4.13 Electromagnetic Fields

4.13.1 Introduction to Resources and Regulatory Requirements

Electric and magnetic fields, known as electromagnetic fields (EMFs), are produced wherever electricity is used. Electric fields are produced by charges. Magnetic fields are produced by the flow of electric current. The greater the electric charge, the greater the electric field. Similarly, the greater the electric current, the greater the magnetic field. EMFs surround all electrical equipment and facilities, including the electrical conveyance lines and electrical devices as proposed in the East Link Project. Although there are no regulatory requirements for EMF, EMF results in electromagnetic interference (EMI), which can cause disruptions and possibly malfunctions in sensitive equipment. In certain situations with sufficiently high exposure, EMF can result in effects on human health. The EMF study area is dependent on the location of sensitive equipment in relation to the light rail line and the amount of electrical power that the East Link Project requires to accelerate or decelerate near sensitive facilities. However, the potential for a light rail vehicle to adversely affect sensitive equipment from a distance greater than 100 feet is rare.

Where there are electric currents, it is possible that stray currents would occur when a portion of the electrical current finds an alternative conducting path, such as metal, water, or a buried pipe or cable. Over time, a stray current can cause corrosion, which in turn can cause pipes to leak or wires to break.

4.13.2 Affected Environment

The affected environment of the East Link system is the area immediately adjacent to project alternatives and on board the train cars. EMI may temporarily interfere with the operation of sensitive electronics and electrical equipment near the right-of-way, so the concern is for facilities that may be sensitive to EMI, such as hospitals or laboratories that use sensitive electronic equipment. Also, the pipes and cable utilities commonly located under and along roadways, including the floating bridge on I-90, can be susceptible to stray currents, which can be conducted some distance away from the right-of-way.

Sound Transit contacted Children's Hospital Bellevue Clinic and Surgery Center (BCSC), Overlake Hospital, and Group Health, all three of which have facilities near I-405, to identify sensitive receptors. As a result of these discussions, Sound Transit identified three buildings—Overlake's portable magnetic resonance imaging (MRI) unit, the Overlake outpatient optical surgery unit, and the MRI unit at Children's Hospital BCSC—as possibly being susceptible to EMI.

The Overlake portable MRI unit is a parked, trailer-mounted MRI unit located at the west end of the North parking garage at a loading dock shipping and receiving area next to several trash dumpsters and an electrical transformer that provides power to buildings on the hospital campus. This portable MRI unit operates next to large, energized electrical equipment and near roadways and parking garages with moving cars and trucks that produce magnetic fields.

The Overlake outpatient optical surgery unit is located just southeast of the NE 12th Street Overpass east of I-405 in the ground floor of Overlake's west garage.

The Children's Hospital BCSC has an MRI unit located in a magnetically shielded room on the second floor of the building. The MRI in the BCSC is located approximately 75 feet south of the south fence of the 116th Maintenance Facility (MF1) and approximately 240 feet north of where the 108th NE Tunnel (C3T), Couplet (C4A), 112th Elevated (C7E), and 110th Elevated (C8E) Alternatives would cross 116th Avenue NE at approximately NE 15th Street, east of I-405. Similar to the MRI unit at Overlake Hospital, the Children's MRI unit is located close to moving cars because it is in a room immediately above the ground-level parking garage beneath the BCSC.

The MRI in the BCSC is also located about 315 feet northwest of a Puget Sound Energy 115-kilovolt (kV) electrical substation. The substation does not produce EMF outside of the substation fence, but the overhead transmission lines that feed the substation and those that run along the east side of 116th Avenue NE presently produce modest levels of EMF (within the lower end of the range of the values reported in Table 4.13-1).

The BCSC MRI is located about 260 feet north of the overhead 115-kV transmission line that serves the substation and about 130 feet east of the transmission line that runs along the east side of 116th Avenue NE next to the BCSC. An earlier report (LTK Engineering Services, 2006) describes extensive measurements and magnetic field modeling performed for the Sound Transit North Link line near the University of Washington campus. In that report, LTK Engineering evaluated the magnetic fields that could be produced by operation of trains on the North Link line as well by as cars, large trucks, and buses that pass close to several of the campus buildings. Because the North Link and East Link light rail lines are similar and part of the Sound Transit light rail system, the model

predictions and measurements described in the LTK Engineering report can also be used to predict the present and future magnetic field environment for the portable MRI unit and the Overlake outpatient optical surgery unit at Overlake Hospital as well as the MRI unit at Children's Hospital BCSC.

TABLE 4.13-1
Estimated External Magnetic Fields Near Children's Hospital Bellevue Clinic and Surgery Center Magnetic Resonance Imaging (MRI) Unit

Source of EMF	Distance from MRI Unit	Estimated Total Peak Magnetic Field [a]
Buses and large trucks moving in northbound lanes of 116th Ave NE	160 feet (46 meters)	0.1 milliGauss
Cars moving in ground level parking garage beneath BCSC	10 feet (3 meters)	20 milliGauss
Cars and trucks on driveway near south entrance to BCSC	135 feet (46 meters)	0.1 milliGauss
Cars moving on north driveway to ground level parking garage	33 feet (10 meters)	<1 milliGauss

[a] Estimates taken from measurements and modeling described in the LTK Engineering Services report (2006).

There are several external periodic magnetic fields located near the BCSC MRI unit, as described in Table 4.13-1. Since the BCSC is a new facility specifically designed for this location, it is not thought that these sources of EMF will cause any malfunctions for the MRI unit.

Similarly, there are several different external periodic magnetic fields located near the Overlake portable MRI unit, as described in Table 4.13-2.

These EMFs result from the perturbations of the earth's magnetic field that are caused by the movement of large metal objects such as cars, trucks, and buses. At present, the EMFs have not caused any malfunctions of the portable MRI unit.

It is likely that there are underground pipe and electrical and telephone cable utility lines along the segment alternatives, especially on I-90 and in Downtown Bellevue, that could be subject to stray currents. Accordingly, these utility lines would need to be carefully evaluated for the possibility of effects from stray currents and the need for protection from stray currents.

TABLE 4.13-2
Estimated External Magnetic Fields Near Overlake Portable Center Magnetic Resonance Imaging (MRI) Unit

Source of EMF	Distance from MRI Unit	Estimated Total Peak Magnetic Field [a]
Buses and large trucks moving in eastbound lanes of NE 12th Street	125 feet (38 meters)	0.1 milliGauss
Cars moving on driveway between West and North Parking Garages	16 feet (5 meters)	5 milliGauss
Large trucks on driveway between West and North Parking Garages	16 feet (5 meters)	10 milliGauss
Cars moving in North Parking Garage	33 feet (10 meters)	<1 milliGauss

[a] Estimates taken from measurements and modeling described in the LTK Engineering Services report (2006).

4.13.3 Environmental Impacts

4.13.3.1 No Build Alternative

The No Build Alternative would not introduce any new sources of EMI into the study area.

4.13.3.2 Impacts during Operation

Electromagnetic Fields

The overhead catenary wires and the power transmission lines that provide power to the traction power substations along the route would produce EMFs. EMFs would also be produced by the train cars themselves, both within and outside the cars, especially when they are moving. The electricity needed to operate the train cars flows from the overhead catenary wires to the traction motors and other electronic equipment. The power flows through cables located either in the ceiling or under the floor of the cars. The amount of electricity flowing in these cables would vary depending on whether the train is accelerating, running at steady speed, decelerating, or is stopped. The electrical current would be highest when the train is accelerating. EMFs would be created whenever the train operates.

Preferred 108th NE At-Grade Alternative (C11A) and *Preferred 110th NE Tunnel Alternative (C9T)* are not located close to any potentially EMF-sensitive sites. Only Alternatives C3T, C4A, C7E, and C8E approach the potentially EMF-sensitive sites. During interviews with staff of Overlake Hospital, Group Health, and Children's Hospital BCSC and personal visits to the Overlake portable MRI unit, the Overlake outpatient optical surgery unit, and the Children's Hospital BCSC MRI unit, the MRI units were the only current

equipment found to be potentially sensitive to EMF. Other parts of Overlake Hospital are too distant to be affected, and Children's Hospital BCSC does not have any other equipment that would be of concern.

The Overlake portable MRI unit trailer is located over 100 feet from proposed East Link alternative routes. The Children's Hospital BCSC MRI unit is located approximately 95 feet from proposed turnaround track in the MF1. The Children's Hospital site is also located just north of an existing Puget Sound Energy overhead electric transmission line and electrical substation.

The EMF level for the East Link light rail train operating in Alternatives C3T, C4A, C7E, and C8E over I-405 is expected to be 0.6 milliGauss (mG) at a distance of 220 feet from the MRI unit at Overlake Hospital. (A milliGauss is a unit of intensity of a magnetic field.) The EMFs from the East Link Project routes would have a lower magnitude than those existing near the Overlake MRI Unit, as shown in Table 4.13-2; therefore, the fields from these sources should not cause a problem for the continued successful operation of this unit.

The Children's Hospital BCSC MRI unit is located inside a shielded room on the second floor. The shielding would be expected to lower the level of EMF penetrating from the outside. The MRI in the shielded room would be approximately 240 feet from the operation of Alternatives C3T, C4A, C7E, and C8E south of the hospital. These conditions may result in approximately 0.5 mG transient magnetic field at the shielded MRI room whenever trains pass at full speed (up to 55 miles per hour [mph]). The MRI would be approximately 95 feet from the south turn around loop track at the MF1. Trains operating on this track would be operating at slow train speed (approximately 8 mph speed in the maintenance facility) that would result in an exposure to the MRI shielded room of about 1 mG. Given the existing exposures from sources in or near the BCSC (see Table 4.13-1), especially from cars moving in the BCSC parking garage immediately below the MRI unit (approximately 20 mG), the EMF from East Link operations is not expected to have an impact on the facility.

Stray Currents

Without control measures, a portion of the electrical current flowing through the light rail trains could stray into a buried pipe or cable, then flow along conducting utility lines in the ground back to the traction power substation. To avoid this issue, however, Sound Transit would coordinate control measures with entities that own and operate the utility lines that could be affected.

Sound Transit would minimize or avoid the potential for stray current impacts by selecting best management practices (BMPs) appropriate for the circumstances. The BMPs may include one or a combination of the following:

- Installing cathodic protection systems in nearby utility lines to protect them from corrosion
- Installing insulating unions to break the electrical conductivity of the pipe and thus force the stray current to take another path
- Isolating the electrical rails from ground
- Installing stray-current-control track-fastening systems where appropriate:
  - Tie-and-ballasted track using high-resistance track-fastening systems on concrete ties
  - Direct-fixation track using high-resistance, rubberized track-fastening systems
  - Embedded track using various methods of rail encapsulation such as rail coatings, polyurethane encasement, and rail boots

New natural gas and water lines routed below East Link tracks, and/or new piping systems close to the tracks, would require cathodic protection systems. Cathodic protection system components include the following:

- Galvanic anodes
- Electrical isolation with insulating unions at connections to existing piping
- Pipe coatings
- Bonded mechanical pipe joints
- Permanent test facilities to monitor stray currents and rates of corrosion

Where tracks are elevated on overhead guideway structures, the return current cannot get to ground as easily as on structures that are not elevated; therefore, EMFs from overhead structures are less likely to affect underground utility lines.

Sound Transit and an Independent Review Team (IRT), a team of engineering experts funded by the Washington state legislature and overseen by the Joint Transportation Committee, have investigated the potential impacts of stray current on the Homer M. Hadley (I-90) floating bridge. The concern is that stray current could cause corrosion in the bridge structure,

thereby reducing the lifespan of the bridge. To address this concern, the IRT has recommended three layers of protection: isolating the rail by constructing special insulating systems, installing a stray current collector mat, and potentially upgrading the cathodic protection system. An upgraded cathodic protection system could be attached to the floating bridge to mitigate stray current leakage from the light rail track that may accumulate in the reinforcing steel used on the floating bridge. The project would also place a monitoring system on the bridge to monitor stray current levels. Additionally, the cathodic protection system for the adjacent Lacey V. Murrow floating bridge may also be upgraded. With these measures in place, no impact on either bridge would be expected.

Potential Health Effects from Light Rail Alternatives

EMFs can cause a variety of impacts on humans. Certain EMF combinations can cause shock and burn injuries through direct contact with energized components; others can interfere with the operation of electrical and magnetic devices, including heart pacemakers. Based on data available from similar rail systems, however, operation of the light rail is unlikely to generate health impacts for riders or people along the tracks. Anticipated EMF intensities at locations of human exposure within and adjacent to the light rail line are considerably below exposure guidelines established by the American Conference of Governmental Industrial Hygienists and the more recent guidelines established by the International Commission on Non-Ionizing Radiation Protection. These guidelines address known biological effects and do not address speculative concerns about cancer and other possible health effects. Given uncertainties in potential biological effects, these guidelines do incorporate safety factors. Among the various alternatives, no notable differences exist in potential health impacts related to EMFs.

4.13.3.3 Impacts during Construction

No impacts from EMF on nearby sensitive facilities are anticipated during construction.

4.13.4 Potential Mitigation Measures

No mitigation measures for EMI from the East Link Project are needed for sensitive equipment at Overlake Hospital or Children's Hospital BCSC because the projected EMF from East Link is lower than the existing EMF environment. Standard design measures are necessary for protection against stray currents. These measures would be developed and implemented in consultation with utility owners during final design.

The I-90 section of the light rail would incorporate measures to prevent stray electrical current from corroding the steel components of the I-90 bridge, as agreed to with WSDOT.