Detailed Magnetic Field Management Plan for the South Orange County Reliability Enhancement Project

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Work Order No.: **BP5984480**
In-Service Date: **2017**

Transmission Lines: **TL695, 13812, 13816, 13831, 13833, 13834, 13835, 13836,13837, 13846, 13847, 13848, 23007, 23030**

Central File No.: **ELA 140.B.XX**

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I. Project Scope

The South Orange County Reliability Enhancement Project (Proposed Project) is intended to meet the area load growth and service reliability for approximately 129,000 customers within southern Orange County. In order to increase service and reliability to its customers and substations in the southern Orange County region, SDG&E is proposing to replace the existing 138/12kV Capistrano Substation with a new 230/138/12kV Gas Insulated Substation (GIS), conducting minor alterations to the existing Talega Substation, and bringing two (2) new 230kV transmission lines into the southern Orange County area by replacing a section of an existing 138kV transmission line (TL13835) with a new 230kV double-circuit extension between Capistrano Substation and Talega Substation. The Proposed Project would have an anticipated in-service date of approximately 2017.

The new 230kV double circuit will be an extension of TL23007 and TL23030 from the Talega Substation area to the Capistrano Substation. This "Detailed Magnetic Field Management Plan (FMP)" is for analysis of the new 230kV double circuit extension.

II. Magnetic Field Management Design Guidelines

The California Public Utilities Commission ("CPUC") requires SDG&E apply its *EMF*[1] *Design Guidelines for Electrical Facilities* ("Guidelines") to all new electric transmission projects to reduce public exposure to magnetic fields. SDG&E filed its Guidelines with the CPUC in accordance with CPUC Decision 93-11-013 and updated them in accordance with the 2006 CPUC Decision 06-01-042.

Consistent with SDG&E's Guidelines and with the CPUC order, magnetic fields and possible magnetic field management measures were evaluated along the existing, and proposed, transmission circuit locations associated with the Project. The results of this evaluation are contained in this FMP.

The FMP deals solely with magnetic fields. Moreover, reducing the magnetic field strength is but one of many factors to be considered in planning and designing a transmission system, along with other issues such as safety, environmental concerns, reliability, insulation and electrical clearance requirements, aesthetics, cost, operations and maintenance.

III. Methodology

In Decision 06-01-042, the CPUC notes that modeling is used to compare the relative effectiveness of field-reduction options and is not to be used to predict post-construction field levels. CPUC Decision 06-01-042, Finding of Fact 14: "Utility modeling methodology is intended to compare differences between alternative EMF [Electromagnetic Field] mitigation measures and not determine actual EMF amounts."[2] The CPUC also notes that "modeling indicates relative differences in magnetic field reductions between different transmission line construction methods, but does not measure actual environmental magnetic fields."[3]

[1] EMF refers to electric and magnetic fields.
[2] CPUC Decision D.06-01-042, Finding of Fact 14, p. 20.
[3] Ibid, p.11.

In accordance with its Guidelines, SDG&E will take the following measures for the Project:

- Apply SDG&E's EMF Guidelines for transmission circuit facilities to the Project design.
- Identify and implement appropriate "no-cost" measures, i.e., those that will not increase overall project costs but will reduce the magnetic field levels.
- Identify and implement appropriate "low-cost" measures, i.e., those measures costing in the range of 4% of the total budgeted project cost that will reduce the magnetic field levels by 15% or more at the edge of the right-of-way (ROW).
- When a sufficiency of "low-cost" measures is available to reduce magnetic field levels, such that it is difficult to stay within the 4% cost guideline, apply these "low-cost" measures by priority, per the Guidelines.

The 15% minimum reduction required for low-cost measures is in addition to any field reduction due to "no-cost" measures. It is not cumulative.

Since the Project requires permitting under General Order 131-D, a Detailed Field Management Plan ("FMP") will be used. The Detailed FMP consists of a project description, a checklist table showing evaluation of magnetic field reduction measures adopted or rejected per segment, evaluation of "no-cost" and "low-cost" magnetic field reduction techniques, magnetic field models, and a summary with recommendations, including tables showing resultant magnetic field reduction levels at the edge of the ROW where applicable.

Tables showing calculated resultant magnetic field levels at the edges of the ROW are included in "Section VIII- Summary of Calculated Magnetic Field Levels" in this report.

Field levels were calculated using the Resicalc program developed and maintained by the Electric Power Research Institute**.** As the proposed in-service date of the Project would be Fall 2017, the projected high usage currents, "2017 heavy summer," were used in the calculations. For the purpose of evaluating the field management measures, magnetic field levels were calculated and compared at a height of one meter above ground.

To evaluate the effectiveness of various magnetic field reduction measures, calculated values for a given technique were compared to calculated values without the technique. Since all segments of the Project are within defined easements, magnetic field levels were calculated and compared at the adjacent parallel property lines, or edges of ROW.

The edges of the ROW are identified as "West", "East", "North", or "South" for consistency when reviewing the sketches included in "Appendix 1" and the tables included in "Section VIII- Summary of Calculated Magnetic Field Levels" in this report.

IV. Project Description

The South Orange County Reliability Enhancement Project (Proposed Project) is intended to meet the area load growth and service reliability for approximately 129,000 customers within southern Orange County. In order to increase service reliability to its customers and substations in the southern Orange County region, SDG&E is proposing to replace the existing 138/12kV Capistrano Substation with a new 230/138/12kV Gas Insulated Substation (GIS), make minor changes to the existing Talega Substation, and bring two (2) new 230kV transmission lines into the southern Orange County area by replacing a section of existing 138kV transmission line (TL13835) with a new 230kV double-circuit extension between Capistrano Substation and Talega Substation. The Proposed Project will have an anticipated in-service date of 2017.

The transmission line portion of this Proposed Project is approximately eight miles in length with components primarily located in portions of the cities of San Juan Capistrano and San Clemente, as well as unincorporated Orange County, and the United States Marine Corps Base Camp Pendleton (Camp Pendleton). (see Appendix 1, "Segment Map") This area of southwestern Orange County is composed of residential, commercial, recreational, and open space land uses.

This "Detailed Magnetic Field Management Plan" is specifically for the following Proposed Project components:

- Relocate the three existing 138kV transmission lines from the Capistrano Substation into the new San Juan Capistrano substation. Loop-in the two 138kV transmission lines that currently bypass the existing substation into the new San Juan Capistrano substation. Underground all of the westbound 138kV transmission line getaways.
- The Proposed Project includes replacing an existing 138kV transmission line, TL13835, between Capistrano Substation and Talega Substation, with two (2) new 230kV transmission lines which will be installed on common, double-circuit structures. TL23007 will be disconnected from Talega Substation and connected to the new transmission lines on the west side of the common double-circuit structures, extending it from its other terminating substation, San Onofre Substation, beyond Talega Substation to Capistrano Substation. The other new transmission line on the east side of the structures will tie to TL23030 where it currently enters Talega Substation on the east side coming from its other termination at Escondido Substation, making it a three terminal line at that point, and extending it from Talega Substation to Capistrano Substation. These changes are described as follows:
    - Within SDG&E's existing right-of-way (ROW) build approximately 7.5 miles of new overhead double-circuit 230kV transmission lines connecting to existing 230kV transmission lines (TL2007, TL23030) near Talega Substation;
    - Acquire new ROW for approximately 0.25 mile of new overhead 230kV transmission line (TL23030) adjacent to SDG&E's Talega Substation;
    - Within SDG&E's existing Vista Montana street easement and franchise position, replace 0.36 miles of one (1) existing 138kV underground transmission duct bank with two (2) new 230kV underground transmission duct banks;
- Remove and relocate 12kV distribution lines from within SDG&E's existing Capistrano to Talega utility corridor to accommodate the new 230kV double-circuit line;
- Relocate existing 69kV and 138kV transmission lines near the Talega Substation;

- Install approximately 81 new steel transmission line structures (49 - 230kV structures, 23 - 138kV structures, and 9 - 69kV structures);
- Remove approximately 86 wood structures, 12 - steel structures, and 5 - steel lattice towers;
- Upgrade remote ends of 138kV and 230kV transmission lines affected, as required.

For the purposes of this document, the transmission line work associated with the Proposed Project has been divided into four (4) segments. Segment 1 and 3 were further subdivided due to configuration changes in those segments which affect modeling:

Segment 1a – Following the completion of the new San Juan Capistrano 230/138/12kV gas insulated substation, six (6) 138kV transmission lines will connect to the new facility via underground getaways. Four of the six 138kV transmission lines, TL13833, TL13834, TL13847, and TL13837, will exit the substation site via underground conduit duct banks on the west side, and cross under Camino Capistrano, heading west to four new steel cable poles. Two of these, TL13847 and TL13837, will continue west in an underground position within an existing 60 foot wide SDG&E easement for approximately 600 feet until transitioning to an overhead position on a new steel cable pole located along Avenida de la Vista. There is a community recreation facility on the north side of this easement, along with residential structures on both sides. From there they connect to their existing transmission circuits within franchise, and continue westerly to Laguna Niguel Substation.

The other two, TL13833 and TL13834, transition overhead to new steel cable poles near Camino Capistrano, approximately 200 feet from Capistrano Substation, where they connect to their existing transmission circuits and head north, within franchise, to Trabuco Substation.

The last two of the six 138kV transmission lines, TL13816 and TL13848, will exit the substation to the east via new steel cable poles that will be installed in the northeast corner of the substation site. From there, these two 138kV lines will connect to their appropriate, existing, transmission lines, which currently reside within an existing 150 foot wide SDG&E easement, and head toward Rancho San Juan residential development, along with the new 230kV double circuit transmission lines as defined in Segment 1b. Land use in this Segment is residential.

Segment 1b – This Segment includes construction of a new 230kV double circuit overhead transmission line between the new San Juan Capistrano 230/138/12kV gas insulated substation and the Rancho San Juan residential development, located near the intersection of La Pata Avenue and Vista Montana, a distance of approximately 2.7 miles. It will involve the removal of wood structures, lattice towers and steel poles, and the installation of new taller steel poles. The new 230kV steel poles will be installed within SDG&E's existing 150 foot ROW, using the same alignment as existing TL13835. Land use in this Segment is residential and undeveloped land.

Segment 2 – Segment 2 will include the installation of two separate 230kV underground conduit duct banks, for a distance of approximately 0.4 miles, where the Proposed Project goes past San Juan Hills High School. The first 230kV circuit, TL23030, will be located in a franchise position just north of centerline within Vista Montana between Via Pamplona and La Pata Avenue. The second 230kV circuit, TL23007, will also be installed within Vista Montana, but south of centerline, within an existing 30-foot easement. The 230kV circuits will transition on both sides

of Vista Montana from underground to overhead via two new 230kV steel cable poles at each end of the Rancho San Juan segment, for a total of four new 230kV steel cable poles. It should be noted that this segment removes two existing 138kV steel cable poles, one on each end of Vista Montana, and the associated 138kV cable as they are no longer necessary. One existing 138kV double-circuit steel cable pole (currently TL13833 and TL13816) located near the intersection of Vista Montana and Via Pamplona will be replaced. The replaced pole will be installed just north of the existing pole to make room for the new 230kV (TL23030) underground cable system. Land use for this segment is residential and school.

Segment 3a – Segment 3a of the Proposed Project will include the installation of approximately 3.4 miles of new 230kV overhead on approximately twenty-two (22) double-circuit steel poles located within the cities of San Juan Capistrano and San Clemente, as well as within unincorporated Orange County following the previous, TL13835, alignment. It begins where the new underground transmission lines will transition to an overhead position adjacent to the proposed Rancho San Juan residential development, and end where the 138kV tielines loop in to Pico Substation. Land use for this segment is mostly undeveloped land until it nears Pico Substation where there are commercial/industrial and residential areas.

Segment 3b – This Segment includes the section of Segment 3 from Pico Substation where the two 138kV tielines (TL13846 and TL13836) come out and head east, staying parallel to the new 230kV transmission lines, then south to the Talega Hub, a distance of approximately 0.8 miles. At the Talega Hub, the new TL23030 circuit continues on east (see Segment 4) to the north east corner of Talega Substation, where it turns south to the new TL23030 Talega Tap. The other 230kV tieline, TL23007, continues south within the Talega Hub area and connects to the existing TL23007 pole line (see Segment 4), which ultimately terminates at the San Onofre Substation. The existing connection of TL23007 at Talega Hub to Talega Substation will be disconnected. Land use for this segment is commercial/industrial and undeveloped.

Within Segment 3, approximately thirty-two (32) 138kV wood structures (two and three pole structures currently used to support TL13835) will be removed along with all associated 138kV conductor and hardware to make room for the new 230kV transmission lines and structures.

Segment 4 – Within Segment 4 of the Proposed Project, the two new 230kV transmission lines will follow separate routes. Therefore, each new 230kV transmission line is described separately below by circuit number.

TL23007

TL23007 will travel south within the Talega Hub area for approximately 600 feet until it connects to existing TL23007 at an existing steel lattice tower structure.

TL23030

TL23030 will continue traveling east, on centerline of a new 100 foot-ROW, until it turns south at the northeast corner of Talega Substation, then continue south until it ends at the new Talega Tap where existing TL23030 transmission line coming from Escondido Substation currently enters Talega Substation, a total distance of approximately 2,630 feet. To provide for this, an existing 230kV dead end steel pole will be replaced with a 230kV steel pole.

Transmission line work within Segment 4 also includes re-locating existing 138kV and 69kV transmission lines, both within new and existing ROWs, by installing new overhead structures and underground duct banks. This is required for clearance purposes when the new 230kV transmission lines and structures are installed near Talega Substation. All of Segment 4 lies well within the SDG&E utility easements at the Talega Hub and Talega Substation site so modeling was not performed. Land use adjacent to Segment 4 is Camp Pendleton Military Base on the east and south with buildings over 1,000 feet away, a golf course to the west, and undeveloped land for at least 500 feet to the north. For these reasons land use was defined as "undeveloped land". Modeling was not done due to the complexity of placement of the transmission lines.

Drawings and descriptions showing a typical pole top configuration, tieline relative locations to each other and left and right ROW are included in Appendix 1. Figure 1 below shows the drawing symbols; the arrows on the drawings indicate the viewing direction for orienting each drawing and the direction of current flow.

Figure 1: Drawing Symbol Definitions

Symbol	Interpretation	Meaning
	Viewing Direction	The orientation as seen when looking toward the north
	Current flow into the page	Direction of current flow is same as viewing direction
	Current flow out of the page	Direction of current flow is opposite of viewing direction
	Underground Transmission Circuit	Location of underground transmission circuit
	Underground Transmission Circuit	Location of Underground Transmission in Bridge Cell

V. Field Management Measures Considered for the Transmission Portion of the Proposed Project

Per the "EMF Design Guidelines for Electrical Facilities, Table 3-1", all Segments were reviewed for suitable application of magnetic field reduction measures, as listed in "*Table 1: Magnetic Field Reduction Measures Adopted or Rejected*" below. These techniques will be discussed under the "Section VI- Magnetic Field Reduction Measures Evaluated for the Project" that follows.

Table 1: Magnetic Field Reduction Measures Adopted or Rejected

Segment(s)	Location (Street, Area)	Adjacent Land Use	Reduction Measure Considered	Measure Adopted? (Yes/No)	Estimated Cost to Adopt
All	Entire Project Corridor	Residential, Commercial, Industrial, Undeveloped	**Locate power lines closer to center of the utility corridor to extent possible.**	**No**	**N/A**
	Reason not adopted: SEG 1a and SEG 2 underground is designed to be as close to center of easement as possible. The new 230kV tielines in SEG 1b, SEG 3a, and SEG 3b are using the existing 138kV pole alignment within the SDG&E corridor. TL23030 is designed to be in the center of the new easement in SEG 4. No other alignment is feasible for safety and reliability reasons for other transmission lines in SEG 4. Therefore this option was discarded.				
1b, 3a, 3b	Overhead Project Corridor	Residential, Commercial, Industrial, Undeveloped	**Increase structure height.**	**Yes**	**Not Available**
	SEG. 1b, SEG. 3a, and SEG. 3b will require a standard 230kV double circuit steel pole. Some structure heights will increase to maintain or increase sag distance from ground to the circuit by design. Making structure heights taller was modeled for 15% reduction at ROW and consideration of the cost exceeding 4% of the total Proposed Project cost was evaluated. A conclusion was made and is discussed below. (see "Magnetic Field Reduction Measures Evaluated for the Project" below)				
4	Overhead Project Corridor	Residential, Commercial, Industrial, Undeveloped	**Increase structure height.**	**No**	**N/A**
	Reason not adopted: Land use adjacent to SEG 4 is "undeveloped land " to the north, east and west . There are no structures for at least 400 feet on land north of Segment 4, and for at least 1,000 feet on the east and south sides. To the west is a golf course, on which the nearest structure is more than 1,000 feet from the Segment 4 corridor. Due to the adjacent land uses to the north, east and south, and the complexity of placement of the transmission lines in this Segment, increasing structure heights to reduce magnetic fields was rejected for Segment 4.				
All	Entire Project Corridor	Residential, Industrial, Undeveloped	**Reduce conductor (phase) spacing.**	**No**	**N/A**
	Reason not adopted: In SEG 1b, SEG. 3a, SEG. 3b,and SEG 4, pole top spacing is per SDG&E Standards recommended for a 230kV double circuit steel pole to avoid possibility of blow-out. SEG. 1a and SEG. 2 underground will be installed in SDG&E Standards recommended				

	underground conduit duct banks with set conductor phase spacing. Therefore this option was discarded.				
1b, 3a, 3b	Overhead Project Corridor	Residential, Commercial, Industrial, Undeveloped	**Place Overhead Underground**	**No**	**N/A**
	<u>Reasons not adopted</u>: The combined length of the 230 kV tielines in proposed project segments 1b, 3a and 3b is approximately 7.7 miles. The cost to underground these segments would far exceed the 4% benchmark guideline for "low-cost" magnetic field reduction. Therefore, undergrounding the proposed 230 kV tielines in these segments was rejected as an option to reduce magnetic fields.				
1a & 2	Underground Project Corridor	Residential, School	**Increase trench depth**.	**Yes**	**Not Available**
	Undergrounding the 138kV tielines in SEG 1a, and the 138kV and 230kV tielines in SEG 2, is per SDG&E Standards designed to be at 3 feet top-of-conduit (TOC). Increasing the depth was modeled and consideration of the cost exceeding 4% of the total Proposed Project cost and the possibility of degradation of the ampacity and rating of the tieline due to more heat at deeper depths was reviewed. A conclusion was made and is discussed below. (see "Magnetic Field Reduction Measures Evaluated for the Project" below)				
All	Project Corridor	Residential, Commercial, Industrial, Undeveloped	**Phasing circuits to reduce magnetic fields.**	**No**	**N/A**
	<u>Reasons not adopted</u>: Reduction of magnetic field values (milligauss) through phasing techniques was considered and modeled for the Proposed Project. **SEG 1a** 138kV tielines, TL13847 and TL13837, were phased per a previous FMP for Laguna Niguel and must keep their existing phasing for lowest field values. TL13833 and TL13844 were found to be phased for lowest field values so should remain as is. The 138kV tielines in **SEG 1b, 3a, and 3b** were reviewed in various combinations of phasing and also found to be phased for lowest field values so should remain as is. The SDG&E proposed 230kVextension tielines were modeled with various phase combinations and it was found if TL23030 were reverse phased C-B-A(top-to-bottom) from TL23007 A-B-C(top-to-bottom) a reduction was achieved at the edge of ROW for **SEG 1b, 3a, and 3b.** However, TL23030 should remain as is, since the southerly termination of that circuit is at Escondido Substation, which is out of scope of this Proposed Project and it shares common structures with other transmission lines within the corridor between Talega Sub and Escondido Sub which were phased for lowest field values at ROW in previous FMPs. The phasing of underground **Segment 2,** and overhead phasing of **Segment 4,** being portions of the new 230kV extension between Capistrano and Talega Sub. must remain consistent with that of the overhead lines. This is do to safety issues that may arise when "fault tracking" a tieline from either substation it ties into, any phase change of a tieline must be done as it connects to the rack at each substation it terminates at. The portion of Segment 4 containing TL23007 has a southerly termination at San Onofre Substation and outside the scope of this Proposed Project, thereby precluding analysis of phase arrangement, as described above. In summary, phase arrangement was rejected as an option for all segments of the Proposed Project.				

VI. Magnetic Field Reduction Measures Evaluated for the Transmission Portion of the Proposed Project

Per SDG&E EMF Design Guidelines for Electrical Facilities, this FMP is limited to an assessment of increasing structure height for SEG 1b, SEG 3a, and SEG 3b, and increasing trench depth, as field reduction techniques for SEG 1a and SEG 2. Other techniques such as changes in locating power lines closer to the center of the corridor, reducing conductor (phase) spacing, and phasing circuits to reduce magnetic fields were not implemented.

Locating power lines closer to the centerline of the corridor: Every effort was made to locate the power line closer to center of corridor or franchise for the Proposed Project. SEG1a and SEG 2 underground is designed to be as close to center of easement as possible. The new 230kV tielines in SEG 1b, SEG 3a, and SEG 3b are using the existing 138kV pole alignment within the SDG&E corridor for safety and reliability reasons. TL23030 is designed to be in the center of the new easement in SEG 4. For all other transmission lines in SEG 4, no other alignment is feasible for safety and reliability reasons. Therefore this option was discarded.

Increasing structure height: Land use adjacent to SEG 4 is "undeveloped land " to the north, east and west . There are no structures for at least 400 feet on land north of Segment 4, and for at least 1,000 feet on the east and south sides. To the west is a golf course, on which the nearest structure is more than 1,000 feet from the Segment 4 corridor. Due to the adjacent land uses to the north, east and south, and the complexity of placement of the transmission lines in this Segment, increasing structure heights to reduce magnetic field**s** was rejected for Segment 4.

Reducing conductor phase spacing: Reducing conductor spacing of overhead and underground installations is not an acceptable mitigation technique. The SDG&E Standards for underground installation provides the closest separation without degradation of the circuit's rating due to interference and heat between the three phases. The overhead pole top spacing is per SDG&E Standards recommended for a 230kV double circuit steel pole to avoid possibility of blow-out. Therefore this option was discarded.

Phasing circuits to reduce magnetic fields: Reduction of magnetic field values (milligauss) through phasing techniques was considered and modeled for the Proposed Project. SEG 1a 138kV tielines, TL13847, TL13837, were phased per a previous FMP for Laguna Niguel and must remain their existing phase for lowest field values. TL13833 and TL13844 were found to be phased for lowest field values so should remain as is. The 138kV tielines in SEG 1b – SEG 3b were reviewed in various combinations of phasing and also found to be phased for lowest field values so should remain as is. The SDG&E proposed 230kVextension tielines were modeled with various phase combinations and it was found if TL23030 were reverse phased C-B-A(top-to-bottom) from TL23007 A-B-C(top-to-bottom) a reduction was achieved at the edge of ROW for SEG 1b – SEG 3b. However, TL23030 should remain as is, since the southerly termination of that circuit is at Escondido Substation, which is out of scope of this Proposed Project. TL23030 also shares common structures with other transmission lines within the corridor between Talega Substation and Escondido Substation, which were phased for lowest field values at ROW in previous FMPs. Also, do to safety issues that may arise when "fault tracking" a tieline from either substation it ties into, any phase change of a tieline must be done as it connects to the rack at each substation it terminates at. Therefore this option was discarded.

Increasing structure height: The design pole height required to maintain minimum 30 foot sag (distance from ground) for 230kV tielines was used for the new 230kV double circuit steel poles in SEG 1b, SEG 3a, and SEG 3b. Some structure heights were increased to maintain or increase sag distance from ground to the circuit by design due to the contour of the land they travel over. Increasing pole height, which will increase sag height, would not be a "no-cost" option but a "low-cost" option. To adopt a "low-cost" option, the calculated reduction at one edge-of-ROW, must be at least 15% and the other edge-of-ROW must not increase in milligauss value. Modeling was done to try to get an additional 15% reduction at edge-of-ROW for these overhead Segments, which includes residential, commercial/industrial, and undeveloped land use, and the structure height would have to increase an additional 8 feet (38 feet minimum sag). Therefore, increasing structure height was recommended as a low-cost measure for SEG 1b, 3a and 3b. (see "Magnetic Field Reduction Measures Recommended for the Project" below).

For SEG 4, there are no structures for at least 400 feet on land north of SEG 4, and for at least 1,000 feet on the east and south sides. To the west is a golf course, on which the nearest structure is more than 1,000 feet away. Due to the adjacent land uses to the north, east and south and the complexity of placement of the transmission lines in this segment, increasing structure heights to reduce magnetic field**s** was rejected for Segment 4.

Increasing trench depth: Designed depth of the underground duct bank for TL13847, TL13837 in SEG1a, and the new 230kV tielines, TL23007 and TL23030 in SEG 2, is the standard 3 feet top-of-conduit. Going beyond this depth would not be a "no-cost" option but a "low-cost" option.

Land uses adjacent to SEG 1a includes residential and a community park; land uses adjacent to SEG 2 include San Juan Hills high school.

Magnetic field modeling showed that the trench depth would have to increase approximately 5 feet for SEG 1a (8 feet top-of-conduit), and approximately 3 feet for Segment 2 (6 feet-top-of-conduit), to achieve a 15% reduction at the edge of ROW. Therefore, increasing trench depth was recommended as a low-cost measure for Segments 1a and 2. (see "Magnetic Field Reduction Measures Recommended for the Project" below)

VII. Magnetic Field Reduction Measures Recommended for the Transmission Portion of the Proposed Project

Reduction of magnetic field values by increasing structure height and increasing trench depth field reduction techniques were adopted as viable methods to reduce magnetic fields at the edge-of-ROW for the Proposed Project. For the percentage of magnetic field reduction see tables located in *"Section VIII. - Summary of Calculated Magnetic Field Levels."* The recommended field reduction techniques are:

A. "No-Cost" Field Management Technique:

There are no "no-cost" magnetic field reduction techniques recommended for this Project.

B. "Low-Cost" Field Management Technique:

After discussing increasing structure height and increasing trench depth field reduction techniques with Transmission Engineering, the following was selected for most viable "low-cost" techniques to reduce magnetic fields:

SEG 1a: Modeling was done to try to get an additional 15% reduction at edge-of-easement for SEG 1a, which includes residential land use and a community park, and the depth would have to increase to approximately **8 feet top-of-conduit**.

SEG 1b: Modeling was done to try to get an additional 15% reduction at edge-of-ROW for SEG 1b, which includes residential and undeveloped land use, and the structure height would have to increase an additional **8 feet (38 feet minimum sag)**.

SEG 2: Modeling was done to try to get an additional 15% reduction in SEG 2, which goes past San Juan Hills High School, by making the 230kV duct banks deeper, and the depth would have to increase to approximately **6 feet top-of-conduit**.

SEG 3a: Modeling was done to try to get an additional 15% reduction at edge-of-ROW for SEG 3a, which includes residential, commercial/industrial, and undeveloped land use, and the structure height would have to increase an additional **8 feet (38 feet minimum sag)**.

SEG 3b: Modeling was done to try to get an additional 15% reduction at edge-of-ROW for SEG 3b, which includes commercial/industrial, and undeveloped land use, and the structure height would have to increase an additional **8 feet (38 feet minimum sag)**.

VIII. Summary of Calculated Magnetic Field Levels for the Transmission Portion of the Proposed Project

The following tables show the initial design and recommended ("low-cost") design magnetic field values (milligauss) and the percent change for SEG1a – SEG 3b of the Proposed Project. A positive percentage value shows a reduction in milligauss, while a negative value shows an increase in milligauss from the initial design. The magnetic field values were calculated at the edges-of-ROWs, or edge-of-easement for all Segments. Since increasing structure height and increasing trench depth field reduction techniques were the only viable techniques, other modeling tables were not included. The location of the Segments and their corresponding land uses are included in the attached "Appendix 1".

Table 2: Segment 1a – Underground TL13847 and TL13837 west of Capistrano Substation.

SEGMENT 1a			Make Underground Deeper			
Underground 13847_13837 west of Capistrano Substation						
INITIAL	DESIGN		Low-Cost	Design	Percent (%)	
TL13847	(A-B-C)t-b				milligauss	
TL13837	(C-B-A)t-b				Reduction	
3 foot Top-Of-Conduit			Make 5 feet deeper (8 ft. TOC)			
North	South		North	South	North	South
2.71	2.71		2.21	2.21	18.5%	18.5%

- Residential land use. Community Park on north edge-of-easement.
- Length = approx. 600 feet, 60 foot wide SDG&E easement
- Make trench 5 ft. deeper, making TOC 8 ft.
- See "**Appendix 1 – Segment 1a**" attached for further detail.

Table 3: Segment 1b – Overhead TL23007 and TL23030 from Capistrano Substation east to Rancho San Juan residential development.

SEGMENT 1b		Raise SAG Height				
Overhead- Capistrano Substation east to Rancho San Juan UG						
INITIAL	DESIGN		Low-Cost	Design	Percent (%) milligauss Reduction	
TL13816	C-B-A (t-b)					
TL13848	A-B-C (t-b)					
TL23030	A-B-C (t-b)					
TL23007	A-B-C (t-b)					
			Raise by 8 feet			
North	South		North	South	North	South
13.84	32.26		12.68	27.32	8.4%	15.3%

- Residential and undeveloped land use.
- Length = approx. 2.7 miles, 150 ft. wide SDG&E ROW
- Increase structure height 8 ft.
- See "**Appendix 1 – Segment 1b**" attached for further detail

Table 4: Segment 2 – Underground at Rancho San Juan residential development within franchise of Vista Montana between Via Pamplona and La Pata Avenue

SEGMENT 2		Make Underground Deeper				
Rancho San Juan - Underground						
INITIAL	DESIGN		Low-Cost	Design	Percent (%) milligauss Reduction	
TL23030	A-B-C (t-b)					
TL23030	A-B-C (t-b)					
TL13816	C-B-A (t-b)					
TL13848	A-B-C (t-b)					
TL23007	A-B-C (t-b)					
TL23007	A-B-C (t-b)					
			Make 3 feet deeper (6ft. TOC)			
North	South		North	South	North	South
3.16	14.16		2.95	11.83	6.6%	16.5%

- Residential land use. Goes past San Juan Hills High School to the north.
- Length = approx. 0.4 miles, within franchise Vista Montana
- Increasing the depth by 3 ft. (6 ft. TOC)
- See "**Appendix 1 – Segment 2**" attached for further detail.

Table 5: Segment 3a – Overhead from Rancho San Juan Underground to Pico Substation

SEGMENT 3a			Raise SAG Height			
Overhead- Rancho San Juan UG - Pico Substation						
INITIAL	DESIGN		Low-Cost	Design	Percent (%)	
TL13816	C-B-A (t-b)				milligauss	
TL13847	A-B-C (t-b)				Reduction	
TL23030	A-B-C (t-b)					
TL23007	A-B-C (t-b)					
			Raise by 8 feet			
East	West		East	West	East	West
13.84	32.26		12.68	27.32	8.4%	15.3%

- Commercial/industrial and residential land use
- Length = approx. 3.4 miles, 150ft. wide SDG&E ROW
- Increasing structure height 8 ft.
- See "**Appendix 1 – Segment 3a**" attached for further detail.

Table 6: Segment 3b – Overhead from Pico Substation to Talega Hub.

SEGMENT 3b			Raise SAG Height			
Overhead-Pico Substation - Talega Hub						
INITIAL	DESIGN		Low-Cost	Design	Percent (%)	
TL13836	C-B-A (t-b)				milligauss	
TL13846	A-B-C (t-b)				Reduction	
TL23030	A-B-C (t-b)					
TL23007	A-B-C (t-b)					
			Raise by 8 feet			
East	West		East	West	East	West
18.02	32.80		16.79	27.80	6.8%	15.2%

- Commercial/Industrial and undeveloped land use.
- Length = approx. 0.8 miles, 150ft. wide SDG&E ROW
- Increasing structure height 8 ft.
- See "**Appendix 1 – Segment 3b**" attached for further detail.

IX. Simplified Field Management Plan Checklist for the San Juan Capistrano Substation Portion of the Proposed Project

Generally, magnetic field values along the substation perimeter are low compared to the substation interior because of the distance to the energized equipment. Normally, the highest values of magnetic fields around the perimeter of a substation are caused by overhead power lines and underground duct banks entering and leaving the substation, and not by substation equipment. Therefore, the magnetic field reduction measures generally applicable to a substation project are as follows:

- Site selection for a new substation;
- Setback of substation structures and major substation equipment (such as bus, transformers, and underground cable duct banks, etc.) from perimeter;
- Field reduction for transmission lines entering and exiting the substation.

The Substation Checklist FMP evaluates the no-cost and low-cost measures considered for the substation project, the measures adopted, and reasons that certain measures were not adopted.

No.	No-Cost and Low-Cost Magnetic Field Reduction Measures Evaluated for a Substation Project	Measure Adopted? (Yes/No)	Reason(s) if not Adopted
1	Keep high current devices, transformers, capacitors, and reactors, away from the substation property lines by bringing into the substation property as much as possible.	Yes	
2	For underground duct banks, the minimum distance should be 12 feet from the adjacent property lines or to the extent practical.	Yes	
3	Locate new substations close to existing transmission line rights-of-way to the extent practical.	Yes	
4	Increase the substation property boundary to the extent practical.	Yes	
5	Other:		

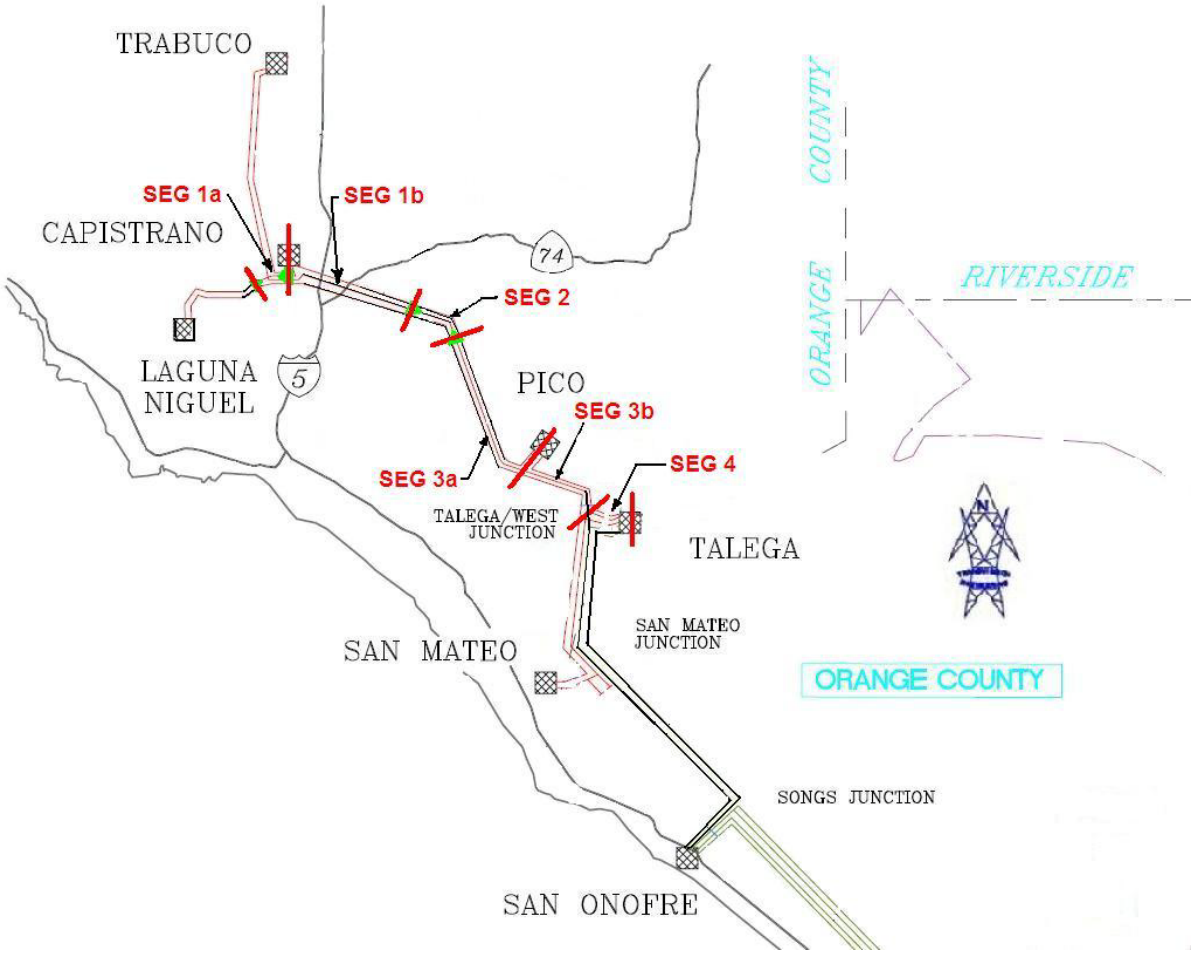
Prepared By: Date:

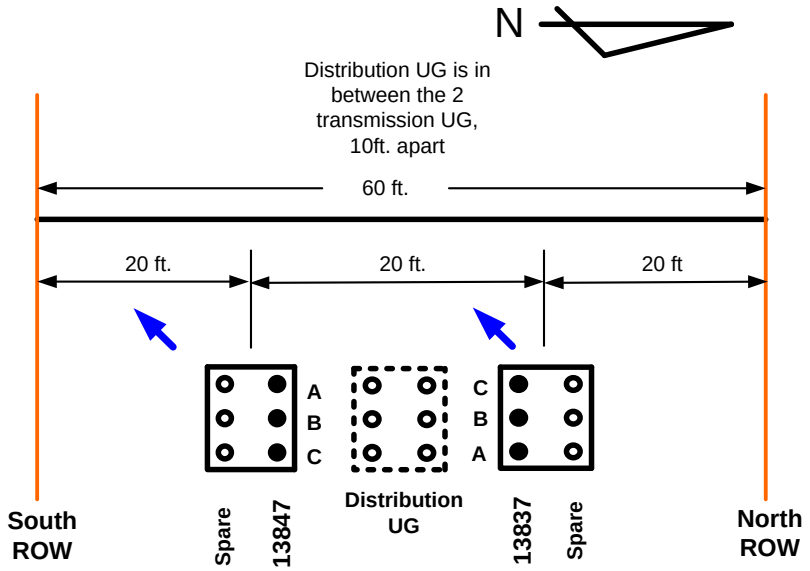
S.C. Campbell April 24, 2012
Substation Engineering Team Lead

Appendix 1

South Orange County
Reliability Enhancement Project

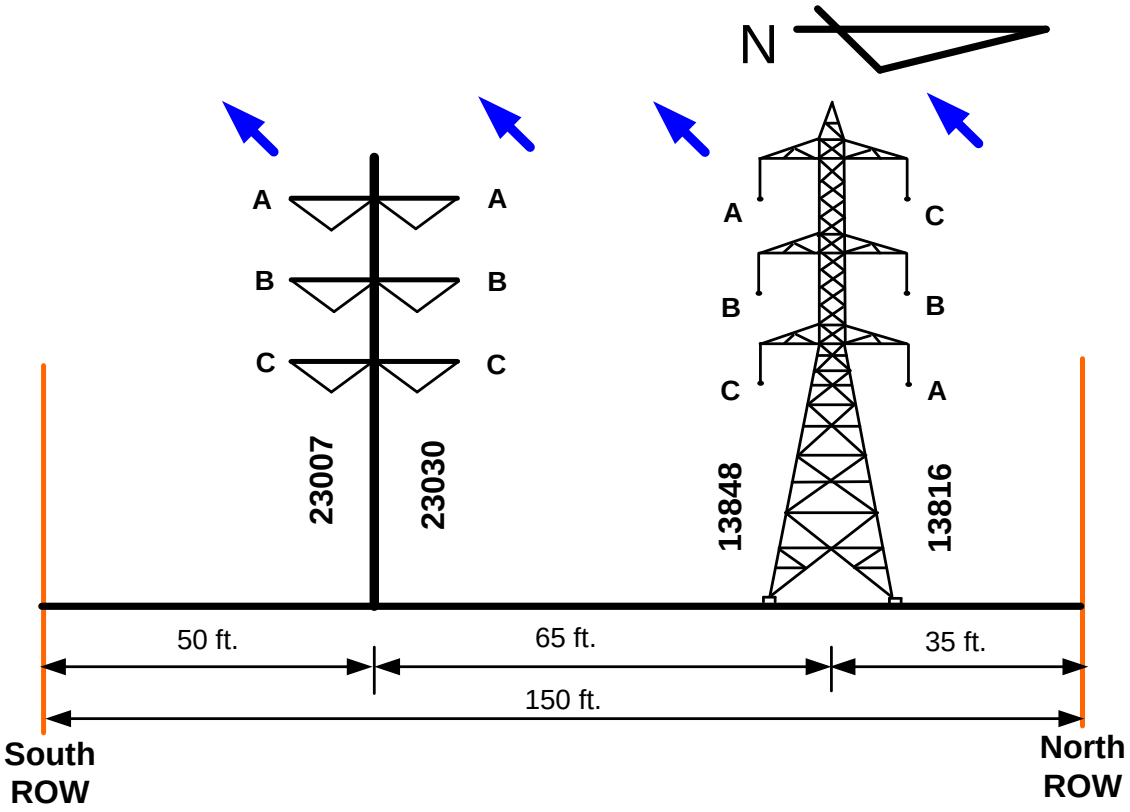
Segment Map





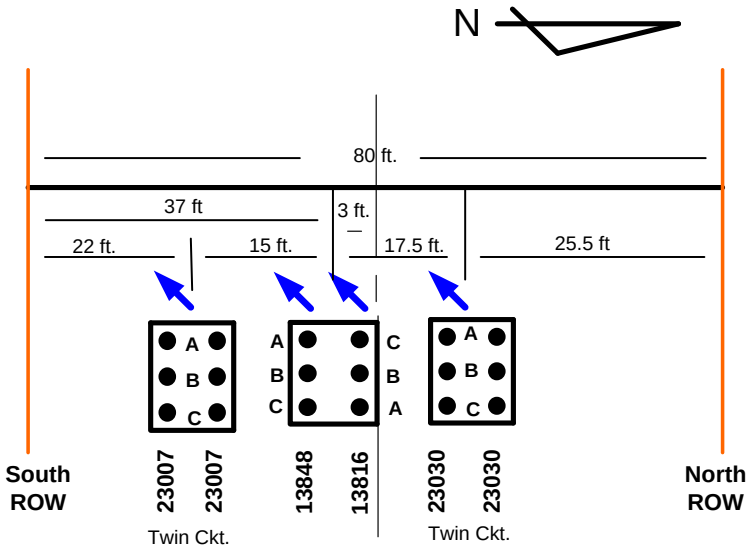
Segment 1a – Initial Design

Approximate Location:	Underground getaway west of Capistrano Substation
Transmission Circuits:	TL13847, TL13837
Land Use:	Residential
Length:	600 ft.
Right-of-Way Width:	60 ft.



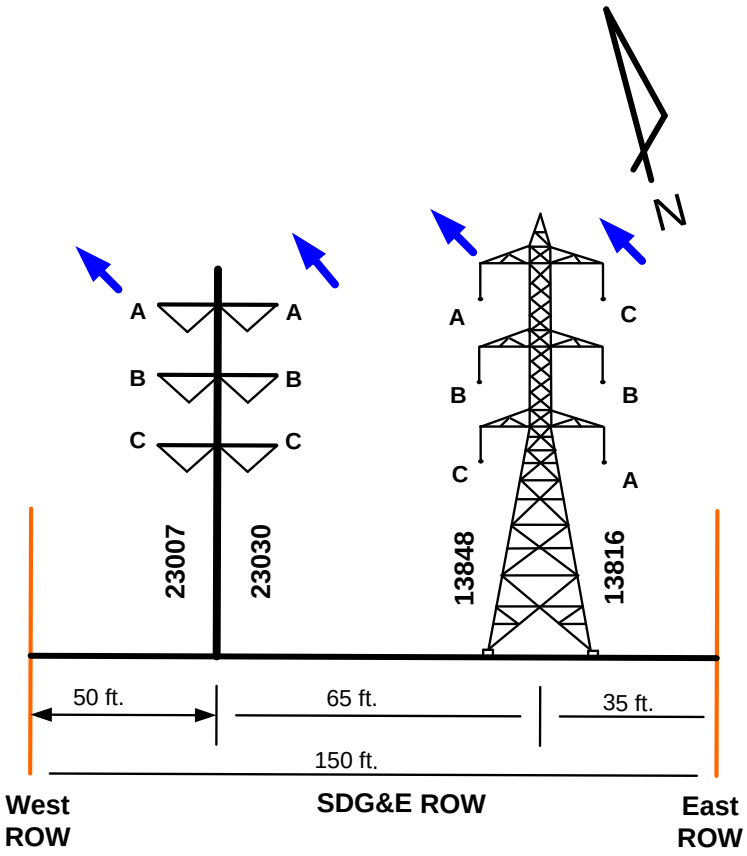
Segment 1b – Initial Design

Approximate Location:	Overhead- east of Capistrano Substation to Rancho San Juan UG
Transmission Circuits:	TL13816, TL13848, TL23030, TL23007
Land Use:	Residential, Undeveloped
Length:	2.7mi.
Right-of-Way Width:	150 ft.



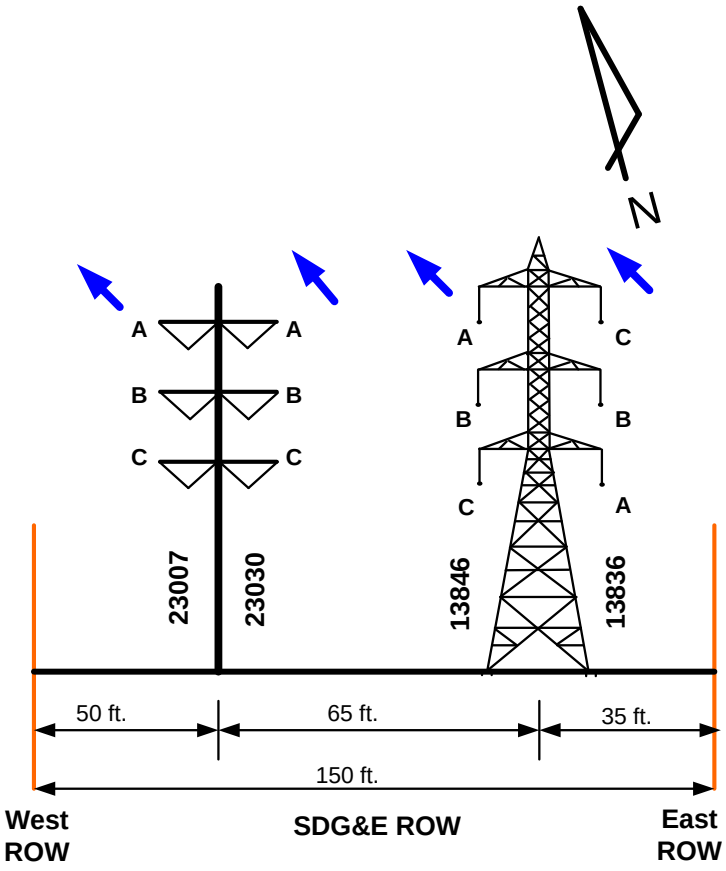
Segment 2 – Initial Design

Approximate Location:	Underground within Vista Montana between Via Pamplona and La Pata Avenue at Rancho San Juan
Transmission Circuits:	TL23030, TL13816, TL13848, TL23007
Land Use:	Residential, School (San Juan Hills High School)
Length:	0.40 mi.
Right-of-Way Width:	80 ft., within franchise Vista Montana



Segment 3a – Initial Design

Approximate Location:	Overhead - from Rancho San Juan UG to Pico Substation
Transmission Circuits:	TL13816, TL13848, TL23030, TL23007
Land Use:	Residential, Commercial/Industrial, Undeveloped
Length:	3.4 mi.
Right-of-Way Width:	150 ft.



Segment 3b – Initial Design

Approximate Location:	Overhead - Pico Substation to Talega Hub
Transmission Circuits:	TL13836, TL13846, TL23030, TL23007
Land Use:	Residential, Commercial/Industrial, Undeveloped
Length:	0.8 mi.
Right-of-Way Width:	150 ft.

Segment 4 – Initial Design

Do to the complex nature of Segment 4, and that adjacent land use out a minimum of 400 feet is undeveloped land or Camp Pendleton Military Base modeling was not required and a profile was not needed.

Approximate Location:	Talega Hub to Talega Substation
Transmission Circuits:	Many
Land Use:	Undeveloped, Camp Pendleton Military Base
Length:	TL23007 (approx. 600 ft.), TL23030 (approx. 2,630 ft.)
Right-of-Way Width:	200 ft. for Talega Hub, 150 ft. for SDG&E corridor