7 Assessment of Potential Effects

7.12 Electric and Magnetic Fields

7.12.1 Summary

The key highlights from the review of electric and magnetic fields (EMF) for the Surrey Newton-Guildford Light Rail Transit (LRT) (the Project) are presented below:

- Project EMFs were reviewed based on the potential for electromagnetic interference (EMI) with electronics and radio communication systems, and potential health effects.
- Project EMFs were reviewed for the overhead catenary system, trains, traction powered sub-stations (TPSS), and Operations and Maintenance Facility (OMF).
- EMF mitigations include the placement of the TPSS and OMF further away from areas with sensitive electronics and people where feasible, electrical design mitigations to limit EMF levels at the source, passive engineering controls that block or redirect EMFs away from a specific area, and EMF monitoring during start-up commissioning to confirm EMF levels are within EMI standards and health reference levels.
- EMFs from the overhead catenary system and trains would predominantly be 0 to 60 Hz in frequency with field intensities inside the trains approximately 1,000 V/m (electric fields) and 160 mG (magnetic fields). EMF intensities outside of the train decline rapidly with increasing distance.
- Project EMFs at the OMF are expected to be near urban background levels outside of the facility's perimeter fencing.
- Project EMFs at the eight TPSS are expected to be near urban background levels beyond 10 metres of the building.
- Project EMFs along the Alignment and inside the train are unlikely to interfere with the function of personal electronic devices, such as cell phones and laptops, and medical and health devices such as pacemakers and electric wheelchairs.
- Project EMFs along the Alignment are not expected to have acute effects on people because the Project produces non-ionizing, low frequency, and low intensity EMFs that are below the applicable health guidelines.
- Project EMFs along the Alignment are not expected to have chronic human health effects.

7.12.2 Introduction

The review of potential effects for EMF was conducted based on the information requirements identified in the Terms of Reference (ToR) and is summarized in Table 7.12-1.

Table 7.12-1: Potential Effects and Review Indicators for EMF

Topics Included in Review	Potential Effects	Review Indicator
EMF Effects	Change in EMF levels from baseline due to the Project	Potential change in EMF during construction and operation phases due to the Project (including the OMF, vehicles and control systems) using the following parameters compared to baseline: • Electric field (V/m) • Magnetic field (mG) Stray current

7.12.2.1 Project Background

During Project operations, the electrical system and electrical infrastructure will generate EMFs along the Alignment. The major EMF sources, and the focus of this assessment, are as follows:

- The 750 volt direct current (DC) overhead catenary system that will produce a static (0 Hz) field
- LRT trains which will produce a moving EMF field along the Alignment
- Eight TPSS locations
- Electrical equipment within the OMF.

Trains may also be the source of unintentional EMFs caused by electrical discharges between the overhead catenary system and the train's power pickup, known as arcing. Arcing can occur when the train's power pickup is not in direct contact with the overhead catenary system. This phenomenon can be commonly observed on electric-powered trolley buses operated by Coast Mountain Bus Company. EMFs have the potential to cause electromagnetic interference (EMI) with other electrical systems and exposure to certain types of EMFs may have health effects. This chapter assesses the potential of Project related EMFs to cause EMI with common electronics (e.g., cell phones and computers), communications systems (e.g., radio communications systems), and health-related electronics (e.g., pacemakers and electric wheelchairs), and the potential effects this may have on human health.

EMFs produced during Project construction will be primarily from vehicles and equipment. These sources are similar to those commonly found in urban environments and will not contribute a substantial change in EMFs.

7.12.2.2 Characteristics of Electric and Magnetic Fields

EMFs are physical fields produced by electrically charged objects, which can affect other electrically charged objects within the field. An electric field is produced when voltage is applied to electrical conductors and equipment, such as when a lamp is plugged into an electrical socket. Voltage refers to the difference in potential energy between two points. The electric field intensity is measured in volts per metre (V/m). Electric fields can be blocked by conductive materials,

which include most types of common building materials (e.g., wood, concrete, metal), ground materials (e.g., soil, rocks), water and living objects (e.g., trees and the human body).

Magnetic fields are produced by electrical currents, which are comprised of a flow of electrons, such as when a lamp is plugged in and turned on. The magnetic field intensity is measured in milligauss (mG). Unlike electric fields, magnetic fields are not blocked when passing through most types of materials. For this reason, research on the potential effects of EMFs has generally focused on magnetic fields because they are more difficult to manage and control. However, magnetic fields can be redirected away from EMF-sensitive equipment or locations.

Electric fields and magnetic fields are distinctly different phenomena, but they are collectively referred to as EMFs because they are produced in tandem when operating electronics or electrical infrastructure. Electric fields are distinguished from magnetic fields in this review as needed, when describing the levels produced by the Project, and when describing the mitigations for each type of field.

When characterizing EMFs, the following characteristics of the EMF field are considered:

- Field intensity – EMF intensity at the source can vary depending on the voltage (for electric fields) and current (for magnetic fields). The field intensity declines rapidly with increasing distance from the EMF source. For example, the EMF intensity at 20 m from a source is only 25% of the intensity at 10 m from the source. The EMF intensity at 30 m from the source is only about 11% of the intensity at 10 m from the source. EMF field strength attenuates rapidly with increased distance from the source, and exposure to a strong field intensity is more common when a receptor is very close to the source of the field. The relationship between distance from the EMF source and the field intensity is known as the inverse square law[1].

- Frequency – The frequency of an EMF refers to the wave oscillation of the field as shown in Figure 7.12-1. The EMF frequency is measured in hertz (Hz); higher frequencies indicate a higher energy state of the field. The Project's rail vehicles operate on direct current (DC), which produces a static, or constant EMF with a frequency of 0 Hz, at the lowest end of the electromagnetic spectrum.

  The standard frequency for electrical power in North America is 60 Hz alternating current (AC); EMFs of frequencies less than 300 Hz are referred to as extremely low frequencies (ELF). EMFs with ELFs are found in household wiring and common household electrical items (e.g., lights, computers, televisions). These types of EMFs may be produced by electrical systems in a Project facility, such as lighting, communications systems, and wiring.

  Higher frequencies of non-ionizing EMFs associated with radio wave (ranging in the kilohertz to megahertz) and microwaves (in the range of gigahertz) are not expected to be produced by the Project at an appreciable field intensity that could affect other systems. Ionizing EMFs such as X-rays and gamma rays will not be produced by Project activities.

[1] The inverse square law states that the intensity of a specified quantity is inversely proportional to the square of the distance from the source of the physical quantity.

- Vector – EMFs are vector fields, meaning that the field has a direction at each point in space. Multiple EMFs from various sources interact; they can add together, cancel out and change the overall field vector, depending on their relative vectors, field intensities and frequencies.

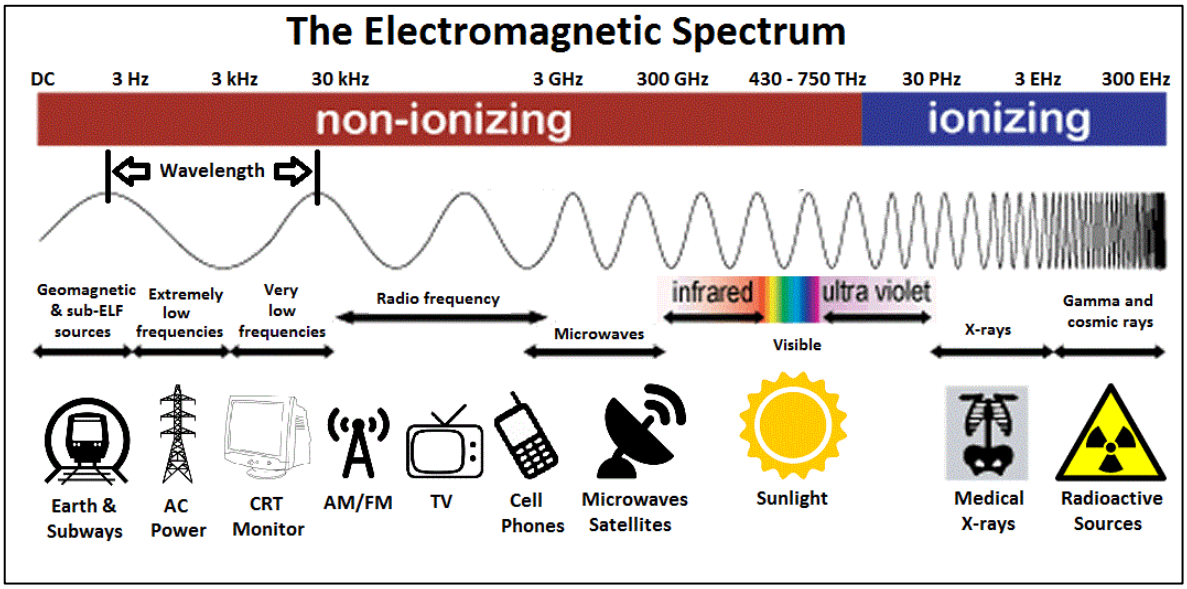


Figure 7.12-1: Electromagnetic Field Frequency Range

7.12.3 Potential Effects and Review Indicators

7.12.3.1 Selection of Review Elements

The EMFs Review Element was selected because of the potential to interact with other electrical systems, such as those in electronics (e.g., cell phones, computers, pacemakers), and potential health effects. EMFs also have the potential to interfere with radio communications. This assessment characterizes the potential changes in EMFs from the Project, and the potential for EMI on other electrical systems, electronics and the potential effects on people.

7.12.3.2 Selection of Effects and Indicators

Table 7.12-2 lists the potential effects on EMFs and provides a summary of the Project effect mechanisms and indicators used to assess the potential effects. Project effect mechanisms are presented in this table to show the linkage with the potential Project effect. Effects mechanisms, identified in this table, are described in more detail in Section 7.12.7 (Project Interactions).

Table 7.12-2: Potential Effects and Review Indicators for EMF

Potential Effects	Project Effects Mechanisms	Indicators	Rationale for Selection of Indicators
Change in electric and magnetic field levels	• EMFs ranging from 0 to 3,000 Hz are generated by the Project's electrical infrastructure (e.g., overhead catenary system, TPSS, OMF, and electrical components in the train) during operation	• EMF levels relative to applicable EMF criteria	• EMFs generated by the Project's electrical infrastructure may cause EMI with radio communications or other electrical systems. • Address perceived health risks associated with EMF exposure.

7.12.3.3 EMF Standards and Policy Framework

There are currently no provincial or federal regulations or criteria for EMFs applicable to LRT systems. Canadian standards listed in Table 7.12-3 are available to inform the design and electrification of railways and associated electrical infrastructure, such as TPSS. These standards can be applied to establish the acceptable EMF emission levels of LRT systems and associated infrastructure (e.g., TPSS, trains) to mitigate the potential for EMI and maintain electromagnetic compatibility with other systems.

International standards applicable to LRT systems provide guidance on acceptable levels of EMF emissions, and help establish test methods for measuring and monitoring EMFs. International agencies that provide EMF standards for railways and LRT include the American Public Transportation Association, European Standards, Institute of Electrical and Electronic Engineers, and the International Electrotechnical Commission.

Table 7.12-3: Standards Applicable to Rail Systems

Regulatory Agency	Standard
Canadian Standards Association	• CSA C22.3 No. 8-M91 – Railway Electrification • CAN3-C108.3.1-M84 – Canadian Standard for Limits and Measurement of Electromagnetic Noise from AC Power Systems, 0.15-0.30 MHz • CAN/CSA-C22.3 No. 3 – Canadian Standard for Electrical Coordination between Power Supply and Communication Conductors • CSA C22.3 No. 6 – Principles and Practices of Electrical Coordination between Pipelines and Electric Supply Lines

Health Criteria

Health Canada does not have guidelines or standards for ELF EMFs. However, Health Canada recognizes international exposure guidelines established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP 2009) and the International Committee for Electromagnetic Safety (ICES 2002) (Health Canada 2015). These agencies have reference levels for whole body exposure to EMFs ranging from 0 Hz to 300 gigahertz (GHz). Table 7.12-4 shows the reference levels applicable to the EMF frequency range that the Project is expected to produce from the overhead catenary system (0 Hz) and the trains (0 to 3,000 Hz). These reference levels were developed to protect people from possible thermal/heating effects from short-term exposure to high-intensity EMFs. Such high-intensity exposures are typically associated with work

near highly electrified equipment, such as those found at a sub-station or power plant. These reference levels assume an exposure duration that is comparable to a typical work week (i.e., 8 hours/day, 5 days/week). In a typical urban environment, the public is generally not exposed to EMFs that could reach the reference levels for an extended duration, since an individual would need to be in very close proximity (e.g., less than 1 metre) to a strong EMF source.

The links between exposures to ELF EMFs have been extensively reviewed by several scientific agencies, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP), International Committee for Electromagnetic Safety (ICES), and the World Health Organization (WHO). Based on their reviews, these agencies have concluded that there is no identifiable causal link between exposures to ELF EMF and changes in human health (ICNIRP 1998, ICES 2002, and WHO 2007). Therefore, the ICNIRP and ICES do not provide long-term exposure reference levels for ELFs from low-intensity fields. This is also the position of Health Canada, which "does not consider that any precautionary measures are needed regarding daily exposures to electromagnetic fields at extremely low frequencies (i.e., less than 300 Hz)" (Health Canada 2004).

Table 7.12-4: Reference Levels for Whole Body Exposure to Electromagnetic Fields at 0, 60 and 3,000 Hertz

Regulatory Agency	0 Hertz		60 Hertz		3,000 Hertz	
	Electric Field	Magnetic Field	Electric Field	Magnetic Field	Electric Field	Magnetic Field
ICNIRP	N/A	400,000 mG	4,167 V/m	833 mG	87 V/m	63 mG
ICES	N/A	N/A	5,000 V/m	9,040 mG	N/A	N/A

NOTES:

ICNIRP (1998); ICNIRP guidelines for limiting exposure to time-varying EMFs (up to 300 GHz)

ICNIRP (2009); Guidelines on Limits of Exposure to Static Magnetic Fields.

ICES (2002); IEEE Standard for Safety Levels with Respect to Human Exposure to EMFs 0 to 3 kHz

Studies regarding the potential health effects from exposure to EMFs at radiofrequencies are inconclusive. The most recent animal study on radiofrequency EMFs conducted by the U.S. National Toxicology Program resulted in inconclusive findings (NTP 2018a, 2018b). The conclusions do not definitively demonstrate a health effect, nor do they definitively conclude the absence of a health effect.

The communications system used for the Project may emit some radiofrequency EMFs. Communication systems and radiofrequency broadcasting equipment used for the Project will be manufactured by third parties and will apply Industry Canada EMF standards and regulations (e.g., Broadcasting Equipment Standards, Radio Equipment Standards, and Interference Causing Equipment Standards). When considering high-frequency non-ionizing EMFs in the GHz range from cellular phone towers and radiofrequencies, Health Canada provides radiofrequency exposure guidelines for EMF frequencies ranging from 3,000 Hz to 300 GHz (Health Canada 2015). However, the Project mainly produces EMFs in the frequency range of 0 to 3,000 Hz and would not produce radio frequency EMFs at magnitudes that approach these exposure reference levels.

Certain types of high-frequency ionizing EMFs (e.g., ultraviolet radiation, x-rays, and gamma rays) are clearly related to health effects because they cause cellular and genetic damage in all forms of life. Health Canada provides safety code documents related to ionizing EMF exposure from medical (e.g., medical and dental x-ray machines, magnetic resonance imaging machines, mammography machines) and industrial sources (e.g., baggage x-ray machines). Ionizing high-frequency EMFs are not produced by the Project and are not considered further.

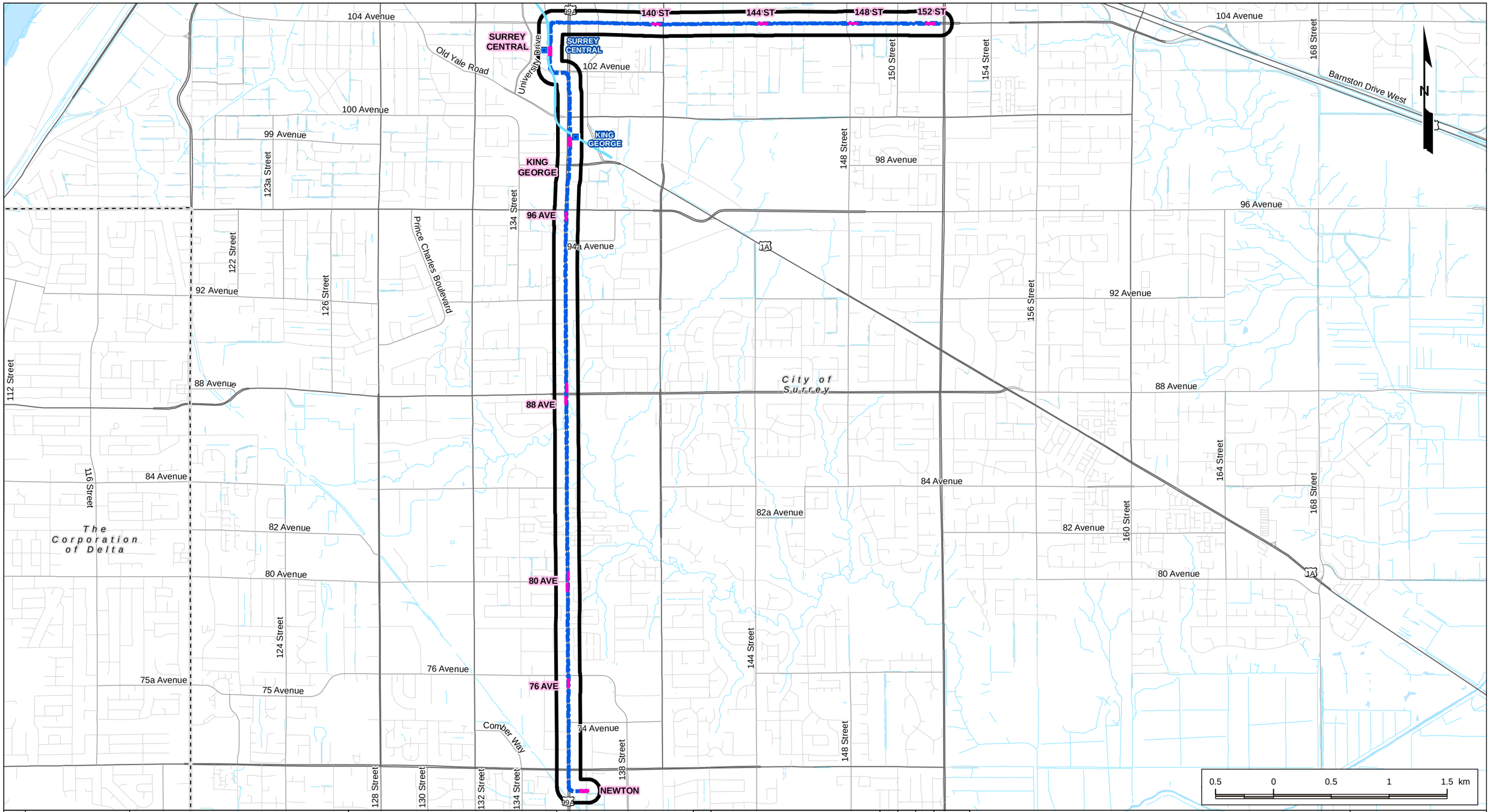
Other Considerations

The standards and criteria described above do not extend to potential effects and interactions with some types of electronic equipment. For example, precision medical equipment, such as pacemakers, may be sensitive to certain types of EMFs. EMF sensitivity may also vary between pacemaker brands and models. With respect to pacemakers, the American Conference of Governmental Industrial Hygienists recommends an EMF exposure criterion of 1,000 V/m for electric fields and 1,000 mG for magnetic fields (ACGIH 2009). Pacemakers are not likely to be affected by EMFs below these exposure criteria.

7.12.4 Spatial Boundaries

The spatial boundary for the Review Area for EMFs is a 100 m buffer from the centerline of the Alignment, as well as a 100 m radius from the locations of the TPSS and OMF. This boundary encompasses specific locations identified as areas of concern during consultation. Project-related EMFs beyond 100 m from the centreline of the Alignment are expected to decrease with distance to a level that is negligible.

Figure 7.12-2 shows the Project Alignment and EMF Review Area.



6	XP-TR-A0-GEN-PLN-PLTF (SXR)	LRT STATIONS (17-09-06)
5	XP-RD-A0-GEN-PLN-104-MSTR (SXR)	104TH AVE ROAD BASE PLAN (17-09-06)
4	C3D-TR-A0-GEN-104-ALG-MSTR (SXR)	KGB ROAD BASE PLAN (17-09-06)
3	XP-RD-A0-GEN-PLN-KGB-MSTR (SXR)	KGB ROAD BASE PLAN (17-09-06)
2	C3D-TR-A0-GEN-KGB-ALG-MSTR (SXR)	KGB TRACK ALIGNMENT (17-09-06)
1	XR-ES-P0-GEN-KGB-ALG-MSTR (SXR)	CITY OF SURREY CADASTRAL
REF.	DRAWING NUMBER	DRAWING TITLE

REFERENCE DRAWINGS

LEGEND:
- EXISTING SKY TRAIN STATION
- EXISTING SKY TRAIN
- LRT TRACK CENTRELINES
- LRT STOP
- WATERCOURSE
- REVIEW AREA
- MUNICIPAL BOUNDARY

ENGINEER STAMP:

No.	DESCRIPTION	DWN	CHK	APP	YY/MM/DD
P1	FIRST ISSUE	NP	MK	XX	YY/MM/DD

REVISIONS

HATCH steer davies gleave Stantec

CLIENT: TRANSLINK

DESIGNED BY:	AF	18/03/28	ENG. CHECK:	RF	18/03/28
DRAWN BY:	NP	18/03/28	APPROVED BY:	RF	18/03/28

STATUS:

SURREY NEWTON-GUILDFORD LINE PROJECT: EMF REVIEW AREA

CLIENT REFERENCE DRAWING NO. - FIGURE 7.12-2

PROJECT/DWG No: 350135-EV-100-A0-SOC-EC-0100

REV No: P1

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7.12.5 Input from Public and First Nation Consultation

7.12.5.1 Public Engagement

EMF and issues identified by the public during the ESR Process are listed in Table 5-16 as stated in the Public and Stakeholder Engagement and Information Distribution Section 5.

Concerns included the potential health effects on people exposed to EMFs, EMI with other electronics, AM/FM radio frequencies and other forms of communication. Locations of interest identified during consultation included the following:

Guildford Town Centre

Guildford Town Centre shopping mall extends over 104 Avenue, which makes retail space above susceptible to EMI from the overhead catenary system and trains running directly below. One retail location within the mall, the Shaw Store, may contain sensitive electronic equipment that could be affected.

Royal Canadian Mounted Police (RCMP) station (10395 148th Street)

The RCMP station, located at the corner of 104 Avenue and 148 Street, may contain sensitive electronic equipment, including radio equipment that could be susceptible to EMI from the overhead catenary system and passing trains.

Fraser Valley and Northern Tax Services office (9755 King George Highway)

The Fraser Valley and Northern Tax Services office is located on King George Highway, and may contain sensitive electronic equipment that could be susceptible to EMI.

Surrey BC Biomedical Laboratories (9656 King George Boulevard)

The Surrey BC Biomedical Laboratories is located at a moderate distance from the Alignment, but it may contain sensitive scientific and medical equipment, making this location susceptible to EMI.

Surrey Memorial Hospital (13750 96 Avenue)

The Surrey Memorial Hospital is located approximately 100 m from the Alignment and may contain sensitive medical and scientific equipment, making it susceptible to EMI from the overhead catenary system and passing trains.

7.12.5.2 First Nation Engagement

Based on feedback from First Nations groups on the draft TOR, the review of EMF as a Review Element, helped to refine the scope of review, and identified additional discussion topics for inclusion in the review scope.

7.12.6 Baseline Conditions

The existing conditions for EMFs are defined as the types and ranges of EMFs that typically exist in urban environments, such as Surrey. This includes EMFs from a variety of sources, including: common household electronics and appliances (e.g., computer, television, fridge, oven, microwave, lights), electrical wiring, transmission and distribution power lines, vehicles (e.g., cars,

buses, trucks), cellular phone towers, and cell phones. The EMF frequencies from these devices vary, as shown in Figure 7.12-1.

Quantifying EMFs in an urban environment is complex due to the ubiquity of EMF in urban areas. Background EMFs from the Earth's electromagnetic field varies but it is generally less than 0.65 mG for magnetic fields, and between 100 and 150 V/m for electric fields (WHO 2018). In a household environment, the EMF field intensity of most household appliances at a distance of 30 cm is 10 mG or less for magnetic fields, and 180 V/m or less for electric fields (WHO 2018).

7.12.7 Project Interactions

Project activities and physical works that may result in a change in EMF levels are identified in Table 7.12-5, and indicated by check marks. A change in EMF levels is defined as an increase in EMF levels above those typically found in urban city environments. For example, the electronics in vehicles produce EMFs. However, Project-related construction does not contribute to an appreciable change in EMF levels beyond those that typically occur along a city road with normal volumes of vehicle traffic and, therefore, is unlikely to change EMF levels.

During operation, the LRT will generate low-frequency EMFs at intensities that are higher than those currently found along the Alignment. Therefore, train operations, including that of TPSS, could result in EMF effects.

Table 7.12-5: Potential Project Interactions and Effects on Change in Electric and Magnetic Field Levels

Project Activities and Physical Works	Potential Effects Change in Electric and Magnetic Field Levels
Construction	
Property acquisition	-
Site preparation (e.g., clearing, grading, and set up of temporary facilities), culvert replacement and extensions, and utility relocation	-
Roadworks, including construction of guideway, drainage upgrades, sidewalk and road widening, system structures (e.g., sub-stations, power and communication lines), exchanges and stops, excavation and operations and maintenance building	-
Vehicle traffic (e.g., road use and construction traffic)	-
Management and disposal of waste and excavated materials	-
Commissioning and start-up	✓
Operations	
Train operation, including wayside and power	✓
Train and track maintenance, administration, transit police	-
Traffic function (e.g., changes to, and maintenance of roadway crossings and intersection functions	-

7.12.8 Mitigation Measures

Recommended mitigation measures to avoid, control or limit EMFs and EMI are applied during Project design, equipment procurement, construction and operation, or applied by manufacturers of trains and LRT electrical infrastructure (e.g., TPSS, overhead catenary system).

The U.S. Department of Transportation provides guidance on the prevention and mitigation of environmental, health, and safety and effects of EMFs and radiation for electric transit systems (USDOT, undated). These mitigation measures and best practices are described below.

7.12.8.1 Mitigation Measures for Change in Electric and Magnetic Field Levels

Mitigation measures are recommended to meet the objective of reducing Project related EMFs outside facility fence-lines and along the Alignment. Table 7.12-6 summarizes the mitigation measures that may be applied to control, mitigate and limit EMFs and EMI with receptors and which meet the above objective. Additional description of these recommended measures is provided below:

- **Equipment procurement -** It is recommended that TransLink procure trains and LRT equipment that meets the available Canadian EMF standards or its equivalent standard by international agencies. This recommendation excludes general purpose electronic equipment that is not specific to the operation of the trains, such as communications systems, radios, and display monitors because it is assumed that the manufacturers of such equipment will observe and apply the EMF standards and guidelines applicable to their respective products and industries.

- **Location of the TPSS and OMF** – Place Project infrastructure that emits high-intensity EMFs further away from places with people (e.g., residences and schools), and locations of interest with sensitive electronic and communication equipment (e.g., RCMP station). Perimeter fencing around the OMF and placing TPSS in location that are not frequented by people (e.g., adjacent to parking lots) or at least 10 metres away from a permanent residence will also limit public exposure.

- **Electrical design and layout** – These mitigation measures are integrated into the engineering design of the electrical system and trains to limit stray EMFs. For example, the use of DC current in the overhead catenary system avoids the electromagnetic radiation that is inherent with alternating current (AC). AC is converted to DC at the TPSS; the electromagnetic radiation that is inherent to AC would be at the TPSS, which are not accessible to the public. Another example is that the trains will use electrical components in the overhead catenary system that minimize EMI from electrical arcing with the train's power pickup. EMI with train electronics can be mitigated by selecting electronics that can operate in high EMF environments.

- **Passive engineering controls** – These types of mitigation measures are integrated into the train design or construction of the OMF and TPSS to shield or block sources of high-intensity electric fields, or to redirect high-intensity magnetic fields away from train passengers, to the extent feasible. For example, the TPSS facilities will be constructed with concrete or brick walls. This material is more effective at blocking electric fields than wood structures.

- **EMF Monitoring during start-up commissioning –** EMF monitoring during start-up commissioning along the Alignment to confirm that the EMF levels near sensitive locations (e.g., RCMP station, Guildford Mall) are within the applicable EMI standards, and within health reference levels at sensitive locations (e.g., residences) near TPSS.

Recommended measures suggested below are based on typical best practices for construction and operation in Metro Vancouver/BC and the Construction Contractor and Operator will be responsible for meeting performance objectives as appropriate to their means and methods.

Table 7.12-6: Recommended Mitigation Measures for Project EMF

Review Element	No.	Objective	Proposed Mitigation	Project Phase	Environmental Management Plan
Electric and Magnetic Fields	7.12-1	Limit Project related EMFs outside facility fence-line	Location of the traction-powered sub-stations and Operations and Maintenance Facility to optimize the distance between EMF sources and receptors that are sensitive to EMFs	Design	BMPs, comparable to other TransLink projects
	7.12-2	Limit Project related EMFs along the Alignment	Electrical design and layout – engineering design of the trains and electrical infrastructure to reduce stray EMFs (e.g., electrical arcing between the overhead catenary system and the train), to the extent feasible	Design	BMPs, comparable to other TransLink projects
	7.12-3	Limit Project related EMFs at the EMF source	Procure trains and LRT equipment that meet the available Canadian EMF standards or its equivalent standard by international agencies	Construction	BMPs, comparable to other TransLink projects
	7.12-4	Limit Project related EMFs along the Alignment	Design the Project with passive engineering controls (e.g., infrastructure or shielding) to block or redirect EMFs near its source	Construction	BMPs, comparable to other TransLink projects
	7.12-5	Confirm that EMF levels at sensitive locations are within the applicable EMI and health reference levels	Conduct EMF monitoring along the Alignment during start-up commissioning	Operations	BMPs, comparable to other TransLink projects

7.12.9 Discussion of Review Results

7.12.9.1 Change in EMF Levels

After the incorporation of the applicable EMF and EMI standards, and the implementation of design mitigation, EMFs generated by the Project are expected to be similar to those estimated for other urban mass transit systems that use DC motors powered by a 750 V overhead catenary system, such as Toronto's Metrolinx UP Express (Parsons Brinckerhoff 2014).

The overhead catenary system and trains would predominantly emit 0 to 60 Hz EMFs. Toronto's Metrolinx UP Express applies a similar range of voltage and current through the overhead catenary system and trains. Assuming that the overhead catenary system and trains' electric motors have a similar EMF profile as the Metrolinx UP Express, the estimated EMF intensity inside the Project's train cars would be 1,000 V/m and 160 mG.

At the TPSS and OMF, incorporation of the applicable EMF and electromagnetic compatibility (EMC) standards will limit EMF intensities to those that are similar to urban background levels. Perimeter fencing around the OMF and placing TPSS in locations that are less frequented by people or at least 10 metres away from a permanent residence will limit public exposure.

7.12.9.2 EMFs and Health Risks

Assuming that the Project's trains have a similar EMF intensity as the Metrolinx UP Express, the expected EMF levels are well below the ICNIRP reference levels for whole body exposure, as indicated in Table 7.12-3. Considering that the ICNIRP reference levels are applicable to occupational exposure durations (i.e., occupational exposures of 8 hours per day, 5 days per week), passengers on trains and at stations would experience shorter exposure durations. When considering long-term EMF exposure, Health Canada and the World Health Organization do not consider the exposure to low-intensity, low-frequency EMFs to be a health risk to the public, as described earlier in Section 7.12.4. Based on these factors, there are no significant health risks to the public or to train operators from exposure to Project EMFs.

7.12.9.3 EMI

The Project is predicted to produce EMFs at levels that meet the applicable regulations and standards listed in Table 7.12-3, which are intended to maintain electromagnetic compatibility and mitigate the potential for EMI. It is unlikely that Project EMFs, under normal operating conditions, would interfere with other electrical systems, or AM/FM radio services if the EMFs are within the applicable criteria and standards.

EMFs are produced by equipment manufactured by third parties (e.g., communications systems, trains) but these third-party manufacturers are expected to comply with the applicable Industry Canada standards and regulations for those products. Such equipment is assumed to meet the applicable criteria to mitigate the potential for EMI with communications and radio frequencies.

Electrical arcing from the overhead catenary system with the train's power pickup will result in momentary radio frequency EMFs (i.e., 3,000 Hz to 300 GHz). These EMFs have the potential to temporarily interfere with the operation of nearby radio frequency receivers such as radios, radar and communications towers. EMF monitoring at locations with higher potential for EMF interference (i.e., RCMP station) is recommended during start-up and commissioning to confirm

that radio frequency EMFs during arcing events do not reach levels that could interfere with radio frequency receivers in these areas. Additional mitigation measures may be applied if EMI/EMC issues are encountered, or if there are reports of EMI/EMC from businesses along the Alignment (e.g., Guildford Town Centre, Fraser Valley and Northern Tax Services, Surrey BC Biomedical Laboratories). As the Surrey Memorial Hospital is 100 m from the centreline of the Alignment, it is considered beyond the reasonable distance that EMFs from the Project could cause EMI/EMC to sensitive medical or scientific equipment. Due to attenuation, the Project will not generate EMF intensities that could cause interference with other electronics at such distances.

EMI with personal electronics, wheelchairs, and personal medical devices is not expected on the trains and station platforms. There is sufficient separation between people at these locations and any strong EMF sources from the Project. A review of EMF compatibility guides by various pacemaker manufacturers indicates that pacemakers are designed to be compatible with the types of EMFs associated with LRT, magnetic levitation trains, and high-speed trains (Boston Scientific 2017, Medtronic 2017, Tikkaja et al. 2013).

7.12.10 Conclusion

The review of EMFs examines the potential effects related to EMI and EMC with radio frequency receivers (e.g., AM/FM radio communications), electronic systems and electronic devices, as well as potential health effects. During normal operations, EMFs from the Project are not expected to interfere with radio frequency receivers. A risk of radio frequency interference was identified for electrical arcing between the overhead catenary system and the train's power pickup. EMF monitoring during start-up and commissioning near receptor sites, such as the RCMP station, is recommended to confirm that the EMFs do not pose an EMI risk along the Alignment.

Pacemakers and wheelchairs are designed to be compatible with the types of EMFs associated with LRT. Therefore, no EMC issues are expected for people with pacemakers or those using wheelchairs or other electronic assistance devices. The Surrey Memorial Hospital is considered beyond the reasonable distance that EMFs from the Project could cause EMI/EMC to sensitive medical or scientific equipment.

With regards to public health, the EMF frequency and intensity produced by the Project are below the acute reference levels indicated by ICNIRP for occupational exposures; chronic exposures to low frequency EMFs is not recognized as a potential health concern by Health Canada or the World Health Organization. Therefore, EMF generated by the Project is not expected to result in effects on human health.

7.12.11 References

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