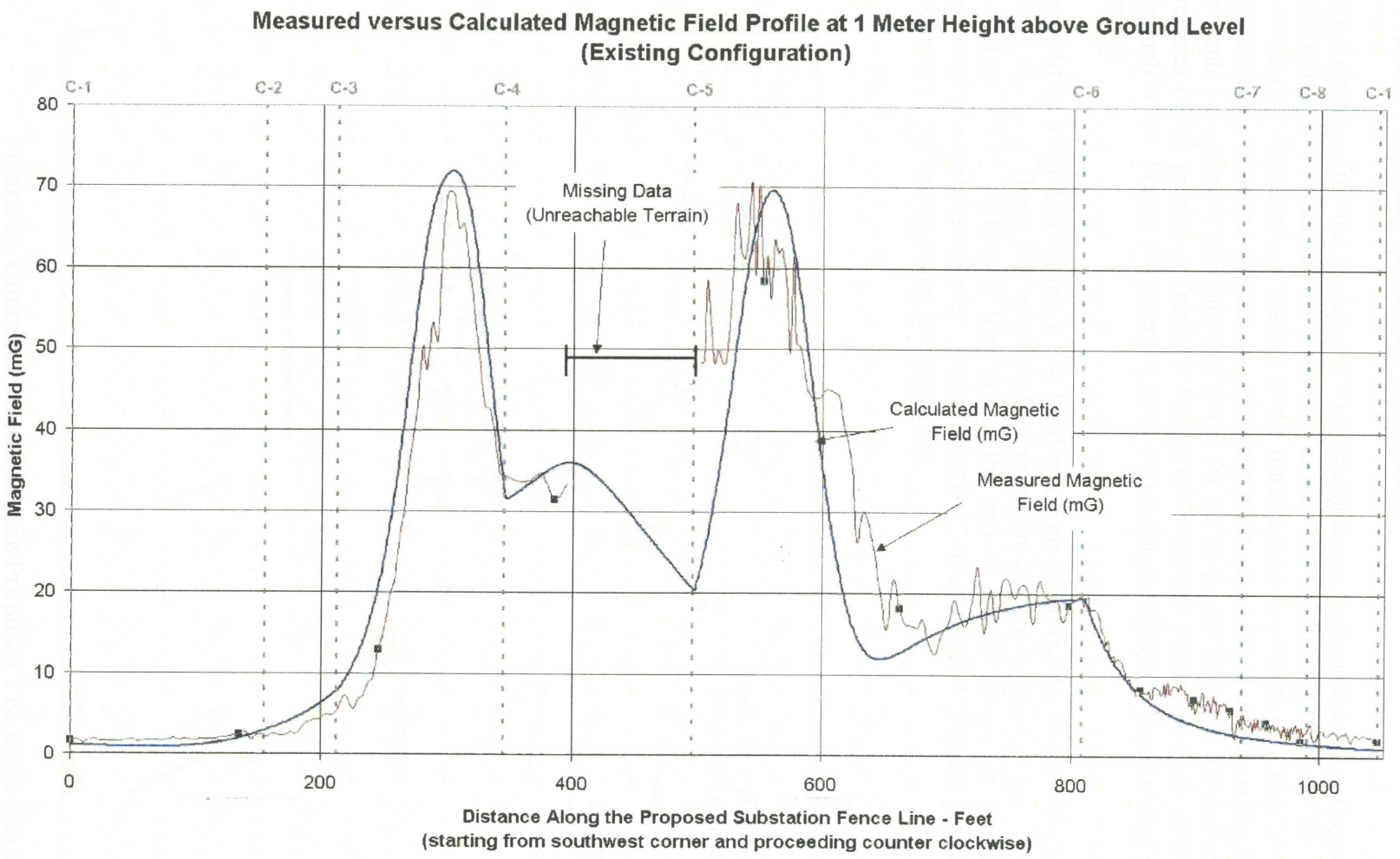

Figure 17. Comparison of Measured versus Calculated Magnetic Field Values Along the Proposed Trumbull Substation Fence Line For Measurements Conducted on May 7, 2003

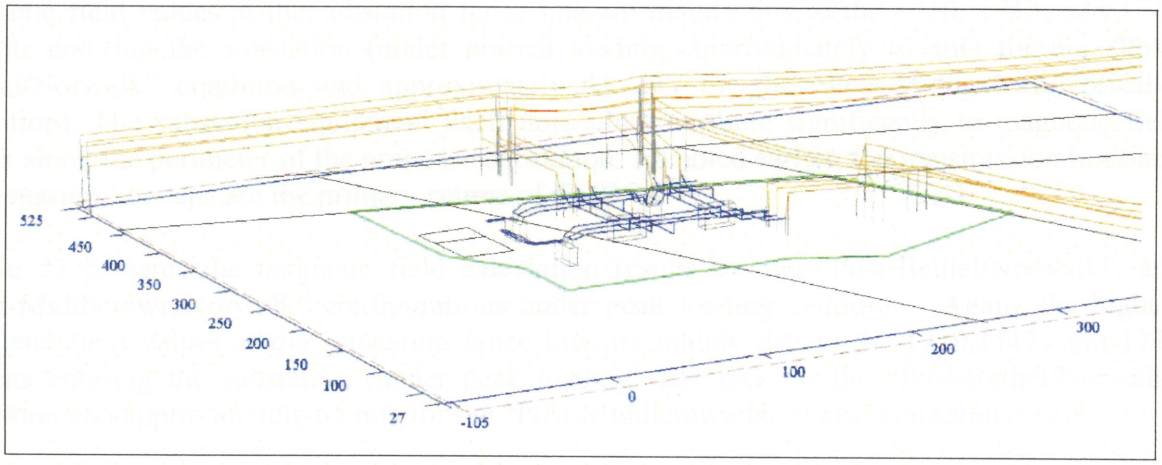

Figure 19. 3-D Diagram of the Proposed Trumbull Substation Computer Model

Electric field levels were calculated for the proposed substation configuration. Since the electric field is a function of voltage and not loading, only one electric field calculation was performed. The results of the calculations are shown in Figure 20. The highest calculated electric field value at the substation fence line is approximately 770 V/m, underneath of the 1714 115 kV transmission line as it enters the substation overhead. The electric field will be due primarily to the overhead 115 kV lines entering the substation. The electric field at the periphery of a substation produced by non-power line substation equipment is negligible.

The magnetic field for the proposed configuration was calculated for the "Pre-Bethel/Norwalk" configuration. This is a hypothetical loading condition that will not occur, as the Bethel/Norwalk Project will be in-service in December 2006, a year before the December 2007 in-service date of Trumbull Substation. However, this condition has been modeled in order to more accurately depict the changes in the electric and magnetic fields that would be attributable to the operation of Trumbull Substation, only, with out the impact of the Bethel/Norwalk Project. In this condition, the 115 kV transmission lines were loaded the same as during the day of measurements in May 2003 (See Table 3). The purpose of this condition is to show that the primary EMF sources are the transmission lines and transmission line taps, not the substation. Using the loading from the day of measurements in 2003, but including the Trumbull Substation in the computer model, the calculated peak magnetic field (along the fence line) increases from approximately 72 mG without the substation to approximately 78 mG with the substation. The slight increase in the strength of the magnetic field is attributable to the geometric relationship of the altered transmission line configuration at this measurement point, which is along the substation fence line that crosses the UI transmission line right-of way (between locations C-3 and C-4). The results of the calculations are shown in Figure 21. The "peaks" correspond to locations where the transmission lines (or new tap lines) pass overhead.

The magnetic field for the proposed configuration was calculated for normal and peak loading conditions. The results of these magnetic field calculations are shown in Figures 22 and 23. Figure 22 presents the calculation results for the "Post-Bethel/Norwalk", and "Post-Middletown/Norwalk" configurations under normal loading conditions. The highest calculated

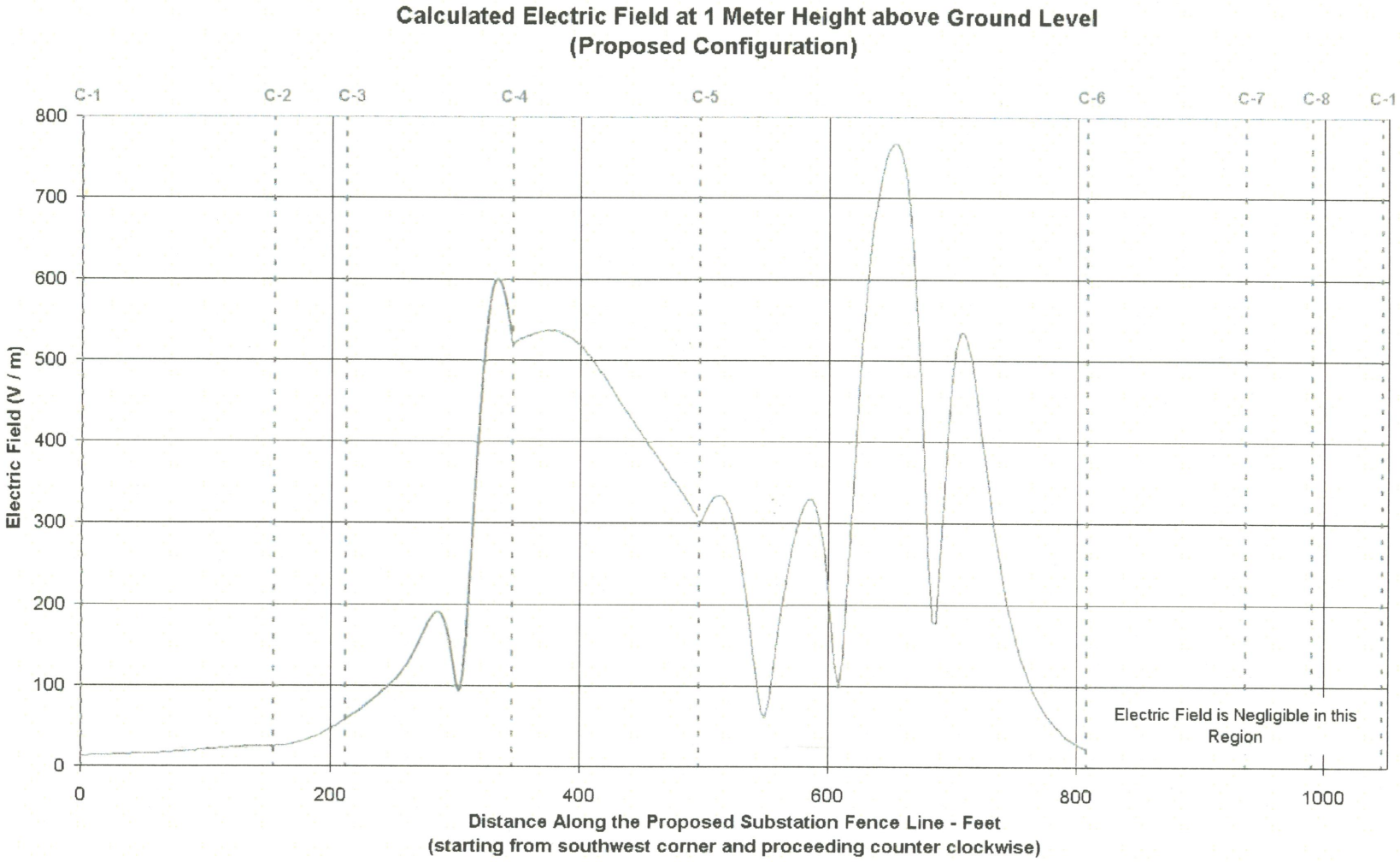

Figure 20. Calculated Electric Field Along the Proposed Trumbull Substation Fence Line (Proposed Configuration)

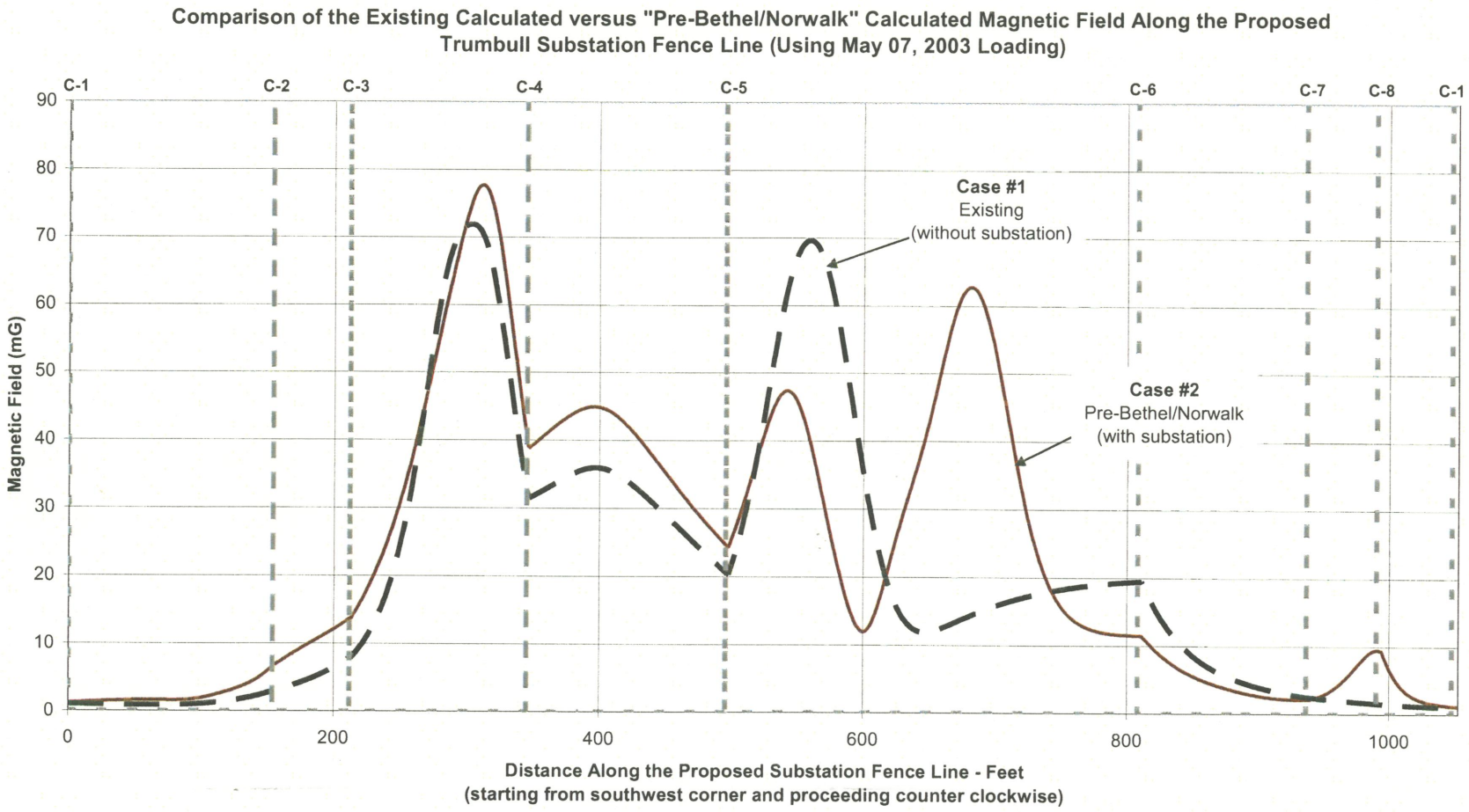

Figure 21. Comparison of the Existing Calculated versus "Pre-Bethel/Norwalk" Calculated Magnetic Field Along the Proposed Trumbull Substation Fence Line (Using May 07, 2003 Loading). This Plot Shows the Effect of Adding the Substation with the Same System Loading to Isolate the Substation's Contribution to EMF Levels. Peak Values Are Under Transmission or New Tap Lines.

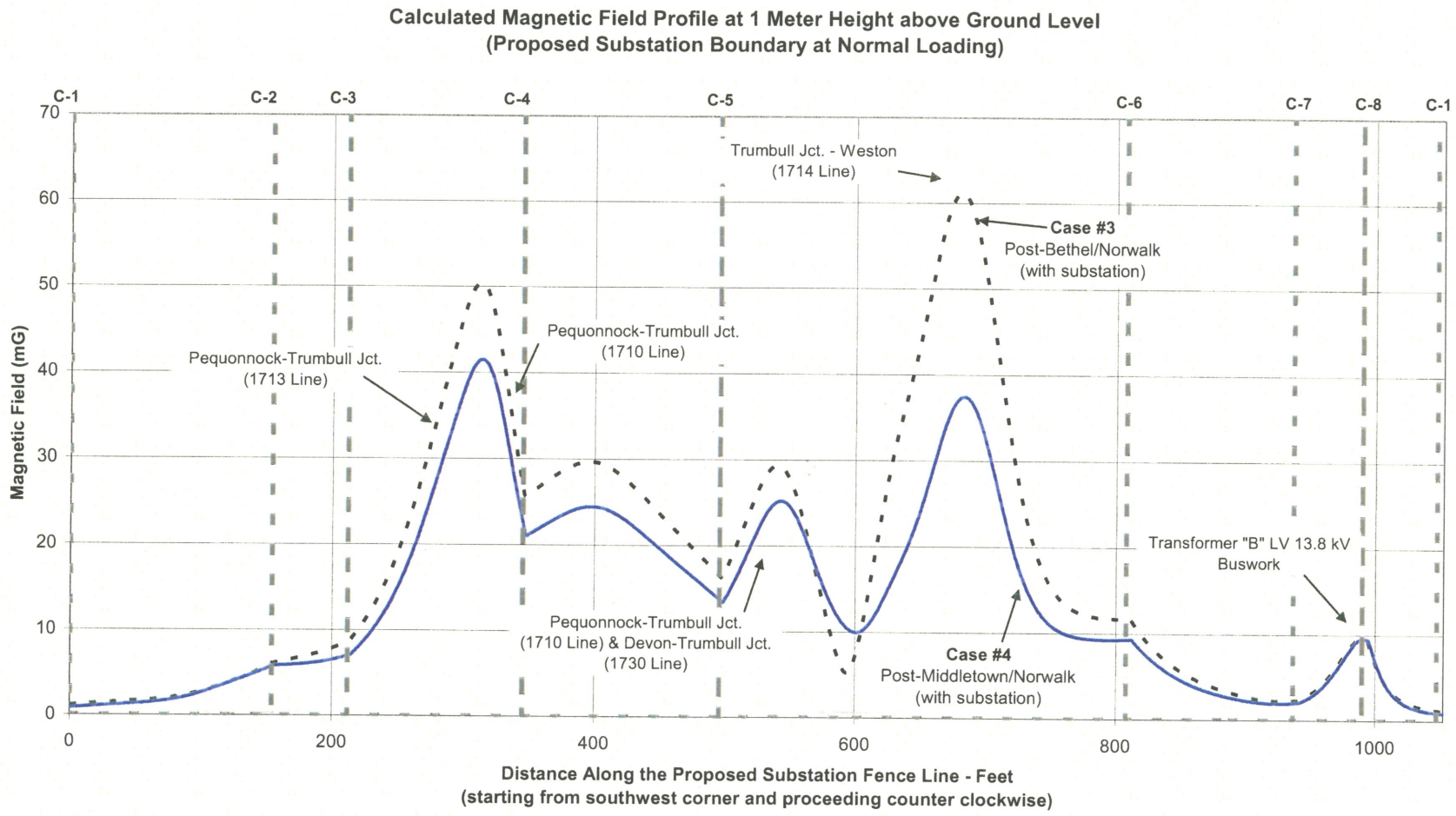

Figure 22. Calculated Magnetic Field Along the Proposed Trumbull Substation Fence Line (Normal Loading). Case #3 is Post-Bethel/Norwalk and Case #4 is the Ultimate Situation for Post-Middletown/Norwalk

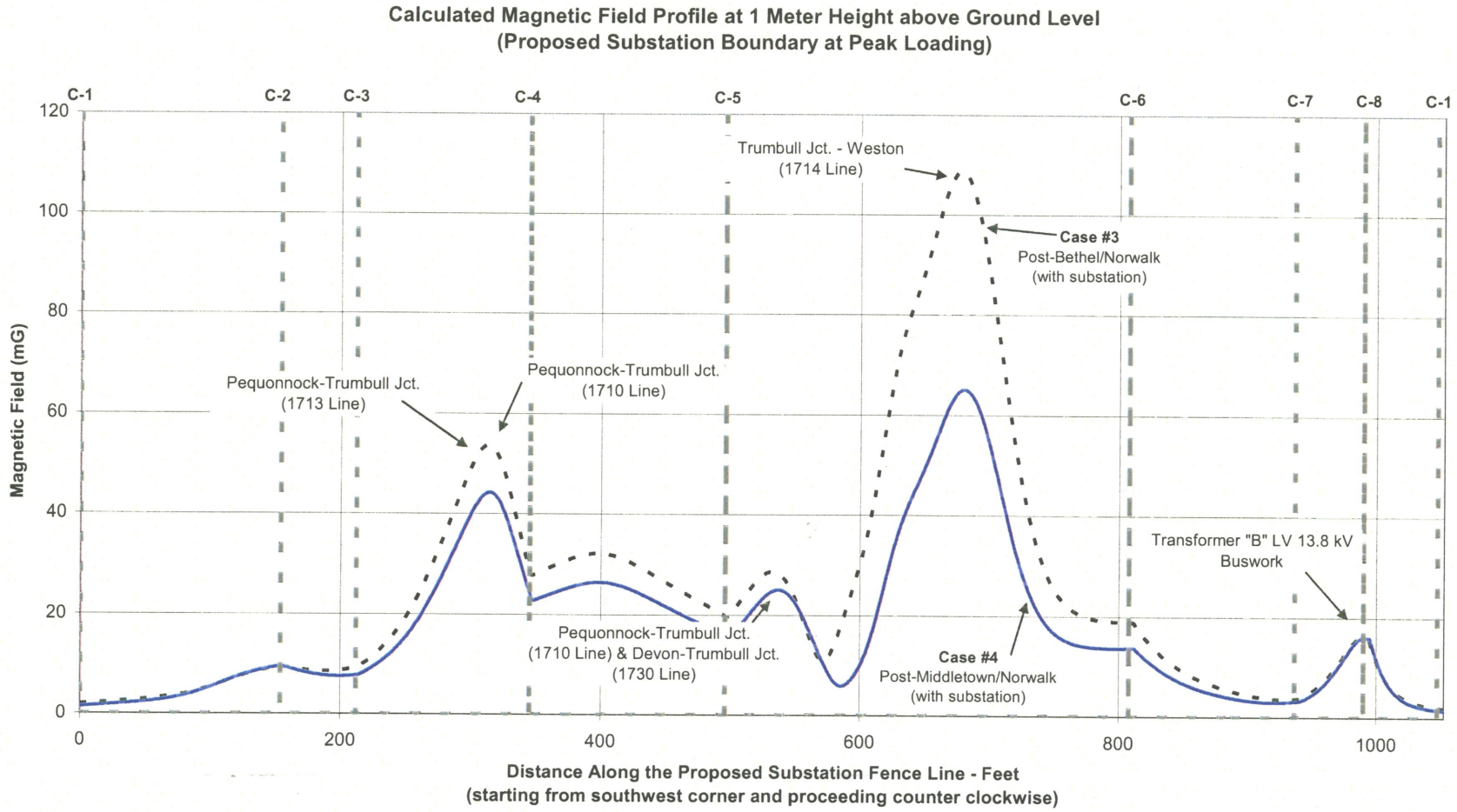

Figure 23. Calculated Magnetic Field Along the Proposed Trumbull Substation Fence Line (Peak Loading). Case #3 is Post-Bethel/Norwalk and Case #4 is the Ultimate Situation for Post-Middletown/Norwalk

Summary of Magnetic Field Calculation Results

A comparison of the magnetic field results for measured and calculated levels for the existing 115 kV transmission lines at Trumbull Junction was previously presented in Figure 17. Location points can be referenced in Figure 18.

Table 4 presents a summary magnetic field calculation results for the existing and proposed Trumbull Junction configuration for normal and peak loading conditions (both with the Trumbull Substation operational). This table demonstrates that, in general, magnetic field levels are reduced for the ultimate condition, after the Middletown/Norwalk is complete (one exception is the small areas under the short spans that tap into the new substation).

Table 4. Summary of Calculated Magnetic Field for Existing and Proposed Conditions.

Reference point	Calculated Magnetic Field- mG					
	2003 Load	2003 Load	Normal Load		Peak Load	
	Case #1: Existing Conf.	**Case #2: "Pre-Bethel/ Norwalk"** (with Trumbull)	**Case #3: "Post-Bethel/ Norwalk"**	**Case #4: "Post-Middletown/ Norwalk"**	**Case #3: "Post-Bethel/ Norwalk"**	**Case #4: "Post-Middletown/ Norwalk"**
Point "C-1" (Fence Corner)	1.2	1.2	1.2	0.9	2.0	1.5
Point "C-2" (Fence Corner)	3.1	7.1	6.1	5.7	9.6	9.6
Point "C-3" (Fence Corner)	7.9	14.3	8.8	7.2	9.4	8.2
Point "C-4" (Fence Corner)	31.7	39.3	26.0	21.3	28.1	23.1
Point "C-5" (Fence Corner)	21.4	25.0	16.3	13.8	20.2	15.7
Point "C-6" (Fence Corner)	19.4	11.3	11.5	9.4	18.2	13.5
Point "C-7" (Fence Corner)	2.5	2.2	2.4	2.1	4.0	3.4
Point "C-8" (Fence Corner)	1.6	9.4	9.5	9.4	16.0	15.9
Maximum Along the Entire Fence Line	71.9 (C-3 to C-4)	77.8 (C-3 to C-4)	61.0 (C-5 to C-6)	41.0 (C-3 to C-4)	108.0 (C-5 to C-6)	65.0 (C-5 to C-6)
Point "D-1" (Driveway)	0.3	1.0	0.9	0.7	1.6	1.1
Point "D-2" (Edge of CL&P Easement)	8.5	5.5	5.4	3.8	10.3	6.5
Point "D-3" (Edge of CL&P Easement)	8.0	10.0	8.7	6.3	13.2	8.3
Point "D-4" (Edge of CL&P Easement)	5.1	9.3	8.6	5.7	16.5	10.4

EMF Guidelines

Two organizations have developed voluntary guidelines for occupational and public exposure to electric and magnetic fields: the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the American Conference of Governmental Industrial Hygienists (ACGIH). Tables 5 and 6 present a summary of the electric and magnetic field levels of these guidelines respectively.

The ICNIRP established these guidelines to provide protection against known adverse effects. While the ICNIRP reviewed all of the scientific literature, the adverse effects on humans that were fully verified by a stringent evaluation were short term, immediate health consequences (such as nerve and muscle stimulation, shocks and burns, etc.).

The ACGIH established threshold limit values to which it is believed that nearly all workers may be exposed repeatedly without adverse health effects, based upon an assessment of available data from laboratory research and human exposure studies. The threshold limit values include additional safety factors and were developed as a guideline to assist in the control of health and safety hazards.

Both the ICNIRP and ACGIH guidelines are based on established adverse health effects (such as burns, shocks, nerve stimulation, etc.). Electric and magnetic field levels as specified in these guidelines, and which would cause these types of effects, are much higher than typical levels found in residential and most occupational environments.

Table 5. Summary of ICNIRP 50/60 Hz Exposure Guidelines

International Commission on Non-Ionizing Radiation Protection Guidelines		
Exposure (60 Hz)	Electric Field	Magnetic Field
Occupational:		
Reference Levels for Time-Varying Fields	8.333 kV/m (8,333 V/m)	4.167 G (4,167 mG)
Current Density for Head and Body	10 mA/m^2 (25 kV/m)	10 mA/m^2 (5 G)
General Public:		
Reference Levels for Time-Varying Fields	4.167 kV/m (4,167 V/m)	0.833 G (833 mG)
Current Density for Head and Body	2 mA/m^2 (5 kV/m)	2 mA/m^2 (1 G)

Table 6. Summary of ACGIH 60 Hz Exposure Guidelines

ACGIH Occupational Threshold Limit Values for Sub-Radio Frequency Fields	
Electric Field	Magnetic Field
Occupational exposures should not exceed: 25 kV/m (from 0 Hz to 100 Hz)	Occupational exposures should not exceed: 60 Hz : 10 G (10,000 mG) 50 Hz : 12 G (12,000 mG)
For workers with cardiac pacemakers, maintain exposure at or below 1 kV/m.	For workers with cardiac pacemakers, the field should not exceed 1 G (1,000 mG).

OVERALL PROJECT EMF ASSESSMENT

The United Illuminating Company (UI) proposes to construct a new 115/13.8 kV electric power substation, named the Trumbull Substation. This substation will be located in Trumbull, Connecticut at the intersection of two existing transmission line corridors. Two 115 kV transmission lines within an existing UI corridor intersect two 115 kV transmission lines within an existing Connecticut Light & Power (CL&P) corridor.

This report contains the results of measurements of EMF produced by the existing transmission lines in the two corridors at the proposed substation boundary. The report also contains the calculated EMF for the proposed substation configuration at its boundary. Normal (15 GW) and peak (27.7 GW) system loading conditions were specified by ISO New England.

The measured magnetic field at the proposed substation fence line ranged from about 1 to 71 mG, depending upon measurement location. The measured electric field ranged from about 89 to 390 V/m. Measurements were performed to comply with CSC guidelines and to validate the modeling results based upon the UI transmission line and substation input data. The highest values correspond to locations at the fence line where a 115 kV transmission line passes overhead.

For the existing transmission line configuration, the highest calculated magnetic field was 72 mG near the location where 71 mG was measured. The highest calculated electric field was about 521 V/m. This calculated maximum (521 V/m) occurs at a nearby location to where the maximum measured electric field was recorded (390 V/m). The lower measured value was due to shielding by trees on site.

Calculations were also performed to validate the model and to evaluate future electric and magnetic field levels once the proposed substation is constructed and in operation. For the proposed substation configuration, the peak electric field was calculated to be approximately 768 V/m. The highest electric field corresponds to those locations at the fence line where the 115 kV lines and taps pass overhead.

The in-service date for the Trumbull Substation is December 2007. The first phase of the 345-kV system expansion is the Bethel/Norwalk 345-kV Project (Bethel/Norwalk) which extends the 345-kV transmission system into Norwalk, has an in-service date of December 2006. The second phase of the 345-kV system expansion, the Middletown/Norwalk 345-kV Project (Middletown/Norwalk), is scheduled for completion in December 2009.

Based on the above information, and because the existing transmission lines will be impacted by the operation of the Pre-Bethel/Norwalk Project, prior to the Trumbull Substation in-service date, the Trumbull Substation EMF assessment modeled the following comparisons so as to more accurately depict the changes in the electric and magnetic fields that would be attributable to the operation of Trumbull Substation, only, though this condition represents a hypothetical situation that will not occur, as the Trumbull Substation will not be in service until after the Bethel/Norwalk Project. Other modeled cases do take into account the impact of the

Bethel/Norwalk Project and also a Post-Middletown/Norwalk condition. The specific modeled cases are:

Case #1: The Existing condition: This is a Pre-Bethel/Norwalk, Pre-Trumbull Substation condition, based on the existing line configuration and validates the predicted levels of electric and magnetic fields, versus the fields measured in May 2003 and May 2005, given the same loading on the transmission lines.

Case #2: The Post-Trumbull Substation, Pre-Bethel/Norwalk condition: This is a hypothetical loading condition that will not occur, as the Bethel/Norwalk Project will be in-service in December 2006, a year before the December 2007 in-service date of Trumbull Substation. However, this condition has been modeled modeled to more accurately depict the changes in the electric and magnetic fields that would be attributable to the operation of the Trumbull Substation. By eliminating the impact of line loading changes due to the Bethel/Norwalk Project, the effect on EMF of just the substation can be evaluated for a case where the loads remain similar but before and after the substation is operational.

Case #3: Post-Trumbull Substation, Post-Bethel/Norwalk loading condition: This modeled condition depicts the predicted levels of electric and magnetic fields that will occur after Trumbull Substation is in service, (and which follows the in service date of Bethel/Norwalk.)

Case #4: Post-Middletown/Norwalk loading condition: This modeled condition depicts the predicted levels of electric and magnetic fields that will occur after the in-service dates of all three projects, Bethel/Norwalk, Trumbull Substation and Middletown/Norwalk.

In modeled Case #2, the 115 kV transmission lines were loaded the same as during the day of measurements in May 2003 and illustrates that the primary EMF sources are the transmission lines and transmission line taps, not the substation. The calculated peak magnetic field (along the fence line) increases from approximately 72 mG without the substation to approximately 78 mG with the substation. The slight increase in the strength of the magnetic field is attributable to the geometric relationship of the altered transmission line configuration at this measurement point, which is along the substation fence line that crosses the UI transmission line right-of way (between fence locations C-3 and C-4).

The Post-Bethel/Norwalk and Post-Middletown/Norwalk load conditions were evaluated because the Bethel/Norwalk and Middletown/Norwalk projects have an impact on the loadings of the 115 kV transmission lines that serve the proposed Trumbull Substation. Since the transmission lines and transmission line taps were shown to be the primary source of magnetic fields (and not the substation), it was decided to evaluate magnetic field levels with and without these other projects. A review of 115 kV line loading reveals that the line loads go down (less EMF) after the Middletown/Norwalk project (with respect to the Bethel/Norwalk project) for the Weston, Old Town, Pequonnock, and Devon lines for both Normal and Peak cases. The impact of the Middletown/Norwalk project (with respect to the Bethel/Norwalk project) is to reduce the 115 kV line loadings (lower EMF).

For the "Post-Bethel/Norwalk" configuration, the highest calculated magnetic field at the fence line was approximately 61 mG for normal loading and approximately 108 mG for peak loading. For the "Post-Middletown/Norwalk" configuration, the highest calculated magnetic field at the fence line was approximately 41 mG for normal loading and approximately 65 mG for peak loading. The following tables summarize the results of the electric and magnetic field assessment performed along the proposed substation boundary:

Electric Field

Measurements	Calculated Electric Field	
	Existing Configuration	Proposed Substation Configuration
89 – 390 V/m	7 – 521 V/m	12 – 768 V/m

Magnetic Field

Measured and Calculated Magnetic Field			
Case #1: Existing Configuration		**Case #2**: "Pre-Bethel/Norwalk" Load Condition (with Substation)	
Measurements	Calculations Based on May 7, 2003 Load	Calculations Based on May 7, 2003 Load	
1 – 71 mG	0.9 – 71.9 mG	1.2 – 77.8 mG	
Case #3: "Post-Bethel/Norwalk" Load Condition (with Substation)		**Case #4**: "Post-Middletown/Norwalk" Load Condition (with Substation)	
Calculations Based on Normal Load	Calculations Based on Peak Load	Calculations Based on Normal Load	Calculations Based on Peak Load
1.1 – 61.2 mG	2.0 – 108.6 mG	0.9 – 41.4 mG	1.5 – 65.1 mG

The 115 kV transmission line phasing arrangements are low-EMF designs due to optimum (or opposite) phasing that result in field cancellation. The project is consistent with the Connecticut Siting Council Best Management Practices for EMF because EMF levels were evaluated as required and in its use of low-EMF design optimum phasing of the 115 kV transmission lines.

All measured and calculated EMF levels for the existing transmission lines at the existing Trumbull Junction Substation location, as well as the calculated EMF levels once the proposed Trumbull Substation is in operation, are lower than the exposure guidelines provided by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the American Conference of Governmental Industrial Hygienists (ACGIH).

REFERENCES

1. "Threshold Limit Values for Chemical Substances and Physical Agents", American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, ISBN 1-88-2417-23-2, 1998

2. "Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (Up to 300 Ghz)", International Commission on Non-Ionizing Radiation Protection (ICNIRP), Health Physics, 74:494-522, 1988

3. "IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines", IEEE Std 644-1994, Institute of Electrical and Electronics Engineers, 1994