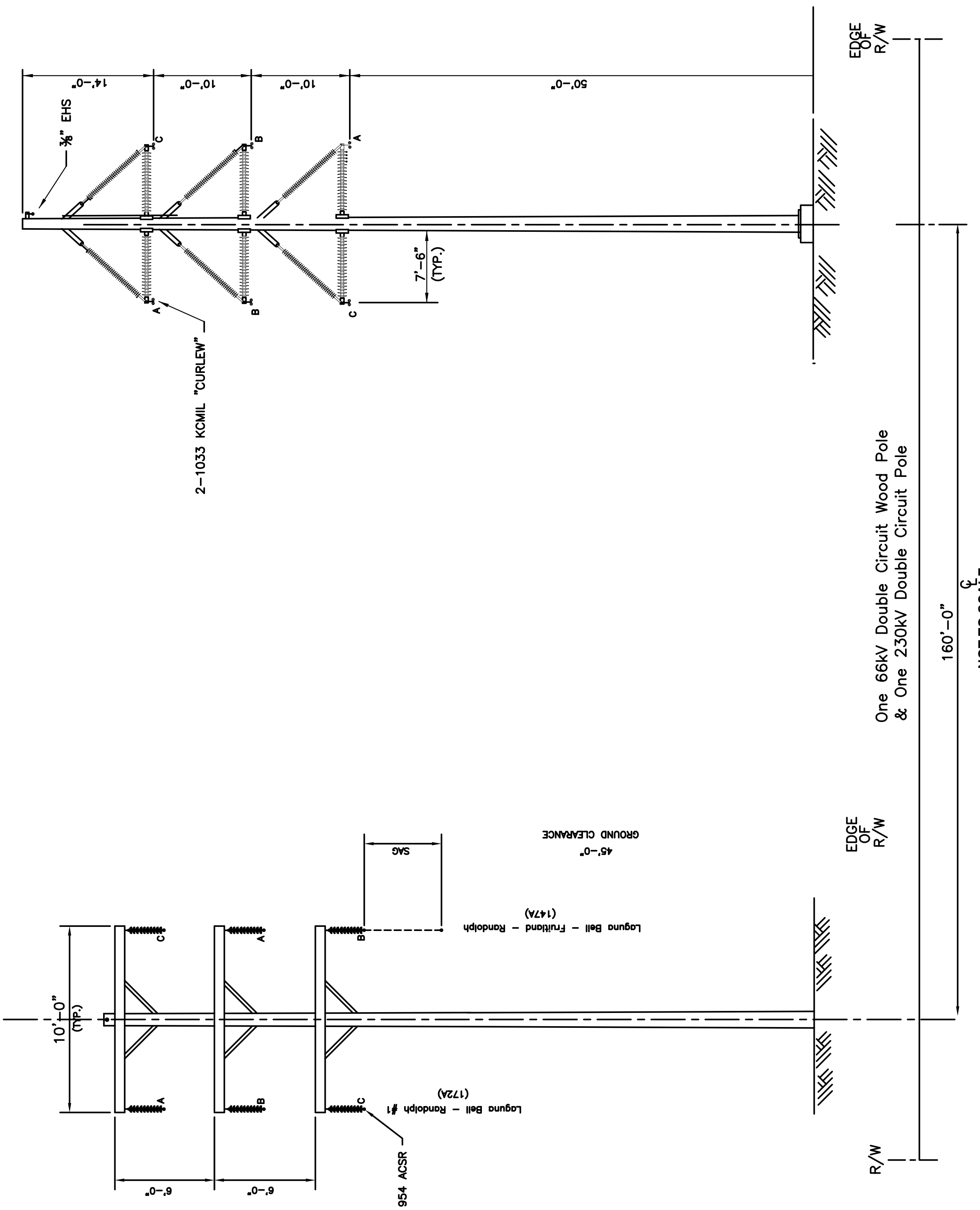

Cross Section L
Randolph At Maywood - New

FIGURE 5.5-12

Vernon Power Project
City of Vernon

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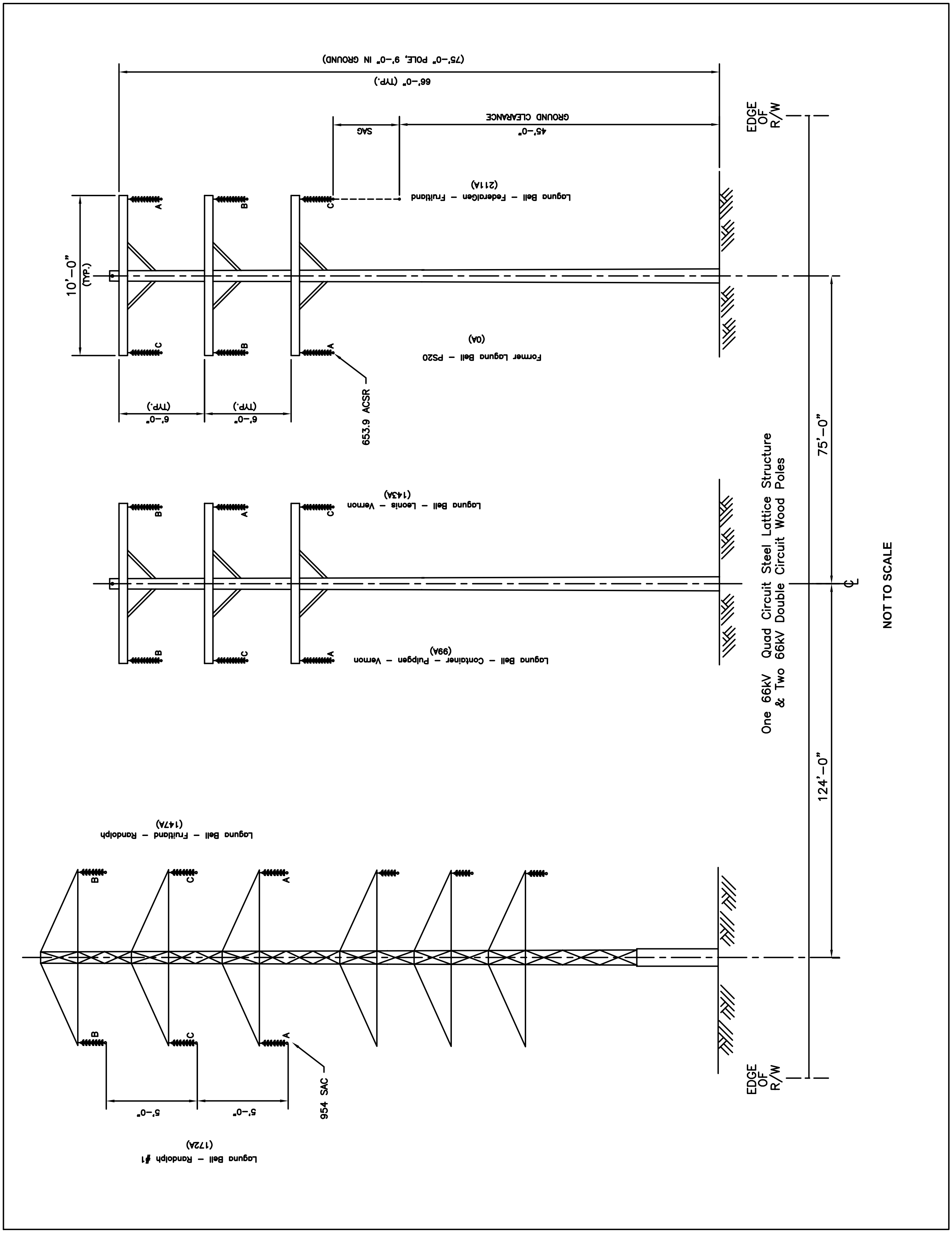

Cross Section M
Randolph At Atlantic - Existing

FIGURE 5.5-13

Vernon Power Project
City of Vernon

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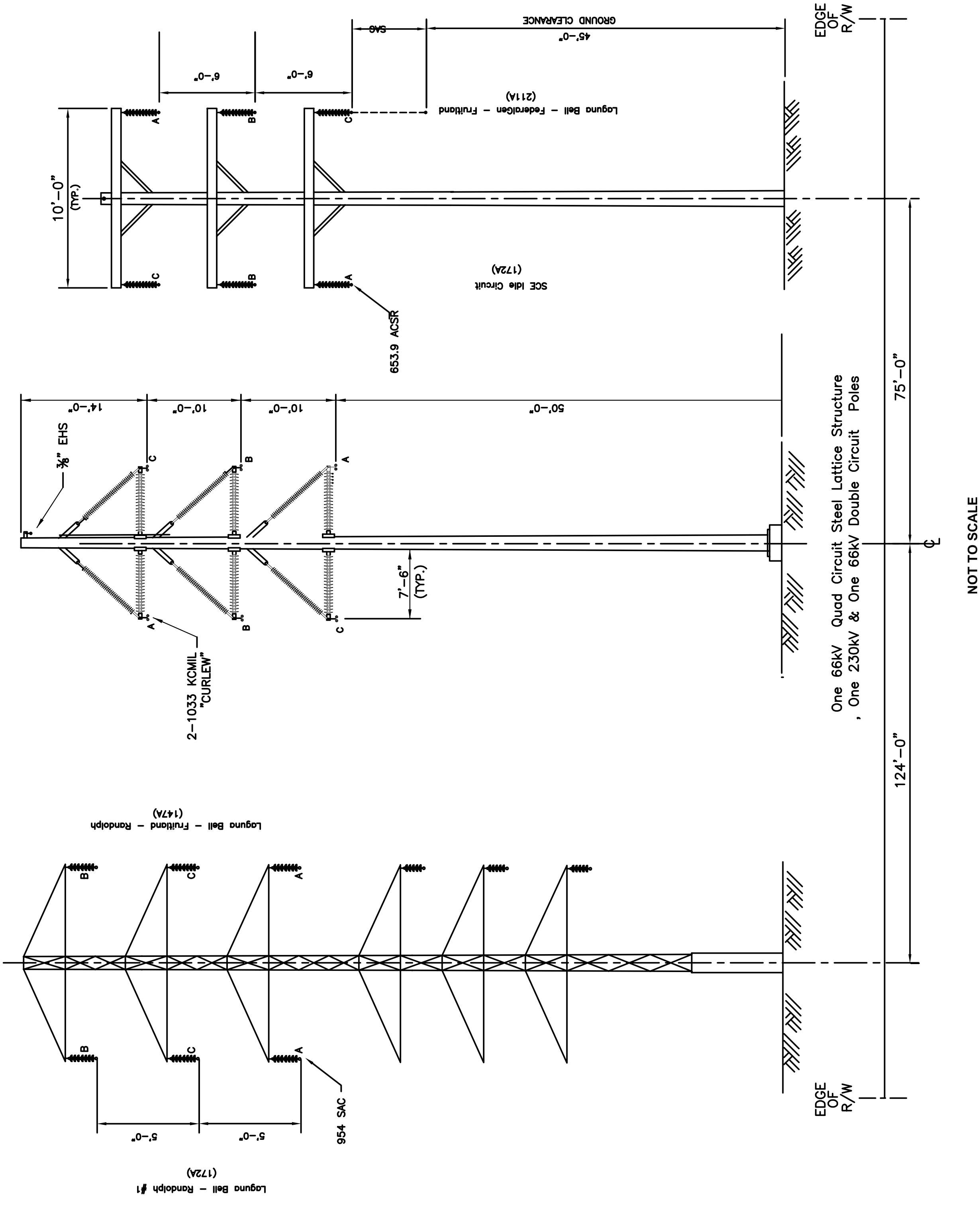

Cross Section N
Randolph At Atlantic - New

FIGURE 5.5-14

Vernon Power Project
City of Vernon

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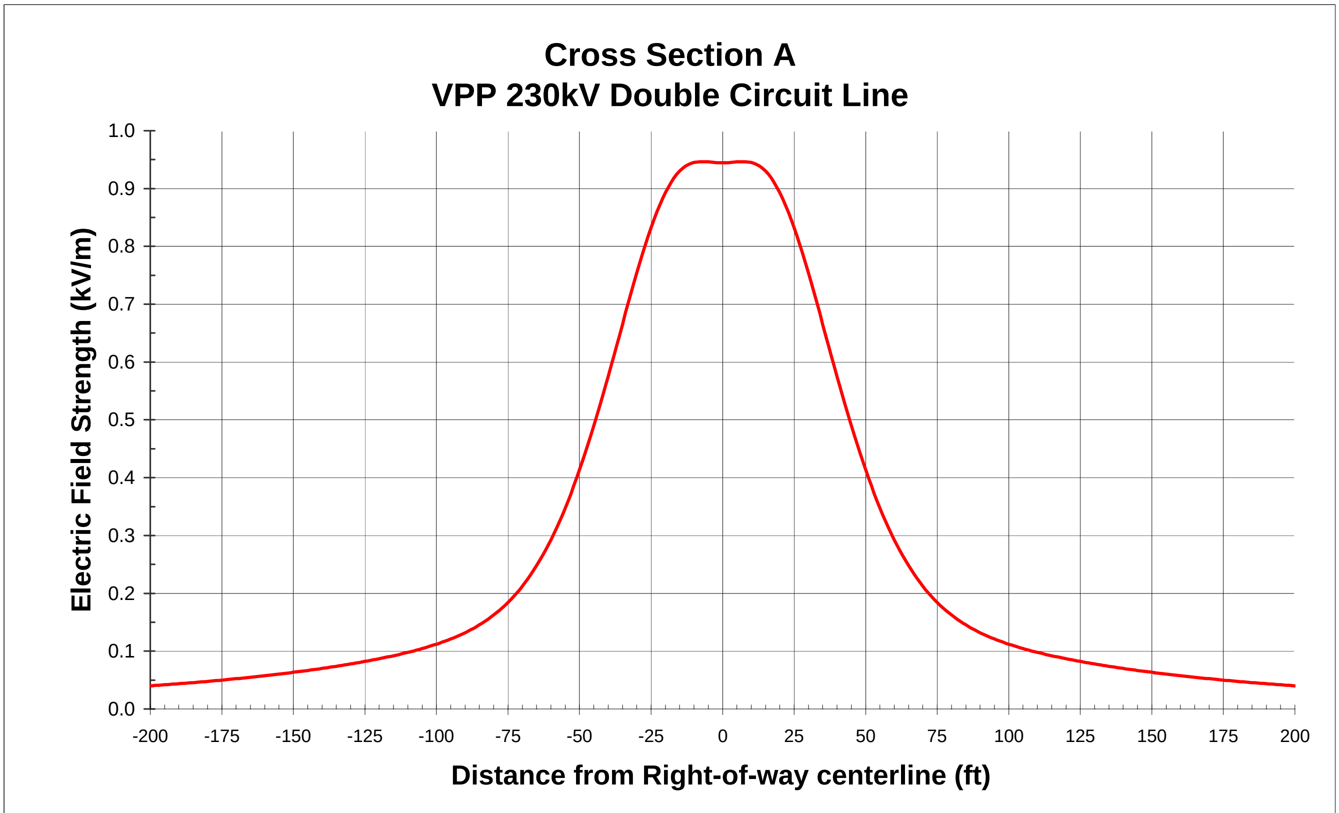
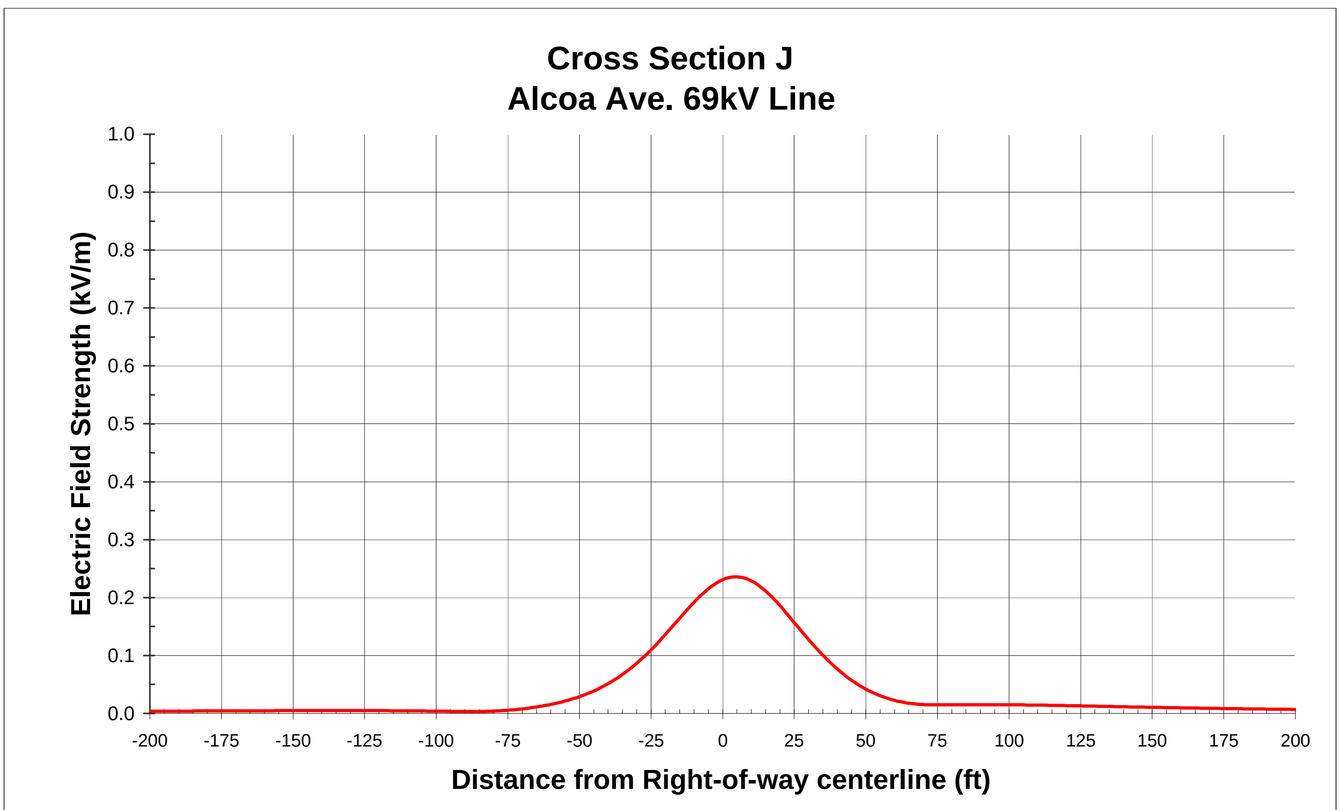
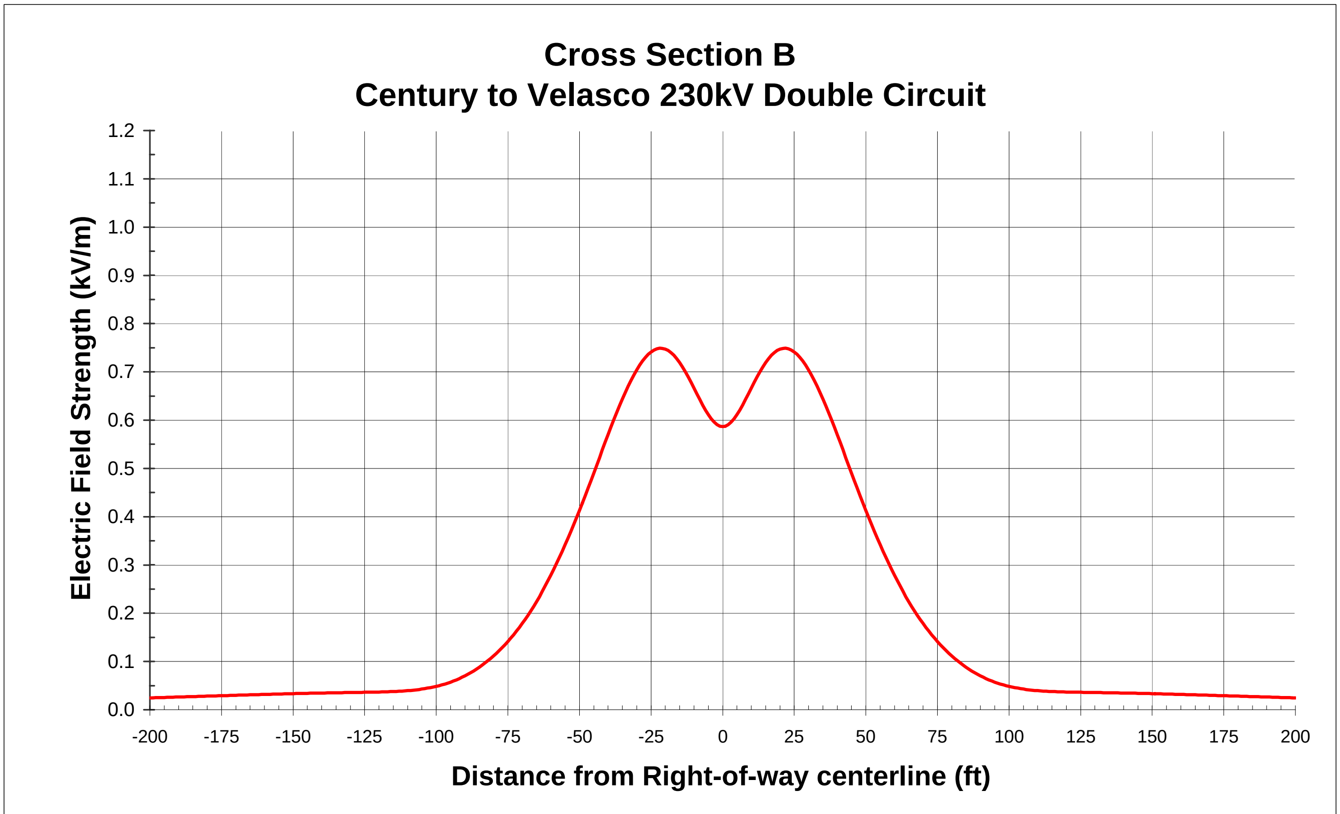
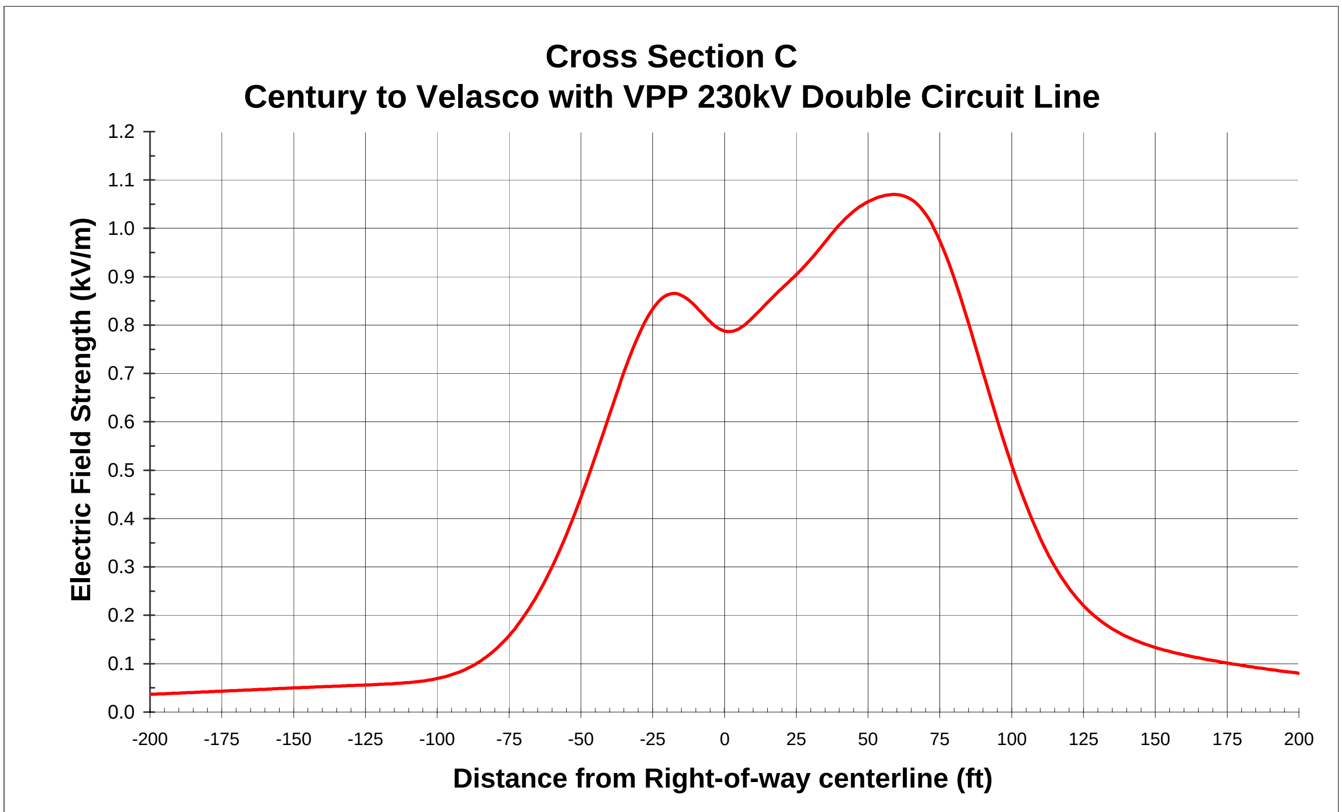




Cross Sections A & J	**Figure 5.5-15**
Electric Field	**Commonwealth Associates Inc.**
Vernon Power Plant	Jackson, Michigan
City of Vernon	engineers . consultants . construction managers





Cross Sections B & C **Figure 5.5-16**

Electric Field
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
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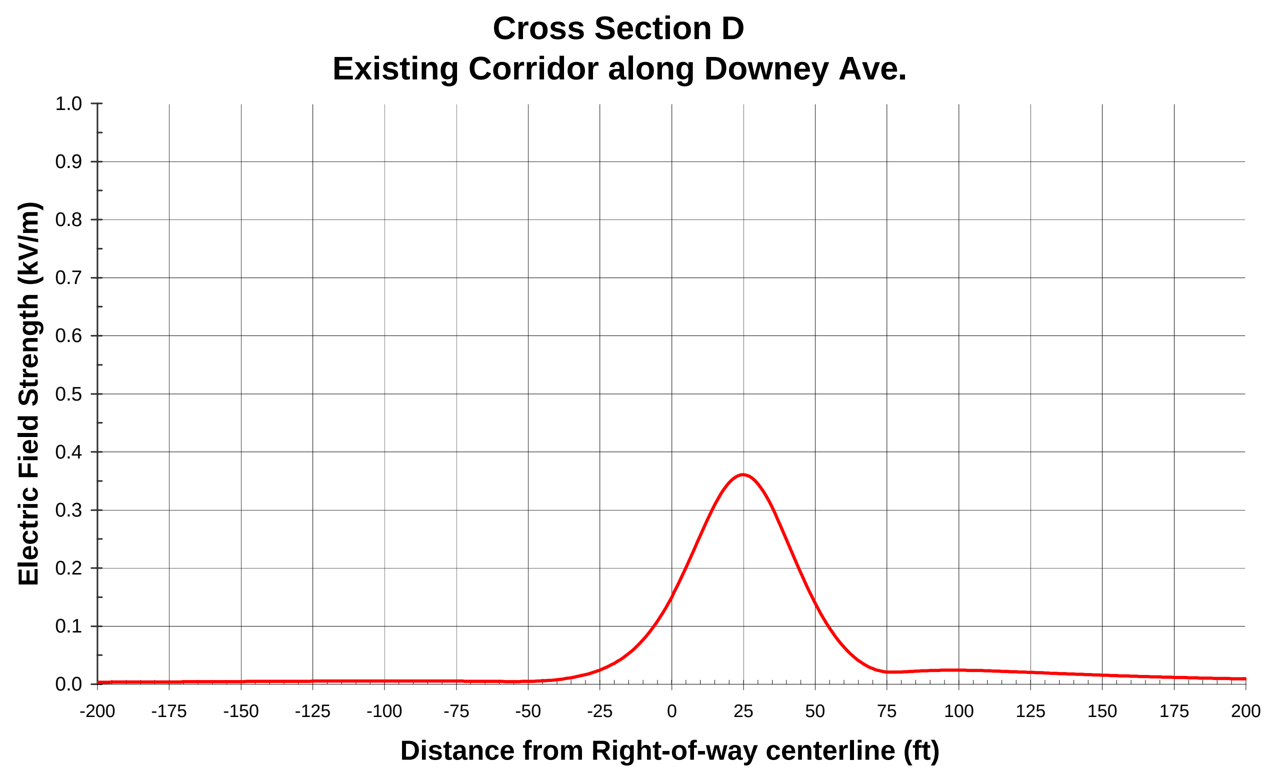
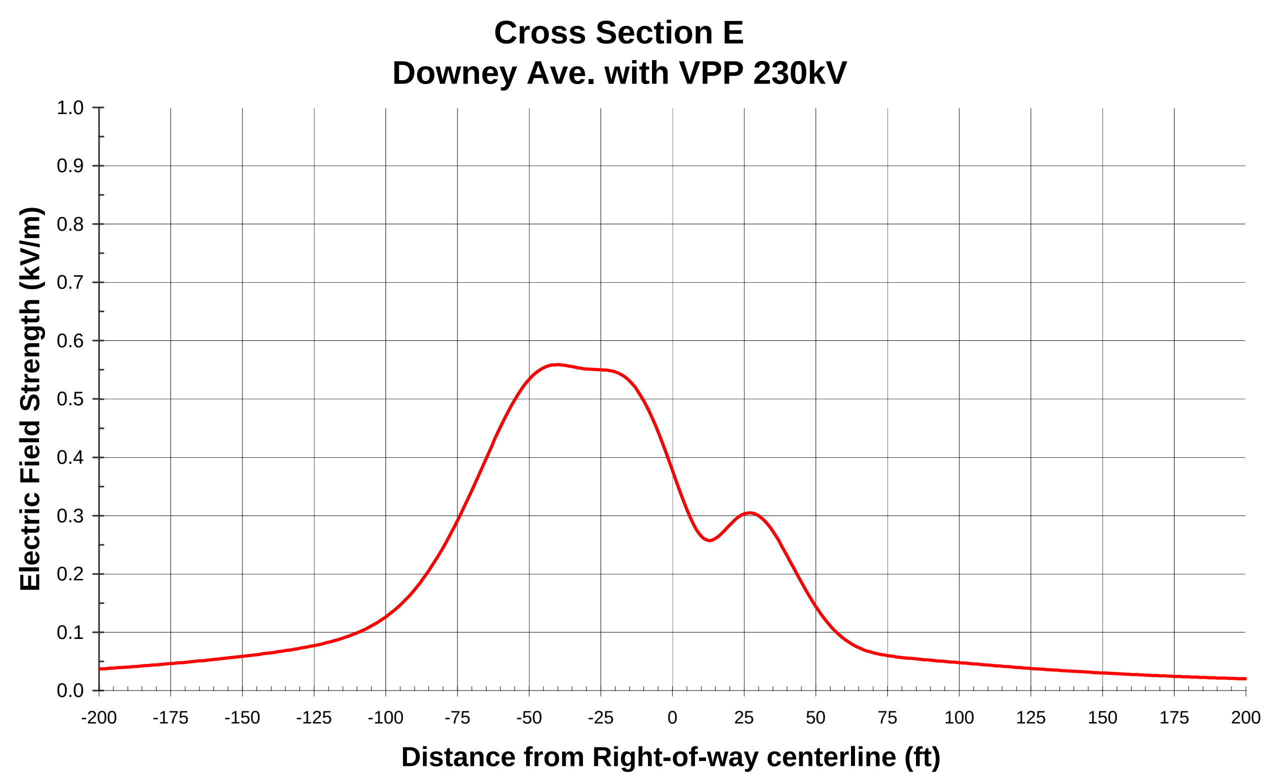
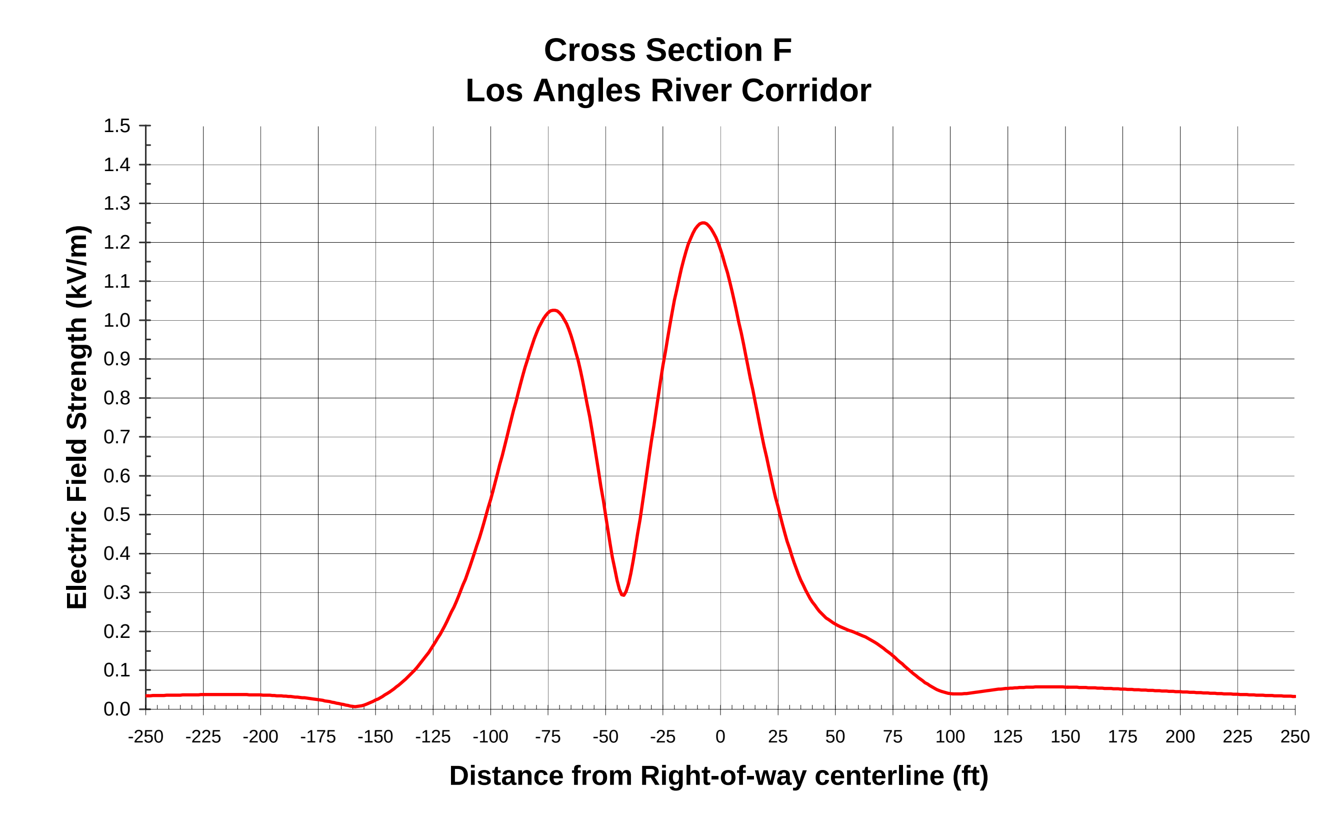
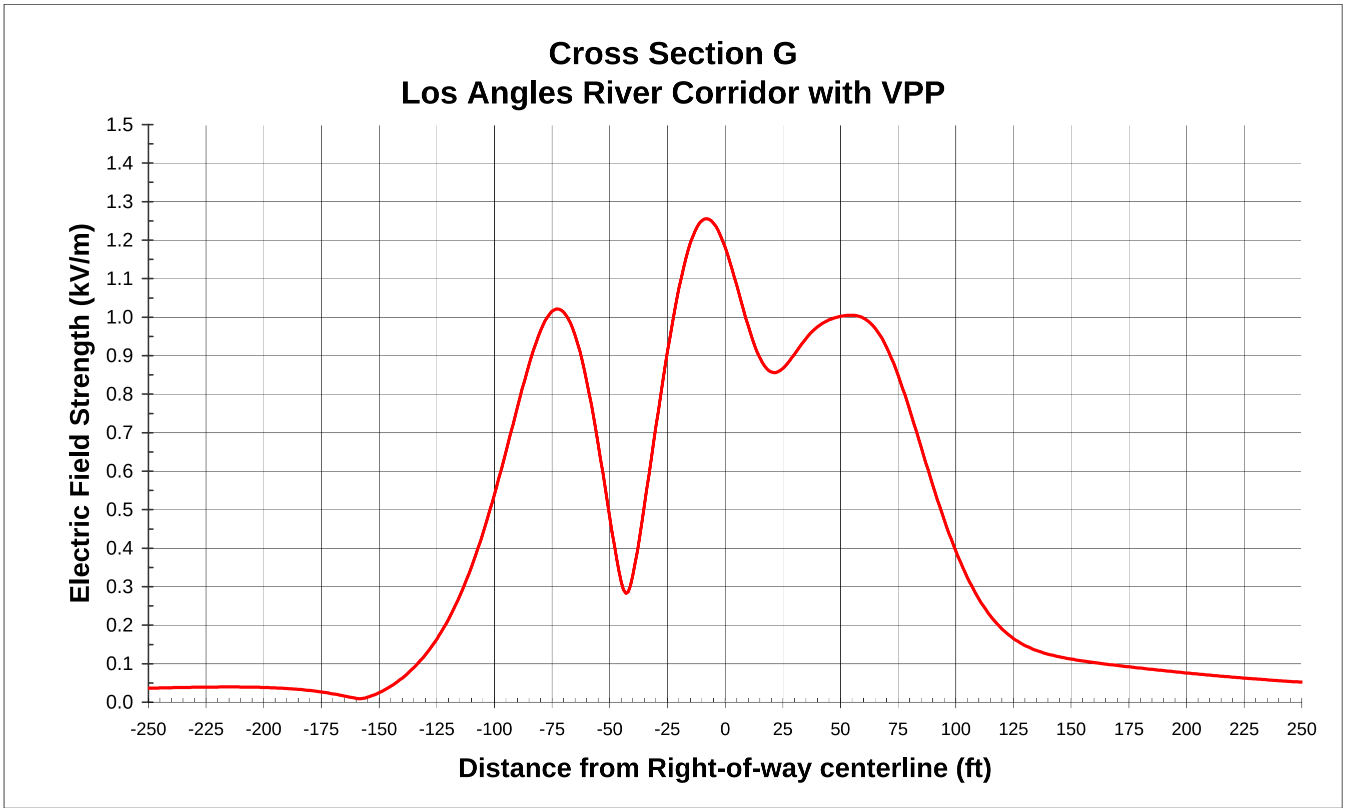


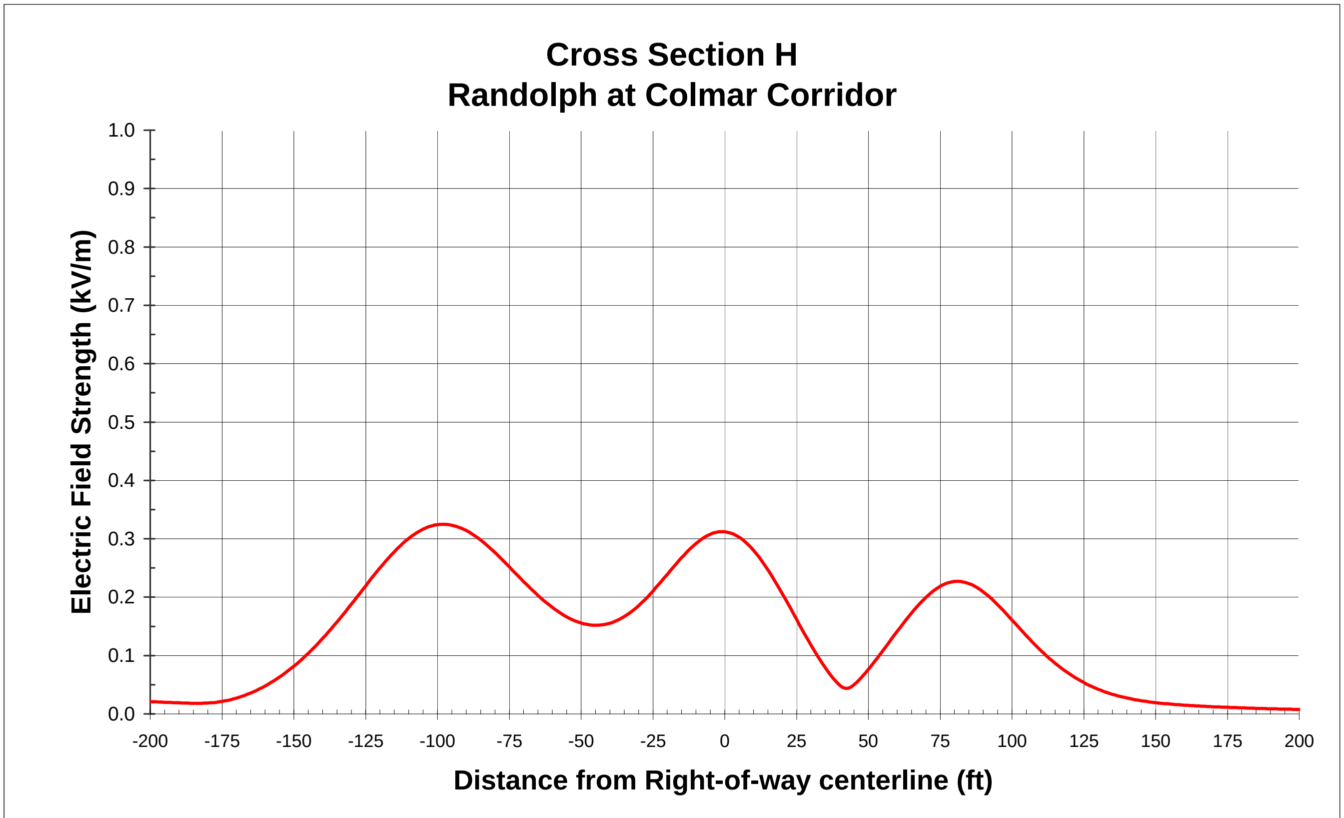


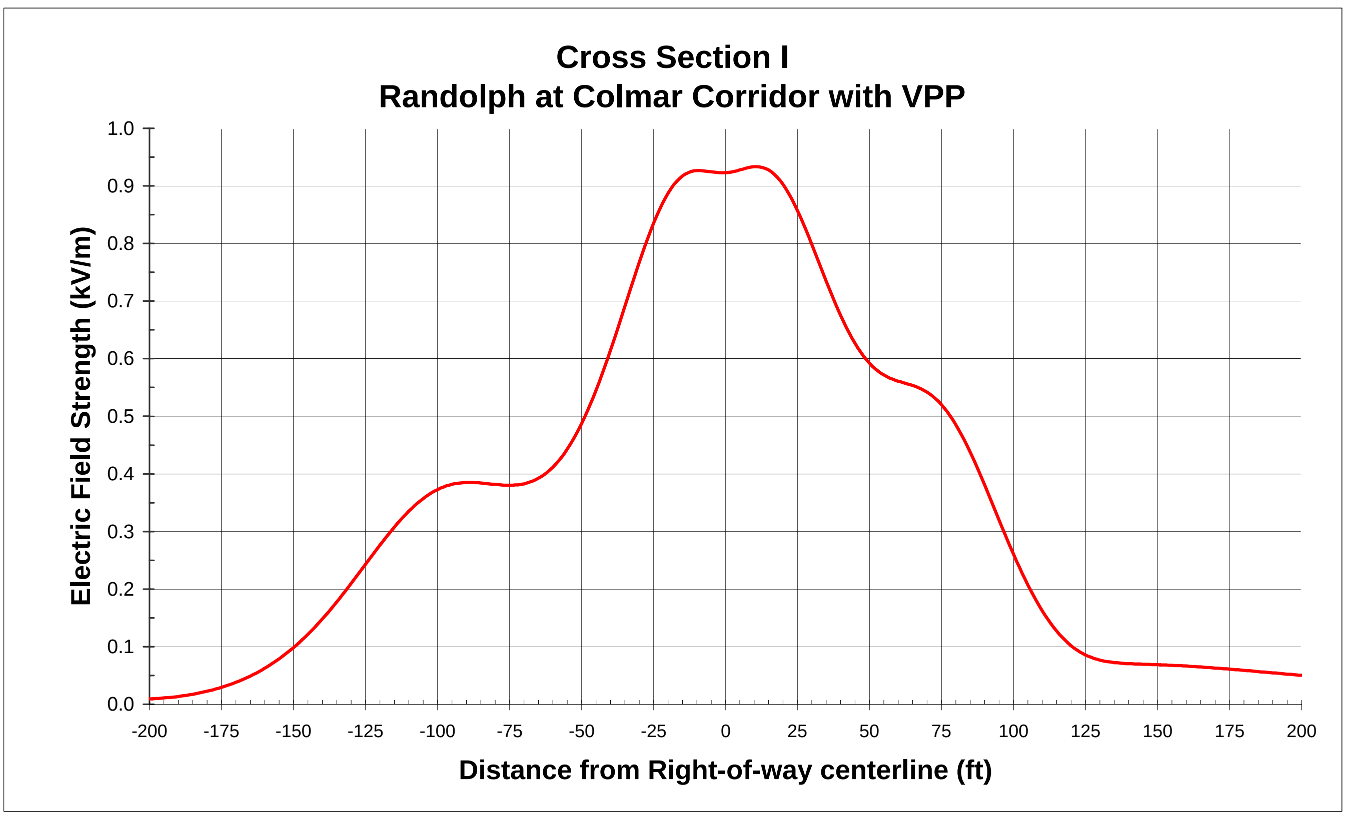
Cross Sections D & E	**Figure 5.5-17**
Electric Field	Commonwealth Associates Inc.
Vernon Power Plant	Jackson, Michigan
City of Vernon	engineers . consultants . construction managers





Cross Sections F & G	**Figure 5.5-18**
Electric Field	**CAI** Commonwealth Associates Inc.
Vernon Power Plant	Jackson, Michigan
City of Vernon	engineers . consultants . construction managers





Cross Sections H & I **Figure 5.5-19**

Electric Field
Vernon Power Plant
City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
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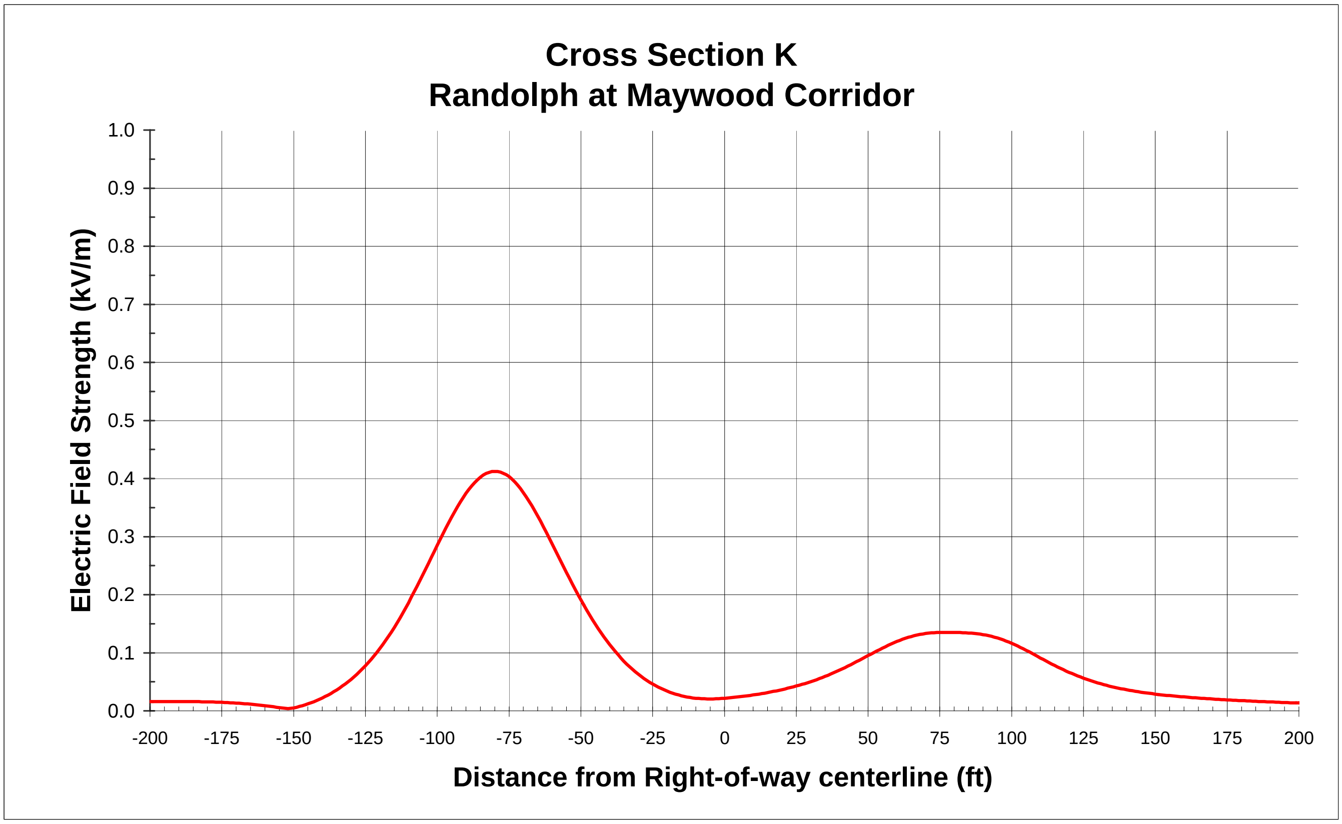

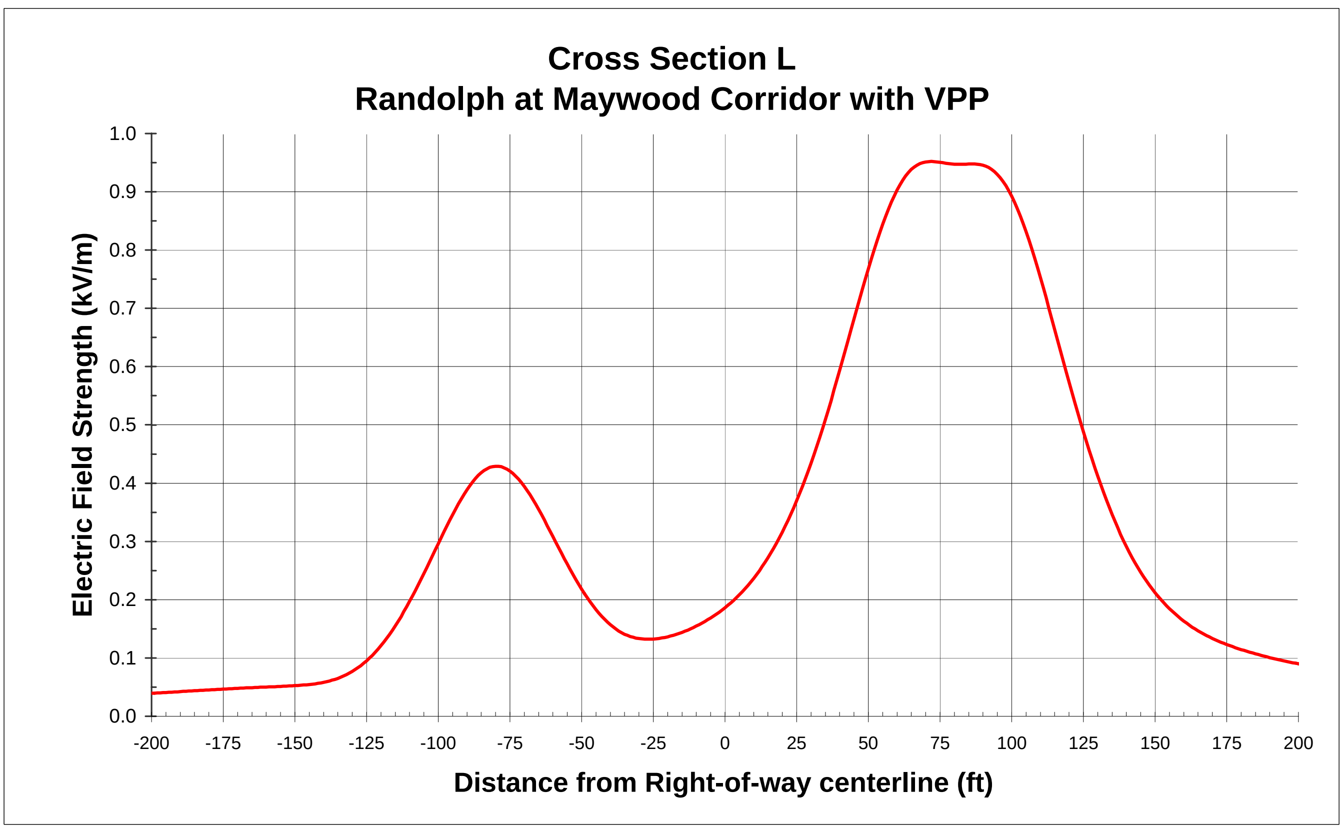

Cross Sections K & L **Figure 5.5-20**

Electric Field
Vernon Power Plant
City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
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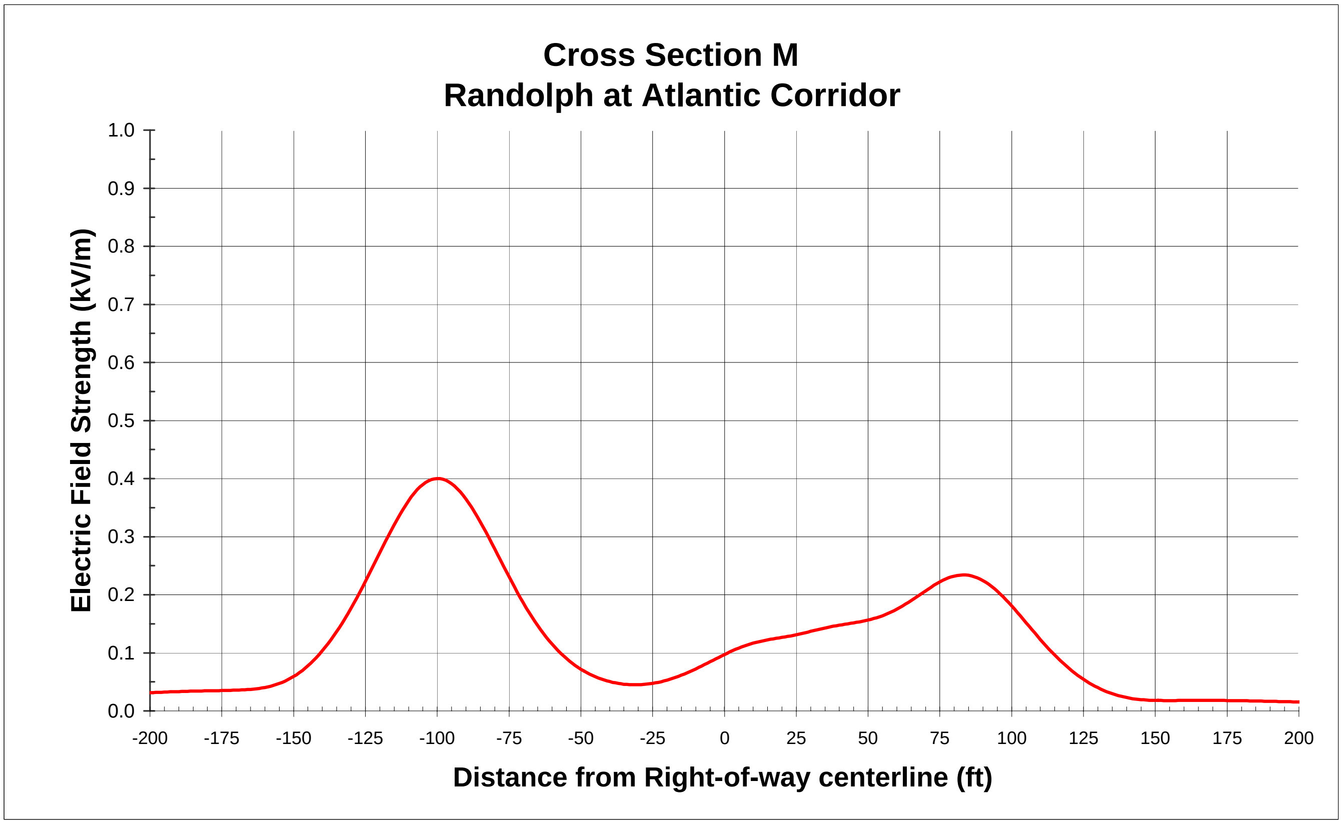

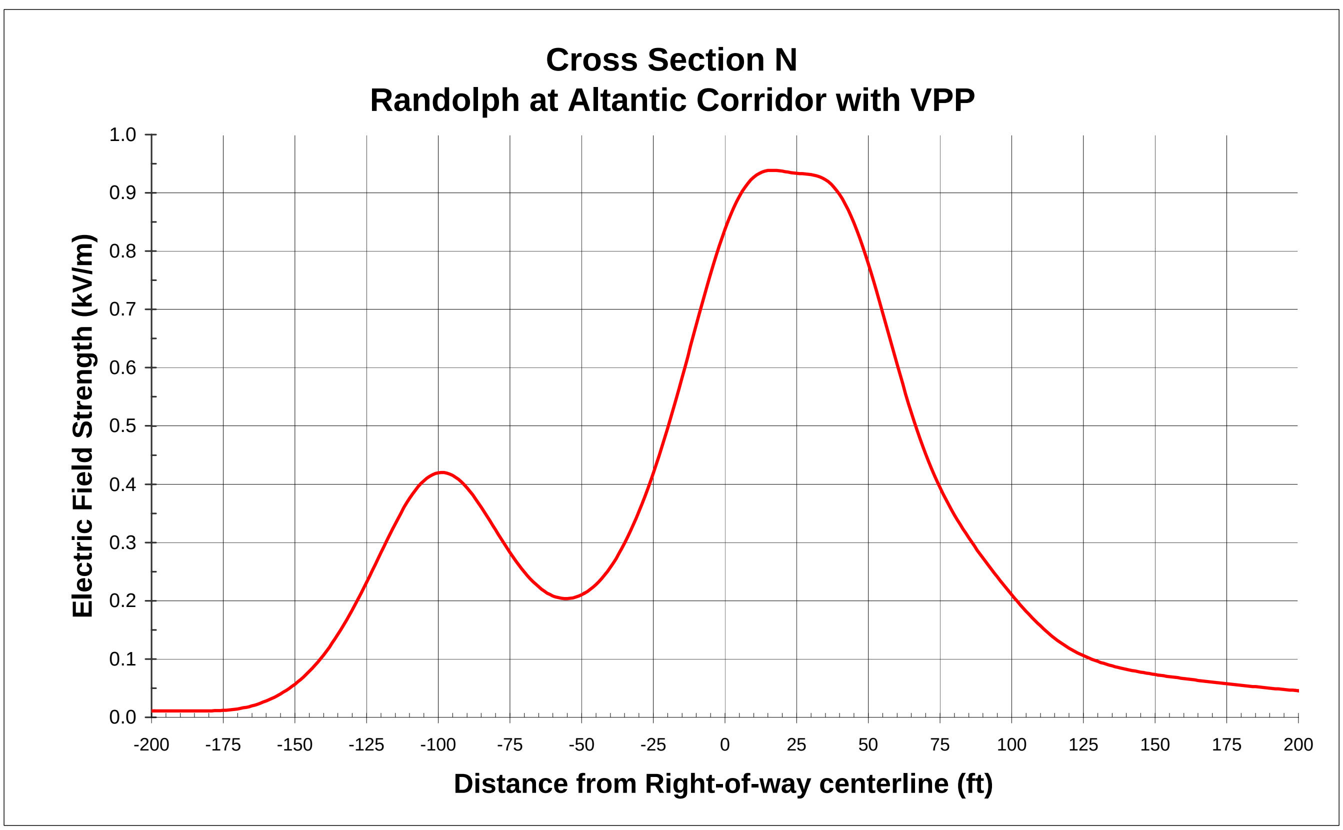

Cross Sections M & N | **Figure 5.5-21**

Electric Field
Vernon Power Plant
City of Vernon

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Jackson, Michigan
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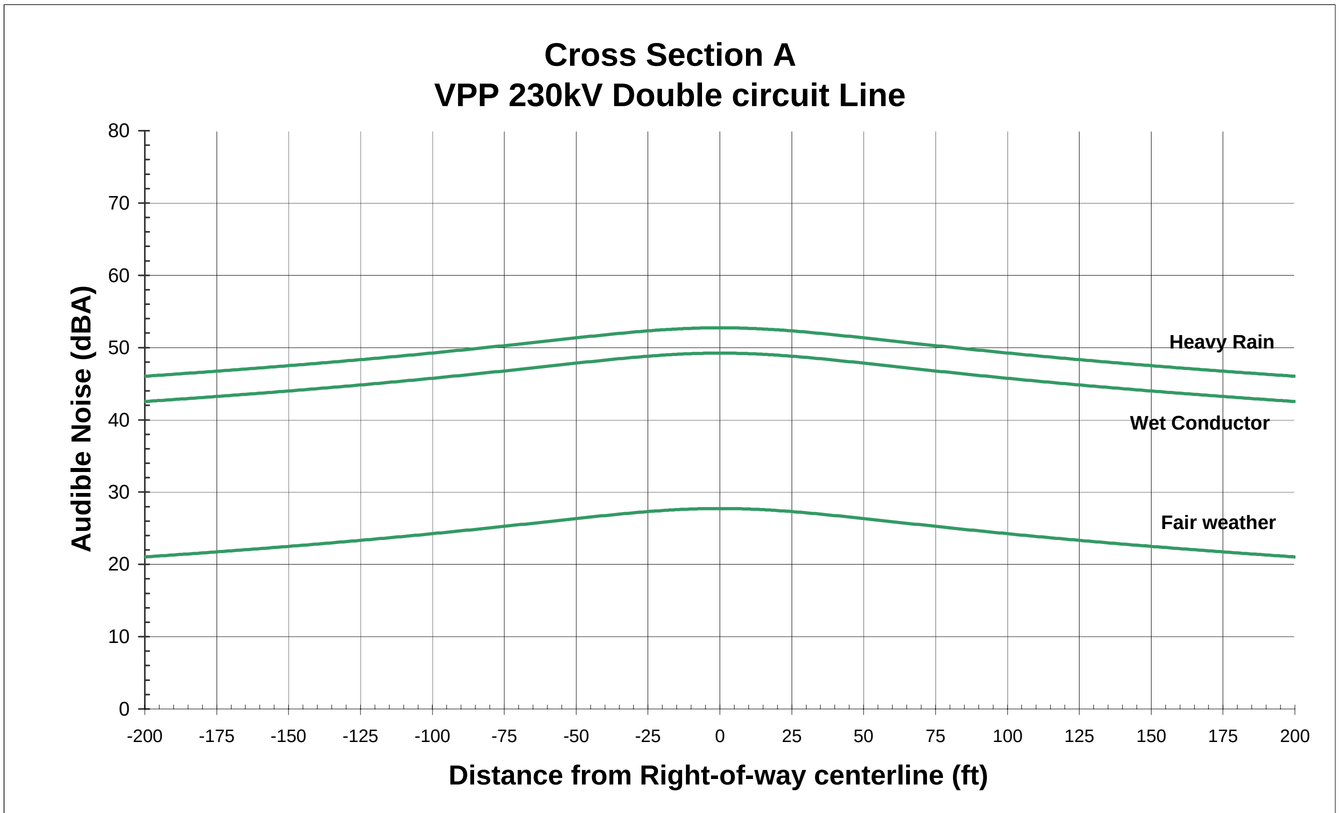

Cross Sections A & J **Figure 5.5-22**

Audible Noise

Vernon Power Plant

City of Vernon

Commonwealth Associates Inc.

Jackson, Michigan

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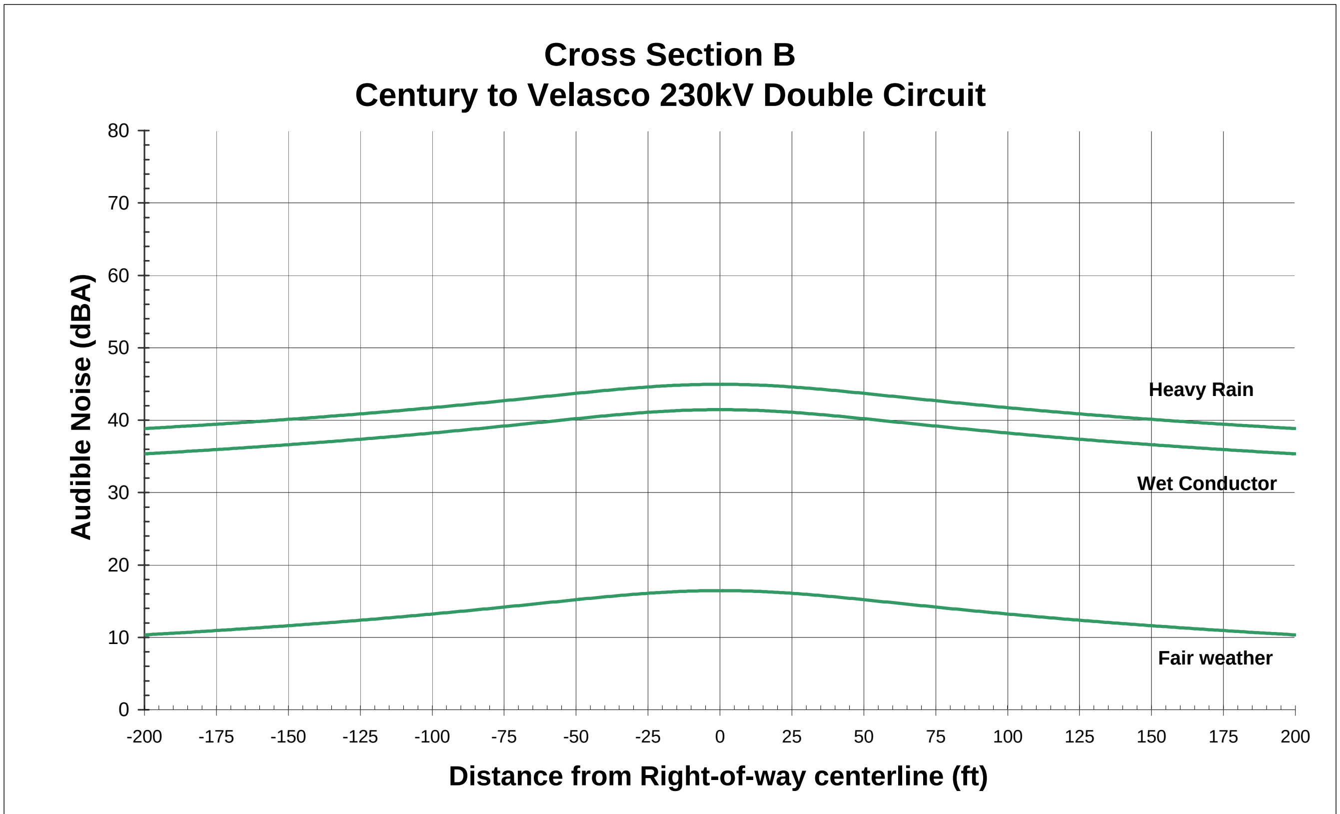

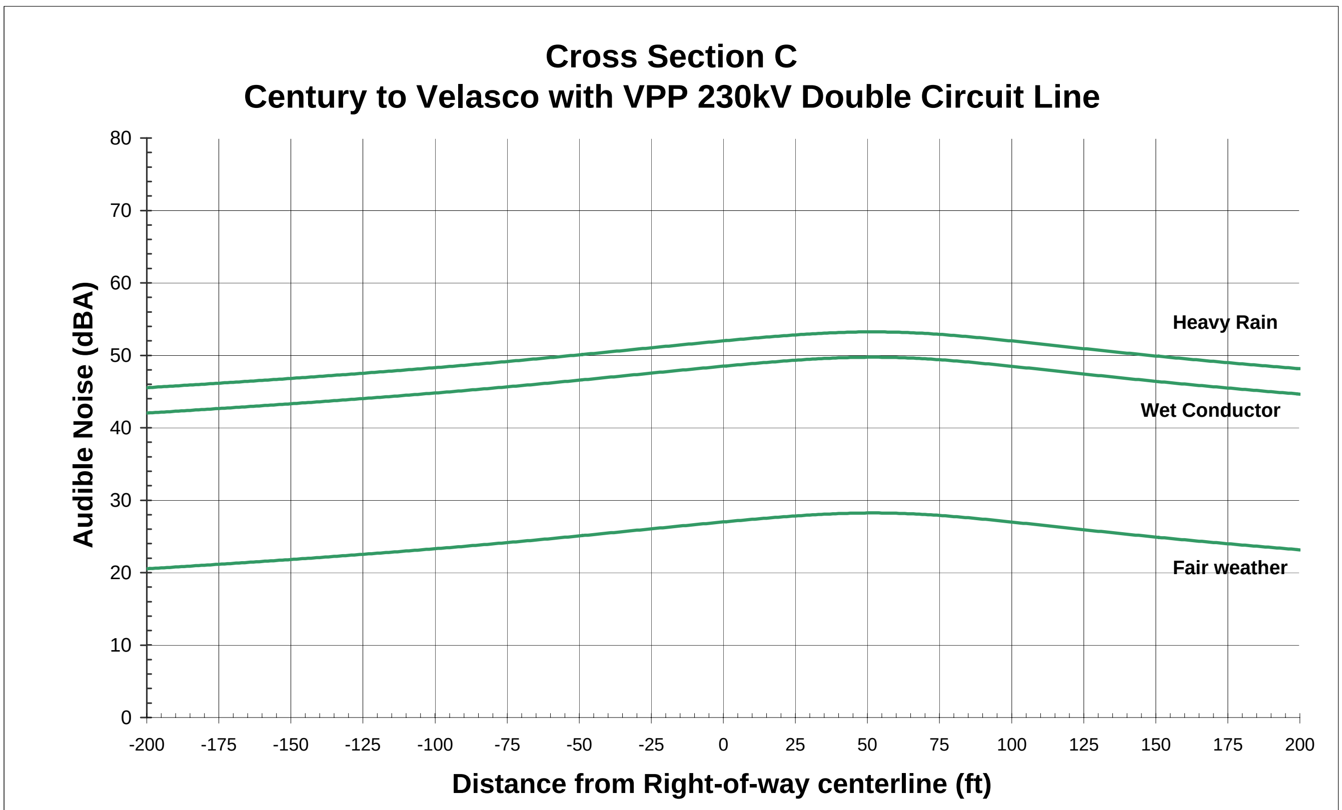

Cross Sections B & C **Figure 5.5-23**

Audible Noise

Vernon Power Plant

City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
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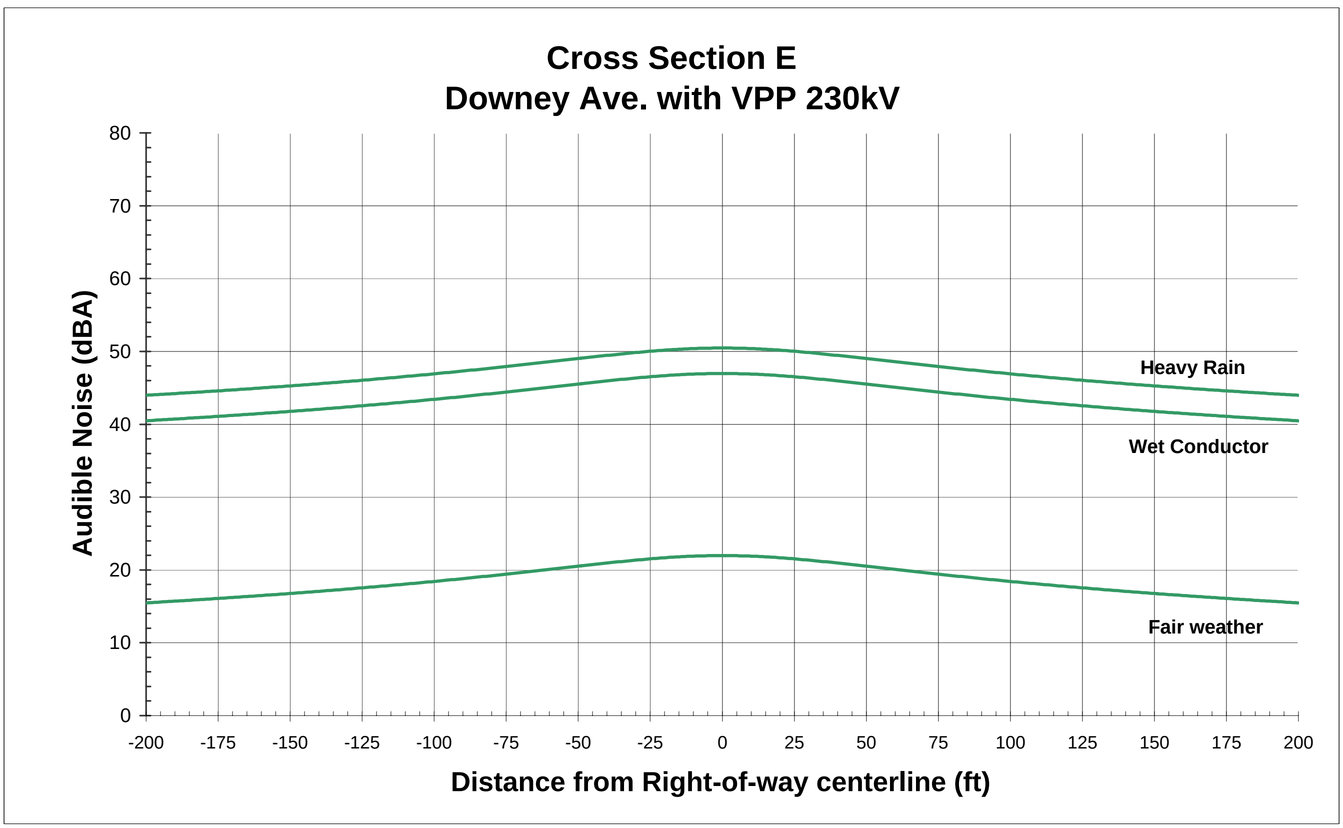


Cross Sections D & E

Figure 5.5-24

Audible Noise

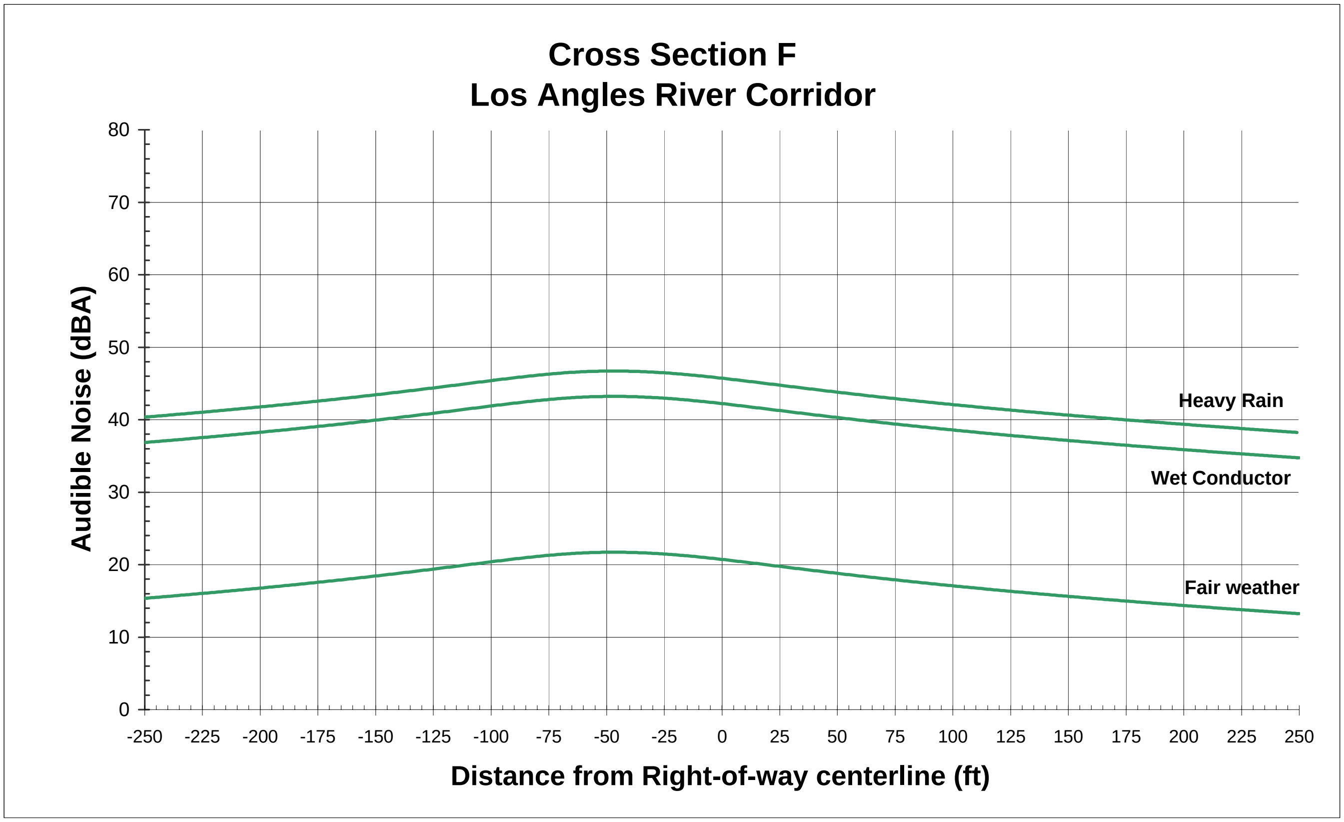
Vernon Power Plant

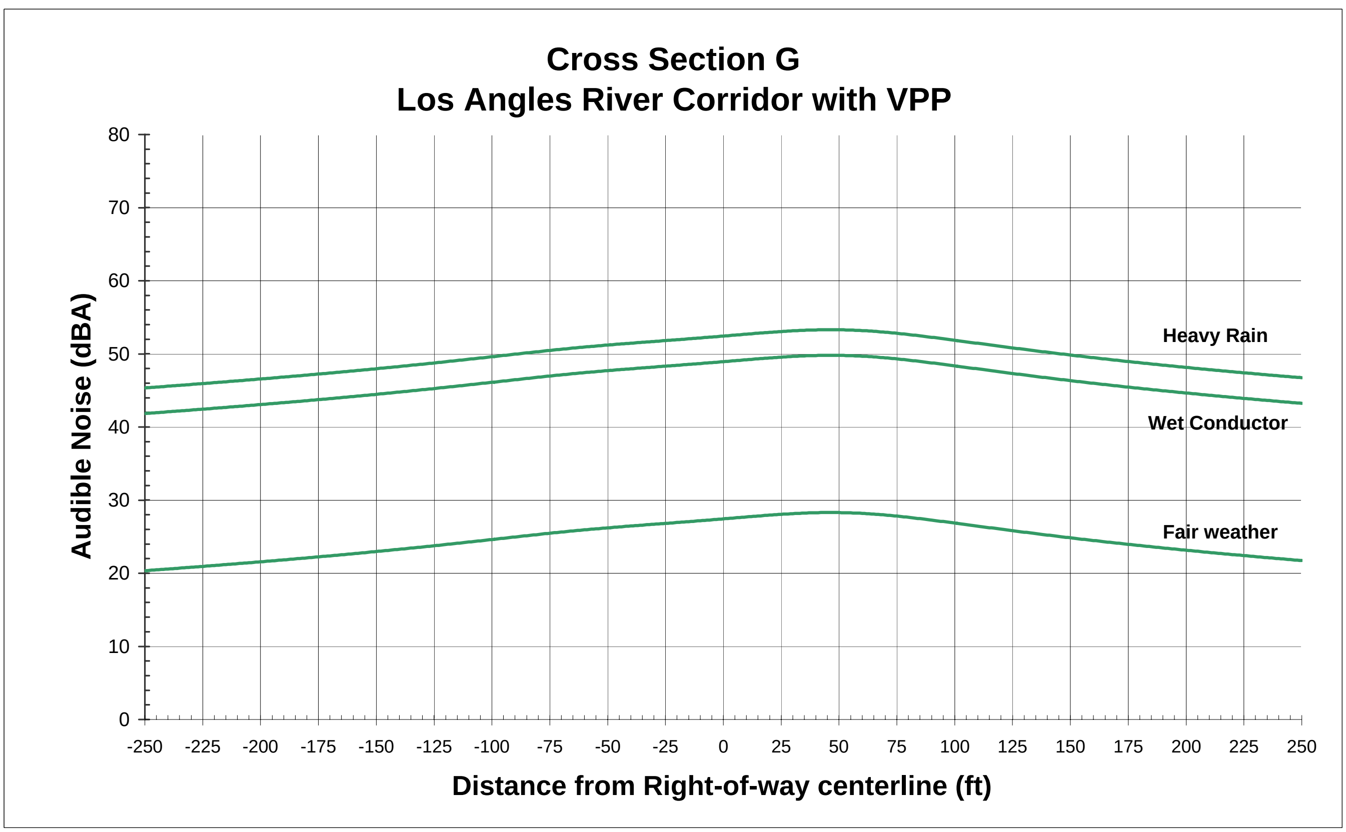
City of Vernon

CAI **Commonwealth Associates Inc.**

Jackson, Michigan

engineers . consultants . construction managers



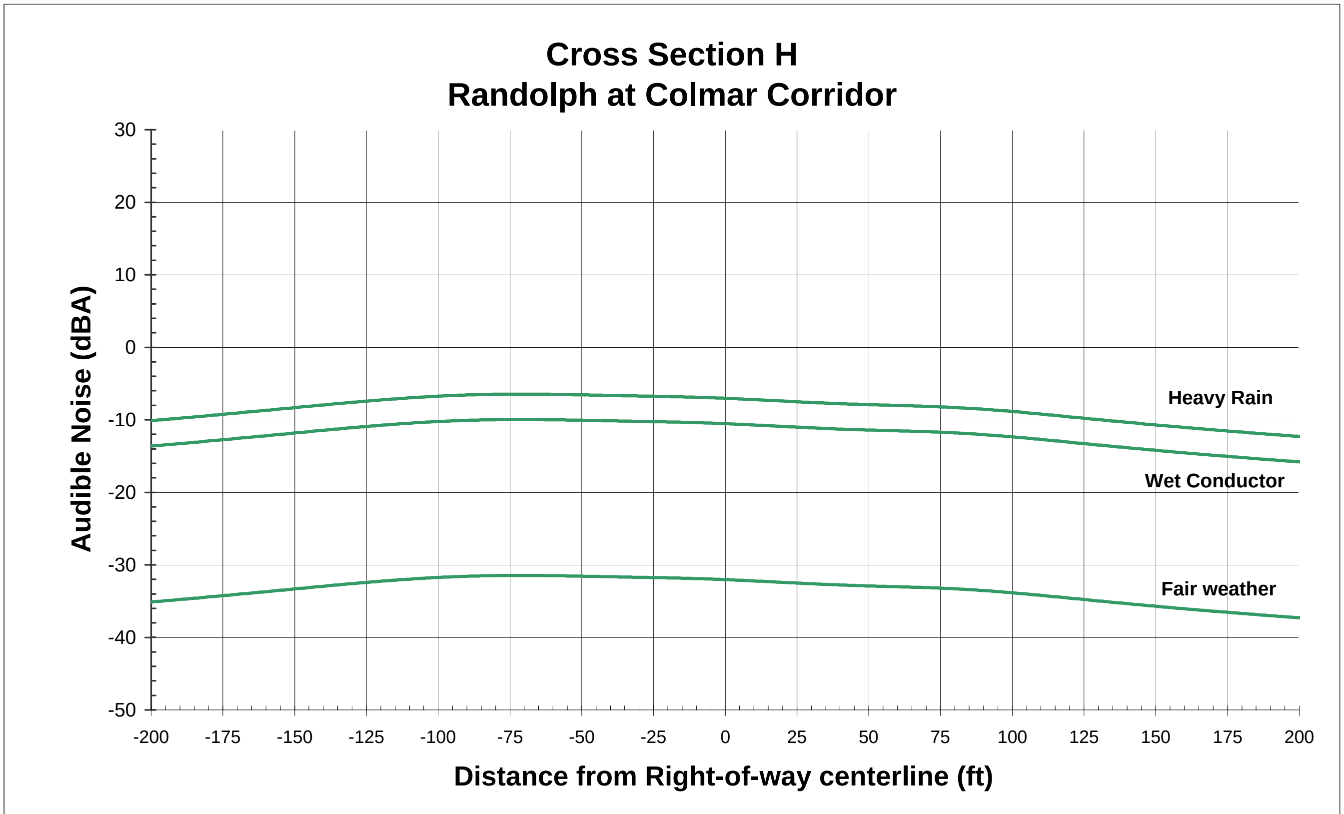


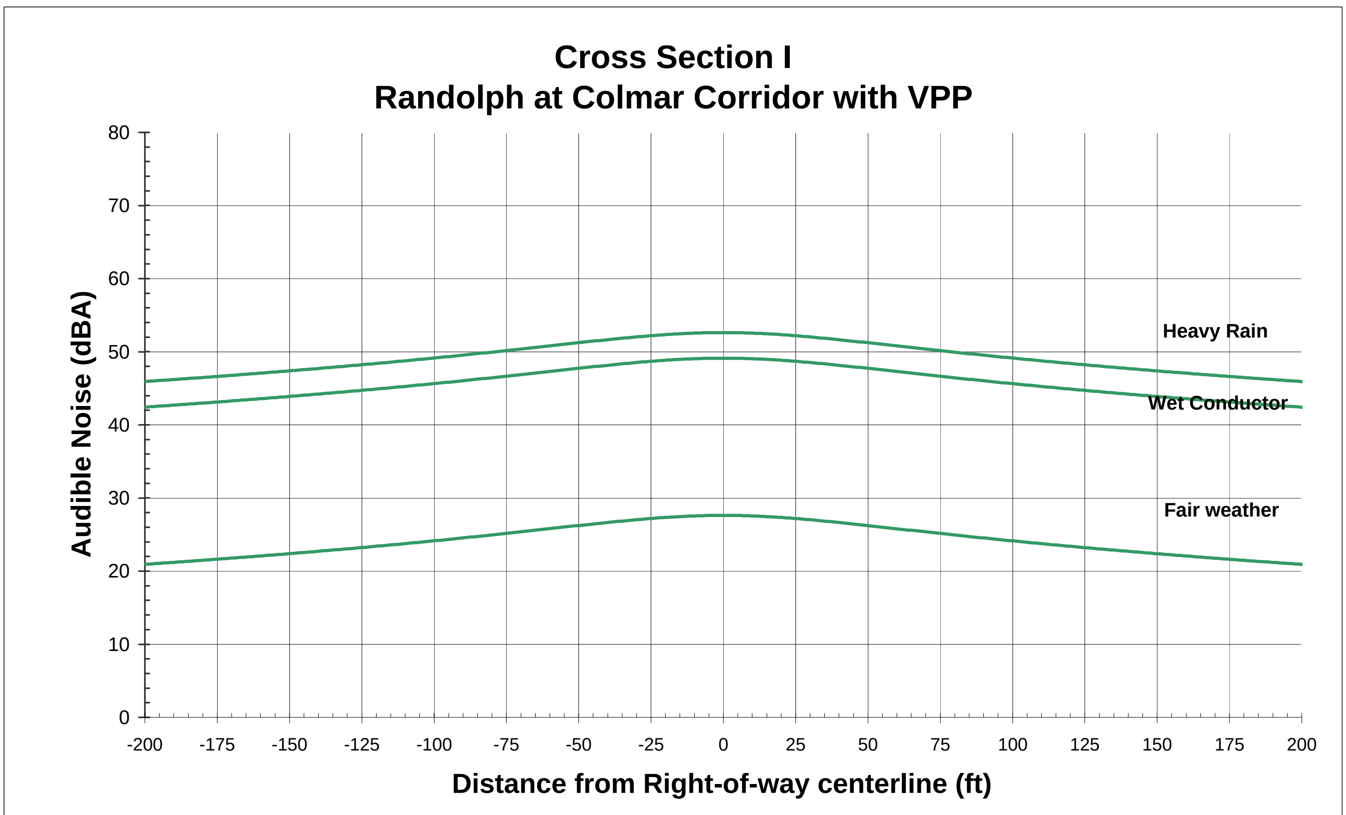
Cross Sections F & G

Figure 5.5-25

Audible Noise
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers

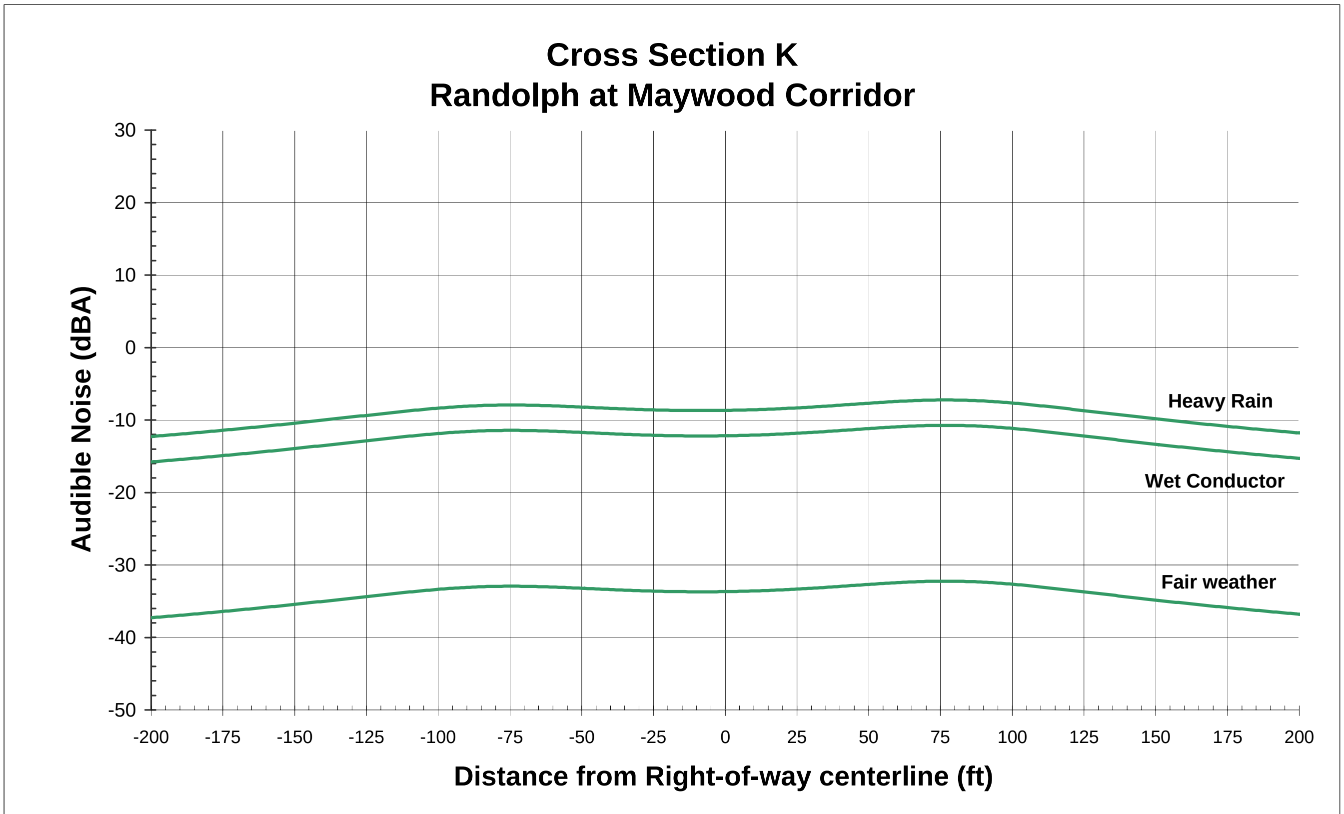


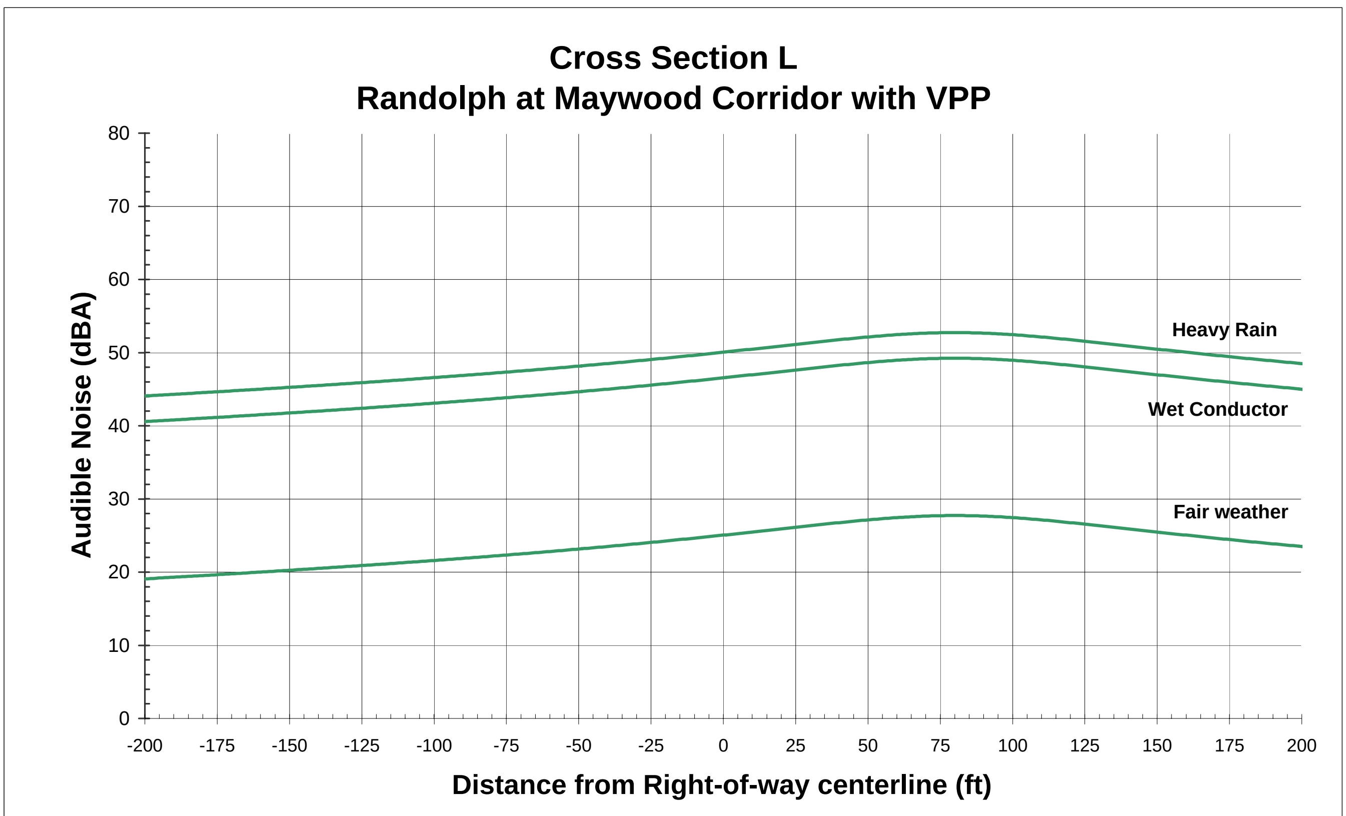


Cross Sections H & I | **Figure 5.5-26**

Audible Noise
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers



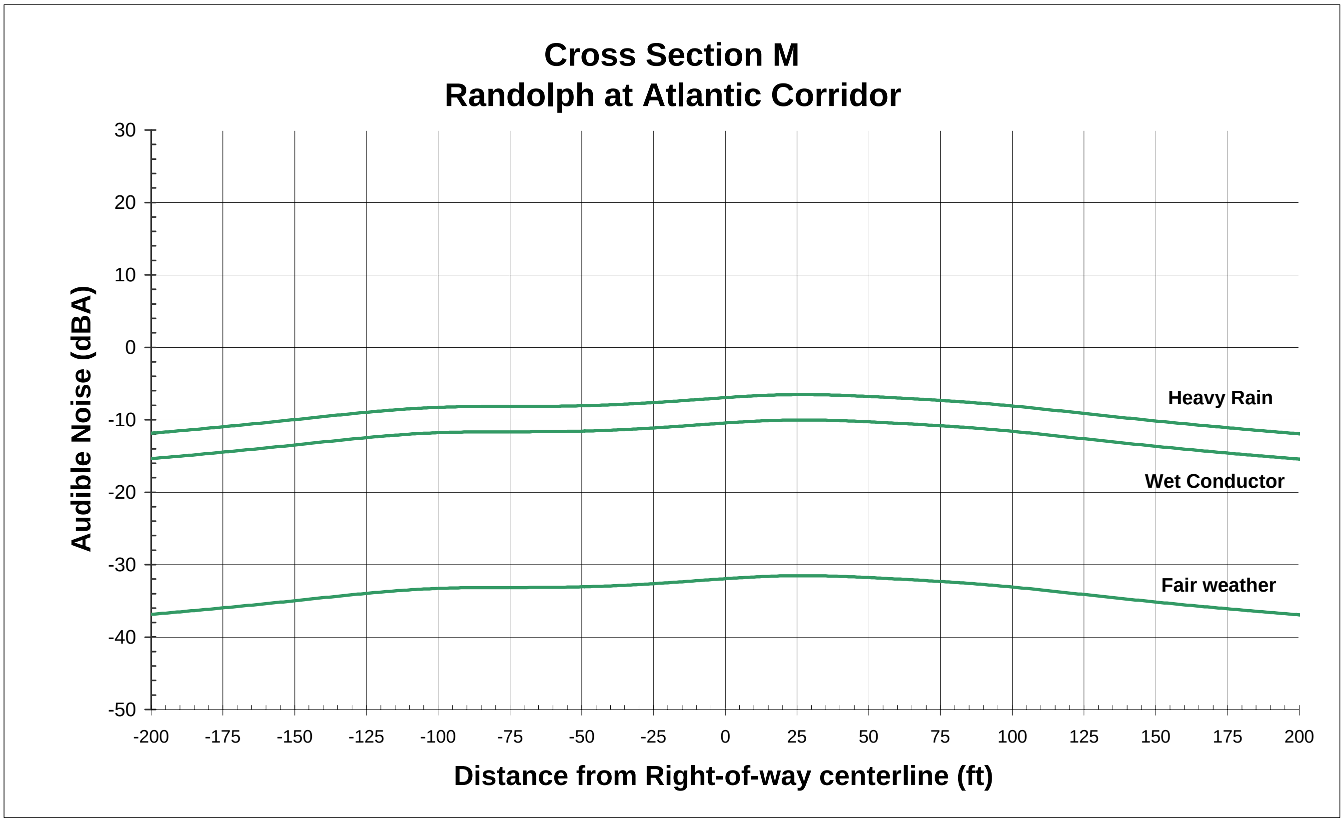


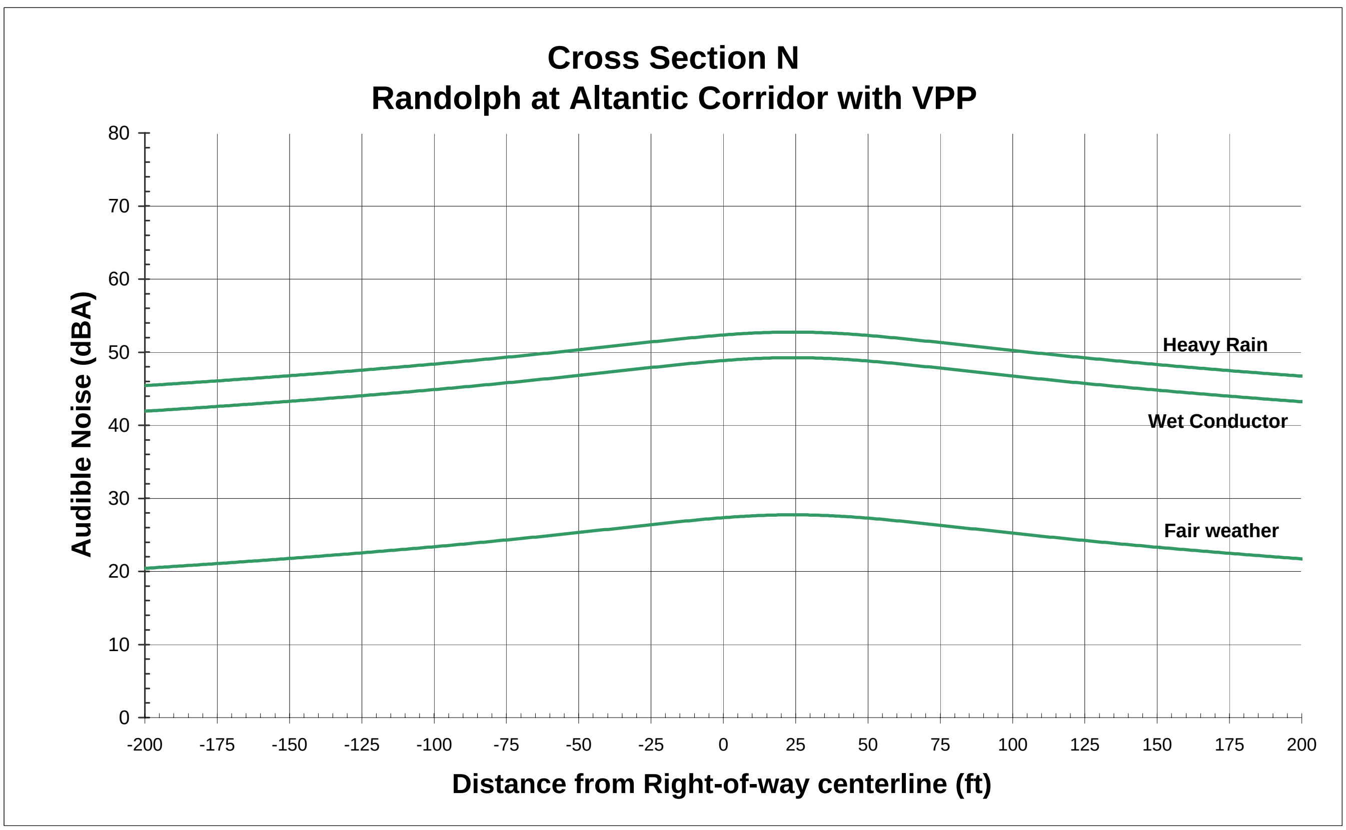
Cross Sections K & L

Figure 5.5-27

Audible Noise
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections M & N

Figure 5.5-28

Audible Noise

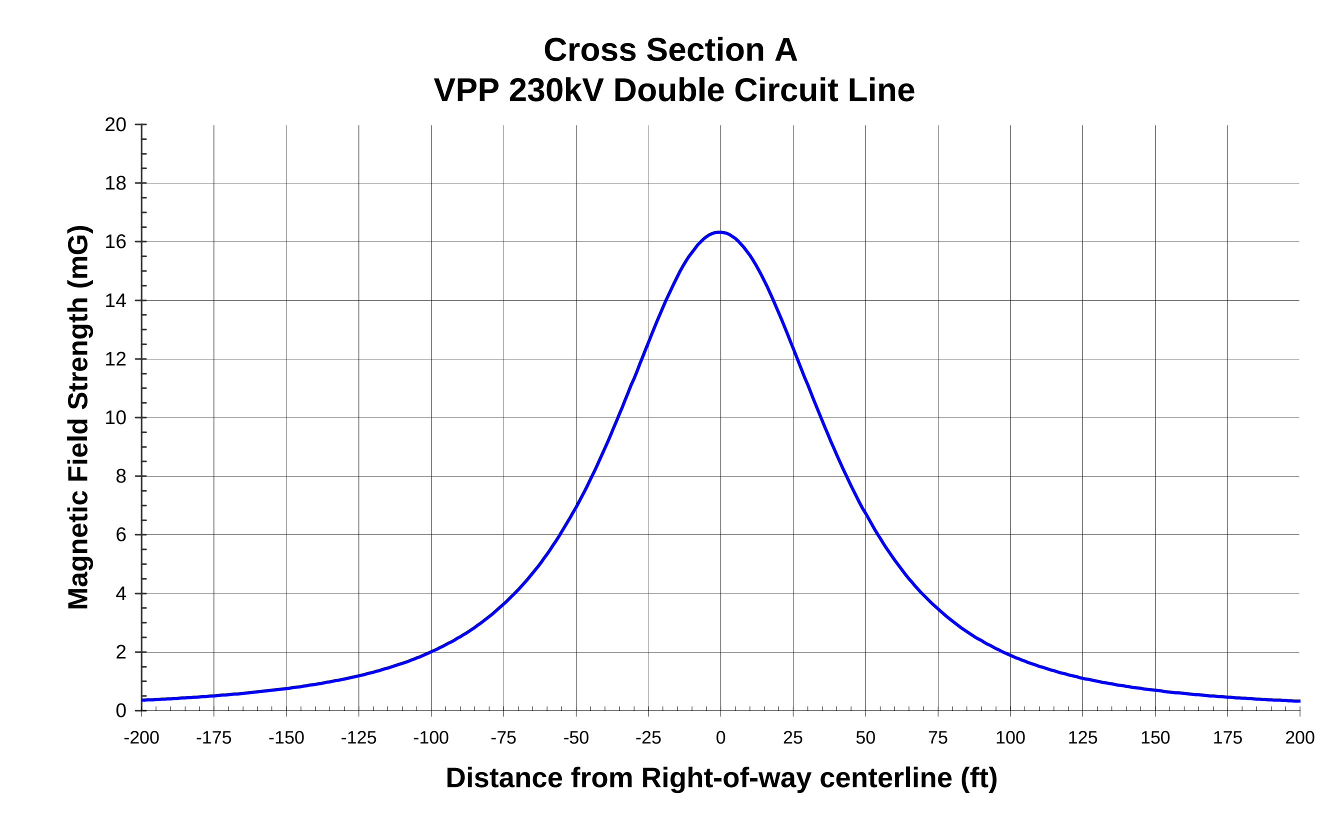
Vernon Power Plant

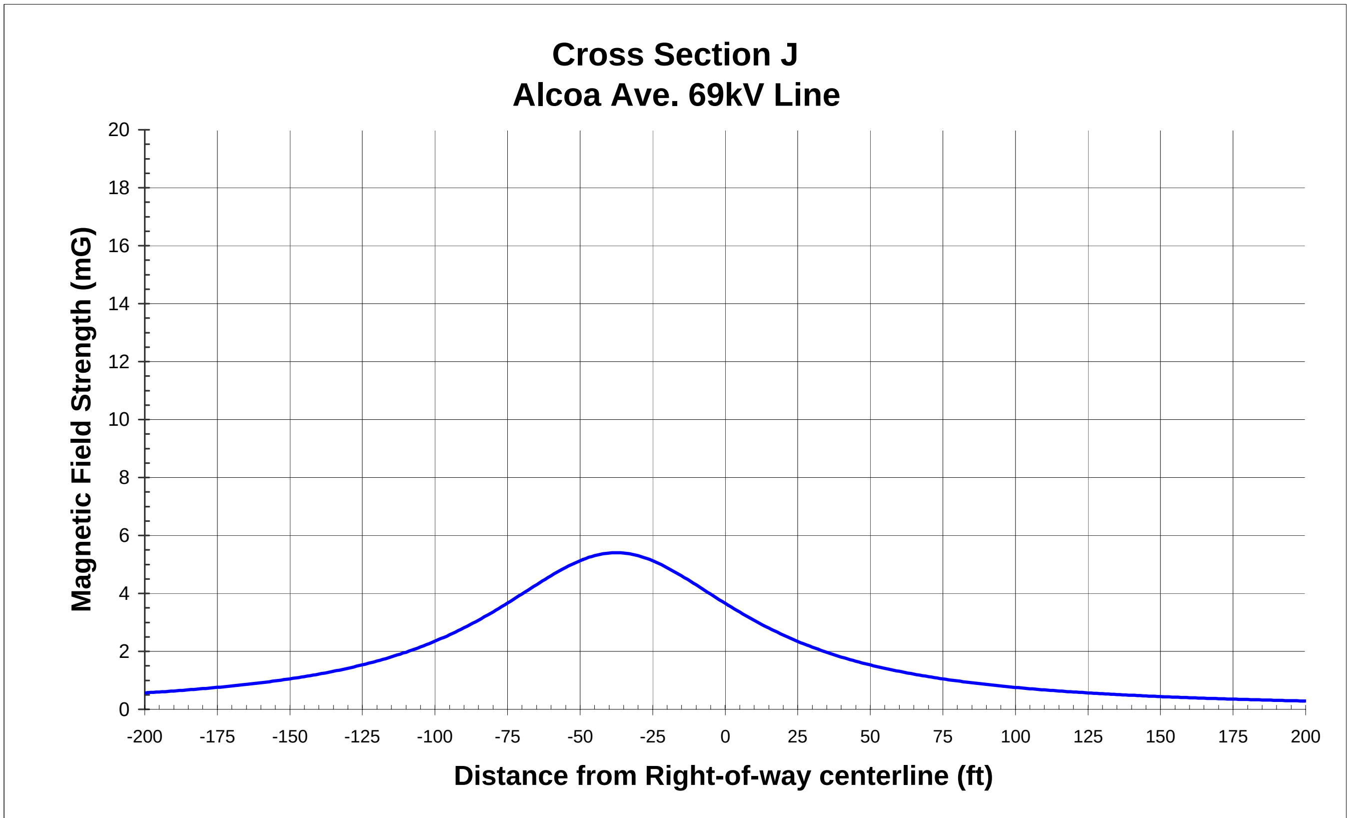
City of Vernon

CAI **Commonwealth Associates Inc.**

Jackson, Michigan

engineers . consultants . construction managers





Cross Sections A & J

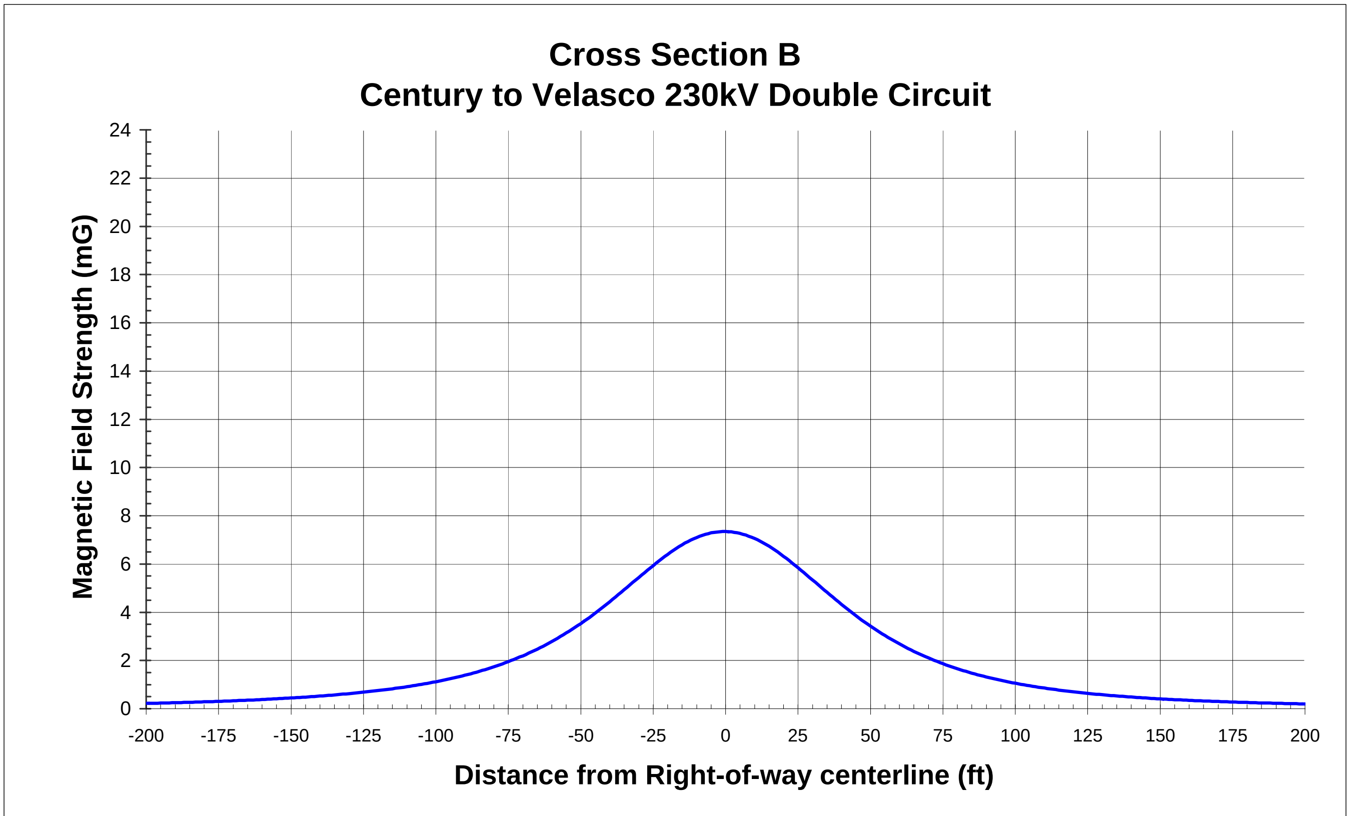
Figure 5.5-29

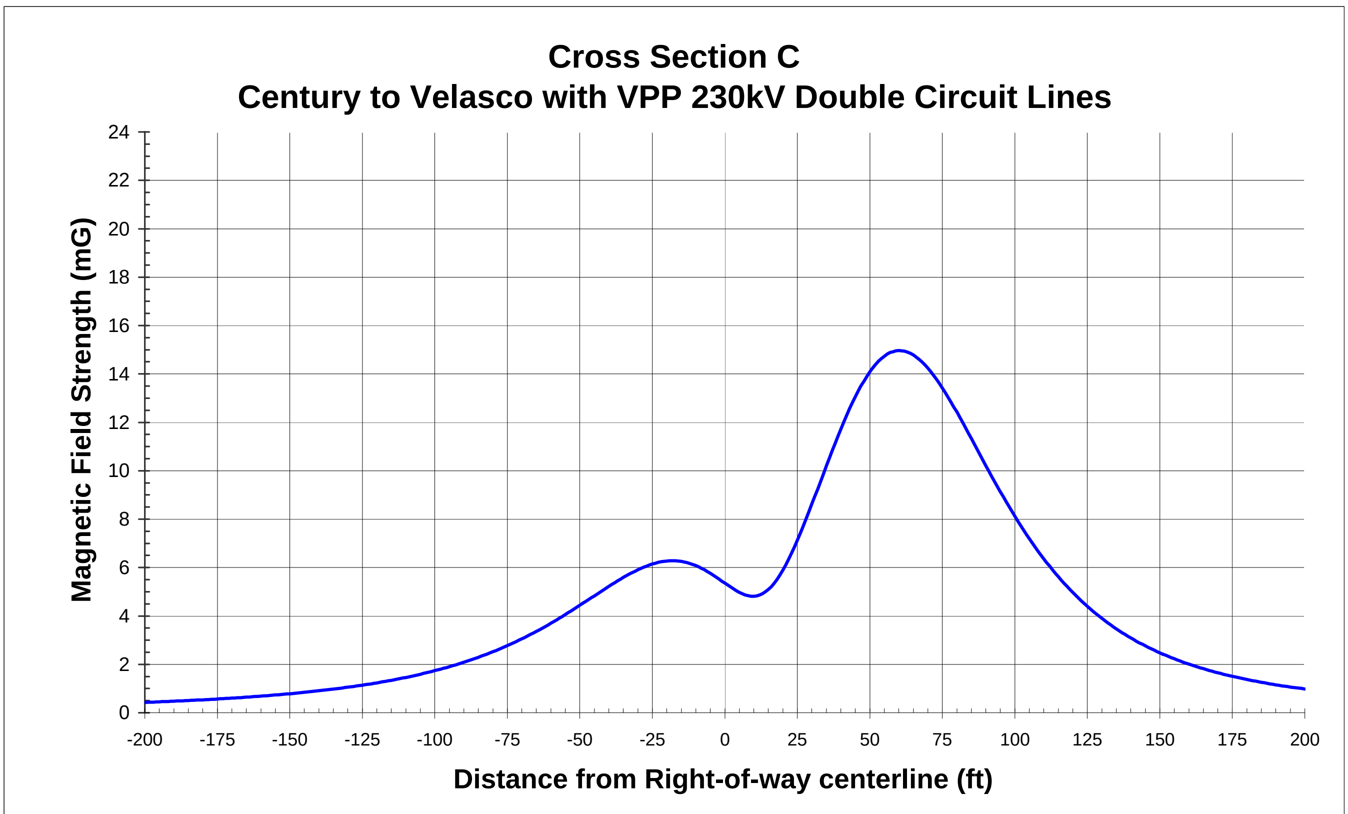
Magnetic Field

Vernon Power Plant

City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections B & C **Figure 5.5-30**

Magnetic Field

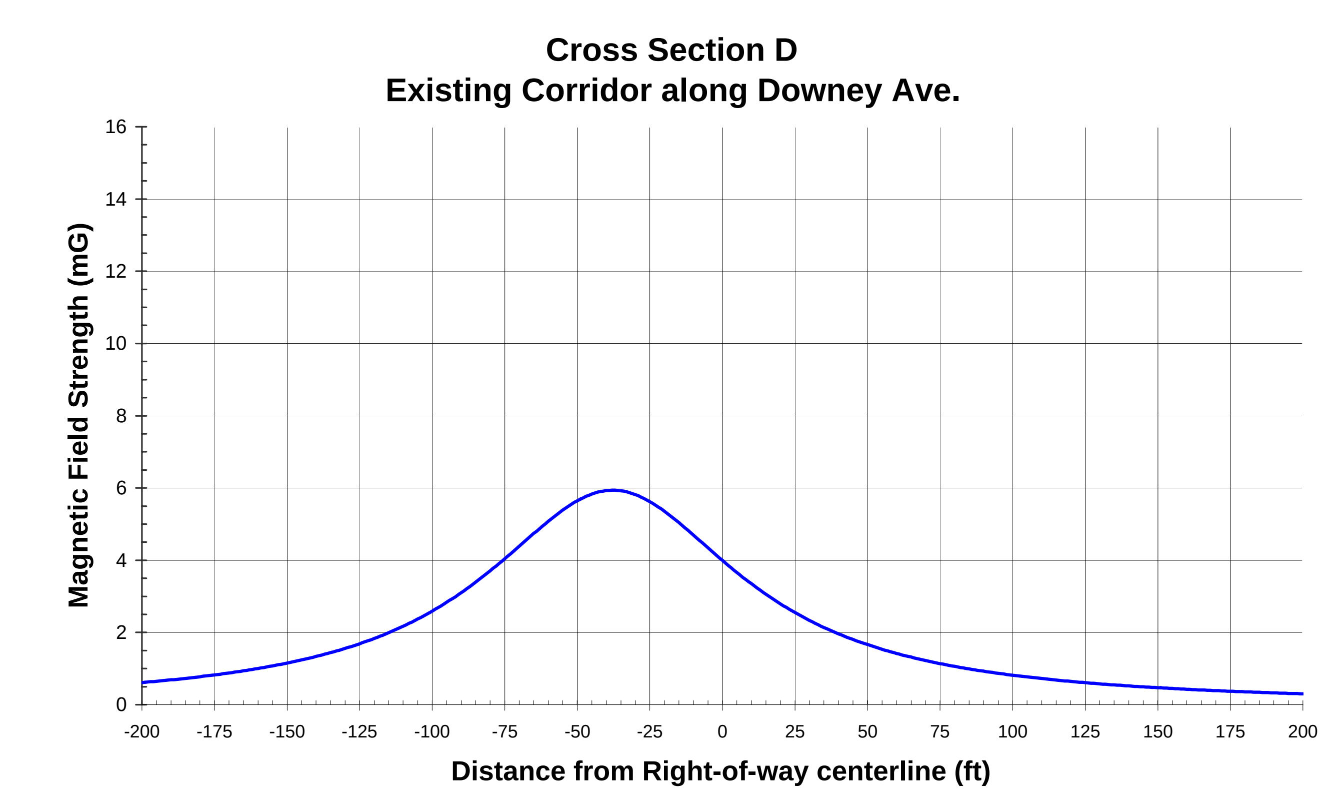
Vernon Power Plant

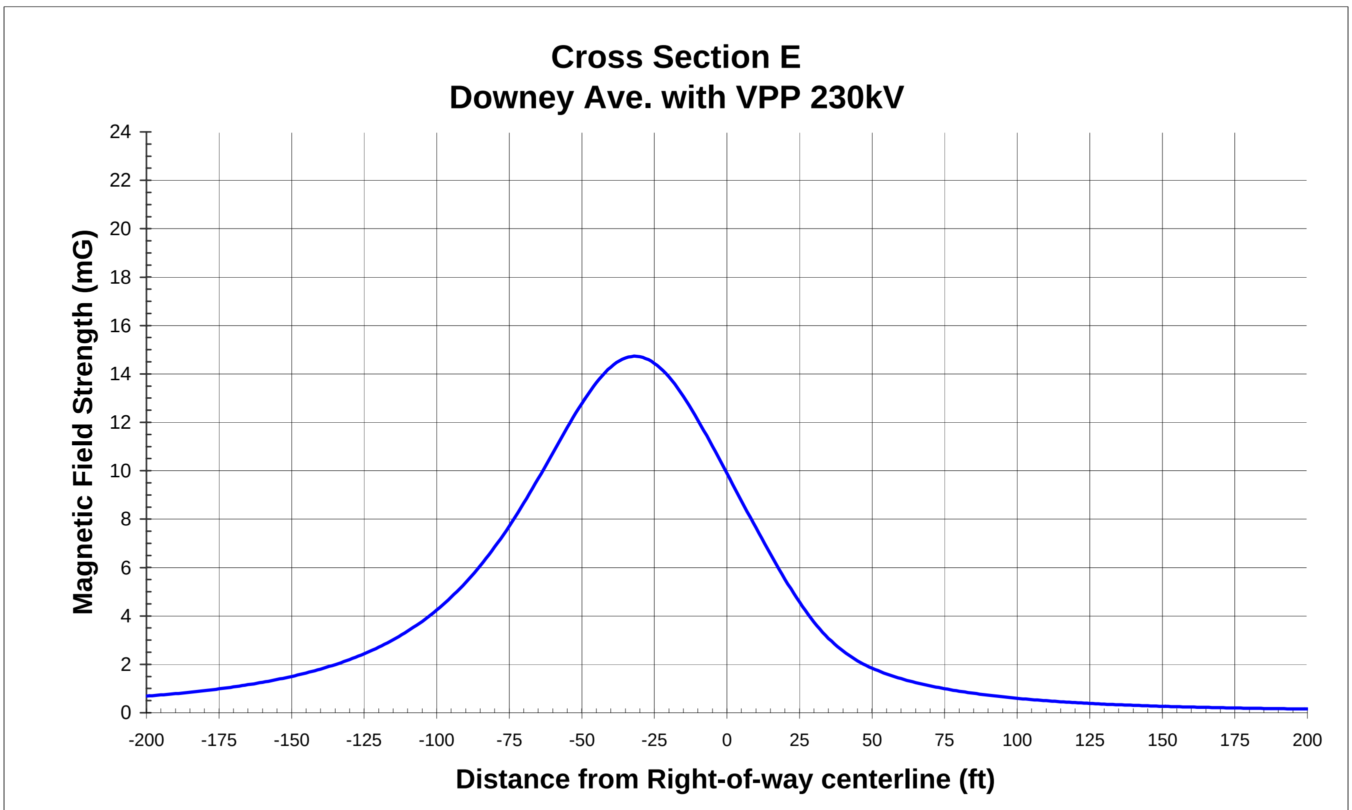
City of Vernon

Commonwealth Associates Inc.

Jackson, Michigan

engineers . consultants . construction managers





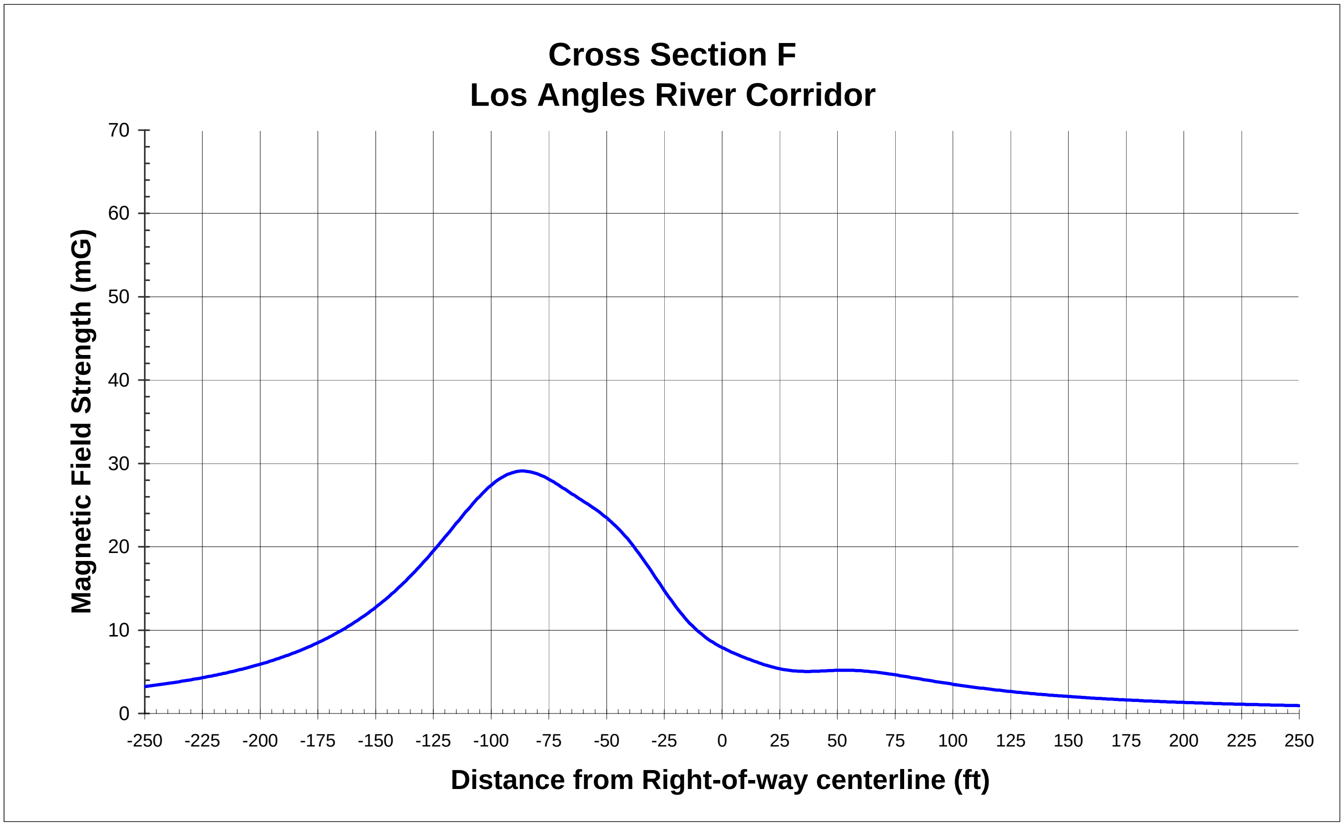
Cross Sections D & E | **Figure 5.5-31**

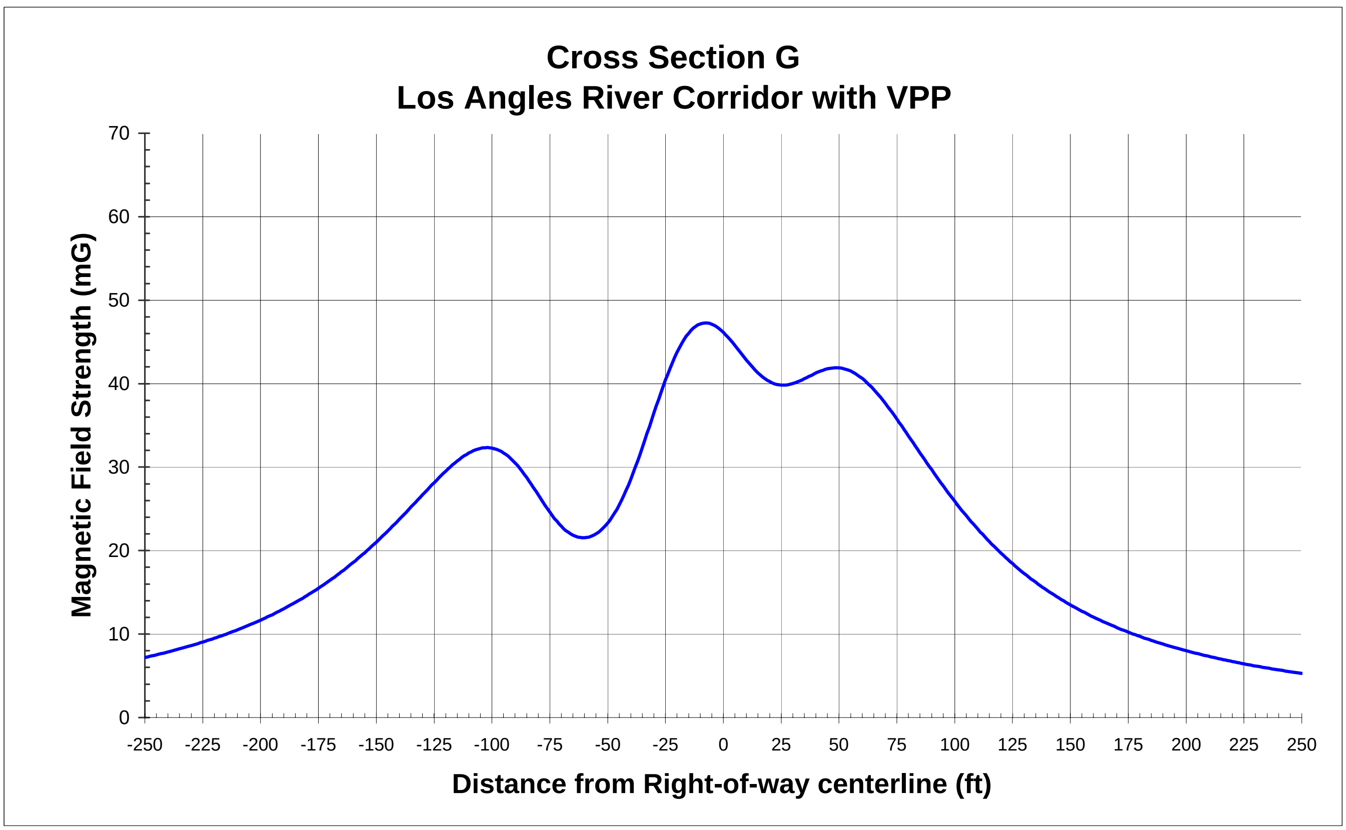
Magnetic Field

Vernon Power Plant

City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers

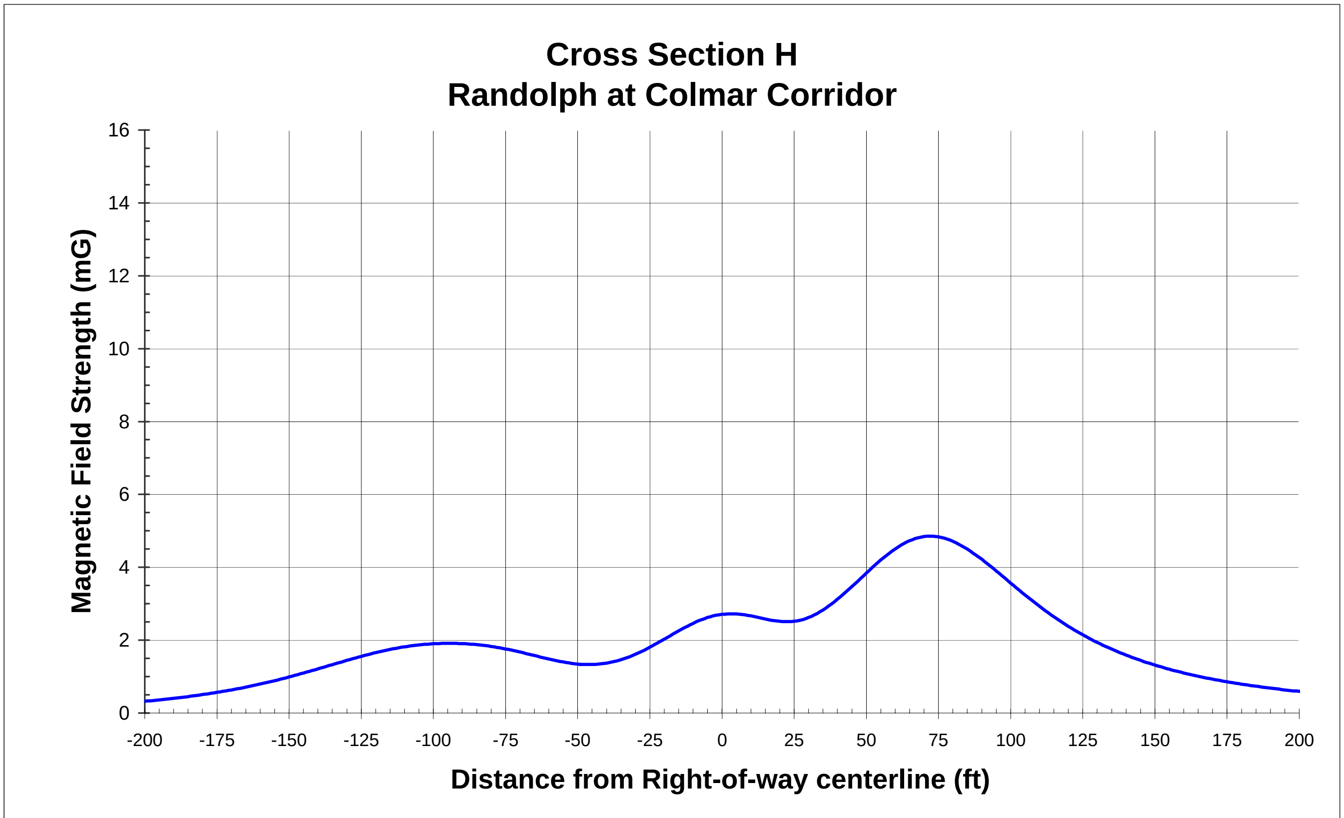


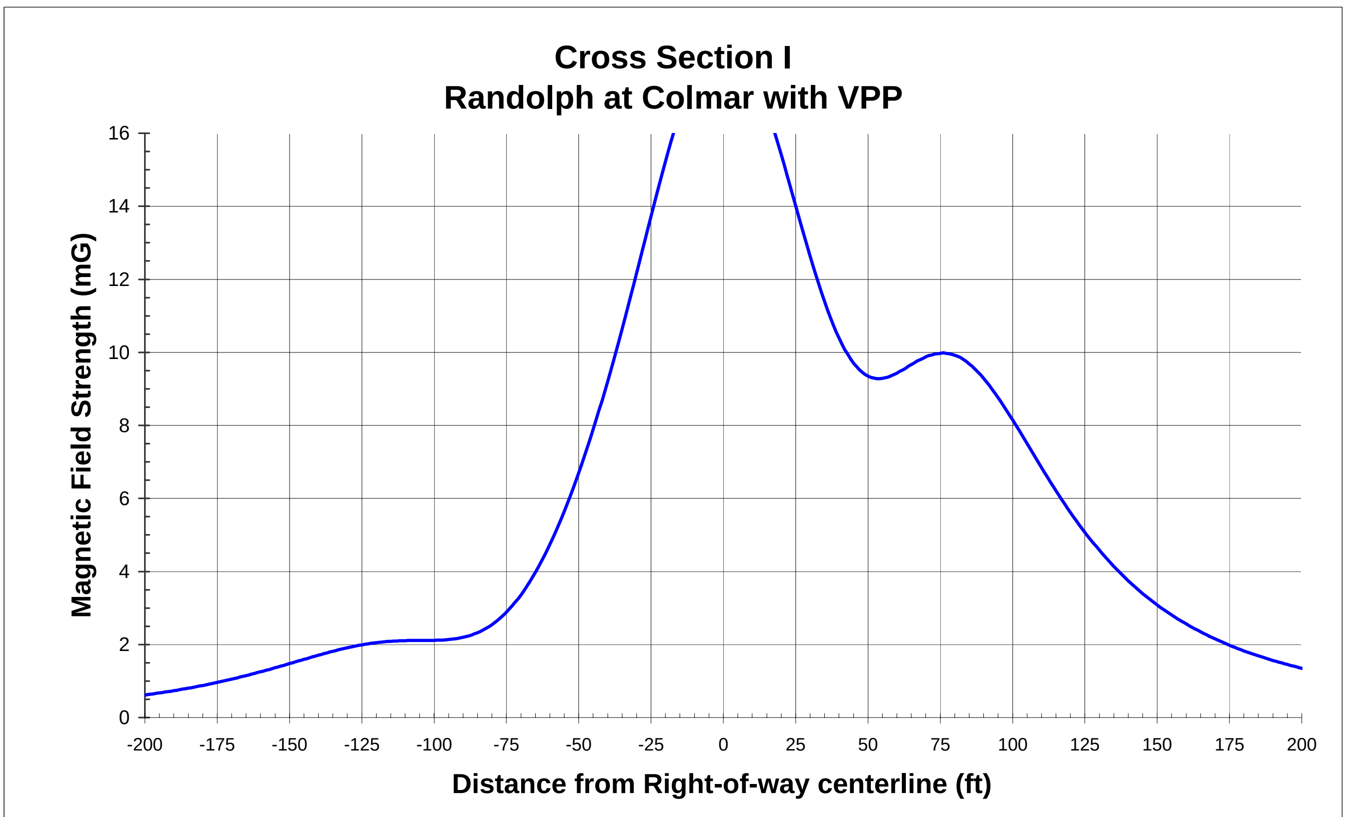


Cross Sections F & G | **Figure 5.5-32**

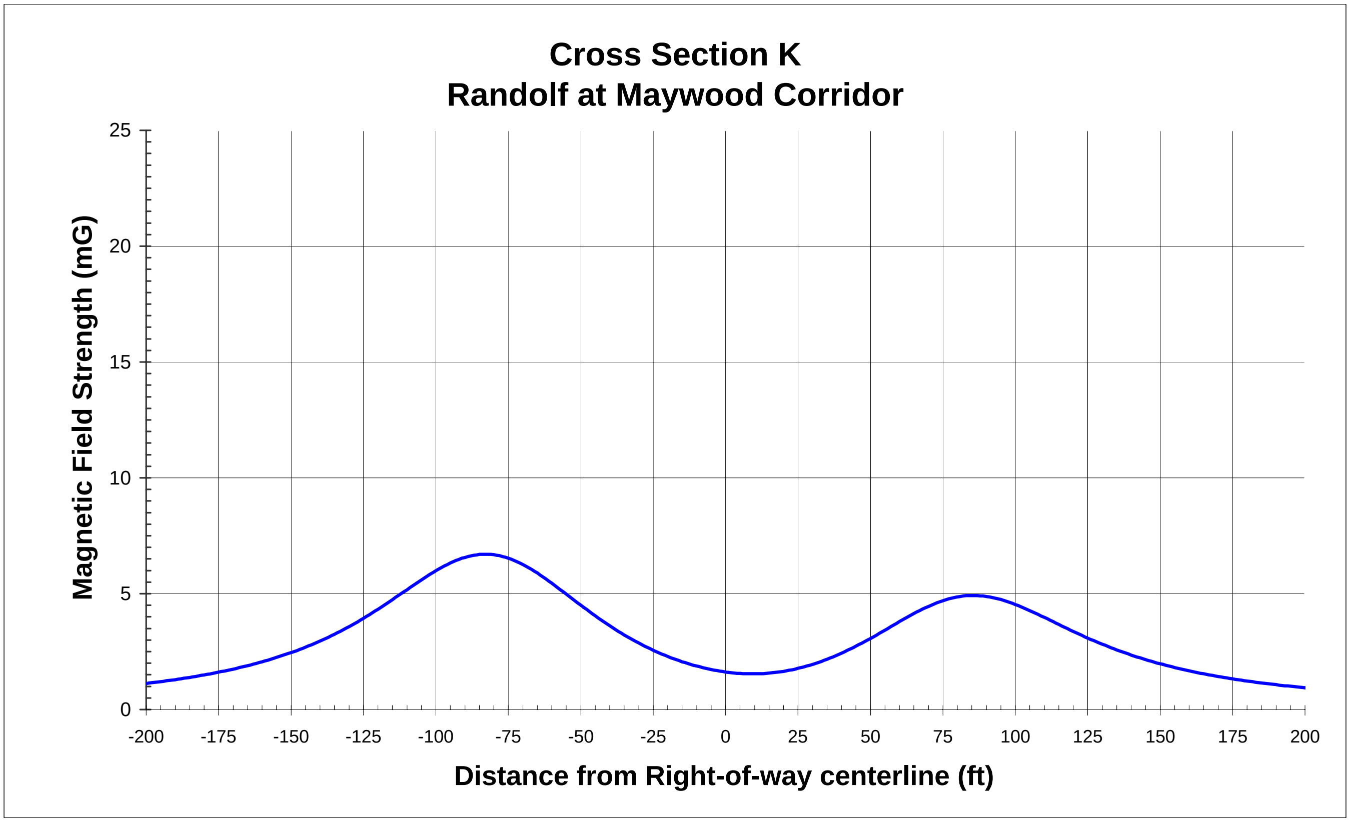
Magnetic Field
Vernon Power Plant
City of Vernon

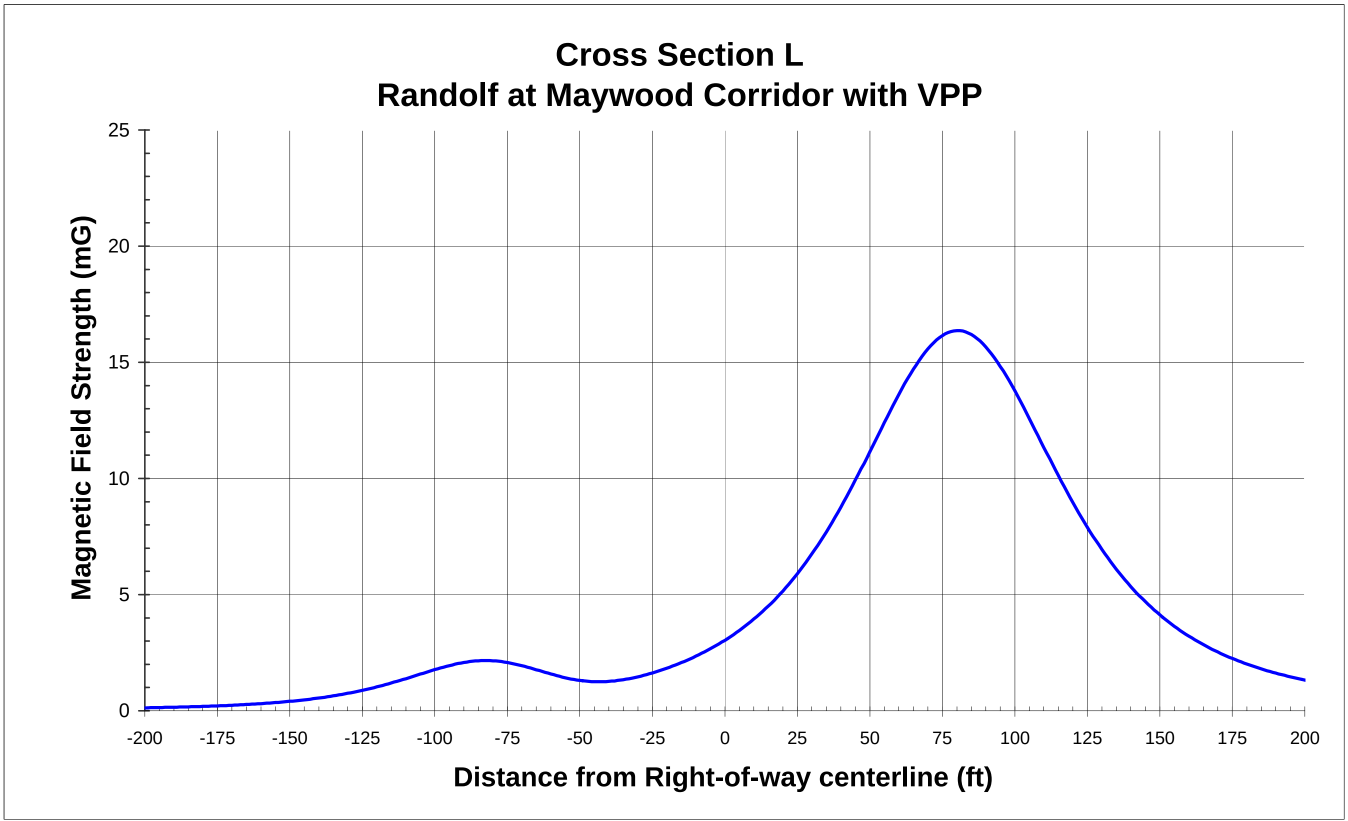
CAI **Commonwealth Associates Inc.**
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections H & I	**Figure 5.5-33**
Magnetic Field	CAI **Commonwealth Associates Inc.**
Vernon Power Plant	Jackson, Michigan
City of Vernon	engineers . consultants . construction managers





Cross Sections K & L

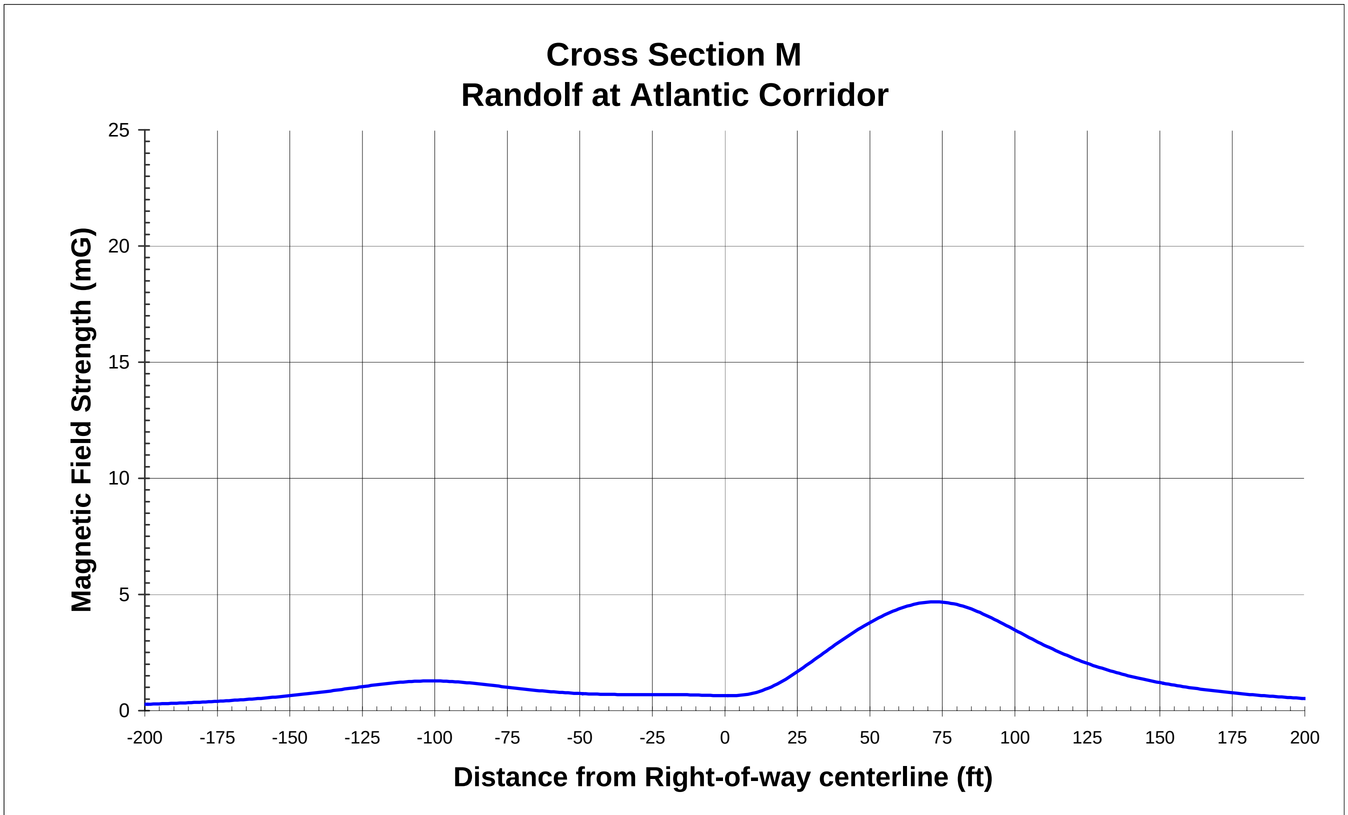
Figure 5.5-34

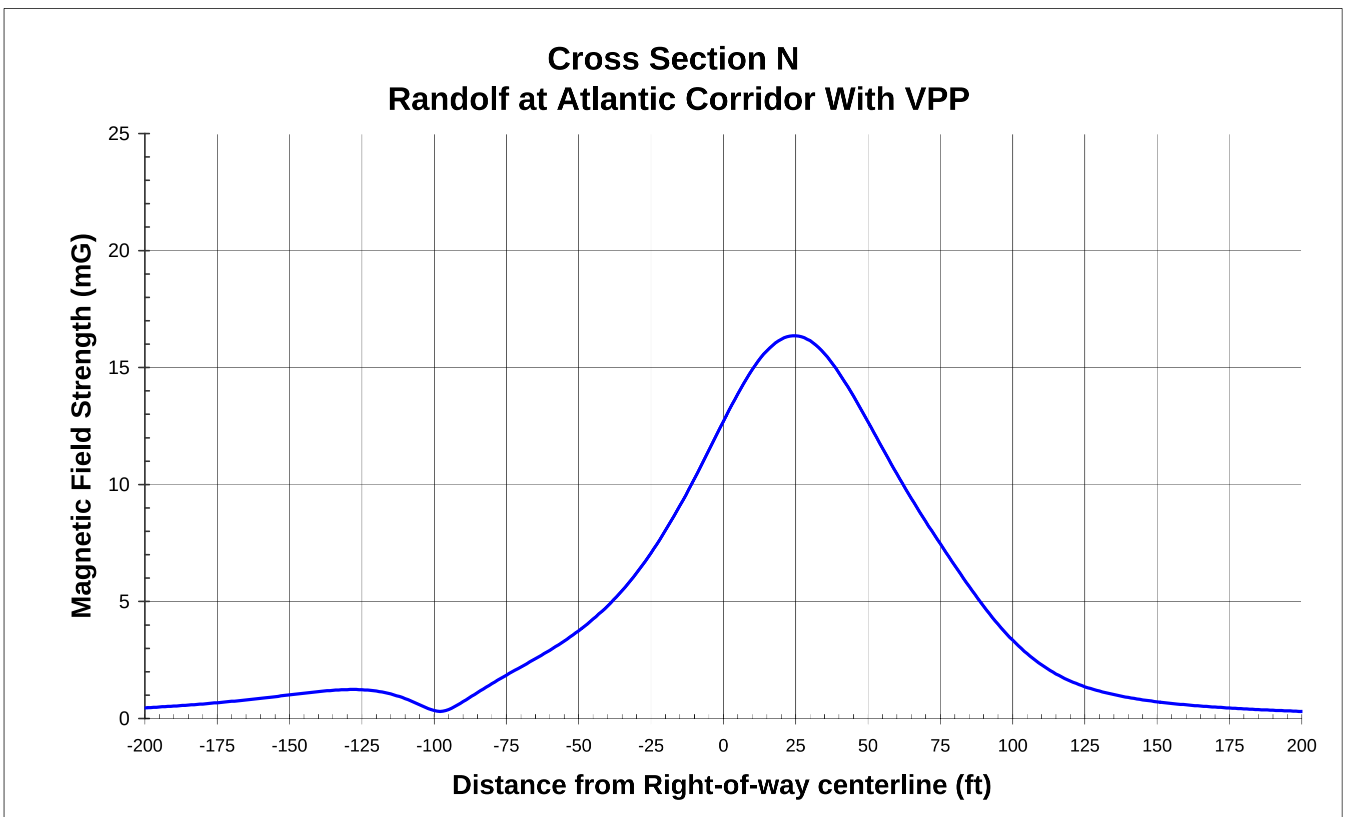
Magnetic Field

Vernon Power Plant

City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers



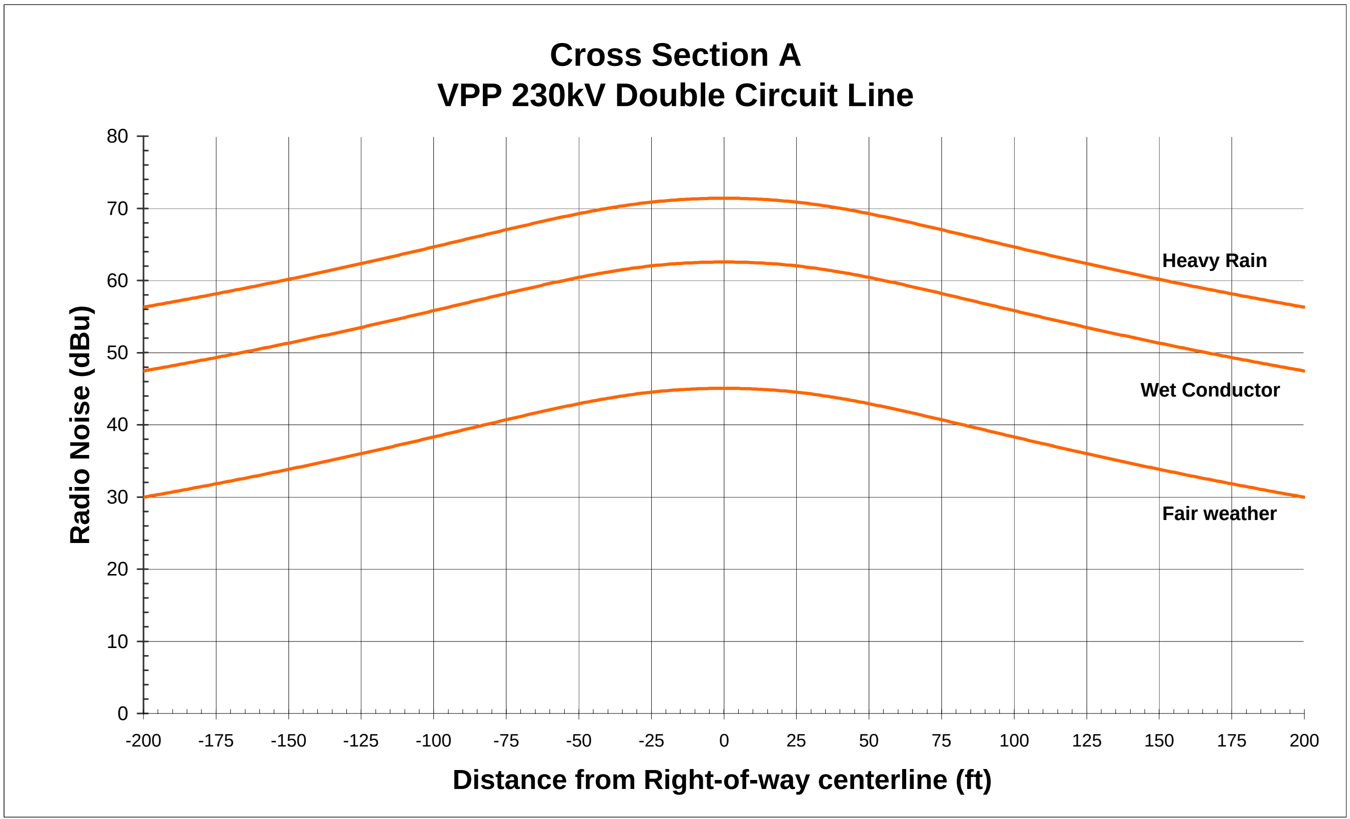


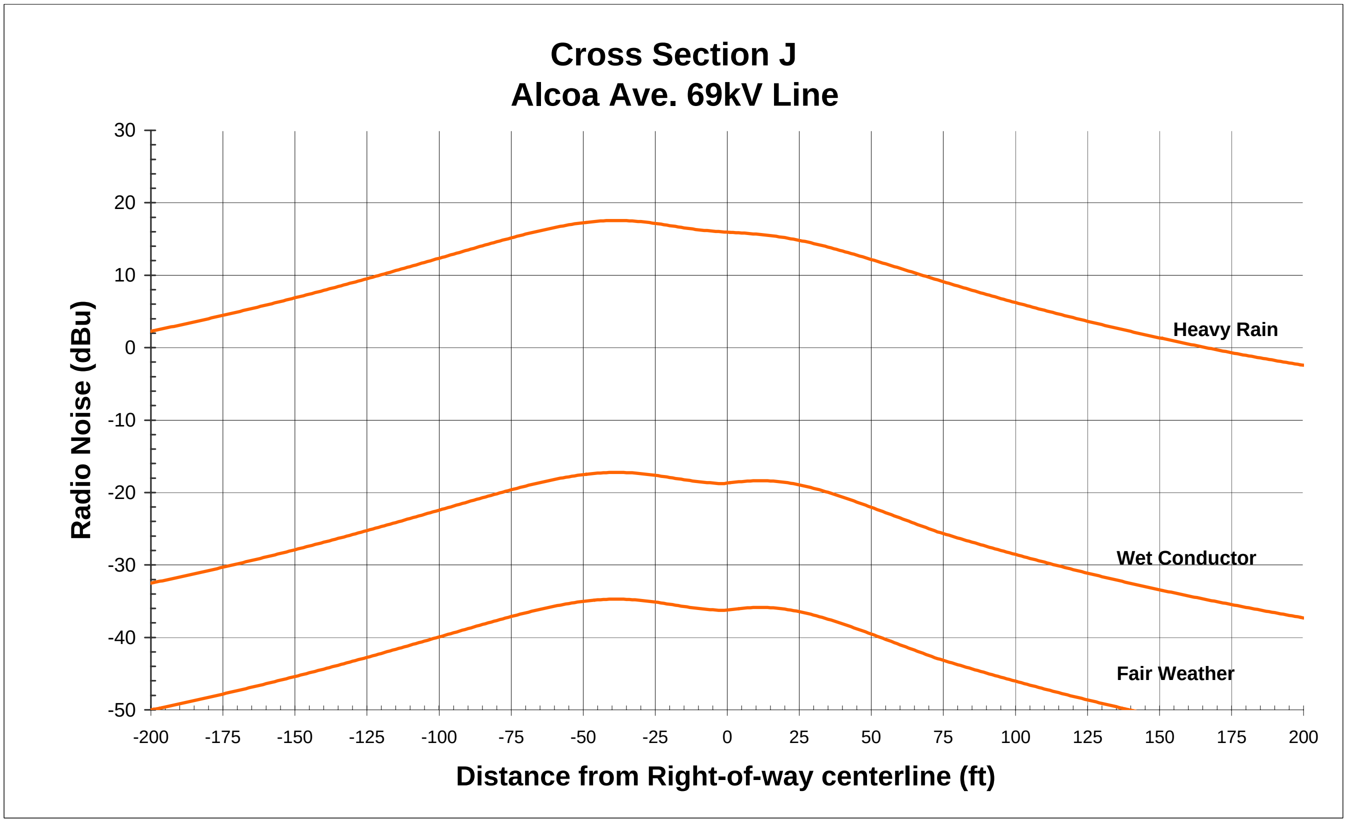
Cross Sections M & N

Figure 5.5-35

Magnetic Field
Vernon Power Plant
City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections A & J **Figure 5.5-36**

Radio Noise

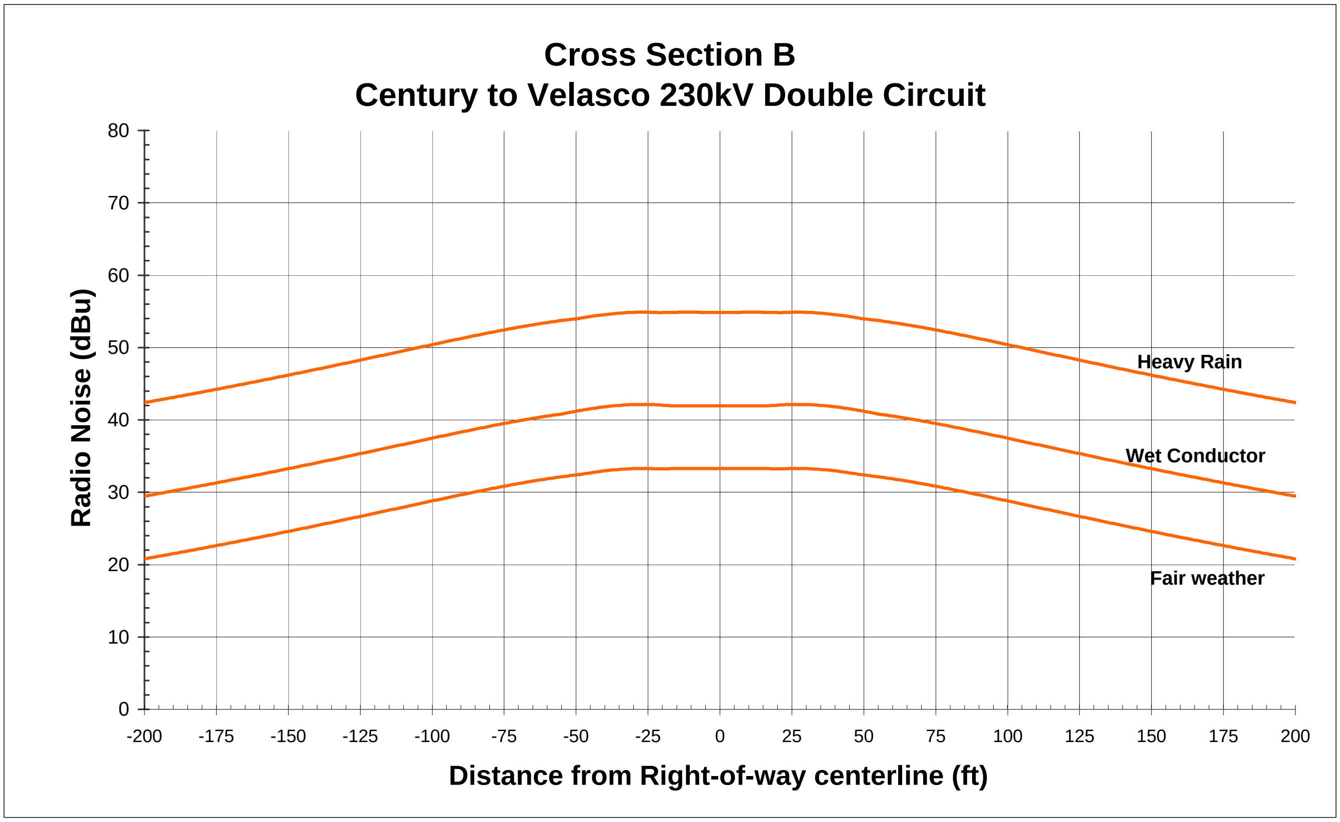
Vernon Power Plant

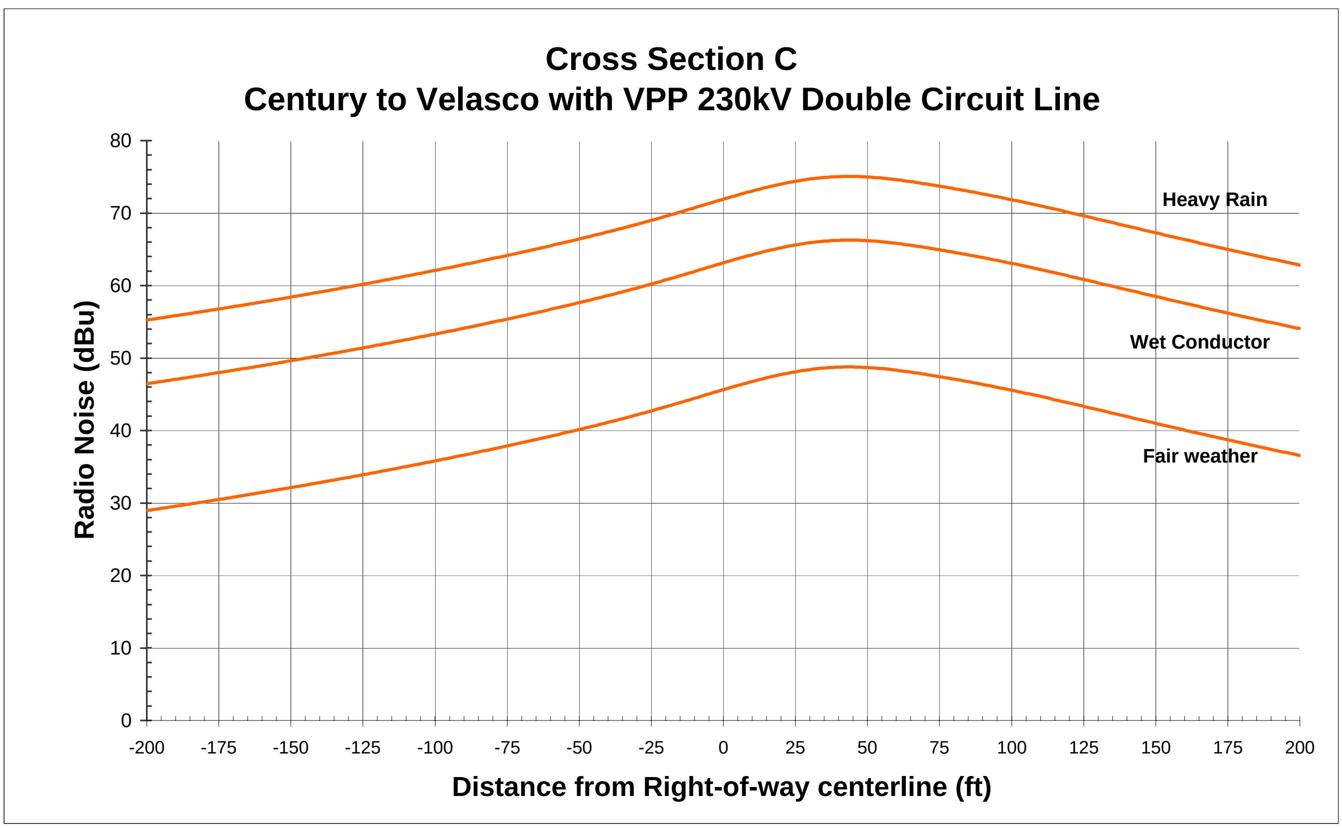
City of Vernon

Commonwealth Associates Inc.

Jackson, Michigan

engineers . consultants . construction managers





Cross Sections B & C

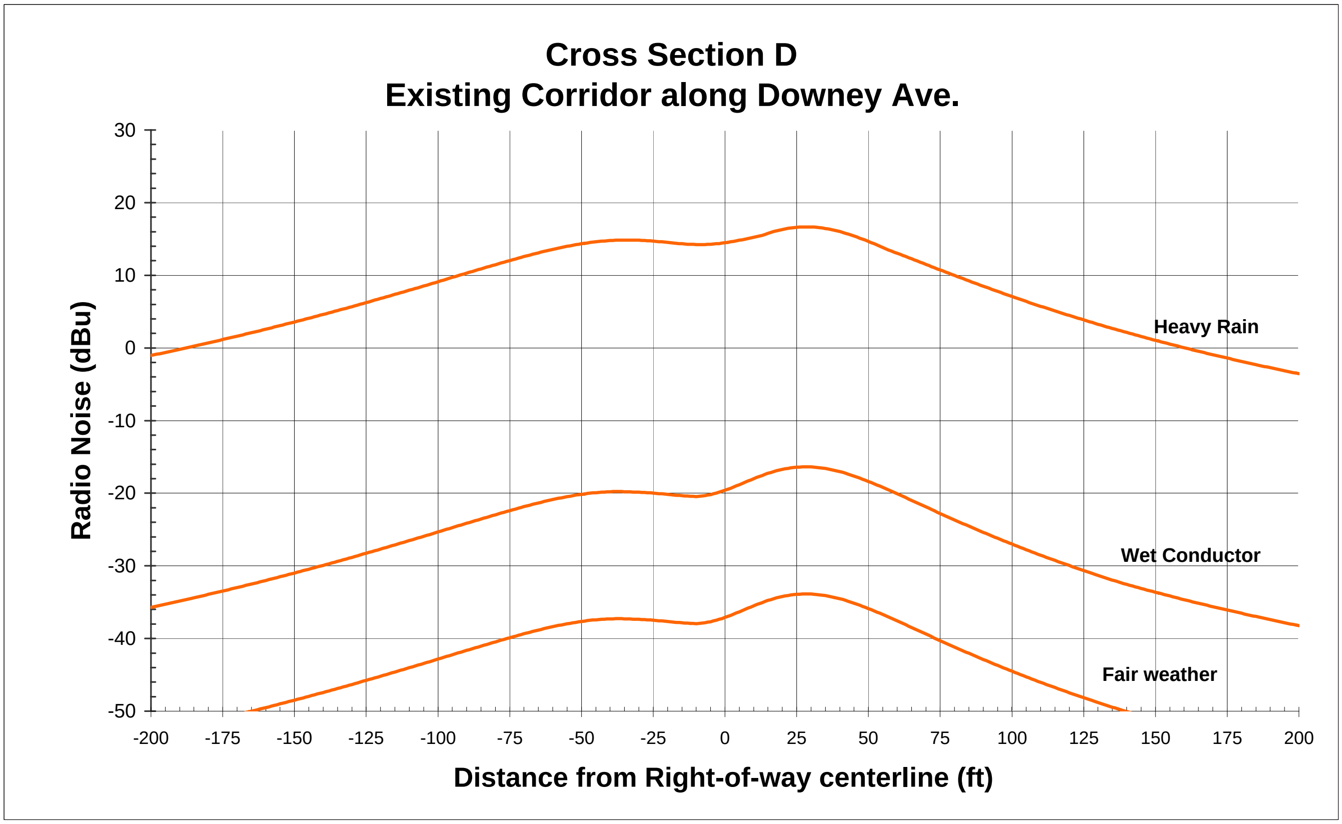
Figure 5.5-37

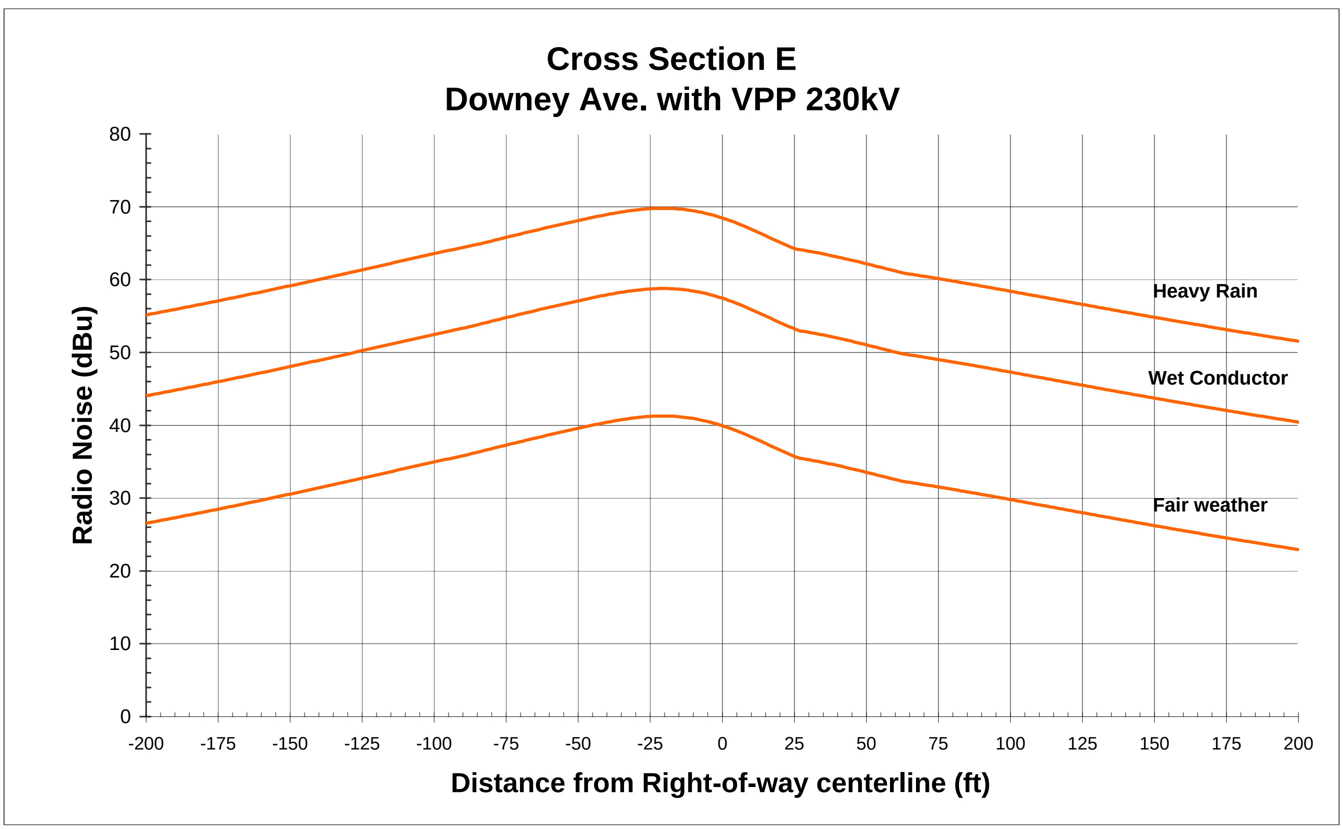
Radio Noise

Vernon Power Plant

City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections D & E | **Figure 5.5-38**

Radio Noise
Vernon Power Plant
City of Vernon

CAI Commonwealth Associates Inc.
Jackson, Michigan
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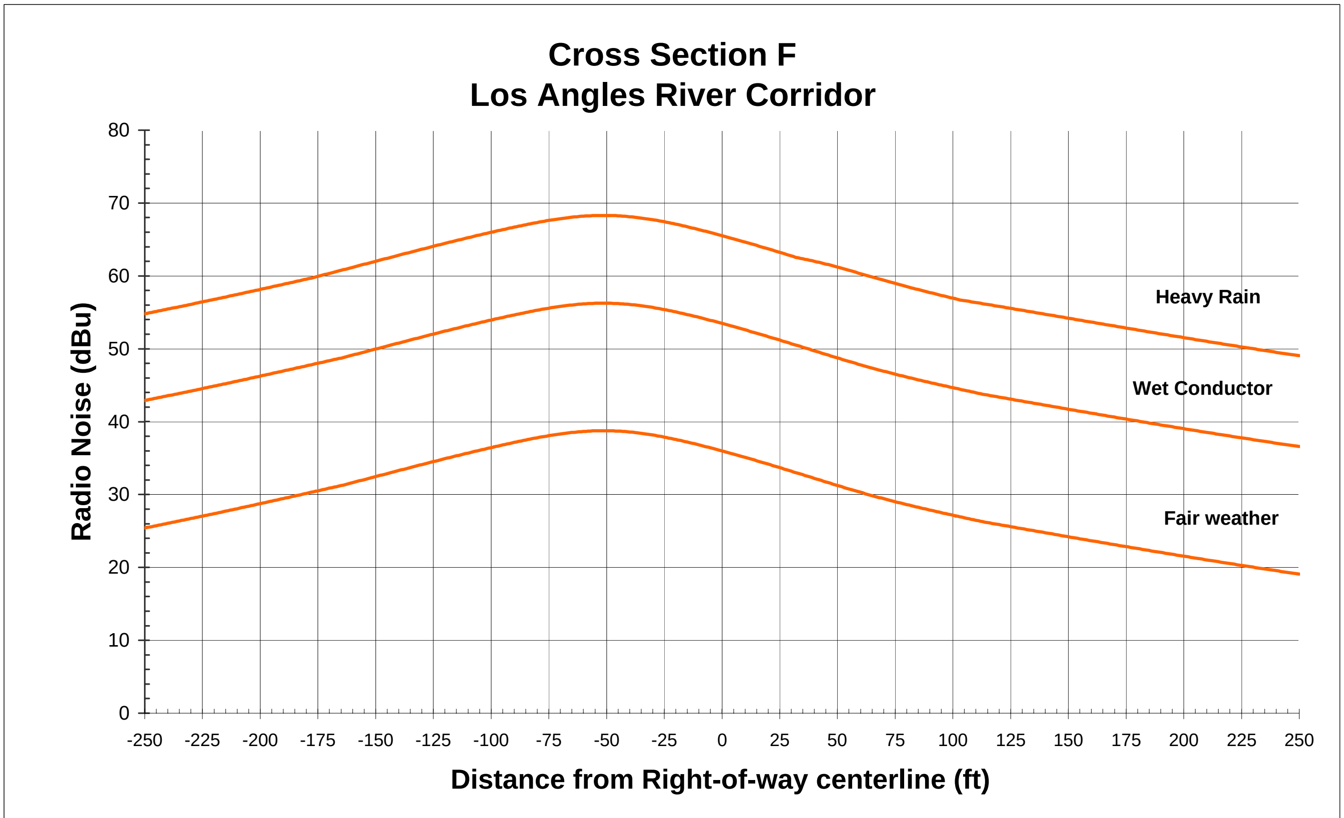
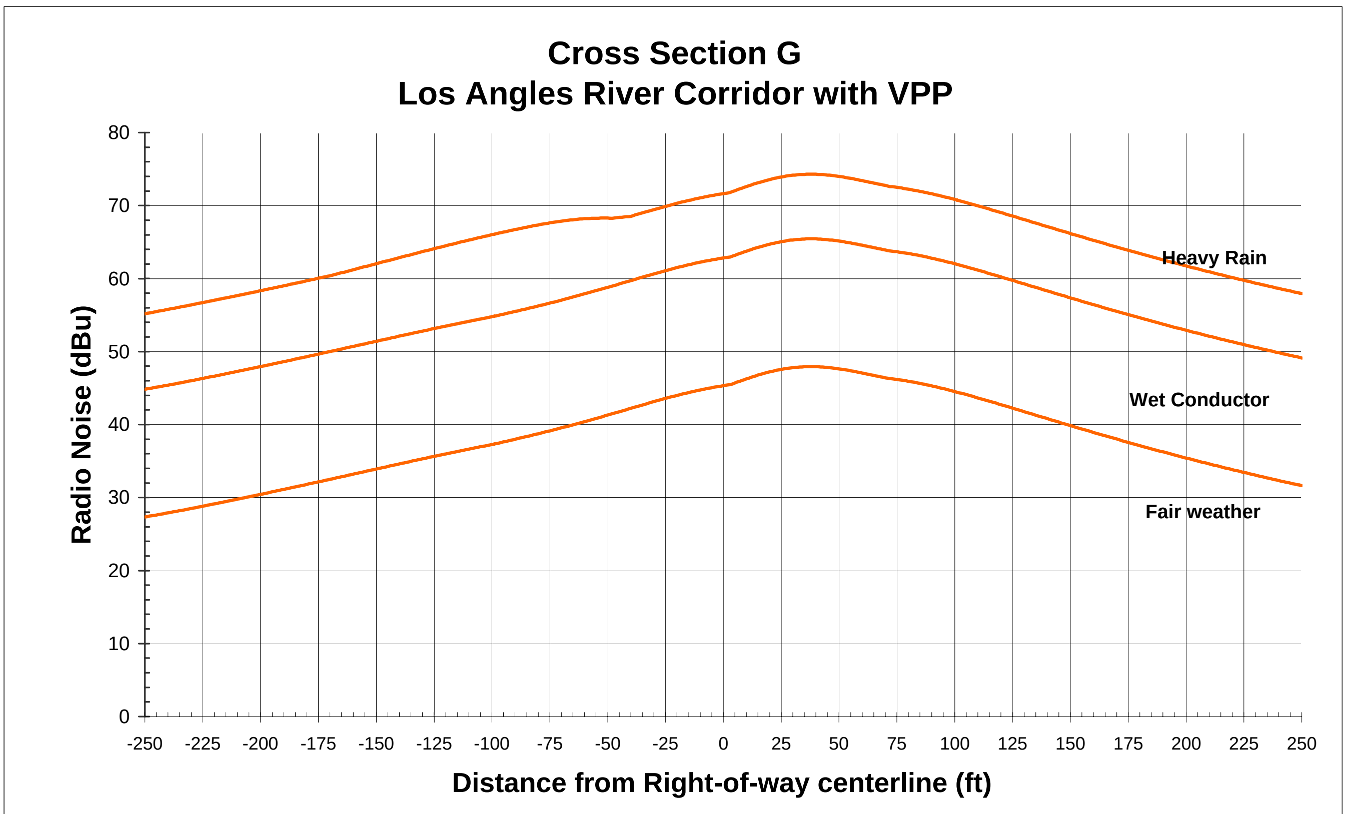


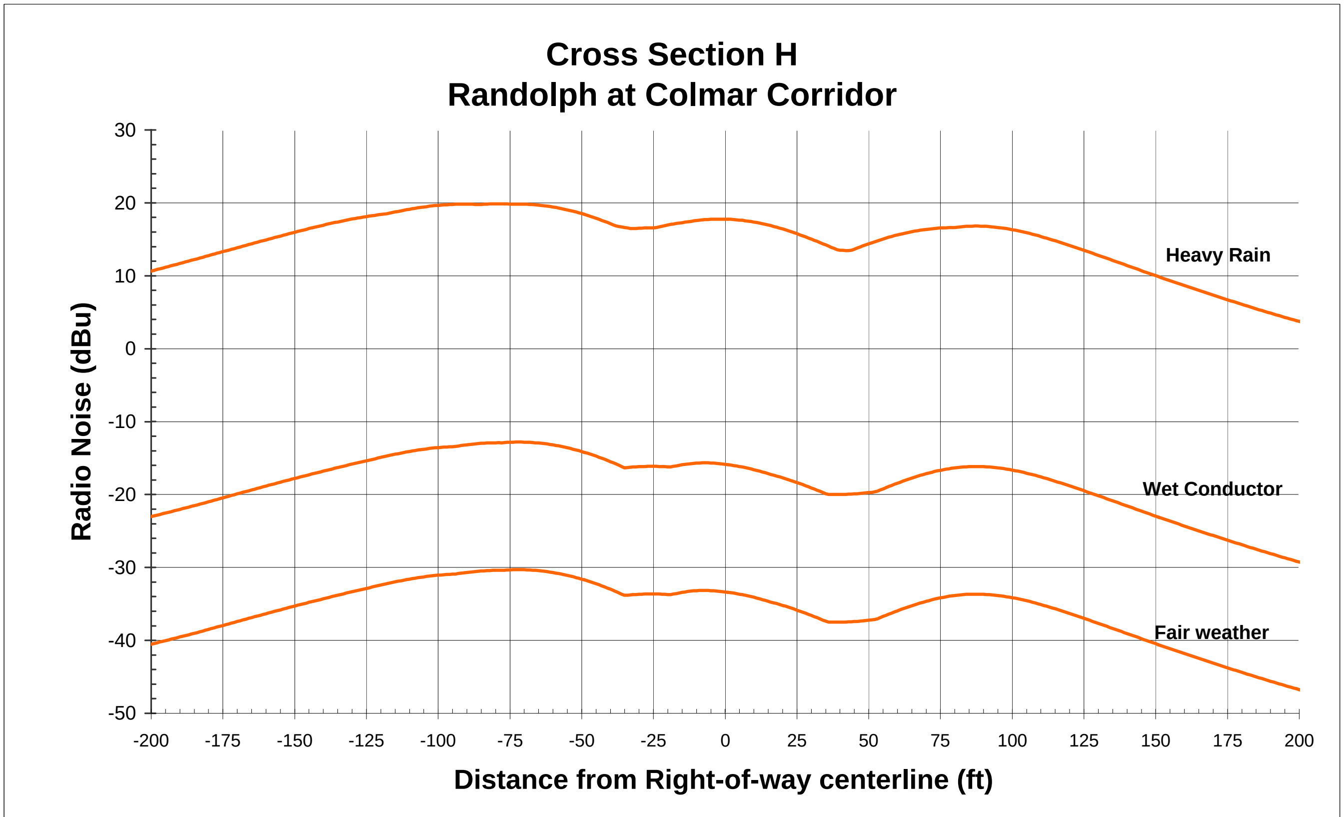


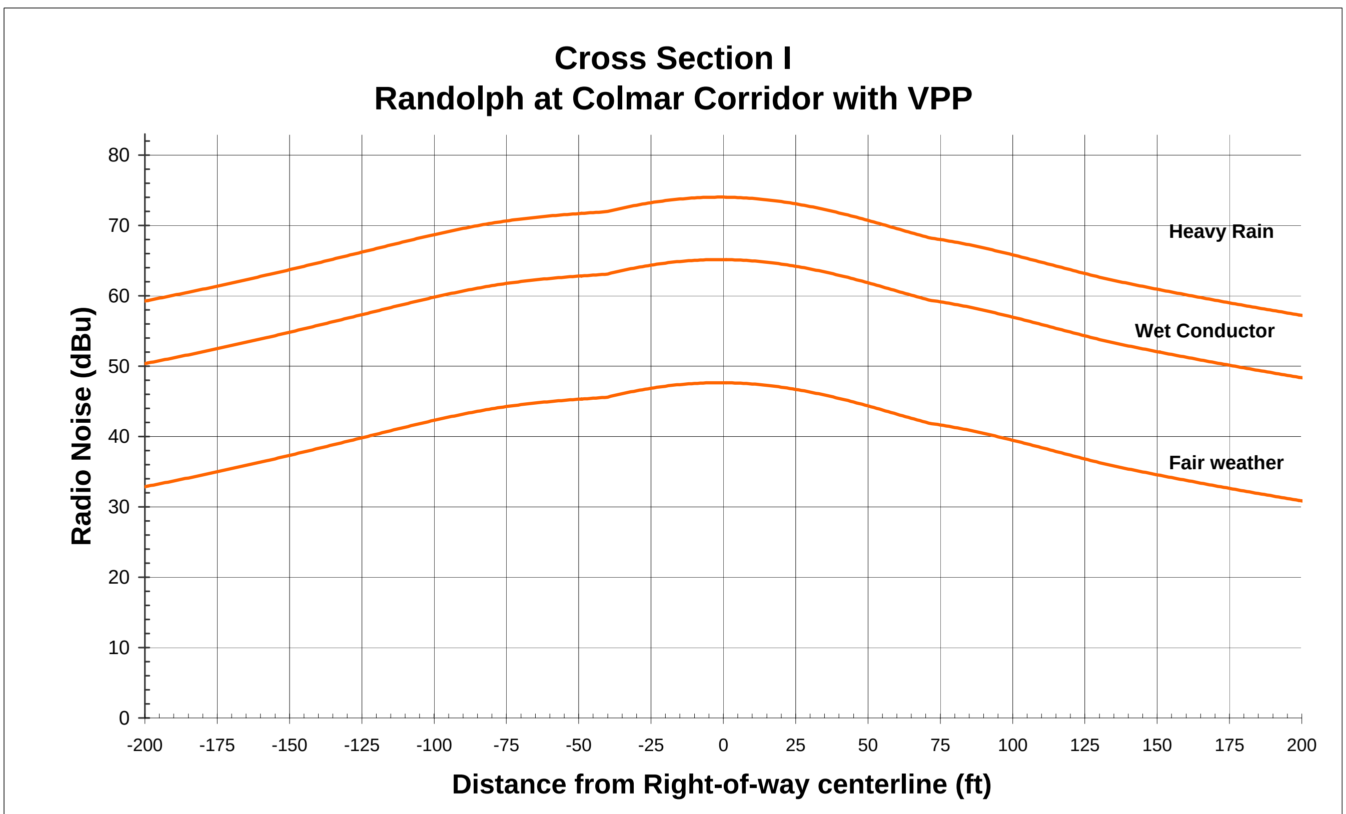
Cross Sections F & G

Figure 5.5-39

Radio Noise
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers



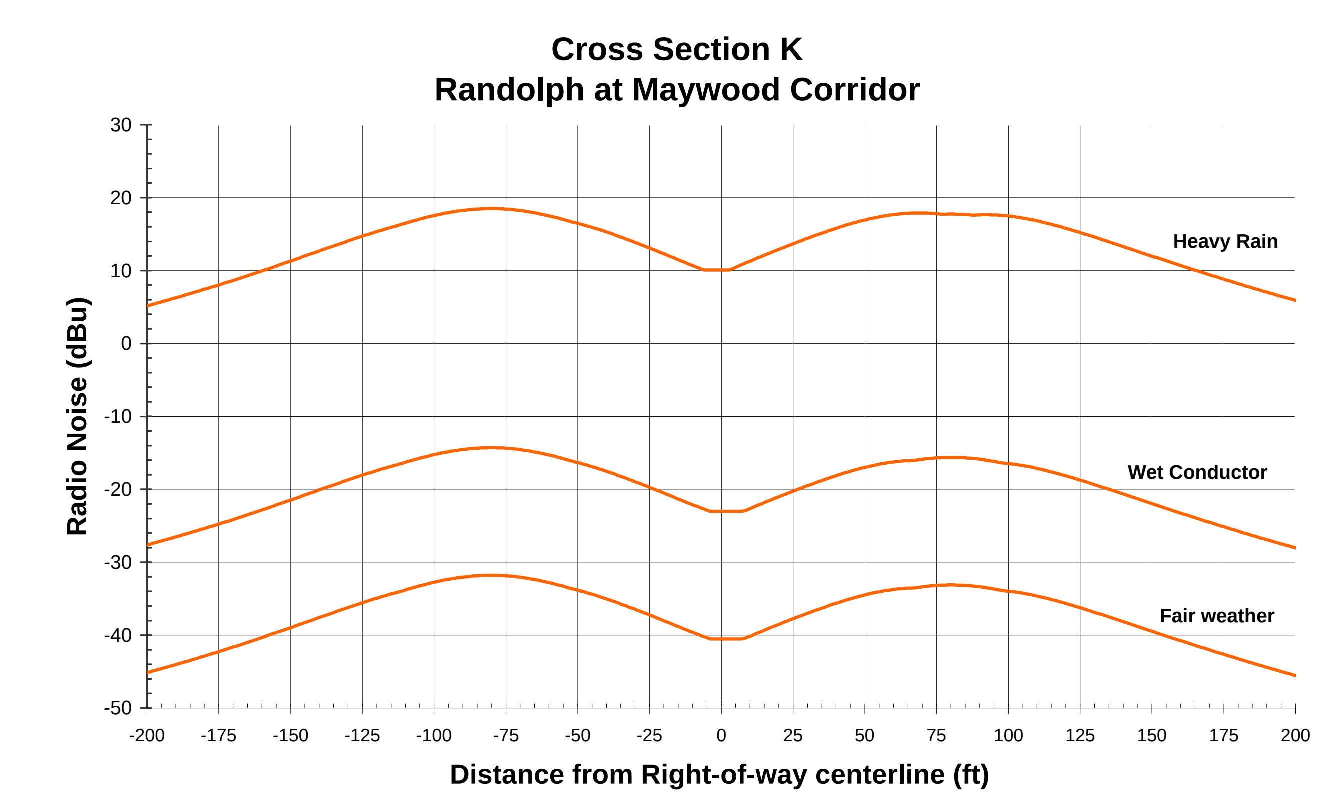


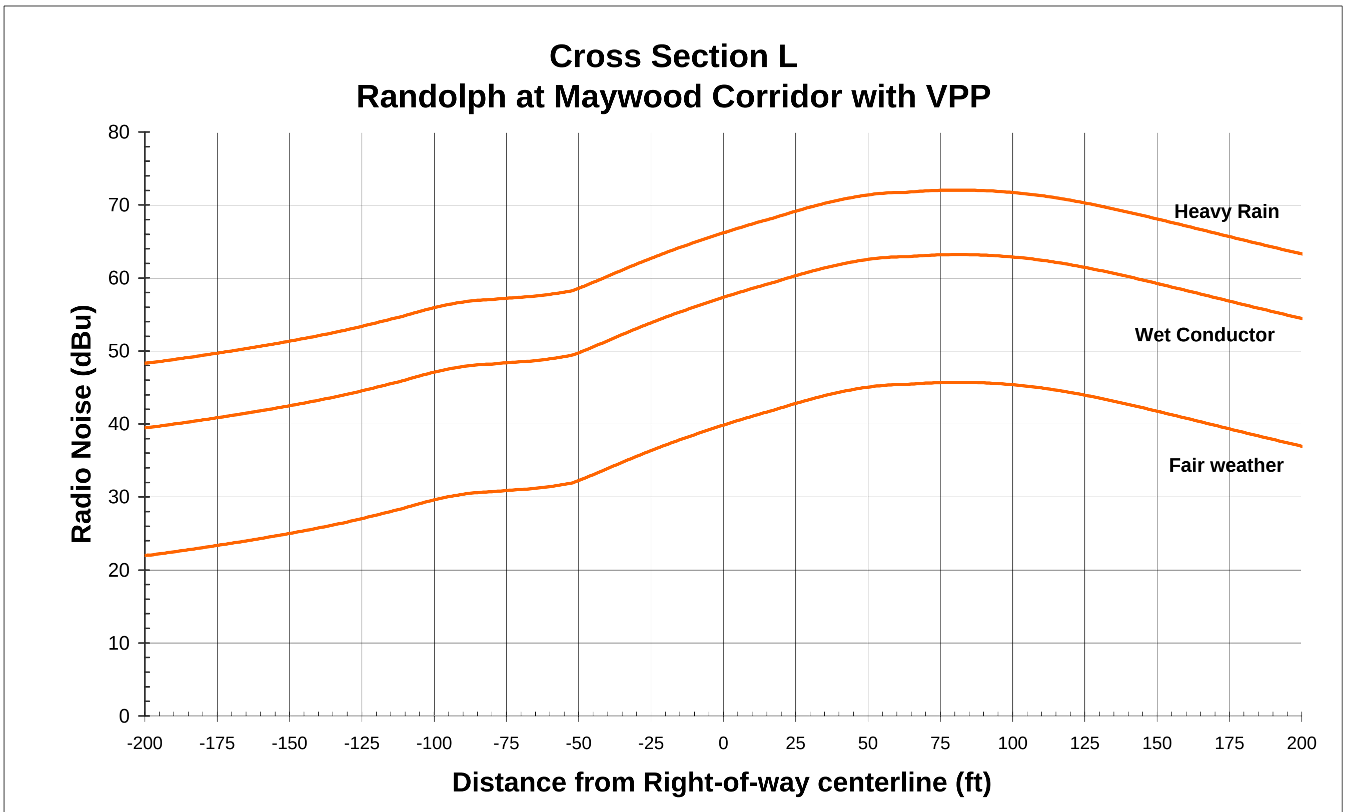
Cross Sections H & I

Figure 5.5-40

Radio Noise
Vernon Power Plant
City of Vernon

Commonwealth Associates Inc.
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections K & L

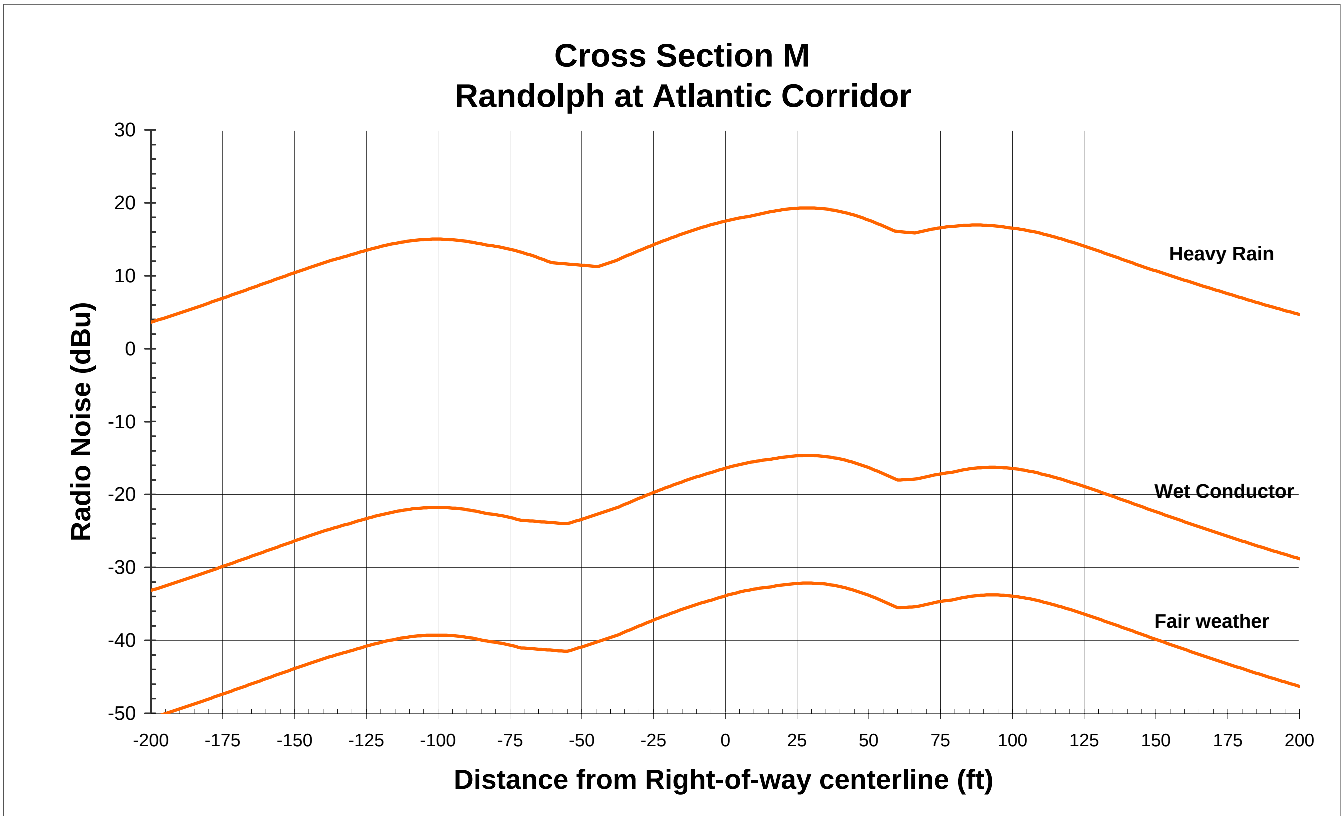
Figure 5.5-41

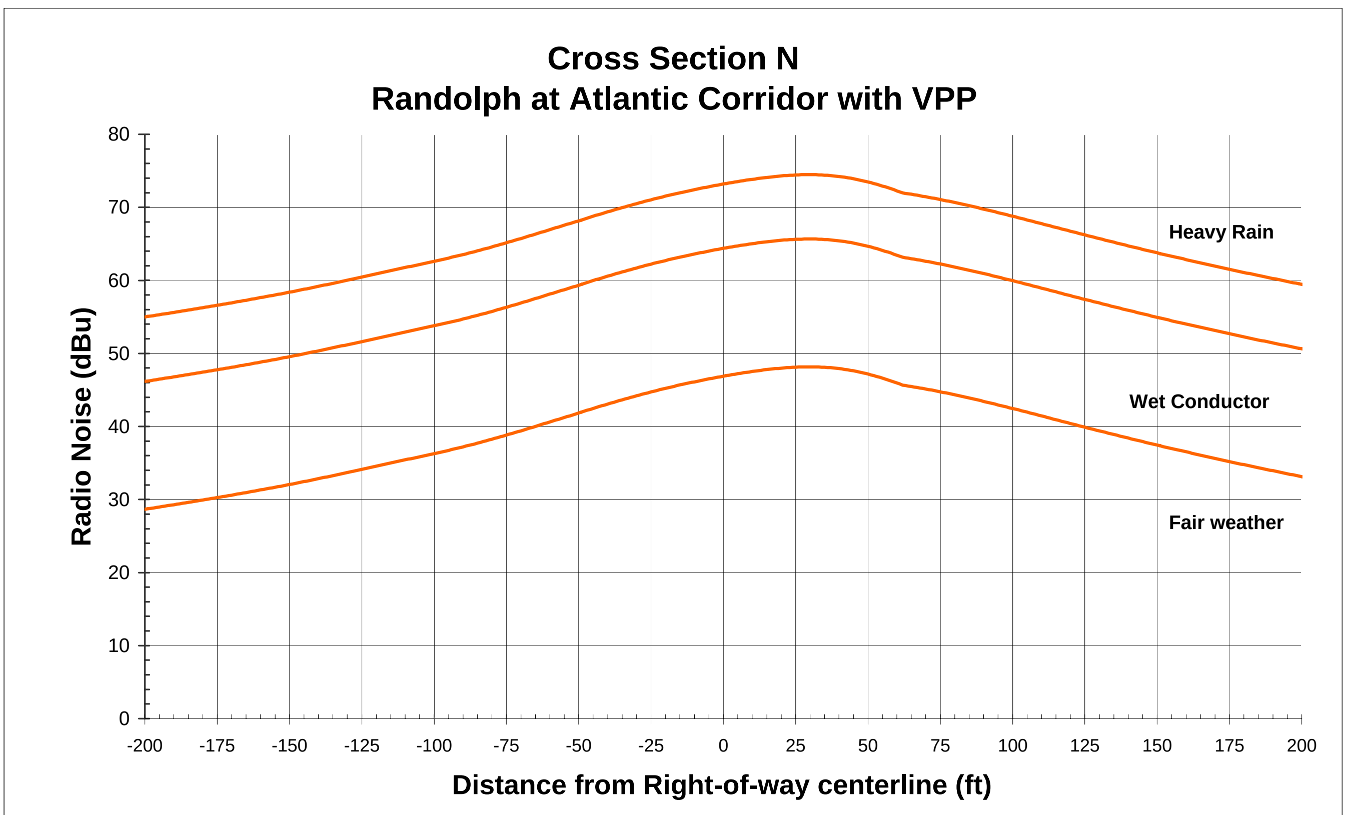
Radio Noise

Vernon Power Plant

City of Vernon

CAI **Commonwealth Associates Inc.**
Jackson, Michigan
engineers . consultants . construction managers





Cross Sections M & N **Figure 5.5-42**

Radio Noise

Vernon Power Plant

City of Vernon

Commonwealth Associates Inc.

Jackson, Michigan

engineers . consultants . construction managers