Needham Board of Health

AGENDA

Thursday, November 10, 2016
4:00 p.m. – 6:15 p.m.

Charles River Room – Public Services Administration Building
500 Dedham Avenue, Needham MA 02492

- **4:00 to 4:05 - Welcome & Review of Minutes (October 21st)**
- **4:05 to 4:30 - Discussion re: Modera Needham Housing**
  - **Lars Unhjem, Vice President, Mill Creek Development**
  - **Doug Brugge, Professor, Tufts School of Medicine**
- **4:30 to 5:00 - Discussion of Marijuana Dispensaries & Residential Parcels**
  - **Matt Borrelli and Marianne Cooley, Board of Selectmen**

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Board of Health Public Presentation/Hearing

- **5:00 to 5:30 - Eversource West Roxbury to Needham Reliability Project and Associated Health Impacts**
  - **Jack Lopes, Community Relations Specialist, Eversource**
- **5:30 to 5:40 - Initial Review of Draft Regulations**
  - **Tobacco Regulations (proposed revisions)**
  - **Marijuana (proposed new regulations)**

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- **5:40 to 5:50 - Board Discussion of Policy Positions, Goals**
- **5:50 to 6:00 - Overview of Public Health Accreditation**
- **6:00 to 6:15 - Director and Staff Reports**
- **Other Items**
- **Next Meeting … Friday December 16th? Friday December 2nd?**
- **Adjournment**

(Please note that all times are approximate)

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Board of Health

ARTICLE 24 **REGULATION TO ENSURE THE SANITARY AND SAFE OPERATIONS OF COMMERCIAL AND RECREATIONAL MARIJUANA ESTABLISHMENTS, AND TO MINIMIZE COMMUNITY IMPACTS AND COLLATERAL CONSEQUENCES OF WIDESPREAD RECREATIONAL MARIJUANA USE AND BOTH COMMERCIAL AND PERSONAL MARIJUANA CULTIVATION**

SECTION 24.1 AUTHORITY

This regulation is promulgated under the authority granted to the Needham Board of Health under Massachusetts General Laws Chapter 111, Section 31 which states that "boards of health may make reasonable health regulations," and to Section 122 of the same chapter of the Massachusetts General Laws which states, in part, that "the board of health shall examine into all nuisances, sources of filth and causes of sickness within its town, or on board of vessels within the harbor of such town, which may, in its opinion, be injurious to the public health, shall destroy, remove or prevent the same as the case may require, and shall make regulations for the public health and safety relative thereto…"

Board of Health Regulations are an exercise of the police power under which the various levels of government are responsible for protection of the public health, safety, and welfare.

Additionally, this regulation is promulgated pursuant to DETAILS OF STATE BALLOT LANGUAGE AND/OR CANNABIS CONTROL COMMISSION REGULATIONS. ~~---- Chapter 369 of the Acts of 2012 An Act for the Humanitarian Medical Use of Marijuana ("The Act") and Massachusetts Department of Public Health Regulations 105 CMR 725.000.~~

SECTION 24.2 PURPOSE & RATIONALE

24.2.1 – PURPOSE FOR REGULATION

The primary purpose of this regulation is to provide for local oversight and inspection of Commercial and Retail Marijuana Establishments (CRMEs) and also to provide for the local oversight and inspection marijuana cultivation sites within the Town of Needham, whether commercial or personal in nature.

Under this regulation, Needham's Board of Health and its agents shall provide oversight and inspections to ensure the safe and sanitary operation of any such CRME or commercial or personal cultivation site within the Town of Needham. The oversight and corresponding inspections shall be consistent with public health and safety standards, and will incorporate DETAILS OF STATE BALLOT LANGUAGE AND/OR CANNABIS CONTROL COMMISSION REGULATIONS.

The regulation is intended to ensure that only people age 21 years or older will acquire marijuana or marijuana-infused products pursuant to the Act, and that marijuana will not be diverted to individuals under the age of 21. Since the existence of a CMRE or any marijuana cultivation site present a risk of improper diversion and other collateral consequences within the community, it is necessary to regulate this activity at the local level.

24.2.2 – RATIONALE FOR REGULATION, INCLUDING PUBLIC HEALTH REASONS

WORK IN PROGRESS

Charged with the protection of the public health, boards of health fulfill their duty by developing, implementing, and enforcing health policies. "The focus of public health is to protect the health of every member of a community." American Lithuanian Naturalization Club, Athol, Mass., Inc. & others v. Board of Health of Athol & another, 446 Mass. 310 (2006). One step in this process is the adoption of local health regulations pursuant to Massachusetts law. Boards of health have statutory powers to develop regulations in many areas of environmental health. G.L. c.111, §31 gives boards general regulatory power to adopt reasonable health regulations. §§31A and 31B address the removal, transportation and disposal of refuse. Section 122 addresses nuisances, §127 addresses house drainage and sewer connections. §127A addresses the sanitary code and §143 addresses (noisome/offensive trades).

Board of health regulations "stand on the same footing as would a statute, ordinance or by-law." Druzik v. Board of Health of Haverhill, 324 Mass. 129, 138 (1949). Moreover, "[a]ll rational presumptions are made in favor of the validity of [the regulations]." Id. Courts will only strike a Board of Health regulation when the challenger proves, on the record, '"the absence of any conceivable ground upon which [the rule] may be upheld.'" Arthur D. Little, Inc. v. Com'r of Health, 395 Mass. 535 (1985) (quotation and citations omitted). If the public health issue is "fairly debatable," the court cannot

substitute its own judgment for that of the Board of Health. Id. (citations omitted). Said rule preserves the separation between the powers of the legislature and its administrative agencies and those of the judiciary. Id. (citations omitted). In addition, said rule acknowledges that Boards of Health are the experts in the area of public health policy. Id. (citations omitted).

The Supreme Judicial Court has repeatedly upheld the broad regulatory authority of boards of health. Most recently, the Court upheld a regulation that prohibited all smoking in private clubs. American Lithuanian Naturalization Club, Athol, Mass., Inc, & others v. Board of Health of Athol & another, 446 Mass. 310 (2006). Stating nothing in G.L. c.111, §31, or our prior case law warrants a conclusion that members of a community may be protected by health regulations only when they are in a location to which the public has access. Even if smoking members choose to disregard the overwhelming evidence of the serious health consequences of smoking, the board rationally could be concerned about the exposure of non-smokers to a "known human carcinogen" Id.

Additionally, boards of health have broad authority to enforce their regulations. See G.L. c.111, §27 (authorizing Boards of Health to "employ the necessary officers, agents and assistants to execute the health laws and its regulations"). Boards may issue enforcement orders. In the event the order is ignored, Boards of Health may seek and obtain injunctive orders in superior court restraining violations of their regulations. G.L. c.111, §187, §189. Boards of health may also suspend, revoke or refuse to issue a permit after a hearing, notice and opportunity to be heard. Butler v. Town of E. Bridgewater, 330 Mass. 33, 38, 110 (1953). In addition, boards may levy specified fines and collect them through criminal proceedings in district court. E.g. G.L. c.111, §31; G.L. c. 111,§122; G.L. c. 111, §31C. Alternatively, boards may, if authorized by the municipality, issue tickets and thereby collect fines through the less arduous non-criminal method of disposition. G.L. c.40, §21D. Additionally, boards of health may, if authorized by the municipality, suspend any license it has issued to any person who has neglected and/or refused to pay a fine issued under the non-criminal method of disposition. G.L. c.40, §57.

A person's business is a property right and is therefore entitled to protection against regulations that violate constitutional guaranties. Unless the regulation is justified as a valid exercise of the police power, the regulation would be declared unconstitutional because enforcement would deprive a person of his property without due process of law. Duplex Co. v. Deering, 254 U.S. 443, 465 (1921), *quoted in* S.S. Kresge Co., 267 Mass. at 151. Persons regulated pursuant to a valid regulation, however, cannot complain that their business has been injured by the exercise of the police power for the benefit of the public health. "The right to engage in business must yield to the paramount right of government to protect the public health by any rational means." Druzik, 324 Mass. at 139; Lawrence v. Board of Registration in Medicine, 239 Mass. 424, 428 (1921).

Regulations may be prospective in nature. That is, boards of health may require precautions to avoid potential dangers as well as to restrict conditions actually harmful. City of Waltham v. Mignosa, 327 Mass. 250, 251-52 (1951); Commonwealth v. E.E. Wilson Co., 240 Mass. 406, 410, (1922); Town of Holden v. Holden Suburban Supply Co., Inc., 343 Mass. 187, 191 (1961).

Regulations adopted pursuant to the board's rule making authority, such as regulations adopted under §31 and §43, do not require a hearing (unless they are relative to Title V, see, Chapter 4) or findings of fact. Arthur D. Little v. Commissioner of Health and Hosp. of Cambridge, 395 Mass. 535, 543 (1985). "It is well established that agency is not obligated to provide a statement of reasons which support its adoption of a regulation." Borden, Inc. v. Commissioner of Pub. Health, 388 Mass. 707, 723 n.9, *cert. denied stub nom. quoted* in Arthur D. Little, 395 Mass. At 543. Formaldehyde Inst., Inc., v. Frechette, 464 U.S. 936 (1983).

§31 of G.L. c.111, is an unusually broad grant of authority which empowers boards of health to adopt "reasonable health regulations." The power of boards of health to adopt regulations under §31 is extensive. Enactment of §31 "provided a comprehensive, separate, additional source of authority for health regulations." Board of Health of Woburn v. Sousa, 338 Mass. 547, 550 (1959). "[Section] 31 was passed as legislation of broad and general scope, after [the predecessor statutes] had been on the statute books for many years. The legislative history shows no purpose to limit its scope." Id. at 551-52.

In Brielman v. Commissioner of Pub. Health of Pittsfield, 301 Mass. 407 (1938), the city board of health had adopted a regulation prohibiting the sale of unpasteurized milk unless it had been certified according to provisions of state law. The regulation prevented the sale of three of the eight classes of milk established by the state of milk regulation board. The regulation was challenged and the court stated that boards of health "may make regulations that are more stringent than the general law." Id. at 410. A strict insistence upon a high standard of purity and safety in milk, in fact higher than that required by the state, was determined to be well within the police power.

The case law is clear that municipal boards and officials do not need statutory authority to adopt licensing and permit fees. Any statutory authorization to a municipality or to a board to regulate includes authorization to require licenses and licensing fees '"to cover reasonable expenses incident to the enforcement of the rules'". Commonwealth v. Plaisted, 148 Mass. 375, 382 (1889), *quoted in* Southview Co-operative Hous. Corp. v. Rent Control Bd. Of Cambridge, 396 Mass. 395, 400 (1985).

Further, if the authority to regulate includes the authority to require licenses and licensing fees, the authority to regulate also includes the authority to exact fees to defray the cost of conducting hearings and performing other services. Southview Co-operative Hous Corp., at 400. As the court observed in Boston v. Schaffer, 26 Mass (9 Pick) 415, 419 (1830), "[t]owns are put to expense in preserving order and it is proper that they should be indemnified for inconveniences or injuries occasioned by employments of this nature". G.L. c.40, §22F

Even though boards have inherent authority to adopt licensing and user fees, the legislature has specifically provided statutory authorization for the imposition of such fees and charges. G.L. c. 40, §22F authorizes municipal boards or officials empowered to issue a license, permit or perform a service or work to fix reasonable fees after the municipality has accepted the provisions of §22F by a vote of town meeting or the city council. G.L. c. 44, § 53G provides that certain municipal board regulations, including the board of health's regulations adopted under G.L. c.31, §111, can provide for the imposition of reasonable fees for the employment of outside consultants.

SECTION 24.3 DEFINITIONS

Unless otherwise indicated, terms used throughout this regulation shall be defined as they are in 105 CMR 725.004.

Board of Health: Town of Needham Board of Health and its designated agents.

Board of Health Agent: The Director of Public Health and any town employee designated by the Director, which may include Public Health Department staff, law enforcement officers, fire officials, and code enforcement officials.

Business Agent: A Dispensary Agent, as also defined in 105 CMR 725.004, who has been designated by the RMD Permit Holder to be a manager in charge of the RMD facility and its operations.

Card Holder: A registered qualifying patient, a personal caregiver, or a dispensary agent of a RMD who has been issued and possess a valid registration card.

Commercial and Recreational Marijuana Establishment (CRME): A Commercial and Recreational Marijuana Establishment is an entity ~~registered under 105 CMR 725.100~~, that acquires, cultivates, possesses, processes (including development of related products such as edible MIPs, tinctures, aerosols, oils, or ointments), transfers, transports, sells, distributes, dispenses, or administers marijuana, products containing marijuana, related supplies, or educational materials to customers age 21 or older. The term CRME may also refer, in context, to the site(s) of dispensing, cultivation, and preparation of marijuana by a CRME entity.

CRME Agent: A CRME Agent is a board member, director, employee, executive, manager, or volunteer of a CRME, who is at least 21 years of age. Employee includes a consultant or contractor who provides on-site services to a CRME related to the cultivation, harvesting, preparation, packaging, storage, testing, or dispensing of marijuana.

CRME Permit: A Commercial and Recreational Marijuana Establishment Permit, to be renewed annually, which may be issued by the Board of Health to an applicant pursuant to 105 CMR 725.000, which permits a CRME to operate within the Town of Needham.

Director: The Director of Public Health.

Home Permit: Issued by the Board of Health, to be renewed annually, which allows the permit holder to cultivate up to six marijuana plants at a specific location within the town. That location is subject to a health and safety inspection and approval by the Director and his designated agents.

Non-Residential Roll-Your-Own (RYO) Machine: A mechanical device made available for use (including to an individual who produces rolled marijuana products solely for the

individual's own personal consumption or use) that is capable of making rolled marijuana products. RYO machines located in private homes used for solely personal consumption are not Non-Residential RYO machines.

Period of Performance: The time period for which violations of a CRME or Home Permit are counted. For example, a violation that occurs in July 2017 will no longer weigh on the CRME or Home Permit holder's record with the Board of Health after the passage of 60 months from the date of the discipline imposed for that violation. If the Board of Health hearing on the violation occurred on July 31, 2017, then the violation will be outside the period of performance and no longer counted on August 1, 2022.

Self-Service Display: Any display from which customers may select marijuana or a marijuana-infused product without assistance from a Commercial and Recreational Marijuana Establishment.

Town: The Town of Needham, Massachusetts.

Vending Machine: Any automated or mechanical self-service device, which upon insertion of money, tokens or any other form of payment, dispenses or makes marijuana products.

Violation: A failure to comply with an operational requirement outlined in this regulation. For this regulation, a MINOR violation is a failure to comply with specific regulatory requirements, which, while important, do not jeopardize the primary purposes of this regulation. A MAJOR violation is one that has the potential to jeopardize the primary purposes of this regulation, meaning that non-compliance in this area may divert marijuana to individuals under the age of 21 and/or which may produce significant collateral consequences to community health and public safety.

SECTION 24.4 PERMIT TO OPERATE A REGISTERED MARIJUANA DISPENSARY

24.4.1 – Permits for a Registered Marijuana Dispensaries

A. No person or organization shall sell or otherwise distribute marijuana or marijuana-infused products within the Town of Needham without first obtaining a RMD Permit. A RMD Permit may only be issued to a nonprofit corporation which:
   (i) has a current Certificate of Registration issued by the Massachusetts Department of Public Health (DPH) pursuant to 105 CMR 725.000; and
   (ii) has a permanent, non-mobile location in Needham approved by the DPH for use as an RMD; and
   (iii) is in compliance with all applicable zoning requirements.

   And which provides satisfactory documentation of compliance with those requirements to the Board of Health.

B. The applicant shall also submit to the Board of Health a copy of the operating policies and procedures for the RMD which was submitted to DPH pursuant to105 CMR 725.000 and any other relevant DPH directives, memorandums or notifications.

C. The applicant shall sign a statement declaring that the applicant understands that, under this local regulation:
   (i) all Dispensary Agents are responsible for complying with all local and state regulations pertaining to the operation of the RMD. Specifically, a violation of any provision of 105 CMR 725.000 or other applicable state regulations constitutes a violation of this regulation, which may be enforced by the Board of Health; and
   (ii) the applicant is responsible for providing instruction and training for dispensary agents in all applicable local and state regulations; and
   (iii) the fact that a Dispensary Agent, vendor, or other person associated with the RMD is unaware of a regulation or lacks understanding of its content, shall not be a defense to any violation; and
   (iv) the Board of Health and its designated agents may conduct periodic, unannounced inspections of the RMD premises.

D. The fee for a RMD Permit shall be at the level determined in the Needham Board of Health's Fee Schedule. All RMD Permits expire on June 30 annually, regardless of the year or day and month on which they were issued.

E. The initial plan review for marijuana-infused product (MIP) production facilities (see section 20.5.1) shall result in a fee at the level determined in the Needham Board of Health's Fee Schedule. The initial plan review for the safe and sanitary storage of marijuana-infused products in a RMD (see section 20.5.2) shall result in a fee at the level

determined in the Needham Board of Health's Fee Schedule. The initial plan review for trash collection and the safe and sanitary disposal of waste (see section 20.5.3) shall result in a fee at the level determined in the Needham Board of Health's Fee Schedule. The plan reviews for emergencies and continuity of operations (see section 20.5.4) and for safety and security (see section 20.5.5) shall result in a fee at the level determined in the Needham Board of Health's Fee Schedule.

F. RMD Permits in good standing may be renewed annually by the Board of Health, at the Board's discretion, based on a completed and satisfactory application, in a form required by the Board, filed by the RMD and payment by the RMD of the annual fee according to the fee schedule.
   (i) Any material changes from the most recent approved operating policies and procedures, or from the plans described in Section E above shall be disclosed in the renewal application, and RMD shall pay the applicable fees for any reviews which the Board deems necessary as a condition of renewal.
   (ii) If a permit has been modified by the Board, the RMD shall demonstrate compliance with any requirements of that modification, to the satisfaction of the Board, as a condition of renewal and shall pay the applicable fees for any reviews which the Board deems necessary as a condition of renewal.
   (iii) If a permit has been suspended by the Board, prior to reinstatement of the permit, the RMD shall provide evidence satisfactory to the Board that it will comply with all requirements of the Board and these regulations, and shall pay the applicable fees for any reviews which the Board deems necessary as a condition of renewal
   (iv) If a permit has been revoked by the Board, the RMD permit may be reissued based on a new application, all necessary fees, and a public hearing.

G. A separate RMD Permit is required for each RMD retail establishment selling marijuana or marijuana-infused products within the Town. A violation of this provision constitutes a MINOR violation of these regulations.

H. Each RMD Permit shall be displayed at the RMD retail establishment in a conspicuous place. A violation of this provision constitutes a MINOR violation of these regulations.

I. A RMD Permit is non-transferable. A violation of this provision constitutes a MINOR violation of these regulations.

J. A RMD Permit will not be renewed if the RMD Permit Holder has failed to pay any outstanding fines or fees or failed to satisfy any other penalties or conditions lawfully imposed by the Town.

K. A RMD may not open for business before 8:00 A.M. and shall close no later than 8:00 P.M., on each day the RMD is open. Deliveries from, or on behalf of, the RMD that are made to patients must adhere to the same hours. The hours and days of RMD operation must be posted conspicuously on the front entrance door. A violation of this provision constitutes a MINOR violation of these regulations.

L. Acceptance of a RMD Permit constitutes an agreement by the RMD that it will adhere to the practices, policies, and procedures described or submitted with its application, as well as the relevant laws, state and local regulations, and conditions imposed by the Board of Health as part of the permit process.

20.4.2 – Inspections and Compliance of Registered Marijuana Dispensaries

A. Dispensary Agents must present their Registration Card on request by any Board of Health agent. A violation of this provision constitutes a MINOR violation of these regulations.

B. Issuance and maintaining a RMD Permit shall be conditioned on the RMD Permit Holder's ongoing consent to periodic, unannounced inspections of the RMD premises by the Board of Health and its designated agents. The applicant also consents to abide by the provisions relating to inspections found in 105 CMR 725.300 and related sections including, but not limited to, "deficiency statements" and "plans of correction." A violation of this provision constitutes a MINOR violation of these regulations.

C. There must be a designated Business Agent on the premises at all times that the RMD is open for business. A violation of this provision constitutes a MINOR violation of these regulations.

D. The Board of Health and its designated agents, as well as the Needham Police Department, shall be provided with an updated phone list through which a Business Agent may be reached on a 24 hour basis. A violation of this provision constitutes a MINOR violation of these regulations.

E. Issuance and maintaining a RMD Permit shall be conditioned on the RMD Permit Holder's ongoing consent to provide the Board of Health with copies of the Registration Cards for all Dispensary Agents working at the RMD, and the names of all Business Agents of the RMD, and to submit any changes in staffing and registration information within five (5) business days. The notification and information about changes in staffing and registration shall be submitted in either paper copy via courier or certified mail or else electronically in a verified/e-signed PDF format. A violation of this provision constitutes a MINOR violation of these regulations.

F. The RMD Permit Holder shall Criminal Offender Record Information (CORI) inquiry and a Sex Offender Registry Information (SORI) inquiry on all applicants for the positions of

Dispensary Agent and for Business Agents. Such checks shall be conducted in all states in which the applicant has worked or resided within the last ten (10) years. The results of those inquiries shall be reported to the Needham Public Health Department. A violation of this provision constitutes a MINOR violation of these regulations.

G. Issuance and maintaining a RMD Permit shall be conditioned on the RMD Permit Holder's ongoing consent to provide the Board of Health with updated copies of all RMD documents including copies of staffing plans, training protocols, audit results, security assessments (subject to appropriate redaction), and all other documents. Updated submissions shall be sent to the Board of Health monthly electronically in a verified/e-signed PDF format. A violation of this provision constitutes a MINOR violation of these regulations.

H. No RMD Permit Holder shall permit any disorder, disturbance, or illegality of any kind to take place in or on the licensed premises. The term "illegality" includes, but is not limited to, any violation of 105 CMR 725.000 and related directives, memoranda or notifications; and any violation of these regulations promulgated by the Board of Health. The Permit Holder shall be responsible for any disorder, disturbance or illegality of any kind whether present or not. A violation of this provision shall be considered may be considered either a MINOR or a MAJOR violation depending upon the severity of the illegality identified.

I. Failure or refusal of an RMD or Home Permit holder to cooperate with the Board of Health or its agent shall be considered a MAJOR violation of these regulations.

20.4.3 – Records Retention of Registered Marijuana Dispensaries

A. A RMD Permit Holder shall notify the Needham Public Health Department and the Board of Health verbally and in writing within 24 hours of a visit to the premises or request for information by any representative of DPH acting in an official capacity. The RMD Permit Holder shall provide the Board with any reports, correspondence, emails or other information from DPH on demand or, in any case, within five (5) business days after receipt by the RMD. A violation of this provision constitutes a MINOR violation of these regulations.

B. Video surveillance shall conform to the requirements of 105 CMR 725.110(D) and any other related regulations, directives, memorandums or notifications from DPH. In addition, as conditions of issuing or maintaining its RMD Permit, the Board of Health may require other, reasonable surveillance operations and security (e.g., an off-site backup system). Furthermore, the RMD must allow for immediate viewing of video surveillance by the Board of Health or its designated agents, upon request. A copy of a requested recording shall be provided as soon as practicable to these officials. All video recordings shall be retained for a minimum of 90 days. Furthermore, as soon as the

RMD is aware of any recording that might relate to a criminal, civil or administrative investigation or legal proceeding of any kind, the RMD shall not alter or destroy the recording without the written permission of both the Director and the Chief of Police for the Town of Needham. A violation of this provision constitutes a MAJOR violation of these regulations.

C. Issuance and maintaining a RMD Permit is conditioned on maintaining all records outlined in 105 CMR 725.105(I) and other DPH regulations, directives, memorandum and notifications, along with any other documents reasonably required by the Board of Health in writing. Following closure of an RMD, all records must be kept for at least two (2) years at the expense of the RMD and in a form and location acceptable to the Board of Health. Moreover, as a condition of issuing and maintaining a RMD Permit, the Board of Health may reasonably require that the new owner of a RMD retain records generated by the previous RMD at the expense of the new RMD. A violation of this provision constitutes a MINOR violation of these regulations.

20.4.4 – Other Restrictions for Registered Marijuana Dispensaries

A. For RMDs that cultivate marijuana, the cultivation and processing facility shall not adversely affect the health or safety of the nearby residents or businesses by creating dust, glare, heat, noise, nuisance odors, noxious gases, materials, processes, products or wastes. Growing areas shall be within a self-contained, locked structure, with a 1-hour firewall assembly made of green board or other construction specifically approved by the Town's building inspector, well ventilated with odor control, and shall not create humidity or mold issues within the establishment. A violation of this provision constitutes a MAJOR violation of these regulations.

B. No RMD is permitted to sell or distribute alcoholic beverages or tobacco products and may not hold either a tobacco sales permit or a liquor license. A violation of this provision constitutes a MAJOR violation of these regulations.

C. No RMD is permitted to hold a Common Victualler license for on-premises food consumption. A violation of this provision constitutes a MAJOR violation of these regulations.

D. No RMD is permitted to be a Massachusetts lottery dealer or to engage in any gaming activities. A violation of this provision constitutes a MAJOR violation of these regulations.

SECTION 24.5 PLAN REVIEWS OF COMMERCIAL AND RECREATIONAL MARIJUANA ESTABLISHMENTS

24.5.1 – Off-Site Cultivation/MIP Preparation Plan Review
An applicant who wishes to sell edible marijuana-infused products (MIPs) at a CRME must, prior to beginning operations, undergo a plan review of any MIP processing and preparation facilities, regardless of their location, for any MIP that will, at some point, be delivered, distributed, produced, sold, or stored within the Town. The Board of Health and its designated agents will conduct the plan review, which may include a facilities inspection, to ensure sanitary handling and processing conditions and practices.

24.5.2 – Plan Review for MIP Storage and Handling at CRME Location
An applicant who wishes to sell edible marijuana-infused products (MIPs) at a CRME must, prior to beginning operations, undergo a plan review of all MIP storage, handling, and sale locations within the CRME. The Board of Health and its designated agents will conduct the plan review, which may include a facilities inspection, to ensure sanitary handling and storage conditions and practices in line with the requirements outlined in the 105 CMR 590, the State Sanitary Code.

The requirements of 105 CMR 590.000 include specific actions to prevent the growth of bacteria. *Clostridium botulinum* is a bacterium whose spores are present on plant material and in soil. Spores are present in many plant material extractions and can survive cooking/pasteurization temperatures. These spores can spontaneously germinate (grow into bacteria) given the right conditions/substrate. The bacteria can produce a powerful toxin that can cause severe illness or death. Specific actions required of a CRME selling MIP are:

A. Except during preparation, cooking, or cooling, time/temperature control for safety (TCS) items shall be maintained at 5°C (41°F) or less to prevent the growth of bacteria. This shall apply, unless specifically permitted by the Board of Health or its agents, to all:
   (i) marijuana extractions and concentrates intended for non-smoking oral consumption (i.e. eating, drinking);
   (ii) infusions made from those extractions, such as infused oils, butters, honey, etc; and
   (iii) foods that have such infusions/extractions as an ingredient.

B. If a marijuana extraction, concentrate, or infusion has been continuously refrigerated and is then added as an ingredient into baked goods that have a low water activity, such as most cookies and brownies, these baked products may be considered shelf-stable if explicitly reviewed and permitted by the Board of Health or its agents.

C. If the extracted marijuana concentrate is immediately infused into a 190/200 proof alcohol with no additional ingredients (including flavorings or other additives) and the tincture is homogenous, then the growth of *C. botulinum* spores may have been prevented. Homogenous 190/200 proof alcohol tinctures may be safe to store outside

of refrigerated temperatures if explicitly reviewed and permitted by the Board of Health or its agents.

D. Approvals for any variance from the safe and sanitary storage requirements outlined above will be based upon:
   (i) a review of written procedures that are followed to make the product;
   (ii) the use of control measures described above; and
   (iii) any other scientific evidence submitted by the manufacturer from a certified laboratory or process authority that demonstrates the safety of the product in question. For example:
      a) pH and/or water activity testing must be conducted by an accredited laboratory;
      b) three samples from separate batches must be tested; and
      c) all samples must meet the criteria for a non-potentially hazardous food as described in Tables A and B of the 2013 *FDA Food Code*.

E. At any time, the Board of Health or its agents may require a Hazard Analysis and Critical Control Points (HACCP) plan before approving the distribution of MIPs.

F. Photos or images of food are not allowed on MIP product labels.

G. All MIP must be contained in an opaque package.

H. If the MIP is identified on the label using a common food name (i.e. Brownie, Honey, Chocolate, Chocolate Chip Cookie, or Green Tea), the phrase "MARIJUANA—NOT FOR PEOPLE UNDER 21" must be written before the common food name. This phrase must be as easy to read as the common food name (i.e. same font size).

I. Only generic food names may be used to describe the MIP. As an example, using "Snickerdoodle" to describe a cinnamon cookie is prohibited.

J. All MIP must state the following:
   (i) A batch number, sequential serial number, and bar code when used, to identify the batch associated with manufacturing and processing;
   (ii) A statement that the product has been tested for contaminants, that there were no adverse findings, and the date of testing in accordance with 105 CMR 725.105(C)(2);
   (iii) The manufacture date as well as a "Best by" or "Use by" or expiration date;
   (iv) Net weight of Marijuana and the THC level in the MIP, and the net weight of Marijuana and the THC level contained **per dose/serving** (if the MIP is not a single serving/dose);
   (v) A list of ingredients as well as the cannabinoid profile of the marijuana contained within the MIP;
   (vi) A warning if nuts or other known allergens are contained in the product;

(vii) Directions for use of the product if relevant;
(viii) The statement "For ADULT Use Only"; and
(ix) The statement, including capitalization: "This product has not been analyzed or approved by the FDA. There is limited information on the side effects of using this product, and there may be associated health risks. Do not drive or operate machinery when under the influence of this product. KEEP THIS PRODUCT AWAY FROM CHILDREN."

Each violation of any of the provisions of 24.5.2 (A) through (J) shall constitute a MINOR violation of these regulations.

24.5.3 – Plan Review for Safe and Secure Disposal of Waste, Refuse, or Damaged Product
An applicant for a CRME Permit shall develop a plan for the safe and secure storage and disposal of any waste, refuse, or damaged marijuana, MIPs, and related products. Such a plan will be based on the requirements outlined in 105 CMR 725.105(J) and will be subject to review and approval by the Board of Health and its designated agents prior to the RMD beginning operations.

24.5.4 – Plan Review for Emergencies and Continuity of Operations
In accordance with emergency planning requirements specified in 105 CMR 725.105(A)(9) and similar to the responsibilities outlined in the Risk Management and Continuous Quality Improvement section of the *Guidelines for the Accreditation of Opioid Treatment Programs* which are authorized in 42 CFR 8.12(c), an applicant for a RMD Permit shall develop an emergency management program to ensure the safety of its staff and customers and a mechanism by which to ensure the continuity of its operations (COOP) in response to inclement weather, man-made emergencies, supply chain disruptions, or discipline (including permit suspension) which result in the RMD being unable to provide medical marijuana and MIPs to patients with a documented medical need. Such a program shall include:

A. A detailed emergency operations plan (EOP) and a process by which staff will be trained on that plan and their knowledge of it tested via drills and exercises. The emergency operations plan will:
   (i) Include a set of contact procedures for staff, customers, and community partners in the event of an emergency;
   (ii) Specify a process for contacting Dispensary Agents on a 24-hour, 7-day-a-week basis through a telephone answering service or a similar service provider; and
   (iii) Include protocols for the maintenance of life safety equipment (fire extinguishers and AEDs, for example) and the training of staff on the proper use of the same;

B. A detailed continuity of operations (COOP) plan for the emergency administration of medication in response to inclement weather, man-made emergencies, supply chain disruptions, or discipline (including permit suspension under these regulations) which

result in the RMD being unable to provide medical marijuana and MIPs to patients with a documented medical need. This continuity of operations plan will:

(i) Include provisions for the notification of patients in the event that inclement weather, man-made emergencies, supply chain disruptions, or discipline under these regulations might result in a temporary disruption to medication supply; and

(ii) Include formal contractual arrangements to fulfill patient orders for medical marijuana and MIPs in the face of service disruption; these plans will specify order fulfillment and delivery arrangements with at least two (2) RMDs that are not otherwise affiliated with the applicant for a Needham RMD Permit.

Such a plan will be subject to review and approval by the Board of Health or its designated agents prior to the RMD beginning operations, and at least annually thereafter.

Comment [TM1]: Remove entirely?

24.5.5 – Safety and Security Plan Review

In accordance with the criteria specified in 105 CMR 725.110—the Security Requirements for Commercial and Recreational Marijuana Establishments—an applicant for a CRME Permit shall develop a comprehensive security plan. Such a plan will be subject to review and approval by the Director, the Chief of Police, and the Fire Chief prior to the CRME beginning operations, and at least semi-annually thereafter.

Comment [TM2]: Find or create new citation

SECTION 24.6 MARIJUANA SALES BY COMMERCIAL AND RECREATIONAL MARIJUANA ESTABLISHMENT

24.6.1 – No person or organization shall sell marijuana or marijuana-infused products from any location other than at a RMD that possesses a valid CRME Permit. A violation of this provision constitutes a MAJOR violation.

24.6.2 – A sign shall be conspicuously posted on the exterior of the establishment at each entrance to the CRME, indicating that the entry to persons under the age of 21 is prohibited. The sign shall remain unobstructed, secured to the building at a height of no less than four (4) feet or greater than seven (7) feet from the ground, and maintained in good condition. A violation of this provision shall be considered a MAJOR violation.

24.6.3 – Dispensary Agents or organizations shall verify the Registration Card or Personal Caregiver Registration Card of the Card Holder in accordance with the procedures outlined in 105 CMR 725.000 and any other directives, memorandums or notifications from DPH. In addition, the Registration Card shall be verified for each and every Card Holder or Personal Caregiver, on each and every occasion that he/she enters the RMD, without exception. The failure to verify, regardless of the prior history of the Card Holder at the RMD, constitutes a MAJOR violation of this regulation.

Comment [TM3]: Remove entirely

24.6.4 – All retail sales of marijuana and marijuana-infused products must be face-to-face between the CRME Agent and the buyer who is age 21 or older, and shall occur on the premises of the CRME, unless the buyer who is age 21 or older is the proper recipient of home delivery in accordance with all applicable state and local regulations. A violation of this provision constitutes a MAJOR violation of these regulations.

24.6.5 – No person shall:

A. Distribute, or cause to be distributed, any free samples of marijuana or marijuana-infused products; or

B. Accept or redeem, offer to accept or redeem, or cause or hire any person to accept or redeem, or offer to accept or redeem, through any coupon or other method, any marijuana or marijuana-infused product for less than the listed or non-discounted price; or

C. Sell marijuana or a marijuana-infused product through any discounts (e.g., “buy-two-get-one-free”) or otherwise provide any marijuana or marijuana-infused product for less than the listed or non-discounted price in exchange for the purchase of any other product.

D. A violation of any of the provisions of 20.6.5(A) through 20.6.5(C) shall constitute a MAJOR violation of these regulations.

24.6.6 – CRMEs are prohibited from using self-service displays. A violation of this provision shall be considered a MINOR violation.

24.6.7 – CRMEs are prohibited from using vending machines. A violation of this provision shall be considered a MINOR violation.

24.6.8 – CRMEs are prohibited from using Non-Residential Roll-Your-Own machines. A violation of this provision shall be considered a MINOR violation.

24.6.9 – A CRME and its Dispensary agents are prohibited, in accordance with restrictions outlined in 105 CMR 725.105(K) and (L), from providing:

A. Any statement, design, representation, picture, or illustration that encourages or represents the use of marijuana for any purpose other than to treat debilitating medical condition or related symptoms;

B. Any statement, design, representation, picture, or illustration that encourages or represents the recreational use of marijuana while driving;

C. Any statement, design, representation, picture, or illustration related to the safety or efficacy of marijuana unless supported by substantial evidence or substantial clinical data with reasonable scientific rigor as determined by the Board of Health or its agents; or

D. Any statement, design, representation, picture, or illustration portraying anyone under 21 years of age.

E. A violation of any of the provisions of 20.6.9(A) through 20.6.9(D) shall constitute a MINOR violation of these regulations.

20.6.10 – A CRME, in accordance with restrictions outlined in 105 CMR 725.105(K) and (L), must adhere to the following Marketing and Advertising Requirements:

A. A CRME may develop and use a logo for labeling, signage, and other materials, but that logo may not contain medical symbols, images of marijuana and marijuana-related paraphernalia, or colloquial references to cannabis and marijuana. Likewise, a RMD may not offer for sale or as a promotional gift any items which contain symbol of or references to marijuana or MIPs, including the logo of the RMD.

B. A RMD may only identify the building/RMD location by the registered name, and shall not display advertisements for marijuana or any brand name nor utilize graphics related to marijuana or paraphernalia on the building.

Comment [TM4]: Find new citation or remove entirely

Comment [TM5]: Remove entirely?

Comment [TM6]: Find new citation or revise/remove entirely.

Comment [TM7]: Good! Retain if possible.

C. CRME external signage shall not be illuminated except for a period of 30 minutes before sundown until closing, and shall comply with Article 5 of the Town of Needham By-Laws which regulates signage advertising. Neon signage is prohibited at all times.

D. No marijuana, MIPs, and other related products shall be visible or displayed in such a way as to seen from the exterior of a CRME. Within the CRME, one sample of each marijuana strain and each MIP may be displayed in a transparent and locked case.

E. Inside the CRME, all marijuana which is not displayed in accordance with state and local restrictions (as outlined in 105 CMR 725.105(L)(10) and in Section 20.6.10(D) above) shall be stored in a locked, access-controlled space in a limited access area during non-business hours. This access-controlled space shall be inaccessible to any persons other than dispensary agents.

F. A RMD shall provide a catalogue or a printed list of the prices and strains of marijuana available at the RMD to registered qualifying patients and personal caregivers upon request, but shall not advertise the price of marijuana.

G. A violation of any of the provisions of 20.6.10(A) through 20.6.10(F) shall constitute a MINOR violation.

H. If, during the course of an inspection or compliance check at the RMD Cultivation/Production Site, mold, infestation, or other diseases affecting marijuana plants is observed, then the Board of Health or its Agents may order the segregation and/or destruction of all such plants (as well as surrounding plants) to prevent a threat to the public's health.

SECTION 20.7 HOME CULTIVATION

20.7.1 – Marijuana cultivation or processing of any kind is prohibited within the town of Needham without a RMD Permit or Home Permit issued by the Needham Board of Health.

20.7.2 – Prior to any home cultivation taking place within the town, even by a qualifying patient or caregiver under 105 CMR 725.000, the respective individual must obtain a Home Permit. Cultivation that takes place without a permit is outside the coverage of the medical marijuana program and is subject to prosecution as a crime under Massachusetts General Laws, Chapter 94C.

20.7.3 – A Home Permit shall be granted if the Board of Health determines that:

A. The applicant does not have access to an RMD by any of:
   (i) public or private transportation, or
   (ii) a caregiver with transportation, or
   (iii) a RMD that will deliver to the applicant or the applicant's caregiver's primary address.

Or that:

B. The applicant has a verified financial hardship (as defined in 105 CMR725.004 as enrollment in either MassHealth or Supplemental Security Income, or else that an individual's income does not exceed 300% of the federal poverty level, adjusted for family size) and does not have access to an RMD willing to provide the applicant marijuana at no or an affordable cost.

   Applicants who fail to meet the above described hardship standard will not receive a Home Permit and will be informed, in a written statement, that marijuana cultivation is prohibited in Needham without a RMD Permit or Home Permit, and that any such cultivation is outside the coverage of the medical marijuana program and is subject to prosecution as a crime under Massachusetts General Laws, Chapter 94C.

20.7.4 – Subject to the provisions of Section 20.7.3, the Board of Health may issue a Home Permit authorizing cultivation activities at a specified address within the town, provided that the applicant:

A. Submits to a pre-approval inspection by the Board of Health or its designated agents, which may include law enforcement officers and fire officials and building inspectors, to ensure that the location specified in the application meets all of the requirements of this regulation; and

B. Meets all the requirements for home cultivation contained in 105 CMR 725.000 and any

related directives, memorandums or notifications. These include, but are not limited to, an enclosed, locked space, not viewable from a public location, in which cultivation and storage takes place in accordance with public health and safety requirements as determined by the Board; and

C. Meets all applicable local regulations within the town including, but not limited, fire safety and building code provisions; and

D. If not the property owner, the applicant has notified the public or private property owner of the specified address, and obtained from that owner consent to any alteration the property's fixtures or structure, including agreement concerning any increased utility costs likely to result from cultivation activities; and

E. Grows only enough marijuana to maintain a sixty (60) day supply, which has been determined to be ten (10) ounces by DPH. The Board of Health or the Director may specifically designate the number and type of plants that may be possessed at any time by the applicant in order to meet this standard; and

F. Submits to reasonable inspections by the Board of Health or its designated agents, which may include law enforcement officers, to ensure compliance with all of the requirements in this regulation; and

G. Agrees that a Home Permit only allows for the cultivation and processing of marijuana without the use of any fire, heat source, or gas, except for cooking on a conventional stove originally supplied with the dwelling; and

H. Agrees that a Home Permit does not allow any method for processing marijuana that presents a risk of explosion or other property damage by any means; and

I. All Home Permits expire on June 30 annually, regardless of the year or day and month on which there were issued.

J. If the Board of Health determines that the conditions to achieve the hardship standard permitting a Home Permit for marijuana cultivation no longer exist, the Board of Health may, after notice and opportunity to be heard, revoke the Home Permit and disallow cultivation of marijuana in the home setting of the affected person or persons.

K. A violation of provision 20.7.4 (B), (C), or (D) shall constitute a MINOR violation of these regulations. A violation of provision 20.7.4 (A), (E), (F), (G), or (H) shall constitute a MAJOR violation of these regulations.

L. If, during the course of an inspection or compliance check at the Home Permit Site, mold, infestation, or other diseases affecting marijuana plants is observed, then the

Board of Health or its Agents may order the segregation and/or destruction of all such plants (as well as surrounding plants) to prevent a threat to the public's health.

SECTION 24.8 VIOLATIONS

24.8.1 – The period of performance for violations of these regulations is five (5) years. MINOR violations shall be rectified within 72 hours of the violation, and shall be subject to re-inspection following that period. MAJOR violations shall be rectified within 24 hours, and shall be subject to re-inspection following that period. Prompt rectification of a violation shall **not** dissolve the record of the violation.

24.8.2 – In addition to any penalty that may be imposed under the non-criminal method of disposition as provided in General Laws, Chapter 40, Section 21D and Town of Needham By Laws, the Board of Health may, after a duly noticed hearing at which the CRME or Home Permit holder has had an opportunity to be heard, suspend, modify, or revoke the CRME Permit or Home Permit. The minimum suspension schedule shall be as follows:

A. In the case of either five (5) or more MINOR violations or in the case of a MAJOR violation the CRME Permit or Home Permit shall be suspended for seven (7) consecutive business days.

B. In the case of a second MAJOR violation or in the case of ten (10) or more MINOR violations, the CRME Permit or Home Permit shall be suspended for one (1) month.

C. In the case of a third MAJOR violation or in the case of fifteen (15) or more MINOR violations, the CRME Permit or Home Permit shall be suspended for six (6) months.

D. In the case of a fourth MAJOR violation or in the case of twenty (20) or more MINOR violations, the CRME Permit or Home Permit shall be suspended for twelve (12) months and may, at the Board of Health's discretion, be permanently revoked.

E. Refusal to cooperate with the Board of Health or its designated agents is considered a separate violation of these regulations and shall result in the suspension of the RMD Permit or Home Permit for a minimum of ninety (90) consecutive business days. This shall be in addition to any other penalty imposed for other violations observed.

F. Any CRME Permit Holder or Home Permit Holder who engages in or allows the sale, distribution or cultivation of marijuana or marijuana-infused products while his or her permit is suspended shall be subject to permanent revocation, and additional civil or criminal proceedings.

24.8.3 – The penalties mentioned in 24.8.2 represent the guidelines for action to be taken by the Board of Health for violations, and do not preclude the licensing authority from taking additional action after a duly noticed hearing at which the CRME Permit or Home Permit holder has an opportunity to be heard.

24.8.4 – If during an inspection or a compliance check, a Board of Health Agent determines a MAJOR violation of these regulations exists or has occurred, the Director may temporarily suspend the CRME Permit or Home Permit for a period not to exceed 96 hours while public notice of a scheduled Board of Health hearing is posted in accordance with the provisions of the Massachusetts Open Meeting Law (M.G.L. c. 30A, §§ 18-25).

24.8.5 – If a CRME permit is suspended, the permit holder shall cease sale and distribution of marijuana or marijuana-infused products, and close and secure the CRME premises to the satisfaction of the Director or his/her agents for the period of the suspension. Additionally, notice of the suspension must be publicly posted on the CRME, the CRME's website, and the Town of Needham's website, all to the satisfaction of the Director or his/her agents.

24.8.6 – If a CRME permit is revoked, the permit holder shall cease all sale, distribution or cultivation of marijuana or marijuana-infused products, and shall close and secure the RMD premises to the satisfaction of the Director or his/her agents, and the RMD shall submit subject to the approval of the Board or its designated agents, or the Board may order, implementation of a plan for the removal of marijuana and marijuana-infused products and related implements and equipment from the CRME retail establishment. Additionally, notice of the revocation must be publicly posted on the CRME, the CRME's website, and the Town of Needham's website, all to the satisfaction of the Director or his/her agents.

24.8.7 – In the case of a suspension or revocation of a Home permit, the Board may order that marijuana or marijuana-infused products and related implements and equipment be removed from the specified Home permit location. The method for removal and storage, and the deadline for compliance, may be specified in the Board's order or at the direction of the Director. In the case of a Home permit, the Board may authorize immediate confiscation of all the items previously mentioned prior to, or after, the hearing, provided that any removed items are not damaged prior to the conclusion of all administrative actions and appeals. Removal and storage of live marijuana plants does not obligate the Board or its agents to assure the maintenance of the plants during the period of suspension or confiscation.

24.8.8 – In the event that a CRME permit or Home permit is suspended or modified, the Permit holder may be ordered to submit a remediation plan addressing all causes for the suspension or modification and all appropriate changes to business practices and operations. That remediation plan is subject to review and approval by the Board of Health prior to reinstating the permit.

SECTION 24.9 ENFORCEMENT

24.9.1 – Enforcement of this Regulation shall be by the Board of Health and its designated agents.

24.9.2 – Whoever violates any provision of this regulation may be penalized by the non-

criminal method of disposition as provided in General Laws, Chapter 40, Section 21D and Town of Needham By Laws, or by filing a criminal complaint.

24.9.3 – Each day any violation exists shall be deemed to be a separate offense.

24.9.4 – Any resident who desires to register a complaint pursuant to this Regulation may do so by contacting the Board of Health, the Public Health Department, or the Needham Police Department.

SECTION 24.10 SEVERABILITY

If any provision of these regulations is declared invalid or unenforceable, the other provisions shall not be affected thereby but shall continue in full force and effect.

SECTION 24.11 EFFECTIVE DATE

This regulation shall take effect upon December 20, 2016. Public hearings and open meetings regarding this regulation were conducted on November 10, 2016 and December 2, 2016. This regulation was approved by a unanimous vote of the Board of Health on December 2, 2016.

NEEDHAM PUBLIC HEALTH

Memorandum

To: Board of Health
From: Timothy Muir McDonald, Director of Public Health
Date: November 10, 2016
Re: Feedback on Eversource West Roxbury to Needham Reliability Project

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Eversource Energy has submitted a proposal for a reliability project in a corridor extending primarily along the Eversource right-of-way (ROW) from West Roxbury through Dedham and into Needham. The project would involve separating what is currently a pair of overhead transmission lines and separating them so that one line runs overhead and that the other line runs underground to increase reliability. The total length of the project is 4.2 miles, of which approximately 1.6 miles occurs along the Eversource ROW and the remaining 2.6 miles of underground transmission line is proposed to run underneath public roadways in Needham.

The proposal includes a many-hundred page Draft Environmental Impact Reports, a thorough analysis of preferred and alternative routes, and a detailed modeling analysis of the Electric and Magnetic fields related to the proposed project.

Representatives from Eversource will participate in a discussion with the Board about the company's West Roxbury to Needham Reliability Project at the Board's November meeting. Eversource has previously presented this topic to the Board of Selectmen in multiple opening meetings and a public hearing in the months of September and October. At the last such event, one of the concerns raised publicly by residents was about the potential health effects from underground electrical transmission lines.

The Board of Selectmen would like the Board of Health to weigh in on the potential health effects, if any, of such a project.

Both Public Health Nurse Donna Carmichael and I have reviewed materials relating to the project, as well as journal articles related to electric and magnetic fields (EMF). The materials include information that shows the modeled EMF values "were all well below the health-based guidelines issued by the International Commission on Non Ionizing Radiation Protection ("ICNIRP") for continuous public exposure to EMFs."[1] Later in that same analysis, it is noted that the modeling "also demonstrated that EMF values at the ROW#3 edges were frequently modeled reduced for the With-Project circuit configurations, as compared to the Without-Project circuit configurations".[2] Or, to put it

[1] Epsilon Associates, Inc. "W. Roxbury to Needham Reliability Project". *ESFB Analysis*. (2016) 5-56.
[2] Ibid.

more simply, the reliability project will likely reduce the measure EMFs along the project right-of-way. The analysis further notes that "the project will contributed to *decreased* electric and magnetic fields at the edges of ROW #3 in West Roxbury and Needham, in particular for the portion of ROW #3 between the Valley Road area in Needham and the Needham Substation of Chestnut Street"[3], and also that "the magnetic fields associated with the Project operation would be similar along both the Preferred Route and the Noticed Alternative Route."[4]

Scientific research that is not specifically focused upon this project but rather on the health effects of EMF generally, has categorized power-line EMF as "possibly carcinogenic to humans, which, in the RF and EMF circumstances, refers to limited-to-inadequate evidence of cancer risk in humans."[5] It further notes that:

> "Power-line EMF has been the focus of considerable research for more than three decades. Over this period of time, the focus has been primarily on the magnetic field component. The three major lines of investigation have involved epidemiology, laboratory animal studies, and biological mechanism studies. The scientific evidence currently accumulated does not support a clear and coherent picture whereby environmental levels of power-line EMF constitute a hazard to human health, primarily because animal studies and mechanistic investigations have not shown a consistent, deleterious effect of typical ambient power-line magnetic fields on biology."[6]

Based upon the available evidence both specific to this project and upon scientific literature which explores the possible health effects of EMF, **I believe that this project does not constitute a clear threat to the health and wellness of Needham residents along the project's planned route.**

Representatives from Eversource and its partners will be available for a discussion with the Board of Health at this afternoon's meeting. Thank you for your consideration of this memorandum. I look forward to discussing with you later today at the next Board of Health meeting.

Sincerely,

Timothy Muir McDonald

Timothy Muir McDonald
Director of Public Health, Town of Needham

Attachments:

1. *Eversource Overview Packet (as previously distributed)*
2. *Health Effects of Magnetic Fields Packet (as previously distributed)*
3. *Email and Letter from Concerned Constituent*

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[3] Ibid.
[4] Ibid.
[5] Valberg, Peter. "Electromagnetic Waves (EMF and RF) and Health Effects". *Hamilton & Hardy's Industrial Toxicology*, 6th Edition. (2015) 6: 1069-1085. Page 1069.
[6] Ibid, page 1072.

West Roxbury to Needham Reliability Project

Town of Needham Board of Selectmen Presentation

March 8, 2016

Agenda

- Greater Boston Energy Solutions
- West Roxbury to Needham Reliability Project
  - ✓ Energy Solutions
  - ✓ Project Need and Benefits
  - ✓ Project Overview
  - ✓ Route Analysis Process
  - ✓ Environmental Permitting
  - ✓ Schedule
- Next Steps
- Proactive Municipal and Community Outreach throughout Project Duration
- Contact Information

Greater Boston & New Hampshire Energy Solutions

EVERSOURCE ENERGY

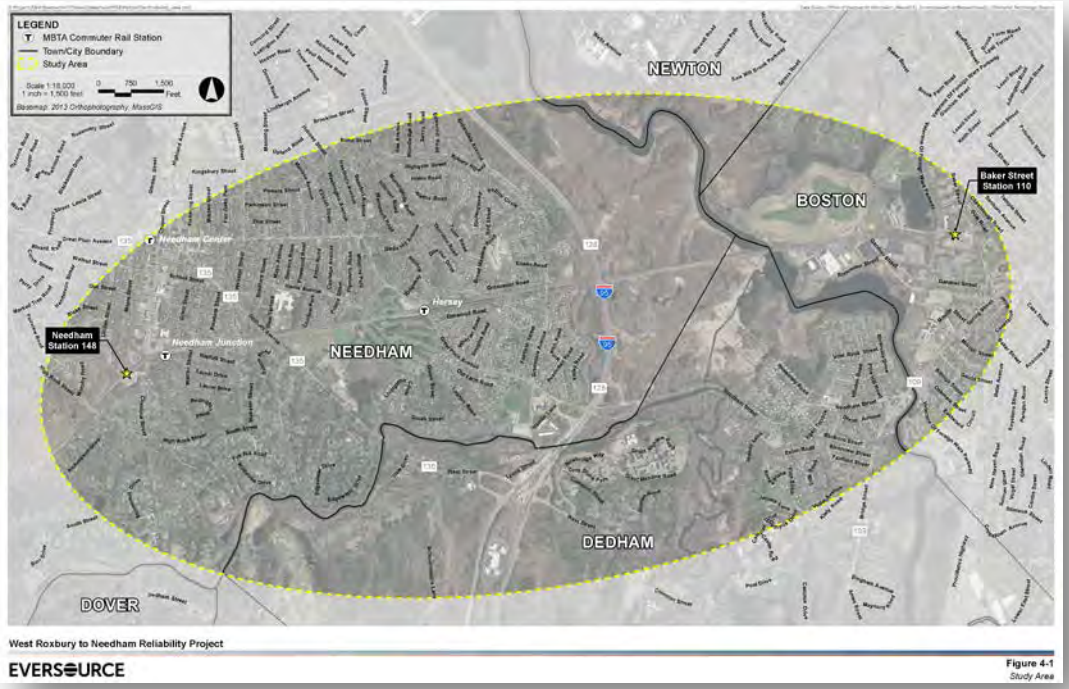
- A strong electrical transmission grid is vital to the safety, security, and economic prosperity of the region. The transmission system serves a critical role to ensure that electricity flows with a high degree of reliability to where power is needed.

- In a recent study, ISO-New England, the independent system operator for New England, concluded that there are inadequate transmission resources to serve the electricity needs in the Greater Boston and Southern New Hampshire area.

- To proactively address these deficiencies and the growing customer demands on the electric system, ISO-New England has directed utilities to implement a series of transmission projects as needed.

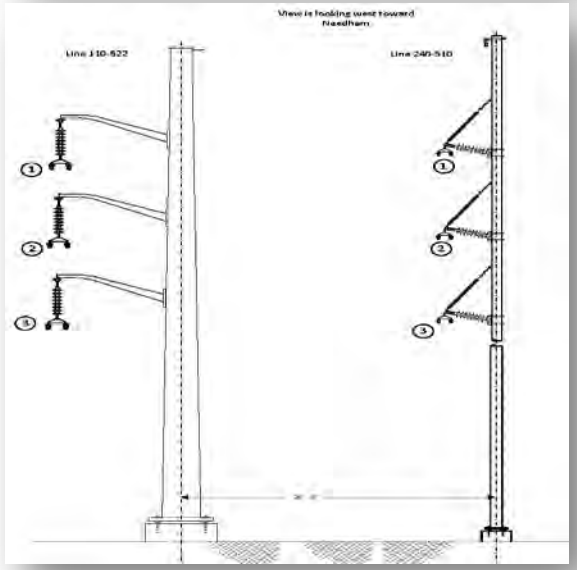
- One of the projects to come out of the solution to solve the identified system reliability problems is the DCT (Double Circuit Tower) separation of two 115-kV circuits between West Roxbury and Needham.

West Roxbury to Needham Reliability Project
Project Need & Benefits



- Eversource's transmission system is not able to maintain supply to approximately 65,000 customers in the western Boston suburbs under certain operating conditions.
- Separating the existing 115-kV DCT overhead transmission lines between the Baker Street Substation and the Needham Substation will mitigate potential area overloads and will significantly reduce the number of customers that are exposed to sustained loss of service.
- Implementing the project will ensure continued compliance with applicable federal and regional transmission reliability standards and criteria, and will maintain reliable 115-kV electric service to several area substations serving the 115-kV systems in the western Boston suburbs.

West Roxbury to Needham Reliability Project Overview



- The proposed project involves a combination of overhead (OH) and underground (UG) transmission line construction.
- The DCT separation work will involve relocating ~1.6 miles of existing overhead transmission line onto new sets of structures (steel monopoles) directly offset ~28-feet north or south of the existing structures on existing Eversource right-of-way in Boston, Dedham and Needham (up to Valley Road area).

West Roxbury to Needham Reliability Project Overview (continued)

- The balance of the DCT separation work will involve ~2.5 miles of new underground cable construction located primarily in public streets in the Town of Needham (generally between Valley Road area and Chestnut Street).
- The existing support arms and one set of wires will likely be removed from the existing steel monopole structures between the OH/UG transition point at Valley Road area and Needham Substation.
- No significant substation work required for the Project (no fence line expansion or removal of existing equipment is required).

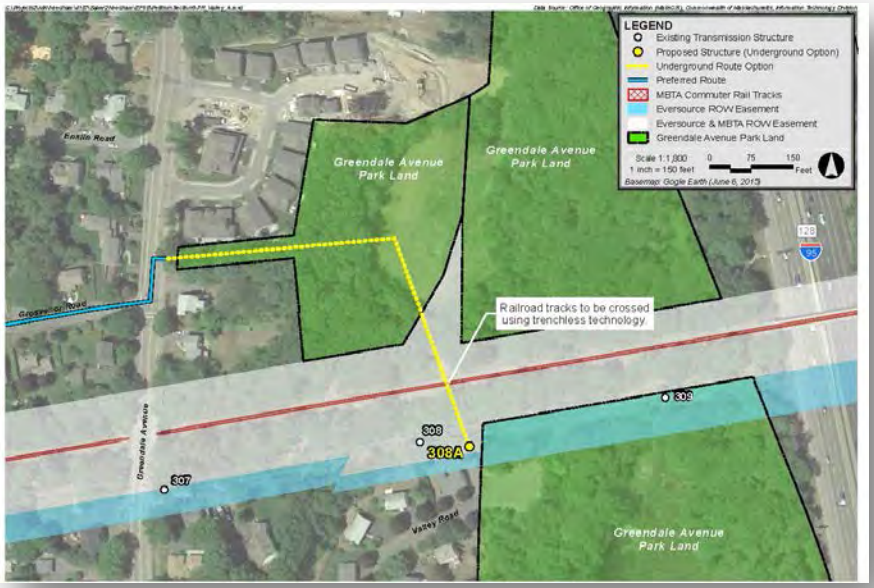
West Roxbury to Needham Reliability Project Overview (continued)

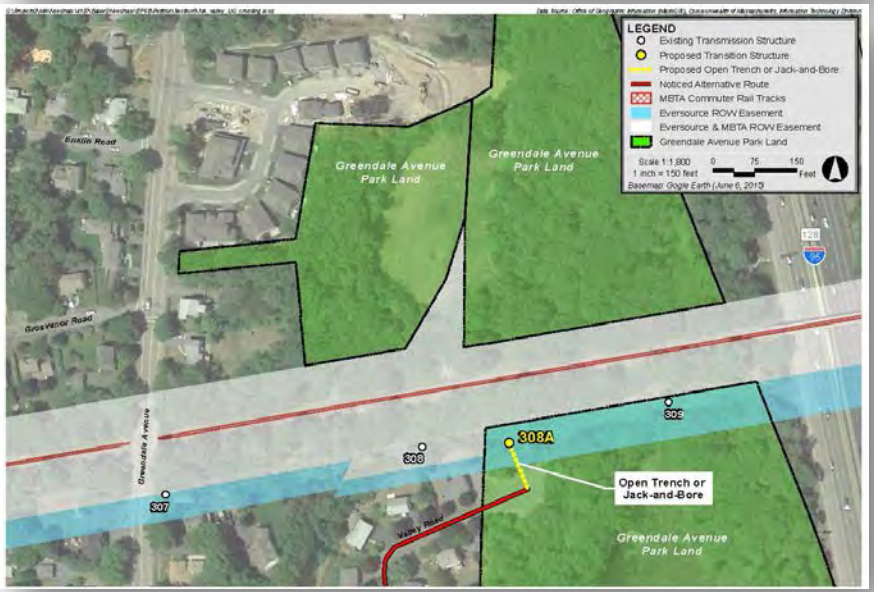
EVERSOURCE ENERGY

- The eastern half of the routing study area is dramatically different from the western half (remote undeveloped areas located in DCR's Cutler Park, I-95 and commercial industrial areas in the City of Boston vs. densely developed residential neighborhoods in the Town of Needham).

- In consultation with Town officials, Eversource made a concerted effort to avoid or minimize impacts to the residential neighborhoods directly abutting the MBTA railroad tracks and Eversource ROW in the Town of Needham, including transitioning from overhead line construction on existing ROW to underground cable construction in public roads at the first possible location where such transition work could potentially occur (Valley Road).

West Roxbury to Needham Reliability Project Overview (continued)





- Pending Town approval, the potential proposed OH/UG transition point is located at the end of the Valley Road cul-de-sac heading north or south across the Greendale Avenue park land towards Greendale Avenue.

- The transmission line across the northern parcel would cross under or over the MBTA railroad tracks.

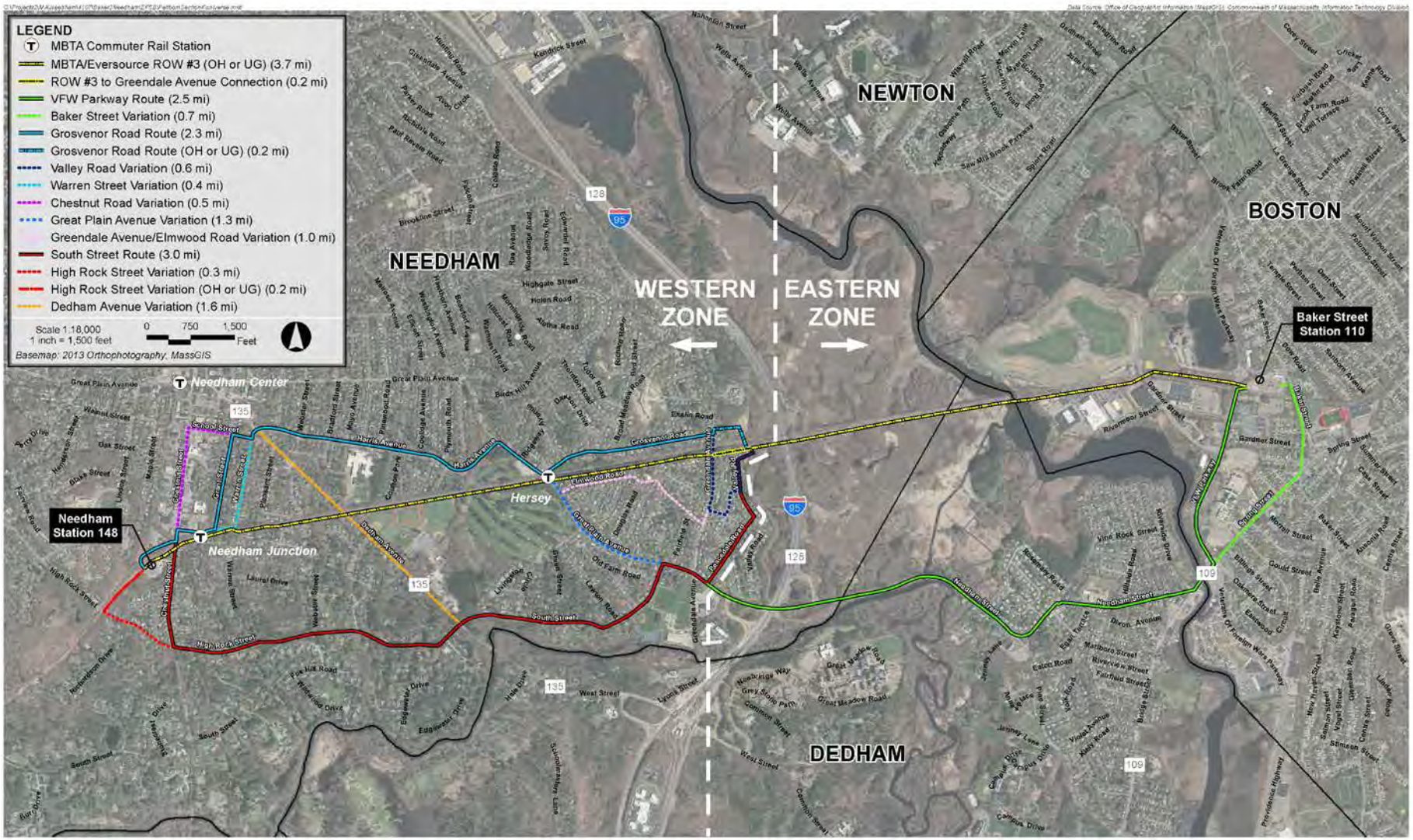
West Roxbury to Needham Reliability Project
Route Analysis Process

EVERSOURCE ENERGY

- Eversource, with environmental consultant Epsilon Associates, Inc. established route selection guidelines to identify all potentially feasible routes between the Baker Street and Needham substations **("Universe of Routes").**
- Routes with obvious flaws were eliminated.
- The **"Candidate Routes"** were evaluated, scored and ranked by applying environmental, constructability, community impact, and conceptual cost estimate criteria.
- Eversource used the scoring and ranking system to select a **"Preferred Route"** and a potential **"Noticed Alternative Route",** as such terms are used by the Energy Facilities Siting Board.

West Roxbury to Needham Reliability Project
Universe of Routes Considered

EVERSOURCE ENERGY



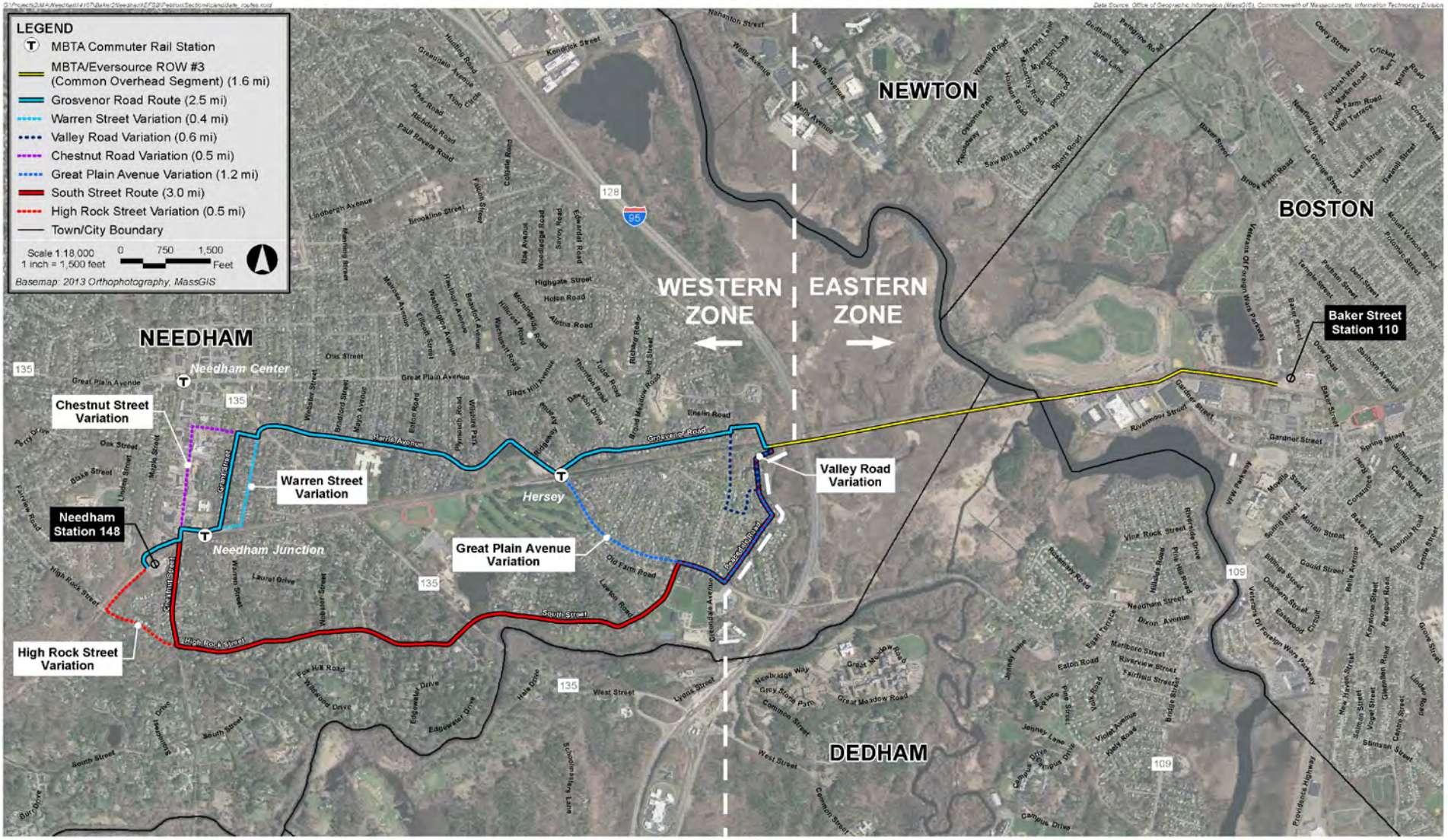
West Roxbury to Needham Reliability Project

EVERSOURCE

Figure 4-2
Universe of Routes

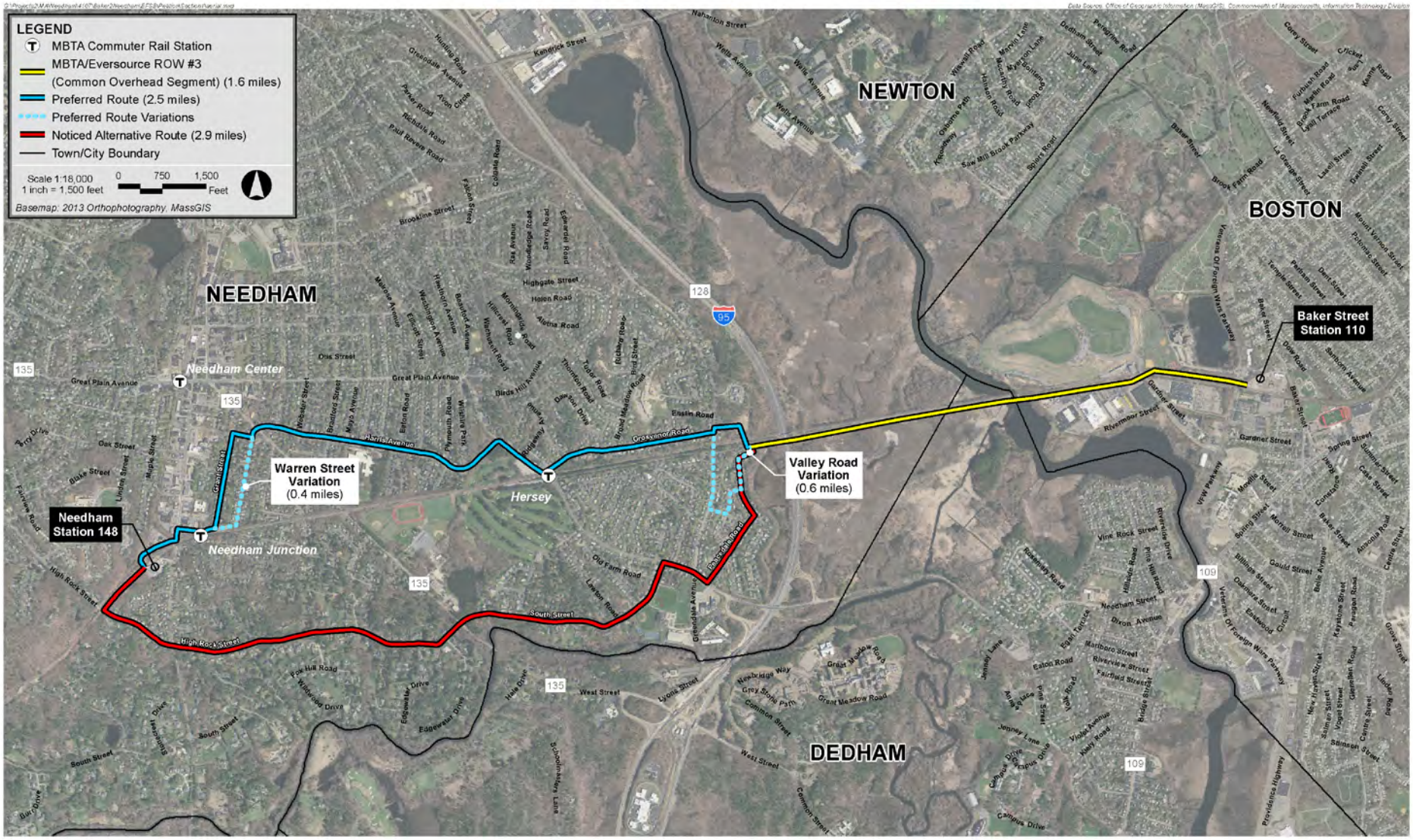
West Roxbury to Needham Reliability Project
Candidate Routes Selected for Scoring

EVERSOURCE ENERGY



West Roxbury to Needham Reliability Project
Preferred and Noticed Alternative Route

EVERSOURCE ENERGY



Preferred UG Route (~2.5 miles)

- Greendale Avenue (via Greendale Ave. park land)
- Grosvenor Road
- Broad Meadow Road
- Great Plain Avenue
- Harris Avenue
- School Street
- Grant Street
- Junction Street
- Chestnut Street

Potential Variations to Preferred Route

- Valley Road (via Greendale Ave. park land)
- Intervale Road
- Warren Street (in lieu of Grant Street)

Noticed Alternative UG Route (~3.0 miles)

- Valley Road (via Greendale Ave. park land)
- Peacedale Road
- Great Plain Avenue
- South Street
- High Rock Street
- West end of ROW to Needham Substation (via High Rock Street)

West Roxbury to Needham Reliability Project
Typical In-Street Construction Process

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- Splice Vault/Manhole installation
- Trench excavation, conduit installation, backfill and temporary paving.
- Install cables between each manhole.
- Cable splicing and testing in manholes.
- Final pavement and other Project restorations completed per municipal town agreements.
- Minor construction at substations will be concurrent with cable construction.

West Roxbury to Needham Reliability Project
Typical Cross-Sections

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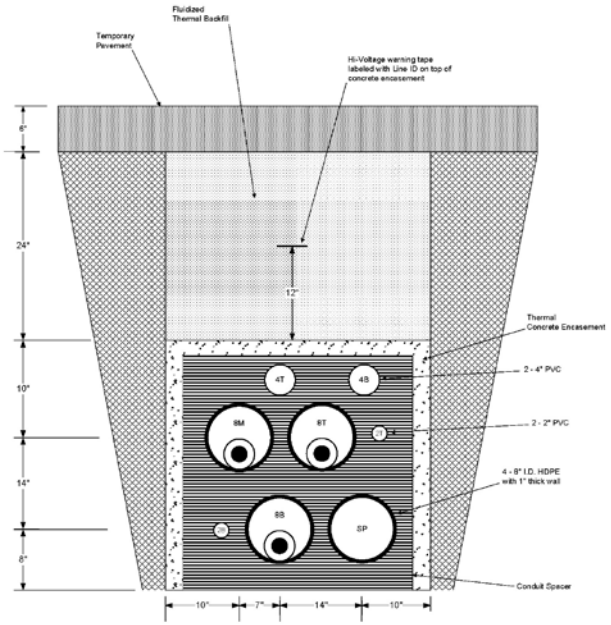
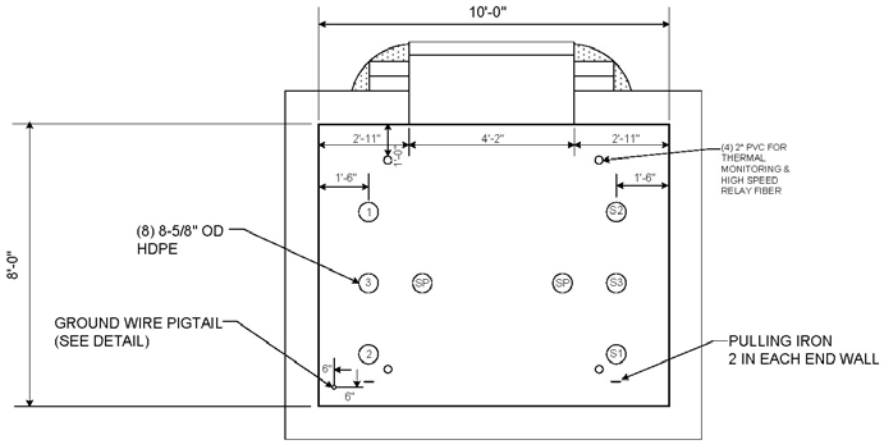
Cable Installation



3’ x 3’ along the underground route

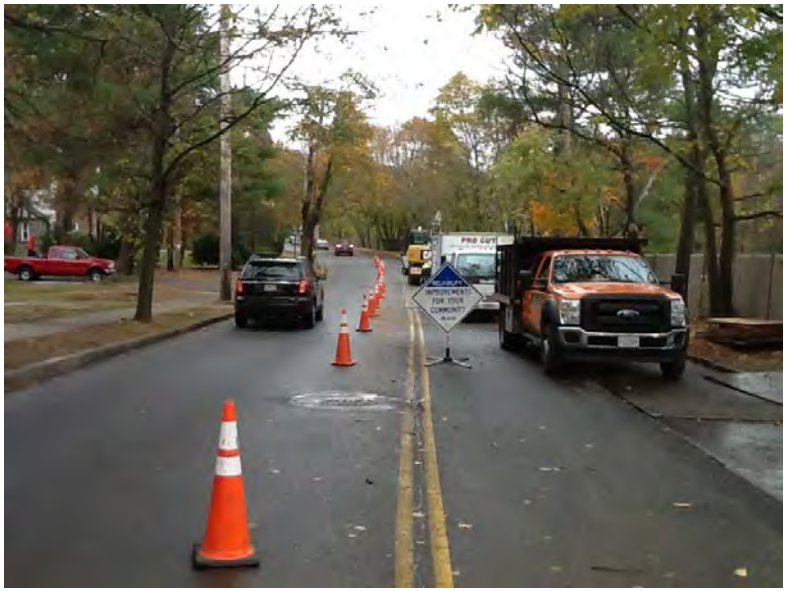
Splice Vault/Manhole

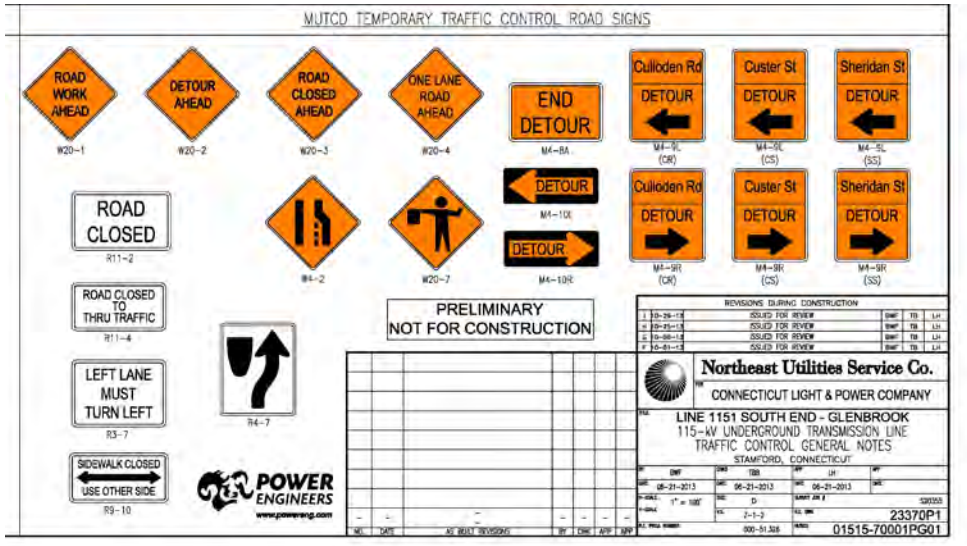


10’ tall x 12’ wide x 30’ long
(approx. 1500’-1800’ apart along the underground route)

Managing Impacts During Construction

- Traffic Management
  - ✓ Traffic Management Plan to be developed jointly with municipalities.
  - ✓ Police details paid by Project
  - ✓ Maintaining access
  - ✓ Hours of Construction
  - ✓ Maintain pedestrian safety
- Eversource will communicate and work closely with neighbors in the communities throughout the process by providing:
  - ✓ Door-to-door outreach
  - ✓ Informational mailings via town certified abutting property owner list
  - ✓ Project website with progress updates
  - ✓ Project hotline and e-mail





West Roxbury to Needham Reliability Project
Typical Overhead Line Construction

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West Roxbury to Needham Reliability Project
Environmental Permitting

EVERSOURCE ENERGY

- Local Conservation Commissions
- State Review and Permitting:
  - MEPA
  - Mass Historic Commission
  - Natural Heritage Endangered Species Program
  - Mass DEP Water Quality
- Federal Review and Permitting:
  - Army Corps of Engineers
  - US Fish and Wildlife Service
  - US Environmental Protection Agency

West Roxbury to Needham Reliability Project
Next Steps

- Conduct **Open Houses** to gather community input. All abutters to the the proposed routes will be invited to the open houses.
  - **March 23, 2016**: Boston Elks, Post 1 Morell Street, West Roxbury (drop in between 7 and 9 p.m.)
  - **March 30, 2016**: Performance Space at Broadmeadow School, Needham (drop in between 7 and 9 p.m.)

- File an application with the Energy Facilities Siting Board (EFSB) and an ENF with MEPA – **April 2016**. After we file, the EFSB will conduct a local public hearing, offering additional opportunity for community input. Abutters will be notified. MEPA will also hold a scoping session and publish notice for comment in Environmental Monitor.

- Assuming receipt of all necessary permits and approvals, construction of the transmission line is anticipated to commence in **2017.**

- Construction is anticipated to occur over an 18-month period, and to be completed by the end of **2018**.

Proactive Municipal and Community Outreach Throughout Project Duration

Stakeholders

- Municipal officials
- State and federal elected officials and agencies
- Property owners & tenants
- Businesses
- Community Groups

Project Communication for Municipalities

- Briefings & Presentations

Project Communication for the Public

- News Releases/Media Advisories
- Door to door outreach, including door hangers
- Transmission 1-800-Hotline
- Project e-mail
- Customer letters

Contact Information

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http://www.mass.gov/envir

July 22, 2016

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: West Roxbury to Needham Reliability Project
PROJECT MUNICIPALITY	: Boston (West Roxbury), Dedham, and Needham
PROJECT WATERSHED	: Charles River
EEA NUMBER	: 15529
PROJECT PROPONENT	: NSTAR Electric Company d/b/a Eversource Energy
DATE NOTICED IN MONITOR	: June 22, 2016

Pursuant to the Massachusetts Environmental Policy Act (M.G.L. c. 30, ss. 61-62I) and Section 11.03 of the MEPA Regulations (301 CMR 11.00), I hereby determine that this project **requires** the preparation of a mandatory Draft Environmental Impact Report (DEIR).

Project Description

As described in the Environmental Notification Form (ENF), the project consists of the separation of 4.2 miles of overhead double circuit electric transmission lines within existing right-of-way (ROW) #3 between the Baker Street Substation in West Roxbury and the Needham Substation in Needham. The project will relocate one of the two overhead electric transmission conductors onto a new set of steel monopoles installed within the limits of ROW #3 before transitioning to a new underground electric transmission line located primarily in public roads in Needham. The overhead and underground segments will extend approximately 1.6 miles and 2.6 miles, respectively, through Boston, Dedham, and Needham. The project will include minimal modifications at the substations to connect the proposed lines.

The project is proposed to relieve potential overloads on elements of the area transmission system, reduce outages, and maintain reliable electric service to customers in the area. Under certain operating conditions, supply to approximately 65,000 customers in the western Boston suburbs cannot be maintained and could create thermal overloads. The Proponent is required to maintain its transmission system consistent with the reliability standards and criteria developed by the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council (NPCC), and the New England Independent System Operator (ISO-NE). The project is one of approximately 40 independent transmission projects recommended by the ISO-NE Greater Boston Working Group to address identified reliability affecting the electric transmission system that serves the New Hampshire - Massachusetts region, and the Greater Boston area in particular. The project will specifically address reliability within Sub-Area C – Downtown Boston of the Northeastern Massachusetts (NEMA)/Greater Boston Study Area.

A short segment of the underground electric transmission line is proposed across a municipal gravel pit in Needham; the remainder of the project will be located in either ROW #3 or in public roads. The project will include 22 steel monopole structures that will likely be constructed on reinforced concrete foundations and be of comparable height to the existing structures (between 90 and 105 feet).

Project Area

The 115-kilovolt (kV) overhead line on ROW #3 is 3.7 miles and runs parallel to the Massachusetts Bay Transportation Authority (MBTA) commuter rail tracks within the ROW. The transmission line extends over several local roadways and some roadways under State jurisdiction including Interstate 95 (I-95) (Massachusetts Department of Transportation (MassDOT)) and the Veterans of Foreign Wars (VFW) Parkway (Massachusetts Department of Conservation and Recreation (DCR)). The ROW crosses the Charles River and it extends through Cutler Park Reservation which is under care, custody and control of DCR. The 2.6-mile underground segment will be constructed entirely in Needham on portions of the following streets: Greendale Avenue (via the municipal gravel pit parcel), Grosvenor Road, Broad Meadow Road, Great Plain Avenue, Harris Avenue, School Street, Grant Street, Junction Street, and Chestnut Street.

The 4.2-mile project route passes through a number of wetland resource areas including: Bordering Vegetated Wetlands (BVW), Isolated Vegetated Wetlands (IVW), Bordering Land Subject to Flooding (BLSF), Bank, Land Under Water and Waterways (LUWW), and Riverfront Area.

It also extends through areas identified by the Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP) as *Priority* and *Estimated Habitat* for several rare species. Historical and archaeological resources have been documented within the project ROW.

Environmental Impacts and Mitigation

Potential environmental impacts are associated with alteration of wetland resource areas, construction period impacts, work within mapped rare species habitat and may include impacts to open space. Permanent impacts, associated with pole foundations, will be limited to fill within 150 square feet (sf) of BVW, 100 sf of Riverfront Area, and 550 sf of BLSF. Other wetland impacts are primarily temporary, construction-related impacts associated with placement of swamp mats to allow for equipment access and work areas in the overhead line segment of the project, and tree clearing. Temporary impacts to wetlands within the corridor will include alteration of approximately: 84,950 sf (2.0 acres) of BVW, including 45,300 sf for placement of swamp mats and the conversion of 39,640 sf of forested BVW to scrub-shrub BVW due to tree clearing; 57,000 sf of BLSF due to tree clearing; and 1,300 sf of IVW for placement of swamp mats.

These impacts will be limited to resource areas located within existing roadways or ROW #3 and will be restored to existing grades and conditions upon completion of the work. The project will use trenchless construction techniques to avoid direct impacts to wetlands and waterways by installing the transmission cables below these resource areas. The Proponent will prepare a Stormwater Pollution Prevention Plan (SWPPP) in accordance with its NPDES CGP. Erosion control measures (ECMs) and best management practices (BMPs) will be implemented to minimize and mitigate potential stormwater runoff impacts within the project corridor and wetland resource areas.

Jurisdiction and Permitting

The project is subject to the preparation of a mandatory EIR pursuant to 301 CMR Section 11.03(3)(a)(1) of the MEPA regulations because it requires State Agency Actions and will alter one or more acres of BVW. The project may also trigger the following ENF thresholds: 301 CMR 11.03(1)(b)(3), conversion of land held for natural resources purposes in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth to any purpose not in accordance with Article 97; and 301 CMR 11.03(2)(b)(2), taking of an endangered or threatened species or species of special concern, provided that the project will disturb greater than two acres of designated priority habitat. The project will require a Section 401 Water Quality Certification (401 WQC) and a Major Modification to Landfill Closure from the Massachusetts Department of Environmental Protection (MassDEP), a Construction Access Permit from DCR, a Non-Vehicular Access Permit from MassDOT, Rail Crossing Permits, licenses and easements from MBTA/MassDOT, a Section 8(m) Permit from the Massachusetts Water Resources Authority (MWRA), a Petition to Construct and Zoning Exemptions from the Massachusetts Department of Public Utilities (DPU) and Energy Facilities Siting Board (EFSB). The project may require a Conservation and Management Permit (CMP) from NHESP. The project is subject to the MEPA Greenhouse Gas (GHG) Emissions Policy and Protocol.

The project will also require Orders of Conditions from the Boston, Dedham, and Needham Conservation Commissions, or in the case of an appeal, Superseding Order(s) of Conditions from MassDEP. The project will require consultation with the Massachusetts Historical Commission (MHC) in accordance with Section 106 of the National Historic Preservation Act of 1966, a Clean Water Act Section 404 General Permit from the United States

Army Corps of Engineers (ACOE), and a National Pollutant Discharge Elimination System Construction General Permit (NPDES CGP) from the United States Environmental Protection Agency (EPA).

Because the project requires DPU approval, subject matter jurisdiction is functionally equivalent to full scope jurisdiction, in accordance with 301 CMR 11.01(2)(a)(3). Therefore, MEPA jurisdiction for this project extends to all aspects of the project that are likely, directly or indirectly, to cause Damage to the Environment as defined in the MEPA regulations.

Review of the ENF

The ENF includes a comprehensive and detailed project description that facilitated review of the project and development of a scope for the DEIR. The ENF includes an alternatives analysis, existing and proposed conditions plans, and estimates of project-related impacts. It identifies measures to avoid, minimize and mitigate environmental impacts.

Alternatives Analysis

The Proponent initiated the route selection process by delineating a Study Area that encompassed possible routes for the transmission line between the Baker Street and Needham substations. The Study Area is constrained by the Charles River and its expansive wetland system located in the Cutler Park Reservation and I-95. Existing routing opportunities included ROW #3, which follows the MBTA commuter railroad ROW between the two substations, and a combination of private, local, and state-controlled roads. Any route would have to cross the Charles River and I-95 and some of the routes would have to cross or run parallel with the MBTA railroad tracks. As part of the EFSB Petition routing analyses, the Proponent evaluated, scored, and ranked potential route segments based on environmental constructability and reliability criteria and cost estimates. Based on this analysis, a Preferred Alternative and a Noticed Alternative Route, which is geographically distinct from the Preferred Route yet would meet the project purpose and would be feasible to construct, were selected.

The Preferred Route would follow ROW #3 east from the Baker Street Substation in West Roxbury for 1.6 miles, crossing the VFW Parkway, the Charles River, the Cutler Park Reservation and I-95. At the Valley Road approach in Needham, the overhead line would transition to the underground line via either an overhead or underground crossing of the MBTA railroad tracks onto the Town of Needham gravel pit parcel. The 2.6-mile underground line would then continue primarily in municipal roads to the Needham Substation. The connection into the Needham Substation would likely occur over an easement obtained on the adjacent commercial property (433 Chestnut Street) and a jack-and-bore crossing of unused MBTA railroad tracks and a municipal sewer line.

The ENF includes an analysis of the following alternatives: No-Build; Non-Transmission Solution; and Transmission. The No-Build Alternative, which would maintain existing conditions, would not address reliability and capacity needs. In addition to studying transmission routes, the Proponent also evaluated potential non-transmission alternatives (NTAs) such as new generation, energy efficiency, demand response programs, and distributed generation, either alone or in combination with a scaled-back transmission project, to meet the identified need

within the load area. The analysis concluded that any hypothetical NTA would be much higher in cost, difficult to implement, and less flexible and robust in operation than the proposed project.

Two transmission alternatives were considered, with Transmission Alternative 1 previously described in the project description selected as the Preferred Alternative. The Proponent also analyzed the feasibility of constructing an all-overhead or all-underground transmission line on ROW #3 between the two substations. These alternatives were deemed to be impracticable because of challenges associated with existing easements and rights; constructability and long-term maintenance access issues; greater environmental impacts; potential conflicts with existing MBTA facilities and other public facilities; land disturbance and removal of remaining vegetated buffers in the more densely residential neighborhoods west of Valley Road in Needham. Importantly, the Town of Needham explicitly indicated their opposition to an overhead transmission line on ROW #3 west of Valley Road. An all-underground line constructed on public streets outside ROW #3 would be approximately two miles longer than any other alternative, cost significantly more, and require work in congested roadways of West Roxbury and crossing the Charles River, and include potentially significant construction period impacts to residences and businesses.

Transmission Alternative 2 consists of reconductoring approximately 11 miles of existing 115-kV underground electric transmission lines from Washington Tap to Baker Street Substation feeding Sub-Area C, replacing phase angle regulators at the Baker Street Substation with larger units and transferring load to substations outside the Sub-Area C load project. The analysis indicates that both transmission alternatives would meet the identified need and are comparable with respect to reliability. Although the potential for environmental impacts associated with Transmission Alternative 2 may be less than for Transmission Alternative 1, the impacts associated with Alternative 1 would be limited to the existing ROW #3 and it would cost $30 million less than Alternative 2. The analysis identifies three variations to the underground segment of the Preferred Route at: Warren Street; Valley Road; and Needham Substation Access.

I note that comments from State legislators and the Town of Needham strongly support the Preferred Route, which bypasses ROW #3 west of Valley Road through the Town of Needham and would avoid impacts to residential neighborhoods along ROW #3. State Agency comments do not request analysis of additional alternatives in the DEIR.

Article 97

The transition from overhead line construction to underground line construction may require authorization in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth (Article 97) and compliance with the Executive Office of Energy and Environmental Affairs (EEA) Article 97 Land Disposition Policy (Article 97 Policy) for crossing of railroad tracks near Valley Road in Needham on adjacent municipal parkland. The Preferred Route overhead railroad crossing design will require a new easement from the Town of Needham to access the municipal gravel pit parcel in the Town of Needham between Valley Road and Greendale Avenue. The overhead railroad crossing design option would require a new easement from the Town and would not result in conversion of Article 97 land because it would avoid work within parkland. The underground railroad crossing design option would require a new easement from the Town and authorization in accordance with Article 97 and the Article 97

Policy for work proposed within ROW #3 on municipal parkland located east and south of the gravel pit parcel. The original easement rights limit work to overhead construction in this location, therefore, the underground option would require conversion of Article 97 land. The Proponent proposes to cross the MBTA railroad tracks in this location with the overhead design option because it would avoid conversion of Article 97 land.

Wetlands and Waterways

The project will result in direct impacts to BVW, IVW, Riverfront Area, and BLSF which are largely unavoidable because of the location of the ROW. The Conservation Commissions in Boston, Dedham, and Needham will review the project to determine its consistency with the Wetlands Protection Act (WPA), the Wetlands Regulations (310 CMR 10.00), and associated performance standards, including the Stormwater Management Standards (SMS). The project is proposed as a Limited Project under the WPA (310 CMR 10.53(3)(d)). MassDEP will review the project to determine its consistency with the Chapter 91 (c. 91) regulations (310 CMR 9.00) and the 401 WQC regulations (314 CMR 9.00). ACOE will review the project to determine its consistency with Section 404 of the Federal CWA.

The project area contains both federal- and State-regulated wetlands. The ENF characterizes and identifies the location of wetland resource areas types along the Preferred Route. In most locations, ROW #3 has been cleared to nearly its full extent. The Proponent maintains upland and wetland areas within the ROW in accordance with its Vegetation Management Plan. Impacts are primarily associated with the overhead line segment of the Preferred Route which are identified in the following table.

Wetland Alteration	BVW	IVW	Riverfront Area	BLSF
Temporary Timber Construction Mats (including work pads)	1.04 ac	0.03 ac	0.47 ac	2.02 ac
Tree Clearing (permanent conversion of forested wetlands to scrub-shrub wetlands)	0.91 ac	0	0	1.31 ac
Monopole Structure Foundations (permanent fill)	150 sf (3 structures)	0	100 sf (2 structures)	550 sf (11 structures)

The ENF indicates that the project will include 2.2 acres of tree clearing in uplands and wetlands. The majority of the tree clearing in wetlands will occur on a parcel of land located adjacent to West Roxbury High School (0.7 acres), which is owned by the Proponent. The remaining tree clearing within wetlands will occur in Needham and Dedham, predominantly within Cutler Park Reservation.

According to the ENF, almost all impacts to wetlands resource areas within the existing ROW will result from clearing and the placement of swamp mats to provide access for construction equipment and work areas. The use of swamp mats is a mitigation measure to prevent permanent impacts to wetlands resource areas due to direct contact with construction vehicles and equipment. Measures to mitigate these temporary construction impacts include removing the swamp mats and restoring pre-construction contours, revegetation and stabilization

of impacted areas, and the use of sedimentation and erosion controls. The Proponent will coordinate with ACOE, MassDEP, and local Conservation Commissions to develop a comprehensive mitigation plan, including compensatory mitigation.

The ENF indicates that the extension of the overhead line over the non-tidal segment of the Charles River will not require a new or modified c. 91 License pursuant to 310 CMR 9.065(3)(g). This project element will be addressed by the Boston and Dedham Conservation Commissions in the review of the Notices of Intent (NOI).

Traffic and Transportation

The overhead segment of the Preferred Route will also span the VFW Parkway, I-95, and the MBTA Needham Line commuter rail tracks within ROW #3. Two MBTA commuter rail stations are located along the underground segment of the Preferred Route (Needham Junction and Hersey). The underground segment will cross the active MBTA tracks near Valley Road in Needham and an unused section of tracks near the entrance to the Needham Substation facility on Chestnut Street.

The project requires a Non-Vehicular Access Permit from MassDOT for work spanning I-95, a Construction Access Permit from DCR for work spanning the VFW Parkway, and Rail Crossing Permits from the MBTA. The ENF indicates that the Proponent has consulted with the State Agencies to secure approvals and easements. Work associated with the railroad crossings will be designed according to the MBTA's Railroad Operations Directorate and the terms and conditions of any license, access agreement, and temporary/permanent easements obtained from the MBTA. The Proponent will prepare traffic management plans (TMPs) to evaluate construction-related traffic impacts and propose mitigation including night work, signage, and similar measures. The ENF describes the issues that will be addressed in the TMP.

Rare Species

Portions of the project site contain *Estimated* and *Priority Habitat* for two state-listed plant species. According to the ENF, the Proponent is consulting with NHESP regarding whether the project will result in a "take" of any rare and endangered species and whether a Conservation and Management Permit (CMP) in compliance with the Massachusetts Endangered Species Act (MESA) and its implementing regulations (321 CMR 10.00) may be required. The Proponent is undertaking botanical surveys to map the presence of rare plants. The ENF does not detail any rare species avoidance, minimization, or mitigation measures.

Historic and Archaeological Resources

According to the ENF, the Preferred Route is adjacent to seven historic properties listed on the Inventory of Historic and Archaeological Assets of the Commonwealth and over the VFW Parkway which is listed on the State and National Registers of Historic Places. The project does not involve demolition of any historic building or structure. It is unlikely that significant archaeological resources would be located below or immediately adjacent to roadways within which work is proposed. The Proponent retained the services of Public Archaeology Lab (PAL) which has indicated the roadway portions of the Preferred Route have low archaeological

sensitivity. PAL identified two areas of moderate/high archaeological sensitivity within and/or adjacent to the MBTA/ROW #3 corridor that may warrant further testing to determine eligibility for listing on the National Register.

The project is subject to review under Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800) and by MHC in compliance with M.G.L. c.9 ss.26-27C as amended by Chapter 254 of the Acts of 1988. MHC review is typically undertaken concurrently with Section 106 Review through consultation with the ACOE. The Proponent will coordinate with ACOE and MHC regarding avoidance of adverse effects to any eligible historic and archaeological resources.

Solid Waste

According to the ENF, a portion of the closed and capped Gardner Street landfill in West Roxbury, which is adjacent to Millennium Park, extends onto ROW #3 where overhead line construction and access will occur. The project will require a Major Modification to Landfill Closure and a SW45 Facility Modification Permit from MassDEP. The Proponent will manage contaminated soil or other material along the Preferred Route pursuant to the provisions of a Utility Release and Abatement Measures (URAM) regulated under the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000).

Construction Period

The ENF includes plans of the Preferred Route which identify constraints, wetland resource areas, stream crossings, structure locations, easements, potential construction access routes, work pads, swamp mat locations, and areas of tree clearing.

It appears from plans that construction access will be gained using existing access routes (public roads intersecting the ROW and other established access points) within the corridor. Clearing will be required along some areas of the ROW. The ENF indicates that the vast majority of the ROW is already maintained and cleared of mature trees. Swamp mats will be used to minimize impacts associated with temporary access through and within wetland resource areas. Following completion of work within wetland areas, access roads and swamp mats will be removed and the area will be restored to pre-construction grade and seeded with an appropriate native seed mix.

ECMs and BMPs will be implemented to minimize and mitigate potential stormwater runoff impacts within the project corridor and wetland resource areas. The Proponent must obtain a NPDES CGP from EPA and prepare a SWPPP.

In compliance with Section 8(m) of Chapter 372 of the Acts of 1984, the Proponent must obtain approval for the project from the MWRA since the MWRA has sewer infrastructure within or adjacent to the site (Upper Neponset Valley Replacement Sewer, Section 685).

The Proponent exclusively uses ultra-low sulfur diesel (ULSD) fuel in its own diesel-powered construction equipment and will require its contractors to do the same. The Proponent will also direct contractors working on the project to retrofit any diesel-powered non-road

construction equipment rated 50 horsepower or above to be used for 30 or more days over the course of the project with U.S. EPA-verified (or equivalent) emission control devices (e.g., oxidation catalysts or other comparable technologies). The project will comply with MassDEP regulations limiting vehicle idling (310 CMR 7.11 (1)(b)). Asphalt and concrete will be handled separately from soil to allow for recycling.

SCOPE

General

The DEIR should follow Section 11.07 of the MEPA regulations for outline and content, as modified by this scope.

Project Description and Permitting

The DEIR should include a detailed description of the proposed project and describe any changes to the project since the filing of the ENF. The DEIR should include updated site plans as necessary to reflect modifications to infrastructure design, access roadways, wetland impact areas, and mitigation areas. The DEIR should provide a brief description and analysis of applicable statutory and regulatory standards and requirements, and a description of how the project will meet those standards. The DEIR should include a list of required State Agency Permits, Financial Assistance, or other State approvals and provide an update on the status of each of these pending actions. Given the significant role ACOE will play in the selection, scope and implementation of wetlands mitigation, the DEIR should include an update on the federal permitting process, including coordination efforts and anticipated compliance with regulatory and permitting standards and mitigation requirements. In addition, it should summarize consultation regarding impacts to archaeological resources.

The DEIR should identify the applicable standards set by the DPU or other applicable regulatory agency that govern the required minimum distances between structures, transmission lines and related equipment, vegetation management requirements, and other design criteria to demonstrate that the project will avoid, minimize and mitigate Damage to the Environment.

Alternatives Analysis

The DEIR should include a comparison of the environmental impacts associated with each transmission line alternative and a summary table of anticipated wetland/rare species/land impacts for each alternative. This narrative should support the selection of the Preferred Alternative and demonstrate how it will avoid, minimize and mitigate Damage to the Environment. A graphic should be included identifying key features for each transmission line alternative and potential environmental impact areas (i.e., habitat, wetlands, etc.).

Article 97

The DEIR should provide an update on the preferred transition option for the crossing of MBTA railroad tracks near Valley Road in Needham. A change in use of Article 97 land requires

legislative authorization and compliance with the EEA Article 97 Policy. A primary goal of the Policy is to ensure no net loss of Article 97 lands under the ownership and control of the Commonwealth. If the Preferred Route will require conversion of Article 97 land, the DEIR should describe how the project will be consistent with the EEA Article 97 Land Disposition Policy, including an alternatives analysis and identification of mitigation.

Land Alteration

The DEIR should more fully describe construction access and individually identify the amount of land alteration in upland and wetland areas associated with access, swamp mat placement, work pads, and areas of tree clearing. The ENF indicates that the project will require clearing along areas of the ROW. The DEIR should clearly identify on project plans the extent of proposed clearing within wetland resource areas along access roadways (permanent or temporary), within upland portions of these access roadways, and along the ROW itself. The DEIR should discuss how the ROW and access routes will be maintained over time to limit encroachment by vegetation (native or invasive), limit impacts to habitat and wildlife, and identify the type and frequency of maintenance activities. The DEIR should discuss the implementation of measures to limit unauthorized access to the permanent access roadways by off-highway vehicles. The DEIR should also discuss the Proponent's policies and procedures for notifying municipalities and property owners about proposed clearing and vegetation management along the ROW in conjunction with the project.

The DEIR should characterize the type of land clearing proposed (i.e., stump removal and grinding, use of wood chips, etc.), selective retention of low-growth vegetation, invasive species removal, etc. The type and extent of restoration efforts should be clearly described and identified on project plans.

Climate Change Adaptation and Resiliency

The DEIR should discuss potential effects of climate change on the project in the context of improving reliability and resiliency of the system. The DEIR should identify any potential impacts and address how the project will be designed to adapt and/or sustain such impacts. To assist in the evaluation of climate change resiliency and adaptation measures the Proponent should review EOEEA's *Climate Change Adaptation Report* (September 2011) (http://www.mass.gov/eea/docs/eea/energy/cca/eea-climate-adaptation-report.pdf).

Wetlands and Stormwater

As noted previously, the project will result in unavoidable impacts to wetlands resource areas. The project includes wetland resource areas and activities that trigger both Federal, State and local wetland permitting jurisdiction, each with its own performance standards and regulations. The DEIR should demonstrate that the project will avoid, minimize or mitigate wetland resource area impacts to the maximum extent practicable. It should clearly outline a comprehensive wetland mitigation program that meets ACOE, MassDEP, and local bylaw requirements and performance standards. This mitigation program should include construction period measures, post-construction period monitoring and restoration, and measures to promote

wildlife habitat and to remove/prevent the establishment of invasive species. The DEIR should respond to MassDEP comments regarding wetlands and the 401 WQC.

The comment letter from the Needham Conservation Commission indicates that it issued an Order of Conditions approving geotechnical investigations and wetland resource area boundaries in Needham. The DEIR should reference the updated delineation. The DEIR should clarify the potential amount of permanent impact and temporary wetland alteration, identify the project's consistency with the WPA, identify proposed wetland replication amounts and locations, and demonstrate compliance with 401 WQC standards at 314 CMR 9.06 that require the project to avoid, minimize, and mitigate the placement of fill in BVW. Wetland replication areas should be designed consistent with the MassDEP *Inland Wetlands Replication Guidance* document. Finally, the DEIR should specifically discuss how the locations of replacement or new utility structures were determined to avoid wetland impacts while meeting engineering requirements of utility pole span and conductor clearance. If applicable, the DEIR should include the results of a Wildlife Habitat Evaluation completed pursuant to the WPA regulations (310 CMR 10.60) and the procedures and methods detailed in MassDEP's *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands*.

The DEIR should identify impacts to wetland resource areas (i.e. associated with use of swamp mats and general construction activities) that will be subject to ACOE review. ACOE regulations and guidance categorize wetland impacts as either permanent (fill), temporary (disturbance), or secondary. The DEIR should identify applicable ACOE performance standards and regulations to assist in determining the potential overlap or potentially conflict with State wetland permitting requirements. The DEIR should include narrative and supporting data or graphics as necessary to demonstrate that the project can meet all applicable performance standards and regulations. If these standards and regulations cannot be met, the DEIR should describe how construction of the project may otherwise proceed (i.e., a variance, etc.). The DEIR should include a discussion of the content and results of coordination meetings with various regulatory agencies and stakeholders undertaken since the filing of the ENF.

The DEIR should discuss how the use of swamp mats will be effectively managed to limit permanent impacts to wetland resource areas. The DEIR should describe how construction sequencing will be conducted to minimize impacts to wetland resource areas. The DEIR should describe potential monitoring and mitigation (i.e., supplemental plantings, regrading, etc.) efforts to ensure that wetlands will not be permanently impacted and to limit the likelihood of repopulation with invasive species. Any proposed mitigation program should include a discussion of how pre-construction grades and natural wetland vegetation will be restored. The DEIR should include a discussion of providing a vegetative buffer at roadway crossings.

The DEIR should evaluate potential impacts from stormwater runoff during construction and post-construction. It should demonstrate that source controls, pollution prevention measures, erosion and sedimentation control measures, and any required post-construction drainage system will be designed in compliance with MassDEP Stormwater Management Regulations. The DEIR should consider use of low impact development (LID) measures and integrated management practices (IMP), if applicable to the project.

Rare Species

The DEIR should provide an update on rare species habitat surveys and discussions with NHESP, including whether the project is likely to result in a "take." These surveys should be provided to NHESP prior to the filing of the DEIR to facilitate its review. If the project results in a take, the DEIR should specifically address how the project will meet the CMP requirements. The DEIR should describe measures to avoid, minimize and mitigate impacts to rare species habitat, including adjusting work zones to avoid locations with rare plant species, time of year restrictions, restoration and, if warranted, conservation of off-site land containing rare species habitat.

Solid Waste

The DEIR should include additional information regarding the proposed post-closure use to allow MassDEP to evaluate the project and determine the appropriate permitting pathway for the project. The DEIR should confirm if the appropriate permit category would be for post-closure use (i.e. SW36 if the work will be on the landfill final cover (capped area), or SW37 if it is not on the landfill cap). MassDEP comments indicate that other permit categories may apply. The Proponent should consult with MassDEP prior to filing the DEIR.

Traffic and Transportation

Traffic impacts are limited to the construction period. The Proponent will prepare TMPs to maintain safe and efficient access for all modes of travel in the vicinity of access points to the ROW. The Proponent, MassDOT, DCR, and MBTA should coordinate appropriate times, length and management of roadway shutdowns to limit impacts to travelers. The MassDOT comment indicates that the Proponent should continue consultation with MassDOT Highway District 6 to establish a construction management plan that will minimize impacts and duration of work within the state highway layout. Review and approval of the TMPs will likely occur in conjunction with the MassDOT permitting process. The DEIR should provide an update on any consultations with MassDOT, DCR, and MBTA. The DEIR should provide an outline of the TMPs and describe potential construction sequencing and its impacts to traffic, particularly on local roadways in Needham.

The DEIR should identify if the project will involve any alteration of bank or terrain regarding the widening of the existing access point and gated entrance onto ROW #3 from I-95. The DEIR should provide an update on the need for airspace review from the Federal Aviation Administration (FAA) and MassDOT Aeronautics Division for the proposed steel monopole structures and identify any required permits or notifications.

Greenhouse Gas Emissions

The project is subject to the MEPA Greenhouse Gas Policy and Protocol (GHG Policy) because it exceeds thresholds for a mandatory EIR. The GHG Policy includes a de minimus exemption for projects that will produce minimal amounts of GHG emissions. Given the nature of the project, I have concluded that this project falls under the de minimus exemption; therefore, the Proponent is not required to prepare a GHG analysis. However, I encourage the Proponent to

incorporate measures to avoid and minimize GHG emissions (and other air pollutants) during the construction period through the use of emissions-reduction technologies.

Historic and Archaeological Resources

The DEIR should provide an update on the project's potential impacts to historical and archaeological resources and the outcome of any consultations with ACOE and MHC. The DEIR should indicate if the two areas of moderate/high archaeological sensitivity will warrant further testing to determine eligibility for listing on the National Register. The DEIR should describe additional field work or surveys and the development of avoidance and mitigation plans.

Construction Period

The project must comply with MassDEP's Solid Waste and Air Pollution Control regulations, pursuant to M.G.L. c.40, s.54. The DEIR should discuss the use of alternative types of equipment for the construction of all, or part, of the project that may serve to reduce overall wetland impacts (e.g., smaller low-pressure equipment, etc.). The DEIR should clearly identify the proposed locations of both permanent and temporary (i.e., construction period only) access roads to and within the ROW. The DEIR should identify whether existing access routes may require maintenance and improvements to facilitate equipment movement, including the placement of gravel to provide a level surface within the access route and clearing or pruning of overgrown vegetation. The DEIR should discuss how temporary access routes will be restored to original conditions subsequent to the conclusion of the construction period. The DEIR should clarify if restoration of temporary access roads will be limited to those within wetland resource areas or if it will also include roads within the 100-foot buffer zone to BVW.

I strongly encourage the Proponent to incorporate construction and demolition (C&D) recycling activities as a sustainable measure for the project, as allowed. The DEIR should also confirm the location of MWRA infrastructure within the project and commit to work with the MWRA to complete the 8(m) permitting process.

Mitigation and Section 61 Findings

The DEIR should include a separate chapter summarizing proposed mitigation measures. This chapter should also include draft Section 61 Findings for each State Agency that will issue permits for the project. The DEIR should contain clear commitments to implement mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation, and contain a schedule for implementation.

Responses to Comments/Circulation

The DEIR should contain a copy of this Certificate and a copy of each comment letter received. In order to ensure that the issues raised by commenters are addressed, the DEIR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended, and shall not be construed, to enlarge the scope of the DEIR beyond what has been expressly identified in this certificate.

The Proponent should circulate the DEIR to those parties who commented on the ENF, to any State Agencies from which the Proponent will seek permits or approvals, and to any additional parties specified in section 11.16 of the MEPA regulations. A copy of the DEIR should be made available for review at the West Roxbury, Dedham, and Needham public libraries.

July 22, 2016
Date

Matthew A. Beaton

Comments received:

07/11/2016	Massachusetts Water Resources Authority (MWRA)
07/12/2016	Massachusetts Department of Transportation (MassDOT)
07/12/2016	Massachusetts Department of Environmental Protection – Northeast Regional Office (MassDEP/NERO)
07/12/2016	Massachusetts Division of Fisheries and Wildlife – Natural Heritage and Endangered Species Program (NHESP)
07/12/2016	Needham Conservation Commission
07/12/2016	Needham Board of Selectmen
07/12/2016	State Representative Denise C. Garlick, State Senator Michael F. Rush, and State Senator Richard J. Ross
07/13/2016	Boston Water and Sewer Commission (BWSC)
07/13/2016	Charles River Watershed Association (CRWA)
07/22/2016	Department of Conservation and Recreation

MAB/PPP/ppp

MASSACHUSETTS WATER RESOURCES AUTHORITY

Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
Fax: (617) 788-4899
TTY: (617) 788-4971

July 11, 2016

Matthew A. Beaton, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge St, Suite 900
Attn: MEPA Office, Purvi Patel
Boston, MA 02114

Subject: EOEEA #15529 – Environmental Notification Form
West Roxbury to Needham Reliability Project
Boston, Dedham and Needham, MA

Dear Secretary Beaton:

The Massachusetts Water Resources Authority (MWRA) appreciates the opportunity to comment on the Environmental Notification Form (ENF) submitted by Eversource (the "Proponent") for the West Roxbury to Needham Reliability Project (the "Project" within the City of Boston and Towns of Dedham and Needham, MA

The West Roxbury to Needham Reliability Project (the "Project") proposes to separate approximately 4.2 miles of existing overhead double circuit electric transmission lines located along its right-of-way ("ROW") #3. The double circuit electric transmission lines are currently collected on double circuit steel monopole structures ("DCT") between the Proponent's Baker Street Substation in West Roxbury and the Needham Substation located on Chestnut Street in Needham. The transmission line separation work will occur by relocating one of the existing overhead electric transmission conductors onto a new set of steel monopoles installed within the limits of the existing Eversource ROW #3 before transitioning to a new underground electric transmission line located primarily in public roads in the Town of Needham. Portions of the proposed work will occur in the communities of Boston, Dedham and Needham. The overhead electric transmission line segment within ROW #3 is approximately 1.6 miles; the underground electric transmission line segment located primarily in public roads in Needham is approximately 2.6 miles.

MWRA comments focus on the need for Section 8 (m) permitting from the Wastewater Permitting Group and the need for a USEPA-NPDES permit to discharge groundwater during construction.

Section 8 (m) Permitting

Section 8 (m) of Chapter 372 of the Acts of 1984, MWRA's Enabling Legislation, allows the MWRA to issue permits to build, construct, excavate, or cross within or near an easement or other property interest held by the MWRA, with the goal of protecting Authority-owned infrastructure. MWRA Staff have met with the Proponent and they have been informed that a Section 8 (m) Wastewater permit will be required due to the proximity of MWRA's Upper Neponset Valley Replacement Sewer, Section 685 to the Project site. Kevin McKenna of MWRA's Wastewater Permitting Group will continue to work with the Proponent to assist them in securing the necessary 8 (m) permit and can be reached at (617) 305-5956.

Construction Groundwater Discharge

The MWRA prohibits the discharge of groundwater to the sanitary sewer system, pursuant to 360 C.M.R. 10.023(1) except in a combined sewer area when permitted by the Authority and the municipality. The proposed Project site has access to a storm drain and is not located in a combined sewer area; therefore, the discharge of groundwater to the sanitary sewer system associated with this Project is prohibited. Instead, the Proponent must secure a USEPA-NPDES General Permit for Storm Water Discharges from its construction activities.

If you have any questions or need additional information, please do not hesitate to contact me at (617) 788-1165.

Sincerely,

Marianne Connolly

Marianne Connolly
Senior Program Manager
Environmental Review and Compliance

cc: Kevin McKenna, Wastewater Permitting
Kattia Thomas, MWRA TRAC

C:MEPA:15529West Roxbury to Needham Reliability Project ENF.docx

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, MassDOT Secretary & CEO

massDOT
Massachusetts Department of Transportation

July 12, 2016

Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114-2150

RE: Boston/Needham/Dedham: Eversource's West Roxbury to Needham Reliability Project – ENF (EEA #15529)

ATTN: MEPA Unit
Purvi Patel

Dear Secretary Beaton:

On behalf of the Massachusetts Department of Transportation, I am submitting comments regarding the proposed Eversource reliability project in Boston, Needham, and Dedham, as prepared by the Office of Transportation Planning. If you have any questions regarding these comments, please contact J. Lionel Lucien, P.E., Manager of the Public/Private Development Unit, at (857) 368-8862.

Sincerely,

David J. Mohler
Executive Director
Office of Transportation Planning

DJM/jll

Ten Park Plaza, Suite 4150, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
www.mass.gov/massdot

cc: Thomas J. Tinlin, Administrator, Highway Division
Patricia Leavenworth, P.E., Chief Engineer, Highway Division
Walter Heller, P.E., District 6 Highway Director
Neil Boudreau, State Traffic Engineer
PPDU Files

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, MassDOT Secretary & CEO

massDOT
Massachusetts Department of Transportation

MEMORANDUM

TO: David J. Mohler, Executive Director
Office of Transportation Planning

FROM: J. Lionel Lucien, P.E., Manager
Public/Private Development Unit

DATE: July 12, 2016

RE: Boston/Dedham/Needham – Eversource's West Roxbury to Needham Reliability Project – ENF (EEA #15529)

The Public/Private Development Unit (PPDU) has reviewed the Environmental Notification Form (ENF) for the proposed Eversource Reliability project in Boston, Dedham, and Needham. The project involves the construction of a new overhead/underground electric transmission line to improve the reliability of electrical service for the communities it passes through. The transmission line would be a total length of 4.2 miles along public roads and run parallel to the MBTA commuter rail tracks within existing right of way.

The transmission line construction would largely impact roadways under local jurisdiction, but overhead lines are expected to span locations under MassDOT and DCR jurisdiction, including Interstate-95 and VFW Parkway, respectively.

The project requires a MassDOT Non-Vehicular Access Permit because of the limited construction impacts on state roadways. The Proponent should continue coordination with the MassDOT Highway District 6 in establishing a construction management plan that minimizes the impacts and the duration of work within the state highway layout.

We recommend that no further environmental review be required based on transportation related issues. The Proponent is encouraged to continue consultation with the MassDOT District 6 office in the preparation of a construction management plan. If you have any questions regarding these comments, please contact me at (857) 368-8862 or Derek Valentine at (857) 368-8885.

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Northeast Regional Office • 205B Lowell Street, Wilmington MA 01887 • 978-694-3200

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

July 12, 2016

Matthew A. Beaton, Secretary
Executive Office of
Energy & Environmental Affairs
100 Cambridge Street
Boston MA, 02114

RE: Boston, Dedham, Needham
West Roxbury to Needham Reliability Project
From Baker Street West Roxbury Substation
to Chestnut Street Needham Substation.
EEA # 15529

Attn: MEPA Unit

Dear Secretary Beaton:

The Massachusetts Department of Environmental Protection Northeast Regional Office (MassDEP-NERO) has reviewed the Environmental Notification Form (ENF) submitted by NSTAR Electric Company/Eversource Energy to separate the overhead electric transmission lines within Eversource ROW3 for a length of 4.2 miles in West Roxbury, Dedham, and Needham (EEA #15529). The project will include 1.6 miles of new steel monopoles and 2.6 miles of underground electric transmission line in public roads in Needham. The work within the substations to accommodate the new line include a new connection to the breaker at the same location and a modification of the structure at the western end of the Needham Substation and modifications of the control circuits to accept the new line. The purpose of the project is to minimize the potential for overload to the system and loss of service. This project is among those in ISO-New England's AC Plan in the *Greater Boston Solutions Study.* The project is categorically included for the preparation of an environmental impact report. MassDEP provides the following comments.

Wetlands

Even though the transmission line project is proposed primarily within existing right of way, there will be significant wetlands impacts and impacts to areas of priority habitat. The ENF provides a table identifying the wetlands resource impacts for the preferred route that includes almost three acres of bordering vegetated wetlands (1.95 acres plus 150 square feet (sf)), 0.03 acres of isolated vegetated wetlands, 0.47 acres plus 100 sf of Riverfront Area, and 3.33 acres plus 550 sf of bordering land subject to flooding. Within each resource area, the table segregates the temporary construction impacts, tree clearing impacts that result in conversion of forested wetlands to scrub-shrub wetlands, and the permanent losses of wetland resource areas by the installation of monopole structure foundations.

All extent of wetland alteration for the project should be described, quantified, and shown on plans in the EIR. The EIR also should demonstrate that the project would comply with the performance standards in the wetlands regulations, and provide documentation to show that alteration of resource areas has been avoided, minimized, and mitigated where applicable.

The EIR should consider layout modifications, drainage, alternate construction methods, erosion and sediment controls, and the use of materials with optimum durability and minimal maintenance requirements, taking into consideration extreme storm events anticipated due to climate change, to avoid and minimize impacts to wetlands, including the need for future work within the ROW. The EIR also should demonstrate that the project avoids impacts, including short and long term adverse effects, in accordance with the standards for wetlands permitting within Estimated Habitat for rare species, 310 CMR 10.59. To the extent possible, staging areas for equipment, materials, and excavated soils should be kept out of all wetland resource areas.

Where impacts cannot be avoided, the applicant would be required to provide mitigation. The EIR also should identify and quantify the wetlands replication areas and demonstrate that altered wetland functions will be restored. The wetlands replication/mitigation should be consistent with the BVW performance standards in 310 CMR 10.55(4), and the design for the replication should be based upon the MassDEP *Massachusetts Inland Wetland Replication Guidelines*, March 2002. In addition, as part of a wetlands restoration plan, removal of invasive species is recommended. While monitoring the wetland restoration, it also would be beneficial to include a plan for removal of newly established invasive plants.

The EIR should also address impacts to BLSF and mitigate for loss of storage by providing a compensatory flood storage plan in accordance with performance standards in 310 CMR 10.57(4). The Regulations do not provide an exemption for perceived negligible impacts to BLSF. The EIR should also include a section describing in more detail impacts associated with RA and provide an evaluation of no significant adverse impact in accordance with 310 CMR 10.58(4)(d).

401 Water Quality Certificate

The project requires a 401 Water Quality Certificate from MassDEP because the work proposed will result in a discharge of fill to more than 5,000 square feet (sf) of bordering vegetated wetlands and isolated vegetated wetland resources.

The MassDEP requests a demonstration that that alteration of wetlands resource areas has been avoided and minimized to the greatest extent feasible, and will consider alternatives that reduce wetlands impacts, as required in 401 permitting. Practicable alternatives in 401 permitting are those that can be done after taking into consideration costs, existing technology, and logistics in light of overall project purposes. The Department recommends that low-pressure impact equipment be used as an alternative to, or in combination with, the proposed swamp mats.

Controlling the length of time construction equipment and swamp mats are in the resource area can minimize wetlands impacts. This project presents unique construction sequencing challenges, such that wetlands impacts would need to be carefully planned to avoid multiple disturbances and impacts during sensitive periods for areas within the priority habitat.

Undertaking the construction in the wetlands areas during dormant growth periods also can help to minimize impacts.

The Department requests removal of any unused utility structures, gravel/soil materials, and ancillary materials that will not be needed when the new transmission line support structures are installed. Removed materials should be replaced with appropriate wetlands or native soils for the reestablishment of wetlands and associated essential hydrology, as well as uplands. In addition, MassDEP requests that the equipment vehicles be washed to prevent introduction of invasive species, and materials and excavated soils be stockpiled in upland areas, away from wetland resources.

A wetlands replication plan and commitment to restoration must be developed in greater detail to demonstrate that unavoidable impacts to wetlands would be mitigated adequately. Generally, the Department is recommending replication of permanent impacts at a rate greater than 1:1 to ensure a margin of error in the event that wetlands replication is not entirely successful. The wetlands replication/mitigation should be consistent with the BVW performance standards in 310 CMR 10.55(4), and the design for the replication should be based upon the MassDEP *Massachusetts Inland Wetland Replication Guidelines*, March 2002.

Solid Waste

The ENF indicates that the project requires a Major Modification to Landfill Closure from MassDEP for transmission line work in the vicinity of a closed and capped landfill at Millenium Park in West Roxbury.

Based on this limited project information, and the fact that the Gardner Street landfill is capped and closed, it appears that the proper permit category would be for post-closure use, (i.e., SW36 if the work will be on the landfill final cover (capped area), or SW37 if it is not on the landfill cap). Depending on the full scope of the proposed work, other permit categories may apply, such as SW45. MassDEP requests additional information in the EIR in order to evaluate the project and determine the appropriate permitting pathway for the project.

The MassDEP Northeast Regional Office appreciates the opportunity to comment on this proposed project. Please contact Jill.Provencal@state.ma.us, at (978) 694-3250 for further information on the wetlands and 401 Water Quality Certification permitting issues and Mark.Fairbrother@state.ma.us , at (978) 694-3298 with questions on the solid waste related issues. If you have any general questions regarding these comments, please contact Nancy.Baker@state.ma.us , MEPA Review Coordinator at (978) 694-3338.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John D. Viola
Deputy Regional Director

cc: Brona Simon, Massachusetts Historical Commission
Susan Ruch, Mark Fairbrother, Jessica Kenny, Jill Provencal, Phil DiPietro, MassDEP-NERO
Boston, Dedham, and Needham conservation commissions

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Jack Buckley, *Director*

July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Environmental Affairs
Attention: MEPA Office, Purvi Patel, EEA No. 15529
100 Cambridge St.
Boston, Massachusetts 02114

Project Name:	West Roxbury to Needham Reliability Project
Proponent:	NSTAR Electric Company d/b/a Eversource Energy
Location:	Existing ROW and public roads in Boston, Dedham, Needham
Document Reviewed:	Environmental Notification Form
Project Description:	Separation of overhead double circuit electric transmission lines
EEA No.:	15529
NHESP Tracking No.	15-35032

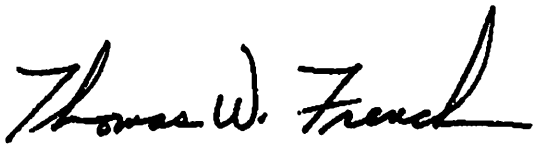
Dear Secretary Beaton:

The Natural Heritage & Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries & Wildlife (Division) has reviewed the Environmental Notification Form (ENF) for the West Roxbury to Needham Reliability Project and would like to offer the following comments.

Portions of the proposed project located within *Priority Habitat* and *Estimated Habitat* as indicated in the 13th Edition of the *MA Natural Heritage Atlas* and therefore the project requires review through a direct filing with Division for compliance with the Massachusetts Endangered Species Act (MESA, MGL c.131A) and its implementing regulations (321 CMR 10.00). Review of the NHESP database indicates that the proposed project will occur within the habitat of plant species which are state-listed and protected in accordance with the MESA.

In anticipation of filing the proposed project for compliance with the MESA, the project proponent has been consulting with the Division on any potential rare species concerns associated with the proposed work. Currently, the Division is awaiting the results of botanical surveys to determine whether there will be any impacts to state-listed species and their habitats. The Division will not render a final decision until the MEPA review process and associated public and agency comment period is completed, and until all required MESA filing materials are submitted by the proponent to the Division. As our MESA review is ongoing, no alteration to the soil, surface, or vegetation and no work associated with the proposed project shall occur until the Division has made a final determination. We look forward to continued careful coordination with the proponent on the details of the project design and implementation. If you have any questions or need additional information, please contact Eve Schlüter, Ph.D., Chief of Regulatory Review at (508) 389-6346 or eve.schluter@state.ma.us.

Sincerely,



Thomas W. French, Ph.D.
Assistant Director

cc: Corinne Snowdon, Epsilon Associates, Inc.
Boston City Council
Boston Conservation Commission
Boston Redevelopment Authority
Dedham Board of Selectmen
Dedham Conservation Commission
Dedham Planning Department
Needham Board of Selectmen
Needham Conservation Commission
Needham Planning Department
DEP Northeastern Regional Office, MEPA Coordinator

TOWN OF NEEDHAM
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July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Attn: MEPA Office

RE: Eversource's West Roxbury to Needham Reliability Project
Boston, Dedham, Needham, MA
MEPA Environmental Notification Form

Dear Secretary Beaton,

The Needham Conservation Commission (NCC) is in receipt of the above-referenced ENF and is pleased to provide comments for those portions of work proposed to occur within the Town of Needham.

On June 24, 2016, the Needham Conservation Commission issued an Order of Conditions (OOC) approving geotechnical investigations and approving wetland resource boundaries within the project area. The wetland boundaries contained within the ENF document are not the boundaries approved in the OOC. All future MEPA filings should reflect the wetland boundaries approved by the Conservation Commission and shown on the plans referenced in the OOC. Additionally, all proposed resource impact calculations should be based on the approved wetland boundaries.

The ENF states that there will be permanent impacts to regulated wetland resources within the Town of Needham related to the installation of new structures, including the conversion of forested wetlands to scrub-shrub wetlands. Additionally, there will be temporary impacts related to the installation of timber construction mats. The Needham Conservation Commission encourages the Applicant to provide evidence that the conversion of forested wetlands to scrub-shrub wetlands will not adversely impact the ability of the resource areas to protect the interests of the Massachusetts Wetlands Protection Act and the interests of the Needham Wetlands Protection Bylaw (Article 6), particularly with regard to the protection of wildlife habitat. Special attention should be paid to the potential for the influx or expansion of non-native, invasive plant species in areas where vegetation will be disturbed. Although the project is

anticipated to be proposed as Limited Project in the Notice of Intent process, the Commission strongly encourages the Applicant to fully meet all applicable performance standards under the Act and the Bylaw.

Should you have any questions on the information contained in this letter, please feel free to contact me at (781) 455-7550 [x248] or at mvarrell@needhamma.gov.

Regards,

Matthew Varrell, PWS
Director of Conservation

cc: Epsilon Associates, Inc.
Needham Board of Selectmen
Needham Planning Board
Needham Board of Health

TOWN OF NEEDHAM

TOWN HALL
1471 Highland Avenue
Needham, MA 02492-2669

Office of the
TOWN MANAGER

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July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston MA 02114

RE: EEA #15529, Eversource's West Roxbury to Needham Reliability Project.

Dear Secretary Beaton:

On behalf of the Needham Board of Selectmen, I am pleased to submit the following comments in response to the Environmental Notification Form ("ENF") submitted by NSTAR Electric d/b/a Eversource Energy ("Proponent") for the West Roxbury to Needham Reliability Project (the "Project").

The Town appreciates the Proponent's cooperation and outreach efforts thus far as evidenced by the numerous pre-filing consultation meetings conducted with various municipal departments including, but not limited to, the Board of Selectmen, Town Manager's office, Engineering and Public Works, Park and Recreation, and Conservation. These meetings were held over the course of 2015 and 2016 leading up the filing of the ENF. The Proponent also held a voluntary "open house" on March 30, 2016 at the Broadmeadow School to provide residents an opportunity to learn more about the Project, ask questions and provide comments. The Proponent was receptive and responsive to the concerns of the Town and abutters, accommodating requests for modifications to the Project's design, when possible.

As we understand it, the Project will make improvements to the Proponent's existing electric transmission line system in the western Boston suburbs by separating the existing double circuit tower ("DCT") transmission lines between the Baker Street Substation in Boston and the Needham Substation located on Chestnut Street in Needham. In general, the Town is supportive of efforts by the Proponent to improve the reliability of its existing transmission line system and the customers it serves throughout Needham and the Greater Boston area.

A primary focus of the pre-filing consultation meetings with the Proponent has been on the topic of routing with an emphasis on avoiding or minimizing impacts to the residents of Needham during construction and operation of the transmission line. Approximately 3.2 miles (or nearly 76%) of the proposed 4.2 mile transmission line route is located in the Town. As such, Needham is a significant stakeholder in this Project. Of this total, approximately 0.64 miles is comprised of overhead transmission lines conducted within the limits of Eversource's existing ROW, up to the Valley Road area. The balance of the transmission line (approximately 2.6 miles) would be installed underground primarily in public roads located entirely in Needham.

From the inception of the Project, the Town has been clear and firm in its direction to the Proponent that it would not support a route involving construction of a new overhead transmission line on the ROW west of the Valley Road area. It is the Town's opinion that constructing a new overhead transmission line along this portion of ROW would result in significant and unacceptable negative impacts to the residential neighborhoods directly abutting the ROW and MBTA railroad tracks. These impacts would include but are not necessarily limited to the removal of the last remaining vegetative screening buffers and the installation of new steel monopole structures closer to a number of residential dwellings than the existing structures, which, in many instances, are already close to residents' homes and backyards.

In light of the Town's clearly expressed concerns, the Proponent has worked over the past year to identify a transmission line route that appears to generally avoid impacts to the residential neighborhoods directly abutting the existing ROW and MBTA railroad corridor west of the Valley Road area. The Town of Needham is currently working with the Proponent to advance the "Preferred Route" described in the ENF including the development of an acceptable easement document that allows for the installation of the transmission line outside of the ROW across a municipally-owned "gravel pit" near Greendale Avenue or municipal park land onto Valley Road.

With regard to the balance of the Project that is proposed in public roads, the Town expects that the Proponent will continue to work closely and cooperatively with Town officials as the design of the Project is advanced in order to minimize impacts to the residents of Needham during construction of the Project, including the development of an acceptable host community agreement.

Thank you for the opportunity to comment. If you have questions or need further information, please contact me.

Very truly yours,

Kate Fitzpatrick
Town Manager

cc: Representative Denise Garlick
Board of Selectmen
Rick Merson, Director of Public Works
Patty Carey, Director of Park & Recreation

The Commonwealth of Massachusetts
House of Representatives
State House, Boston 02133-1054

REPRESENTATIVE
DENISE C. GARLICK
13TH NORFOLK DISTRICT
NEEDHAM, DOVER, MEDFIELD

CHAIR
JOINT COMMITTEE ON ELDER AFFAIRS

ROOM 167, STATE HOUSE
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Email: Denise.Garlick@MAhouse.gov

July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act Unit
100 Cambridge St. Suite, 900
Boston, MA 02114

RE: Project # EEA 15529: Eversource Transmission Line Reliability Project from West Roxbury to Needham

Dear Mr. Secretary, Matt,

As the legislative delegation for the Town of Needham, we are pleased to submit the following comments in response to the Environmental Notification Form submitted by NSTAR Electric d/b/a Eversource Energy for the West Roxbury to Needham Reliability project.

We support the principle of improving the reliability of the existing transmission line system and the customers' interests.

We stand united with the Town of Needham and will not support a route involving construction of an overheard transmission line on the Right-of-Way west of the Valley Road area.

In all future work, we anticipate and expect that Eversource Energy will work closely and cooperatively with the Town of Needham, including an acceptable host community agreement. We look forward to working in partnership with the Town and Eversource Energy.

Thank you for your careful consideration of these comments. Please do not hesitate to contact us with any questions or concerns.

Yours in service,

Denise C. Garlick
State Representative
13th Norfolk

Michael F. Rush
State Senator
Norfolk & Suffolk

Richard J. Ross
State Senator
Norfolk, Bristol & Middlesex

cc: Kate Fitzpatrick, Needham Town Manager
Needham Board of Selectmen

Boston Water and Sewer Commission

980 Harrison Avenue
Boston, MA 02119-2540
617-989-7000

July 7, 2016

Mr. Matthew Beaton, Secretary
Executive Office of Energy & Environmental Affairs
Attn: MEPA Office
Mr. Purvi Patel
100 Cambridge Street, Suite 900
Boston, MA. 02114

Re: NSTAR's West Roxbury to
Needham Reliability Project
Environmental Notification Form

Dear Secretary Beaton:

The Boston Water and Sewer Commission (Commission) has reviewed the Environmental Notification Form (ENF) for the proposed NSTAR West Roxbury to Needham Reliability Project in the communities of Needham, Dedham and the West Roxbury section of Boston. The proposed project will separate approximately 4.2 miles of existing overhead double circuit electric transmission lines between Eversource's Baker Street Substation in West Roxbury and NSTAR's Chestnut Street Substation in Needham.

The ENF describes several alternatives to the preferred alternative for this project. The preferred alternative includes installation of approximately 2.6 miles of underground transmission lines in the Town of Needham from the Chestnut Street Substation to the Massachusetts Bay Transit Authority (MBTA) commuter rail corridor just west of route I-95. From the MBTA's commuter rail corridor, the transmission lines will continue overhead for approximately 1.6 miles alongside of the MBTA commuter rail tracks in Dedham and West Roxbury to the Baker Street Substation.

This letter provides the Commission's comments on the ENF.

1. The Commission maintains water, sewer and storm drains facilities along the route of the proposed transmission lines. If during construction, the contractor encounters a conflict with existing Commission facilities, NSTAR must modify the design to avoid conflicts with Commission facilities.

2. The Commission requests that NSTAR submit a site plan to the Commission's Engineering Customer Service Department for review and comment. The site plan must

be drawn at a scale of one inch equals twenty feet. Existing and proposed underground structures and conduits greater than six-inches in diameter must be drawn to scale. All proposed structures within 100 feet of Commission facilities must also be shown in both plan and profile view.

3. The Commission requires that NSTAR take all necessary precautions to prevent damage to existing water, sewer, storm drains and service lines. Should damage to Commission facilities occur, the Contractor shall immediately call the Commission's Operation Department at 617-989-7000.

4. The zone of influence for new footing and foundation for proposed structures with the exception of conduits must not encroach on water, sewer or drain lines.

5. The Contactor shall install and maintain silt sacks or other devices to prevent construction materials from entering catch basins and manholes until the final paving is complete.

6. The discharge of dewatering drainage to a sanitary sewer is prohibited by the Commission. The discharge of any dewatering drainage to the storm drainage system requires a Drainage Discharge Permit from the Commission. If the dewatering drainage is contaminated with petroleum products, the proponent will be required to obtain a Remediation General Permit from the Environmental Protection Agency for the discharge.

7. The Commission is not a member of dig safe, for mark-out of Commission water, sewer or storm drain facilities, the contractor must contact the Commission's Operations Department at 617-989-7000 at least 72 hours prior to the start of work.

8. The Contractor must have a spill management plan for any hazardous materials, hydraulic fluids and petroleum products which may be used on site. Specifically the Contractor should be prepared to effectively deal with spillage of fuels, hydraulic fluids, oils and coolant that may leak from equipment. A quick absorbent material, such as "speedy dry" shall be stored in a dry and accessible area at the work site. All hazardous material spills, shall be in handled in accordance with state, local and federal requirements.

9. NSTAR is required to obtain a Hydrant Permit for use of any hydrant during the construction phase of this project. The water used from the hydrant must be metered. NSTAR should contact the Commission's Meter Department for information on and to obtain a Hydrant Permit.

Thank you for the opportunity to comment on this project.

Yours truly,

John P. Sullivan, P.E.
Chief Engineer

JPS/rja

cc: M. Howard, Epsilon Associates, Inc.
M. Zlody, BED via e-mail
P. Larocque, BWSC via e-mail

CRWA
Saving the Charles River since 1965

RECEIVED
JUL 18 2016
MEPA

By Email and Mail

July 13, 2016

Matthew Beaton, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

Attn: Purvi Patel, MEPA Office

Re: West Roxbury to Needham Reliability Project, Environmental Notification Form, EOEA No. 15529

Dear Secretary Beaton:

The Charles River Watershed Association (CRWA) submits the following comments on the Environmental Notification Form for the above project. This project, with a mandatory environmental impact report, requires multiple permits. Because it involves the conversion of Article 97 land,[1] MEPA review is broad scope.

- There will be significant impacts to wetlands and priority habitat. The proponent downplays this stating that only 150 s.f of bordering vegetated wetlands (BVW) will be permanently filled through the placement of three monopole structure concrete foundations for the overhead line segment—two of which will be in the Cutler Park Reservation in Dedham. Eversource proposes a 1:1 ratio for replicated wetlands for this loss. It also proposes conversion of forested wetlands to scrub-shrub wetlands. The DEIR should fully describe and discuss the placement of the 50 s.f. concrete foundations in wetlands, the resource values that will be impacted by this fill, including conversion from forested to scrub-shrub wetlands, impacts to surrounding wetlands, identify all temporary impacts to the wetlands[2] (and buffer zone work), and how these surrounding wetlands will be restored. At minimum, 2:1 replication for the loss of wetlands should be required. This is important given the failure rate of replicated wetlands.

- Visual impacts of the monopoles (and tree clearing) in Cutler Park should be described and the proponent should discuss how it will comply with the Article 97 Land Disposition Policy of the Executive Office of Energy and Environmental Affairs. The proponent recognizes that the municipal parkland crossing in Needham may well require Article 97 authorization.

[1] The proponent identifies work in Needham as potentially requiring article 97 authorization, but it does not discuss Cutler Park in this context.

[2] For example, the proponent states that the Needham Substation Access Variation to the Preferred Route would require a 30-foot wide workspace corridor through the wetlands. ENF at 17.

- 11 monopole structures will also be located in floodplain with approximately 550 s.f. of fill. The proponent should explain its statement in the ENF at 16 that "fill material in the 100-year floodplain should not result in any measurable displacement of flood storage. . ." Floodplains are important resources, now more than ever given the extreme storm events with increased precipitation predicted with climate change. If this displacement ultimately is unavoidable, the proponent should commit to full compensatory flood storage in accordance with wetland regulatory performance standards.

- 2.2. acres of tree clearing in wetlands and uplands is proposed with 0.91 acres of forested wetland converted to shrub-scrub wetlands. Given the importance of trees in CO2 sequestration, the proponent should commit to a planting program in the affected towns to replace the number of trees removed.

- Impacts to riverfront areas should be fully analyzed in the DEIR including evaluation/explanation of "no significant adverse impact."

- The Stormwater Pollution Prevention Plan should be included in the DEIR. Any dewatering activities, their locations and management should be identified in the DEIR. It is important to control stormwater runoff during construction; no stockpiling of soils and trucking them away as excavated is critical, as the proponent recognizes.

- Impacts under MESA and potential takes based on plant surveys should be fully discussed in the DEIR.

Please feel free to call me if you have any questions at 781-788-0007 ext. 234.

Sincerely,

Margaret Van Deusen

Margaret Van Deusen
Deputy Director and General Counsel

dcr
Massachusetts

July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Energy and Environmental Affairs
Attn: Purvi Patel, MEPA Office
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: EOEEA #15529 West Roxbury to Needham Reliability Project

Dear Secretary Beaton:

The Department of Conservation and Recreation ("DCR" or "Department") is pleased to submit the following comments in response to the Environmental Notification Form ("ENF") submitted by NSTAR Electric Company d/b/a Eversource Energy (the "Proponent") for the West Roxbury to Needham Reliability Project (the "Project").

As described in the ENF, the Project proposes to separate 4.2 miles of existing double circuit electric transmission lines from an existing substation in West Roxbury, through Dedham to an existing substation on Chestnut Street in Needham. The work will relocate existing overhead electric transmission conductors onto a new set of steel monopoles. Under the Preferred Route as outlined in the ENF, approximately 1.6 miles of the proposed work will be conducted on overhead lines, and the remaining 2.6 miles will be beneath roadways in the town of Needham. In addition to the Preferred Route, the ENF outlines a No-Build Alternative; Non-Transmission Solution Alternatives; two Transmission Alternatives that explored an all-underground or all-overhead options, and an all-underground line outside the existing Right-of-Way through town roads; two routing variations to the Preferred Route; and a Noticed Alternative Route that is geographically distinct from the Preferred Route. The Project is being conducted to mitigate potential overloading of the transmission system and will reduce the number of customers that are exposed to sustained loss of service. The Project triggers a mandatory Environmental Impact Report ("EIR") due to alteration of one or more acres of Bordering Vegetated Wetlands ("BVW").

A portion of the Project crosses DCR's Cutler Park in the towns of Dedham and Needham, as well above a section of DCR's Veterans of Foreign Wars ("VFW") Parkway, adjacent to an existing railroad bridge. DCR understands that all of the work being conducted within the Department's property is within an existing easement that is currently occupied by the existing double circuit electric transmission lines and poles. All alternatives explored in the ENF will impact equal areas of DCR property, as the alternatives only differ in areas west of Cutler Park and the VFW Parkway. Tree clearing within Cutler Park is limited to 0.09 acres within Cutler Park. The Project will require a Construction and Access Permit from DCR.

DCR submits the following comments regarding the project and its potential impacts to DCR property:

Wetlands
The ENF notes that under the Preferred Route, the Project will result in placement of two monopole structure foundations within BVW in Cutler Park, resulting in the permanent filling of approximately 100

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251 Causeway Street, Suite 600
Boston MA 02114-2119
617-626-1250 617-626-1351 Fax
www.mass.gov/dcr

Charles D. Baker
Governor

Karyn E. Polito
Lt. Governor

Matthew A. Beaton, Secretary, Executive
Office of Energy & Environmental Affairs

Leo Roy, Commissioner
Department of Conservation & Recreation

square feet. The Project proposes to compensate the filling through a 1:1 ratio or greater amount if required by the local wetland bylaw. In its EIR, DCR requests the Proponent evaluate alternatives to avoid permanent filling of wetlands of DCR property, indicate the anticipated ratio at which permanent wetland impacts will be compensated and where these areas might be located.

In the EIR, DCR requests the Proponent provide estimates of the amount of temporary alteration that will be conducted within wetland areas in Cutler Park, and commit to ensure wetland functionality will be maintained after construction. In areas where wetland functionality will be adversely affected by the Project, DCR requests the Proponent commit to installing a wetland seed mix to stabilize and revegetate such areas.

DCR notes the area within its property is within Priority Habitat for State-Protected Species. DCR defers to recommendations by the Natural Heritage Endangered Species Program ("NHESP") on its property.

Construction Access
In its EIR, DCR requests the Proponent identify project laydown areas where equipment will be stored during the duration of the project, identify potential construction access routes and alternatives, and estimate the length of time that the Project will be conducted on DCR property. DCR will provide specifics on what information will be requested for the Construction and Access permit in our comments on the EIR.

Thank you for the opportunity to comment on the ENF. If you have questions or need further information related to the DCR Construction and Access permit process, please contact Sean Casey at (617) 626-1444 or sean.casey@state.ma.us.

Sincerely,

Leo Roy
Commissioner

cc: Sean Casey, Jim Comeau, Patrice Kish, Rob Lowell, Norman Orrall, Nathaniel Tipton (DCR)
Kevin McCune, Eversoure Energy
Michael Howard, Epsilon Associates

The Commonwealth of Massachusetts
House of Representatives
State House, Boston 02133-1054

REPRESENTATIVE
DENISE C. GARLICK
13TH NORFOLK DISTRICT
NEEDHAM, DOVER, MEDFIELD

CHAIR
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Email: Denise.Garlick@MAhouse.gov

July 12, 2016

Secretary Matthew A. Beaton
Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act Unit
100 Cambridge St. Suite, 900
Boston, MA 02114

RE: Project # EEA 15529: Eversource Transmission Line Reliability Project from West Roxbury to Needham

Dear Mr. Secretary, Matt,

As the legislative delegation for the Town of Needham, we are pleased to submit the following comments in response to the Environmental Notification Form submitted by NSTAR Electric d/b/a Eversource Energy for the West Roxbury to Needham Reliability project.

We support the principle of improving the reliability of the existing transmission line system and the customers' interests.

We stand united with the Town of Needham and will not support a route involving construction of an overheard transmission line on the Right-of-Way west of the Valley Road area.

In all future work, we anticipate and expect that Eversource Energy will work closely and cooperatively with the Town of Needham, including an acceptable host community agreement. We look forward to working in partnership with the Town and Eversource Energy.

Thank you for your careful consideration of these comments. Please do not hesitate to contact us with any questions or concerns.

Yours in service,

Denise C. Garlick
State Representative
13th Norfolk

Michael F. Rush
State Senator
Norfolk & Suffolk

Richard J. Ross
State Senator
Norfolk, Bristol & Middlesex

cc: Kate Fitzpatrick, Needham Town Manager
Needham Board of Selectmen

GREENDALE VILLAGE
NEEDHAM

OPPOSITION TO THE WEST ROXBURY TO NEEDHAM RELIABILITY PROJECT
(hereinafter the "Project")
EFSB 16-02/D.P.U. 16-77
NSTAR ELECTRIC COMPANY D/B/A EVERSOURCE ENERGY

Now come Christopher Reece and John Curtis, Trustees of the Greendale Village Condominium Trust and submit the following Opposition, with photographs, to the Preferred Route which abuts Greendale Avenue and Greendale Village unit owners, regarding the above-identified Project as follows:

1. We, Christopher Reece, who resides at 900 Greendale Avenue, Unit #10 and John Curtis, who resides at 900 Greendale Avenue, Unit #19, are duly elected Trustees of the Greendale Village Condominium Trust;

2. The attached documents and photographs are herewith filed in support of our Opposition to said Project since we believe that utilizing a Preferred Route in Needham, a portion of which abuts Greendale Avenue and the Greendale Village unit owners, is unnecessary, does not serve the public convenience and is not consistent with the public interest;

3. The Greendale Village development consists of 20 recently built condominium units, as approved by the Town of Needham. The units were built during the last 2 and one-half years; the last purchaser moved in during the summer of 2016. The Project has just been made known to the new unit owners to their financial detriment and inconvenience in the potential loss of shade, noise buffer from the mature trees, and potential health hazards from living in such close proximity to the Project;

4. Therefore, we respectfully request elimination of the Greendale route and your reconsideration of the alternate proposed routes.

Respectfully submitted,

Christopher Reece, Trustee
Greendale Village Condominium Trust

John Curtis, Trustee
Greendale Village Condominium Trust

GREENDALE VILLAGE
NEEDHAM

John F. Curtis and Christopher Reece, Trustees
Greendale Village Condominium Trust
900 Greendale Avenue Unit 19 and Unit 10
Needham, MA 02492
781-400-1239 (mobile 617-872-6325) J. Curtis
781-400-5829 (mobile 617-633-1536 C. Reece

REFERENCE – Docket Numbers – EFSB 15-06/D.P.U. 15-180 (as stated on page 5 pf the Notice of Adjudication and Notice of Public Comment hearing EFSB 16-02/D.P.U. 16-77)

M. Kathryn Sedor, Esq., Presiding Officer
Energy Facilities Siting Board
One South Station
Boston, MA 02110
617-305-3500
kathryn.sedor@state.ma.us
dpu.efiling@state.ma.us

Attention Energy Facilities Siting Board – REQUEST TO BE LIMITED PARTICIPANTS:

We, John F. Curtis and Christopher Reece, reside at 900 Greendale Avenue, Unit #19 and #10, respectively and are duly elected Trustees of the Greendale Village Condominium Trust.

We have submitted the attached package titled "OPPOSITION TO THE WEST ROXBURY TO NEEDHAM RELIABILITY PROJECT (hereinafter the "Project") Docket Number EFSB 16-02/D.P.U. 16-77 and Docket Number EFSB 15-06/D.P.U. 15-180.

The Greendale Village development consists of 20 recently built condominium units, as approved by the Town of Needham. The units were built during the last 2 and one-half years; the last purchaser moved in during the summer of 2016. The Project has only just been made known to the new unit owners to their financial detriment and inconvenience in the potential loss of shade, noise buffer from mature trees and potential health hazards to our families including children living in such close proximity to the Project.

Therefore, pursuant to the attached opposition, we respectfully request designation as "Limited Participants" in order to provide us the opportunity to present further written or oral arguments regarding the Project. We request such designation both as individuals and in our role as duly elected Trustees of the Greendale Village Condominium Trust.

Respectfully submitted,

Christopher Reece, Trustee
Greendale Village Condominium Trust

John Curtis, Trustee
Greendale Village Condominium Trust

DATED: October 7, 2016

Cc David S. Rosenzweig, Esq. and Erika J. Hafner, Esq. Keegan Werlin LLP 225 Franklin Street. Boston, MA 02110 via email and FedEx

Eversource Proposal
Views from 900 Greendale Ave

Eversource's Proposed "Preferred* Route'~ *if even feasible given the extremely tight pathway, will gravely damage the Environment- removing the entire strip of land {30 feet wide by approximately 200 feet long) wiping out between 35 to 45 Mature Trees that shield road noise, MBTA noise and are home to substantial wildlife. The homeowners at 900 Greendale Ave. request reconsideration.

Eversource Proposal – Views from 900 Greendale Ave

Starting from Greendale Avenue facing East.

One can clearly see how tight this area is with respect the planned Eversource 30 foot wide Clear-cut requested Right of Way.

The width of this parcel is less than 35 feet.

The telephone pole is right of center

The homes on the left are all part of the 900 Greendale Avenue development; in some cases the units are positioned such that their decks/patios are within only a few feet of the lot line.

Virtually ALL trees will be removed and NOTHING left as a buffer.

Eversource Proposal – Views from 900 Greendale Ave

Note the rocks and the wall (lot line) on the lower left of this picture, demonstrating the proximity of units 21, 20 and 19 to the Eversource proposed Right of Way.

Note the density of the trees within the Eversource proposed "Preferred Route"

Eversource Proposal – Views from 900 Greendale Ave

This view demonstrates the proximity of the requested Right Of Way to the recently constructed 900 Greendale Units #21, #20 and #19 (left to right, respectively).

Individual is standing on the lot line.

The occupants of these units include children under the age of 10.

Eversource Proposal – Views from 900 Greendale Ave

View from Unit #20, facing South East.

Demonstrates the extreme proximity to these 900 Greendale Units (wall on lower left is approximate lot line).

Also demonstrates the tree density of the existing parcel that serves as a natural buffer and home to wildlife.

Eversource Proposal – Views from 900 Greendale Ave

A view facing East (with Greendale Avenue behind) showing Unit #19's deck, demonstrating the extreme proximity of the proposed Right of Way.

Of importance is to note that the total width of the parcel for which the Eversource's Right of Way is sought appears to be no more than 34 feet wide.

Eversource Proposal – Views from 900 Greendale Ave

A view facing North (with Greendale Avenue to the left) showing Unit #19's deck and one of Eversource's test borings (located approximately in the mid-point of the proposed Right of Way) - demonstrating the extreme proximity of the proposed Right of Way the abutter.

Again, of importance is to note the total width of the parcel appears to be no more than 34 feet wide behind units #21, #20 and #19 (the section for which the Eversource's Right of Way is sought)

Eversource Proposal – Views from 900 Greendale Ave Units 19-20-21 demonstrating the extreme proximity of these units to the proposed "Preferred Route"

Eversource Proposal – Views from 900 Greendale Ave

Same view facing West (with Greendale Avenue straight-ahead) showing the same Eversource test boring from slide 7 (located approximately in the mid-point of the proposed Right of Way) - demonstrating the very limited space for the proposed Eversource Right of Way.

Eversource Proposal – Views from 900 Greendale Ave

Same view facing West – slightly North West (with Greendale Avenue straight-ahead) showing the same Eversource test boring from slides 7 & 8 (located approximately in the mid-point of the proposed Right of Way) demonstrating the proximity of the Right of Way and proposed High Voltage lines to homes – in this case Units #21 & #20 where children under 10 years of age reside.

The stone wall on the right of this picture shows the lot line of units #21 & #20.

Eversource Proposal – Views from 900 Greendale Ave

A view again facing West (with Greendale Avenue straight-ahead) and the Eversource boring hole (located in the lower quarter of the picture in the center).

This view demonstrates that the loss of this treed buffer parcel will materially, adversely and directly affect the homeowners of units 21, 20, 19 & 18 (shown on the right) 900 Greendale Ave.

Additionally, the placement of the Eversource boring hole demonstrates that the distance to these units is de minimus.

Eversource Proposal – Views from 900 Greendale Ave

Another view again facing West (with Greendale Avenue straight-ahead and residence #926 Greendale Avenue to the left) and the Eversource boring hole (located in the lower quarter of the picture in the center). 900 Greendale units are to the right (not pictured).

This view demonstrates that the loss of this treed buffer parcel will materially, adversely and directly affect the homeowners of 926 Greendale Avenue as well as the units of 900 Greendale Ave.

Additionally, the placement of the Eversource boring hole demonstrates that the tightness of this space

Eversource Proposal – Views from 900 Greendale Ave

Same view as prior slide (#2) with homeowner standing to demonstrate the maturity and size of the trees that would wiped out by the proposed Eversource Right of Way.

Eversource Proposal – Views from 900 Greendale Ave

Example of the mature trees that would be wiped out by the Eversource clear cut Right of Way

Eversource Proposal – Views from 900 Greendale Ave

View facing West from Gravel Pit area showing the planned route to the proposed Eversoure Right of Way (in the background are units #19 and #20 Greendale Avenue.

Eversource Proposal – Views from 900 Greendale Ave

View facing North West in the Gravel Pit with one of Eversource's test borings shown by the orange stake.

The proposed path of the Eversource Right of Way is shown from the orange stake to the individual.

101

ELECTROMAGNETIC WAVES (EMF AND RF) AND HEALTH EFFECTS

PETER A. VALBERG

First aid: Remove from RF or ELF-EMF exposure by increasing distance from the emissions source or by de-energizing the source (e.g., transmitting antenna).

Target organ(s): For high level RF: skin, cornea, inner ear. For high level power-line EMF, none known other than non-adverse "magneto-phosphenes" stimulated in retinal receptor cells. Other, putative organs: lymphocyte stem cells in the bone marrow, neurons and neural support cells in the brain, peripheral nervous system.

Occupational exposure limits: ACGIH TLV: For power-line (60 Hz) fields: 1 mT (10,000 mG); for workers with implanted cardiac pacemakers: 0.1 mT (1000 mG). For RF fields, see values tabulated in TLV handbook, which range from 10 to 100 W/m^2. For FCC and ICNIRP values, see Tables 101.4 and 101.5 in this chapter.

Reference values: No RfC derived for either RF or ELF-EMF exposure. Radio frequencies specific absorption limit (SAR) is 0.08 W/kg for the general public, and 0.40 W/kg for RF workers.

Risk/Safety Phrases: IARC Group 2B Carcinogen; ACGIH, A4; ACGIH has Threshold Limit Values (TLVs) for EMF exposure that are protective of worker health and are listed by frequency. There are currently no OSHA standards for worker exposure to extremely low frequency (ELF) fields. Likewise, there are no OSHA-specific standards for radiofrequency and microwave radiation exposure. The Federal Communications Commission (FCC) is the U.S. federal regulatory agency as to radiofrequency exposure limits.

BACKGROUND: THE ELECTROMAGNETIC WAVE SPECTRUM, NONIONIZING *VERSUS* IONIZING RADIATION

As illustrated in Table 101.1 below, the electromagnetic spectrum encompasses wave energy with a vast range in frequency from very low (e.g., power lines at 60 Hz), through the kilo- and megahertz radio frequencies (RF) (e.g., radio and television signals), to microwaves (gigahertz), and on up into waves of infrared, light, ultraviolet, X-rays, and gamma rays. The last three categories (from UV and higher in frequency) are considered "ionizing radiation," and this chapter focuses on electromagnetic waves with wavelengths longer, and frequencies below those of ultraviolet, namely, waves that fall into the "nonionizing" portion of the electromagnetic spectrum. Ionizing radiation is discussed in Chapter 100 of this book, and ionizing radiation is distinguished by the fact that those electromagnetic waves have sufficient energy to break apart chemical bonds in biological molecules, whereas nonionizing waves do not.

The International Agency on Research in Cancer (IARC) has classified ultraviolet light and ionizing radiation as "Group 1" or "known" carcinogens, meaning epidemiology of exposed populations is sufficiently strong to establish that elevated exposure increases cancer risk in humans. For nonionizing radiation, IARC has classified power-line (extremely low frequency) electric and magnetic fields (ELF-EMF) and RF as "Group 2B" or "possibly carcinogenic to humans," which, in the RF and EMF circumstances, refers to limited-to-inadequate evidence of cancer risk in humans

Hamilton & Hardy's Industrial Toxicology, Sixth Edition. Edited by Raymond D. Harbison, Marie M. Bourgeois, and Giffe T. Johnson.

TABLE 101.1 The Electromagnetic Spectrum: The Columns Illustrate How Wave Properties Change as You Go Up in the Spectrum (The Second Row Gives Median Values for Wavelength, Frequency, and Photon Energy

Power Lines	Navigation, AM Radio, Ham Radio	FM Radio, UHF TV, Cell Phones	Microwave Beacons and Radar	Radiant Heating, Infrared	Sunlight, e.g., yellow light	Medical and Dental x-Rays	α-, β-, γ-Rays
5000 km	300 m	30 cm	3 mm	6 μm	600 nm	0.3 nm	0.0003 nm
50–60 Hz	0.001 GHz	1 GHz	100 GHz	50 THz	500 THz	10^{18} Hz	10^{21} Hz
0.24 peV	4 neV	4 μeV	0.0004 eV	0.2 eV	2 eV	4,000 eV	4 MeV
		◆		◆	◆		◆
		Cell phones, ~1–2 GHz		Body heat	Vision		cosmic rays
–	–	–	–	←←Nonionizing←←		→Ionizing→→→→	
		(*RF heating currents*)		(*Photochemistry*)		(*molecular damage*)	

nm = nanometers = 10^{-9} meter = one-billionth of a meter.
GHz = gigahertz = 10^9 Hz = one thousand million cycles per second.
THz = terahertz = 10^{12} Hz = 10^{12} cycles per second = one million cycles per second.
eV = electron volt = energy gained by electron accelerated through 1 volt potential difference.

and limited-to-inadequate evidence of carcinogenicity in experimental animals.

The Physical Properties of Electromagnetic Waves are Frequency and Intensity

All matter contains electrically charged particles. Most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, we experience electrical effects caused by the force between electric charges, such as the static electricity attraction between a comb and our hair, or the force between current carrying wires in an electric motor. Electric charges that accelerate back and forth ("oscillate") can lose their energy into electromagnetic radiation that propagates away at the speed of light.

Electric and magnetic fields (EMF) are essentially constructs created by scientists to help understand how electrically charged particles interact with each other. Scientists explain the forces exerted by charges by saying that each electric charge generates an electric field that exerts force on other nearby charges. That is, an electric field is a measure of force per unit charge (newtons per coulomb), but is usually expressed in units of volts per meter (V/m) or kilovolts per meter (kV/m). When electric charges move, an electric current exists, and a current generates a magnetic field. Units of electric current are amperes (A), and current measures the flow of electricity, somewhat like the flow of water in a plumbing system. The current of moving electric charges produces a magnetic field that exerts force on other moving charges. That is, a magnetic field expresses the force per unit length of current-carrying wire (newtons per ampere-meter), but is usually expressed in units of gauss (G) or milligauss (mG). Another magnetic field unit is the tesla (T), where 1 T = 10,000 G, and thus, 1 μT = 10 mG.

Oscillation Frequencies for Electromagnetic Waves

Oscillating, electrically charged particles create "waves" in the EMF lines associated with them, and these waves move outward at the speed of light. That is, electromagnetic waves have a time period or frequency equal to the rate at which the electric charges creating them are being shaken back and forth. The overall result is called an "electromagnetic wave," with the frequency given in "Hertz" (Hz), which is the same as "cycles per second." Table 101.1 (above) shows the vast range in frequencies of electromagnetic waves. The energy contained in the electromagnetic waves increases in proportion to their frequency.

The science of electromagnetic waves has been studied and tested over a very long period of time. James Clerk Maxwell described the basic interactions between electromagnetic waves and matter in the 1860s, and he showed that electromagnetic waves travel at the speed of light. In 1887, Heinrich Hertz experimentally demonstrated the existence of electromagnetic waves, and, in 1909, Guglielmo Marconi was awarded the Nobel Prize in physics for inventing the radio, i.e., showing how electromagnetic waves could be used to transmit information without wires. Notably, Maxwell's 1867 equations (with the addition of quantum mechanics) have been verified time and time again as valid predictors of how electromagnetic waves and matter interact. No exceptions to Maxwell's equations have been found, and no unexplained electromagnetic phenomena have been encountered.

Radio-wave frequencies cover the range from about 300,000 Hz (i.e., 0.3 megahertz, or 0.3 MHz) to 30,000,000,000 Hz (i.e., 30 gigahertz, or 30 GHz), and beyond. Communications signals rely on a "carrier frequency," which is different for each communication signal, and the difference in frequencies allows many RF signals to

be present simultaneously, because the information carried at each frequency can be extracted by frequency-selective electronic tuners. For example, for cellular telephone technology, the carrier frequencies range from about 900 MHz up to about 2200 MHz.

By itself, an RF carrier wave is an unchanging continuous electromagnetic wave, and it carries no information. Information is imposed on the carrier wave by a modulation process that alters it by changing its amplitude, frequency, or phase in step, with the voice frequency (or other information) being imposed (amplitude modulation, AM; or frequency modulation, FM). Alternatively, information can be coded into computer bits, and the carrier wave can be modulated by changing its amplitude or frequency in discrete steps (digital modulation). The interaction of RF waves with cells and molecules depends on the frequency of the carrier wave, but not on the type information being transmitted, e.g., "voice," or "music," or "computer bits." This is because the physical energy of the RF waves depends only on the power of the carrier wave, and studies have provided no evidence that the biological impact (or lack of impact) of RF depends on the information content carried by the radio waves.

Visible light is the major source of electromagnetic energy in our daylight environment. Also, the human body, by virtue of being alive and warm, generates heat energy (electromagnetic energy in the infrared portion [IR] of the spectrum), which can be seen by a "night vision" camera, in the absence of visible light.

Absorption of Energy from Electromagnetic Waves

In considering potential health effects of EMF or RF, it is important to recognize that electromagnetic radiation, although "wave-like" in nature, can also act like "particles" when being absorbed or emitted by matter. That is, absorption and emission of radiation occurs in discrete energy units, photons or quanta, with energy content $E = h\upsilon$, where h is Plank's constant and υ is the frequency. Table 101.1 lists photon energies, and these energies can be compared to chemical bond energies, which are typically 3–12 electron-volts (eV) per bond. Thus, high frequency radiation, e.g., X-ray photons have high enough energy content to ionize (disrupt) biological molecules held together by covalent bonds. Photons in the visible and UV range can excite molecules and initiate molecular shape changes or chemical reactions. Photon energies of electromagnetic radiation in the microwave region and above can excite vibrational energy levels of molecules. Lower frequencies, including microwaves and down to 50/60-Hz EMF have small photon energies, and in fact, 50/60-Hz EMF are not considered to "radiate."

For EMF or RF exposures to cause or exacerbate disease in humans, such exposures would have to trigger a series of sequential steps that lead to a disease outcome. The causal chain would begin with human exposure to some particular frequency/intensity/duration of EMF or RF. To complete the first step, the fields would interact with biological molecules (or structures) in such a way as to alter their size, shape, charge, chemical state, function, or energy (by a mechanism currently unknown). In this energy "transduction" step, some absorption of electromagnetic energy must occur or there can be no effect. For observable biological (and possibly health adverse) effects to follow transduction, a cascade of sequential events at the molecular, cellular, and tissue level would be required, leading without interruption to the final outcome. Identifying a plausible, mechanistic or transduction step, in this multistep pathway has been one of the most challenging and elusive puzzles, despite considerable effort by biologists, chemists, and physicists.

Identifying how electromagnetic waves alter biological systems is crucial to determine the correct exposure metric. Since the health and viability of the human body depends in a fundamental way on the normal structure and function of large molecules (e.g., proteins, nucleic acids, carbohydrates, and lipids), a theory on how EMF or RF mechanisms act must predict how weak electromagnetic energy could interfere with or modify the normal synthesis, function, or degradation of these molecules. For example, a viable mechanism would predict thresholds of exposure effectiveness in terms of electromagnetic wave amplitude, frequency, time of onset, intermittency, coherence, exposure duration, polarization, etc.

ELECTRIC POWER: 60 Hz ELECTRIC AND MAGNETIC FIELDS (EMF)

Electrical effects can occur through the generation and use of electric power. The power grid creates EMF varying in time at 50 or 60 Hz (cycles per second), which are considered "extremely low frequency" (ELF) fields.

The electrical tension on utility power lines is expressed in V or kilovolts (kV; 1 kV = 1000 V). Voltage can be thought of as the pressure driving the flow of electricity. The existence of a voltage difference between power lines and ground results in an electric field, which is usually expressed in units of kV/m. The size of the electric field depends on the voltage, the separation between lines and ground, and other factors.

Power lines also carry an electric current that creates a magnetic field. The units for electric current are A and are a measure of the flow of electricity. Electric current can be envisioned as analogous to the flow of water in a plumbing system. The magnetic field produced by an electric current is usually expressed in units of G or mG, where 1 G = 1000 mG. As noted earlier, another unit for magnetic field levels is the microtesla (μT), where 1 μT = 10 mG. The size of the magnetic field depends on the electric current, the distance to the current-carrying conductor, and other factors. The units of measure are basically the same as those for static fields.

For example the steady magnetic field from the earth is 570 mG (57 μT).

Properties of Power-Line EMF

When EMF derives from different sources (e.g., adjacent wires), the size of the net EMF produced will be somewhere in the range between the sum of EMF from the individual sources and the difference of the EMF from the individual sources. Thus, EMF may partially add, or partially cancel, but generally, because adjacent wires are often carrying current in opposite directions, the EMF produced tends to be cancelled. Inside residences, typical baseline 60-Hz magnetic fields (far away from appliances) range from 0.5 to 5.0 mG. Electric and magnetic fields in the home arise from electric appliances, indoor wiring, grounding currents on pipes and ground wires, and outdoor distribution or transmission circuits.

Larger 60-Hz magnetic field levels are found near operating appliances. For example, can openers, mixers, blenders, refrigerators, fluorescent lamps, electric ranges, clothes washers, toasters, portable heaters, vacuum cleaners, electric tools, and many other appliances generate magnetic fields of size 40–300 mG at distances of 1 ft (NIEHS, 2002). Magnetic fields from personal care appliances held within ½ ft (e.g., shavers, hair dryers, massagers) can produce 600–700 mG. At school and in the workplace, lights, motors, copy machines, vending machines, video-display terminals, pencil sharpeners, electric tools, and electric heaters are all sources of 60-Hz magnetic fields.

Although the steady geomagnetic field does not have the 60-Hz time variation characteristic of power line EMF, people's movements in its presence can cause it to be experienced as a changing magnetic field. Also, moving magnets generate time-varying magnetic fields. For example, a magnet spinning at 60 times a second will produce a 60-Hz magnetic field indistinguishable from that found near electric power lines carrying the appropriate level of electric current. Even the rotating steel-belted radial tires on a car produce time-varying magnetic fields. Magnetic resonance imaging (MRI) is a diagnostic procedure that puts humans in large steady and changing magnetic fields (e.g., static fields of size 20,000,000 mG). In contrast to medical X-rays, MRIs have no known health risks (other than the large forces exerted on nearby steel objects).

Review of Power-Line EMF Bioeffects

Power-line EMF has been the focus of considerable research for more than three decades. Over this period of time, the focus has been primarily on the magnetic field component. The three major lines of investigation have involved epidemiology, laboratory animal studies, and biological mechanism studies. The scientific evidence currently accumulated does not support a clear and coherent picture whereby environmental levels of power-line EMF constitute a hazard to human health, primarily because animal studies and mechanistic investigations have not shown a consistent, deleterious effect of typical ambient power-line magnetic fields on biology.

EMF epidemiology studies focused on childhood leukemia have received considerable attention. An observational epidemiologic study published by Wertheimer and Leeper (1979) suggested that living near electric power distribution lines was linked to an increased risk of childhood cancer. In this and subsequent epidemiology studies, the actual EMF levels that children had been exposed to were unknown, so researchers developed surrogates for past EMF exposures based, for example, on the proximity, number, and size of electric-utility distribution (or transmission) lines near the homes. In the initial 1979 study, the electric utility distribution line configuration near a home was called its "wire code," and homes with high wire codes (and presumably higher EMF levels) were found to be represented in a greater proportion of the leukemia cases as compared to the control children.

During the 35 years since this first study, a large number of epidemiological studies have examined associations between disease and various proxies of power line field strength (e.g., the "wire code" classification of homes, the distance to power-line corridors, present-day EMF measurements, the field strength calculated from power-line loading). If a correlation was detected, it was generally interpreted as linking power-line EMF to increased risk for the disease being studied, but consistency of the findings was poor. Often, the associations became weaker or disappeared when actual personal-monitor measured magnetic fields were substituted in place of other surrogate measures. It was found that some surrogates used for ranking EMF exposure also correlated with non-EMF factors such as traffic density, age of the home, rental vs. ownership, and assessed value of the home. Such potential confounders made it problematic to interpret the associations as an effect of EMF exposure per se. That is, the statistical correlations did not establish that power-line EMF exposure was the "causal" factor.

Hundreds of EMF epidemiology and laboratory research studies have been published in the 35 years since the initial 1979 study reported a statistical correlation between residential "wire codes" and childhood leukemia. Generally, each study focused on a particular hypothesis, and the range of possible investigations has been immense. Some of the most important work was done under the auspices of the National Institute of Environmental Health Sciences (NIEHS). The NIEHS had a program called "EMF RAPID,"[1] which funded laboratory research to determine what, if any, aspects of power-line magnetic fields (ELF-EMF) interaction with

[1] RAPID = "research and public information dissemination."

biological systems had the potential to trigger adverse disease outcomes. The conclusion of this extensive laboratory research program was summarized by NIEHS (1999).

> The scientific evidence suggesting that ELF-EMF exposures pose any health risk is weak. . . . No indication of increased leukemias in experimental animals has been observed. . . . Virtually all of the laboratory evidence in animals and humans, and most of the mechanistic studies in cells fail to support a causal relationship between exposure to ELF-EMF at environmental levels and changes in biological function or disease status.

For the proposition that power-line EMF exposure leads to health effects, there continues to be a lack of supporting laboratory-animal evidence, or support as to a plausible biological mechanism (Wood, 1993; Valberg et al., 1997; Boorman et al., 1999, 2000; McCormick et al., 1999; Swanson and Kheifets, 2006; Brain et al., 2003; Foster, 2003; WHO, 2007; SCENIHR, 2009).

Epidemiologic analyses have continued over the years, and some associations continue to be reported. The following list provides examples of prominent analyses, reviews, and/or summaries of the more recent power-line EMF literature. Notably, the epidemiological associations have not become stronger over the years, i.e., following the advent of larger, more in-depth studies. There still remains considerable inconsistency among the epidemiology results, the levels of incremental risk are low, and often do not reach statistical significance. Although the listing below (15 articles, 2000–2014) is not intended as a comprehensive review, it provides a sampling of some of the more recent and more significant epidemiological results. The reader is encouraged to read some of the individual studies in more detail.

- Ahlbom et al. (2000): "When [we] pooled nine epidemiology studies, . . . [we] found a relative risk of 2.0 (1.27–3.13) for childhood leukemia in the children with average exposures of 4 mG or greater. For children with lower average exposures, no significant elevation of childhood leukemia was found in the pooled studies. . . . The explanation for the elevated risk is unknown, but selection bias may have accounted for some of the increase."
- Greenland et al. (2000): "Summary estimates from 12 studies that supplied magnetic field measures exhibited little or no association of magnetic fields with leukemia when comparing 0.1–0.2 and 0.2–0.3 microtesla (μT) categories with the 0–0.1 μT category, but the Mantel-Haenszel summary odds ratio comparing >0.3 μT versus 0–0.1 μT was 1.7." "Based on a survey of household magnetic fields, an estimate of the U.S. population attributable fraction of childhood leukemia associated with residential exposure is 3%."
- Hatch et al. (2000): "Our recent large case-control study [638 cases, 620 controls] found little association between childhood acute lymphoblastic leukemia (ALL) and electric-power-line wire codes."
- Kleinerman et al. (2000): "Neither distance nor exposure index was related to risk of childhood acute lymphoblastic leukemia, although both were associated with in-home magnetic field measurements. Residence near high-voltage lines did not increase risk."
- UKCC (2000): "Our results provide no evidence that proximity to electricity supply equipment or exposure to magnetic fields associated with such equipment is associated with an increased risk for the development of childhood leukemia nor any other childhood cancer."
- Rubin et al. (2005): "The symptoms described by "electromagnetic hypersensitivity" sufferers can be severe and are sometimes disabling. However, it has proved difficult to show under blind conditions that exposure to EMF can trigger these symptoms. This suggests that "electromagnetic hypersensitivity" is unrelated to the presence of EMF, although more research into this phenomenon is required."
- Kabuto et al. (2006): "We analyzed 312 children newly diagnosed with ALL or AML in 1999–2001. [. . .] Weekly mean MF level was determined for the child's bedroom. [. . .] The odds ratios for children whose bedrooms had MF levels $\geq$0.4 μT compared with the reference category (MF < 0.1 μT) was 2.6 (n.s., 95% CI = 0.76–8.6) for AML + ALL and 4.7 (1.15–19.0) for ALL only."
- Mezei and Kheifets (2006): "The International Agency for Research on Cancer [has] classified ELF-MF as a possible human carcinogen. Since clear supportive laboratory evidence is lacking and biophysical plausibility of carcinogenicity of MFs is questioned, a causal relationship between childhood leukaemia and magnetic field exposure is not established. Among the alternative explanations, selection bias in epidemiological studies of MFs seems to be the most plausible hypothesis. In reviewing the epidemiological literature on ELF-MF exposure and childhood leukaemia, we found evidence both for and against the existence of selection bias."
- Kavet et al. (2008): "Limits on exposures to extremely low-frequency electric fields, magnetic fields and contact currents, designated as voluntary guidelines or standards by several organizations worldwide, are specified so as to minimize the possibility of neural stimulation." "[We describe] neurostimulation thresholds and the relevance of magnetophosphenes to setting guideline levels."
- Kheifets et al. (2010): "10,865 cases and 12,853 controls were pooled from 7 studies; 24-hr meas. or calculated MF; >3 mG, compared to MF <1 mG: OR = 1.44 (n.s.,

95% CI 0.88–2.36), "the results are compatible with no effect [of EMF]. Overall, the association is weaker in the most recently conducted studies, but these studies are small and lack the methodological improvements needed to resolve the apparent association."

- Kroll et al. (2010): "For children born in England and Wales during 1962–1995; there were 28,968 complete matched case–control pairs [calculated fields for 58,162 total]." "We found no statistically significant associations between childhood-cancer risks and estimated magnetic fields from high-voltage power lines near the child's home address at birth."
- Keegan et al. (2012): In a case-control study of paternal occupation and childhood leukaemia, "results showed some support for a positive association between childhood leukaemia risk and paternal occupation involving social contact." Of the 16,764 cases of childhood leukemia, 93% were either acute myeloid leukemia or lymphoid leukemia, and neither showed an association with parents' occupational EMF exposure. Of the 7% "other leukemias," EMF exposure showed an increased odds ratio (OR = 1.6), but it was based on small numbers.
- Elliott et al. (2013): "[Our] study included 7,823 leukemia, 6,781 brain/central nervous system cancers, 9,153 malignant melanoma, 29,202 female breast cancer cases, and 79,507 controls [. . .] 15–74 years of age living within 1000 m of a high-voltage overhead power line." "We observed no meaningful excess risks and no trends of risk with magnetic field strength for the four cancers examined." "Our results do not support an epidemiologic association of adult cancers with residential magnetic fields in proximity to high-voltage overhead power lines."
- Pedersen et al. (2014): "1,698 childhood leukemia cases were compared to 3,396 controls; exposure assessment used the distance between residence at birth and the nearest 132–400 kV overhead power line; children who lived 0–199 m from the nearest power line had OR = 0.76 [0.40–1.45] when compared to children >600 m away. Overall distance to the nearest power line was not associated with a higher risk of childhood leukemia. We did not observe any association with close distance or further away."
- Bunch et al. (2014): "16,630 leukemia cases 1962–2008 compared to 20,429 matched controls; calculated distances of mother's address at child's birth to power lines used as exposure metric. Odds ratio for leukemia, 0-200 m compared with >1,000 m over the whole period OR = 1.12 (0.90–1.38) – not statistically significant. Over the whole period, there is no evidence of a distance effect for any of the three cancer groups."

As can be seen, the power line magnetic-field epidemiology studies have yielded some statistical associations, and scientists have struggled with whether such associations can really be interpreted as having a causal basis. Over the years, EMF epidemiology studies have stimulated numerous laboratory experiments where scientists examined the adverse health effect hypothesis, i.e., can environmental power-line EMF affect biology, alter processes in living cells, or change molecules in such a way as to increase the risk of cancer or other diseases?

To date, there is neither an accepted mechanism by which power line EMF can cause disease, nor is there any animal model in which lifetime exposure to even considerably elevated 60-Hz magnetic fields has reliably produced a disease or a pre-disease condition (Valberg et al., 1997). That is, the research work has not been able to identify what aspect of EMF is the one we should potentially avoid or regulate. If adverse health effects are to be expected, would they be due specifically to the frequency of oscillation, the electric fields, the magnetic fields, continuous exposure, intermittent exposure, peak fields, transients? Despite considerable effort and many years of work, no firm evidence of adverse EMF effects has been found in the laboratory for any of the measures of EMF exposure that have been experimentally examined. Because the laboratory evidence and mechanistic analyses have not supported a causal link for the increments in risk suggested by the epidemiology studies, most scientists give less weight to the statistical correlations.

Public Health Agency Views on EMF Causing Health Effects

In 2002, the IARC classified power-line-frequency EMF as "possibly carcinogenic to humans" which refers to the circumstances where there is limited-to-inadequate evidence of carcinogenicity in humans and limited-to-inadequate evidence in experimental animals. As noted, a biological mechanism to support this carcinogenic effect has not been found, because 60-Hz EMF interact weakly with the human body, because a 60-Hz wavelength is much larger than body size, and EMF exposure results in extremely low levels of energy deposition in the body. One must also consider the many years of human experience with EMF, i.e., use of electricity at an increasing rate for more than 100 years with no indication of increasing disease at the national, population level (Jackson, 1992).

The scientific data on EMF and health have been assembled and reviewed by many independent consensus groups of research and health scientists. These groups and agencies include (among many others) the European Union (EU), International Commission on Nonionizing Radiation Protection (ICNIRP), World Health Organization (WHO), the National Academy of Sciences, (NAS) the American Cancer Society (ACS), and the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). As illustrated by the examples listed below,

these "blue-ribbon" panels do not conclude that ambient levels of EMF are unsafe. The reports of these groups are voluminous, thorough, and evenhanded. Some of their conclusions are illustrated below, but many of the documents extend to many hundreds of pages, so a more complete view of their analyses and opinions requires going to the reports themselves.

- American Cancer Society (ACS) (2014a): "The possible link between electromagnetic fields and cancer has been a subject of controversy for several decades. It's not clear exactly how electromagnetic fields, a form of low-energy, non-ionizing radiation, could increase cancer risk. Plus, because we are all exposed to different amounts of these fields at different times, the issue has been difficult to study."
- European Union (EU) (2009): "Animal studies do not provide evidence that ELF magnetic field exposure alone causes tumours or enhances the growth of implanted tumours. Some inconsistent evidence has suggested that ELF magnetic fields might be co-carcinogenic (enhance the effects of known carcinogens) and that they may cause cancer-relevant biological changes in short-term animal studies. However, it was concluded that the data were not sufficient to challenge IARC's evaluation that the experimental evidence for carcinogenicity of ELF magnetic fields is inadequate."
- Institute of Electrical & Electronics Engineers (IEEE) (2002): "Protection is to be afforded to individuals in the general population by limiting maximum permissible exposure to magnetic field levels of 9,040 mG at 60-Hz power-line frequencies."
- International Agency for Research on Cancer (IARC) (2002): "The association between childhood leukemia and high levels of magnetic fields is unlikely to be due to chance, but it may be affected by bias. In particular, selection bias may account for part of the association." (p. 332) [Thus] there is limited evidence in humans for the carcinogenicity of extremely low-frequency magnetic fields in relation to childhood leukemia. There is inadequate evidence in humans for the carcinogenicity of extremely low-frequency magnetic fields in relation to all other cancers." (p. 338)[2]
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2010): "[Two pooled epidemiological analyses] indicated that long-term exposure to 50–60 Hz magnetic fields might be associated with an increased risk of leukemia. . . . However, a combination of selection bias, some degree of confounding, and chance could possibly explain the results. In addition, no biophysical mechanism has been identified and the experimental results from animal and cellular laboratory studies do not support the notion that exposure to 50–60 Hz magnetic fields is a cause of childhood leukemia."
- National Academy of Sciences (NAS) (1999): "Results of the EMF-RAPID program do not support the contention that the use of electricity poses a major unrecognized public-health danger."
- National Cancer Institute (NCI) ((2005): "Currently, researchers conclude that there is limited evidence that magnetic fields from power lines cause childhood leukemia, and that there is inadequate evidence that these magnetic fields cause other cancers in children. Researchers have not found a consistent relationship between magnetic fields from power lines or appliances and childhood brain tumors."
- Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2013): "Some epidemiological studies are consistent with earlier findings of an increased risk of childhood leukemia with long-term average exposure to magnetic fields above 0.3 to 0.4 μT [3 to 4 mG]. However, as stated in [SCENIHR's] previous opinions, no mechanisms have been identified that could explain these findings. The lack of experimental support and shortcomings identified for the epidemiological studies prevent a causal interpretation."
- World Health Organization (WHO) (2007): "Uncertainties in the hazard assessment [of epidemiological studies] include the role that control selection bias and exposure misclassification might have on the observed relationship between magnetic fields and childhood leukemia. 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."

[2] In 2002, the IARC classified ELF magnetic fields as Group 2B (possibly carcinogenic) on the IARC scale of carcinogenic risk to humans. IARC uses the "possibly carcinogenic" category when talking about both cell phone RF fields and power-line magnetic fields ("EMF"), and the IARC category 2B includes many ordinary exposures as "possible carcinogens," e.g., coconut oil, gasoline, diesel fuel, fuel oil, mobile phones, "carpentry and joinery," coffee, carbon black (car tires), car-engine exhaust, surgical implants, talc-based body powder, iron supplement pills, mothballs, nickels, pickled vegetables, safrole tea, titanium dioxide, chloroform, for a total of 285 substances.

Regulatory Guidelines for Electric and Magnetic Fields

The US has no federal standards limiting occupational or residential exposure to 60-Hz EMF. Table 101.2 shows guidelines for power-line EMF suggested by national and

TABLE 101.2 60-Hz EMF Guidelines Established by Health and Safety Organizations

Organization	Magnetic Field	Electric Field
American Conference of Governmental and Industrial Hygienists (ACGIH) (occupational)	10,000 mG[a] 1000 mG[b]	25 kV/m[a] 1 kV/m[b]
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (general public, continuous exposure)	2000 mG	4.2 kV/m
Non-Ionizing Radiation (NIR) Committee of the American Industrial Hygiene Assoc. (AIHA) endorsed (in 2003) ICNIRP's occupational EMF levels for workers	4170 mG	8.3 kV/m
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.6 (general public, continuous exposure)	9040 mG	5.0 kV/m
UK, National Radiological Protection Board (NRPB) (now Health Protection Agency [HPA)]	2000 mG	4.2 kV/m
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Draft Standard, Dec. 2006[c]	3000 mG	4.2 kV/m
Comparison to steady (see text) (*DC*) *EMF, encountered as EMF outside the 60-Hz frequency range:*		
Earth's magnetic field and atmospheric electric fields, steady levels, typical of environmental exposure[d]	520 mG[e]	0.2 kV/m up to >12 kV/m
Magnetic resonance imaging scan, static magnetic field intensity[d]	20,000,000 mG	–

[a]The ACGIH (2014) guidelines for the general worker.
[b]The ACGIH (2014) guidelines for workers with cardiac pacemakers.
[c]ARPANSA (2006, 2008).
[d]These EMF are steady fields and do not vary in time at the characteristic 60 cycles per second that power-line fields do. However, if a person moves in the presence of these fields, the body experiences a time-varying field.
[e]At 42 degrees latitude (NOAA, 2013).

WHO. The levels shown in Table 101.2 are designed to be protective against any adverse health effects. The limit values should not be viewed as demarcation lines between safe and dangerous levels of EMF, but rather, levels that assure safety with an adequate margin of safety to allow for uncertainties in the science. Table 101.3 lists guidelines that have been adopted by various states in the United States. State guidelines are not health effect based

TABLE 101.3 State EMF Standards and Guidelines for Transmission Lines

	Electric Field		Magnetic Field	
State/Line Voltage	On ROW	Edge ROW	On ROW	Edge ROW
Y69–230 kV	8.0 kV/m	2.0 kV/m[b]		150 mG
Florida[a]	10.0 kV/m			200 mG, 250 mG[c]
Y500 kV				
Massachusetts		1.8 kV/m		85 mG
Minnesota	8.0 kV/m			
Montana	7.0 kV/m[d]	1.0 kV/m[e]		
New Jersey		3.0 kV/m		
New York[a]	11.8 kV/m	1.6 kV/m		200 mG
	11.0 kV/m[f]			
	7.0 kV/m[d]			
Oregon	9.0 kV/m			

ROW = right-of-way; mG = milligauss; kV/m = kilovolts per meter.

Sources: NIEHS (2002); FDEP (2008).

[a]Magnetic fields for winter-normal, i.e., at maximum current-carrying capability of the conductors.
[b]Includes the property boundary of a substation.
[c]500 kV double-circuit lines built on existing ROWs.
[d]Maximum for highway crossings.
[e]May be waived by the landowner.
[f]Maximum for private road crossings.

and have been typically adopted to maintain the status quo for EMF on and near transmission line rights-of-way (ROWs).

RADIOFREQUENCY (RF) WAVES AND COMMUNICATIONS TECHNOLOGIES

The RF portion of the electromagnetic spectrum lies at much higher frequencies than the ELF-EMF frequency range, but at a lower frequency range than radiation in the infrared (heat) or visible (light) portion of the spectrum (see Table 101.1). In the RF range, some sources of radio-wave energy include the following:

- Commercial radio (AM, FM), television (VHF, UHF, digital), amateur (ham) radio
- Marine and aviation radio services, military and weather radar, satellite TV/radio, GPS
- Hospital (EMS), fire, police dispatch services
- Wireless paging, routers, remote-control, baby monitors, walkie-talkies, etc.
- Cordless telephones, cell phones, smart phones, smart meters, base station antennas
- Microwave ovens (RF leakage); microwave computer links
- RF in medicine: ablation, cautery, diathermy, MRI

As can be appreciated from this list, our society has used RF communication for more than 100 years, and RF energy has been used in medical treatments for over 75 years (Hunt, 1982). The health effects of RF have been vigorously investigated from the 1950s, when military uses of RF, and radar in particular, were greatly expanded, on up to the present day (Schwan, 1954; Guy, 1975; Adair, 1983; Lin and Michaelson, 1987; Valberg, 1997; Valberg et al., 2007; Lin and Michaelson, 2010; Foster and Moulder, 2013).

In 2011, IARC classified RF as a "possible carcinogen," which IARC describes circumstances where there is limited-to-inadequate evidence of carcinogenicity in humans and limited-to-inadequate evidence in experimental animals (IARC, 2011). But, as in the case of ELF-EMF, laboratory animal and biological mechanism evidence fail to support adverse health effects from low levels of RF exposure. Notably, MRI uses radio frequency waves to generate images of all parts of the human body, and MRI scans are not considered to pose health risks, in contrast to imaging techniques that use ionizing radiation (X-rays, CAT scans, PET scans, etc.).

Properties of Radiofrequency (RF) Electromagnetic Waves

In the above list of communications technologies, the total amount of RF energy transmitted by these sources varies widely, and it's helpful to compare the RF emissions to a "100 watt light bulb." Most commercial radio and television broadcast stations are licensed to operate at power outputs of tens of kilowatts to millions of watts; cell telephone base antennas range in power from 100 to 1000 W; a cell-phone handset typically produces less than 2–4 Wof RF energy. For any antenna, the energy emitted is spread across a wide angle (in different directions), and the RF energy level decreases rapidly with distance. At the closest publicly accessible point, all transmitters must comply with the RF safety standards and guidelines for the general public, which in the United States are set by the Federal Communications Commission (FCC), and which are overall similar world-wide (ICNIRP, 2009). Below is a list of some sources of electromagnetic energy, listed according to the power they emit into the electromagnetic spectrum (mostly in the RF spectrum, but, for perspective, including some with emissions in the "heat" and "light" part of the electromagnetic spectrum).

Electric utility "smart meters"---	<1 W
Handheld cell phones, cordless phones---	<2–4 W
Remote control toys and nursery monitors---	~3 W
Typical flashlight---	~5 W (light + heat)
"Walkie-talkies"---	~10 W
Cellular telephone base stations---	~100–1000 W
Incandescent light bulb---	~100 W (light + heat)
The living human body---	~100 W (heat [IR waves])
Inside a microwave oven---	~1500 W (some RF leaks out)
Electric space heater---	~1500 W (light + heat)
Radio and television antennas---	~50,000 to 1,000,000 W

Typical measurements of the intensity of RF waves provide "energy per unit area," and the results are given in "microwatts per square centimeter" or $\mu W/cm^2$. A microwatt is a millionth of a watt. Sometimes the units are "watts per square meter" of W/m^2 ($1\ W/m^2 = 100\ \mu W/cm^2$). The Safety-standard allowable RF exposure levels vary with the frequency of the radio waves, being lowest (most restrictive) level in the frequency range 30–300 MHz (FM radio). The RF safety standard for public exposure in the AM-radio frequency band is 20,000 $\mu W/cm^2$, in the FM-radio frequency band is 200 $\mu W/cm^2$, at cellular telephone frequencies of 910 MHz is 610 $\mu W/cm^2$, and at cellular telephone frequencies of 2000 MHz and above is 1000 $\mu W/cm^2$. (Refer also to Tables 101.4 and 101.5 at the end of the chapter.) By comparison, summertime sunlight at noon bathes us with about 150,000 $\mu W/cm^2$ of electromagnetic energy in the visible light portion of the spectrum.

When considering biological effects, another useful comparison to consider is the whole-body specific absorption rate (SAR) guideline used by the FCC, ICNIRP, and IEEE for the

TABLE 101.4 FCC Limits for Maximum Permissible Exposure (MPE), 300 kHz to 100 GHz

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
(A) Limits for Occupational/Controlled Exposure[a]				
0.3–3.0	614	1.63	(100)*	6
3.0–30	1842/*f*	4.89/*f*	($900/f^2$)*	6
30–300	61.4	0.163	1.0	6
300–1500	–	–	*f*/300	6
1500–100,000	–	–	5	6
(B) Limits for General Population/Uncontrolled Exposure[b]				
0.3–1.34	614	1.63	(100)*	30
1.34–30	824/*f*	2.19/*f*	($180/f^2$)*	30
30–300	27.5	0.073	0.2	30
300–1500	–	–	*f*/1500	30
1500–100,000	–	–	1.0	30

f = frequency in MHz.

*Plane-wave equivalent power density.

[a]Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply, provided he or she is made aware of the potential for exposure.

[b]General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

TABLE 101.5 IEEE Basic Restrictions (BRs) for Frequencies Between 100 kHz and 3 GHz

		Action level[a] SAR[b] (W/kg)	Persons in Controlled Environments SAR[c] (W/kg)
Whole-body exposure	Whole-body Average (WBA)	0.08	0.4
Localized exposure	Localized (peak spatial-average)	2[c]	10[c]
Localized exposure	Extremities[d] and Prinnae	4[c]	20[c]

[a]These are basic restrictions (BR) for the general public when an RF safety program is unavailable.

[b]SAR is averaged over 30 min for the general public and over 6 min for controlled (worker) environments.

[c]Averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube [the volume of the cube is approximately 10 cm^3]).

[d]The "extremities" are the arms and legs distal from the elbows and knees, respectively.

general public, which is 0.08 W/kg, and which is the basis of the RF "maximum permissible exposure" guidelines.[3] How much would this amount of continuous energy input (0.08 W) heat up a kilogram of water (1 l of water) over 1 h of exposure? The answer is that, absorbing 0.08 W for a whole hour would raise the water temperature by 0.07 °C, assuming all of the heat input from the RF remained with the water, and did not get conducted, convected, or radiated away.[4] By way of comparison, the human body generates energy constantly at about 100 W, in the process of "burning" ingested food and staying warm at about 37 °C. When exercising, the energy generation rate of the human body goes up many-fold. The IR radiation from the warm human body (37 °C, or 310 K) has an intensity of about 50 mW/cm^2, and the IR wavelength ranges from 6 to 14 μm (Rogalski, 2010). Thus, if our bodies, organs, cells, and molecules typically function well in a 100 W bath of IR electromagnetic energy (with IR photons having much more energy than RF photons), it is hard to explain why absorbing less than a watt of RF power would disrupt physiological function.

Research Studies on Health Effects of RF

The absorption of RF energy by living organisms is well understood to cause some degree of heating, in an amount dependent upon the RF intensity and RF frequency (or wavelength). This well established effect of RF exposure (thermal effects) forms the basis of guidelines protective against adverse effects via this mechanistic pathway, for both occupational and general-public RF exposure standards (IEEE, 2006; ICNIRP, 2009). Although "nonthermal" effects of RF are regularly reported in the research literature, the consistency, reproducibility, and usefulness of the "nonthermal" results have not achieved a reliability to the point where they can form the basis of RF exposure standards.

Epidemiologic analyses have continued over the years, and more recent studies have primarily focused on cellular telephone exposures, because this technology has become so ubiquitous. The 15 articles listed below (2002–2014) provide examples of prominent analyses, reviews, and/or summaries of the more recent RF literature. Although not a comprehensive review, the summary conclusions provide a sampling of some of the more recent and more significant epidemiological results. Even though very brief, quoted conclusions are presented, the reader is of course, encouraged to consult the complete article for a more complete presentation.

- Groves et al. (2002): "This study reports on over 40 years of mortality follow-up of 40,581 Navy veterans of the

[3] Federal Communications Commission: http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf

[4] 0.08 W = 0.08 joules/sec, so for 1 h, energy going in = 288 joules = 69 calories, which would raise the temperature of 1000 g of water by 0.069 °C.

Korean War." For these radar technicians, "Deaths from all diseases and all cancers were significantly below expectation overall, and [in particular] for the 20,021 sailors with high radar exposure potential. There was no evidence of increased brain cancer in the entire cohort or in high-exposure occupations." "No significant excesses were seen for lymphoid malignancies."

- Johansen (2004): "At present, there is little, if any, evidence that the use of mobile phones is associated with cancer in adults, including brain tumors, acoustic neuroma, cancer of the salivary glands, leukemia, or malignant melanoma of the eye."
- Takebayashi et al. (2008): In this study of exposure to radiofrequency electromagnetic fields from mobile phone use, and brain tumor risk: "the adjusted odds ratios (ORs) for regular mobile phone users [was] 1.22 (95% confidence interval (CI): 0.63–2.37) for glioma and 0.70 (0.42–1.16) for meningioma. When the maximal SAR value inside the tumour tissue was accounted for in the exposure indices, the overall OR was again not increased and there was no significant trend towards an increasing OR in relation to SAR-derived exposure indices. A non-significant increase in OR among glioma patients in the heavily exposed group may reflect recall bias."
- Ahlbom et al. (2009): p. 642. Glioma: "The pooled analysis of Nordic and UK Interphone studies, which to date includes the largest number of glioma cases, found an OR of 1.0 (0.7–1.2) based on 143 exposed cases, among persons who started to use a mobile phone 10 or more years before diagnosis." p. 646. Meningioma: "The largest study so far—the pooled analysis of the Nordic and UK Interphone studies— found an OR of 0.9 (0.7–1.3) for long-term use. Pooling all original studies gave risk estimates close to or below unity." p. 647. Acoustic neuroma: "For long durations of exposure (10 years or more), the Nordic-UK pooled analysis included the largest number of cases, and reported an OR of 1.0 (0.7–1.5)." "Pooling all studies gave summary risk estimates of 1.2 (0.8–2.0) for long-term use, and 1.1 (0.8–1.4) for ever-use." p. 650. Salivary gland tumors: "There is no consistent evidence of an increased risk of salivary gland tumors among mobile phone users"
- Aydin et al. (2011, 2012): "There is no plausible explanation of how a notably increased risk from use of wireless phones would correspond to the relatively stable incidence time trends for brain tumours among children and adolescents observed in the Nordic countries." "Regular users of mobile phones were not statistically significantly more likely to have been diagnosed with brain tumors compared with nonusers." "Almost 90% of the [Swedish] population had been using mobile phones for at least seven years in 2009, and the proportion that had been using them for 10 years or even 15 years must have been substantial. Hence, the absence of a trend in the incidence of brain tumours in national statistics is reassuring [as to mobile phones not increasing risk of brain cancer]."
- de Vocht et al. (2011): "Given the widespread use and nearly two decades elapsing since mobile phones were introduced, an association should have produced a noticeable increase in the incidence of brain cancer by now. Trends in rates of newly diagnosed brain cancer cases in England between 1998 and 2007 were examined. There were no time trends in overall incidence of brain cancers for either gender, or any specific age group." "The increased use of mobile phones between 1985 and 2003 has not led to a noticeable change in the incidence of brain cancer in England between 1998 and 2007."
- INTERPHONE Study Group (2011): "There was no increase in risk of acoustic neuroma with ever regular use of a mobile phone or for users who began regular use 10 years or more before the reference date,"
- Swerdlow et al. (2011): "Although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumors in adults."
- Larjavaara et al. (2011): "The study included 888 gliomas from 7 European countries (2000–2004), with tumor midpoints defined on a 3-dimensional grid based on radiologic images." "[Our] results do not suggest that gliomas in mobile phone users are preferentially located in the parts of the brain with the highest radio-frequency fields from mobile phones."
- Schüz et al. (2011): "In this study including 2.9 million subjects, a long-term mobile phone subscription of $\geq$11 years was not related to an increased vestibular schwannoma risk in men (RR = 0.87, 95% CI: 0.52, 1.46), and no vestibular schwannoma cases among long-term subscribers occurred in women versus 1.6 expected. Vestibular schwannomas did not occur more often on the right side of the head, although the majority of Danes reported holding their mobile phone to the right ear."
- Deltour et al. (2012) and Little et al. (2012): Time trends in brain cancer rates do not reflect increases in mobile phone use, suggesting that there is no effect of low-level RF on brain cancer risk. "Age specific incidence rates of glioma remained generally constant in 1992–2008 (−0.02% change per year, 95% CI −0.28% to 0.25%), a period coinciding with a substantial increase in mobile phone use from close to 0% to almost 100% of the US population. If phone use [were] associated with glioma risk, we expected glioma incidence rates to be higher than those observed, even with a latency period of 10 years and low relative risks (1.5)."

- Mohler et al. (2012): "The results of [our] large cross-sectional study did not indicate an impairment of subjective sleep quality due to exposure from various sources of RF EMFs in everyday life." "We did not find evidence for adverse effects on sleep quality from RF-EMF exposure in our everyday environment." "individuals who claim to be able to detect low level RF-EMF are not able to do so under double-blind conditions"
- Barchana et al. (2012): "We found a statistically significant decrease in [gliomas] over 30-years period that correlates with introducing of mobile phones technology" "[This] is in-line with other observations and does not support the assumption that mobile phone use is a causative factor for brain gliomas."
- Kwon et al. (2012): [people with self-reported electromagnetic hypersensitivity (EHS)] "In this double-blind study, two volunteer groups of 17 EHS and 20 non-EHS subjects were simultaneously investigated for physiological changes (heart rate, heart rate variability, and respiration rate), eight subjective symptoms, and perception of RF-EMFs during real and sham exposure sessions." . . . "There was no evidence that EHS subjects perceived RF-EMFs better than non-EHS subjects." "32 min of RF radiation emitted by WCDMA mobile phones demonstrated no effects in either EHS or non-EHS subjects."
- Lagorio and Röösli (2014): "A meta-analysis of [29] studies on intracranial tumors and mobile phone use published by the end of 2012 was performed." "High heterogeneity was detected across estimates of glioma and acoustic neuroma risk in long term users, with cRRs ranging between 1.19 (95% CI 0.86–1.64) and 1.40 (0.96–2.04), and from 1.14 (0.65–1.99) to 1.33 (0.65–2.73), respectively." "Overall, the results of our study detract from the hypothesis that mobile phone use affects the occurrence of intracranial tumors."

Public Health Agency Views on RF Causing Health Effects

As with guidelines and standards, generally RF exposure standards have been developed by interdisciplinary, consensus groups, based on the scientific knowledge accumulated from many years of laboratory work and of human experience with RF waves (e.g., radio, television, navigation, telemetry, cell telephones, radar). As is the case with power-line EMF, research findings on potential health effects of RF waves have been assembled and periodically reviewed by numerous independent scientific professional groups composed of research, engineering, medical, and public health scientists. The reports of these groups, written by researchers, medical doctors, biologists, engineers, and toxicologists, are voluminous, thorough, and evenhanded.

To account for uncertainties in the data and increase confidence that adverse health effects will not occur at exposure levels below the RF standards, the established threshold of actual biological effects is generally divided by a factor of 10 to provide a margin of safety for occupational environments. For general public environments, an additional factor of 5 is applied, meaning that the RF guidelines are typically 50-fold lower than the empirically observed threshold for RF effects that might be considered adverse to health. The public health groups looking at RF health effects include the ACS, ICNIRP, WHO, and SCENIHR. As illustrated by the examples listed below, a consistent finding is that, by limiting RF exposures according to the current RF guidelines, we can expect to be protective of health.

- American Cancer Society (ACS) (2014b). "Most animal and laboratory studies have found no evidence of an increased risk of cancer with exposure to RF radiation. A few studies have reported evidence of biological effects that could be linked to cancer. Studies of people who may have been exposed to RF radiation at their jobs (such as people who work around or with radar equipment, those who service communication antennae, and radio operators) have found no clear increase in cancer risk."
- Advisory Group on Non-Ionizing Radiation (AGNIR) (2012). "Exposure of the general public to low level RF fields from mobile phones, wireless networking, TV and radio broadcasting, and other communications technologies is now almost universal and continuous." "In summary, although a substantial amount of research has been conducted in this area, there is not convincing evidence that RF exposure below internationally accepted guidance levels causes health effects in adults or children."
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2012). "Laboratory studies do not provide evidence to support the notion that RF fields cause cancer. Review groups evaluating the state of knowledge about possible links between RF exposure and excess risk of cancer have concluded that there is no clear evidence for any links."
- Federal Communications Commission (FCC) (2014) "Some health and safety interest groups have interpreted certain reports to suggest that wireless device use may be linked to cancer and other illnesses, posing potentially greater risks for children than adults. While these assertions have gained increased public attention, currently no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses. Those evaluating the potential risks of using wireless devices agree that more and longer-term

studies should explore whether there is a better basis for RF safety standards than is currently used. The FCC closely monitors all of these study results. However, at this time, there is no basis on which to establish a different safety threshold than our current requirements."

- Food and Drug Administration (FDA) (2012) "Many people are concerned that cell phone radiation will cause cancer or other serious health hazards. The weight of scientific evidence has not linked cell phones with any health problems."
- Health Canada, Royal Society of Canada (RSC) (2003) "All of the authoritative reviews completed within the last two years have concluded that there is no clear evidence of adverse health effects associated with RF fields"
- Health Council of the Netherlands (NHC) (2011) "Available data do not indicate that exposure to radiofrequency electromagnetic fields affect brain development or health in children."
- Institute for Electrical and Electronics Engineers (IEEE) (2006) "[RF standards] protect against harmful effects in human beings exposed to electromagnetic fields in the frequency range from 3 kHz to 300 GHz."
- International Agency for Research on Cancer (IARC) ((2013). In May of 2011, the IARC Working Group determined that "There is *limited* evidence in humans for the carcinogenicity of radiofrequency radiation. Positive associations have been observed between exposure to radiofrequency radiation from wireless phones and glioma, and acoustic neuroma." "Radiofrequency electromagnetic fields are *possibly* carcinogenic to humans (Group 2B)." "There was, however, a minority opinion that current evidence in humans was *inadequate*, therefore permitting no conclusion about a causal association."[5] However, IARC's classification, because it did not include a quantitative analysis, has not led to the modification of RF guidelines and standards for safe exposure levels.
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2009) "With regard to [RF and] non-thermal interactions, it is in principle impossible to disprove their possible existence but the plausibility of the various non-thermal mechanisms that have been proposed is very low. In addition, the recent *in vitro* and animal genotoxicity and carcinogenicity studies are rather consistent overall and indicate that such effects are unlikely at low levels of exposure."
- National Cancer Institute (NCI) (2013). "Cell Phones and Cancer Risk." "Studies thus far have not shown a consistent link between cell phone use and cancers of the brain, nerves, or other tissues of the head or neck. More research is needed because cell phone technology and how people use cell phones have been changing rapidly.
- National Council on Radiation Protection & Measurements (NCRP) (2003). "[NCRP] concludes that the scientific literature related to modulation-dependence of biological effects of RF energy is not sufficient to draw any conclusions about possible modulation-dependent health hazards of RF fields, nor is there any apparent biophysical basis from which to anticipate such hazards apart from exposure to very intense RF pulses produced by some specialized military equipment."
- National Radiological Protection Board (NRPB) (2013) "The [Interphone] study provides no clear, or even strongly suggestive, evidence of a hazard. Moreover, it indicates that if there is any hazard of brain cancer or meningioma from use of mobile phones then the risk during the initial 10–15 years of use must be small. This conclusion is consistent with the findings of most other epidemiological studies that have examined the relation of brain tumours to use of mobile phones, and also with the absence of demonstrable effects on cancer incidence when laboratory animals have been exposed to radiofrequency radiation experimentally."
- New Zealand Ministry for the Environment (NZME) (2012). "The Ministry of Health considers there are no established adverse effects from exposures to radiofrequency fields which comply with the ICNIRP guidelines and the New Zealand Standard."
- Norwegian Institute of Public Health (2012-3) "With the exception of some case-control studies, the majority of the case-control studies and cohort studies have reported no increased risk of cancer. The results of the incidence studies show no evidence of increasing incidence of these cancers over time." "A number of studies of cancer in animals have been performed, and relevant mechanisms have also been studied using micro-organisms and cells. Overall, these studies provide further evidence that exposure to weak RF fields does not lead to cancer." Electromagnetic Hypersensitivity: "Blind trials show that symptoms also occur when subjects are not exposed. This means that electromagnetic fields do not need to be present for health problems attributed to electromagnetic fields to occur."
- Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2013): "Overall, there is evidence that exposure to RF fields does not cause

[5] IARC uses the "possibly carcinogenic" category when talking about both cell phones and power-line magnetic fields ("EMF"), and the IARC category 2B includes "possible carcinogens" such as coconut oil, gasoline, diesel fuel, fuel oil, power-line EMF, "carpentry and joinery," coffee, carbon black (car tires), car-engine exhaust, surgical implants, talc-based body powder, iron supplement pills, mothballs, nickels, pickled vegetables, safrole tea, titanium dioxide (sunscreen), chloroform, and many other substances. http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf

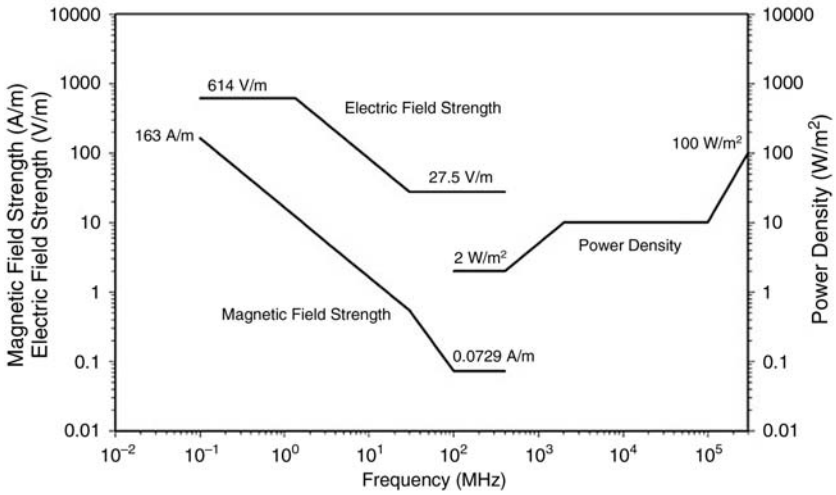

FIGURE 101.1 Graphic Representation of MPEs. Reprinted with permission from IEEE (2006), p. 27, Figure 4.

symptoms or affect cognitive function in humans. The previous SCENIHR opinion concluded that there were no adverse effects on reproduction and development from RF fields at exposure levels below existing limits. The inclusion of more recent human and animal data does not change that assessment." (p. 5) "The results [. . .] have typically not found any effect of exposure to radiofrequency fields on self-reported symptoms, are supported by a series of meta-analyses conducted by Augner, Gnambs, Winker and Barth (2012). These authors identified nine single- or double-blind provocation studies which assessed the effects of [RF] exposure on five self-reported symptoms (headache, nausea, dizziness, fatigue and skin irritation) and which were suitable for inclusion in a meta-analysis. No evidence was found in the meta-analyses that any of these endpoints were affected by exposure." (p. 109)

- World Health Organization (WHO) (2011) "A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use."

In summary, there is general agreement among a wide range of "blue ribbon" scientific review panels that the current standards used to prevent overexposure to RF levels can be expected to be health protective.

RF Electromagnetic Wave Exposure Limits and Guidelines

A number of scientific consensus groups have developed quantitative RF exposure guidelines, both for the occupational and general public environment. The groups that have produced numerical values include the following, and the standards are generally in agreement with each other.

- American Conference of Governmental Industrial Hygienists (ACGIH, 2014)
- Federal Communications Commission (FCC, 1997)
- Health Canada, Safety Code 6 (Canada, 2010)
- Institute of Electrical & Electronics Engineers/American National Standards Institute (IEEE, 2006)
- International Commission for Non-Ionizing Radiation Protection (ICNIRP, 2009)

Rather than display all of the possible standards, the FCC and IEEE standards are tabulated above to show the general manner in which these RF standards are presented.

The FCC standards were finalized in 1997 (FCC, 1997), and the agency has periodically reviewed the literature to ascertain that the standards remain current and health protective.[6]

The IEEE/ANSI standards for RF were finalized in 2005, and published in 2006, and in the table below, basic restrictions on human exposure to RF are given in terms of a SAR (energy absorbed per unit mass of tissue), over either a 6 min (occupational) or 30 min (general public) averaging time. The units of energy absorption are "watts per kilogram." The "Action Level" is the value applied for the general public, and the "Controlled Environment" figure is applied to occupational environments where workers are fully aware of the potential for exposure and can exercise control of their RF exposure levels.

Because the amount of energy absorbed from RF waves by the human body varies with frequency, the IEEE graph above (Figure 101.1) illustrates how these limitations in SAR

[6] http://www.fcc.gov/encyclopedia/faqs-wireless-phones

play out in terms of maximum permissible exposure (MPS's) limits for RF as a function of RF frequency (IEEE, 2006).

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Electric and Magnetic Field (EMF) Modeling Analysis for the West Roxbury to Needham Reliability Project

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1 Introduction and Summary

Eversource Energy (Eversource) has proposed to construct a new combination overhead/underground 115-kilovolt (kV) transmission line between the Baker Street Substation located on Baker Street in the West Roxbury section of Boston and the Needham Substation located on Chestnut Street in Needham. This project is known as the West Roxbury to Needham Reliability Project. As shown in the attached Candidate Route Map (Appendix A), the new overhead line segment of approximately 1.57 miles is to be installed on Eversource's existing right-of-way (ROW) #3 that runs in an east-west direction between the Baker Street Substation and the Valley Road area in Needham adjacent to the Massachusetts Bay Transportation Authority ("MBTA") Needham Line commuter rail corridor (Epsilon, 2015). For this overhead segment, one of the two existing 115-kV circuits (for overhead line segments east of Gardner Street in West Roxbury, the 240-510 circuit, and for overhead line segments west of Gardner Street in West Roxbury, the 110-522 circuit) will be moved to a new set of steel monopoles, with the other circuit remaining in service on the existing double-circuit towers. In the vicinity of the Valley Road cul-de-sac, the 110-522 115-kV line will be transitioned to a new underground 115-kV transmission line that is expected to be installed predominantly in public or private roads between Valley Road and the Needham Substation, with the other 240-510 115-kV line remaining in service on the existing double-circuit towers between Valley Road and the Needham Substation.

Epsilon Associates, Inc. (Epsilon) requested that Gradient perform an independent assessment of the electric and magnetic field (EMF) impacts associated with the West Roxbury to Needham Reliability Project. For this assessment, EMF impacts were modeled for several representative overhead and underground line cross-sections using projected non-emergency summer peak and average transmission line loadings provided by Eversource for the year 2018, which is the expected in-service date for the project (Leonard, 2016).

As described in this report, modeled EMF values both within and at the edges of ROW #3 for each of the overhead line cross-sections representative of the post-project circuit configurations and 2018 load conditions (referred to in the report as "With-Project" EMF results; these modeled results are compared to modeled results for present-day circuit configurations and 2018 load conditions, which are referred to in the report as "Without-Project" EMF results) were all well below the health-based guidelines issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for continuous public exposure to EMFs (4.2 kilovolts per meter [kV/m] and 2,000 milligauss [mG]; ICNIRP, 2010). Importantly, for each of the three representative overhead line cross-sections evaluated in the EMF assessment (East of Gardner Street, West of Gardner Street/East of Valley Road cul-de-sac, West of Valley Road cul-de-sac), the modeled results showed that With-Project within-ROW maximum EMF values were all less than the corresponding Without-Project within-ROW maximum values. For example, for the non-emergency summer peak 2018 load level modeling scenario, the With-Project within-ROW maximum magnetic field values ranged from 37.4-53.1 mG for the three overhead line cross-sections, as compared to the Without-Project within-ROW maximum magnetic field value of 67.8 mG. For electric fields, the With-Project within-ROW maximum electric field values ranged from 1.58-2.23 kV/m for the three overhead line cross-sections, as compared to the Without-Project within-ROW maximum electric field value of 2.63 kV/m. These lower With-Project within-ROW maximum EMF values are primarily due to the greater separation between the two circuits that will result from their placement on two different poles for the project, as compared to the present-day circuit configuration in which the two circuits are located on a single pole.

As shown in Table 1.1, the modeling also demonstrated that EMF values at the ROW #3 edges were frequently reduced for the With-Project circuit configurations, as compared to the Without-Project circuit configurations for the modeling of 2018 loading conditions. This is particularly the case for the West of Valley Road cul-de-sac overhead line segment that is the only overhead line segment in which the ROW sometimes passes close to residential neighborhoods in the Town of Needham. For the non-emergency summer peak 2018 load level modeling scenario, modeled Without-Project magnetic field values ranged from 6.3-64.5 mG at the southern edge of ROW #3 and 2.8-18.7 mG at the northern edge of ROW #3, as compared to modeled With-Project magnetic field values that ranged from 2.7-29.3 mG and 1.4-10.6 mG at the southern and northern edges of the ROW, respectively.[1] Similarly, the EMF modeling for the West of Valley Road cul-de-sac overhead line cross-section yielded modeled Without-Project electric field values ranging from 0.03-2.29 kV/m at the southern edge of ROW #3 and 0.05-0.11 kV/m at the northern edge of ROW #3, as compared to modeled With-Project magnetic field values ranging from 0.05-0.95 kV/m and 0.03-0.07 kV/m at the southern and northern edges of the ROW, respectively. These reductions in modeled EMF values at the edges of ROW #3 for this overhead line segment are primarily due to the removal of the overhead 110-522 line from service in the ROW from the Valley Road cul-de-sac to the Needham Substation.

Table 1.1 Modeled Edge-of-ROW Magnetic Field Values for Each Overhead Cross-section and Load Scenario

Load Scenario	Cross Section/Route Segment	Southern Edge-of-ROW Magnetic Field (mG)[1]		Northern Edge-of-ROW Magnetic Field (mG)[1]	
		Without-Project	With-Project	Without-Project	With-Project
Non-emergency summer peak 2018 load level	East of Gardner St.	8.6-9.5	8.4-9.2	5.2-35.1	6.1-42.5
	West of Gardner St./ East of Valley Road cul-de-sac	8.2-23.9	10.3-31.9	3.7-8.8	3.6-8.3
	West of Valley Road cul-de-sac	6.3-64.5	2.7-29.3	2.8-18.7	1.4-10.6
Average 2018 load level	East of Gardner St.	4.0-4.4	3.9-4.3	2.4-16.3	2.9-19.8
	West of Gardner St./ East of Valley Road cul-de-sac	3.8-11.1	4.8-14.8	1.7-4.1	1.7-3.9
	West of Valley Road cul-de-sac	2.9-29.9	1.3-13.6	1.3-8.7	0.7-4.9

Notes:
mG = Milligauss; ROW = Right-of-Way.
(1) Ranges are provided to reflect the range in the locations of the southern and northern ROW edges for the different route segments.

For the proposed underground 115-kV line segments, modeled magnetic field levels immediately above the underground cables (at a height of 3 feet [~1 m] above ground) are well below the ICNIRP health-based guideline of 2,000 mG for public exposure to magnetic fields (Table 1.2). At the non-emergency summer peak 2018 loading, the With-Project maximum magnetic field value generated by the proposed underground line in the standard inverted-delta (∇) configuration was 71 mG, falling to 7.8 mG at a horizontal distance of ±20 feet away from the centerline of the conductors. At peak load, in the vicinity of manhole/splice vault sections, the With-Project maximum magnetic field value was 98.6 mG, falling to 20 mG at a horizontal distance of ±20 feet away from the centerline of the conductors. At annual average load, the maximum modeled magnetic field value for the majority of the line length (for the ∇

[1] Note that we reported ranges for edge-of-ROW EMFs that correspond to maximum and minimum locations of the northern and southern edges of ROW #3 provided by Epsilon Associates, Inc. for three overhead line sections based on an existing conditions survey plan prepared by VHB Associates, Inc., titled "NSTAR ROW #3, Needham, Dedham, Boston, MA," dated January 22, 2015/rev. February 10, 2015.

configuration) was 33 mG, falling to 3.6 mG at ±20 feet; for the vertical conductor configuration in the splice vaults, the corresponding maximum modeled magnetic field was 46 mG, falling to 9 mG at ± 20 feet from the centerline of the conductors. In all cases, field values decrease rapidly with lateral distance from the lines. Underground lines produce no above-ground electric fields, so these new 115-kV conductors will not produce any above-ground electric fields.

Table 1.2 Modeled Magnetic Fields Three Feet Above Ground Surface for With-Project Underground Line 110-522 Segments

Line Section	Load Scenario	Maximum Magnetic Field (mG), Directly Above Line	Magnetic Field (mG), 20 ft to Either Side of Centerline
Typical Inverted-Delta (∇) Line Sections	Average 2018 load level	32.8	3.6
	Non-emergency summer peak 2018 load level	70.9	7.8
Splice Vault Sections	Average 2018 load level	45.6	9.4
	Non-emergency summer peak 2018 load level	98.6	20.3

Note:
mG = Milligauss.

Section 2 of this report describes the nature of EMFs, provides values for EMF levels from common sources, and reports on available EMF exposure guidelines. Section 3 outlines the EMF modeling procedures for calculating EMF strengths as a function of lateral distance from an electric transmission (or distribution line) and provides graphical and tabular results for the modeled cross-sections. Section 4 summarizes the conclusions, and the Reference list provides the references cited in this report.

2 Nature of Electric and Magnetic Fields

All matter contains electrically charged particles. Most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, we experience electrical effects, such as the static electricity attraction between a comb and our hair or drawing sparks after walking on a synthetic rug in the wintertime. Electrical effects occur both in nature and through our society's use of electric power (generation, transmission, consumption).

2.1 Units for EMFs Are Kilovolts Per Meter (kV/m) and Milligauss (mG)

The electrical tension on utility power lines is expressed in volts or kilovolts (1 kV = 1,000 V). Voltage is the "pressure" of the electricity and can be envisioned as analogous to the pressure of water in a plumbing system. The existence of a voltage difference between power lines and ground results in an "electric field," usually expressed in units of kilovolts per meter (kV/m). The size of the electric field depends on the voltage, the separation between lines and ground, and other factors.

Power lines also carry an electric current that creates a "magnetic field." The units for electric current are amperes (A) and are a measure of the "flow" of electricity. Electric current can be envisioned as analogous to the flow of water in a plumbing system. The magnetic field produced by an electric current is usually expressed in units of gauss (G) or milligauss (mG) (1 G = 1,000 mG). Another unit for magnetic field levels is the microtesla (μT) (1 μT = 10 mG). The size of the magnetic field depends on the electric current, the distance to the current-carrying conductor, and other factors.

2.2 There Are Many Natural and Man-made Sources of EMFs

Everyone experiences a variety of natural and man-made EMFs. EMF levels can be slowly varying or steady (often called "direct current" or "DC fields"), or can vary in time (often called "alternating current" or "AC fields"). When the time variation of interest corresponds to that of power line currents (*i.e.*, 60 cycles per second), the fields are called "60-hertz (Hz)" EMF. Man-made magnetic fields are common in everyday life. For example, many childhood toys contain magnets. Such permanent magnets generate strong, steady (DC) magnetic fields. Typical toy magnets (*e.g.*, "refrigerator door" magnets) have fields of 100,000-500,000 mG. On a larger scale, Earth's core also creates a steady DC magnetic field that can be easily demonstrated with a compass needle. The size of Earth's magnetic field in the northern US is about 550 mG (over 100 times smaller than fields generated by "refrigerator door" magnets).

2.3 Power-frequency EMFs Are Found Near Electric Lines and Appliances

Electric power transmission lines, distribution lines, and electric wiring in buildings carry AC currents and voltages that change size and direction at a frequency of 60 Hz. These 60-Hz currents and voltages create 60-Hz EMFs nearby. The size of the magnetic field is proportional to the line current, and the size of the electric field is proportional to the line voltage. The EMF associated with electrical wires and electrical equipment decrease rapidly with increasing distance away from the electrical wires.

When EMF derives from different wires that are in close proximity, or adjacent to one another, the size of the net EMF produced will be somewhere in the range between the sum of EMF from the individual sources and the difference of the EMF from the individual sources. EMF may partially add, or partially cancel, but generally, because adjacent wires are often carrying current in opposite directions, the EMF produced tends not to be additive.

EMFs in the home arise from electric appliances, indoor wiring, grounding currents on pipes and ground wires, and outdoor distribution or transmission circuits. Inside residences, typical baseline 60-Hz magnetic fields (away from appliances) range from 0.5-5.0 mG.

Higher 60-Hz magnetic field levels are found near operating appliances. For example, can openers, mixers, blenders, refrigerators, fluorescent lamps, electric ranges, clothes washers, toasters, portable heaters, vacuum cleaners, electric tools, and many other appliances generate magnetic fields of size 40-300 mG at distances of 1 foot (NIEHS, 2002). Magnetic fields from personal care appliances held within half a foot (*e.g.*, shavers, hair dryers, massagers) can produce average fields of 600-700 mG. At school and in the workplace, lights, motors, copy machines, vending machines, video-display terminals, pencil sharpeners, electric tools, electric heaters, and building wiring are all sources of 60-Hz magnetic fields.

2.4 State, National, and International Guidelines for EMFs Are Available

The US has no federal standards limiting occupational or residential exposure to 60-Hz EMF. Table 2.1 shows guidelines suggested by national and world health organizations that are designed to be protective against any adverse health effects. The limit values should not be viewed as demarcation lines between safe and dangerous levels of EMFs, but rather, levels that assure safety with an adequate margin of safety to allow for uncertainties in the science. Table 2.2 lists guidelines that have been adopted by various states in the US. State guidelines are not health-effect based and have typically been adopted to maintain the *status quo* for EMFs on and near transmission line ROWs.

Table 2.1 60-Hz EMF Guidelines Established by Health and Safety Organizations

Organization	Magnetic Field	Electric Field
American Conference of Governmental and Industrial Hygienists (ACGIH) (occupational)	10,000 mG[1] 1,000 mG[2]	25 kV/m[1] 1 kV/m[2]
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (general public, continuous exposure)	**2,000 mG**	**4.2 kV/m**
Non-Ionizing Radiation (NIR) Committee of the American Industrial Hygiene Assoc. (AIHA) endorsed (in 2003) ICNIRP's occupational EMF levels for workers	4,170 mG	8.3 kV/m
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.6 (general public, continuous exposure)	9,040 mG	5.0 kV/m
UK, National Radiological Protection Board (NRPB) (now the Health Protection Agency [HPA])	2,000 mG	4.2 kV/m
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (Draft Standard, December 2006[3])	3,000 mG	4.2 kV/m

Notes:
EMF = Electric and Magnetic Field; kV/m = Kilovolts Per Meter; mG = Milligauss; ROW = Right-of-Way.
(1) The ACGIH guidelines for the general worker (ACGIH, 2015, p. 128-131).
(2) The ACGIH guideline for workers with cardiac pacemakers (ACGIH, 2015, p. 128-131).
(3) ARPANSA (2006, 2008).

Table 2.2 State EMF Standards and Guidelines for Transmission Lines

State	Line Voltage (kV)	Electric Field (kV/m)		Magnetic Field (mG)	
		On ROW	Edge ROW	On ROW	Edge ROW
Florida[1]	69-230	8.0	2.0[2]		150
	500	10.0			200, 250[3]
Massachusetts			**1.8**		**85**
Minnesota		8.0			
Montana		7.0[4]	1.0[5]		
New Jersey			3.0		
New York[3]		11.8 11.0[6] 7.0[4]	1.6		200
Oregon		9.0			

Notes:
EMF = Electric and Magnetic Field; kV/m = Kilovolts Per Meter; mG = Milligauss; ROW = Right-of-Way.
Sources: NIEHS (2002); FLDEP (2008); MAEFSB (2010).
(1) Magnetic fields for winter-normal (*i.e.*, at maximum current-carrying capability of the conductors).
(2) Includes the property boundary of a substation.
(3) 500-kV double-circuit lines built on existing ROWs.
(4) Maximum for highway crossings.
(5) May be waived by the landowner.
(6) Maximum for private road crossings.

3 EMF Modeling

3.1 Software Program Used for Modeling EMFs for Line Cross-sections

The FIELDS computer program, designed by Southern California Edison, was utilized to calculate EMF strengths from the proposed lines. This program operates using Maxwell's equations, which accurately apply the laws of physics as related to electricity and magnetism (EPRI, 1982, 1993). Modeled fields using this program are both precise and accurate for the input data utilized. Results of the model have been checked extensively against each other and against other software (*e.g.*, CORONA, from the Bonneville Power Administration, US Dept. of Energy) to ensure that the implementation of the laws of physics are consistent. In these validation tests, program results for EMFs were found to be in very good agreement with each other (Mamishev and Russell, 1995).

3.2 Power-line Loads

Magnetic fields produced by the proposed lines were modeled using line loadings communicated by Eversource (Leonard, 2016). The current per phase satisfies the relationship:

(Eq. 3.1) $$S = \sqrt{3} \times V \times I_{phase}$$

where:

S	=	The power in kilovolt-amps (kVA)
V	=	The line voltage in kilovolts (kV)
I_{phase}	=	The current per phase in amperes (A)

Thus, the current per phase conductor is:

(Eq. 3.2) $$I_{phase} = \frac{S}{\sqrt{3} \times V}$$

Real power is given in megawatts (MW) (P), and apparent power in megavolt-amps (MVA) (S).[2] To convert between power quoted in MW to MVA, one must divide by the power factor.

Both Without-Project and With-Project transmission line electric current and voltage values provided by Eversource are summarized in Table 3.1 for the two circuits by load scenario (Leonard, 2016).

[2] MVA is apparent power and is the vector sum of real (active) and imaginary (reactive) power. MW and MVA are not the same unless power factor = 1.0, which, in a practical AC circuit, is generally not the case.

Table 3.1 Modeled Without-Project and With-Project Electric Current (A) and Voltages (kV) by Load Scenario for West Roxbury to Needham 115-kV Transmission Lines

Load Scenario	110-522 (115-kV)				240-510 (115-kV)			
	Electric Current (A)		Electric Voltage (kV)		Electric Current (A)		Electric Voltage (kV)	
	Without-Project	With-Project	Without-Project	With-Project	Without-Project	With-Project	Without-Project	With-Project
Average 2018 load level	199	212	118.9	119	200	192	118.9	119
Non-emergency summer peak 2018 load level	432	458	118.0	118.1	428	412	118.0	118.1

Notes:
A = Amperes; kV = Kilovolt.
(1) Direction of current flow is from Needham Tap to Baker Street Substation for both lines and load scenarios.

3.3 EMF Modeling for the Without-Project and With-Project Circuits

For the existing overhead 110-522 and 240-510 115-kV circuit configuration in ROW #3, Gradient modeled electric and magnetic fields expected to exist 3 feet (~1 meter) above the ground surface for a single representative cross-section with the conductor configurations and phasings depicted in Appendix B and under the 2018 projected loading scenarios described above. Although there is some variation in the location depicted for the ground wire on the existing double-circuit towers (*e.g.*, northern side of tower, southern side of tower, middle of tower – *i.e.*, dead end on pole), the model assumed that it is located in the middle, at the highest point of the support tower for the EMF modeling.

EMF modeling was also conducted for three cross-sections selected to represent different overhead line segments corresponding to possible With-Project transmission line configurations:

1. East of Gardner Street Cross-section, which represents the segment where Line 110-522 remains in service on the existing double-circuit towers, and Line 240-510 is moved to a newly constructed set of steel monopoles (see Proposed Construction – East of Gardner Street figure in Appendix B);
2. West of Gardner Street/East of Valley Road cul-de-sac Cross-section, which represents the segment where Line 240-510 remains in service on the existing double-circuit towers, and Line 110-522 is moved to a newly constructed set of steel monopoles (see Proposed Construction – West of Gardner Street figure in Appendix B); and
3. West of Valley Road cul-de-sac Cross-section, which represents the segment where Line 110-522 has been taken out of service due to the new underground routing for this circuit that begins at this location, and only Line 240-510 remains in service on the existing double-circuit towers (with the same conductor configuration and phasings as per the Proposed Construction – West of Gardner Street figure in Appendix B).

For each Without-Project and With-Project cross-section, a cross-sectional view of EMF strengths was modeled as a function of distance perpendicular to the direction of current flow along a segment of the route where the transmission line runs straight. Variation in the height of the nearby grade along ROW #3 was not accounted for given the general Eversource policy to model EMF for the most

conservative location of lowest conductor sag (*i.e.*, closest to the ground surface); for 115-kV transmission lines, this corresponds to 30 feet above the ground for the lowest conductors (Bodkin, 2015). Given variability in the location of the ROW edges for the overhead line segments, EMF levels were modeled out to 200 feet on either side of the existing double-circuit tower. Ranges for edge-of-ROW EMFs correspond to maximum and minimum locations of the northern and southern edges of ROW #3 that were based on an existing conditions survey plan prepared by VHB Associates, Inc.

EMF modeling of the proposed underground 115-kV circuit included calculation of magnetic fields levels expected to exist 3 feet (~1 meter) above the ground surface per standard industry practices (IEEE Power Engineering Society, 1995a,b) for the loading scenarios described above. Eversource provided Gradient with proposed conductor configuration schematics as well as circuit specifications (select drawings are included as Appendix C to this report). The 115-kV transmission line conductors are within three 8-inch diameter ducts depicted below in Figure 3.1, which shows them in an inverted-delta (∇) arrangement (note that the fourth duct shown in Figure 3.1 is a spare duct). The vertical and horizontal spacing between the centerline of the conductors is 14 inches (additional details are shown in Appendix C).

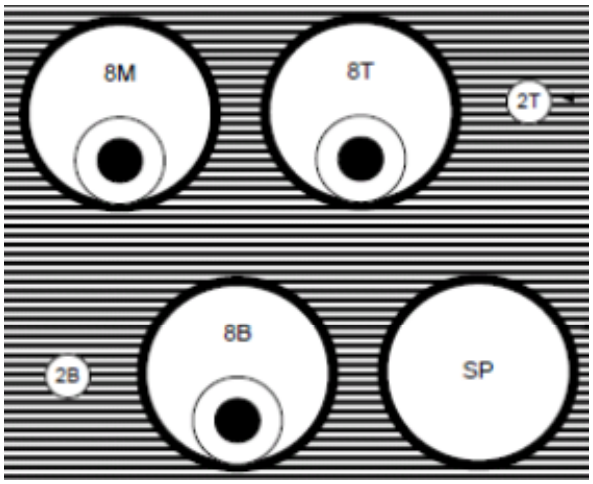

Figure 3.1 The Inverted-Delta Configuration of the Underground, 115-kV Conductors, Inside 7.27" ID, HDPE Pipes Having 0.639" Walls

The configuration of the conductors while passing through a splice vault is shown in Figure 3.2. This figure, which was taken from the detailed schematic in Appendix C, shows the conductors arranged vertically above each other, with a separation of 2 feet.

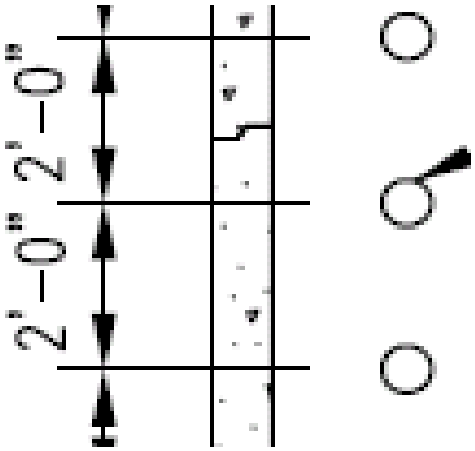

Figure 3.2 Vertical Configuration of the Individual Phase Conductors (Circles on the Right) During Their Travel Through the Splice Vault/ Manhole Section

3.4 EMF Modeling Results

3.4.1 Magnetic Field Modeling Results for Overhead Line Cross-sections

Detailed results of the magnetic field modeling for the Without-Project and With-Project overhead transmission line cross-sections are summarized in Table 3.2 and Figures 3.3-3.5. As reflected in this table and the figures, With-Project magnetic field values for the overhead transmission line cross-sections all fall below the health-based guideline of the ICNIRP for continuous public exposure to magnetic fields (2,000 mG; ICNIRP, 2010), both at the ROW edges and within ROW #3. Moreover, both the table and figures show that With-Project within-ROW maximum magnetic field values are less than the corresponding Without-Project within-ROW maximum value for each of the three cross-sections. Specifically, for the non-emergency summer peak 2018 load level modeling scenario, the With-Project within-ROW maximum magnetic field values ranged from 37.4-53.1 mG for the three overhead line cross-sections, as compared to the Without-Project within-ROW maximum magnetic field value of 67.8 mG. Similarly, for the average 2018 load level modeling scenario, the With-Project within-ROW maximum magnetic field values ranged from 17.4-24.6 mG for the three overhead line cross-sections and were thus less than the Without-Project within-ROW maximum magnetic field value of 31.5 mG.

Figures 3.3-3.5 show the ranges in the locations of the southern and northern ROW #3 edges for the three overhead line cross-sections. With-Project magnetic field values are frequently reduced as compared to Without-Project values at the edges of the ROW, with only slightly increased With-Project magnetic field values along the southern ROW edge for just one of the three overhead line segments (the West of Gardner Street/East of Valley Road cul-de-sac line segment due to the installation of the new steel monopoles with the relocated Line 110-522 circuit to the south of the existing towers in this segment) and along the northern ROW edges for just one of the three overhead line segments (the East of Gardner Street line segment due to the installation of the new steel monopoles with the relocated Line 240-510 circuit to the north of the existing towers in this segment). In all other instances, With-Project magnetic field values are reduced at the ROW edges as compared to Without-Project magnetic field values.

Table 3.2 Modeled Peak Edge-of-ROW and Within-ROW Magnetic Field Values for Each Overhead Cross-section and Load Scenario

Load Scenario	Cross Section/ Route Segment	Southern Edge-of-ROW Magnetic Field (mG)[1]		Northern Edge-of-ROW Magnetic Field (mG)[1]		Within-ROW Maximum Magnetic Field (mG)	
		Without-Project	With-Project	Without-Project	With-Project	Without-Project	With-Project
Non-emergency summer peak 2018 load level	East of Gardner St.	8.6-9.5	8.4-9.2	5.2-35.1	6.1-42.5	67.8	52.2
	West of Gardner St./ East of Valley Road cul-de-sac	8.2-23.9	10.3-31.9	3.7-8.8	3.6-8.3	67.8	53.1
	West of Valley Road cul-de-sac	6.3-64.5	2.7-29.3	2.8-18.7	1.4-10.6	67.8	37.4
Average 2018 load level	East of Gardner St.	4.0-4.4	3.9-4.3	2.4-16.3	2.9-19.8	31.5	24.2
	West of Gardner St./ East of Valley Road cul-de-sac	3.8-11.1	4.8-14.8	1.7-4.1	1.7-3.9	31.5	24.6
	West of Valley Road cul-de-sac	2.9-29.9	1.3-13.6	1.3-8.7	0.7-4.9	31.5	17.4

Notes:
mG = Milligauss; ROW = Right-of-Way.
(1) Ranges are provided to reflect the range in the locations of the southern and northern ROW edges for the different route segments.

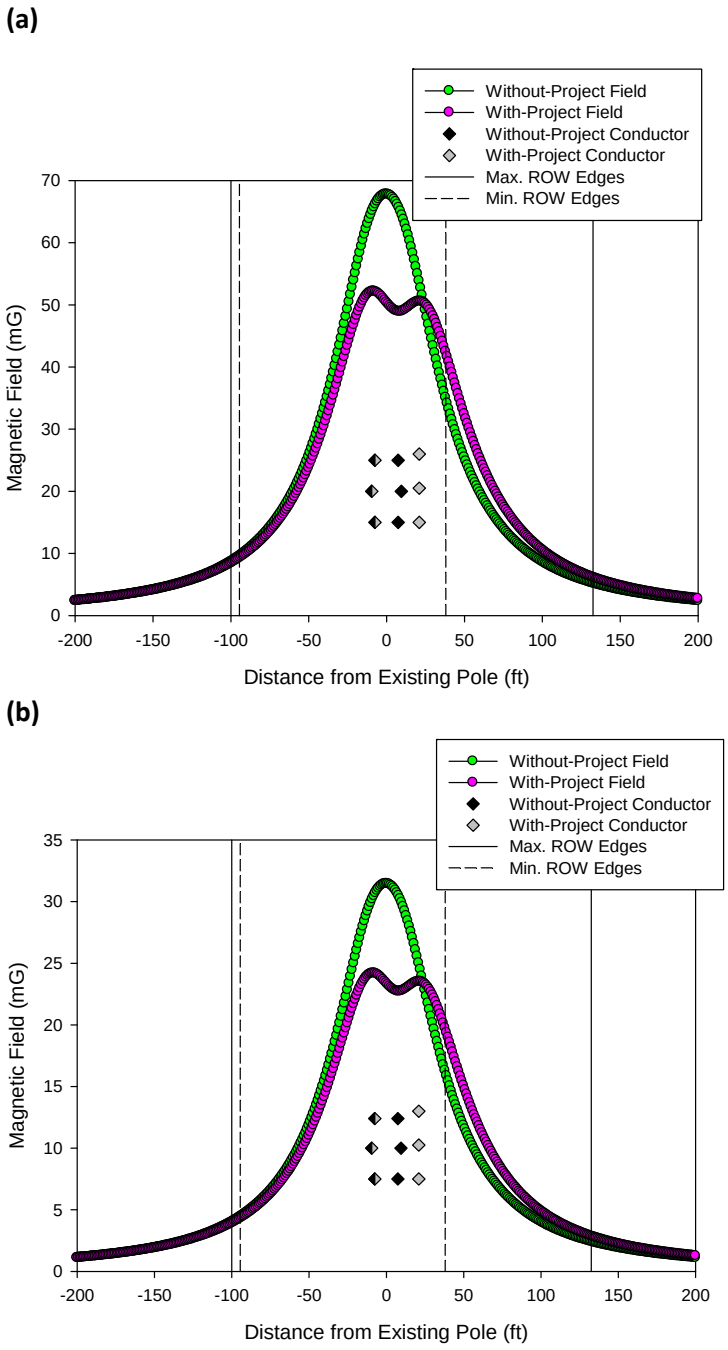

Figure 3.3 East of Gardner Street ROW Cross-section Magnetic Field Values at Projected Non-emergency Summer Peak 2018 Load Level (Panel a) and Average 2018 Load Level (Panel b). The view is to the west towards the Needham Substation, with the cross-section being shown perpendicular to the directions of electric current. The Transmission Line 110-522 conductors are shown on the far left (black and gray diamonds), and the relocated Transmission Line 240-510 conductors are shown on the far right (gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment.

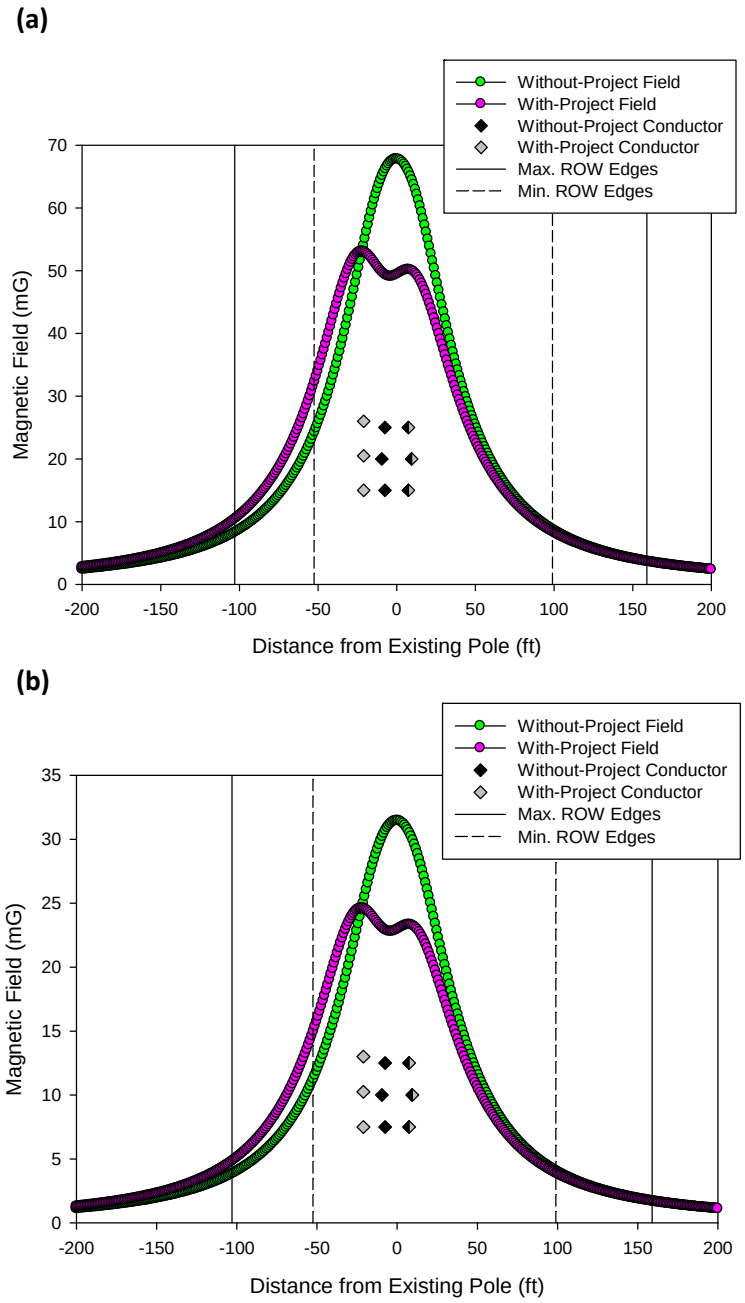

Figure 3.4 West of Gardner Street/East of Valley Road Cul-de-sac ROW Cross-section Magnetic Field Values at Projected Non-emergency Summer Peak 2018 Load Level (Panel a) and Average 2018 Load Level (Panel b). The view is to the west towards the Needham Substation, with the cross-section being shown perpendicular to the directions of electric current. The Transmission Line 240-510 conductors are shown on the far right (black and gray diamonds), and the relocated Transmission Line 110-522 conductors are shown on the far left (gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment.

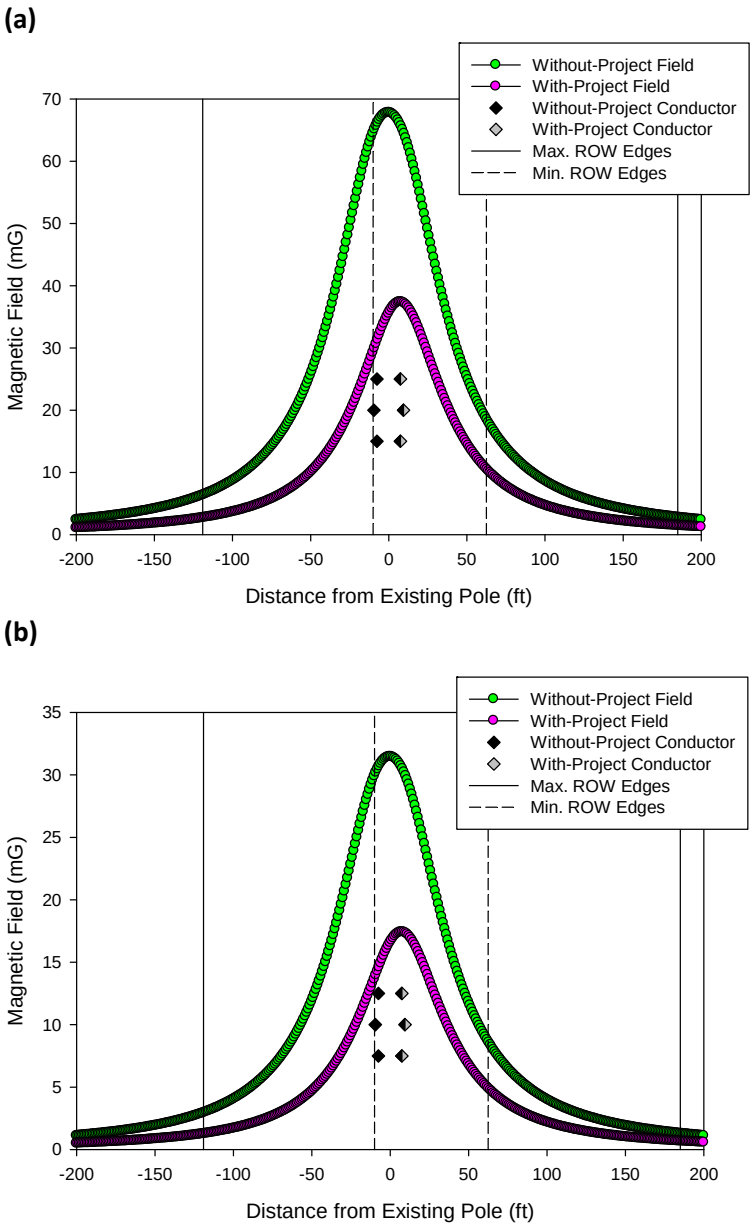

Figure 3.5 West of Valley Road Cul-de-sac ROW Cross-section Magnetic Field Values at Projected Non-emergency Summer Peak 2018 Load Level (Panel a) and Average 2018 Load Level (Panel b). The view is to the west towards the Needham Substation, with the cross-section being shown perpendicular to the directions of electric current. The existing Transmission Line 110-522 conductors that are to be taken out of service are shown on the far left (black diamonds), while the Transmission Line 240-510 conductors are shown on the far right (black and gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment.

3.4.2 Magnetic Field Modeling Results for Underground Line Segments

The graphs in Figures 3.6 and 3.7 plot the magnetic field *versus* horizontal distance from centerline, both for the standard inverted-delta (∇) underground conductor configuration, and for the vertical conductor configuration in splice vault/manhole sections. In both cases, all modeled magnetic field values fall well below the ICNIRP health-based guidelines for public exposure to EMF (2,000 mG, see Section 2, Table 2.1).

Both graphs show that magnetic field values decrease rapidly with lateral distance from the lines. At the non-emergency summer peak 2018 loading, the maximum modeled magnetic field value generated by the proposed underground line was 71 mG, falling to 7.8 mG at a horizontal distance of ±20 feet away from the centerline of the conductors. At peak load, in the vicinity of manhole/splice vault sections, the maximum magnetic field value was 98.6 mG, falling to 20 mG at a horizontal distance of ±20 feet away from the centerline of the conductors. At annual average load, the maximum modeled magnetic field value for the majority of the line length (for the ∇ configuration) was 33 mG, falling to 3.6 mG at ±20 feet; for the vertical conductor configuration in the splice vaults, the corresponding maximum modeled magnetic field was 46 mG, falling to 9 mG at ±20 feet from the centerline of the conductors. Underground lines produce no above-ground electric fields, so no electric field model results are provided.

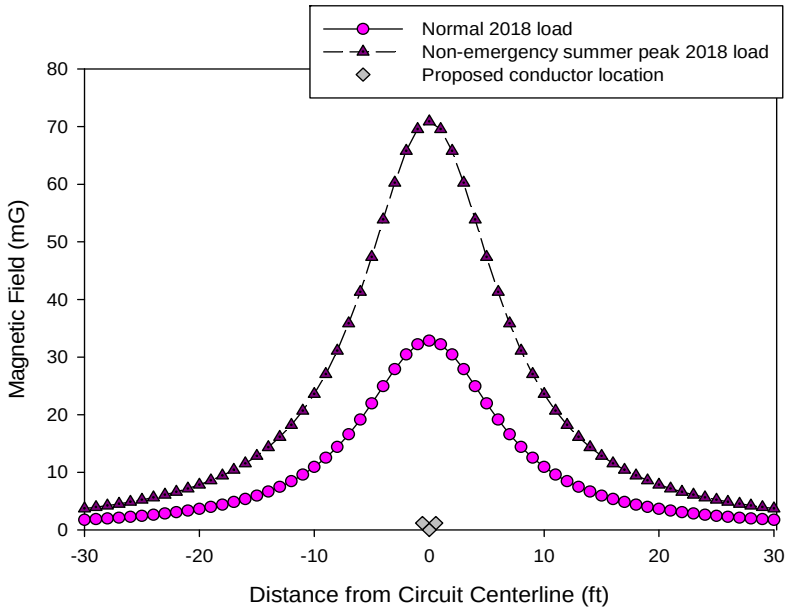

Figure 3.6 Magnetic Field *versus* Lateral Distance from the Centerline of the Conductors (x = 0 ft) for the Proposed Underground Line 110-522 Conductors at Projected Non-emergency Summer Peak 2018 Load Level (Purple Triangles) and Average 2018 Load Level (Pink Circles)

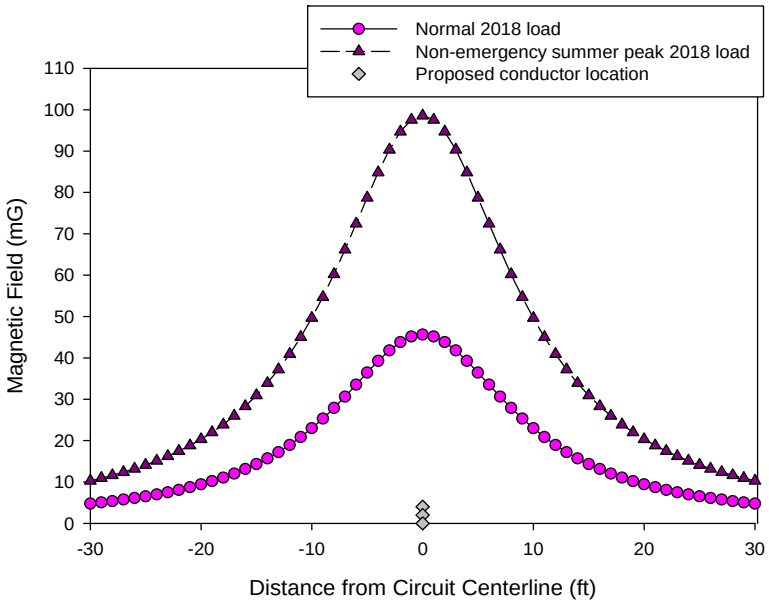

Figure 3.7 Magnetic Field *versus* Lateral Distance from the Centerline of the Conductors (x = 0 ft) for the Vertical Configuration of the Proposed Line 110-522 Underground Conductors at Projected Non-emergency Summer Peak 2018 Load Level (Purple Triangles) and Average 2018 Load Level (Pink Circles)

3.4.3 Electric Field Modeling Results for Overhead Line Cross-sections

Because the electric field is dependent on voltage and the spatial configuration of the conductors, and has little dependence on load, there are only six unique electric field profiles: Without-Project and With-Project for the East of Gardner Street cross-section, Without-Project and With-Project for the West of Gardner Street/East of Valley Road cul-de-sac cross-section, and Without-Project and With-Project for the West of Valley Road cul-de-sac cross-section.[3] Results of the electric field modeling are summarized in Table 3.3 and Figures 3.8-3.10.

[3] The minor differences in voltages shown for the two loading scenarios in Table 3.1 will only result in negligible differences in electric fields for the two loading scenarios.

Table 3.3 Modeled Peak Edge-of-ROW and Within-ROW Electric Field Values by Overhead Cross-section

Cross Section/ Route Segment	Location	Without-Project Electric Field (kV/m)[1]	With-Project Electric Field (kV/m)[1]
East of Gardner Street	Southern Edge-of-ROW	0.10-0.11	0.091-0.094
	Northern Edge-of-ROW	0.08-0.39	0.04-1.11
	Within-ROW Maximum	2.63	2.23
West of Gardner Street/ East of Valley Road cul-de-sac	Southern Edge-of-ROW	0.03-0.11	0.04-0.40
	Northern Edge-of-ROW	0.06-0.10	0.05-0.09
	Within-ROW Maximum	2.63	2.23
West of Valley Road cul-de-sac	Southern Edge-of-ROW	0.03-2.29	0.05-0.95
	Northern Edge-of-ROW	0.05-0.11	0.03-0.07
	Within-ROW Maximum	2.63	1.58

Notes:
kV/m = Kilovolts Per Meter; ROW = Right-of-Way.
(1) Ranges are provided for the ROW edges to reflect the range in the locations of the southern and northern ROW edges for the different route segments.

Similar to the magnetic field results, all modeled pre- and With-Project within-ROW maximum electric field values are well below the health-based guideline of the ICNIRP for continuous public exposure to electric fields of 4.2 kV/m (ICNIRP, 2010). In addition, the electric field modeling results show that the With-Project within-ROW maximum electric fields are reduced as compared to the Without-Project within-ROW maximum electric fields.

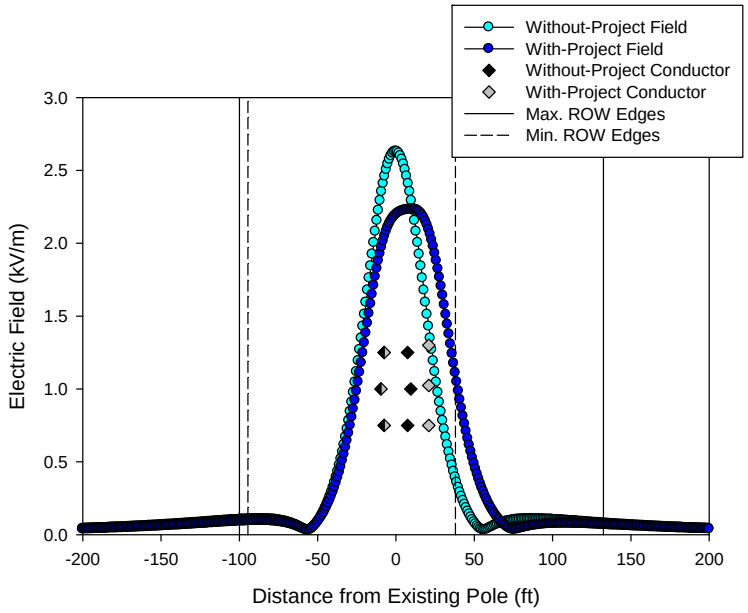

Figure 3.8 East of Gardner Street ROW Cross-section Electric Field Values. The view is to the west towards the Needham Substation, with the ROW cross-section being shown perpendicular to the directions of electric current. The Transmission Line 110-522 conductors are shown on the far left (black and gray diamonds), and the relocated Transmission Line 240-510 conductors are shown on the far right (gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment.

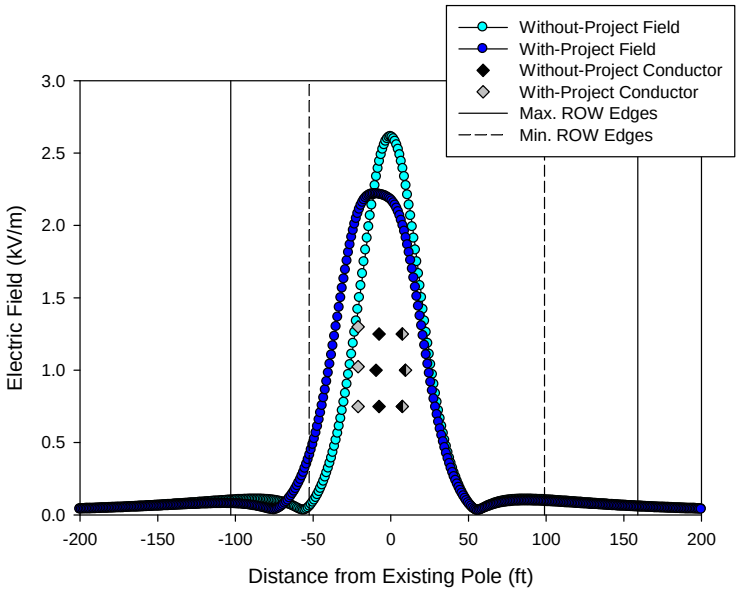

Figure 3.9 West of Gardner Street/East of Valley Road Cul-de-sac ROW Cross-section Electric Field Values. The view is to the west towards the Needham Substation, with the ROW cross-section being shown perpendicular to the directions of electric current. The Transmission Line 240-510 conductors are shown on the far right (black and gray diamonds) and the relocated Transmission Line 110-522 conductors are shown on the far left (gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment

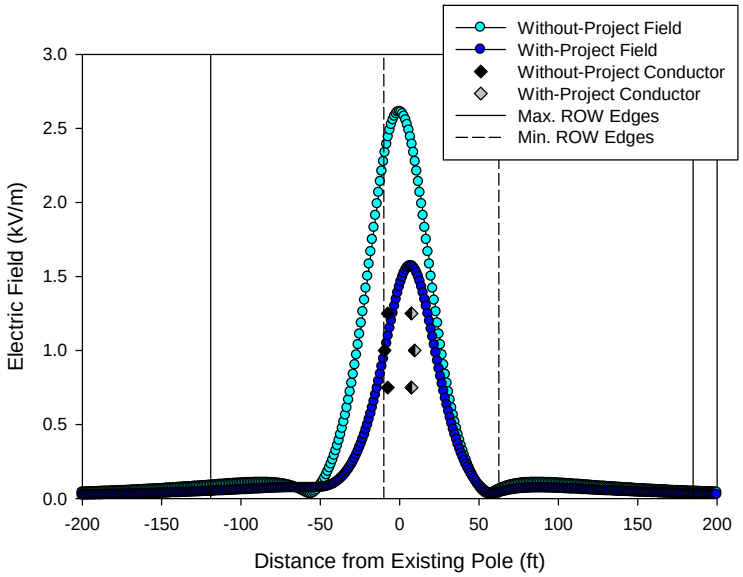

Figure 3.10 West of Valley Road Cul-de-sac ROW Cross-section Electric Field Values. The view is to the west towards the Needham Substation. The existing Transmission Line 110-522 conductors that are to be taken out of service are shown on the far left (black diamonds), and the Transmission Line 240-510 conductors are shown on the far right (black and gray diamonds). The centerline of the existing ROW #3 tower has been set at x = 0, and the vertical solid and dashed lines indicate the maximum and minimum locations of the ROW edges, respectively, for this line segment.

4 Conclusions

Using the FIELDS model, Gradient calculated the EMF levels at 3 feet (~1 meter) above the ground surface for representative cross-sections of overhead 115-kV transmission lines between the Baker Street Substation and the Needham Substation for the present-day circuit configuration and post-project circuit configurations, and for typical cross-sections of the proposed 115-kV underground conductors to be installed between the Valley Road area in Needham and the Needham Substation. EMF modeling was performed using projected non-emergency summer peak and average transmission line loadings provided by Eversource for the year 2018, which is the expected in-service date for the project. As discussed above, the maximum modeled electric and magnetic field levels predicted within and at the edges of ROW #3, as well as the maximum magnetic field levels predicted above the proposed underground circuits, all fall well below accepted health-based guidelines for allowable public exposure to electric and magnetic fields (4.2 kV/m and 2,000 mG, respectively; ICNIRP, 2010).

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Appendix A

Plan View Candidate Route Map for the West Roxbury to Needham Reliability Project (from Epsilon, 2015)

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Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

LEGEND

- MBTA Commuter Rail Station
- MBTA/Eversource ROW #3 (Common Overhead Segment) (1.59 miles)
- Preferred Route (2.55 miles)
- Preferred Route Variations
- Noticed Alternative Route (2.92 miles)
- Town/City Boundary

Scale 1:18,000
1 inch = 1,500 feet

0 750 1,500 Feet

Basemap: 2013 Orthophotography, MassGIS

Warren Street Variation (0.36 miles)

Valley Road Variation (0.62 miles)

Needham Substation Access Variation (0.16 miles)

Needham Station 148

Baker Street Station 110

NEEDHAM

NEWTON

BOSTON

DEDHAM

Needham Center

Needham Junction

Hersey

West Roxbury to Needham Reliability Project

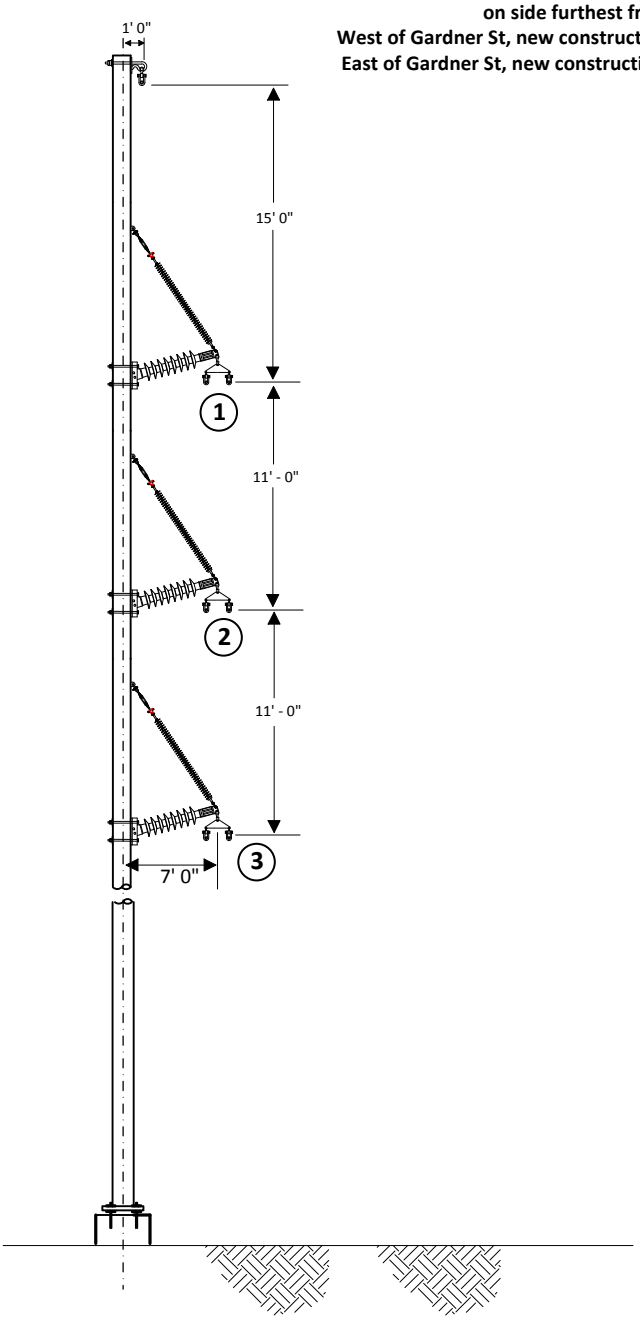
EVERSOURCE

Figure 1-2
Aerial Locus Map

Appendix B

West Roxbury to Needham Reliability Project Overhead Tower Outlines and Configurations

Proposed construction for line to be split off, will be installed on side furthest from tracks
West of Gardner St, new construction will be on line 110-522
East of Gardner St, new construction will be on line 240-510



Conductor – 954 kcmil AAC, 37, "Magnolia", two subconductors per phase
Subconductor spacing 18"; conductor diameter 1.124"

Static Wire – OPGW, diameter 0.512"

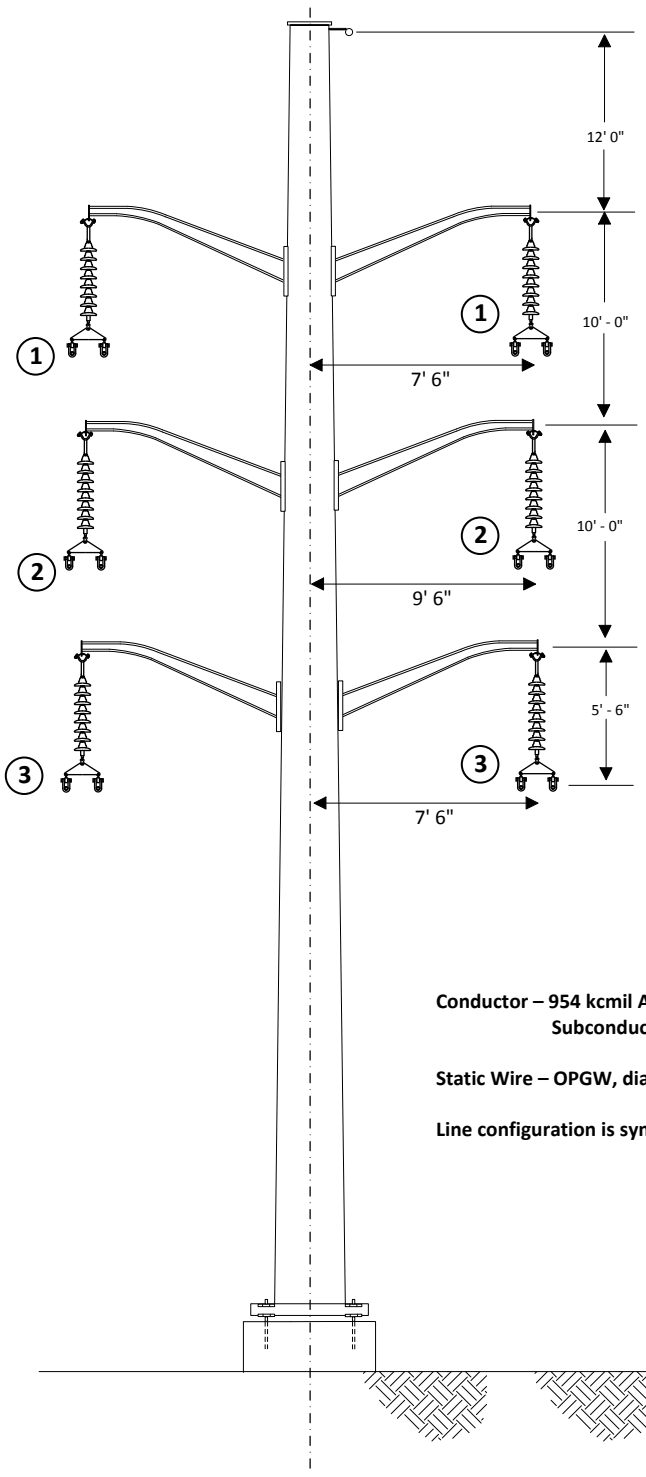
EVERSOURCE ENERGY

Baker to Needham DCT Split
Configuration of Proposed New Line
For EMF and Permitting Only

View is looking west toward Needham

Line 110-522

Line 240-510



Conductor – 954 kcmil AAC, 37, "Magnolia", two subconductors per phase
Subconductor spacing 18"; conductor diameter 1.124"

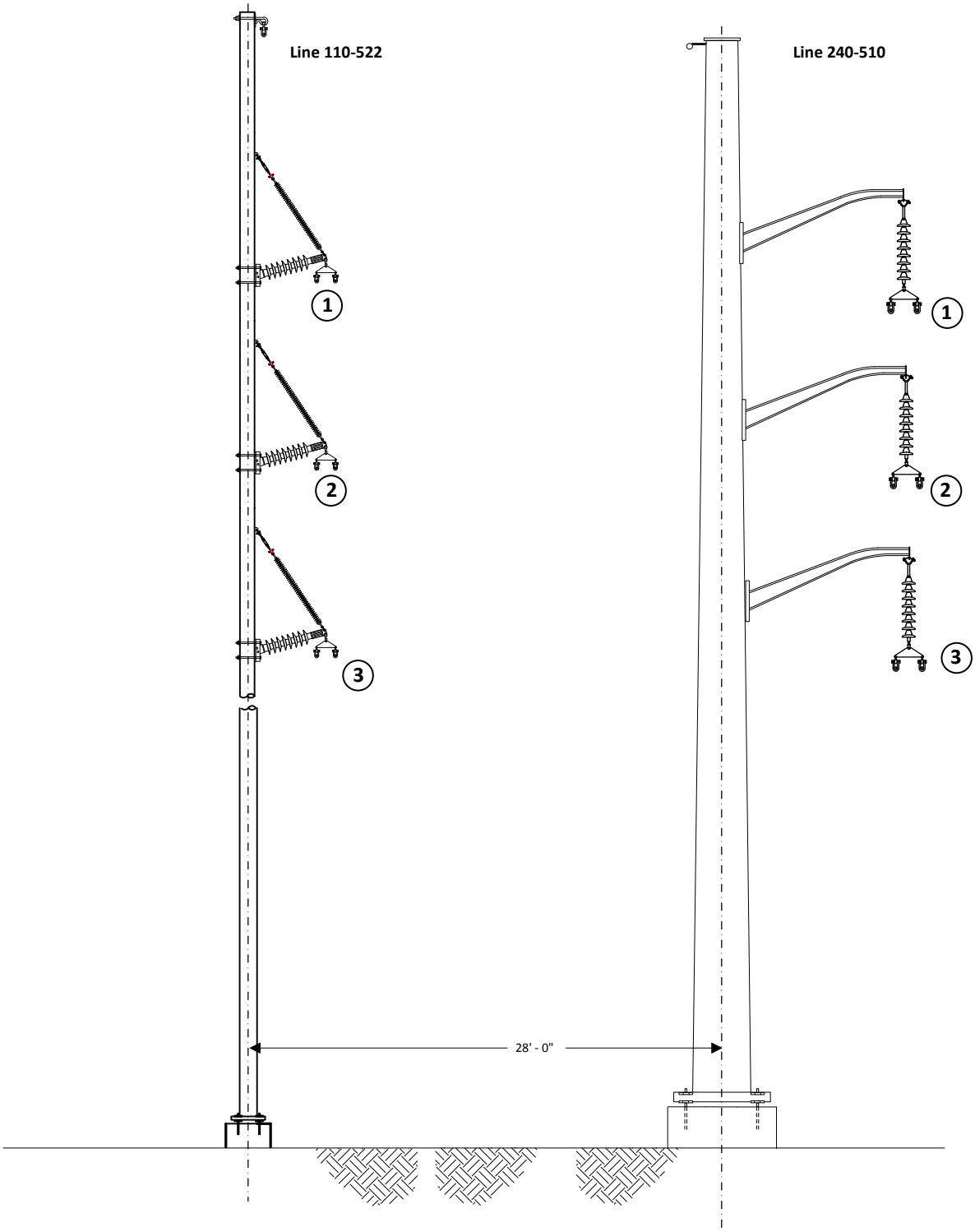
Static Wire – OPGW, diameter 0.646"

Line configuration is symmetrical on both sides

EVERSOURCE ENERGY

Baker to Needham DCT Split
Configuration of Existing Lines
For EMF and Permitting Only

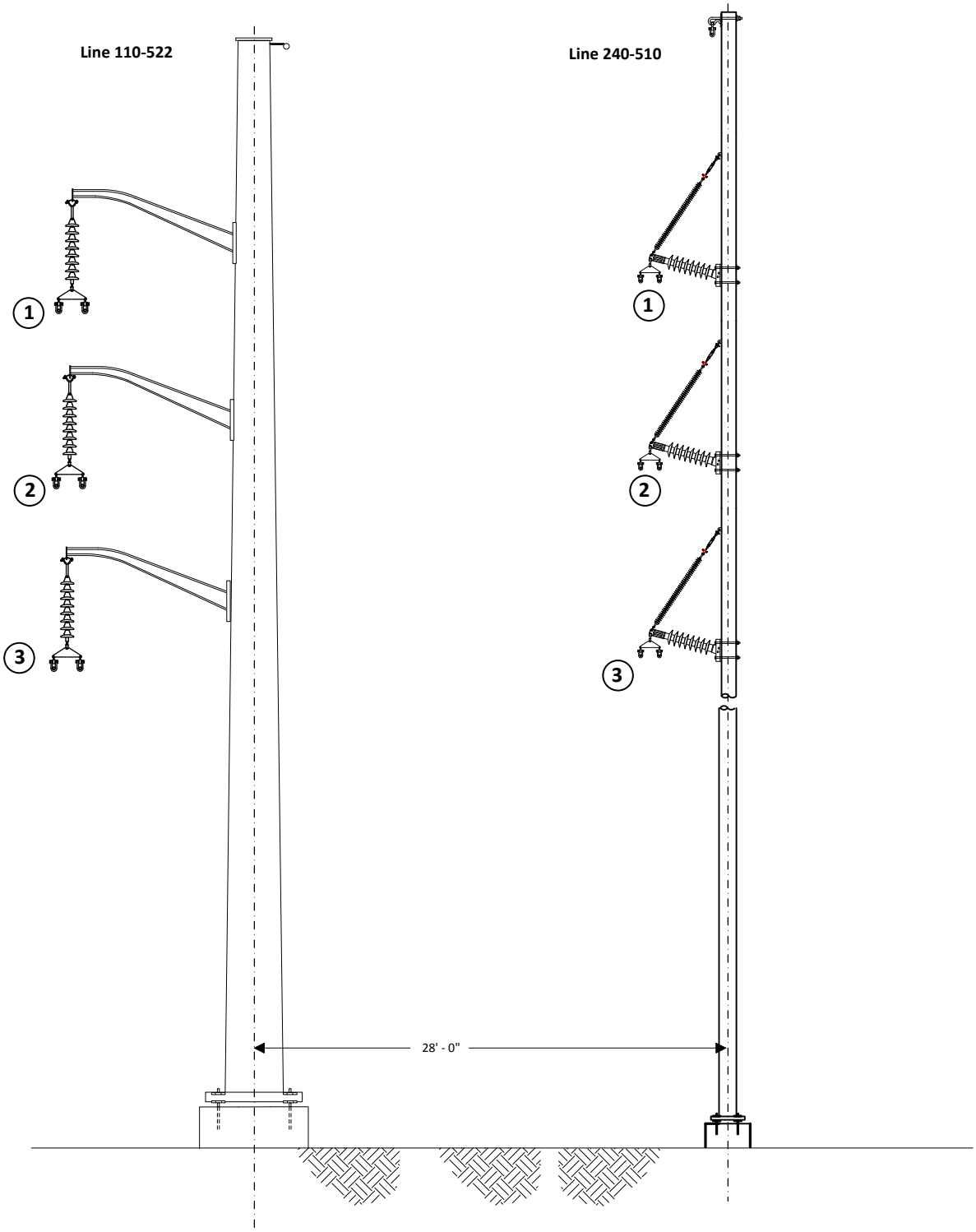
View is looking west toward Needham



EVERSOURCE ENERGY

Baker to Needham DCT Split
Proposed Construction – West of Gardner Street
For EMF and Permitting Only

View is looking west toward
Needham

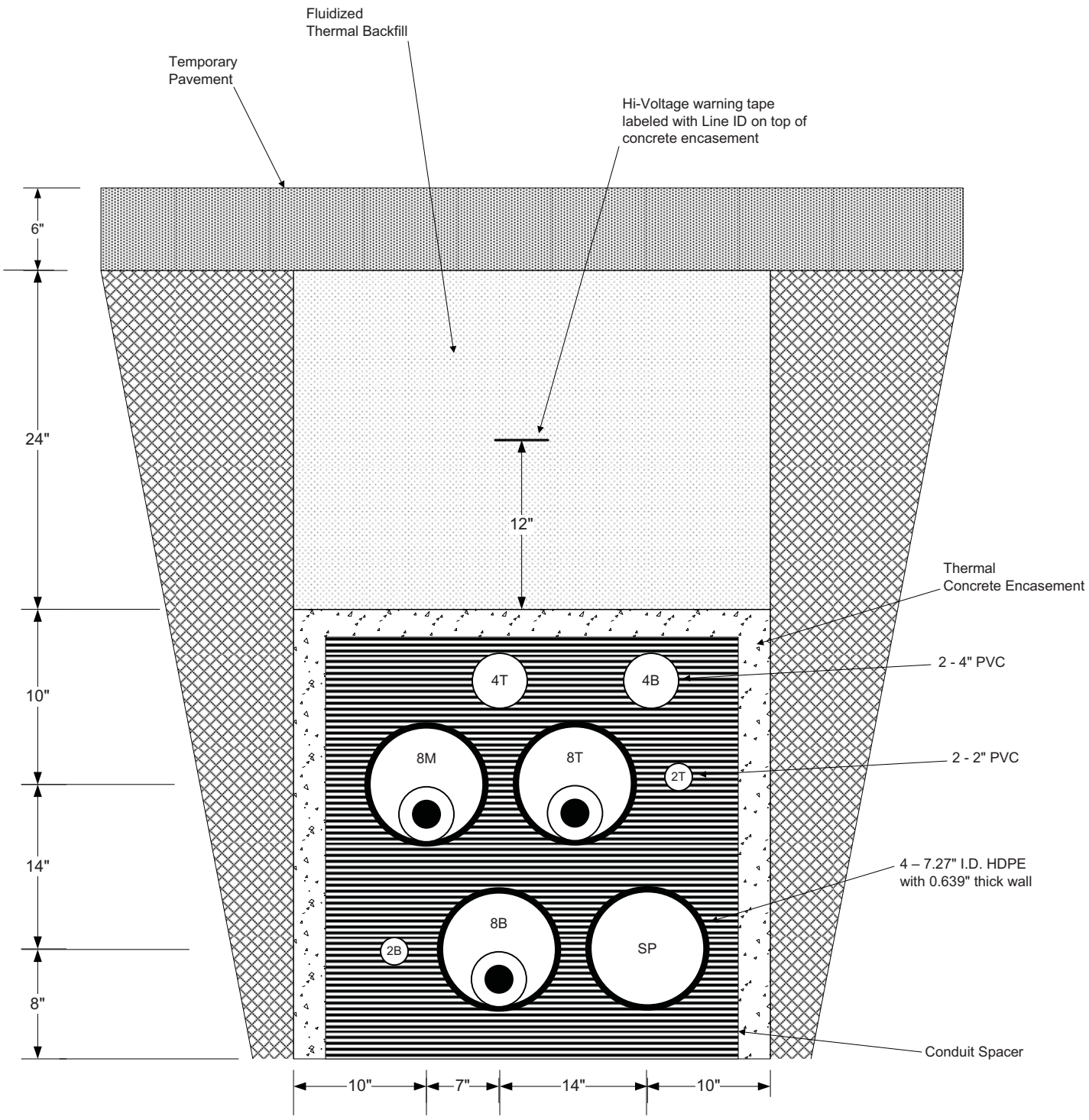


EVERSOURCE ENERGY

Baker to Needham DCT Split
Proposed Construction – East of Gardner Street
For EMF and Permitting Only

Appendix C

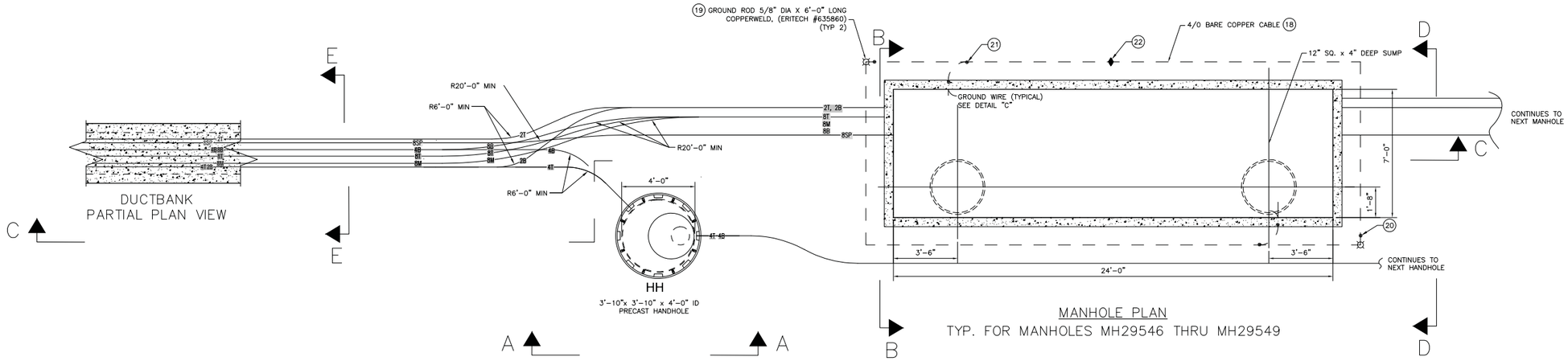
Cross-sections of West Roxbury to Needham Reliability Project Underground 115-kV Transmission Line Duct Bank and Manhole Sections

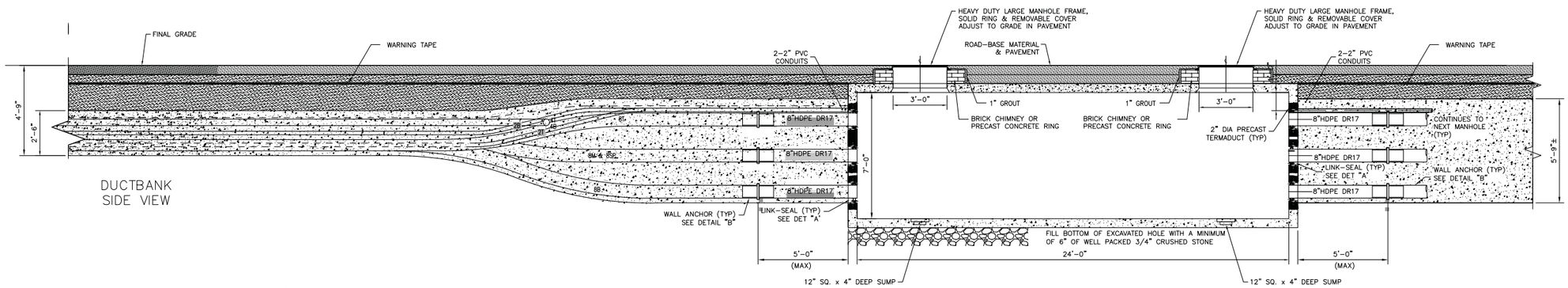


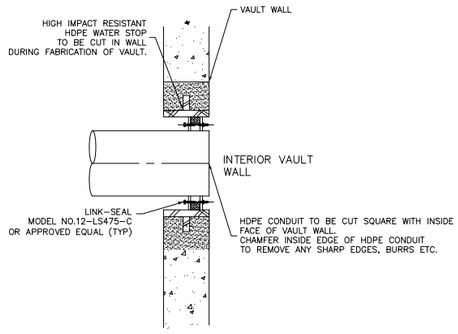
NOTE: Not to Scale

0	XX/XX/XX	Issued
Rev.	Date	Description

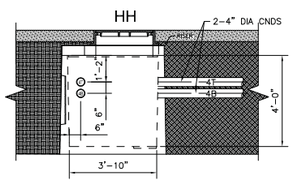
	115 KV / 345 KV XLPE Cross Section	Appendix XX Rev 0 Sheet X of X



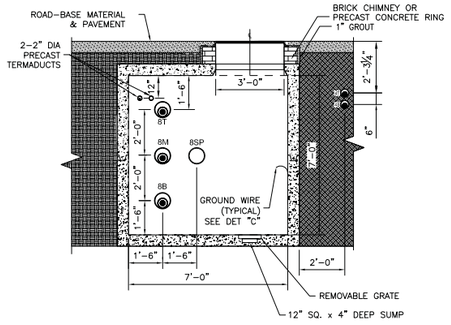




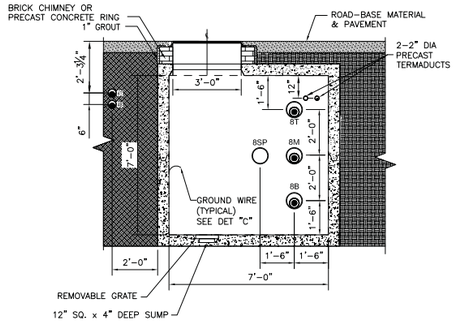
LINK-SEAL DETAIL "A"
N.T.S



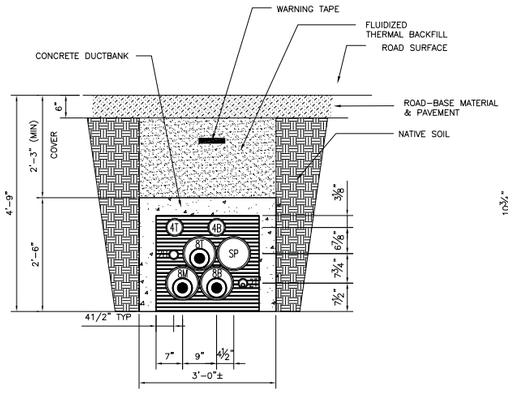
SECTION A-A
TYP. FOR HANDHOLES HH29546 THRU HH29549



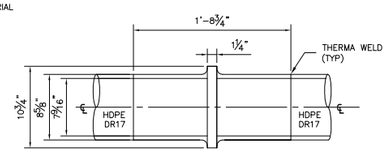
SECTION B-B
TYP. FOR MANHOLES MH29546 THRU MH29549



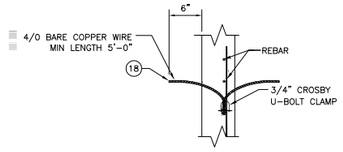
SECTION D-D
TYP. FOR MANHOLES MH29546 THRU MH29549



SECTION E-E
(4-8", 2-4" & 2-2" DUCTS)
N.T.S



WALL ANCHOR DETAIL "B"
PERFORMANCE TYPE F08-WA APPROVED EQUAL
N.T.S



GROUND WIRE DETAIL "C"
N.T.S

GROUNDING LEGEND

- 4/0 BARE COPPER GROUND CABLE
- 3/4"-6'-0"L COPPER CLAD GROUND ROD. CADWELD CONNECTION GTC189F (100)
- HORIZONTAL TEE CONNECTION RUN-19#9, TAP-19#9. CADWELD TAC9F9F (101)
- PARALLEL CONNECTION RUN-19#9, TAP-19#9 CADWELD PTC9F9F (104)

GROUNDING NOTES

1. REFER TO GROUNDING MATERIAL LIST FOR MORE INFORMATION OF MATERIAL ITEM NUMBERS.

CONDUIT LEGEND:

8T - NUMERAL DENOTES SIZE & LETTER INDICATES DESIGNATION OF CND; TOP, MIDDLE & BOTTOM ROW.

0 2' 4' 6' 8'
SCALE: 3/8"=1'-0"
VERIFY, PRINT MAY HAVE BEEN REDUCED

NOTES:

1 DESIGN OF DUCT BANK IS BASED ON CLEAN AND STRUCTURALLY SOUND IN SITU CONDITIONS. IF ACTUAL CONDITIONS ARE DIFFERENT, CONTRACTOR SHALL NOTIFY ENGINEER TO DEVELOP APPROPRIATE MITIGATION PLAN.

2. LOCATION OF EXISTING UNDERGROUND UTILITIES IS BASED ON AVAILABLE INFORMATION. IN THE EVENT THAT OBSTACLES ARE ENCOUNTERED, CONTRACTOR SHALL NOTIFY ENGINEER TO DEVELOP APPROPRIATE MITIGATION PLAN.

3. DIG SAFE TO BE NOTIFIED PRIOR TO START OF CONSTRUCTION.

REV.	DATE	DESCRIPTION
B	9/19/12	REVISED SECTION E-E
A	9/10/12	95% IFR

VANDERWEIL POWER GROUP
R.G. Vanderweil Engineers, LLP
274 Summer Street
Boston, MA 02210
617.423.7423 TEL
617.423.7401 FAX
vanderweil.com

RGV Job No. 26991	Sheet 1 of 1
Drawn by: JA	
Checked by: AJM	
Date of Original: 9/4/12	
Scale: 3/8"=1'-0"	
Project	

Title

345kV TRENCH MANHOLE SECTIONS AND DETAILS

E-001

From: Kate Fitzpatrick
Sent: Thursday, November 10, 2016 1:53 PM
To: Timothy McDonald
Subject: FW: Eversource Update

Kate

Kate Fitzpatrick
Town Manager
Town Hall
1471 Highland Avenue
Needham, MA 02492
Tel: 781-455-7500 extension 0
Fax: 781-449-4569

Live, Work, Play, Needham

Follow us on Twitter: @TownofNeedham

Like us on Facebook: Town of Needham

From: Maurice Handel [mailto:maurice.handel@icloud.com]
Sent: Thursday, November 10, 2016 6:26 AM
To: Claire Fialkov
Cc: Kate Fitzpatrick
Subject: Re: Eversource Update

Claire, I am copying the Town Manager with this note so that it can be forwarded to the Board of Health along with your petition.

Moe

On Nov 9, 2016, at 11:55 PM, Claire Fialkov <Claire_Fialkov@williamjames.edu> wrote:

Hi Moe,

I just heard from Anne Weinstein that there is a hearing tomorrow night about the health risks from the Eversource project. Unfortunately, I am in Florida until Friday evening and did not know about the hearing until today.

In addition to the evidence that is on both sides of the health (mostly childhood leukemia and breast cancer) issues, I would like to offer a perspective on the impact of anxiety on residents walking on streets with the high voltage below. There is evidence that believing that there is a danger increases anxiety and concern for residents, especially parents about their children. Given that the National Institute for Health is still investigating, and direct causality difficult to prove in environmental/ medical research, it is doubtful that the Town of Needham will be in a position to resolve the global scientific debate on the impact of underground high voltage wires. To that end, a much simpler question is: *Why increase the anxiety of residents by placing the wiring under walk-able streets? Why not place it only on routes with no sidewalks?* This seems like a win-win solution. A price increase to the Eversource project is the cost of possible reduced risk of childhood leukemia and breast cancer, and definite reduced anxiety and fear coupled with increased well-being in our community.

I would appreciate it if these ideas might be represented at tomorrow's meeting. Thank you.

I am attaching our neighborhood's Petition to Participate (FYI)

Claire

Claire Fialkov, Ph.D.
Associate Professor, Clinical Psychology William James College
One Wells Avenue, Newton, MA 02459
617-462-3131 – www.williamjames.edu

On Oct 11, 2016, at 11:07 AM, Maurice Handel wrote:

Hi Claire.

The Town has fled for Intervener Status. Qe have also gotten confirmation that the Siting Board will take comments from interested parties throughtout the process.

Moe

<EFSB 16-02D.P.U 16-77 - Fialkov Petition.pdf>

M. Kathryn Sedor, Esq.
Presiding Officer
Energy Facilities Siting Board
One South Station
Boston, MA 02110

Re: EFSB 16-02/D.P.U. 16-77 - Petition to Participate as Limited Participants

Dear Ms. Sedor:

Please accept this letter as our petition to participate as limited participants in the above-referenced matter. We are residents of the Warren Street and Grant Street neighborhood in Needham, streets located on the routes considered "Preferred" by NSTAR Electric Company d/b/a Eversource Energy ("Eversource") in connection with its proposal to construct, operate and maintain a massive new transmission line.

We are concerned that Eversource has not fully:

(a) explained or justified the need for the new transmission line described in the proposal;

(b) considered and shared with the public the pros and cons of the various alternative routes it has considered for the proposed transmission line before narrowing its options to the currently proposed route and limited route variations; and

(c) considered and shared with the public the potential environmental impact, neighborhood disruption and health risks, associated with the proposed transmission line.

Please let us know if you need any additional information from us in connection with this request to participate as limited participants in this matter. Please contact Claire Fialkov in the event of questions.

Thank you for your consideration.

Sincerely,
Claire Fialkov, Ph.D.
216 Warren Street
617-462-3131

Louise Nagler	232 Warren Street
Iris Nagler	232 Warren Street
Michael Hug	224 Warren Street
Jay Fialkov	216 Warren Street
Andrew McSherry	39 Grant Street
Cheryl McSherry	39 Grant Street

Lynn Crawford	213 Warren Street
Michael Crawford	213 Warren Street
Kelly Hale	249 Warren Street
Laura Quinlan	224 Warren Street
Ronald Ruth	248 Warren Street
Mary Ruth	248 Warren Street

West Roxbury to Needham Reliability Project

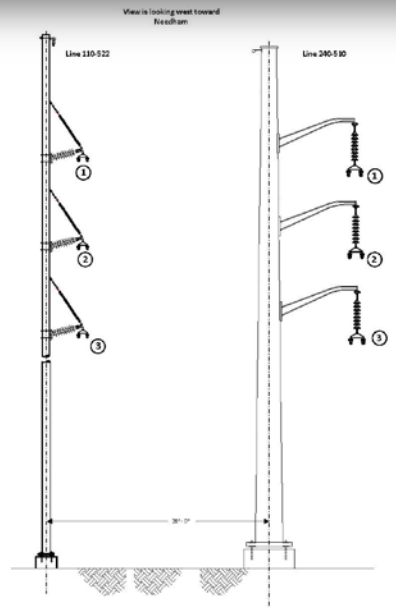
Town of Needham Board of Health EMF Presentation
November 10, 2016

Agenda

- Introductions
- Overview
- Understanding the Need for the Project
- Review of Proposed Transmission Line Route(s)
- Review of Gradient's EMF Assessment Report

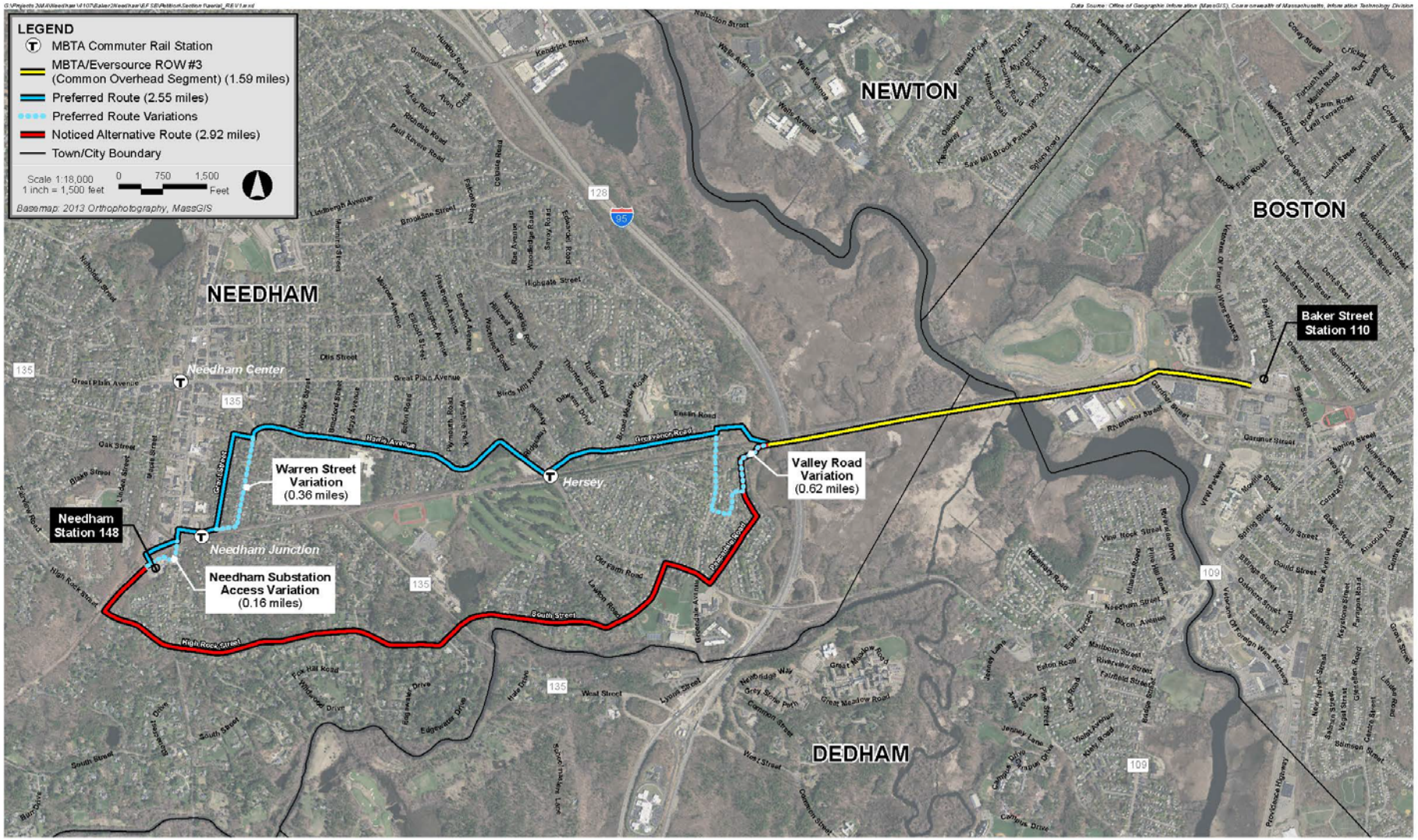
Overview

- The West Roxbury to Needham Reliability Project proposes to separate the existing overhead lines between West Roxbury and Needham. Separating the lines improves reliability by ensuring that a single pole failure cannot fault both lines.
- The line separation work will occur by:
    1. Relocating one set of existing wires to a new set of poles installed generally offset from the existing poles within the existing ROW. This work will occur over 1.6 miles from W. Roxbury to Valley Road area in Needham; and
    2. From Valley Road area, the separated line will exit the ROW and transition from an overhead line design to an underground line design located primarily in local streets to the Needham Substation on Chestnut Street. The underground line segment is ~2.6 miles.
- When the line separation work is complete, one of the existing overhead wires currently located between Valley Road and Needham Substation will be removed along with the support arms. The existing structures will remain along this stretch but with one less overhead wire and set of arms.



West Roxbury to Needham Reliability Project
Preferred and Noticed Alternative Routes

EVERSOURCE ENERGY



Greater Boston Regional Need
Why is the project needed and how is need determined?

- The loss of both the double circuit tower (DCT) 115-kV lines between West Roxbury and Needham could result in an overload situation of underground lines located elsewhere in the system.

- If such an overload scenario were to occur, the Company's load at risk would be potentially as many as 24,000 customers in the immediate Project area and potentially up to 65,000 in the western Boston suburbs.

What Does the Line Separation Work Do from an EMF Perspective?

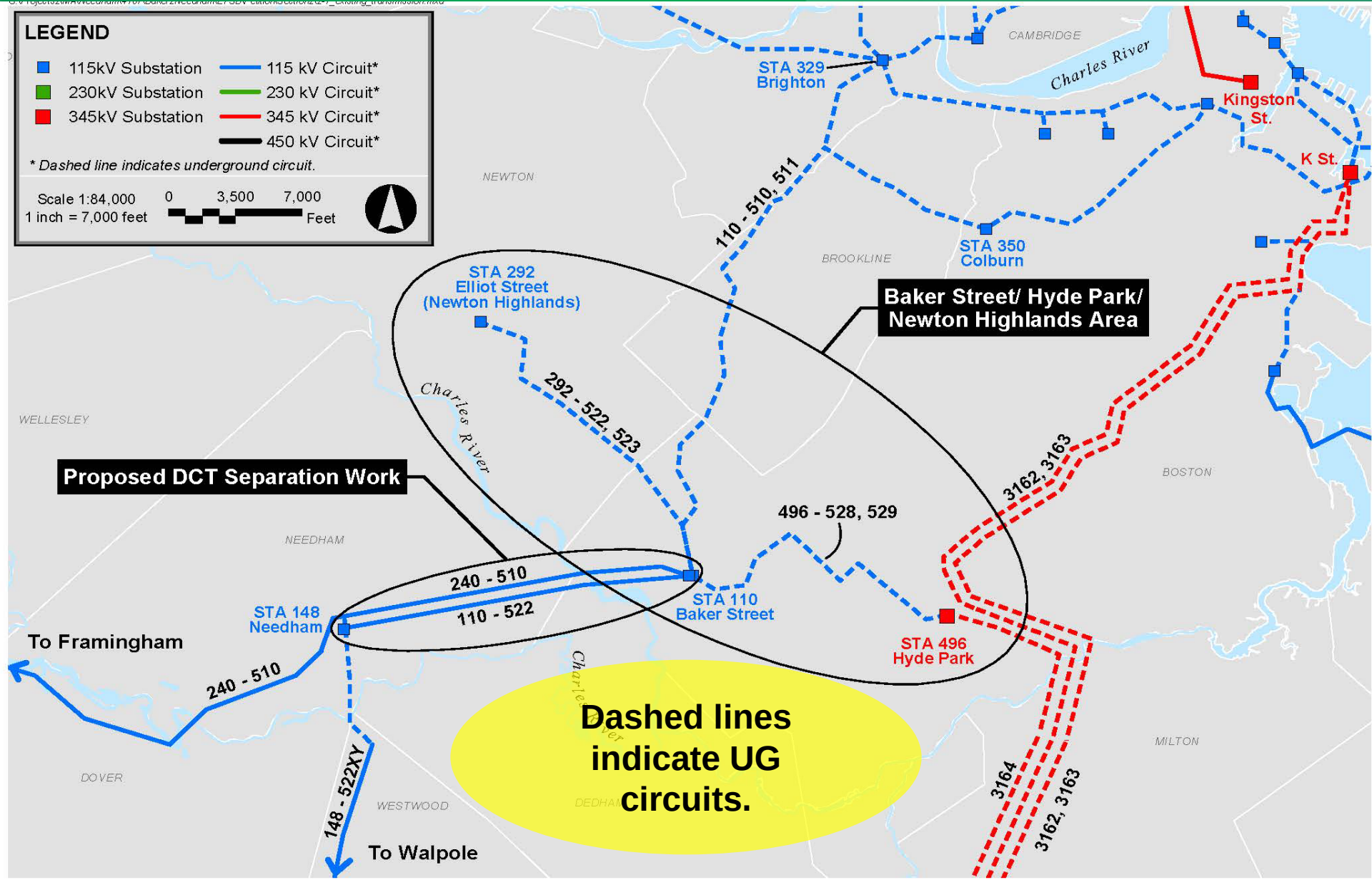
- Removing one of the overhead lines on the ROW between Valley Road and Chestnut Street will reduce the Electric Field (EF) and Magnetic Field (MF) levels produced nearby to these lines, and levels from the ROW will be lower.

- While the underground segment introduces a new source of MF, not EF, in certain streets and the municipal gravel pit parcel, the falloff rate with distance is much faster than with an overhead line.

- There are numerous examples of safely operating underground transmission lines throughout the Project area, primarily in streets.

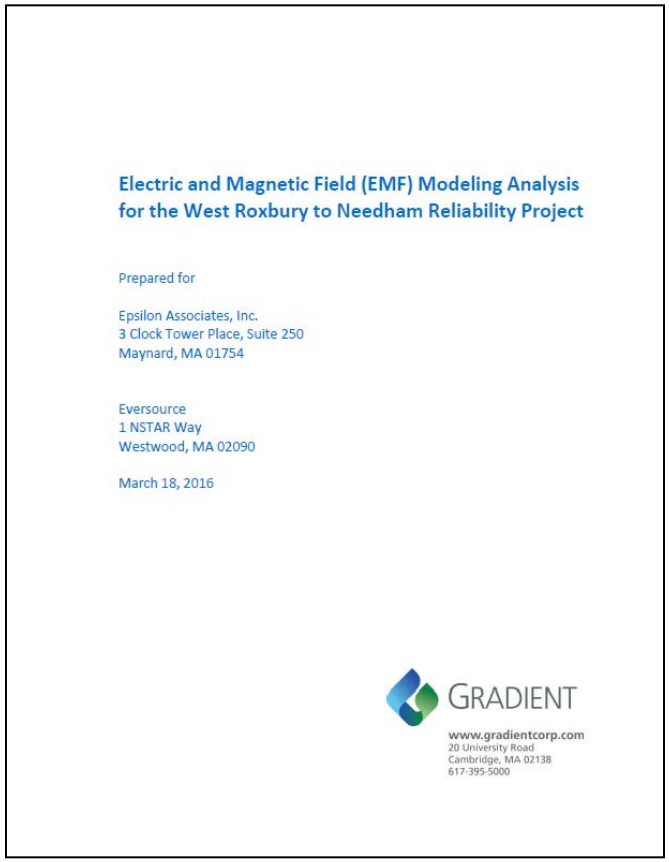
West Roxbury to Needham Reliability Project
Locations of Other UG Transmission Lines in Vicinity of Project

EVERSOURCE ENERGY



Gradient's EMF Assessment

- Gradient conducted an independent EMF (electric and magnetic fields) assessment and described its findings in a report dated March 18, 2016**.**
- The EMF analysis was conducted by Dr. Chris Long and Dr. Peter Valberg of Gradient.
- EMFs were modeled for several representative overhead and underground line cross-sections using projected non-emergency summer peak and average transmission line loadings provided by Eversource for the year 2018, which is the expected in-service date for the project.



Electric and Magnetic Field (EMF) Modeling Analysis
for the West Roxbury to Needham Reliability Project

Prepared for

Epsilon Associates, Inc.
3 Clock Tower Place, Suite 250
Maynard, MA 01754

Eversource
1 NSTAR Way
Westwood, MA 02090

March 18, 2016

GRADIENT
www.gradientcorp.com
20 University Road
Cambridge, MA 02138
617-395-5000

Properties of EMF

- EMF are present wherever electricity is used.
- All of us come into daily, if not constant, contact with power frequency EMF from sources in our homes, place of work, etc. Common sources are household appliances, building wiring, machinery, and distribution lines.
- EMF from some of these sources can be much higher than what might be associated with a transmission line. This is, in part, due to the distance between an individual and the source of the field (the conductors) which is high above the ground (for overhead) or some distance below the ground (with an underground design).
- EMF drops off rapidly with distance from any source.
- National and international independent health and scientific organizations and governmental bodies that have reviewed the 40+ years of scientific research regarding EMF and health have reached similar consensus opinions that there is no clear or credible evidence demonstrating any established adverse health risk.

Measured Magnetic Fields for Common Household Appliances

EVERSOURCE ENERGY

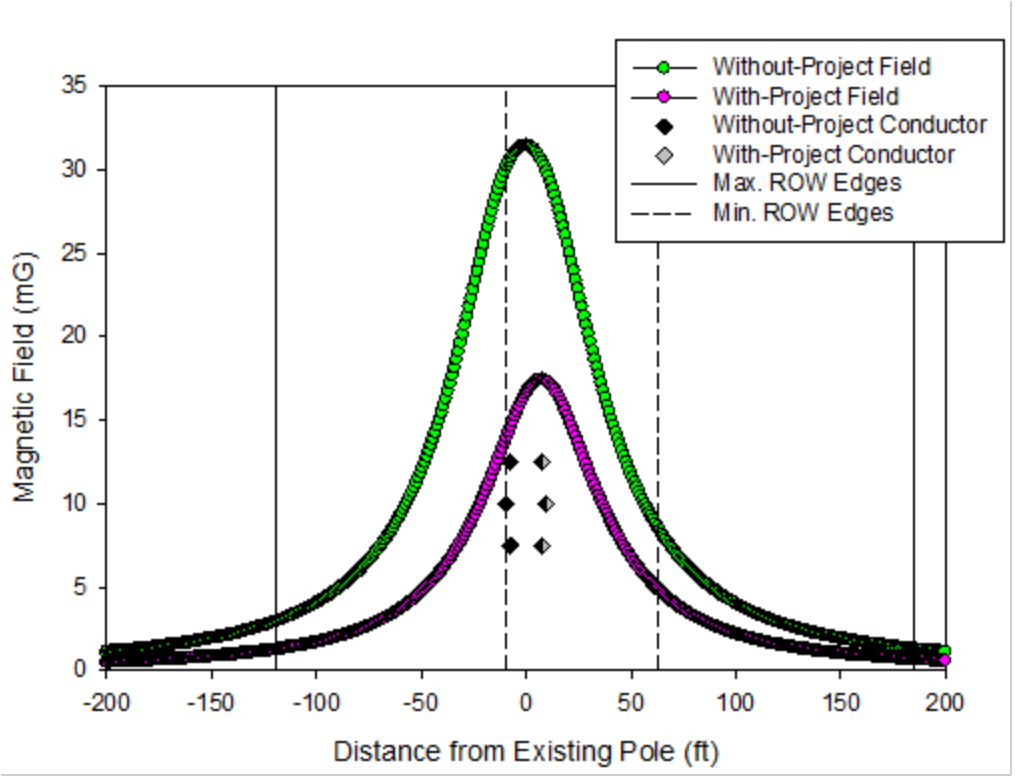
Source	Distance from Source	
	6 inches (mG)	1 foot (mG)
Can opener	600	150
Vacuum cleaner	300	60
Hair dryer	300	1
Electric pencil sharpener	200	70
Power saw	200	40
Microwave	200	4
Electric shaver	100	20
Portable heater	100	20
Kitchen mixer	100	10
Blender	70	10
Electric range	30	8
Dishwasher	20	10

Source: NIEHS (2002)
Numbers shown are median values.

Overhead Line Modeling Results for ROW Portion in Needham West of Valley Road Area

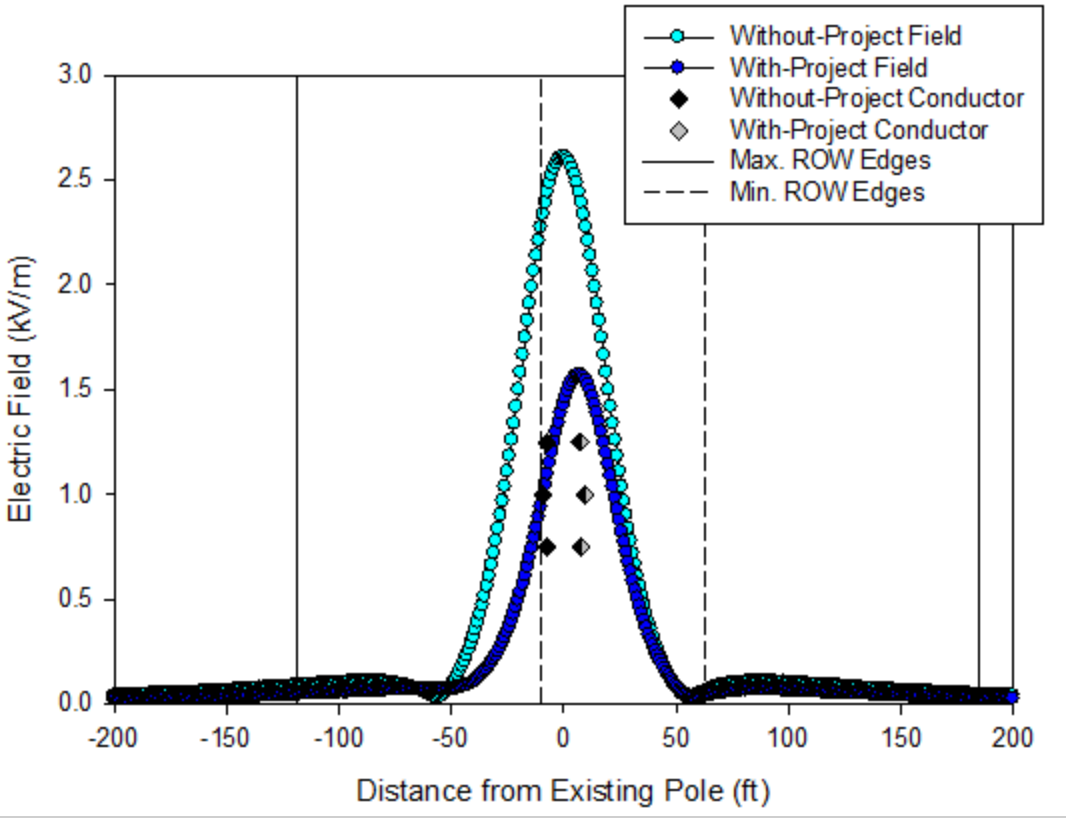
EVERSOURCE ENERGY

Predicted magnetic fields for expected year 2018 average load levels



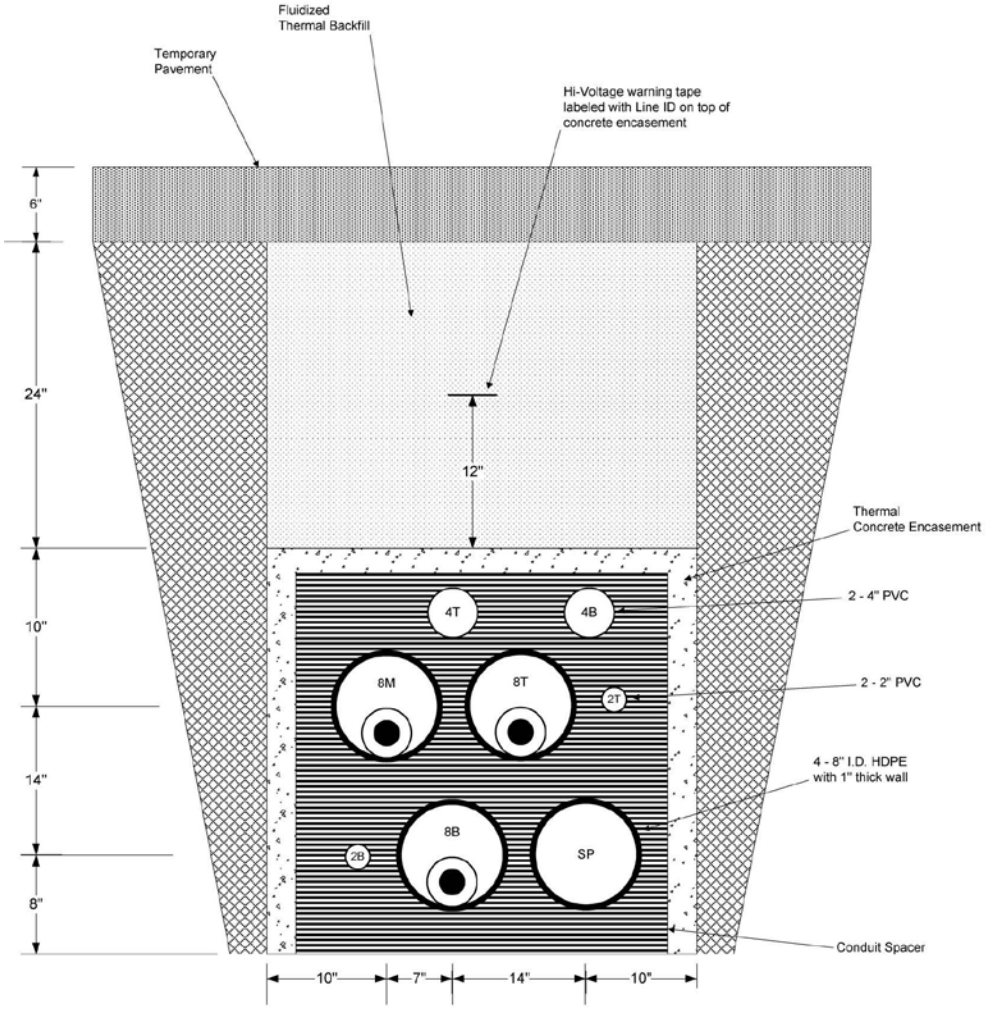
Overhead Line Modeling Results for ROW Portion in Needham West of Valley Road Area (continued)

Predicted electric fields for expected year 2018 average load levels



Underground Line Modeling Results

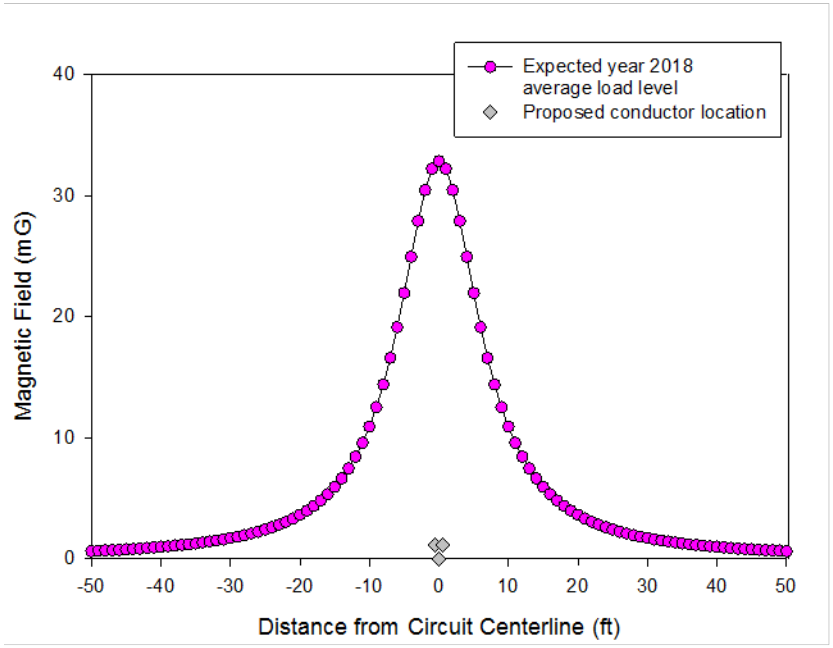
- Gradient modeled the typical underground line configuration and the underground lines in manhole sections.



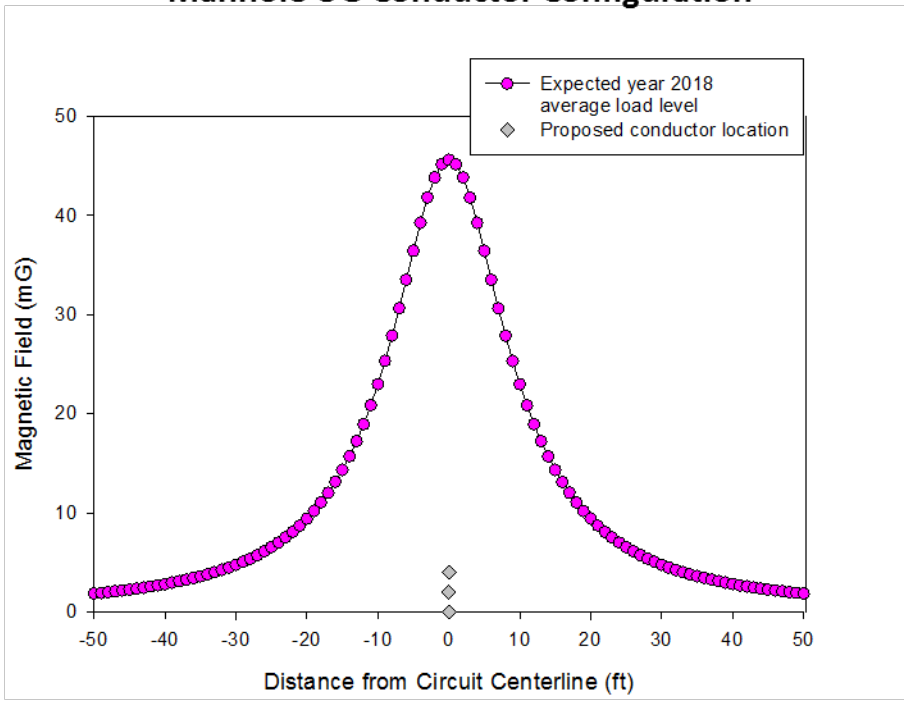
Underground Line Modeling Results (continued)

EVERSOURCE ENERGY

Typical UG Conductor Configuration



Manhole UG Conductor Configuration



EMF Conclusions

- Both current and projected EMF values (both overhead and underground) were found to be well below the ICNIRP health-based guidelines for the public exposure to EMF (4.2kV/m and 2,000mG).

- Moreover, the project will result in a reduction in the EMF values near the lines between Valley Road and Needham Substation due to the elimination of one of the present day overhead lines.

- The proposed Project will result in EMF levels that are typical and consistent with any similar technology in use or approved to be constructed elsewhere in Massachusetts or throughout the U.S.

Contact Information

Jack Lopes
Community Relations Specialist
508-660-5251
Jack.Lopes@eversource.com