CL&P Docket No. 370
Data Request CSC-02
Dated 04/02/2009
Q-CSC-049-BULK

SUPPLEMENT TO CL&P's FIELD MANAGEMENT DESIGN PLAN

SPECIFIC TO THE

CONNECTICUT PORTION OF THE MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE

BETWEEN AGAWAM, MA AND LUDLOW, MA

Supplement to Application
Appendix O-1
CL&P's Field Management Design Plan

March 20, 2009

I. INTRODUCTION

The purpose of this document is to supplement CL&P's Field Management Design Plan (FMDP) originally included as Appendix O-1 in CL&P's Application to the Connecticut Siting Council (Council) for the Greater Springfield Reliability Project (GSRP or Project). An FMDP section had not been completed for the Connecticut Portion of the Massachusetts Southern Route Alternative at the time of the Application.

In accordance with the Council's Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut, December 14, 2007 (hereinafter referred to as "BMP"), a Field Management Design Plan (Plan) was developed for the Connecticut Portion of the Agawam to Ludlow 345-kV line on the Massachusetts Southern Route Alternative. This Plan begins with a design of the proposed overhead transmission line incorporating standard utility practice to which "no-cost" magnetic field management design features are added (see Section O of the Application). This design is called the "base line design". The Plan then examines modified overhead line designs incorporating low-cost magnetic field management design features at locations where the transmission line route could be considered by the Council to be adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The BMP further call for the incorporation of low-cost modified line designs to reduce magnetic fields at certain locations. The benchmark for additional Project spending on these modified designs is up to 4% of the estimated Project cost using the base line design, including the cost of the Project's related substation work. The BMP also specifies that this extra cost allowance should be used on measures to achieve magnetic field reductions at edges of the ROW of 15% or more with respect to the base line design's associated levels. The extra cost allowance associated with any decision to build the Agawam to Ludlow 345-kV line on the Massachusetts Southern Route Alternative would be $0.9 million. Should this alternative be chosen, the total available allowance for the Project would increase from $5.3 million to $6.2 million. In addition, any allowance funds remaining from the FMDP decision for the proposed GSRP 345-kV line from Agawam to North Bloomfield would also be available for FMDP spending on the Connecticut portion of the Agawam to Ludlow 345-kV line on the Massachusetts Southern Route Alternative. CL&P's recommended FMDP spending on the proposed GSRP 345-kV line from Agawam to North Bloomfield was $2.2 million. If this recommendation were to be accepted without change by the Council, the remaining $4.0 million (2.6 percent of total Project cost in Connecticut) would be available for field management along the Connecticut portion of the Massachusetts Southern Route Alternative.

The intention of the BMP is to achieve magnetic field reductions using some or all of the extra cost allowance. However, the overall 4% project spending guideline and the 15% reduction target are both flexible guidelines. As stated in the BMP, minor increases above the 4% spending guideline and decreases from the 15% reduction guideline may be justifiable in some circumstances. The Council will review CL&P's recommendations in the FMDP, and then select from CL&P's design alternatives the best means to achieve the BMP goals.

Follow-up information on magnetic fields and the Plan can be obtained by contacting Mr. Robert E. Carberry of Northeast Utilities Services Company at 860-665-6774 and Dr. Gary Ginsberg of the Connecticut Department of Public Health (DPH) at 860-509-7750.

II. GREATER SPRINGFIELD RELIABILITY PROJECT – MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE

II.1 PROJECT DESCRIPTION AND BASE LINE DESIGN

In addition to the Connecticut Portion of the proposed 345-kV line between North Bloomfield Substation in Bloomfield, Connecticut and the Agawam Substation in Agawam, Massachusetts, it is possible that one other segment of new 345-kV line may be located in Connecticut. This segment would be part of the "geographically distinct designated alternative" to the proposed line route between the Agawam and Ludlow Substations, both located in Massachusetts. WMECO is required to present this alternative to the Massachusetts Energy Facilities Siting Board (EFSB) as part of its application for approval of the proposed Massachusetts facilities.

The majority of this designated alternate route would be located in Massachusetts; however, part of it crosses into Connecticut for a distance of approximately 5.4 miles. Within Connecticut, the new 345-kV line would be located on an existing ROW which is typically 280 to 300 feet wide. This ROW has sufficient unused width to construct the new 345-kV line on H-Frame structures with the line conductors in a horizontal configuration. A horizontal line configuration is the preferred base line configuration because it allows for less visible lower structure heights and is the most economical configuration to build. For the base line configuration, the phasing of the 345-kV line will be selected to minimize the magnetic field produced by this line and the adjacent 115-kV line on the ROW edges.

II.2 FOCUS AREAS FOR MAGNETIC FIELD MANAGEMENT

Per the Council's BMP, the primary focus area for applications of low-cost magnetic field management designs are those locations where public or private schools, licensed child day-care facilities, public playgrounds, licensed youth camps, or residential areas are adjacent to a proposed new transmission line. For the Connecticut portion of the Massachusetts Southern Route Alternative of GSRP, there are three schools and several child day-care facilities in the general vicinity of the proposed line. These facilities are not "adjacent to" the line and are sufficiently distant from it that magnetic field levels at the facilities will not be appreciably changed by the new line. However, over a 3.7-mile distance in Enfield, both sides of the ROW are bordered by dense residential development appearing to qualify as "residential areas" within the meaning of the underground presumption of Section 16-50i(p) of the Connecticut General Statutes. This section of ROW is between existing structures 22024 and 22052, beginning west of Interstate 91 and continuing east, past North Maple Street (State Route 192) to Mayfield Road. Maps in Volumes 9 and 11 of the Application illustrate the locations of homes along the Connecticut Portion of the Massachusetts Southern Route Alternative 345-kV Line Route.

Should the Massachusetts Southern Route Alternative be chosen for the proposed Agawam to Ludlow 345-kV line, then this area in Enfield would be a focus area for considering magnetic field management measures.

II.3 BASE AND ALTERNATIVE GSRP - MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE LINE DESIGNS FOR MAGNETIC FIELD REDUCTIONS IN THE ENFIELD FOCUS AREA

II.3.1 Horizontal Conductor Configuration Using 345-kV H-Frame Line Structures, the Base Line Design

A depiction of a typical 345-kV H-Frame line structure is shown in Figure 1. With "no-cost" best circuit phasing in relation to any adjacent lines, this is CL&P's preferred and base line design for use in all areas where sufficient ROW exists. Throughout the ROW in the focus area, the base H-Frame line would be centered at 120 feet from the northern ROW edge. Structure, and therefore conductor, heights can be increased to reduce the magnetic field at both edges of the ROW, but only relatively large height increases in this case would achieve the 15% reduction target at both ROW edges. Typical 345-kV H-Frame line costs for two average structure heights, based upon use of laminated wood poles with direct embedded foundations, are summarized in Table 1.

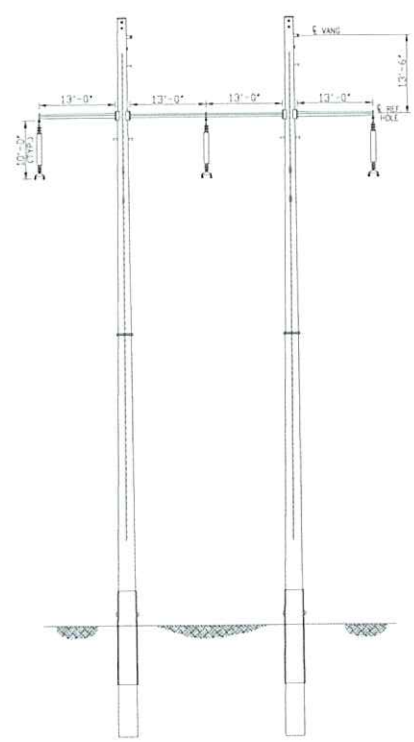
Table 1: Typical 345-kV H-Frame Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
90' H-Frame	$3,739,000
110' H-Frame	$3,914,000

Notes:

- *Structure costs are based on (10) structures per mile [(8) tangents and (2) 3-pole structures for H-Frames].*
- *Conductor costs are based on (2) 1590-kcmil ACSR "Lapwing" conductors.*
- *Costs include labor, material, and hardware.*

Figure 1: Tangent H-Frame Structure



II.3.2 345-kV Delta Line Configuration

A typical 345-kV delta line structure is shown in Figure 2. Such a line would be constructed using steel monopoles and concrete pier foundations. A delta configuration of the line conductors allows for a narrower line which would lower magnetic field levels in the focus area's ROW edges if constructed on the same centerline as the base case line design. Typical 345-kV delta line costs for two average structure heights can be found in Table 2.

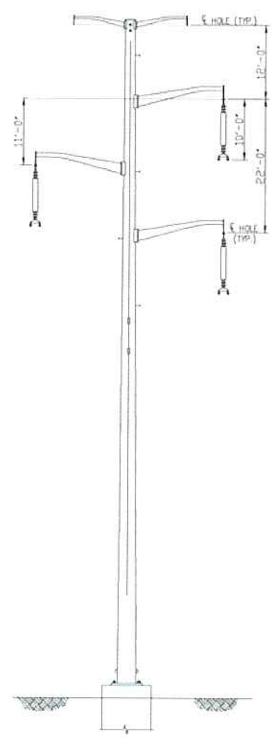
Table 2: Typical 345-kV Delta Line Costs Per Mile

Cost Per Mile	
Structure Description	Total
110' Delta	$4,613,000
130' Delta	$5,241,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) DE].*
- *Conductor costs are based on (2) 1590-kcmil ACSR "Lapwing" conductors.*
- *Costs include labor, material, and hardware*

Figure 2: Tangent Delta Structure



II.3.3 345-kV Vertical Line Configuration

Vertical lines, using structures as shown in Figure 3, are typically constructed on narrower ROWs or where several lines are routed on the same ROW. Such a line would be constructed using steel monopoles and concrete pier foundations. A vertical line configuration is the narrowest possible line configuration, and it produces lower magnetic field levels at the northern ROW edge in the focus area if its conductors are installed over the same centerline as the base case H-Frame line. In fact, the magnetic field levels at the ROW edges would be close to those for the delta line configuration. Typical 345-kV vertical line costs for two average structure heights are provided in Table 3.

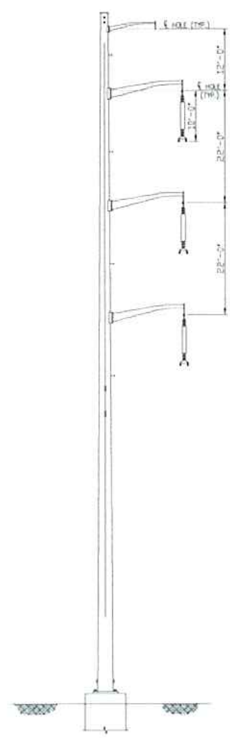
Table 3: Typical 345-kV Vertical Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Vertical	$5,015,000
150' Vertical	$5,497,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) DE].*
- *Conductor costs are based on (2) 1590-kcmil ACSR "Lapwing" conductors.*
- *Costs include labor, material, and hardware*

Figure 3: Tangent Vertical Structure



II.3.4 345-kV Split-Phase Line Configuration

A 345-kV split-phase line configuration, using structures as shown in Figure 4, would employ twice as many line conductors, thus reducing the current in any one conductor by half. This difference, together with reverse phasing of the two sets of line conductors, achieves larger reductions in magnetic field levels in the focus area's ROW edges than can be achieved by either the delta or vertical line designs. Such a line would be constructed using steel monopoles and concrete pier foundations. Typical 345-kV split-phase line costs for one average structure height are provided in Table 4.

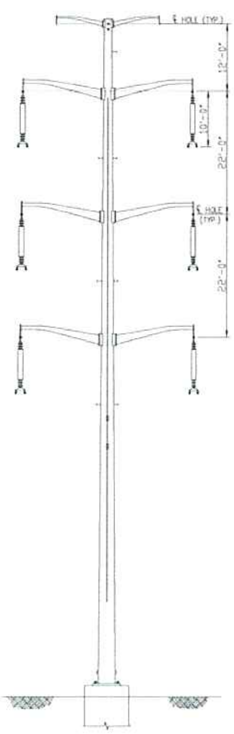
Table 4: Typical 345-kV Split-Phase Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Split-phase	$9,348,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) DE].*
- *Conductor costs are based on (2) 1590-kcmil ACSR "Lapwing" conductors.*
- *Costs include labor, material, and hardware*

Figure 4: Tangent Split-Phase Structure



II.3.5 345/115-kV Composite Line Configuration

By using a 345/115-kV composite line configuration, shown in Figure 5, the conductors of the two transmission circuits on the ROW can be supported in a vertical configuration on a shared line of structures. If the phasing of the two circuits is optimized, and the 345-kV line conductors are installed on the same centerline as the base case H-Frame line, then the edge-of-ROW magnetic field levels in the focus area can be reduced to lower levels than a base case 345-kV H-Frame line and the existing 115-kV line on adjacent H-Frame structures would produce. By combining the 115-kV circuit on the 345-kV line structures, the nearest line conductors to the northern ROW edge will be about 50 feet further from this ROW edge than at present. This line configuration would be constructed using steel monopoles with concrete pier foundations. Typical 345/115-kV composite line costs for one average structure height are provided in Table 5.

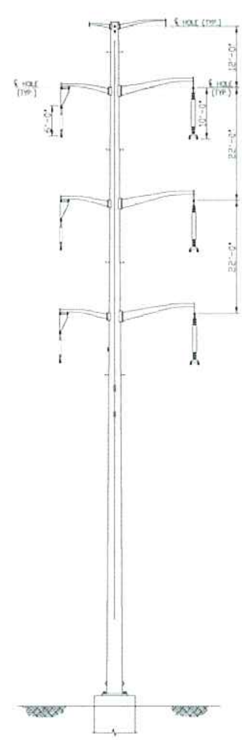
Table 5: Typical 345-kV Composite Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Composite	$8,972,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) DE].*
- *Conductor costs are based on (2) 1590-kcmil ACSR "Lapwing" conductors.*
- *Costs include labor, material, and hardware*

Figure 5: Tangent Composite Structure



II.3.6 Conductor Heights Above Ground

CL&P calculates magnetic fields using typical conductor heights above ground at the middle of cross-country line spans. Wherever conductor heights are higher above ground, magnetic fields will be lower at the ground level on and immediately adjacent to the ROW. Because conductor heights above ground increase between the mid-span points and the line structures, magnetic field levels will be lower at ROW edge locations which are not opposite the mid-span points than CL&P's calculated values. At an additional cost, all of the previously depicted 345-kV line designs can be constructed with additional conductor heights above ground by increasing the supporting structures' heights. In this Plan, additional conductor heights above ground of 20 feet were modeled for the base case line design and two alternative line designs.

II.3.7 Conductor Separation

Reducing the separation distance between each of the three conductor bundles of a 345-kV line can reduce magnetic field levels. However, reducing the conductor separations below CL&P's standard separations for each 345-kV line design can reduce reliability and make it unsafe for line workers to perform live-line maintenance. To achieve at least a 15% reduction in magnetic field levels at ROW edges, an H-Frame line would require its conductor-bundle separation distance be reduced from the standard 26 feet to 22 feet. For 345-kV lines, reduced conductor separation will also result in increases in corona-caused noise levels in wet weather. CL&P has evaluated this reduced phase spacing on H-Frame structures and determined it would compromise safe live-line maintenance. As such, CL&P is not considering any use of reduced conductor separations in this Plan.

II.3.8 Passive Loop Shielding

Magnetic field reduction can be achieved over small areas with wire loops installed parallel to overhead lines, for example along a ROW edge. These loops can be designed such that the magnetic fields produced by currents induced in the loop conductors partially cancel the transmission line magnetic fields, resulting in a decreased magnetic field at the ROW edge. The area of reduced magnetic fields near passive loops is relatively small, and the additional structures and wires add visual impact. For these reasons, CL&P does not consider passive loop shielding to be a practical field-management tool for this Project.

II.3.9 Shifting the ROW or Alignments of Lines on a ROW

Under certain circumstances, an entire ROW segment could be shifted to provide additional distance between the new lines and adjacent facilities, thereby reducing magnetic fields at these facilities. This is seldom a practical or low-cost option as it would require purchasing new easements and would result in a proposal of lines on new ROW when the existing ROW could be more than adequate to construct a proposed new line.

Shifting line alignments on a ROW is also seldom a practical magnetic field management option. For a ROW adjacent to residential areas, where there are residences on both sides of the ROW, any shift in line alignment on a ROW usually would reduce magnetic field levels at the residences on one side of the ROW and increase the levels at residences on the other side. Doing this where the ROW is wide enough for a future line addition will make that future line's construction on the ROW difficult without reworking the line shift.

II.4 MAGNETIC FIELD LEVELS PRODUCED BY THE BASE LINE DESIGN AND BMP ALTERNATIVE LINE DESIGNS IN THE FOCUS AREA

CL&P's consultant, Exponent, calculated magnetic fields for the ROW cross section over the 3.7-mile Southern Route Alternative section in Enfield per recognized industry practice (i.e., typical minimum mid-span clearance of conductors to ground, 1 meter above ground, assumption of flat terrain and balanced currents). These calculations were made at three New England system load levels estimated by CL&P to occur in the year 2017, specifically the annual average load, the annual peak load, and the peak-day average load. Please refer to Section O of the Application for the assumptions made in system load-flow modeling to determine the line currents over this ROW section for each of the three load levels and to Appendix O-4 for summaries of the resulting magnetic fields at the average annual, annual peak, and peak day average loadings.

Table 6 shows the difference in calculated magnetic field levels at the ROW edges for the pre-NEEWS condition in 2012 and the post-NEEWS condition in 2017 with the base case line design.

Table 6: Magnetic Field Comparison, Pre- and Post-NEEWS Configurations on GSRP - Southern Route Alternative ROW in Enfield

XS-S07 Cross Section Configuration	Average Annual Load Case		
	Maximum Level on ROW (mG)	North ROW Edge Level (mG)	South ROW Edge Level (mG)
Pre-NEEWS (2012)	20.1	7.0	0.3
Post-NEEWS (2017) - Base Line Design	277.7	17.3	15.2

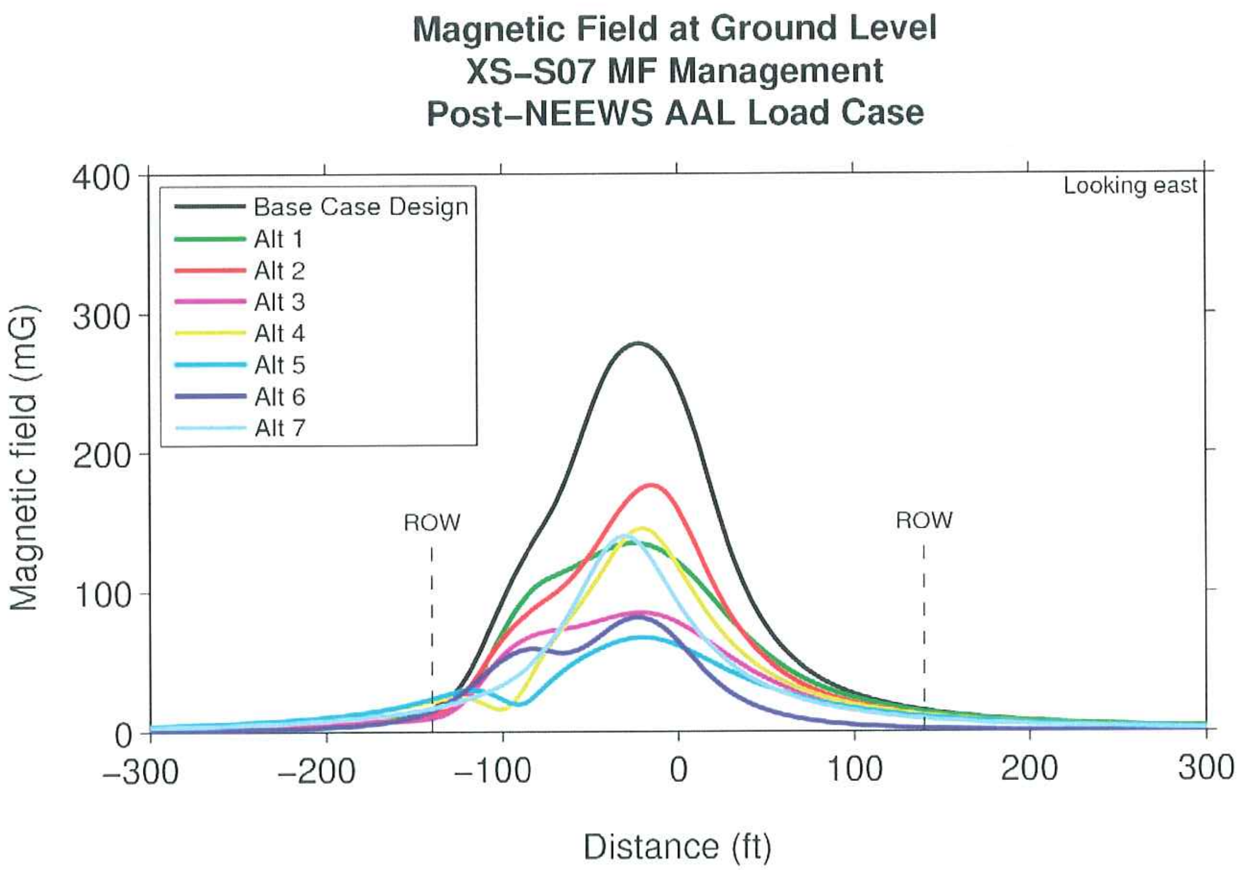
Table 7 shows the calculated edge-of-ROW magnetic field levels at mid-span along this 3.7-mile ROW segment in Enfield. It includes levels for the base design of the new line and for seven alternative designs, as well as local construction costs associated with each of these line designs. The table shows the percentage by which these mid-span edge-of-ROW magnetic fields would be reduced or increased for the alternative line designs, relative to the edge-of-ROW magnetic field levels of the base line design. The result comparison is for a 2017 annual average load.

Table 7: Magnetic Field Management Results for a 3.7-mile Section of the GSRP – Massachusetts Southern Route Alternative ROW in Enfield

XS-S07 Cross Section Configuration	Typical Structure Height (ft)	Average Annual Load Case					Cost	
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge			
			Level (mG)	Change (%)	Level (mG)	Change (%)	Section Amount ($)	Project Increase (%)
Base Line Design H-Frame	90	277.7	17.3		15.2		$11,714,000.00	-
Alt 1 - H-Frame +20 feet	110	134.9	10.3	- 40%	14.3	- 6%	$12,225,000.00	0.3%
Alt 2 - Delta Configuration	110	170.5	12.1	- 30%	11.9	- 22%	$15,067,000.00	2.2%
Alt 3 - Delta +20 feet	130	85.0	10	- 42%	10.9	- 28%	$16,908,000.00	3.4%
Alt 4 - Vertical Configuration	130	143.8	22.3	+ 29%	11.9	- 22%	$15,998,000.00	2.8%
Alt 5 - Vertical +20 feet	150	67.1	24	+ 39%	10.8	- 29%	$17,432,000.00	3.7%
Alt 6 - Split Phase	130	81.5	15.4	- 11%	2.5	- 84%	$26,631,000.00	9.6%
Alt 7 - 345/115-kV Composite	130	137.6	17.2	- 1%	9.4	- 38%	$ 27,527,000.00	10.2%

Figure 6 provides a graphical representation of the calculated magnetic field levels over the ROW cross section for the line segment between existing 115-kV line structures 22024 and 22052, based on the 2017 annual average load case. This graph includes the base case line design and all seven design alternatives.

Figure 6: Magnetic Field Profiles for a 3.7-mile Section of the GSRP – Massachusetts Southern Route ROW in Enfield



The table and figure show that the delta line configuration is the only line configuration that would achieve a magnetic field reduction of over 15% on both edges of the ROW. A height increase of 20 feet on the delta line configuration would further reduce the levels on both edges, but with additional cost. A vertical line configuration would increase the magnetic field levels on one ROW edge while reducing levels on the other edge. The split-phase and the composite 345/115-kV line configurations would each reduce magnetic field levels on both edges of the ROW, but not by at least 15% on both edges, and not within the 4% cost allowance.

II.5 CL&P RECOMMENDATION FOR THE 3.7-MILE GSRP – MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE ROW LINE SEGMENT IN ENFIELD

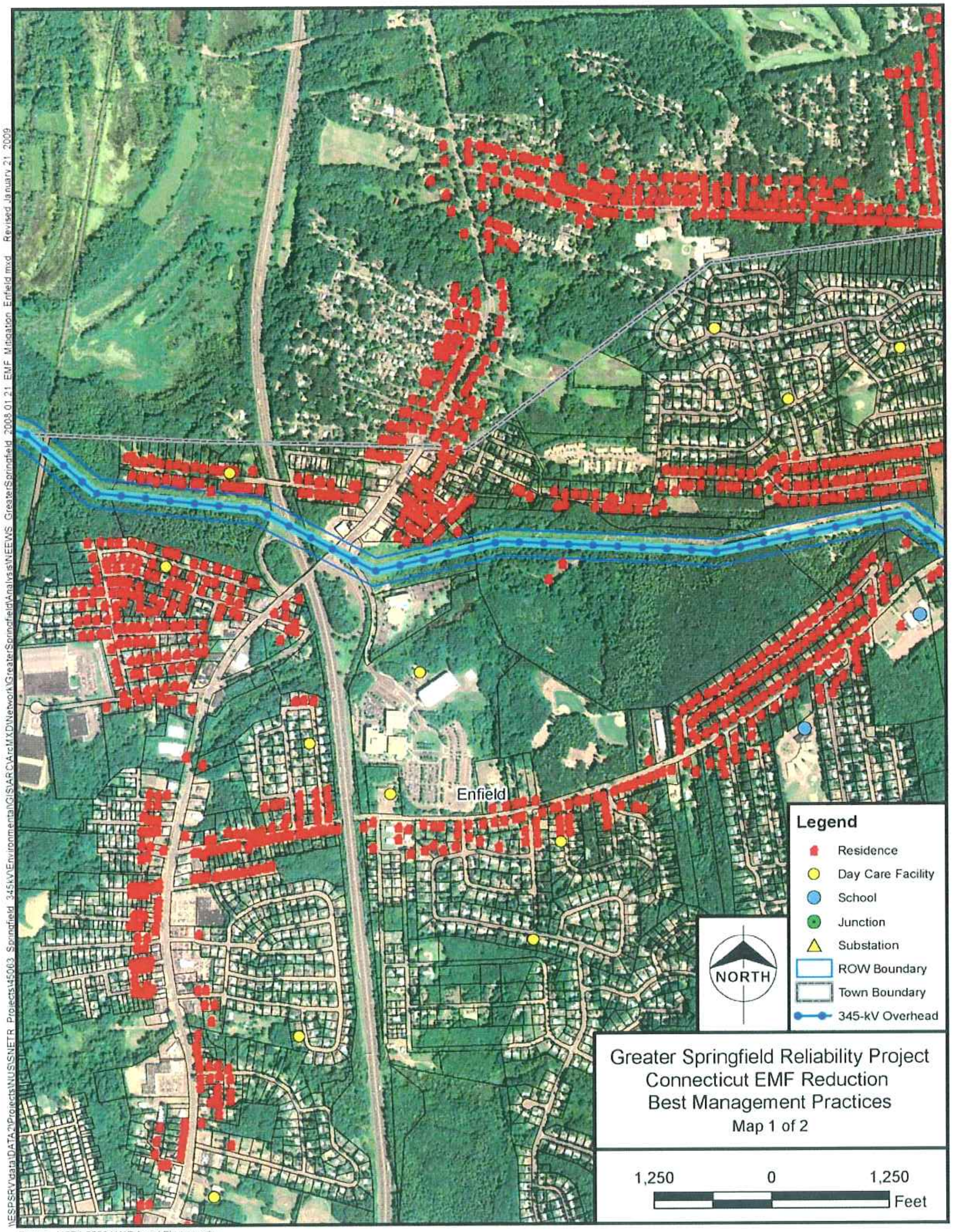
Alternative line designs for magnetic field reductions that cause safety or reliability consequences, do not achieve magnetic field reductions of at least 15% on both edges of the ROW, or that interfere with the ability of the ROW to accept future lines are not recommended. A delta line configuration, or a delta line configuration with an additional 20 feet of height , are the only alternative line designs for this focus area which meet the listed criteria. The delta line configuration results in a magnetic field decrease of over 5mG on the north ROW edge and over 3mG on the south ROW edge. Increasing the delta line height by 20 feet would further reduce magnetic field levels on the north edge by 2mG and on the south edge by 1mG, and would entail an increased cost exceeding 1% the Project cost. The delta line design over 3.7 miles in Enfield could be implemented in addition to the CL&P magnetic field management recommendation for the proposed GSRP route in CT without exceeding the 4% spending allowance. Therefore, CL&P recommends a delta line design in this focus area.

Should the Council, in its balancing of impacts and magnetic field management, conclude that the base line design or any other 345-kV line design alternative examined in the Plan are preferred, CL&P is prepared to build any of these line designs over the 3.7-mile segment.

II.6 AERIAL MAPS FOR THE CONNECTICUT SECTION OF THE GSRP – MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE

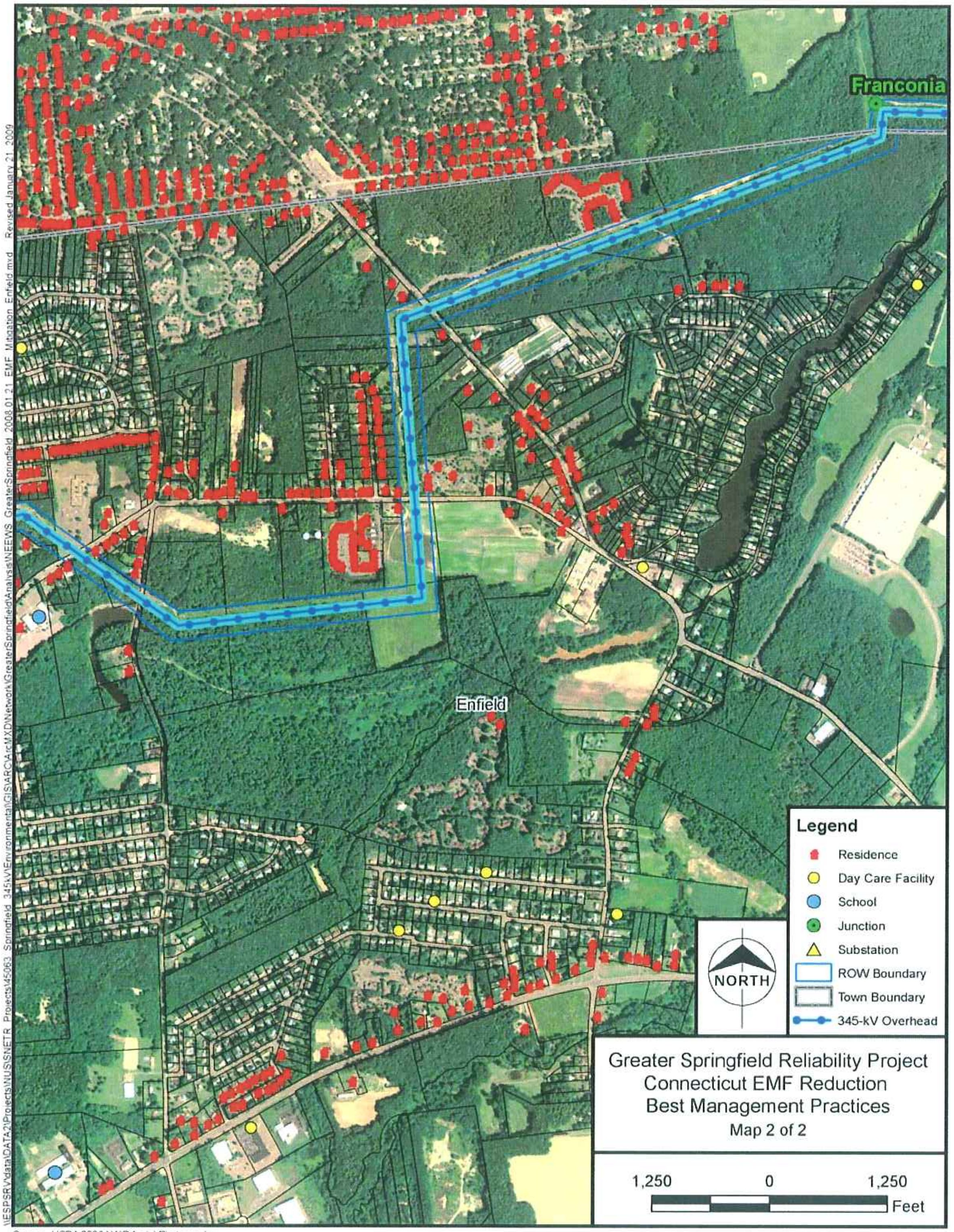
Aerial maps of homes in the area near the Connecticut Portion of the GSRP – Massachusetts Southern Route follow.

Figure 7: Aerial Map for Connecticut Portion of the GSRP – Massachusetts Southern Route Alternative, Page 1 of 2



Source USDA 2006 NAIP Aerial Photography

Figure 8: Aerial Map for Connecticut Section of the GSRP – Massachusetts Southern Route Alternative, Page 2 of 2



Source: USDA 2006 NAIP Aerial Photography

II.7 CROSS SECTIONS FOR THE CONNECTICUT SECTION OF GSRP – MASSACHUSETTS SOUTHERN ROUTE ALTERNATIVE

The following cross sections are provided for reference to the various alternate configurations.

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