3.5 Electromagnetic Interference and Electromagnetic Fields

3.5.1 Introduction

Section 3.5, Electromagnetic Interference and Electromagnetic Fields, of the Burbank to Los Angeles Project Section Environmental Impact Report/Environmental Impact Statement (EIR/EIS) describes the regulatory setting, affected environment, effects, and mitigation measures for electromagnetic interference (EMI) and electromagnetic fields (EMF) associated with the No Project Alternative and the Burbank to Los Angeles Project Section High-Speed Rail (HSR) Build Alternative. The analysis examines the potential impacts on EMF- and EMI-sensitive receptors from local sources of EMF and EMI and the impact of HSR generated EMF-EMI. The analysis also describes impact avoidance and minimization features (IAMF) that would avoid, minimize, or reduce impacts from constructing or operating the HSR Build Alternative.

Electromagnetic Interference and Electromagnetic Fields

Electromagnetic interference (EMI) is the disruption of operation of an electronic device when exposed to electromagnetic fields (EMF) generated by another electronic device. This EMI/EMF analysis was performed in order to protect sensitive equipment near the proposed alignment and to inform the public with regards to potential impacts from the project.

Additional details on EMI and EMF are provided in the following appendices in Volume 2 of this Draft EIR/EIS:

- Appendix 3.1-B, Regional and Local Policy Inventory
- Appendix 3.5-A, Pre-Construction Electromagnetic Measurement Survey

Six other resource sections in this Draft EIR/EIS provide additional information about issues related to EMF and EMI:

- **Section 3.2, Transportation**—Analyzes construction and operations changes caused by the HSR Build Alternative related to other freight and passenger railroad transportation that exist where the HSR Build Alternative would be located.
- **Section 3.6, Public Utilities and Energy**—Evaluates construction and operations changes caused by the HSR Build Alternative related to utilities and electric transmission facilities for the HSR Build Alternative.
- **Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources**—Evaluates operations changes caused by the HSR Build Alternative related to local soil properties and the electrification system for the HSR Build Alternative.
- **Section 3.11, Safety and Security**—Analyzes construction and operations changes caused by the HSR Build Alternative related to safety and security in communities adjacent to the rail corridor.
- **Section 3.18, Regional Growth**—Provides information regarding regional growth, construction- and operation-related employment, and the HSR Build Alternative's potential to induce growth.
- **Section 3.19, Cumulative Impacts**—Identifies construction and operations changes caused by the HSR Build Alternative related to EMI/EMF in combination with other past, present, and reasonably foreseeable projects.

3.5.1.1 Definition of Resources

This section provides definitions related to EMI and EMF as analyzed in this Draft EIR/EIS.

- **EMF** consists of electric and magnetic fields. EMF occurs throughout the electromagnetic spectrum, is found in nature, and is generated both naturally and by human activity. Naturally occurring EMF include the Earth's magnetic field, static electricity, and lightning. EMF is also created by the generation, transmission, and distribution of electricity; the use of everyday household electric appliances and communication systems; industrial processes; and scientific research.
- **Electric Fields** are forces that electric charges exert on other electric charges.
- **Magnetic Fields** are forces that a magnetic object or moving electric charge exerts on other magnetic materials and on electric charges.
- **EMI** is the interference that occurs when the EMF produced by a source adversely affects the operation of an electrical, magnetic, or electromagnetic device. EMI may be caused by a source that intentionally radiates EMF (such as a television broadcast station) or one that does so incidentally (such as an electric motor).

Definitions: Electromagnetic Spectrum and Electromagnetic Waves

The electromagnetic spectrum is the range of waves of electromagnetic energy. It includes static fields such as the Earth's magnetic field, radio waves, microwaves, X-rays, and light. Electromagnetic waves have frequencies and wavelengths that are directly related to each other—as frequencies increase, wavelengths get shorter.

The information presented in this section primarily concerns EMF at the 60-hertz (Hz) power frequency and at radio frequencies produced intentionally by communications or unintentionally by electric discharges. EMFs from the HSR operation would consist of the following:

- **Power-frequency electric and magnetic fields from the traction power system and electrical infrastructure**—Switching stations, paralleling stations, electrical lines, emergency generators that provide backup power to the stations in case of a power outage, and utility feeder lines—60-Hz electric fields would be produced by the 25-kilovolt (kV) operating voltage of the 2 x 25-kV HSR traction power system, and 60-Hz magnetic fields would be produced by the flow of currents providing power to the HSR vehicles. Along the tracks, magnetic fields would be produced by the flow of propulsion currents to the trains in the overhead contact system (OCS), negative feeder, and rails.
- **Harmonic magnetic fields from vehicles**—Depending on the design of power equipment in the HSR trains, power electronics would produce currents with frequencies in the kilohertz (kHz) range. Potential sources include power conversion units, switching power supplies, motor drives, and auxiliary power systems. Unlike the traction power system, these sources are highly localized in the trains, and move along the track as the trains move.
- **Radio frequency fields**—Radio frequency (RF) fields are any of the electromagnetic wave frequencies that lie in the range extending from around 3 kHz to 300 gigahertz (GHz), which include those frequencies used for communications or radar signals. The HSR system would use a variety of communications, data transmission, and monitoring systems—both on and off vehicles—that operate at radio frequencies. These wireless systems would meet the Federal Communications Commission (FCC) regulatory requirements for intentional emitters (47 Code of Federal Regulations [C.F.R.] § 15 and FCC Office of Engineering Technology

Unit Definitions and Conversions

Hertz (Hz) – Unit of frequency equal to one cycle per second

- 1 kilohertz (kHz) = 1,000 Hz
- 1 gigahertz (GHz) = 1 billion Hz
- Gauss (G) – Unit of magnetic flux density (intensity) (cgs units)
- 1 G = 1,000 milligauss (mG)
- Tesla (T) – Unit of magnetic flux density (intensity) (International units)
- 1 T = 1 million microtesla (μT)
- 1 G = 100 μT
- 1 mG = 0.1 μT

Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields).

These concepts are discussed in more detail in the following sections.

3.5.1.2 Characteristics of Electromagnetic Radiation

The electromagnetic spectrum spans an enormous range of wavelengths or frequencies. The most energetic radiation consists of short-wavelength or high-frequency radiation, and includes ultraviolet, x-ray, and gamma ray radiation. At longer wavelengths, electromagnetic radiation includes radio waves, microwaves, and infrared radiation. Visible light is the portion of the electromagnetic spectrum that lies between the infrared and ultraviolet portions of the electromagnetic spectrum. Less energetic, longer-wavelength radiation, including visible light, infrared radiation, microwaves, and radio waves, is sometimes referred to as "non-ionizing radiation." This section addresses the possible impacts of electromagnetic radiation at wavelengths below those of visible light on human health and on sensitive electric and electronic equipment and facilities for the HSR Build Alternative.

Non-ionizing electromagnetic radiation consists of waves characterized by variations in electric fields (measured in volts per meter, or V/m) and magnetic fields (measured in Tesla [T] or Gauss [G]). These periodic waves move through a medium, such as air, transferring energy from place to place as they go. The waves move at the speed of light and have dimensions of intensity or amplitude; wavelength, or the distance between two adjacent peaks of the wave; and number of cycles per second (Hz), or frequency. Table 3.5-1 shows wavelengths for a range of different frequencies. Table 3.5-2 shows the magnetic field strengths of electrical devices and facilities commonly found in urban areas.

Table 3.5-1 Relationship between Typical Frequencies and Their Wavelengths

Frequency	Wavelength	Common Commercial Uses
60 Hz	3,105 miles	Electric power grid
10 kHz	18.6 miles	Radio navigation
10 MHz	98.4 feet	Shortwave radio
100 MHz	9.8 feet	FM radio
2000 MHz	6 inches	Cellular communications

Source: California High-Speed Rail Authority, 2017
Hz = hertz MHz = megahertz
kHz = kilohertz

Table 3.5-2 Typical Magnetic Field Strengths

Electrical Source	Magnetic Field Strength (mG)
Dishwasher	30[1]
Hair Dryer	70[1]
Electric Shaver	100[1]
Vacuum Cleaner	200[1]
High-Voltage Power/Transmission Line (115 kV to 500 kV)	30 to 87[2]
Medium Voltage Power Distribution Line (4 kV to 24 kV)	10 to 70[2]

Source: National Institute of Environmental Health Sciences, 2002
[1] Measured 1 foot from appliance
[2] At ground level, directly beneath the lines
kV = kilovolts mG = milligauss

EMF Frequencies

EMFs are described in terms of their frequency, which is the number of times the EMF increases and decreases in intensity each second. The U.S. commercial electric power system operates at a frequency of 60 Hz, or 60 cycles per second, meaning that the field increases and decreases in intensity 60 times per second. Electric power system components are typical sources of electric and magnetic fields. These components include generating stations and power plants, substations, high-voltage transmission lines, and electric distribution lines. Even in areas not adjacent to transmission lines, 60 Hz EMF are generated by electric power systems and building wiring, electrical equipment, and appliances.

Natural and human-generated EMFs cover a broad frequency spectrum. EMFs that are nearly constant in time are called direct current (DC) EMFs. EMFs that vary in time are called alternating current (AC) EMFs. AC EMFs are further characterized by their frequency range. Extremely low frequency (ELF) magnetic fields typically are defined as having a lower limit of 3 to 30 Hz and an upper limit of 30 to 3,000 Hz. The HSR OCS and electrical transmission, power, and distribution system primarily would generate ELF fields at 60 Hz and at harmonics (multiples) of 60 Hz.

Radio and other communications operate at much higher frequencies, often in the range of 500,000 Hz (500 kHz) to 3 GHz. Typical RF sources of EMF include antennas on cellular telephone towers; radio and television broadcast towers; airport radar, navigation, and communication systems; high-frequency and very high-frequency communication systems used by police, fire, emergency medical technicians, utilities, and governments; and local wireless systems, such as wireless fidelity (WiFi) or cordless telephone. The project would employ active radio-frequency EMF sources.

The strength of magnetic fields is expressed in milligauss (mG), gauss (G), tesla (T), or microtesla (μT). For comparison, Earth's ambient magnetic field ranges from 300 to 600 mG DC (0.3 to 0.6 G) (30 to 60 μT) at its surface. Average AC magnetic field levels within homes are approximately 1 mG (0.001 G) (0.1 μT), and measured AC values range from 9 to 20 mG (0.009 to 0.020 G) (0.9 to 2 μT) near appliances (Severson et al. 1988). The strength of an EMF rapidly decreases with distance away from its source; thus, EMFs higher than background levels are usually found close to EMF sources. For overhead transmission and power lines, the strength of an EMF is typically the highest directly under the overhead line and decreases rapidly with increasing distance from the line. Table 3.5-3 shows the typical EMF levels from overhead electrical lines at varying distances. EMF levels at a distance of 200 feet from a 230-kV transmission line and a 115-kV power line are reduced by approximately 97 and 99 percent, respectively.

Table 3.5-3 Typical Electromagnetic Field Levels for Transmission/Power Lines

Voltage of Source	Field Strength at Specified Distances from Source				
	Directly under Lines	50 feet	100 feet	200 feet	300 feet
230-kV Transmission Line Electric Field Strength (kV/m)	2.0	1.5	0.3	0.05	0.01
230-kV Transmission Line Mean Magnetic Field (mG)	57.5	19.5	7.1	1.8	0.8
115-kV Power Line Electric Field Strength (kV/m)	1.0	0.5	0.07	0.01	0.003
115-kV Power Line Mean Magnetic Field (mG)	29.7	6.5	1.7	0.4	0.2

Source: National Institute of Environmental Health Sciences, 2016

kV = kilovolts mG = milligauss

kV/m = kilovolts per meter

EMF Exposure and Health Effects

EMFs can cause EMI and can disrupt sensitive equipment (e.g., implanted medical devices), possibly triggering a malfunction. At sufficiently high exposure levels, EMFs also directly affect human health. Extensive research on EMF has led the majority of scientists and health officials to conclude, however, that low-frequency EMF has no adverse health effects at typical exposure levels. Objective scientific reviews of animal studies, from which some human health risks have been extrapolated, have also concluded that existing data are inadequate to indicate a potential risk of cancer, which is the primary human health concern associated with EMF exposure (World Health Organization 2007; International Agency for Research on Cancer 2002). However, EMF remains a human health concern and is the subject of continuing research (World Health Organization 2007).

Electromagnetic Interference

General Considerations

EMI is an electromagnetic disturbance from an external source that interrupts or degrades the performance of an electrical device, circuit, or signal. Ambient EMI occurs when electromagnetic radiation intentionally or unintentionally jams, or blocks, another electromagnetic signal in free space. Hardware EMI occurs when electromagnetic radiation induces an unintended current in an electrical circuit. To interfere with a radio or microwave signal, the EMI must be at or near its frequency. Radio and other communications systems typically operate in the range of 500 kHz to 3 GHz.

Commercial standards developed for electromagnetic compatibility (EMC) both limit EMI generated by electrical devices and reduce susceptibility of electrical devices to external EMI. For example, the Federal Aviation Administration's interim EMC commercial standards require aircraft systems to withstand EMF of up to 200 V/m (Federal Aviation Administration 2014).

EMI and Radio Communications

Intentional radio signals exist in a sea of unwanted RF noise, so radio communications systems and devices are designed to operate in this environment. General frequency ranges are assigned for various types of radio signals, and specific radio frequencies and power output levels are assigned to individual users to minimize the potential for disruptions. Radio equipment is designed to separate the frequency of interest from background noise and to reject transient or unfocused signals.

EMI and Sensitive Equipment

Research equipment is generally designed to operate within the Earth's natural magnetic field and to compensate for fluctuations in that field of up to 10 mG (Field Management Services 2009). Industries associated with the use, assembly, calibration, or testing of sensitive or unshielded RF equipment, however, are still sensitive to EMI. In particular, fluctuations in the magnetic field can interfere with nuclear magnetic resonance (NMR), nuclear magnetic imaging (NMI), and other imaging equipment, such as electron microscopes. Computed tomography (CT) and computed axial tomography (CAT) scanning devices also are sensitive to EMI, as are some semiconductor, nanotechnology, and biotechnology operations. NMR spectrometers are sensitive to time-varying DC magnetic fields of under 2 mG (Field Management Services 2009). For unshielded equipment that is sensitive to magnetic fields in the range of 1 to 3 mG, such as magnetic resonance imaging (MRI) systems, electromagnetic interference is possible at distances of up to 200 feet. An installation guide for NMR equipment recommends a separation distance of 330 feet from electric trains (Field Management Services 2009).

3.5.2 Laws, Regulations, and Orders

This section describes the federal, state, and local laws, regulations, orders, and plans that are relevant to EMF and EMI.

3.5.2.1 Federal

Federal Railroad Administration, Procedures for Considering Environmental Impacts (64 Federal Register 28545)

These Federal Railroad Administration (FRA) procedures state that an EIS should consider possible impacts from EMI/EMF.

Other Federal Requirements

U.S. Department of Transportation, Federal Railroad Administration, 49 C.F.R. 236.8, 238.225, 229 Appendix F, and 236 Appendix C

These regulations provide rules, standards, and instructions regarding operating characteristics of electromagnetic, electronic, or electrical apparatus and safety standards for passenger equipment.

U.S. Department of Commerce, FCC, 47 C.F.R. 15

Part 15 provides rules and regulations regarding licensed and unlicensed RF transmissions. Most telecommunications devices sold in the United States, whether they radiate intentionally or unintentionally, must comply with Part 15. However, Part 15 does not govern any device used exclusively in a vehicle, including in HSR trains.

U.S. Department of Commerce, FCC, Office of Engineering and Technology Bulletin 65, Evaluating Compliance with Federal Communications Commission Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields (FCC 1997)

Office of Engineering and Technology Bulletin 65 provides assistance in evaluating whether proposed or existing transmitting facilities, operations, or devices comply with limits for human exposure to RF fields adopted by FCC (FCC 1997).

U.S. Department of Commerce, FCC, 47 C.F.R. 1.1310, Radiofrequency Radiation Exposure Limits

FCC regulations at 47 C.F.R. Part 1.1310 are based on the 1992 version of the American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) C95.1 safety standard. Table 3.5-4 shows the Maximum Permissible Exposure (MPE) contained in the ANSI/IEEE C95.1 and FCC standards at frequencies of 450, 900, and 5,000 MHz, which covers the range of frequencies that may be used by HSR radio systems. FCC MPEs are based on an averaging time of 30 minutes for exposure of the general public and 30 minutes for occupational exposure. As shown in Table 3.5-4, the differences between the ANSI/IEEE C95.1 and FCC MPEs are minor.

Table 3.5-4 Radio Frequency Emissions Safety Levels Expressed as Maximum Permissible Exposure

	ANSI/IEEE C95.1 MPE (mW/cm²)		FCC MPE (mW/cm²)		OSHA MPE (mW/cm²)
Frequency	Occupational	General Public	Occupational	General Public	Occupational
450 MHz	1.5	0.225	1.5	0.3	10
900 MHz	3.0	0.45	3.0	0.6	10
5,000 MHz	10	1.0	5.0	1.0	10

Source: ANSI/IEEE, 2006; 47 C.F.R. 1.1310, Table 1 (FCC); 29 C.F.R. 1910.97 (OSHA)
ANSI/IEEE = American National Standards Institute/Institute of Electrical and Electronics Engineers
C.F.R. = Code of Federal Regulations
cm = centimeter
FCC = Federal Communications Commission
MHz = megahertz
MPE = maximum permissible exposure
mW/cm² = milliwatts per square centimeter
OSHA = Occupational Safety and Health Administration

U.S. Environmental Protection Agency, Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997)

Executive Order 13045 directs federal agencies to make it a priority to identify and assess environmental health and safety risks that may disproportionally affect children and to ensure that policies, programs, activities, and standards address disproportionate risks to children, including risks from EMF exposure.

U.S. Department of Labor, Occupational Safety and Health Administration, 29 C.F.R. 1910.97, Non-ionizing Radiation

Title 29 C.F.R. Part 1910.97 provides safety standards for occupational exposure to RF emissions in the 10-MHz to 100-GHz range. Table 3.5-4 shows MPEs contained in the OSHA standards. The OSHA safety levels do not vary with frequency and are less stringent than the equivalent ANSI/IEEE and FCC MPEs, except for occupational exposure to fields with frequencies above 5,000 MHz where the OSHA MPE is equal to the ANSI/IEEE C95.1 MPE and is 2 times higher than the FCC MPE. The OSHA MPEs are based on averaging over any 6-minute time interval.

3.5.2.2 State

California High-Speed Rail Authority—Electromagnetic Compatibility Program Plan

The Electromagnetic Compatibility Program Plan (EMCPP) defines the project's High-Speed Transport Protocol Electromagnetic Compatibility (EMC) objective, which would provide for electromagnetic compatibility of HSR equipment and facilities with themselves, with equipment and facilities of the HSR's neighbors, and with passengers, workers, and neighbors of the HSR. The EMCPP would also guide and coordinate the EMC design, analysis, testing, documentation, and certification activities among HSR project management, systems, and sections through the project phases; conform to the EMC-related HSR system requirements; and comply with applicable regulatory requirements, including EMC requirements in 49 C.F.R. 200-299 for the HSR system and project sections (California High-Speed Rail Authority [Authority] 2010a).

California Department of Education, California Code of Regulations, Title 5, Section 14010(c)

This section sets minimum distances for siting school facilities from the edge of power line easements: 100 feet for 50- to 133-kV line, 150 feet for 220- to 230-kV line, and 350 feet for 500- to 550-kV line.

California Public Utilities Commission

The HSR Build Alternative would involve modifications to existing Los Angeles Department of Water & Power facilities subject to the jurisdiction of the California Public Utilities Commission (CPUC):

- **Decision D.93-11-013**—The CPUC decision adopted a policy regarding EMF from regulated utilities.
- **Decision D.06-01-042—**The August 2004 CPUC decision updates the EMF policy originally defined in Decision D.93-11-013. Decision D.06-01-042 reaffirmed D.93-11-013 in that health hazards from exposures to EMF have not been established and that state and federal public health regulatory agencies have determined that setting numeric exposure limits is not appropriate. The CPUC also re-affirmed the existing no-cost and low-cost precautionary-based EMF policy to be continued. Decision D.06-01-042 ordered the utilities to convene a utility workshop, to develop standard approaches for design guidelines, including the development of a standard table showing EMF mitigation measures and costs.
- **California Public Utilities Commission Electromagnetic Field Guidelines for Electrical Facilities**—These CPUC guidelines, based on Decisions D.93-11-013 and D.06-01-042, establish priorities between land use classes for EMF mitigation. While the CPUC decisions, general orders, and guidelines do not directly apply to the HSR, they are listed because:

- The Burbank to Los Angeles Project Section would handle potential environmental impacts of the HSR Build Alternative and associated electric power substations, station switches, and high-voltage transmission lines consistent with CPUC Decisions D.93-11-013 and D.06-01-042.
- Decision D.06-01-042 reaffirms the key elements of the updated EMF policy.

3.5.2.3 Regional and Local

Table 3.5-5 lists county and city general plan goals, policies, and ordinances relevant to the HSR Build Alternative.

Table 3.5-5 Regional and Local Plans and Policies

Policy Title	Summary
City of Burbank	
Burbank Municipal Code	The Burbank Municipal Code is current through Ordinance 16-3,889, passed December 20, 2016. It includes the following relevant electromagnetic policies: ▪ 10-1-1118.C.1: An application is required for all WTFs. A WTF application must include documentation of compliance with FCC regulations pertaining to radio frequency emissions, including cumulative emissions from any existing WTFs on the site and the proposed WTF, in a manner deemed appropriate by the director. ▪ 10-1-1118.D.3.l: No WTF may, by itself or in conjunction with other WTFs, generate radio frequency emissions and/or electromagnetic radiation in excess of FCC standards and any other applicable regulations. ▪ 10-1-1118.E.2: Every 5 years following compliance with 1-1-1118 E(1) above, the applicant shall, at the WTF owner's sole cost, prepare and submit to the City an independently prepared updated radio frequency emissions compliance report and certification, and shall certify that the WTF complies with all applicable FCC standards as of the date of the update. ▪ 10-1-1118.E.3: If the radio frequency emissions compliance report and certification, and/or any update thereto, demonstrates that the cumulative levels of radio frequency emissions exceed or may exceed FCC standards, the director may require the applicant to modify the location or design of the WTF and/or implement other mitigation measures to ensure compliance with FCC standards.
City of Glendale	
Glendale Municipal Code	The Glendale Municipal Code is current through Ordinance 5893, passed December 2016. It includes the following relevant policies: ▪ 12.08.037.G.2: An engineering certification demonstrating planned compliance with all existing federal radio frequency emissions standards. ▪ 12.08.037.V.1: At all times, permittee shall ensure that its wireless telecommunications facilities shall comply with the most current regulatory and operational standards including, but not limited to, radio frequency emissions standards adopted by the FCC and antenna height standards adopted by the FAA. ▪ 12.08.037.V.1: Within 30 calendar days following the activation of any WTF, the applicant shall provide a radio frequency emissions compliance report to the director certifying that the unit has been inspected and tested in compliance with FCC standards.

Policy Title	Summary
City of Los Angeles	
Los Angeles Municipal Code	The Los Angeles Municipal Code, effective from October 24, 2016, includes the following relevant electromagnetic policies: ▪ 1.2.12.21.20.a.1: The antenna on any monopole or support structure must meet the minimum siting distances to habitable structures required for compliance with FCC regulations and standards governing the environmental effects of radio frequency emissions. ▪ 1.2.12.21.20.b.4: (Application requirements): Statements regarding the regulations of the FAA and the FCC, respectively, that: (ii) the application complies with the regulations of the FCC, or a statement from the applicant that compliance is not necessary, and the reasons therefore.

Sources: City of Burbank, 2016; City of Glendale, 2016; City of Los Angeles, 2016
FAA = Federal Aviation Administration
WTF = wireless telecommunications facilities
FCC = Federal Communications Commission

3.5.3 Consistency with Plans and Laws

As indicated in Section 3.1, Introduction, California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) regulations require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws. Several federal and state laws, listed above, govern compliance with EMF and EMI limits for construction projects and for transportation facilities. The Authority, as the federal lead agency (the Authority is the lead federal agency pursuant to 23 U.S.C. 327 and the terms of the Memorandum of Understanding between FRA and the State of California effective July 23, 2019) and lead state agency proposing to construct and operate the HSR system, is required to comply with all federal and state laws and regulations and to secure all applicable federal and state permits before initiating construction of the project. Therefore, there would be no inconsistencies between the HSR Build Alternative and these federal and state laws and regulations.

The Authority is a state agency and therefore is not required to comply with local land use and zoning regulations; however, it has endeavored to design and construct the HSR project so that it is compatible with land use and zoning regulations. The Authority reviewed the municipal codes for the Cities of Burbank, Glendale, and Los Angeles; the HSR Build Alternative would not be inconsistent with any of them.

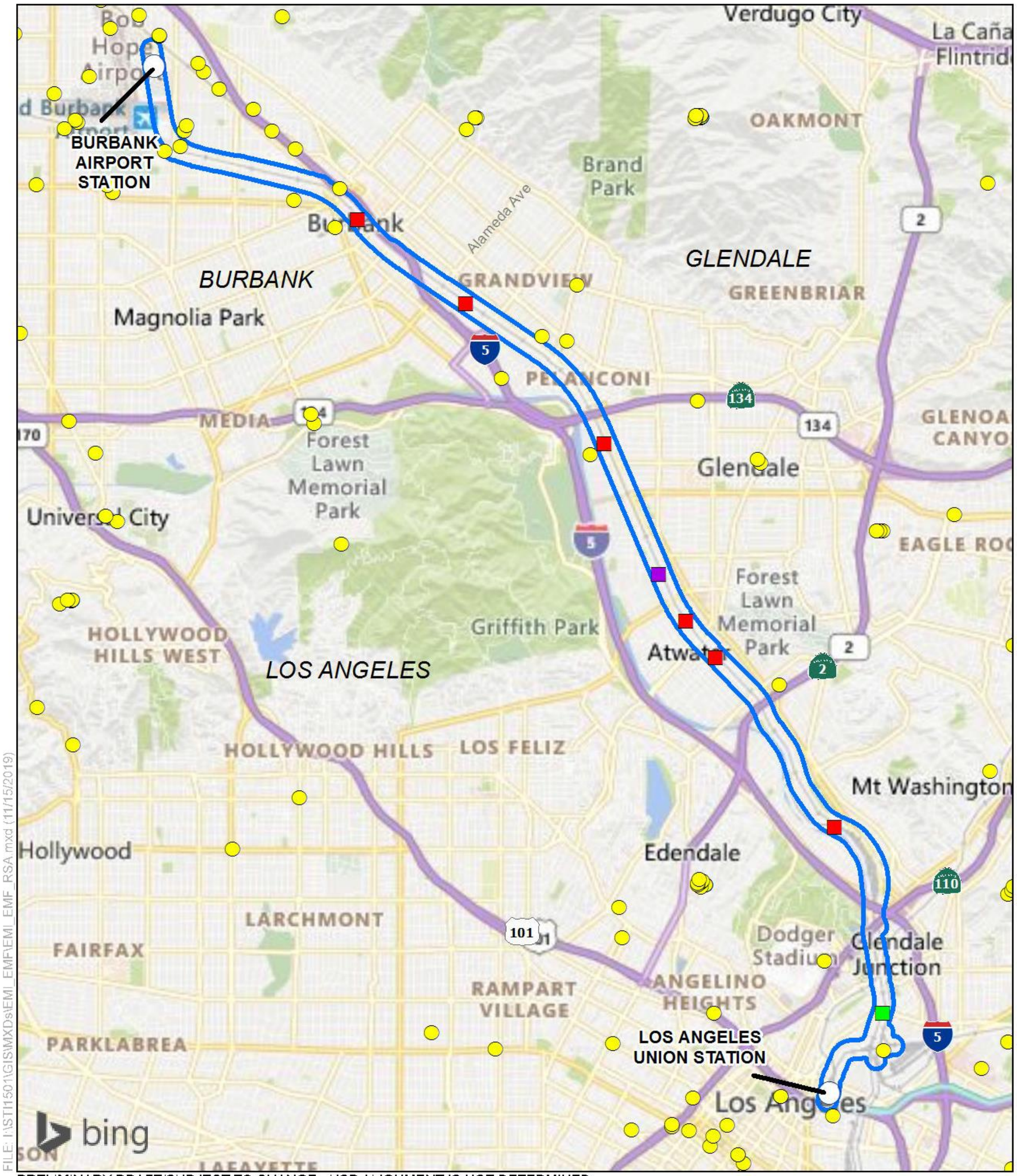
For additional details, please see Appendix 3.1-B, Regional and Local Policy Inventory.

3.5.4 Methods for Evaluating Impacts

NEPA and CEQA require impacts from EMF and EMI sources to be evaluated. As summarized in Section 3.5.1, Introduction, six other resource sections provide additional information related to EMF and EMI: Section 3.2, Transportation; Section 3.6, Public Utilities and Energy; Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources; Section 3.11, Safety and Security; Section 3.18, Regional Growth; and Section 3.19, Cumulative Impacts.

3.5.4.1 Definition of Resource Study Area

Resource study areas (RSA) are the geographic boundaries in which environmental investigations specific to each resource topic were conducted. Table 3.5-6 provides a general definition of the RSA for impacts of EMF and EMI. This 500-foot distance identified in the table was established because modeling demonstrated that 500 feet is the distance from a source at which EMI decays to a level of no concern. The EMF and EMI impact analysis focuses on the impacts of source EMF and EMI on sensitive receptors. Figure 3.5-1 shows the RSA for EMI/EMF impacts.



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HSR ALIGNMENT IS NOT DETERMINED
SOURCE: Bing (2018); CHSRA (11/2019)

HSR Stations
EMI/EMF Resource Study Area
Existing Radio Frequency (RF) Emitter
Equipment Sites
Paralleling Station
Switching Station
Radio Transmitter Site

0 4,100 8,200 Feet
0 1,250 2,500 Meters

Figure 3.5-1 Resource Study Area for Electromagnetic Interference/Electromagnetic Fields

Table 3.5-6 Definition of Resource Study Area

General Definition	Resource Study Area Boundary and Definition
Direct Resource Study Area	The project footprint, plus 500 feet from both sides of the HSR alignment centerline (a 1,000-foot-wide corridor) and 500 feet from the perimeter of the proposed traction power facilities (switching stations and paralleling stations) and associated work areas, and other existing electric utility facilities to be modified.

The RSA has been determined based on typical screening distances identified in Authority Technical Memorandum 300.07, *EIR/EIS Assessment of HSR Alignment EMF Footprint* (Authority 2012), and project-specific factors. Screening distances indicate whether any EMF and EMI-sensitive receptors are near enough to the HSR Build Alternative for EMF and EMI impact to be possible under typical conditions. If sensitive receptors are located farther than these screening distances, Technical Memorandum 300.07 (Authority 2012) indicates that EMF and EMI impacts would be unlikely.

3.5.4.2 Impact Avoidance and Minimization Features

As noted in Section 2.5.2.10, High-Speed Rail Project Impact Avoidance and Minimization Features, the HSR Build Alternative would incorporate standardized IAMFs to avoid and minimize potential environmental impacts of the HSR project. The Authority would incorporate IAMFs during design and construction of the HSR Build Alternative, taking into account all applicable IAMFs. Appendix 2-B, Impact Avoidance and Minimization Features, provides a detailed description of IAMFs that are part of the HSR Build Alternative design. IAMFs applicable to EMI/EMF include:

- EMI/EMF-IAMF#1: Preventing Interference with Adjacent Railroads—Reduces potential exceedances to EMI/EMF standards by requiring the contractor to work with railroad engineering departments and apply standard design practices to prevent interference with the electronic equipment operated on parallel railroad facilities.
- EMI/EMF-IAMF#2: Controlling Electromagnetic Interference/Electromagnetic Fields—Reduces potential exceedances to EMI/EMF standards by requiring the contractor to design the HSR to international guidelines and comply with federal and state laws and regulations related to EMI/EMF.

3.5.4.3 Methods for NEPA and CEQA Impact Analysis

This section describes the sources and methods the Authority used to analyze the potential impacts on EMI/EMF-sensitive receptors in the RSA. These methods apply to both NEPA and CEQA unless otherwise indicated. Refer to Section 3.1.3.4, Methods for Evaluating Impacts, for a description of the general framework for evaluating impacts under NEPA and CEQA. The Laws, Regulations, and Orders that regulate EMFs and EMI, listed in Section 3.5.2, were also considered in the evaluation of impacts.

The methods used to establish EMF and EMI baseline conditions and to determine potential impacts associated with construction and operation of the HSR Build Alternative combine data collection, electromagnetic field survey, and mathematical modeling to predict EMF levels. For the analysis of EMI/EMF effects, the Authority assessed:

- The magnitude of the change between the existing and modeled EMF levels
- The potential to which the proposed project could exceed applicable standards, including impacts on public health through exposure of people to EMF health risks in exceedance of applicable standards, exposing people to electric shock, or interfering with implanted biomedical devices
- The potential for the proposed project to affect public safety by interfering with the operation of nearby railroads, rail transit systems, airports, or other businesses

To identify regional and local sources of EMF and EMI, the analysis relied upon aerial imagery, surveys, photographs, and FCC databases, as well as observations of existing conditions obtained during a pre-construction electromagnetic survey of the RSA, described below.

Local Conditions

As part of this evaluation, a pre-construction electromagnetic survey was performed at six locations—selected in part from the visual survey described above—within the RSA. The six measurement sites are identified in Figure 3.5-2. The purpose of the survey was to (1) provide a baseline characterization of the existing electromagnetic environment, (2) permit comparisons with the expected electromagnetic footprint from the planned HSR Build Alternative, and (3) provide guidance for EMC requirements by defining the typical electromagnetic environment that the HSR Build Alternative must operate in without interference.

The Authority reviewed existing facilities and uses within the RSA with respect to the electromagnetic environment, and six measurement sites were selected to obtain a representative cross-section of typical EMF sources, such as power lines and antenna towers, potentially sensitive facilities such as medical facilities, and relatively quiet areas for comparison.

Two types of measurements were performed at each of the six locations. The first involved measurement of radiated electric fields strengths (RF levels) from 10 kHz to 6 GHz, meant to characterize the existing RF environment. These RF levels were measured using an RF spectrum analyzer and calibrated antennas. Typical sources of RF signals include:

- Cell towers (cellular telephone)
- Broadcast towers (radio and television broadcasts)
- Airport radar and communications equipment
- General high-frequency and very high-frequency communications systems (police, fire, utility, and government)
- Local wireless (WiFi and Worldwide Interoperability for Microwave Access)

The second measurement involved background DC and power frequency magnetic fields along the HSR alignment. These magnetic fields were recorded using three-axis fluxgate sensors with a waveform-recording data acquisition system. Typical sources of DC and low-frequency magnetic fields include:

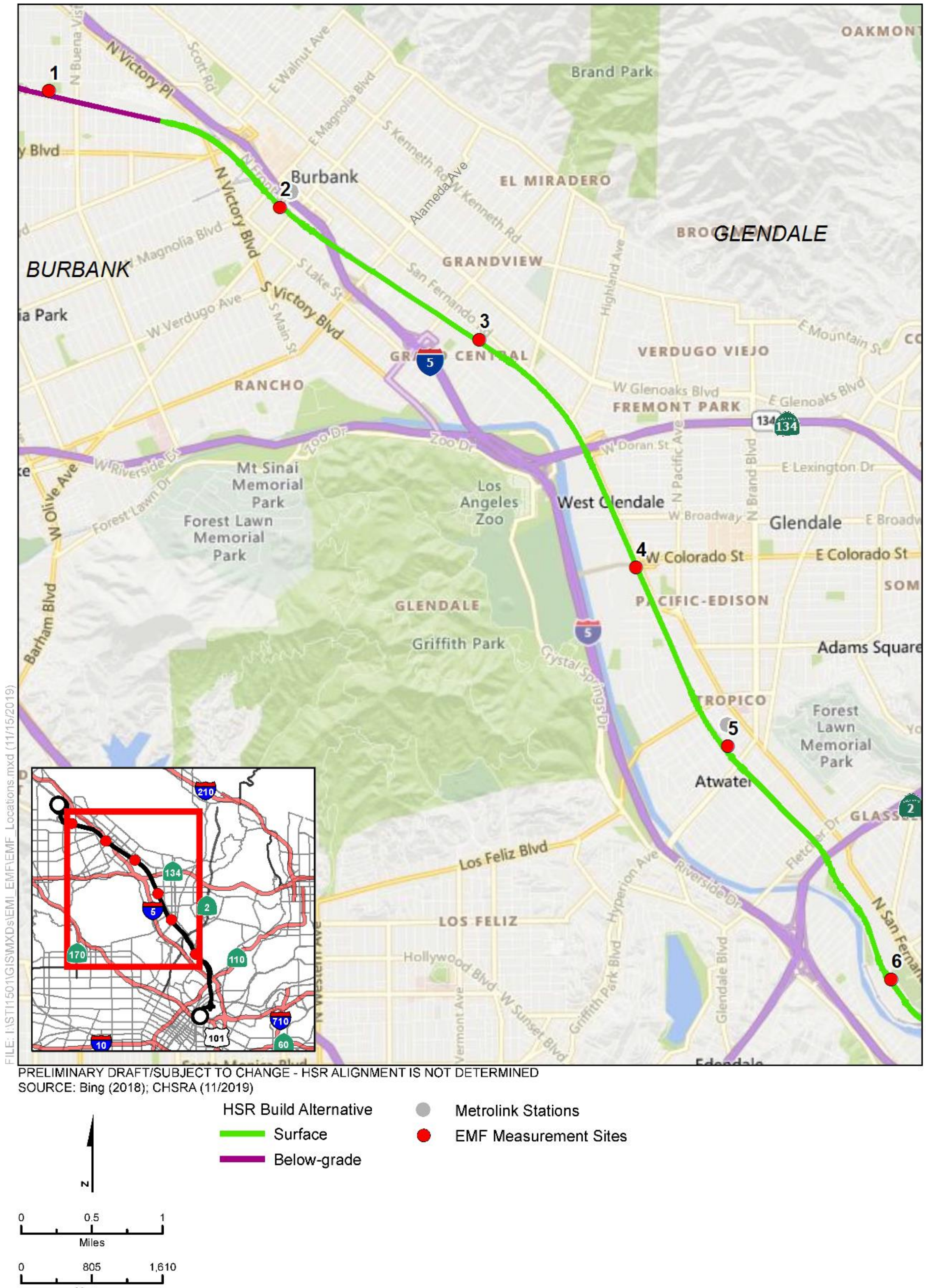
- The geomagnetic field[1]
- Utility high-voltage transmission/power lines
- Utility electric distribution lines
- Utility substations
- Utility switching stations
- Utility electrical generation facilities
- Geomagnetic perturbations due to passing vehicles and trains on nonelectrified lines

The facilities most sensitive to shifts in the static (DC) or AC magnetic fields are:

- High-tech semiconductor (e.g., electron microscopes, electron-beam lithography)
- Medical imaging systems (e.g., MRI scanners, positron emission tomography [PET] scanners)
- Bio-tech research (e.g., NMR spectrometers)

Appendix 3.5-A, Pre-Construction Electromagnetic Measurement Survey, documents the process for conducting field survey measurements, describes measurement sites, and discusses the existing EMF levels within the RSA.

[1] The geomagnetic field is produced naturally by electric currents flowing in the earth's metallic core. At the earth's surface, this field varies in strength from approximately 0.3 to 0.6 mG.



Source: California High-Speed Rail Authority and Federal Railroad Administration, 2016

Figure 3.5-2 Electromagnetic Field Measurement Site Locations

Sensitive Receptors

The impact analysis focused on the potential impacts on sensitive receptors, which consist of land uses and facilities susceptible to EMF and EMI that would be produced by the HSR Build Alternative. These receptors include adjacent railroads and rail transit systems, airports, residential dwellings, schools, preschools and daycare facilities, public parks, hospitals, and commercial and industrial facilities. These land uses have communications systems, sensitive equipment, or other electronic devices that could be disrupted by EMF. Residences are considered to be EMF-sensitive because people residing in the residences could be exposed to EMF.

EMF and EMI Levels

To predict EMF levels from HSR operations, the following assessment approach was implemented:

- EMF-sensitive land uses were identified through a review of aerial imagery, county parcel data, and local planning documents.
- Baseline EMF levels were measured as described above and in Appendix 3.5-A.
- The Magnetic Field Calculation Model, a mathematical model of the HSR Build Alternative traction electrical system, was then used to calculate the anticipated maximum 60-Hz magnetic fields that a single HSR train would produce.

The model incorporates conservative assumptions for the potential EMF impacts of the HSR Build Alternative. For example, the projected maximum magnetic fields would exist only for a short period and only in certain locations as the train moves along the track or changes its speed and acceleration. The magnetic field levels would decline rapidly as the lateral distance from the tracks increases. For most locations and most times, exposure to EMFs would not be as high as predicted by the model, which predicts peak EMF levels.

The model also identifies how the projected maximum EMF levels would vary with the lateral distance from the centerline of the tracks. For sensitive land uses identified, the maximum EMF levels that would be emitted by the HSR Build Alternative were predicted and compared to measured ambient conditions. Because magnetic fields are expected to be the dominant EMF impact from HSR operations, these results are a key element in the EMF impact analysis.

Predicted EMF levels on sensitive receptors associated with the new/modified electrical infrastructure are based on the distance between the receptor and the nearest source. EMFs are also produced by electric substations, but due to the spacing of electrical equipment, measured field strengths are generally low outside the fence line of the substation. Electrical fields near substations are mainly produced by the entering and exiting power lines (Western Area Power Administration n.d.).

EMF impacts on sensitive land uses were identified based on the differences between predicted EMF levels and existing conditions. The data from the six measurement locations were generalized to represent the entire RSA. Where the predicted magnetic fields would be comparable to or lower than the typical existing levels, no adverse effect would occur, and these locations were screened out. Where the predicted magnetic fields would be higher than typical existing levels for exposure, the potential for EMI was used to evaluate whether adverse effects could be expected.

3.5.4.4 Method for Determining Significance under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (State CEQA Guidelines § 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a significance determination for each impact using a threshold-based analysis (see Section 3.1.3.4, Methods for Evaluating Impacts, for further information). By contrast, under NEPA, significance is used to determine whether an EIS will be required; NEPA requires that an EIS be prepared when the proposed federal action (project) as a whole has the potential to “significantly affect the quality of the human environment.” Accordingly, Section 3.5.9, CEQA

Significance Conclusions, summarizes the significance of the environmental impacts from EMF and EMI for the HSR Build Alternative. The Authority is using the following thresholds to determine if a significant impact from EMF or EMI would occur as a result of the HSR Build Alternative. The significance thresholds are based on relevant research and documentation on potential EMF and EMI safety levels, such as the ANSI/IEEE, FCC, and OSHA safety levels presented in Table 3.5-4. A significant impact is one that would:

- Expose a person to a documented EMF health risk, including a field intensity over the limit of an applicable standard, an electric shock, or interference with an implanted biomedical device; or
- Interfere with nearby sensitive equipment, including at hospitals, industrial and commercial facilities, railroads, rail transit systems, or airports

Human exposure and interference may be defined as follows:

- **Human Exposure**—The MPE limit (IEEE 2002, Table 2) for 60-Hz magnetic fields for the instantaneous exposure of the general public is 9.04 G (904 µT); the MPE for controlled environments where only employees are present is 27.12 G (2,712 µT). The MPE limit (IEEE Standard C95.6, Table 4) for 60-Hz electric fields for the general public is 5,000 V/m, or 5 kV/m. The MPE is 20 kV/m for controlled environments in which only HSR employees would work. MPE limits for RF exposure from HSR radio systems will be taken from Table 3.5-4 at the 450-MHz frequency. IEEE Standard C95.6 was formally adopted by ANSI and is used regularly throughout the U.S. to analyze potential impacts related to EMF. The safety levels established by this standard are well below the levels at which scientific research has shown harmful effects may occur, thus incorporating a large safety factor (ANSI/IEEE 2006). The HSR electrification and traction systems would mainly generate 60 Hz EMFs, which this standard addresses (IEEE 2002).
- **Interference**—Technical Memorandum 300.07(Authority 2012) provides typical interference levels for common types of sensitive equipment. These reported levels are used as the significance criteria for this impact analysis. From the Technical Memorandum, 2 mG is the screening level for potential disturbance to unshielded sensitive equipment. In addition, 2 mG is a typical EMF level from early epidemiological studies, which showed that it is the lowest level of chronic, long-term magnetic field exposure with no statistical association with a disease outcome (Savitz et. al. 1988; Severson et. al. 1988). The value of 2 mG also is a typical EMF level emitted from household appliances (National Institute of Environmental Health Sciences 2002).

The human exposure and equipment interference levels are summarized in Table 3.5-7. The limits for RF exposure vary by frequency, ranging from a low of 0.225 milliwatts per square centimeter (mW/cm^2) at 450 MHz, up to 1.0 mW/cm^2 at 5,000 MHz. Table 3.5-4 lists these RF exposure limits.

Table 3.5-7 Summary of CEQA Impact Thresholds

Exposure	Summary of Threshold
Human Exposure	
60 Hz, public	9.04 G for magnetic fields; 5 kV/m for electric fields
60 Hz, controlled	27.12 G for magnetic fields; 20 kV/m for electric fields
RF exposure (all)	See Table 3.5-4 for limits
Implanted medical devices	1.0 G for magnetic fields; 1 kV/m for electric fields
Equipment Interference	
Research equipment	2.0 mG for magnetic fields; electric field unspecified
Rail signaling systems	No interference permitted (functional definition, no specific threshold)
Airport communications	No interference permitted (functional definition, no specific threshold)

Source: Institute of Electrical and Electronics Engineers, 2002
G = gauss
Hz = hertz
kV/m = kilovolt per meter
mG = milligauss
RF = radio frequency

3.5.5 Affected Environment

This section describes the affected environment related to EMF and EMI in the RSA, including sources of EMF and EMI, local conditions, receivers susceptible to EMI or EMF impacts, and railroad and transportation equipment susceptible to EMF or EMI impacts. This information provides the context for the environmental analysis and evaluation of impacts.

The RSA lies within an urban area and is heavily developed with densely spaced residential housing, high-voltage overhead power lines and associated urban infrastructure. These areas may include laboratories and other facilities that operate EMI-sensitive research or medical devices. Approximately 100 television and radio (AM and FM broadcast) transmitters operate within the region. In addition, there are dozens of cellular communications towers and point-to-point microwave links operating in the region, as well as intermittent fixed and mobile RF sources. This activity results in uniform and relatively high background levels within the RSA over much of the RF spectrum.

A summary of stakeholder issues and concerns related to EMI and EMF from public outreach efforts can be found in Chapter 9, Public and Agency Involvement.

3.5.5.1 Local Conditions

Existing local conditions were determined by measuring EMF levels at six representative locations within the RSA. Table 3.5-8 summarizes the locations where EMF measurements were performed, and Figure 3.5-2 illustrates these locations along the HSR Build Alternative. These six sites provide a representative sampling of the areas within the RSA, chosen per the site selection criteria provided in the *Measurement Procedure for Assessment of the CHSTP Alignment EMI Footprint* (Authority 2010a). All measurement locations are between Burbank Airport Station and U.S. Route 101, which is heavily developed and includes industrial and commercial areas, high-voltage overhead power lines, and associated urban infrastructure. These areas may include laboratories and other facilities that engage in EMI-sensitive research or operate medical devices.

Table 3.5-8 Electromagnetic Field Measurement Locations

Site No.	Location	Nearest Cross Streets	Location	Notable EMF Sources	Sensitive Receptors
1	Burbank	Empire Ave/ Catalina St	34.190964°, -118.341669°	Cell towers, Hollywood Burbank Airport communications and navigation RF sources	Mixed residential/commercial area
2	Burbank	Olive Ave/ Flower St	34.178848°, -118.313265°	Few visible local emitters	Commercial/industrial area near the Downtown Burbank Metrolink station
3	Glendale	San Fernando Rd/Sonora Ave	34.165169°, -118.288816°	Nearby power distribution, railway communications	Industrial/commercial area adjacent to existing rail lines
4	Glendale	San Fernando Rd/Colorado Blvd	34.141646°, -118.269653°	Nearby power distribution, cell towers	Industrial/commercial area; potentially sensitive receptors nearby
5	Glendale	Cerritos Ave/ Gardena Ave	34.123241°, -118.258481°	No visible RF emitters	Industrial/residential area, at the Glendale Metrolink station
6	Cypress Park	San Fernando Rd/Macon St	34.099254°, -118.238545°	Some power transmission lines 750 feet away; no visible RF emitters	At Rio de Los Angeles State Park; light industrial area

Source: California High-Speed Rail Authority, 2017
EMF = electromagnetic field RF = radio frequency

3.5.5.2 Populations near High-Voltage Transmission Lines

There are some occupied structures near the proposed locations for the traction power facilities and associated utility feeds. However, only one industrial building was closer than 100 feet to the nearest traction power facility, and no sensitive receptors were identified within 500 feet.

While the EMF levels developed at or just outside of the fence line of these facilities (or the right-of-way fence line in the case of high-voltage transmission lines) would in most cases exceed the prevailing ambient levels, they would not exceed the electric or magnetic MPE limits for occupational or general public exposure.

3.5.5.3 High-Speed Rail Equipment Susceptible to EMI Effects from Other Transmitters along the Right-of-Way

No emitters were identified that would pose a threat to the RF portions of the HSR communications or control systems. Higher-powered broadcast sources in the region operate at spectrally remote frequencies and are too distant to degrade HSR control or communications equipment. Military and airport transmitters in the region are similarly too distant to present a plausible risk anywhere along the HSR Build Alternative.

3.5.5.4 Measured Electromagnetic Field Levels

The field survey included measurements of existing RF levels from 10 kHz to 6 GHz. This frequency range encompasses many different applications, including broadcast radio and digital television signals, fixed and mobile communications, cellular telephones, and radar and navigation systems. In general, the measured RF levels were consistently high and quite uniform between sites and were consistent with levels observed in other highly urbanized areas.

The survey also quantified typical power-frequency magnetic field levels along the section to characterize typical DC and ELF (up to 1,000 Hz) sources such as high-voltage transmission lines, electrical distribution lines, and electrical substations or generating equipment. The maximum or peak 60-Hz magnetic fields recorded in this survey varied from 0.1 mG to approximately 1.1 mG, with levels depending primarily on the measurement locations' proximity to local distribution and transmission power lines. Appendix 3.5-A provides additional analysis and the full measurement results from the field survey.

Table 3.5-9 summarizes the distance between each measurement site and the nearest proposed electrified track, the average measured DC and AC (60-Hz) magnetic field strengths, and the measured maximum electric field strengths at each of the test sites.

Table 3.5-9 Summary Comparison of Measured and Modeled Magnetic Fields

Site No. and Location	Distance to nearest HSR track (feet)	Measured Average DC field (mG)	Measured Average 60-Hz field (mG)	Measured Maximum Electric Field (V/m/MHz)
1 – Burbank	415	448	0.17	15.3
2 – Burbank	30	395	0.14	15.5
3 – Glendale	60	471	1.23	17.0
4 – Glendale	30	480	1.33	20.2
5 – Glendale	145	443	0.60	18.4
6 – Cypress Park	65	462	0.17	11.6

Source: California High-Speed Rail Authority, 2017
DC = direct current mG = milligauss
Hz = hertz v/m/MHz = volts per meter per megahertz

The observed 60 Hz magnetic field levels at the six measurement locations within the RSA are uniformly below the threshold for EMI effects (2.0 mG) or the most stringent limit for any health-related effects (1,000 mG). Similarly, the observed electric field strengths were well below the exposure limit of 1000 V/m.

3.5.5.5 Sensitive Receptors and Facilities

Table 3.5-10 lists the 17 facilities within the RSA identified as potentially sensitive receptors, along with their distance from the HSR Build Alternative and predicted maximum HSR field strengths for a single train. These receptors were determined to be potentially sensitive based on their location within the RSA for the HSR Build Alternative. In addition to these facilities shown in Table 3.5-10, existing rail systems, buried pipelines, ungrounded metallic fencing, and other linear structures of concern are known to occur in the RSA and have potential EMI concerns. This analysis included Hollywood Burbank Airport as a sensitive receptor given the safety-critical nature of the airport's radio-based systems and uncertainties about the locations of much of the airport equipment.

Table 3.5-10 List of Potentially Sensitive Receptors

Receptor Site ID and Name	Location	Distance to Nearest Track (feet)[1]	Distance to Nearest Construction Easement (feet)	Modeled 60 Hz Field (mG)[2]	Receptor Site Notes
1 – Hollywood Burbank Airport	2627 Hollywood Way, Burbank	50 (estimated)	Adjacent	52.6	Site adjacent to airport property, HSR in tunnel
2 – Gross Park	2800 Empire Ave, Burbank	30	Adjacent	148	Community park, 4.87 ac, HSR passes under park (in tunnel)
3 – Griffith Manor Park	1551 Flower St, Glendale	480	240	0.53	Community park, 2.5 ac, southwest of HSR tracks

Receptor Site ID and Name	Location	Distance to Nearest Track (feet)[1]	Distance to Nearest Construction Easement (feet)	Modeled 60 Hz Field (mG)[2]	Receptor Site Notes
4 – Pelanconi Park	1000 Grandview Ave, Glendale	410	215	0.74	Park and recreation center, 4.0 ac, northeast of HSR tracks
5 – Baxter Healthcare	4501 Colorado Blvd, Los Angeles	75	60	23.1	Possible NMR operator, but unknown equipment, west of HSR tracks
6 – Pacific Park	501 Pacific Ave, Glendale	450	175	0.61	Park and recreation center, 3.5 ac, east of HSR tracks
7 – Chevy Chase Recreation Area	4165 Chevy Chase Dr, Los Angeles	200	95	3.2	Community park, 2.44 ac, west of HSR tracks
8 – Segray Preschool	3201 La Ciede Ave, Los Angeles	425	400	0.7	Preschool in residential area southwest of HSR tracks
9 – LA Community College	2930 Fletcher Dr, Los Angeles	145	115	6.1	Co-located with Environmental Science High School (charter), northeast of HSR tracks
10 – Los Feliz Charter School	2709 Media Center Dr, Los Angeles	75	Adjacent	23.1	K-6 charter school, east of HSR tracks
11 – Sotomayor High School	2050 San Fernando Rd, Los Angeles	135	65	7.0	Large (20 ac) campus housing, 1 middle school, 2 high schools, east of HSR tracks
12 – Rio de Los Angeles State Park	1900 San Fernando Rd, Los Angeles	60	Adjacent	36.4	Park and recreation center, 39.4 ac, northeast of HSR tracks
13 – Cypress Park	2630 Pepper Ave, Los Angeles	430	Adjacent	0.67	Park and recreation center, 3.5 ac, east of HSR tracks
14 – Steelhead Park	2239 Oros St, Los Angeles	440	410	0.64	Community park, 0.2 ac, west of HSR tracks
15 – River Garden Park	570 Ave 26, Los Angeles	460	Adjacent	0.58	Community park, 1.1 ac, east of HSR tracks
16 – Confluence Park	San Fernando Rd / Figueroa St, Los Angeles	180	Adjacent	3.9	Community park, 0.4 ac, east of HSR tracks
17 – Los Angeles County Sheriff Station	441 Bauchett St, Los Angeles	170	155	4.4	County Sheriff/Men's Central Jail, southeast of HSR tracks

Source: California High-Speed Rail Authority, 2017
[1] HSR transits Receptor Site 2 while in tunnel. A nominal 30-foot distance has been assigned in these cases.
[2] Calculated magnetic field for a single HSR train passing the measurement location. Estimated from Figure E-1b of *Technical Memorandum 3.4.11, Measurement Procedure for Assessment of CHSTP Alignment EMI Footprint*.(Authority 2010a)
ac = acre(s)
mG = milligauss
HSR = high-speed rail
NMR = nuclear magnetic resonance

3.5.6 Environmental Consequences

3.5.6.1 Overview

This section evaluates how the No Project Alternative and the HSR Build Alternative could affect EMF and EMI levels. Generation of EMFs and EMI could result in impacts on sensitive receptors and facilities including humans, sensitive equipment, and underground pipelines and cables and adjoining rail systems. This section lists the magnetic field levels used to evaluate the context and intensity of potential impacts. The impacts of the HSR Alternative are described and organized as follows:

- **Construction Impacts**
  - Impact EMI/EMF #1: Temporary Impacts from Use of Heavy Construction Equipment
  - Impact EMI/EMF #2: Temporary Impacts from Communications Equipment
  - Impact EMI/EMF #3: Temporary Impacts from Operation of Electrical Equipment
- **Operations Impacts**
  - Impact EMI/EMF #4: Permanent Human Exposure to Electromagnetic Fields
  - Impact EMI/EMF #5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields
  - Impact EMI/EMF #6: Permanent Interference with Sensitive Equipment
  - Impact EMI/EMF #7: Electromagnetic Interference Effects on Schools
  - Impact EMI/EMF #8: Potential for Corrosion of Underground Pipelines, Cables, and Adjoining Rail
  - Impact EMI/EMF#9: Potential for Nuisance Shocks
  - Impact EMI/EMF #10: Effects on Adjacent Existing Rail Lines
  - Impact EMI/EMF #11: Effects Related to Adjacent Airports

3.5.6.2 No Project Alternative

Recent development trends are expected to continue through 2040 (see Section 2.5.1.1, Planned Land Use) within the Burbank to Los Angeles Project Section under the No Project Alternative. In general, the RSA is highly urbanized. The areas surrounding the RSA are largely built out and can add population and businesses only though limited infill and more intensive development. However, it is reasonable to assume that the use of electricity and RF communication equipment, including high-voltage transmission/power lines and directional and nondirectional (cellular and broadcast) antennas that result in EMFs and EMI, would continue and would likely increase throughout the RSA. Population growth alone would result in additional use of electricity and RF communications, consistent with that found in the urban environments contained in the RSA today. The development of new schools, hospitals, police stations, and other facilities with sensitive equipment would increase the prevalence of receptors potentially sensitive to EMI.

By 2040, the use of electricity and RF communications would increase along with increased development, greater use of electrical devices, and technological advances in wireless transmission (such as wireless data communication). As a result, increased generation of EMF and EMI that might affect people and sensitive receptors is expected. Planned development and transportation projects that would occur under the No Project Alternative would likely include building and equipment design features intended to address increased levels of EMF and EMI.

3.5.6.3 High-Speed Rail Build Alternative

Construction and operations of the HSR Build Alternative could result in temporary and permanent EMF and EMI impacts. Impacts could potentially include changes in the levels of exposure of sensitive receptors to EMF and EMI.

Impacts of the HSR Build Alternative are described below by construction and operational impacts.

Construction Impacts

Construction of the HSR Build Alternative would involve demolition of existing structures, clearing and grubbing; handling, storing, hauling, excavating, and placing fill; possible pile driving; and construction of aerial structures, bridges, road modifications, utility upgrades and relocations, HSR electrical systems, and railbeds. Chapter 2, Alternatives, describes construction activities.

Impact EMI/EMF #1: Temporary Impacts from Use of Heavy Construction Equipment

Construction of the HSR Build Alternative would require the temporary use of heavy equipment, trucks, and light vehicles, which, like all motor vehicles, generate EMFs. Additionally, many types of construction equipment contain electric motors that also generates EMFs. Movement of large construction vehicles could result in transient changes to the static (DC) magnetic field. While such changes can interfere with some sensitive equipment, construction vehicles must be both very large and operate very closely to the equipment in question to cause interference. As an example, articulated buses (approximately 50,000 pounds) produce magnetic field shifts of approximately 0.5 mG at a distance of 70 feet (Electric Research & Management 2007). For a construction vehicle of twice this mass, the magnetic field shift would be 1 mG at 70 feet or at the threshold level of 2 mG at 50 feet. A vehicle with half the mass would need to be within 25 feet to generate the same field shift. Because the magnitude of this disturbance decreases with distance, all but the largest construction vehicles pose no reasonable risk to magnetically sensitive equipment at pass-by distances greater than 50 feet. As the only site within the RSA that houses sensitive equipment, the potential for this impact applies only at Receptor Site 5 (Baxter Healthcare) in Los Angeles.

When heavy construction equipment encroaches within 50 feet, the Authority and its contractors would coordinate with third-party owners of these facilities and, if necessary, apply EMI/EMF-IAMF#2 to avoid or minimize potential interference. As part of the Implementation Stage Electromagnetic Compatibility Program Plan (ISEP), the Authority would monitor field conditions to determine if such EMC issues arise and provide the necessary coordination with affected third parties and the construction contractor to resolve the problem. In the case of Receptor Site 5, steps to resolve such problems could include equipment shielding, equipment relocation, or coordination of construction activities to avoid interference.

It is unlikely that the conditions described above would actually occur during construction. If they were to, it is almost certain that the steps provided as part of EMI/EMF-IAMF#2 would avoid any construction-related impacts. This is particularly true, given the temporary nature of the disruption. Any remaining impacts would be further reduced by implementing EMI/EMF-MM#1 (described in more detail in Section 3.5.7, Mitigation Measures). Under this mitigation measure, the Authority would contact the affected third parties and determine how best to protect sensitive equipment, either through relocation or shielding in place.

The type, number, and size of construction equipment in use can be expected to vary along the subsection, depending upon the type of construction activities involved. Unintended EMF from use of construction vehicles, heavy equipment, and electric motors would be minor, and radio communications systems used on construction sites would comply with FCC regulations. Therefore, construction of the HSR Build Alternative would not:

- Be a substantial source of EMI that could expose a person to a documented health risk
- Cause electric shocks
- Interfere with implanted medical devices
- Interfere with unshielded sensitive equipment
- Affect the operation of nearby railroads, airports, or other businesses

Substantial EMF fluctuations caused by construction vehicle movements would be limited to within 50 feet of the construction footprint, and radio communications systems would comply with FCC regulations designed to prevent EMI. EMF fluctuations caused by construction vehicle movements would be limited to within 50 feet of the construction easement and, with implementation of EMI/EMF-IAMF#2 and, when necessary, EMI/EMF-MM#1, impacts would be minimized. The potential for this impact would only occur at Receptor Site 5 (Baxter Healthcare in Los Angeles), identified in Table 3.5-10.

CEQA Conclusion
Even with implementation of EMI/EMF-IAMF#2, the possibility of construction-related impacts could remain and the impact under CEQA could still be significant at one receptor, Receptor Site 5 (Baxter Healthcare), where magnetic fields may exceed the numerical threshold of 2.0 mG. Therefore, CEQA does require mitigation. EMI/EMF-MM#1 is required to reduce these impacts. The Authority would implement EMI/EMF-MM#1 by contacting affected third parties to explore the possibility of either relocating or shielding the affected equipment, and the Authority would implement such measures to eliminate the interference. Where necessary to avoid interference, the final design would include suitable design provisions to prevent interference. These design provisions may include establishing magnetic field shielding walls around sensitive equipment or installing RF filters into sensitive equipment. With implementation of EMI/EMF-MM#1, temporary construction impacts on sensitive equipment would be less than significant under CEQA because actions such as relocating or shielding affected equipment would eliminate the interference.

Impact EMI/EMF #2: Temporary Impacts from Communications Equipment

The only EMF likely to be generated during construction would be occasional licensed radio transmissions between construction vehicles. As indicated in Section 3.5.2, Laws, Regulations, and Orders, the HSR Build Alternative would adhere to 47 C.F.R. 15 and its general provision that devices may not cause interference, must accept interference from other sources, and must prohibit the operation of devices once the operator is notified by the FCC that the device is causing interference. Through compliance with 47 C.F.R. 15, the HSR Build Alternative would result in no impact from EMF generated by radio transmissions between construction personnel.

CEQA Conclusion
Through compliance with 47 C.F.R. 15 during construction of the HSR Build Alternative, EMF generated by communications equipment during construction of the HSR Build Alternative would not exceed the thresholds identified in Table 3.5-4 and Table 3.5-7, and it would not expose people to an EMF health risk or cause EMI with nearby equipment. The impact under CEQA would be less than significant. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #3: Temporary Impacts from Operation of Electrical Equipment

Many types of construction equipment contain generators or electric motors that also generate EMFs. However, these sources of EMFs would not generate substantial EMI beyond the construction footprint and do not present a health risk to workers or the general public. Electric welding equipment is perhaps the one instance where substantial magnetic fields could be generated. Welders with implanted medical devices and using high welding currents (greater than 225 amperes) should work with caution (Fetter 1996), but others, including those with implanted medical devices, are not at risk.

Regarding sensitive equipment, magnetic field strengths from large electric welders could be in the range of 1 to 5 mG at a distance of 50 feet, so transient interference with magnetically sensitive equipment is possible. In such instances, EMI/EMF-IAMF#2 would be employed to minimize impacts. As part of the ISEP, the Authority would monitor field conditions to determine if such EMC issues arise, and provide the necessary coordination with affected third parties and the construction contractor to resolve the interference. In the case of Receptor Site 5(Baxter Healthcare) in Los Angeles, steps to resolve such problems could include equipment shielding, equipment relocation, or coordination of construction activities to avoid interference.

Potential for this impact applies only at Receptor Site 5 (Baxter Healthcare) in Los Angeles. As with Impact EMI/EMF #1, above, it is unlikely that the conditions described above would occur during construction. If they do, measures implemented as part of EMI/EMF-IAMF#2 would fully avoid and minimize any environmental impacts. Any remaining impacts would then be addressed by implementing EMI/EMF-MM#1, which would require the Authority to contact the affected third parties and determine how best to protect sensitive equipment, either through relocation or shielding in place.

In summary, with implementation of EMI/EMF-IAMF#2 and EMI/EMF-MM#1, operation of electric equipment during construction of the HSR Build Alternative would not:

- Create a substantial source of EMI that could expose a person to a documented health risk
- Interfere with implanted medical devices
- Interfere with unshielded sensitive equipment

CEQA Conclusion

Even with implementing EMI/EMF-IAMF#2 to address possible temporary impacts from the operation of high-current electrical welding equipment during construction, the impact under CEQA could still be significant at Receptor Site 5 (Baxter Healthcare) because construction-generated magnetic fields could exceed 2 mG. Therefore, CEQA requires mitigation. To reduce these environmental impacts, the Authority would implement EMI/EMF-MM#1, which requires affected third parties to be contacted to explore the possibility of either relocating or shielding affected equipment in order to eliminate the interference. With the implementation of EMI/EMF-MM#1, temporary impacts from the operation of electrical welding equipment during construction would be less than significant under CEQA because actions such as relocating or shielding affected equipment would eliminate the interference.

EMF exposure of the general public, including those with implanted medical devices, would not exceed the threshold for human exposure listed in Table 3.5-7, and the impact under CEQA would be less than significant.

Operations Impacts

Operation of the HSR Build Alternative would include routine HSR service, inspection, and maintenance along the track and railroad right-of-way, as well as on the structures, fencing, power system, train control, and communications system. Chapter 2, Alternatives, describes operations and maintenance activities.

Impact EMI/EMF #4: Permanent Human Exposure to Electromagnetic Fields

Human exposure to EMF during operation of the HSR Build Alternative would be permanent but intermittent. Operation of the HSR Build Alternative would generate 60-Hz electric and magnetic fields on and adjacent to trains, including in passenger station areas. Table 3.5-11 presents predicted HSR Build Alternative exterior EMF levels that passengers and other members of the public could be exposed to at a station platform, at the fence line, and 500 feet from the HSR Build Alternative centerline. In all cases, the predicted EMF value would be less than the thresholds of 5 kV/m for electric fields and 9.04 G for magnetic fields for public exposure identified for the HSR Build Alternative.

Table 3.5-11 Summary of High-Speed Rail Build Alternative Exterior EMF Levels

EMF Analysis	Platform: 16 feet from HSR Alignment Centerline	Fence Line: 30 feet from HSR Alignment Centerline	RSA: 500 feet from HSR Alignment Centerline
Electric Field (V/m), typical 2-track OCS geometry[1]	810	110	Less than 1
Magnetic Field (mG) Single-Train HSR[2]	720	177	Less than 1

[1] *Source: California High-Speed Rail Authority, 2017*
[2] *Source: California High-Speed Rail Authority, 2011a*
EMF = electromagnetic field
OCS = overhead contact system
HSR = high-speed rail
V/m = volts per meter
mG = milligauss

Differences in Electrification Methods

The HSR system would use a 2 x 25-kV supply that includes a negative feeder wire running parallel to the contact wire. This arrangement differs in some cases from those employed by the Acela Express and *Train à Grande Vitesse* systems, and in general, it would produce magnetic fields that are equal to or lower than the quoted values. For example, the electrified Northeast Corridor used by the Acela Express is not strictly 2 x 25 kV; some sections are 1 x 12.5 kV or 11.5 kV. Magnetic fields in those sections without the negative return feeder would be higher than in sections with the 2x25-kV traction system arrangement.

Passengers on HSR trains would also be exposed to EMF. Magnetic field measurements have been made in the passenger compartments onboard other HSR systems such as the Acela Express (119 mG) and the French *Train à Grande Vitesse* A (165 mG), as well as in the operator's cab of the Acela Express (58 mG) and *Train à Grande Vitesse* A (367 mG) (FRA 2006).

The design of the HSR Build Alternative would substantially limit and control EMF exposure to passengers and HSR workers. Human exposure to operational EMFs generated by the trains, the OCS, wayside equipment, or HSR maintenance activities would fall well below the MPE limit. Passengers and HSR workers would not be exposed to an EMF health risk.

Permanent EMF effects on people at nearby schools and colleges (Receptor Sites 7 through 11 in Table 3.5-10), and parks (Receptor Sites 1 through 3, 5, 6, and 12 through 16 in Table 3.5-10) would be substantially below the IEEE Standard 95.6 MPE limit of 9.04 G for the public because measurements of existing systems indicate that, even within the HSR right-of-way, these levels would not be reached.

In summary, through compliance with EMI/EMF-IAMF#2, which requires the design of systems to control EMF effects, operation of the HSR Build Alternative would have no impact resulting from permanent human exposure to EMF.

CEQA Conclusion

The impact resulting from permanent human exposure to EMF under CEQA would be less than significant because people would be not be exposed to a documented EMF health risk, including a field intensity over the limit of an applicable standard. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields

Passengers and members of the public with implanted medical devices are especially sensitive to EMF. Magnetic fields of 1,000 to 12,000 mG (1 to 12 G) may interfere with implanted medical devices (Electric Power Research Institute 2004). The American Conference of Governmental Industrial Hygienists recommends magnetic and electric field exposure limits of 1,000 mG and 1 kV/m, respectively, for people with pacemakers (American Conference of Governmental Industrial Hygienists 2015). These levels would occur only inside the switching station south of Verdant Street and west of the railroad right-of-way, and the paralleling station located south of Main Street between the railroad right-of-way and the Los Angeles River. These facilities are unmanned and inaccessible to the general public, because they are located within the fenced right-of-way (50 feet) surrounding the 115-kV and 230-kV utility feeds. Because the electrified interconnection facilities are only accessible to authorized personnel, they would not present a health risk to HSR passengers or members of the public with implanted medical devices. Impacts from exposure to EMF within interconnection facilities would be eliminated through implementation of EMI/EMF-IAMF#2. A provision in the ISEP requires signs to be posting at the switching stations and on tie-line structures warning people with an implanted medical device of the potential for high levels of EMF, avoiding the potential for interference and related health risks.

Alterations to or reconductoring of utility power lines supplying the HSR traction power system would result in little or no change in baseline conditions and would not result in electric or magnetic fields exceeding the recommended exposure limits.

Although EMF levels within interconnection facilities could interfere with implanted medical devices, these facilities would be inaccessible to the general public, and the EMCPP would restrict workers with implanted medical devices from accessing these facilities. These measures would reduce the potential health risk for the public and workers with implanted medical devices.

CEQA Conclusion
With implementation of EMI/EMF-IAMF#2, during operation of the HSR Build Alternative the impact on people with implanted medical devices and exposure to EMF under CEQA would be less than significant. The relevant areas would be off limits to the general public, and signs would be posted to alert employees to avoid potentially hazardous conditions and there would be no human health risk. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #6: Interference with Sensitive Equipment

Medical and high-tech facilities commonly contain equipment that could be affected by EMI, including equipment sensitive to small variations in the surrounding magnetic field (e.g., medical MRI scanners, NMR spectrometers) and focused-beam devices (e.g., electron microscopes, ion-writing systems). Other forms of equipment sensitive to EMI include fire and police radio services, which could be affected by RF interference.

One facility was identified in the RSA that potentially operates magnetically sensitive equipment (NMR spectrometers at Receptor Site 5 in Table 3.5-10). The potential for interference with sensitive equipment in use at high-tech facilities would be addressed through the Authority's EMCPP and the design criteria for constructing and operating the HSR Build Alternative. The EMCPP defines the HSR system's High-Speed Transport Protocol Electromagnetic Compatibility objective (see Section 3.5.2.2, State), which provides for compatibility with equipment of all neighboring facilities. In conformance with the EMCPP and ISEP (Technical Memorandum 300.10), the Authority and its contractors would coordinate with third-party owners of sensitive facilities and equipment in the RSA for constructing and operating the HSR Build Alternative and, if necessary, take steps to avoid or mitigate potential interference. As part of EMI/EMF-IAMF#2 and the ISEP, the Authority would monitor field conditions to determine if such EMC issues arise and provide the necessary coordination with affected third parties to resolve the problem. Chapter 26 of the *California High-Speed Rail Design Criteria Manual* describes the EMI-related measures that could be used to minimize impacts on sensitive equipment, such as equipment siting (Authority 2014c). The Authority would also conduct tests prior to operation of the HSR Build Alternative to confirm equipment would not be affected. These project features would minimize the potential for interference with sensitive equipment at high-tech facilities during operation of the HSR Build Alternative.

There is also one police station located within the RSA (Receptor Site 18 as listed in Table 3.5-10). RF interference with police radio systems associated with HSR radio systems used for enhanced automatic train control, data transfer, and communications would be avoided by implementing EMI/EMF-IAMF#2. The HSR Build Alternative design would comply with the ISEP, which provides detailed EMC criteria for the HSR systems and equipment. As part of the ISEP, the Authority would confirm compatibility of the HSR with the police station's radio systems to avoid potential RF interference. The Authority has acquired two dedicated frequency blocks, each with a width of 4 MHz, for use by automatic train control systems and other wireless communications needs. These blocks would be dedicated for HSR use to avoid EMI with other users due to HSR radio systems (Authority 2011a, 2014a). Most radio systems procured for HSR use would be commercial off-the-shelf systems conforming to FCC regulations in 47 C.F.R. 15, which contain emissions requirements designed to ensure EMC among users and systems. The Authority would require all noncommercial off-the-shelf systems procured for the HSR system to be certified in conformity with FCC regulations for 47 C.F.R. Part 15, Sub-Part B, Class A devices. HSR radio systems would also meet emissions and immunity requirements designed to ensure EMC with other radio users that are contained in the European Committee for Electrotechnical Standardization[2] (CENELEC) EN 50121-4 Standard for railway signaling and telecommunications operations (CENELEC 2006).

[2] Comité Européen de Normalisation Électrotechnique.

Whether interference with a given piece of sensitive instrumentation might occur is contingent on a number of presently unknown factors, including the equipment type and model, where it is located in the building, and whether the instrument has already been shielded. It is unlikely that all the conditions required for impacts would actually occur in the Burbank to Los Angeles Project Section, and the steps provided in EMI/EMF-IAMF#2 would likely avoid any such impacts. However, should EMI/EMF-IAMF#2 not fully reduce or avoid impacts, impacts could be further reduced by implementing EMI/EMF-MM#1, under which the Authority would contact the affected third parties and explore the possibility of shielding or relocating the affected equipment.

In summary, through compliance with EMI/EMF-IAMF#2, EMF generated during operation of the HSR Build Alternative might interfere with sensitive equipment, including high-tech electronic devices, but not with police and fire radio services. Interference with police and fire radio services would be avoided because the HSR Build Alternative includes use of dedicated frequency blocks and procurement of communications equipment meeting FCC regulations. The potential for interference with high-tech electronic devices would be minimized through project design to prevent EMI with identified neighboring uses. In addition, with implementation of EMI/EMF-MM#1, the Authority would coordinate with third parties to identify nearby sensitive equipment, including the one high-tech facility identified in the RSA (Receptor Site 5, Baxter Healthcare) with the potential to be affected by the HSR system, and, if necessary, identify appropriate mitigation to avoid these effects, including performing tests to confirm equipment is free from effects.

CEQA Conclusion

Even with implementation of the EMI/EMF-IAMF#2 to address interference with sensitive equipment during operation of the HSR Build Alternative, the impact under CEQA could still be significant, affecting research instrumentation at one receptor location (Receptor Site 5, Baxter Healthcare) because HSR-generated magnetic fields would exceed 2 mG. Therefore, CEQA does require mitigation. EMI/EMF-MM#1 is required to reduce these impacts. The Authority would implement EMI/EMF-MM#1 by contacting affected third parties to explore the possibility of either relocating or shielding the affected equipment and committing to implement the mitigation. With the implementation of EMI/EMF-MM#1, impacts from interference with sensitive equipment during operation of the HSR Build Alternative would be less than significant under CEQA.

Impact EMI/EMF #7: Electromagnetic Interference Effects on Schools

The HSR Build Alternative would use radio systems for the enhanced automatic train control, data transfer, and communications systems, which would have the potential to result in EMI with the radio systems at nearby schools and colleges. There are four schools within the RSA, listed as Receptor Sites 7, 9, 10, and 11 in Table 3.5-10.

HSR radio systems would transmit radio signals from antennas located at stations and along the track alignment, as well as on locomotives and train cars. As described in Impact EMI/EMF #6 above, the Authority has acquired two dedicated, exclusive-use frequency blocks for the enhanced automatic train control systems, so EMI with other users would not be expected. Communications systems at stations may operate at WiFi frequencies to connect to stationary trains; channels would be selected to avoid EMI with other users, including WiFi systems in use at nearby schools (Authority 2011a, 2014a). RF interference with school WiFi systems associated with HSR radio systems used for enhanced automatic train control, data transfer, and communications would be avoided through the design characteristics and project features of EMI/EMF-IAMF#2. The HSR Build Alternative design would comply with the ISEP, which provides detailed EMC design criteria for the HSR systems and equipment. The Authority would implement an EMCPP during project planning and implementation to ensure EMC with radio systems operated by neighboring uses, including schools and colleges. During the planning stage through system design, the Authority would perform EMC/EMI safety analyses, which would include identification of existing nearby radio systems, design of systems to prevent EMI with identified neighboring uses, and incorporation of these design requirements into bid specifications used to procure radio systems.

During operations, the Authority would conduct monitoring and evaluation of system performance. This would minimize the potential for HSR-generated EMF to affect school communication systems. Moreover, most radio systems procured for HSR use would be commercial off-the-shelf systems conforming to FCC regulations in 47 C.F.R. 15, which contain emissions requirements designed to ensure EMC among users and systems. The Authority would require all noncommercial off-the-shelf systems procured for HSR use to be certified in conformity with FCC regulations for 47 C.F.R. Part 15, Sub-Part B, Class A devices. HSR radio systems would also meet emissions and immunity requirements designed to ensure EMC with other radio users that are contained in the European Committee for Electrotechnical Standardization EN 50121-4 Standard for railway signaling and telecommunications operations (CENELEC 2006).

CEQA Conclusion

EMI with school communication systems would be avoided through system design, compliance with FCC Part 15 regulations, and procedures contained in EMI/EMF-IAMF#2. The impact under CEQA would be less than significant because radio systems used during HSR Build Alternative operations would not be expected to interfere with nearby sensitive communications equipment at schools. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #8: Potential for Corrosion of Underground Pipelines and Cables and Adjoining Rail

The OCS delivers AC current to the HSR trains, with return current flowing from the trains back to the traction power substations (TPSSs) through the steel rails and static wires in the immediate vicinity of the train. At the first paralleling station location, most of the rail return current to the TPSS would be transferred from the rails to the negative feeder due to the autotransformer action. While most return current would be carried by the negative feeder and the static wire back to the TPSS, some return current would continue to find a path through rail connections to ground, and through leakage to ground via the track ballast or insulated clips in nonballasted track sections.

Soils in the RSA tend to be sandy and dry (except where irrigated) and have higher electrical resistivity and lower ability to carry electrical current than soils with more clay and moisture content (refer to Section 3.9, Geology, Soils, and Seismicity, for additional information regarding soil and geologic conditions). Nevertheless, other linear metallic objects, such as buried pipelines or cables, or adjoining rails that parallel the HSR line could carry some AC ground current. AC ground currents have a much lower propensity to cause corrosion in parallel conductors than the DC currents used by rail transit systems such as Bay Area Rapid Transit or the Los Angeles County Metropolitan Transportation Authority (Barlo 1995). However, stray AC currents might cause corrosion by galvanic action. EMI/EMF-IAMF#2 would help avoid and minimize the potential for corrosion impacts on underground pipelines, cables, and adjoining rail.

The Authority would implement and follow the ISEP (Authority 2014a) to help avoid and minimize possible impacts on underground pipelines and cables, including the grounding of pipelines (EMI/EMF-IAMF#2). If adjacent pipelines and other linear metallic structures are not sufficiently grounded through the direct contact with earth, the Authority would include additional grounding of pipelines and other linear metallic objects, in coordination with the affected owner or utility, as part of the construction of the HSR Build Alternative. Inventories of pipelines within the RSA have been identified in related studies (see Section 3.6, Public Utilities and Energy). The contractor would follow the procedures set out in the ISEP to help avoid and minimize the potential for impacts on underground pipelines and cables, including the grounding of pipelines. Alternatively, insulating joints or couplings may be installed in continuous metallic pipes to prevent current flow. Specific measures for avoiding stray current corrosion are discussed in the Chapter 23 of the *Design Criteria Manual* (Authority 2014c) and in detail in “Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems,” NACE SP0177 (NACE 2014). The preventive measures described above, as well as measures such as applying (or repairing) structure coatings and providing cathodic protection, are standardized practices that prevent corrosion. As a result of these steps, the potential for corrosion from ground currents resulting from operation of the HSR Build Alternative would be avoided.

Ground currents generated by operation of the HSR Build Alternative could result in corrosion of underground pipelines and cables. However, project features incorporated into EMI/EMF-IAMF#2 of the HSR Build Alternative, discussed above, include arranging for the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent current flow, such that corrosion would be minor.

CEQA Conclusion

With implementation of EMI/EMF-IAMF#2 and the measures called for in Chapter 23 of the *Design Criteria Manual* (Authority 2014b), operations impacts under CEQA would be less than significant because corrosion of underground pipelines and cables from ground currents would be minor. Project features would minimize corrosion risks by arranging for the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent current flow. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #9: Potential for Nuisance Shocks

Nuisance shocks can occur when induced electrical currents build voltage in ungrounded linear metal structures that are capable of conducting electric current. EMF from the voltage on, and from currents running through, the OCS could induce voltage and current in nearby conductors, such as ungrounded metal fences alongside the HSR alignment. This effect would be more likely where long (1 mile or more), ungrounded fences run parallel to the HSR and are electrically continuous throughout that distance. Such voltages potentially could cause a nuisance shock to anyone who touches such a fence. Other adjacent metal structures such as communications towers should already be properly grounded using National Electrical Code guidelines at Article 250 (NFPA 2019) for building and electrical system safety and lightning protections.

To avoid shock hazards, the HSR Build Alternative design includes grounding and bonding of all HSR metallic fences and of non-HSR parallel metal fences (with the cooperation of the affected owner or utility) within a specified lateral distance of the HSR alignment. As part of EMI/EMF-IAMF#2, ungrounded fences with a potential for nuisance shocks would be identified as part of the EMC coordination effort (Authority 2014a). Section 5 of the ISEP and Chapter 22 of the HSR *Design Criteria Manual* (Authority 2014c) detail the contractor responsibilities and the grounding techniques to be applied. Furthermore, modifications to utility facilities would be implemented pursuant to the CPUC General Order 95 (Rules for Overhead Electric Line Construction) and General Order 174 (Rules for Electric Utility Substations). Such measures would minimize the possibility of nuisance shocks. For cases where such fences are purposely electrified, specific insulation design measures would be implemented to minimize the potential for nuisance shocks.

Electrical currents generated by operation of the HSR Build Alternative could result in nuisance shocks from ungrounded metal structures. Per EMI/EMF-IAMF#2, however, the Authority would identify and ground nearby ungrounded linear metal structures to prevent possible risks.

CEQA Conclusion

The impact under CEQA would be less than significant because project features incorporated into EMI/EMF-IAMF#2 of the HSR Build Alternative would entirely avoid nuisance shocks; consequently, people would not be exposed to a substantial EMF health risk. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #10: Effects on Adjacent Existing Rail Lines

As a result of the high currents used and contact EMI generated by the HSR OCS, permanent interference with the signal systems of adjacent railroads is possible. Signal systems control the movement of trains on the existing nonelectrified railroad tracks that would parallel the HSR alignment between Burbank Boulevard in Burbank and Los Angeles Union Station, a distance of approximately 11 miles. These signal systems serve three general purposes:

- To warn drivers of street vehicles that a train is approaching (the rail signal system turns on flashing lights and warning bells; some crossings lower barricades to stop traffic)
- To warn train engineers of other train activity on the same track a short distance ahead and advise the engineer that the train should either slow or stop

- To show railroad dispatchers in a central control center where trains are located on the railway so train movements can be controlled centrally for safety and efficiency

Railroad signal systems operate in several ways but are generally based on the principle that the railcar metal wheels and axles electrically connect the two running rails. An AC or DC voltage applied between the rails by a signal system will be shorted out (i.e., reduced to a low voltage) by the rail-to-rail connection of the metal wheel-axle sets of a train. This low-voltage condition is detected and interpreted by the signal system to indicate the presence of a train on that portion of track.

The HSR Build Alternative OCS would carry 60-Hz AC electric currents of up to 930 amperes per train. Interference between the HSR 60-Hz currents and adjacent freight or passenger railroad signal systems could occur under the following conditions:

- The high electrical currents flowing in the OCS and the return currents in the overhead negative feeder, HSR rails, and ground could induce 60-Hz voltages and currents in existing parallel railroad tracks. If an adjoining freight railroad track parallels the HSR tracks for a long enough distance (i.e., several miles), the induced voltage and current in the adjoining freight railroad tracks could interfere with the normal operation of the signal system so that it indicates there is no freight train present when in fact one is (or so that it indicates the presence of a freight train when in fact none is there). These conditions exist through most of the Burbank to Los Angeles Project Section.
- Higher-frequency EMI from several HSR sources (electrical noise from the contact on the pantograph sliding along the contact conductor, from electrical equipment onboard the train, or from the cab radio communication system) could cause electrical interaction with the adjoining freight railroad signal or communication systems.

Interference from HSR Build Alternative currents could result in a nuisance or reduction in operational efficiency by interrupting rail traffic. To preclude this possibility, the Authority and the HSR contractor would work with the engineering departments of freight railroads that parallel the HSR line to apply the standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks. The Authority would also implement procedures called for under EMI/EMF-IAMF#1, including assessment of the specific track signal and communication equipment in use on nearby sections of existing rail lines, further evaluation of potential impacts of HSR Build Alternative EMFs on adjoining railroad equipment, and application of suitable design provisions on the adjoining rail lines to prevent interference with adjacent railroad operation. These standard design and operational practices would prevent the following possible effects of HSR Build Alternative operation: (1) disruption of the safe and dependable operation of the adjacent railroad signal system that might cause train delays or hazards and (2) disruption of the road crossing signals that could stop road traffic from crossing the tracks when no train is there (Electric Power Research Institute 2006).

The Authority would follow the American Railway Engineering and Maintenance-of-Way Association, IEEE, and standards used by operators of other 2 x 25-kV 60-Hz electrification systems. The Authority would replace all track circuits as required for compatibility with the new 2 x 25-kV 60-Hz electrification system.

The HSR Build Alternative would use signal equipment currently operating in similar corridors, such as Amtrak's Northeast Corridor, where there are both high-speed passenger trains and slower-speed freight trains operating over the same segment of tracks. There would also be several areas where nonelectrified freight tracks merge onto the corridor. The Authority would employ engineering standards and equipment already in place and tested to FRA standards in the same environment as the Northeast Corridor.

The HSR Build Alternatives would also employ bonding and grounding standards used on existing 2 x 25-kV 60 Hz systems, including in the Northeast Corridor. These methods have been proven for many years and inspected under the authority of the FRA. Proper grounding and cross-bonding of adjacent tracks would be designed and constructed so return currents are properly managed.

Design standards often include the following provisions when electrified trains operate near nonelectrified track: (1) replacing some track circuit on adjoining rail lines with a type of track developed specifically for operation on or near electric railways or utility power lines, (2) providing filters for sensitive communication equipment, and (3) relocating or reorienting radio antennas. These design provisions would be installed and tested for effectiveness before activation of HSR systems that could interfere with adjoining systems.

Although operation of the HSR Build Alternative would generate electrical currents that could result in minor interference with adjacent existing rail lines, effects would be limited because project features of the HSR Build Alternative would include working with the engineering departments of adjacent, parallel railroads to modify or upgrade their signal systems to avoid interference from HSR operations. Therefore, through compliance with EMI/EMF-IAMF#1, the HSR Build Alternative would not interfere with sensitive equipment and the signal systems of adjacent railroads would not be substantially affected.

The engineering approach in EMI/EMF-IAMF#1 takes advantage of decades of experience in successfully addressing these interference problems. During this time, the FRA and system operators have developed solutions for blended corridor situations similar to the Burbank to Los Angeles Project Section. For example, Amtrak's Northeast Corridor has successfully operated blended operations using an identical 2 x 25-kV HSR electrification system. This system has been operating since 2000 without affecting freight and diesel passenger operations sharing the corridor (Siemens 2017).

CEQA Conclusion
Impacts from interference with adjacent railroad equipment would be avoided with implementation of EMI/EMF-IAMF#1 and application of standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks. The impact under CEQA would be less than significant because the Authority would avoid interference with sensitive equipment of adjacent rail lines, and there would be no impact on operations. Therefore, CEQA does not require mitigation.

Impact EMI/EMF #11: Effects Related to Adjacent Airports

Airports operate radio and other electronic systems that are potentially susceptible to EMI from other radio systems. The HSR Build Alternative would pass in a tunnel under the Hollywood Burbank Airport property for approximately 2,300 feet.

In addition to the use of frequency bands dedicated to the HSR system, the Authority would require communications equipment procured for HSR use, including commercial and noncommercial off-the-shelf products, to comply with FCC regulations designed to prevent EMI with other equipment. The Authority would comply with an EMCPP during project planning and implementation to ensure compatibility with radio systems operated by Hollywood Burbank Airport. Potential impacts would be avoided through implementation of EMI/EMF-IAMF#2, which would provide the necessary third-party coordination through the EMCPP and ISEP. During the planning stage through system design, the Authority would perform additional EMC/EMI safety analyses, including:

- Coordination with FAA's spectrum engineering office and airport staff, as necessary
- Identification of existing airport radio systems
- Selection of systems to prevent EMI with identified airport uses and incorporation of these requirements into bid specifications used to procure radio systems

The implementation stage of the EMCPP would include monitoring and evaluation of system performance for compatibility with airport systems.

CEQA Conclusion
With implementation of EMI/EMF-IAMF#2 and associated measures contained in the ISEP, operation of the HSR Build Alternative would not result in interference with airport communications, navigation, or surveillance systems. The potential for EMI impacts on sensitive

equipment at adjacent airports under CEQA would be less than significant. Therefore, CEQA does not require mitigation.

3.5.7 Mitigation Measures

NEPA requires federal agencies to identify potentially adverse effects and to discuss measures to mitigate those effects. CEQA requires that each significant impact of a project be identified and feasible mitigation measures be stated and implemented. Mitigation measures are identified for all impacts (NEPA) and significant impacts (CEQA) that cannot be avoided or minimized adequately by refining project design.

The Authority would implement the following mitigation measures as appropriate to further reduce the EMF and EMI impacts of the HSR Build Alternative, as identified in Section 3.5.6, Environmental Consequences.

EMI/EMF-MM#1: Protect Sensitive Equipment

The Authority would contact entities where sensitive equipment is located to evaluate the potential impacts of both HSR Project-related EMF RF and low-frequency EMI on medical equipment before completion of final design. Where necessary to avoid interference, the final design would include suitable design provisions, which may include establishing magnetic field shielding walls around sensitive equipment or installing RF filters into sensitive equipment.

HSR-related EMI may affect highly susceptible, unshielded sensitive RF equipment, such as older MRI systems and other measuring devices common to medical and research laboratories. Most of the devices manufactured today have adequate shielding from all potential EMI sources; however, the potential exists for older devices to be affected and require shielding.

A shielded enclosure is very effective at preventing external EMI. Metallic materials are used for shielding (specifically high-conductivity metals for high-frequency interference, such as from HSR operation), and high-permeability metals are used for low-frequency interference. Often either the housing of the affected device is coated with a conductive layer or the housing itself is made conductive. In some situations, it may be necessary to significantly reduce EMI for a suite of devices by creating a shielded room or rooms.

Attenuation (i.e., the effectiveness of EMI shielding) is the difference between an electromagnetic signal's intensity before and after shielding. Attenuation is the ratio between field strength with and without the presence of a protective medium, measured in decibels. This decibel range changes on a logarithmic scale, so an attenuation rating of 50 decibels indicates a shielding strength 10 times that of 40 decibels. In general, a shielding range between 60 and 90 decibels may be considered a high level of protection, while 90 to 120 decibels is exceptional.

Impacts from Implementing Mitigation Measure EMI/EMF-MM#1

Implementation of EMI/EMF-MM#1 would mitigate effects on sensitive equipment related to EMI. No secondary environmental impacts would result from implementation of EMI/EMF-MM#1 because the shields and filters would be installed inside the building or on the sensitive equipment.

3.5.7.1 Additional Considerations

The HSR project would adhere to international guidelines and comply with applicable federal and state laws and regulations. Similarly, project design would follow the EMCPP to avoid EMI and to ensure HSR operational safety. Some features of the EMCPP include:

- During the planning stage through the system design stage, the Authority would conduct EMC/EMI safety analyses, which would include the identification of existing nearby radio systems, the design of systems to prevent EMI with identified neighboring uses, and the incorporation of these design requirements into bid specifications used to procure radio systems.

- Pipelines and other linear metallic objects that are not sufficiently grounded through direct contact with earth would be separately grounded in coordination with the affected owner or utility to avoid possible shock hazards.
- The contractor would implement HSR standard corrosion protection measures to eliminate risk of corrosion of nearby metal objects.
- The Authority would work with the engineering departments of the UPRR, Metrolink, and Amtrak, where these railways parallel the HSR system, to apply the standard design practices to prevent EMI with the electronic equipment these railroads operate. Design provisions to prevent EMI would be put in place and determined to be adequately effective prior to the activation of potentially interfering systems of the HSR Build Alternative.

The Authority would include EMC requirements and design provisions in the systems bid specifications and construction bid specifications for all system and construction procurements that raise EMC issues. The Bid Specification Electromagnetic Compatibility Requirements require each affected supplier and contractor to develop, deliver, and follow an EMC plan; use and document appropriate EMC design guidelines, criteria, and methods in equipment and construction; perform required EMC analysis and reporting; and perform required EMC testing.

Appendix 2-D contains the applicable design standards the project would use for addressing EMI/EMF impacts.

3.5.7.2 Early Action Projects

As described in Chapter 2, Section 2.5.2.9, early action projects would be completed in collaboration with local and regional agencies. They include grade separations and improvements at regional passenger rail stations. These early action projects are analyzed in further detail to allow the agencies to adopt the findings and mitigation measures needed to construct the projects. No EMI/EMF mitigation measures are applicable to the early action projects.

3.5.8 NEPA Impact Summary

This section summarizes and compares the impacts of the HSR Build Alternative and the No Project Alternative. All potential EMF impacts generated by the HSR system fall into one of two types for both human effects and equipment interference:

1. Low-Frequency—The magnetic and electric fields generated by the traction power system and associated effects such as induced voltages and ground currents
2. High-Frequency—Impacts resulting from fixed and mobile wireless communications by the HSR system.

In general, the region is highly urbanized. The areas surrounding the project section are largely built out and can add population and businesses only though limited infill and more intensive development. However, it is reasonable to assume that the use of electricity and RF communication equipment, including high-voltage transmission/power lines and directional and nondirectional (cellular and broadcast) antennas that result in EMFs and EMI, would continue under the No Project Alternative and would likely increase along the length of the project section. The development of new schools, hospitals, police stations, and other facilities with sensitive equipment would increase the prevalence of receptors potentially sensitive to EMI.

Construction of the HSR Build Alternative could result in impacts, which include:

- Interference with sensitive equipment, resulting from movement of large construction vehicles or high-current electric welding, at one receptor location within the RSA.

Operation of the HSR Build Alternative could result in impacts, which include:

- Interference with implanted medical devices from EMF levels at traction power facilities and standby generator rooms
- Corrosion of underground metal structures from ground currents generated by HSR operation

- Nuisance shocks from underground metal as a result of electrical currents generated by operation of the HSR Build Alternative
- Minor interference with adjacent railroads from the electrical current generated by the HSR system
- Interference with sensitive equipment at one receptor location within the RSA
- EMI effects at four schools and one daycare
- Radio interference with airport communications and navigation systems from the HSR control and communications equipment

The Authority identified 18 potentially sensitive receptors for EMF and EMI within the RSA. All impacts as a result of construction and operation of the HSR Build Alternative would be avoided or minimized through implementation of the project IAMFs and the mitigation measures described above in Sections 3.5.4.2 and 3.5.7, respectively.

3.5.9 CEQA Significance Conclusions

Table 3.5-12 summarizes the CEQA determination of significance for all construction and operations impacts discussed in Section 3.5.6.3, High-Speed Rail Build Alternative.

Table 3.5-12 Summary of CEQA Significance Conclusions and Mitigation Measures for EMI/EMF

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Construction			
Impact EMI/EMF #1: Temporary Impacts from Use of Heavy Construction Equipment	Significant (1 location)	EMI/EMF-MM#1	Less than Significant
Impact EMI/EMF #2: Temporary Impacts from Communications Equipment	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #3: Temporary Impacts from Operation of Electrical Equipment	Significant (1 location)	EMI/EMF-MM#1	Less than Significant
Operations			
Impact EMI/EMF #4: Permanent Human Exposure to EMF	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #5: People with Implanted Medical Devices and Exposure to EMF	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #6: Interference with Sensitive Equipment	Significant (1 location)	EMI/EMF-MM#1	Less than Significant
Impact EMI/EMF #7: EMI effects on Schools	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #8: Potential for Corrosion of Underground Pipelines and cables, and Adjoining Rail	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #9: Potential for Nuisance Shocks	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #10: Effects on Adjacent Existing Rail Lines	Less than Significant	No mitigation measures are required	Not Applicable
Impact EMI/EMF #11: Effects Related to Adjacent Airports	Less than Significant	No mitigation measures are required	Not Applicable

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