Appendix B
Electric and Magnetic Fields

ESA

Appendix B Section 1
Electric and Magnetic Fields Summary

ESA

Electric and Magnetic Fields

The California Public Utilities Commission (CPUC) and the California Department of Health Services (CDHS) have not concluded that exposure to magnetic fields from utility electric facilities is a health hazard. Many reports have concluded that the potential for health effects associated with electric and magnetic field (EMF) exposure is too speculative to allow the evaluation of impacts or the preparation of mitigation measures. EMF is a term used to describe electric and magnetic fields that are created by electric voltage (electric field) and electric current (magnetic field). Power frequency EMF is a natural consequence of electrical circuits, and can be either directly measured using the appropriate measuring instruments or calculated using appropriate information. EMF are present wherever electricity flows: around appliances and power lines, in offices, schools, and homes. Electric fields are invisible lines of force, created by voltage, and are shielded by most materials. Units of measure are volts per meter (V/m). Magnetic fields are invisible lines of force, created by electric current and are not shielded by most materials, such as lead, soil and concrete. Units of measure are Gauss (G) or milliGauss (mG, 1 1,000 of a Gauss). Electric and magnetic field strengths diminish with distance. These fields are low energy, extremely low frequency fields, and should not be confused with high energy or ionizing radiation such as X-rays and gamma rays.

Possible Health Effects

The possible effects of EMF on human health have come under scientific scrutiny. Concern about EMF originally focused on electric fields; however, much of the recent research has focused on magnetic fields. Uncertainty exists as to what characteristics of magnetic field exposure need to be considered to assess human exposure effects. Among the characteristics considered are field intensity, transients, harmonics, and changes in intensity over time. These characteristics may vary from power lines to appliances to home wiring, and this may create different types of exposures. The exposure most often considered is intensity or magnitude of the field. There is a consensus among the medical and scientific communities that there is insufficient evidence to conclude that EMF causes adverse health effects. Neither the medical nor scientific communities have been able to provide any foundation upon which regulatory bodies could establish a standard or level of exposure that is known to be either safe or harmful. Laboratory experiments have shown that magnetic fields can cause biologic changes in living cells, but scientists are not sure whether any risk to human health can be associated with them. Some studies have suggested an association between surrogate measures of magnetic fields and certain cancers while others have not.

California Public Utilities Commission Summary

<u>Background</u> – On January 15, 1991, the CPUC initiated an investigation to consider its role in mitigating the health effects, if any, of electric and magnetic fields from utility facilities and power lines. A working group of interested parties, called the California EMF Consensus Group, was created by the CPUC to advise it on this issue. It consisted of 17 stakeholders representing citizens groups, consumer groups, environmental groups, state agencies, unions, and utilities. The Consensus Group was charged to 1) consider a balanced set of facts and concerns; 2) define near- term research objectives; and 3)

develop interim policies and procedures to guide the electric utilities in educating their customers, reducing EMF, and responding to potential health concerns. The Consensus Group's fact-finding process was open to the public, and its report incorporated concerns expressed by the public. Its recommendations were filed with the Commission in March of 1992. In August of 2004, the CPUC opened an Order Instituting Rulemaking to update the Commission's policies and procedures related to electric and magnetic fields emanating from regulated utility facilities. The final decision was issued in D.06-01-042.

Findings – Based on the work of the Consensus Group, written testimony, and evidentiary hearings, the CPUC issued its decision (D.06-01-042) to address public concern about possible EMF health effects from electric utility facilities. The conclusions and findings included the following:

- The body of scientific evidence continues to evolve. However, it is recognized that public concern and scientific uncertainty remain regarding the potential health effects of EMF exposure.

- It is not appropriate to adopt any specific numerical standard in association with EMF until we have a firm scientific basis for adopting any particular value.

Interim Policies – The CPUC's decision specifically requires seven measures. One of these measures that is involved with the Project is as follows:

- No-cost and low-cost steps to reduce EMF. In response to a situation of scientific uncertainty and public concern, the CPUC felt it appropriate for utilities to take no-cost and low-cost measures where feasible to reduce exposure from new or upgraded utility facilities. It directs that no-cost mitigation measures be undertaken, and that low-cost options be implemented through the Project certification process. Four percent of total Project budgeted cost is the benchmark in developing EMF mitigation guidelines, and mitigation measures should achieve some noticeable reductions.

The CPUC will continue to monitor these issues. If new information develops in the future, the CPUC may amend its decision to reflect new scientific evidence.

Exemption Criteria – The CPUC agreed that "Utility management should have reasonable latitude to deviate and modify their guidelines as conditions warrant and as new EMF information is received. However, if the EMF guidelines are to be truly used as guidelines, the utilities should incorporate criteria which justify exempting specific types of projects from the guidelines."

Utilities may use the following guidelines to determine those specific types of projects that will be exempt from no/low cost field reduction:

1. Operation, repair, maintenance replacement or minor alteration of existing structures: facilities or equipment.

2. Restoration or rehabilitation of deteriorated or damaged structures, facilities or equipment to meet current standards of public safety.

3. Addition of safety devices.

4. Replacement or reconstruction of existing structures and facilities on the same site and for the same purpose as the replaced structure or facility.

5. Emergency restoration projects.

6. Re-conductoring projects except when structures are reframed or reconfigured.

7. Projects located on land under the jurisdiction of the Forest Service, Bureau of Land Management or other governmental agency.

8. Privately owned tree farms.

9. Agricultural land within the Williamson Act.

10. Areas not suited to residential/commercial development. Such areas might include steep slopes, areas subject to flooding or areas without access to public facilities.

The intent of the exemption criteria is to exclude two types of projects. The first type of projects are those that either replace or make minor additions or modifications to existing facilities. This will include pole replacements or relocations less than 2,000 feet in length. Those projects where more than 2,000 feet of line is relocated or reconstructed or where the circuit is reinsulated or reconfigured should be considered for low cost magnetic field management techniques.

The second type projects are those located in undeveloped areas.

<u>EMF Reduction</u> – Utilities must use the following Guidelines in the application of no and low cost steps to reduce magnetic field strengths:

1. Take low cost steps to reduce fields from new and upgraded facilities in accordance with CPUC decision D.06-01-042 on EMF.

2. No cost measures will be implemented when available and practical.

3. Mitigation measures should not compromise the reliability, operation, safety or maintenance of the system.

4. Total cost of mitigation measures should not exceed 4 percent of the total cost of the Project.

5. Mitigation measures should have a noticeable reduction in the magnetic field level approximately 15 percent or more.

In accordance with the EMF Design Guidelines, filed with the CPUC in compliance with CPUC Decisions 93-11-013 and 06-01-042, the Proposed Project would implement the following "no-cost and low-cost" magnetic field reduction measures. The field reduction measures would include:

For the 220 kV Transmission Line Alignment (first 1.1 miles north of Rector Substation, existing ROW)

- Using a double circuit pole-head configuration for the proposed 220 kV lines.
- Using poles which are 10 feet taller where homes are immediately adjacent to the edges of the ROW; and
- Implementing phasing arrangements to reduce magnetic field levels at edge(s) of ROW. Recommended phasing arrangements are as follows:
  - Big Creek 3-Rector No 1 220 kV : A-C-B (top to bottom)
  - Big Creek 1 – Rector 220 kV : B-C-A (top to bottom)
  - Big Creek 3 – Rector No. 2 220 kV – B-A-C (top to bottom)
  - Rector-Springville 220kV : C-A-B (top to bottom)

For the 220 kV Transmission Line Alignment (17.4 miles of new ROW)

- Using a double circuit pole-head configuration for the proposed 220 kV transmission lines.
- Using poles which are 10 feet taller where homes are immediately adjacent to the edges of the ROW.
- Implementing phasing arrangements to reduce magnetic field levels at edges of ROW. Recommended phasing arrangements are as follows:
  - Big Creek 3-Rector No. 2 220 kV : B-A-C (top-to-bottom)
  - Rector-Springville 220 kV : C-A-B (top-to-bottom)

The field reduction measures identified above would also be applicable to Alternatives 2, 3, and 6. For portions of the line routes for Alternatives 2, 3, and 6 that would travel north on existing ROW from the Rector Substation, the field reduction measures presented above for the first 1.1 miles north of Rector Substation (existing ROW) would apply. For portions of the line routes for Alternatives 2, 3, and 6 that travel eastward on new ROW, the field reduction measures presented above for the 17.4 miles of new ROW would apply. Should one of the alternatives be approved, a revised Field Management Plan would be prepared once final engineering has occurred to fully implement the CPUC's EMF policy.

Appendix B Section 2

Electric and Magnetic Fields Field Management Plan for the Proposed Project

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I. EXECUTIVE SUMMARY

This document is Southern California Edison Company's (SCE) Field Management Plan (FMP) for the Proposed San Joaquin Cross Valley Loop Project (Proposed Project).

Tulare County is one of the fastest growing regions in California. This increased growth has resulted in an increased demand for electricity. SCE has determined that the existing transmission lines, which deliver electricity to Rector Substation located southeast of Visalia, are operating at or near their limits and will be unable to deliver sufficient electricity to safely and reliably serve this increased demand. As a result, SCE is proposing to construct the San Joaquin Cross Valley Loop Project, which consists of the construction of a new 19 mile double-circuit 220 kilovolt (kV) transmission line. This line would connect to an existing 220 kV transmission line, which would allow SCE to deliver additional power from SCE's Big Creek hydroelectric facilities in the Sierra Nevada Mountains into Rector Substation. The proposed transmission line route is approximately 19 miles long. The Proposed Route would begin at Rector Substation and proceed north for one mile within SCE's existing right-of-way. SCE proposes to replace two existing single-circuit 220 kV transmission lines, currently side by side in the right-of-way, with one double-circuit 220 kV transmission line. This would create sufficient space in the right-of-way to accommodate construction of the first mile of the new double-circuit 220 kV transmission line. The remaining 18 miles of the proposed transmission line would be constructed within a new 100-foot wide right-of-way to be acquired by SCE and would run east until the line intersects with the Big Creek 3 – Springville 220 kV transmission line located east of Lemon Cove and Highway 198. The Proposed Project is scheduled to be operational by mid-2011.

SCE provides this FMP in order to inform the public, the California Public Utilities Commission (CPUC), and other interested parties of its evaluation of "no-cost and low-cost" magnetic field reduction measures for this project, and SCE's proposed plan to apply these measures to this project. This FMP has been prepared in accordance with CPUC Decision No.

93-11-013 and Decision No. 06-01-042 relating to extremely low frequency[2] electric and magnetic fields (EMF). This FMP also provides background on the current status of scientific research related to possible health effects of EMF, and a description of the CPUC's EMF policy.

The "no-cost and low-cost" magnetic field reduction measures that are incorporated into the design of the Proposed Project are:

- Using a "double-circuit" pole-head configuration for the proposed 220 kV transmission lines;
- Using 10 ft taller poles for homes located immediately adjacent to the edges of right-of-way (ROW); and
- Implementing phasing arrangements of 220 kV transmission lines to reduce magnetic field levels at edges of ROW

SCE's plan for applying the above "no-cost and low-cost" magnetic field reduction measures for the Proposed Project is consistent with CPUC's EMF policy and with the direction of leading national and international health agencies. Furthermore, the plan complies with SCE's EMF Design Guidelines[3], and with applicable national and state safety standards for new electric facilities.

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[2] The extreme low frequency is defined as the frequency range from 3 Hz to 3,000 Hz.

[3] EMF Design Guidelines, August 2006.

II. BACKGROUND REGARDING EMF AND PUBLIC HEALTH RESEARCH ON EMF

There are many sources of power frequency[4] electric and magnetic fields, including internal household and building wiring, electrical appliances, and electric power transmission and distribution lines. There have been numerous scientific studies about the potential health effects of EMF. After many years of research, the scientific community has been unable to determine if exposures to EMF cause health hazards. State and federal public health regulatory agencies have determined that setting numeric exposure limits is not appropriate.[5]

Many of the questions about possible connections between EMF exposures and specific diseases have been successfully resolved due to an aggressive international research program. However, potentially important public health questions remain about whether there is a link between EMF exposures and certain diseases, including childhood leukemia and a variety of adult diseases (e.g., adult cancers and miscarriages). As a result, some health authorities have identified magnetic field exposures as a possible human carcinogen. As summarized in greater detail below, these conclusions are consistent with the following published reports: the National Institute of Environmental Health Sciences (NIEHS) 1999[6], the National Radiation Protection Board (NRPB) 2001[7], the International Commission on non-Ionizing Radiation Protection (ICNIRP) 2001, the California Department of Health Services (CDHS) 2002[8], and the International Agency for Research on Cancer (IARC) 2002[9].

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4 In U.S., it is 60 Hertz (Hz).

5 CPUC Decision 06-01-042, p. 6, footnote 10

6 National Institute of Environmental Health Sciences' Report on Health Effects from Exposures to Power-Line frequency Electric and Magnetic Fields, NIH Publication No. 99-4493, June 1999.

7 National Radiological Protection Board, Electromagnetic Fields and the Risk of Cancer, Report of an Advisory Group on Non-ionizing Radiation, Chilton, U.K. 2001

8 California Department of Health Services, An Evaluation of the Possible Risks from Electric and Magnetic Fields from Power Lines, Internal Wiring, Electrical Occupations, and Appliances, June 2002.

9 World Health Organization / International Agency for Research on Cancer, IARC Monographs on the evaluation of carcinogenic risks to humans (2002), Non-ionizing radiation, Part 1: Static and extremely low-frequency (ELF) electric and magnetic fields, IARCPress, Lyon, France: International Agency for Research on Cancer, Monograph, vol. 80, p. 338, 2002

The federal government conducted EMF research as a part of a $45-million research program managed by the NIEHS. This program, known as the EMF RAPID (Research and Public Information Dissemination), submitted its final report to the U.S. Congress on June 15, 1999. The report concluded that:

- "The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak."[10]
- "The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard."[11]
- "The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards."[12]

In 2001, Britain's NRPB arrived at a similar conclusion:

> "After a wide-ranging and thorough review of scientific research, an independent Advisory Group to the Board of NRPB has concluded that the power frequency electromagnetic fields that exist in the vast majority of homes are not a cause of cancer in general. However, some epidemiological studies do indicate a possible small risk of childhood leukemia associated with exposures to unusually high levels of power frequency magnetic fields."[13]

In 2002, three scientists for CDHS concluded:

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[10] National Institute of Environmental Health Sciences, NIEHS Report on Health Effects from Exposures to Power-Frequency Electric and Magnetic Fields, p. ii, NIH Publication No. 99-4493, 1999

[11] *ibid.*, p. iii

[12] *ibid.*, p. 37 - 38

[13] NRPB, NRPB Advisory Group on Non-ionizing Radiation Power Frequency Electromagnetic Fields and the Risk of Cancer, NRPB Press Release May 2001

> "To one degree or another, all three of the [C]DHS scientists are inclined to believe that EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease, and miscarriage.
>
> They [CDHS] strongly believe that EMFs do not increase the risk of birth defects, or low birth weight.
>
> They [CDHS] strongly believe that EMFs are not universal carcinogens, since there are a number of cancer types that are not associated with EMF exposure.
>
> To one degree or another they [CDHS] are inclined to believe that EMFs do not cause an increased risk of breast cancer, heart disease, Alzheimer's disease, depression, or symptoms attributed by some to a sensitivity to EMFs. However, all three scientists had judgments that were "close to the dividing line between believing and not believing" that EMFs cause some degree of increased risk of suicide, or
>
> For adult leukemia, two of the scientists are 'close to the dividing line between believing or not believing' and one was 'prone to believe' that EMFs cause some degree of increased risk."[14]

Also in 2002, the World Health Organization's (WHO) IARC concluded:

> "ELF magnetic fields are possibly carcinogenic to humans"[15], based on consistent statistical associations of high-level residential magnetic fields with a doubling of risk of childhood leukemia...Children who are exposed to residential ELF magnetic fields less than 0.4 microTesla (4.0 milliGauss) have no increased risk for leukemia…. In contrast, "no consistent relationship has been seen in studies of childhood brain tumors or cancers at other sites and residential ELF electric and magnetic fields."[16]

In June of 2007, the WHO issued a report on their multi-year investigation of EMF and the possible health effects. After reviewing scientific data from numerous EMF and human health studies, they concluded:

> "Scientific evidence suggesting that everyday, chronic low-intensity (above 0.3-0.4 μT [3-4 mG]) power-frequency magnetic

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[14] CDHS, An Evaluation of the Possible Risks From Electric and Magnetic Fields (EMFs) From Power Lines, Internal Wiring, Electrical Occupations and Appliances, p. 3, 2002

[15] IARC, Monographs, Part I, Vol. 80, p. 338

[16] *ibid*., p. 332 - 334

> field exposure poses a health risk is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukaemia."[17]
>
> "In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern."[18]
>
> "A number of other diseases have been investigated for possible association with ELF magnetic field exposure. These include cancers in both children and adults, depression, suicide, reproductive dysfunction, developmental disorders, immunological modifications and neurological disease. The scientific evidence supporting a linkage between ELF magnetic fields and any of these diseases is much weaker than for childhood leukaemia and in some cases (for example, for cardiovascular disease or breast cancer) the evidence is sufficient to give confidence that magnetic fields do not cause the disease"[19]
>
> "Furthermore, given both the weakness of the evidence for a link between exposure to ELF magnetic fields and childhood leukaemia, and the limited impact on public health if there is a link, the benefits of exposure reduction on health are unclear. Thus the costs of precautionary measures should be very low."[20]

III. APPLICATION OF THE CPUC'S "NO-COST AND LOW-COST" EMF POLICY TO THIS PROJECT

Recognizing the scientific uncertainty over the connection between EMF exposures and health effects, the CPUC adopted a policy that addresses public concern over EMF with a combination of education, information, and precaution-based approaches. Specifically, Decision 93-11-013 established a precautionary based "no-cost and low-cost" EMF policy for California's regulated electric utilities based on recognition that scientific research had not demonstrated that

[17] WHO, Environmental Health Criteria 238, EXTREMELY LOW FREQUENCY FIELDS, p. 11 - 12, 2007

[18] *ibid*., p. 12

[19] *ibid*., p. 12

[20] *ibid*., p. 13

exposures to EMF cause health hazards and that it was inappropriate to set numeric standards that would limit exposure.

In 2006, the CPUC completed its review and update of its EMF Policy in Decision 06-01-042. This decision reaffirmed the finding that state and federal public health regulatory agencies have not established a direct link between exposure to EMF and human health effects,[21] and the policy direction that (1) use of numeric exposure limits was not appropriate in setting utility design guidelines to address EMF,[22] and (2) existing "no-cost and low-cost" precautionary-based EMF policy should be continued for proposed electrical facilities. The decision also reaffirmed that EMF concerns brought up during Certificate of Public Convenience and Necessity (CPCN) and Permit to Construct (PTC) proceedings for electric and transmission and substation facilities should be limited to the utility's compliance with the CPUC's "no-cost and low-cost" policies.[23]

The decision directed regulated utilities to hold a workshop to develop standard approaches for EMF Design Guidelines and such a workshop was held on February 21, 2006. Consistent design guidelines have been developed that describe the routine magnetic field reduction measures that regulated California electric utilities consider for new and upgraded transmission line and transmission substation projects. SCE filed its revised EMF Design Guidelines with the CPUC on July 26, 2006.

"No-cost and low-cost" measures to reduce magnetic fields would be implemented for this project in accordance with SCE's EMF Design Guidelines. In summary, the process of

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[21] CPUC Decision 06-01-042, Conclusion of Law No. 5, mimeo. p. 19 ("As discussed in the rulemaking, a direct link between exposure to EMF and human health effects has yet to be proven despite numerous studies including a study ordered by this Commission and conducted by DHS.").

[22] CPUC Decision 06-01-042, mimeo. p. 17 - 18 ("Furthermore, we do not request that utilities include non-routine mitigation measures, or other mitigation measures that are based on numeric values of EMF exposure, in revised design guidelines or apply mitigation measures to reconfigurations or relocations of less than 2,000 feet, the distance under which exemptions apply under GO 131-D. Non-routine mitigation measures should only be considered under unique circumstances.").

[23] CPUC Decision 06-01-042, Conclusion of Law No. 2, ("EMF concerns in future CPCN and PTC proceedings for electric and transmission and substation facilities should be limited to the utility's compliance with the Commission's low-cost/no-cost policies.").

evaluating "no-cost and low-cost" magnetic field reduction measures and prioritizing within and between land usage classes considers the following:

1. SCE's priority in the design of any electrical facility is public and employee safety. Without exception, design and construction of an electric power system must comply with all applicable federal, state, and local regulations, applicable safety codes, and each electric utility's construction standards. Furthermore, transmission and subtransmission lines and substations must be constructed so that they can operate reliably at their design capacity. Their design must be compatible with other facilities in the area and the cost to operate and maintain the facilities must be reasonable.

2. As a supplement to Step 1, SCE follows the CPUC's direction to undertake "no-cost and low-cost" magnetic field reduction measures for new and upgraded electrical facilities. Any proposed "no-cost and low-cost" magnetic field measures, must, however, meet the requirements described in Step 1 above. The CPUC defines "no-cost and low-cost" measures as follows:

   - Low-cost measures, in aggregate, should:
     - Cost in the range of 4 percent of the total project cost.
     - Result in magnetic field reductions of "15% or greater at the utility ROW [right-of-way]…"[24]

   The CPUC Decision stated,

   > "We direct the utilities to use 4 percent as a benchmark in developing their EMF mitigation guidelines. We will not establish 4 percent as an absolute cap at this time because we do not want to arbitrarily eliminate a potential measure that might be available but costs

[24] CPUC Decision 06-01-042, p. 10

more than the 4 percent figure. Conversely, the utilities are encouraged to use effective measures that cost less than 4 percent."[25]

3. The CPUC provided further policy direction in Decision 06-01-042, stating that, "[a]lthough equal mitigation for an entire class is a desirable goal, we will not limit the spending of EMF mitigation to zero on the basis that not all class members can benefit."[26] While Decision 06-01-042 directs the utilities to favor schools, day-care facilities and hospitals over residential areas when applying low-cost magnetic field reduction measures, prioritization within a class can be difficult on a project case-by-case basis because schools, day-care facilities, and hospitals are often integrated into residential areas, and many licensed day-care facilities are housed in private homes, and can be easily moved from one location to another. Therefore, it may be practical for public schools, licensed day-care centers, hospitals, and residential land uses to be grouped together to receive highest prioritization for low-cost magnetic field reduction measures. Commercial and industrial areas may be grouped as a second priority group, followed by recreational and agricultural areas as the third group. Low-cost magnetic field reduction measures will not be considered for undeveloped land, such as open space, state and national parks, and Bureau of Land Management and U.S. Forest Service lands. When spending for low-cost measures would otherwise disallow equitable magnetic field reduction for all areas within a single land-use class, prioritization can be achieved by considering location and/or density of permanently occupied structures on lands adjacent to the projects, as appropriate.

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[25] CPUC Decision 93-11-013, § 3.3.2, p.10.

[26] CPUC Decision 06-01-042, p. 10

This FMP contains descriptions of various magnetic field models and the calculated results of magnetic field levels based on those models. These calculated results are provided only for purposes of identifying the relative differences in magnetic field levels among various transmission or subtransmission line design alternatives under a specific set of modeling assumptions and determining whether particular design alternatives can achieve magnetic field level reductions of 15 percent or more. The calculated results are not intended to be predictors of the actual magnetic field levels at any given time or at any specific location if and when the project is constructed. This is because magnetic field levels depend upon a variety of variables, including load growth, customer electricity usage, and other factors beyond SCE's control. The CPUC affirmed this in D. 06-01-042 stating:

> "Our [CPUC] review of the modeling methodology provided in the utility [EMF] design guidelines indicates that it accomplishes its purpose, which is to measure the relative differences between alternative mitigation measures. Thus, the modeling indicates relative differences in magnetic field reductions between different transmission line construction methods, but does not measure actual environmental magnetic fields."[27]

IV. PROJECT DESCRIPTION

Tulare County is one of the fastest growing regions in California. This increased growth has resulted in an increased demand for electricity. SCE has determined that the existing transmission lines, which deliver electricity to Rector Substation located southeast of Visalia, are operating at or near their limits and will be unable to deliver sufficient electricity to safely and reliably serve this increased demand. As a result, SCE is proposing to construct the San Joaquin Cross Valley Loop Project, which consists of the construction of a new 19 mile double-circuit 220 kV transmission line. This line would connect to an existing 220 kV transmission line, which would allow SCE to deliver additional power from SCE's Big Creek hydroelectric facilities in the Sierra Nevada Mountains into Rector Substation.

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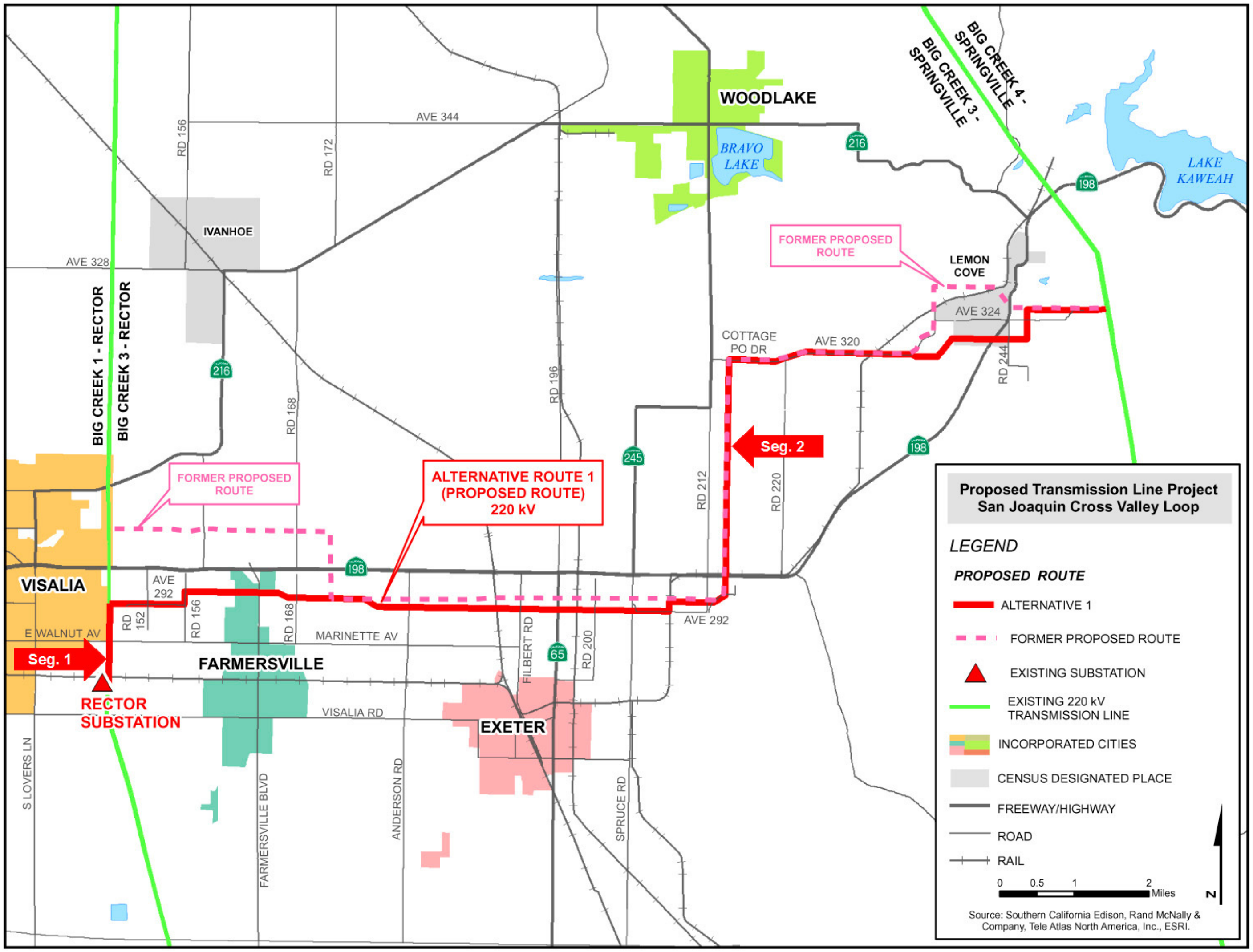
[27] CPUC Decision 06-01-042, p. 11

The proposed transmission line route (Proposed Route) is approximately 19 miles long. The Proposed Route would begin at Rector Substation and proceed north for one mile within SCE's existing right-of-way. SCE proposes to replace two existing single-circuit 220 kV transmission lines, currently side by side in the right-of-way, with one double-circuit 220 kV transmission line. This would create sufficient space in the right-of-way to accommodate construction of the first mile of the new double-circuit 220 kV transmission line (See Figure 2 on page 14). The remaining 18 miles of the proposed transmission line would be constructed within a new 100-foot wide right-of-way to be acquired by SCE and would run east until the line intersects with the Big Creek 3 – Springville 220 kV transmission line located east of Lemon Cove and Highway 198 (See Figure 4 on page 17).

Figure 1 below shows the overall project areas.

Figure 1. Project Area and Proposed Routes[28]



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[28] The "Alternative 1" route in this figure is the Proposed Route.

Currently, there are no schools along the Proposed Route as shown on Figure 1 above. The Proposed Route runs adjacent to residential areas for the first 1.1 miles and adjacent to few scattered homes in mainly agricultural areas for the remainder of the route.

V. EVALUATION OF "NO-COST AND LOW-COST" MAGNETIC FIELD REDUCTION MEASURES

For the purpose of evaluating "no-cost and low-cost" magnetic field reduction design options, the Proposed Project is divided into three parts:

1. Part 1: 220 kV Transmission Line Route Segment 1 (Segment 1)
2. Part 2:: 220 kV Transmission Line Route Segment 2 (Segment 2)
3. Part 3: Rector Substation Modifications

Following magnetic field models and the calculated results of magnetic field levels are intended only for purposes of identifying the relative differences in magnetic field levels among various transmission line design alternatives under a specific set of modeling assumptions (see §VII-Appendix A for more detailed information about the calculation assumptions and loading conditions) and determining whether particular transmission design alternatives can achieve magnetic field level reductions of 15 percent or more. The calculated results are not intended to be predictors of the actual magnetic field levels at any given time or at any specific location when the project is constructed.

Part 1: 220 kV Transmission Line Route Segment 1 (Segment 1)

The Segment 1 consists of 1) replacing approximately 1.1 miles of two sets of single circuit 220 kV transmission towers with a single set of double circuit structures immediately north of SCE's existing Rector Substation and 2) constructing the first 1.1 miles of a new double circuit 220 kV transmission line that would loop the existing Big Creek 3-Springville 220 kV transmission line into the 220 kV Rector Substation, creating the new Big Creek 3-Rector No. 2 220 kV transmission line and the new Rector-Springville 220 kV transmission line.

Figure 2 below shows the existing vs. proposed 220 kV transmission designs (Proposed 220 kV Design) for Segment 1. Typical tower dimensions are shown on § 0 Appendix B.

Figure 2. Existing vs. Proposed 220 kV Designs for Segment 1

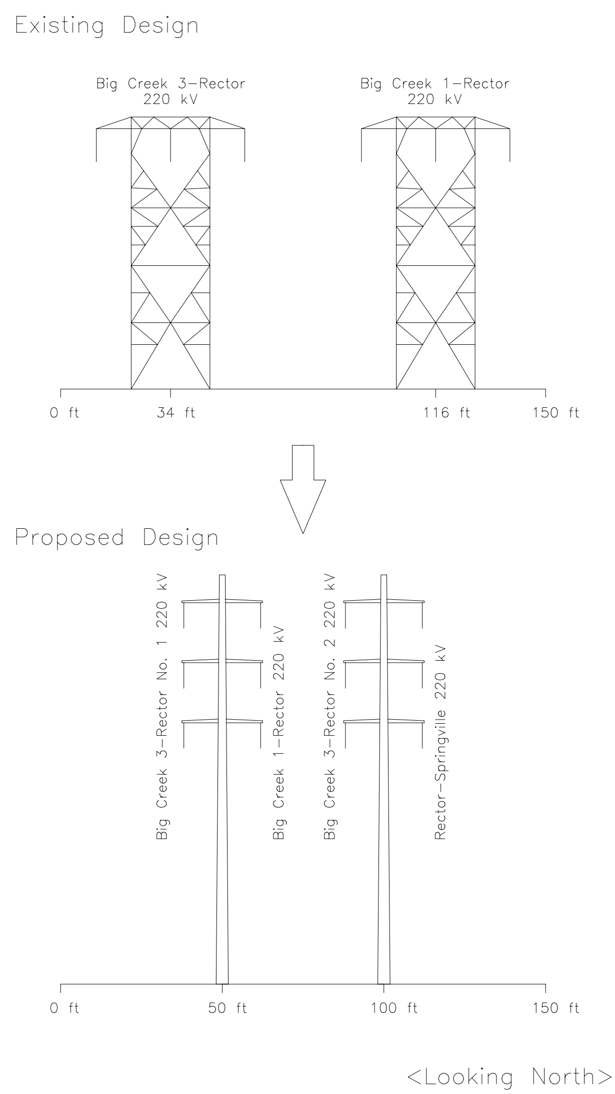

Figure 3. A Design Comparison of Calculated Magnetic Field Levels[29] for Segment 1

(Existing Design vs. Proposed 220 kV Design)

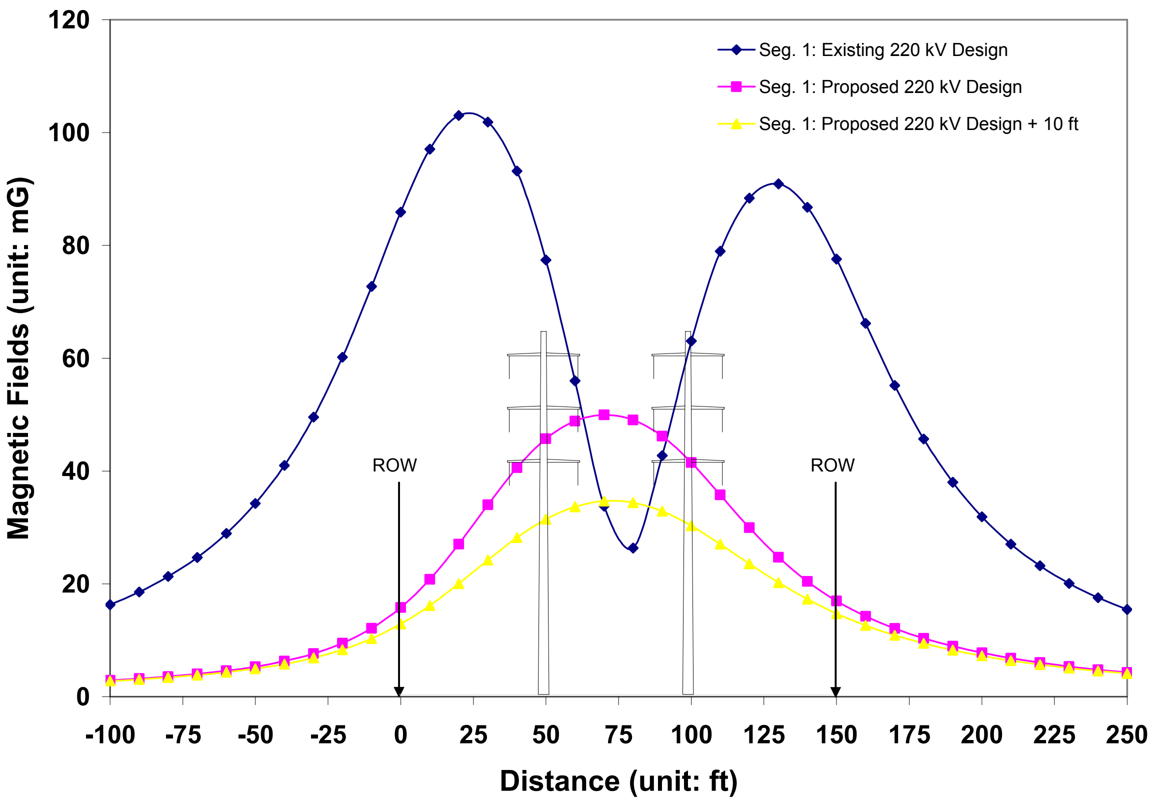

Table 1. A Comparison of Calculated Magnetic Fields[30] at Edges of ROW for Segment 1				
Design Options	Left ROW (mG)	% Reduction	Right ROW (mG)	% Reduction
Seg. 1: Existing 220 kV Design	85.9	Base	77.6	Base
Seg. 1: Proposed 220 kV Design	15.8	81.6	17.0	78.1
Seg. 1: Proposed 220 kV Design + 10 ft	12.9	18.4	14.7	13.5

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29 This graph depicts calculated magnetic field levels for design comparison only and is not meant to predict actual magnetic field levels.

30 This table lists calculated magnetic field levels for design comparison only and is not meant to predict actual magnetic field levels.

As Figure 3 and Table 1 illustrate above that Proposed 220 kV Design (with an added phasing option for reducing magnetic fields) would bring significantly more than 15% magnetic field reduction at edges of ROW compared to the Existing 220 kV Design. Furthermore, using 10 ft taller poles in addition to the Proposed 220 kV Design would meet the additional 15% magnetic field reduction requirement (on average) at edges of ROW. Therefore, using 10 ft taller would be applied for homes immediately adjacent to the Segment 1 as a "low-cost" magnetic field reduction measures.

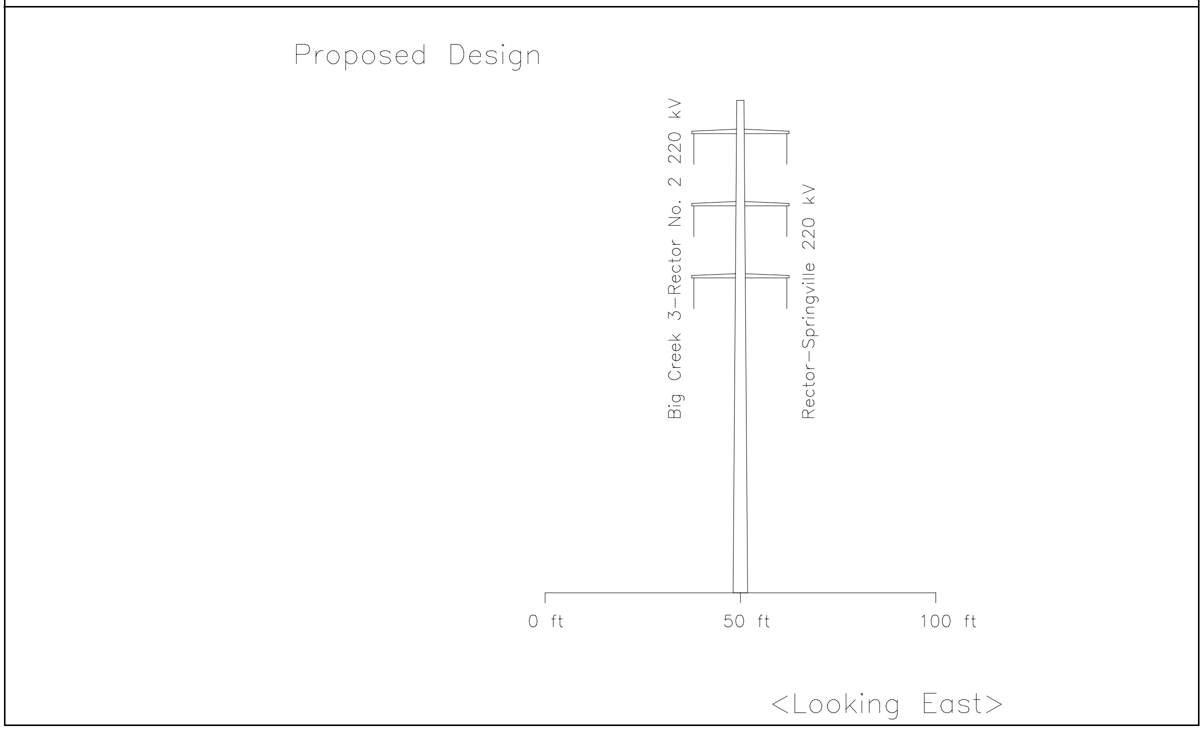
Part 2: 220 kV Transmission Line Route Segment 2 (Segment 2)

The Segment 2 consists of constructing the remaining 18 mile-long, a double-circuit 220 kV transmission line that would loop the existing Big Creek 3-Springville 220 kV transmission line into the 220 kV Rector Substation, creating the new Big Creek 3-Rector No. 2 220 kV transmission line and the new Rector-Springville 220 kV transmission line.

At mile 1.1 (approximately 1.1 mile north from Rector Substation), the new double circuit 220 kV transmission line would be directed east to parallel Avenue 292 to Road 156 for approximately 1 mile. At Road 156, the new double circuit 220 kV transmission line would be directed north for approximately 0.1 miles, and then would turn in an easterly direction for approximately 6.5 miles. At Mile 8.8, the new double circuit 220 kV transmission line would turn north at the former Visalia Electric Railroad bed. At Mile 8.9, the new double circuit 220 kV transmission line would turn east for approximately 0.7 miles to the base of Badger Hill. At the base of Badger Hill, the new double circuit 220 kV transmission line would turn north for approximately 3.2 miles. At Mile 12.9, the new double circuit 220 kV transmission line would turn east to parallels Cottage PO Drive/Avenue 320 until Mile 15.4. At Mile 15.4, the new double circuit 220 kV transmission line would turn southeast for 0.3 miles, and then would turn northeast to parallel an existing SCE 66 kV subtransmission line. At Mile 16.0, the new double circuit 220 kV transmission line would turn east for 1 mile, then north for 0.4 miles, then east again at for 1.1 miles until it reaches the existing Big Creek 3-Springville 220 kV transmission line at a point approximately 58 miles south of Big Creek Powerhouse No. 3.

Figure 4 below shows the proposed 220 kV transmission designs for Segment 2. Currently, there are no existing transmission lines on this Segment 2. Therefore, the Proposed Design would be a new source of magnetic fields in this segment.

Figure 4. Proposed 220 kV Design for Segment 2



As Figure 5 and Table 2 illustrate below that using 10 ft taller poles in addition to the Proposed 220 kV Design (with an added phasing option for reducing magnetic fields) would meet the 15% magnetic field reduction requirement (on average) at edges of ROW. Therefore, using 10 ft taller would be applied for homes immediately adjacent to the Segment 2 as a "low-cost" magnetic field reduction measures.

Figure 5. A Design Comparison of Calculated Magnetic Field Levels[29] for Segment 2

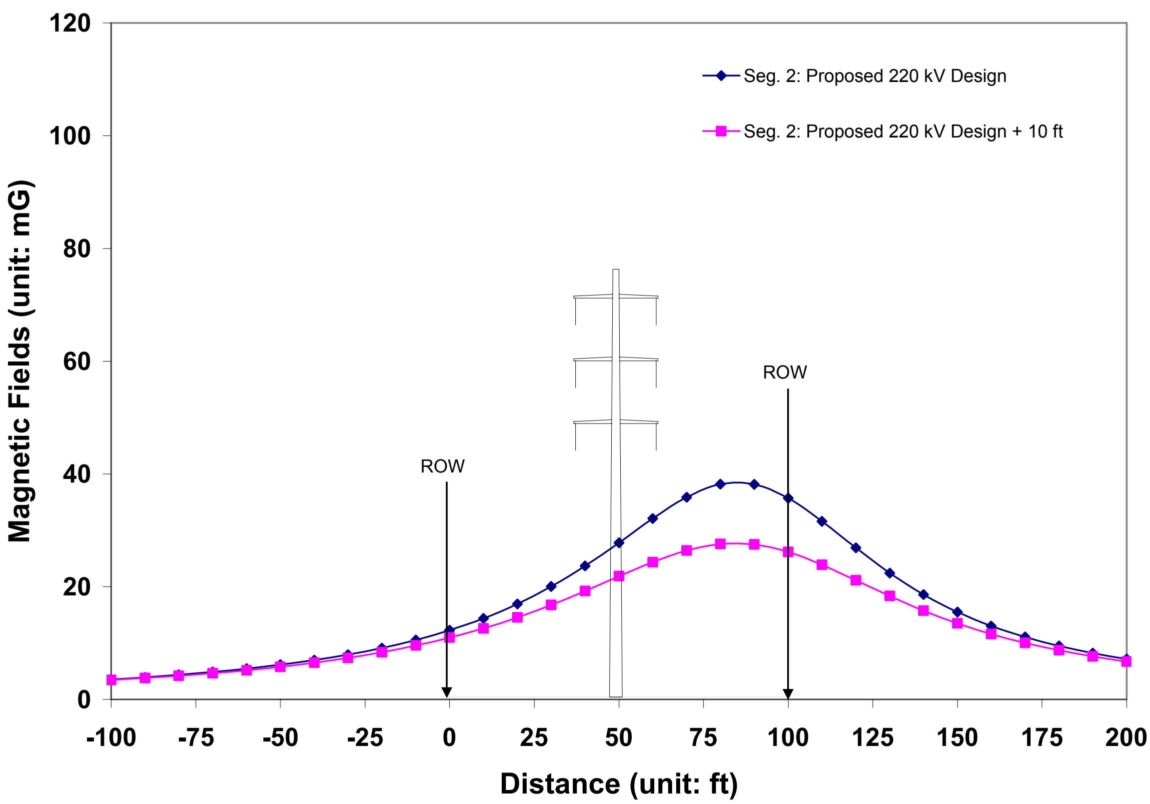


Table 2 A Comparison of Calculated Magnetic Fields[30] at Edges of ROW for Segment 2

Design Options	Left ROW (mG)	% Reduction	Right ROW (mG)	% Reduction
Seg. 2: Proposed 220 kV Design	12.3	Base	35.7	Base
Seg. 2: Proposed 220 kV Design + 10 ft	11.0	10.6	26.2	26.6

Part 3: Existing Rector Substation Modification

Project work at Rector Substation consists of relocating existing transmission lines to adjacent dead-end bays, equipping two 220 kV transmission line positions on the existing 220 kV switchrack with conductor spans, jumpers, connectors, and support structures to accommodate the connection of the new transmission lines.

The project work at Rector Substation is limited in scope and does not provide significant opportunities to implement magnetic field reduction measures. Furthermore, the nearest home is approximately 400 ft away from the area where modification would be made. Therefore, no "no-cost and low-cost" magnetic field reduction measures are considered.

Table 3 on page 20 summarizes "no-cost and low-cost" magnetic field reduction measures that SCE considered for the Proposed Project:

Table 3. "No-cost and Low-cost" Magnetic Field Reduction Measures for Area A through E

Area No.	Location[31]	Adjacent Land Use[32]	MF Reduction Measures Considered	Estimated Cost to Adopt	Measure(s) Adopted? (Yes/No)	Reason(s) if not adopted
Segment 1	From Rector Substation to 1.1 mile north.	2, 5	• Phase circuits, • Double-Circuit Pole-head • Taller poles[33]	• No-Cost • No-Cost • Low-Cost	• Yes • Yes • Yes	
Segment 2	From Segment 1 to East of Lemon Cove and Highway 198	2, 5, 6	• Phase circuits, • Double-Circuit Pole-head • Taller poles[33]	• No-Cost • No-Cost • Low-Cost	• Yes • Yes • Yes	
Rector Sub	Within the existing substation	2	• None			Limited scope and open space (i.e. home(s) are sufficiently away)

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[31] This column shows the major cross streets or substation name as reference points.

[32] Land usage codes are as follows: 1) schools, licensed day-cares, and hospitals, 2) residential, 3) commercial/industrial, 4) recreational, 5) agricultural, and 6) undeveloped land.

[33] Approximately 10 ft taller poles would be places when homes are immediately adjacent to the edges of ROW.

This FMP includes only "no-cost and low-cost" magnetic field reduction measures for SCE's Proposed Routes. SCE's Proponent's Environmental Assessment (PEA) contains various alternative line routes. Comparable "no-cost and low-cost" magnetic field reduction options for the Proposed Route can be applied to all alternative transmission routes.[34]

VI. FINAL RECOMMENDATIONS FOR IMPLEMENTING "NO-COST AND LOW-COST" MAGNETIC FIELD REDUCTION MEASURES

In accordance with the "EMF Design Guidelines", filed with the CPUC in compliance with CPUC Decisions 93-11-013 and 06-01-042, SCE would implement the following "no-cost and low-cost" magnetic field reduction measures for this project. These recommended magnetic field reduction measures would be Proposed Project:

For 220 kV Transmission Line Route (Segment 1):

- Using a "double-circuit" pole-head configuration for the proposed 220 kV transmission lines;
- Using 10 ft taller poles[33] for homes immediately adjacent to the edges of ROW; and
- Implementing phasing arrangement(s) to reduce magnetic field levels at edge(s) of ROW.

  Recommended phasing arrangements are as follows:

  Big Creek 3-Rector No. 1 220 kV : A-C-B (top-to-bottom)

  Big Creek 1-Rector 220 kV : B-C-A (top-to-bottom)

  Big Creek 3-Rector No. 2 220 kV : B-A-C (top-to-bottom)

  Rector-Springville 220 kV : C-A-B (top-to-bottom)

For 220 kV Transmission Line Route (Segment 2):

- Using a "double-circuit" pole-head configuration for the proposed 220 kV transmission lines;

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[34] Depending upon the existing phasing arrangements at the location where proposed transmission lines meet the existing Big Creek 3-Valley 220 kV transmission line, additional work and/or additional towers, such as transposition tower(s), will be required.

- Using 10 ft taller poles[33] for homes immediately adjacent to the edges of ROW; and
- Implementing phasing arrangements to reduce magnetic field levels at edges of ROW. Recommended phasing arrangements are as follows:

  Big Creek 3-Rector No. 2 220 kV : B-A-C (top-to-bottom)

  Rector-Springville 220 kV : C-A-B (top-to-bottom)

For existing Rector Substation:

- None due to limited project scope and adjacent to an open space (i.e. the nearest home is approximately 400 ft away from the area where the modification would be made).

The recommended "no-cost and low-cost" magnetic field reduction measures listed above are based upon preliminary engineering designs, and therefore, they are subject to change during the final engineering designs. If the final engineering designs are different than preliminary engineering designs, SCE, however, would implement comparable "no-cost and low-cost" magnetic field reduction measures. If the final engineering designs are significantly different (in the context of evaluating and implementing CPUC's "no-cost and low-cost" EMF Policy) than the preliminary designs, a supplemental FMP will be prepared.

SCE's plan for applying the above "no-cost and low-cost" magnetic field reduction measures equitably and uniformly for the Proposed Subtransmission Line is consistent with the CPUC's EMF Decisions No. 93-11-013 and No. 06-01-042, and also with recommendations made by the U.S. National Institute of Environmental Health Sciences. Furthermore, the recommendations above meet the CPUC approved EMF Design Guidelines as well as all applicable national and state safety standards for new electric facilities.

APPENDIX A: TWO-DIMENTIONAL MODEL ASSUMPTIONS AND YEAR 2010 FORECASTED LOADING CONDITIONS

Magnetic Field Assumptions:

SCE' uses a computer program titled "MFields"[35] to model the magnetic field characteristics of various transmission designs options. All magnetic field models and the calculated results of magnetic field levels presented in this document are intended only for purposes of identifying the relative differences in magnetic field levels among various transmission line design alternatives under a specific set of modeling assumptions and determining whether particular transmission design alternatives can achieve magnetic field level reductions of 15 percent or more. The calculated results are not intended to be predictors of the actual magnetic field levels at any given time or at any specific location if and when the project is constructed.

Typical two-dimensional magnetic field modeling assumptions include:

- All transmission lines would be considered operating at forecasted loads (see Table 4 below) and all conductors are straight and infinitely long;
- Typical 40 ft minimum ground clearance for all 220 kV overhead transmission designs;
- Average sagging for all 220 kV overhead transmission designs (average sagging is approximately equal to 1/3 of sagging plus minimum clearance to the ground);
- All poles and towers are located next to each other;
- Magnetic field strength is calculated at a height of three feet above ground;
- Resultant magnetic fields are being used;
- All line currents are balanced (i.e. neutral or ground currents are not considered);
- Terrain is flat; and
- Dominant power flow directions are being used.

35 Kim, C, MFields for Excel, Version 2.0, 2007.

Table 4. Year 2011 Forecasted Loading Conditions 220 kV Subtransmission Lines		
Circuit Name	**Without Proposed Pro (Amp)**	**With Propose Project (Amp)**
Big Creek 3-Rector No. 1 220 kV[36]	915	652
Big Creek 1-Rector 220 kV	808	604
Big Creek 3-Rector No. 2 220 kV	N/A	715
Rector-Springville 220 kV	N/A	82

Note:

1. The power flow direction is from other substations to Rector Substation.
2. Forecasted loading data is based upon scenarios representing load forecasts for the year 2011. The forecasting data is subject to change depending upon availability of generations, load increase, changes in load demand, and by many other factors.
3. "Without Proposed Project" indicates the year 2011 forecasted loading conditions if the Proposed Project is not operational.

[36] The existing transmission name is "Big Creek 3-Rector 220 kV."

APPENDIX B: TYPICAL 220 KV TOWER DIMENSIONS

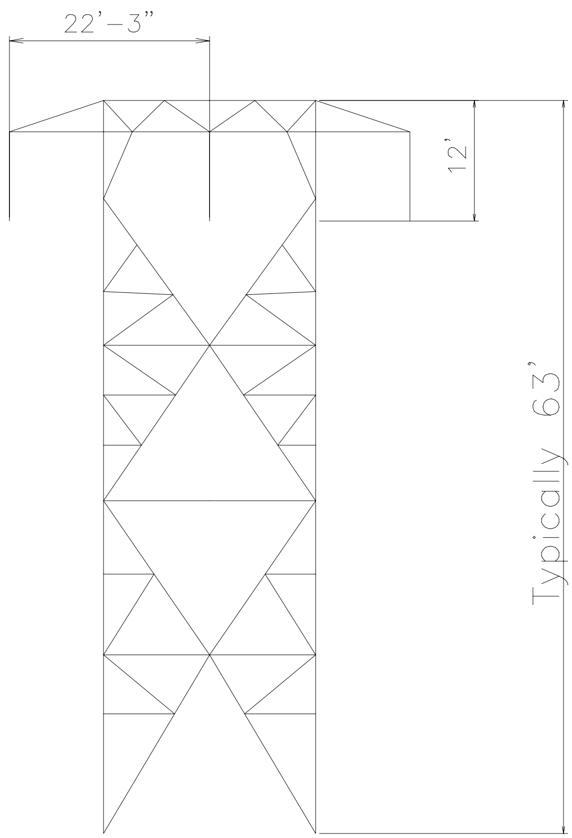
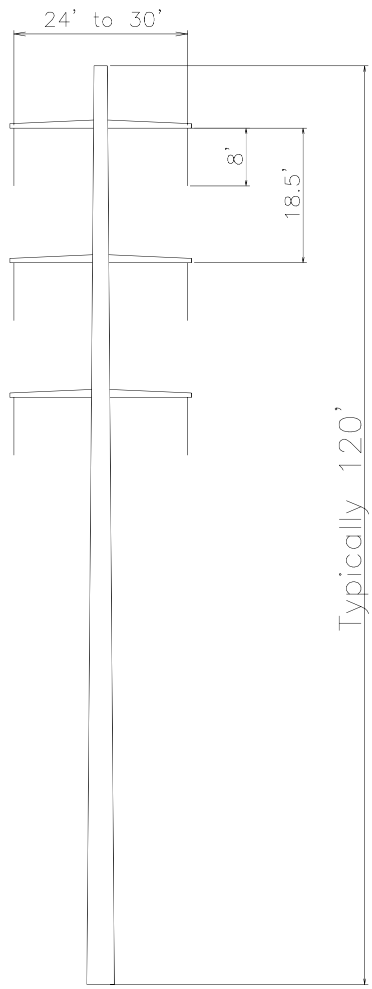
Figure 6. Existing 220 kV Tower Dimensions


Figure 7. Proposed 220 kV Tower

Dimensions[37]



37 The proposed double-circuit 220 kilovolt transmission line would be constructed on tubular poles and lattice steel towers ranging in height from 120 to 160 feet above the ground. All models for the Proposed Designs are based upon 120 ft tall poles as shown. The dimensions for the lattice steel tower are similar to the tubular pole as shown.