exist (*Use of Locomotive Horns at High-way Rail Grade Crossings Draft Environmental Impact Statement* December 1999). The DEIS noted the addition of an active rail line decreased the property values, within a quarter mile of the line, by an average of 2.4 percent. Property values near the maglev guideway may or may not experience a decrease.

Based on several articles and investigations that considered the impact on assessment values in relation to rail transit, property values may increase, which would generate more income for each community. A recent study conducted by Booz-Allen and Hamilton, Inc. entitled *Impacts of Rail Transit on Property Values,* revealed that property values along rail corridors may increase if two factors are achieved: improved interregional accessibility and potential for improved development, both of which could be provided by the Pennsylvania High-speed Maglev Project. Based on these two factors, property values near the stations may increase in value.

4.16.7.4 Mitigation

Based on the minimal losses that each community or municipality may experience, and the development potential at the stations, mitigation is not necessary for the local and regional economies.

4.17 Public Health and Safety

The FRA has the responsibility for ensuring railroad safety throughout the nation and monitoring railroad (including maglev) compliance with federally mandated safety standards. The areas of public health and safety addressed in this section of the DEIS include: electromagnetic fields (EMF), electromagnetic interference (EMI), passenger and worker protection, guideway safety, communication and control system, vehicle component safety, fire protection, emergency preparedness and evacuation, training, and the Maglev Safety Program Plan.

4.17.1 EMF/EMI

4.17.1.1 Background

The FRA has conducted extensive tests and measurements on the existing Transrapid International maglev system in Germany to determine the level of EMF/EMR generated by the system. Professional groups and regulatory agencies have established EMF/EMR human exposure safety standards and guidelines to protect the public. As long as these regulatory standards are met, the maglev operation is considered safe and acceptable to the public.

FRA guidelines require an assessment of potential electromagnetic field impacts for electrified rail projects. Electrified rail systems, such as the proposed maglev system, subways, trains, and trolleys, operate by converting electrical energy into a direct drive or electromotive force that propels the vehicle. In the process of providing and using electrical energy, electric and magnetic fields known as EMFs are produced. Similar to conventional electrified rail, maglev generates EMFs that emanate into the passenger vehicles and the surrounding environment from the propulsion, electrical supply, and on-board communication systems.

The term “electromagnetic field” characterizes electromagnetic radiation (EMR) and refers to both electric fields and magnetic fields (EMF), whose intensity and frequency characteristics vary over time and space. Electric and magnetic fields occur in nature (e.g., static electricity and the earth's magnetic poles), in all living things (e.g., neuromuscular activity and functioning of cell membranes), and as a result of the generation, transmission, and distribution of electricity and the operation and use of electrical equipment.

Electric fields are caused by electrical potential and can be found near any electrical equipment that is switched on from its power source. Electric fields are measured in volts per meter (V/m). Electric fields can be created by high voltage, are strongest close to their source, and are weakened in proportion to the square of the distance from the source. Electric fields can be shielded or reduced by conducting objects such as trees and buildings. This is because most objects conduct the electric field to the ground, in a similar fashion to earth ground wires in one's home.

Magnetic fields are caused by the flow of electricity (current) through a conductor (e.g., wire). Electrical equipment must be switched on and be operating to create a magnetic field. Like electric fields, magnetic fields are higher closer to their source, and increase as the current increases. The Scientific International (SI) unit for measuring or quantifying magnetic fields is tesla (T), with 1 T = 10,000 gauss (G), or milliTesla (mT), with 1 mT = 10 G. It is common to refer to a magnetic field using the equivalent term of gauss or miligauss (mG). This facilitates comparison of field strengths to the earth's static magnetic field, which ranges from 500 to 750 mG. Also, magnetic fields commonly encountered in the public environment typically range from 1 to 10 mG. Magnetic field strength decays or falls with distance from the source depending on the source type, shape, and size of the source. Table 4.17.1-1 provides typical magnetic fields generated from common electrical appliances and power lines. This information should only be used as a general reference, and as discussed elsewhere, the actual source level encountered by a receptor is a direct function of the source characteristics and receptor distance from the source at the time of field exposure. Various reasonable assumptions were made on the receptor distance from the listed sources in order to develop Table 4.17.1–1. (Please note that the upper end value given for the hair dryer magnetic field strength is several orders of magnitude higher than the other cited appliances. The high value is generated at the source by the relatively high current flow through the hair dryer, and since it is held very close when used, there is little to no drop in field strength from the source to the person receptor.)

Table 4.17.1-1 Typical Magnetic Field Levels Generated from Common Electrical Appliances and Power Lines

Source of EMF	Typical Level (mG)	Typical Range (mG)
Hair Dryer	300	60 – 20,000
Television	1	0.1 - 2
Computer	5	2 - 6
Electric Range	8	20 - 30
Electric Toaster	3	1 - 20
Refrigerator	2	2 - 20
Suburban Power Line	2	1-4
High Voltage Transmission Lines	15	Mar-90

Source: DOE/EE-0040 Questions and Answers About EMF, National Institute of Environmental Health Services and U.S. Department of Energy; and Final PEIS, Volume 1, Maglev Deployment Program

Magnetic fields can only be shielded by structures containing ferrous metals or similar material. Magnetic field sources can also induce EMI (i.e., screen jitter in Cathode Ray Tube [CRT] and computer monitors, diagnostic medical equipment and scientific instruments depending on the installation [building], equipment susceptibility, distance, and magnitude of the source).

There are high frequency EMI operation design safety guidelines that are relevant to the proposed Maglev Project. These EMI standards are usable as voluntary guidelines and are not statutory or intended to be used as formal, or bright-line, design guidelines.

The Institute of Electrical and Electronic Engineers (IEEE) has published various EMI operation design safety guidelines, including IEEE Standard 1474.1, IEEE Standard for Communications Based Train Control Performance of Functional Requirements, IEEE P - 1474.1, IEEE Environmental Standard for Transit Rail Car Electronic Equipment (preliminary) Communications Based Train Control Performance of Functional Requirements, and IEEE C62.47 - IEEE Guide on Electrostatic Discharge, Characterization of the Electrostatic Discharge Environment. In addition, the American National Standards Institute (ANSI) has developed an EMI design guideline under ANSI C63.12 – ANSI Standards for Electromagnetic Compatibility Limits – Recommended Practice.1987. Adherence to these respective guidelines is addressed in Section 4.17.1.3, Impact Analysis and Section 4.17.1.5, Mitigation.

Another area of possible EMF concern is the potential for adverse human health effects due to chronic field exposures. Direct health effects due to molecular or cell destruction have been observed with ionizing (high frequency and related energy) sources. These effects cannot occur with the low frequency and energy level EMFs (non-ionizing energy sources) that would be experienced from the proposed maglev system. While concern has been raised related to potential health effects from lower frequency EMF sources, the overwhelming majority of studies dealing with low-level EMFs indicate that there is no association between EMFs and negative human health effects.

There are currently no national mandatory standards in the United States for static or extremely low frequency (ELF) magnetic field human exposure limits. Rather these standards exist as voluntary exposure guidelines. Various groups concerned with the safety of non–ionizing radiation have developed guidelines for electromagnetic field exposure. State and federal agencies have adopted some or all of these voluntary guidelines by consensus as impact review criteria. Also, the states of Florida and New York have formally adopted standards for power frequency electric and magnetic fields, which are based on maintaining existing transmission line field levels.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published guidelines on occupational and general public exposure to static and time-varying fields in 1994 and 1998, respectively. Separate guidelines exist for static and time–varying ELF and radiofrequency (RF) magnetic fields. The ICNIRP public exposure limits at the 60 hertz (Hz) power frequency correspond to 800 mG for magnetic fields and 8.3 kilovolts (kV)/meter.

The American Conference of Governmental Industrial Hygienists (ACGIH) annually publishes voluntary compliance guidelines for workplace threshold limit values of human exposure to static, ELF, and RF magnetic fields. These guidelines are not intended for uncontrolled public exposure. The latest 2004 ACGIH time–varying field guidelines are summarized below (A*merican Conference of Governmental Industrial Hygienists 2002 Time-Varying (AC) Magnetic Field Exposure Guidelines):*

- 1 G (1000 mG) (medical device wearers) at 1 to 300 Hz frequency
- 2 G (2000 mG) at 300 Hz to 3 kilohertz (kHz) frequency
- 10 G (10,000 mG) at 60 Hz frequency (power bandwidth)

The IEEE published a human exposure standard in 2002 for ELF electromagnetic fields, IEEE C 95.6, *Standards for Safety Levels with Respect to Human Exposure to Electromagnetic Fields*, *0 to 3 kHz*. This standard defines exposure levels intended to protect against possible adverse human EMF health effects. The maximum permissible human exposure levels specified in IEEE C 95.6 are higher than the human exposure levels specified in the ICNIRP guidelines.

Additional guideline(s) and standard(s) exist for human exposure to radio frequency EMF. In 1999, the IEEE published IEEE C 95.1, *Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300* gigahertz (Ghz). The Federal Communications Commission (FCC) has also developed a RF human exposure guideline under OET Bulletin 65, Ed. 97-1, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields*. These impact evaluation criteria are relevant to the radio frequency magnetic field levels that will be generated by the proposed maglev operations command, control, and communications equipment and not the maglev system's extremely low frequency electric power supply and distribution system.

4.17.1.2 Methodology

A detailed description of the Transrapid International (TRI) system technology and related EMF sources is contained in the FRA report, *Electromagnetic Field Characteristics of the Transrapid TR08 Maglev* (May, 2002). This report is included in the PTSF.

EMF of various frequencies normally emanate from any electrified transportation and electric power system. In order to evaluate the potential EMF effect on passengers and the surrounding environment, it was necessary to record a wide spectrum of electric and magnetic fields at the TRI testing facility in Emsland, Germany. Details of the recording methodology, actual measured data, and subsequent analysis are provided in the testing facility report included in the PTSF.

Resultant background magnetic field readings were obtained for static direct current (DC) magnetic fields and ELF fields measured in units of mG. These are the predominant magnetic fields generated by the TR08 system. ELF electric fields were not measured since the fields measured from the TR08 system were either small (close to detection range) or equivalent to ambient background at the testing facility and, as a result, were not considered to be significant. RF electric field strengths measured at the testing facility are also insignificant. However, RF fields were measured in volt per meter (V/m) to identify possible sources of RF interference.

Magnetic field readings were obtained over a rolling four-minute interval with the *EMDEX MultiWave System II* fluxgate magnetometer, configured with identical sampling parameters used during the August 2001 TR08 EMF/EMR assessment done at the testing facility. Background RF electric field measurements were also recorded with the *PMM 8053* electric field strength meter and *EP-330* probe over a 5-minute period with one second data capture.

Electric and magnetic field readings were taken inside the TR08 vehicle at numerous locations while the vehicle was stationary and moving along the guideway. A "test mannequin" was deployed with sensors in a seated or standing position in order to record the data. Data were obtained in three locations in each car (lead, middle, and trailer). Refer to the testing facility report contained in the PTSF for further details on the test mannequin configuration and sensor locations. Significant ELF electric fields were not observed on board the vehicle. The static magnetic fields on board the vehicle were, on average, within 25 percent of the normal ambient level and never deviated by more than 120 percent. The principal frequency-related magnetic field sources on board the vehicle were below the floor and uniformly distributed along the length of the vehicle. Average ELF magnetic fields recorded at various locations at waist height in the passenger and attendant compartments had an average range of 1.5 to 66 mG and a maximum reading of 185 mG.

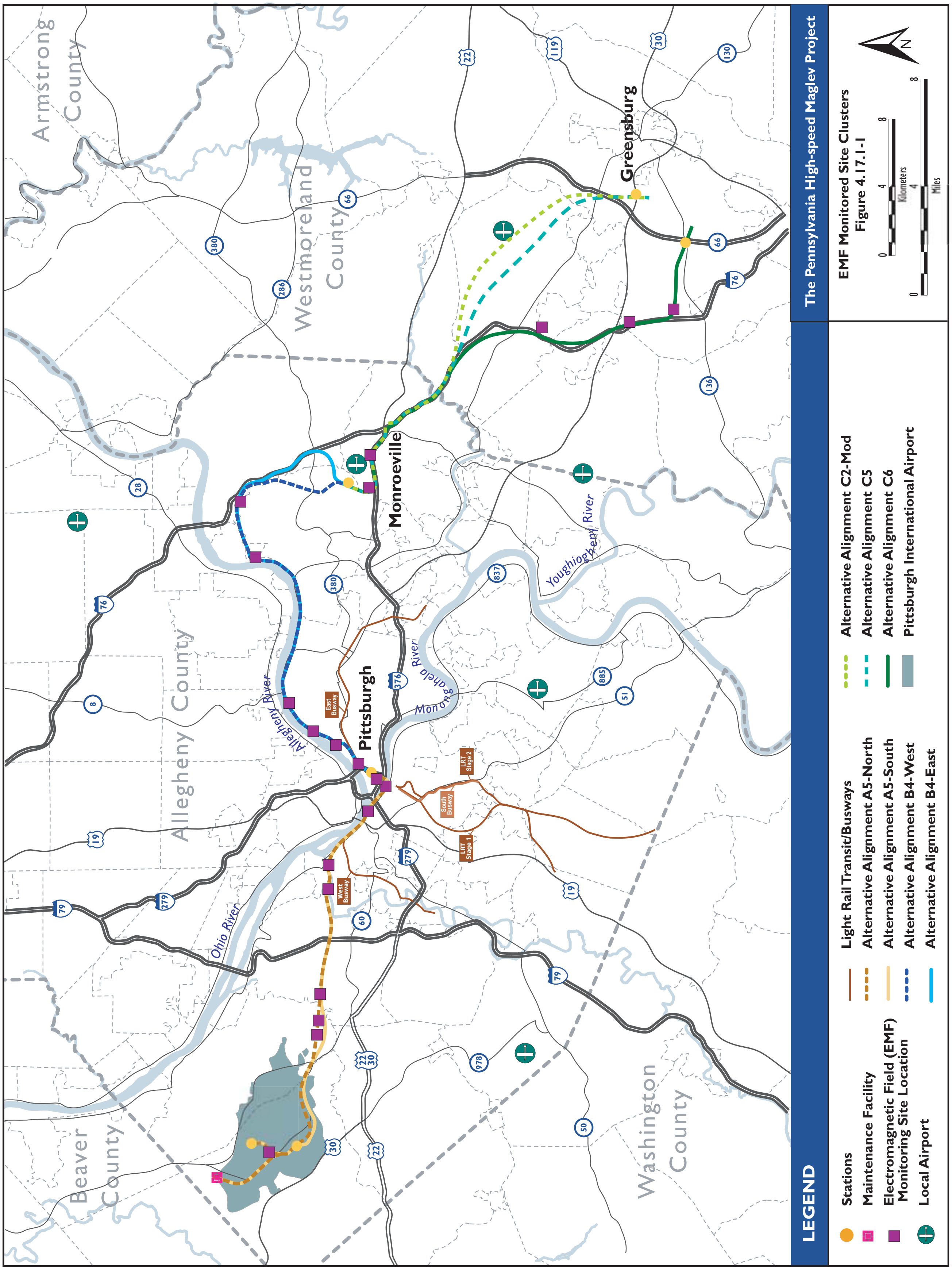
Locations along the proposed alignments were selected to characterize the various types of surroundings or potential existing EMFs or EMR areas of interest. Areas of interest do not imply nor convey that the alignments would pass existing facilities or areas where EMFs or EMR fields are known or expected to be a problem. Rather, these areas of interest would be used to identify potential areas, activities, or facilities that could be affected by elevated fields and existing EMF or EMR field sources that could be affected by additional field sources generated by the maglev system. The field reading locations included schools, businesses, residential neighborhoods, and high voltage transmission lines. Specific areas of interest along the alignments included PIA, the CMU Robotics Lab, and the Pittsburgh Police Department Emergency Operations Center.

Background electric and magnetic field readings were taken at various locations along the proposed alternative alignments. Several of these locations were clustered near one another. These background field readings were taken from April 4 through April 6, 2002 at a total of 37 locations along the alignments as the first step toward characterizing existing background field strengths and developing the projected cumulative ELF field strengths and related impacts.

Resultant background magnetic field readings were obtained for static DC magnetic fields and extremely low frequency AC magnetic fields measured in units of mG and microgauss, respectively. These were the predominant magnetic fields generated by the TR08 system. ELF electric fields were not measured, presumably since the fields measured from the TR08 system were either small (close to detection range) or equivalent to ambient background at the testing facility and, as a result, were not considered to be significant. RF electric field strengths measured at the testing facility are also arguably insignificant. However, RF electric fields were measured in V/m, presumably to identify possible significant sources of RF interference.

Magnetic field readings were obtained over a rolling four-minute interval with the *EMDEX MultiWave System II* fluxgate magnetometer, configured with identical sampling parameters used during the May, 2002 TR08 EMF/EMR test site assessment. Background RF electric field measurements were recorded with the PMM 8053 electric field strength meter and EP-330 probe over a 5-minute period with one second data.

Figure 4.17.1-1 shows various field measurement locations. More detailed location maps and the corresponding field readings can be found in the PTSF. In 32 of 37 locations where readings were obtained, the listed RF electric field values were either zero or less than

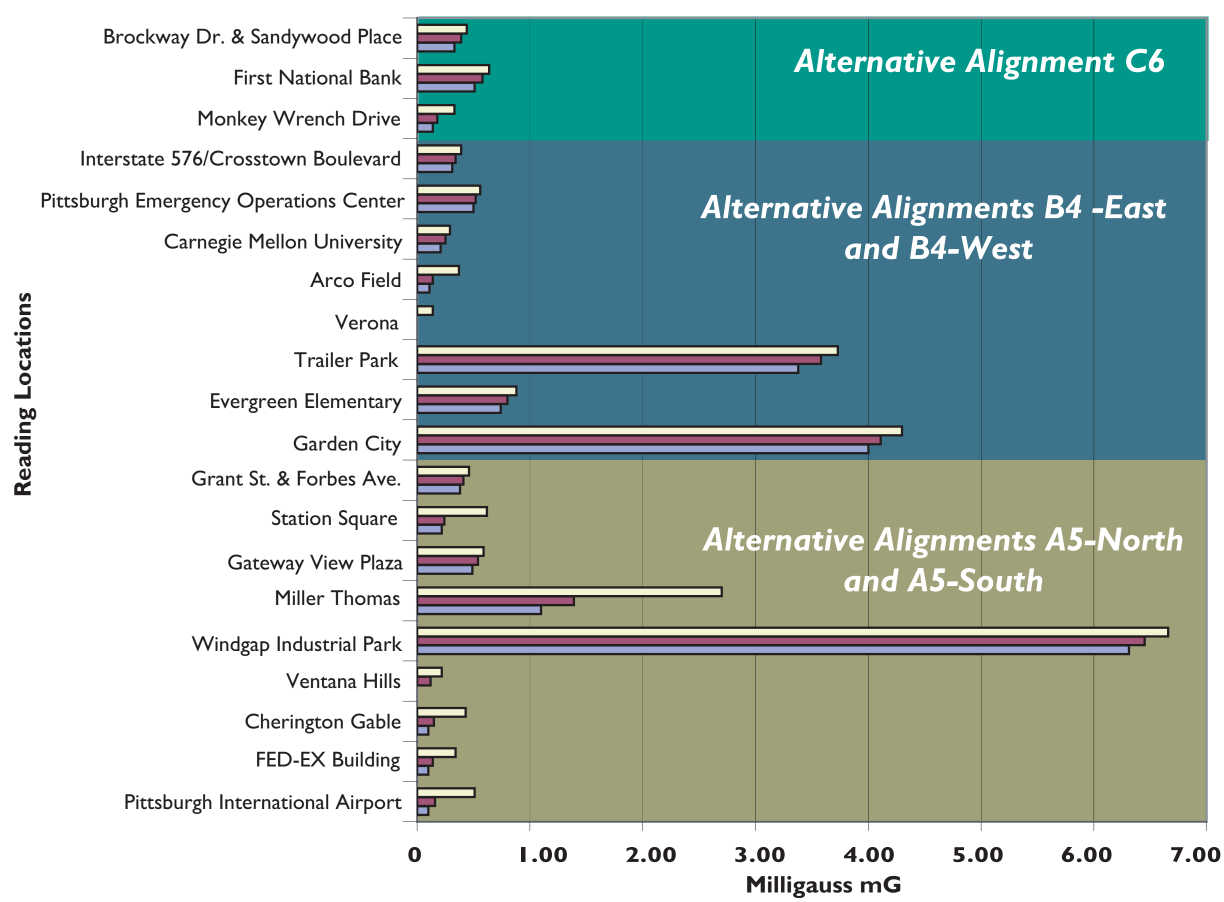

The Pennsylvania High-speed Maglev Project
EMF Monitored Site Clusters
Figure 4.17.1-1
Kilometers
Miles
N
LEGEND
Stations
Maintenance Facility
Electromagnetic Field (EMF) Monitoring Site Location
Local Airport
Light Rail Transit/Busways
Alternative Alignment A5-North
Alternative Alignment A5-South
Alternative Alignment B4-West
Alternative Alignment B4-East
Alternative Alignment C2-Mod
Alternative Alignment C5
Alternative Alignment C6
Pittsburgh International Airport
Armstrong County
Westmoreland County
Allegheny County
Beaver County
Washington County
Greensburg
Monroeville
Pittsburgh
Ohio River
Allegheny River
Monongahela River
Youghiogheny River
East Busway
West Busway
South Busway
LRT Stage 1
LRT Stage 2

1 V/m. In areas where a field reading was recorded, most values were moderately to significantly below one V/m. A summary of measured AC magnetic fields is shown on Figure 4.17.1-2, while Table 4.17.1-2 summarizes the five locations where the measured background RF electric field readings exceeded 1 V/m.

The measured background AC magnetic field

Table 4.17.1-2 Summary of RF Electrical Field Readings Where 1V/m Was Exceeded

Alternative Alignments	Reading Location Number	Location Description	Measured Field Strength (V/m)
A5-North & A5-South	1	Landside Terminal station	< 2
	2	Semi-rural, Hookstown Road, PIA area	
	7	Commercial, south shore of Ohio River	
	8	Public, Smithfield Street Bridge area	
B4-East & B4-West	9	Residential, Lawrenceville neighborhood	



LEGEND:

- Maximum
- Average
- Minimum

The Pennsylvania High-speed Maglev Project

Measured Existing Magnetic Field Strength

Figure 4.17.1-2

readings noted in Figure 4.17.1-2 ranged from less than 1 to under 7 mG. When comparing these levels to measurements taken at the testing facility, single pass ELF magnetic fields measured ranged from approximately 122 mG at the proposed guideway centerline and decreased to approximately 10 mG at a distance 20 meters from the proposed guideway. It is noted that a 10 mG ELF magnetic field strength is an accepted EMI threshold for possible CRT monitor interference. The measured data suggest that a minimum 20-meter separation distance between the proposed guideway and CRT receptors may prevent maglev-induced CRT interference. Potential maglev-induced EMF/EMI interference is expected to be minimal and highly installation and location specific.

As discussed in Section 4.17.1.5, Mitigation, it may be necessary to develop an Electromagnetic Compatibility Control Plan (EMCCP) after project approval and a final alignment has been determined. At that time, all existing data and information and the forthcoming EMCCP data and analysis could be used as a guide to determine specific EMF–induced impacts and to develop EMF mitigation, as necessary.

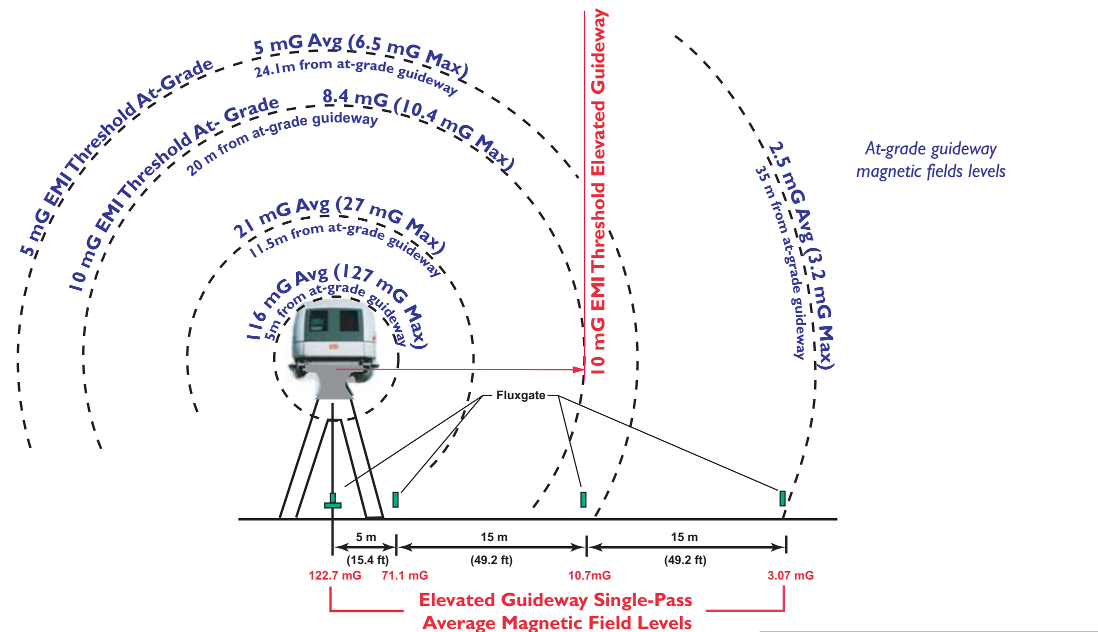
Static magnetic field readings for 19 of 20 sites measured were in the range of 458 to 587 mG. A single static magnetic field reading outside this range was measured at the I-579 and Liberty Avenue crossing, which had a field reading of 785 mG. From the analysis of the testing facility report and the April 2002 site field readings, it is expected that the combined static magnetic fields would be below the 750 mG static DC threshold for EMI that can potentially cause blooming or screen shifts in CRT computer monitors, televisions, and video projectors with CRT-based imaging systems. At the edges of large steel structures there is the potential that fields can converge, possibly causing impacts or interacting with existing field strengths to induce EMI impacts.

4.17.1.3 Impact Analysis

EMFs expected to be generated by the maglev are a small subset of numerous types of electromagnetic sources and corresponding energy levels in our overall environment. Field strengths would be anticipated to fall in the very low frequency end of the magnetic field range (0 - 300 Hz). Similarly, electric power and electrified transportation systems operate in the extremely low frequency range (3 - 3000 Hz) at the bottom of the electromagnetic spectrum.

In 1966, the FCC adopted a public RF field human exposure standard. This FCC guideline is in good agreement with both the ANSI 1999 and ICNIRP 1998 RF exposure guidelines. All of these guidelines contain frequency-dependent RF electric field limits with the most stringent maximum recommended human exposure value of 27.5 V/m between the frequencies of 10 MHz and 300 MHz. Electric field measurements were made at the testing facility using a broadband instrument covering the range of 80 MHz to 40 Ghz. The actual frequency or frequency distribution during the RF measurements could not be determined from this instrument. Accordingly, it can be reasonably assumed that a significant portion of the TR 08 system test range fell between 80 and 300 MHz, and likely fell below the 27.5 V/m threshold found in the above RF exposure guidelines. Comparing that threshold to the average RF electric field levels measured at the testing facility, the RF electric fields that can be expected to be generated by the maglev system will be well below the above RF exposure guidelines even with a wide margin of variation. As previously discussed and summarized in Table 4.17.1–2, Summary of RF Electrical Field Readings: Sections A, B and C, the background RF electric fields that are expected to be encountered along the alternative routes are considered insignificant. When these background readings are considered with the RF electric fields measured at the testing facility, as noted above, it was concluded that RF electric fields do not represent an area of concern for the maglev system.

Single pass magnetic field levels of the TR08 on elevated guideway at four distances from the centerline are shown on Figure 4.17.1-3. Figure 4.17.1-3 also provides a benchmark



AC ELF EMI Thresholds (screen jitter & noise)
5 mG for 17-21 inch CRT computer monitors & diagnostic/medical equipment
10 mG for 12-15 inch CRT computer monitors & electronic/audio equipment

SOURCE: DOT-VNTSC-FRA, TR08, Maglev System, May 2002

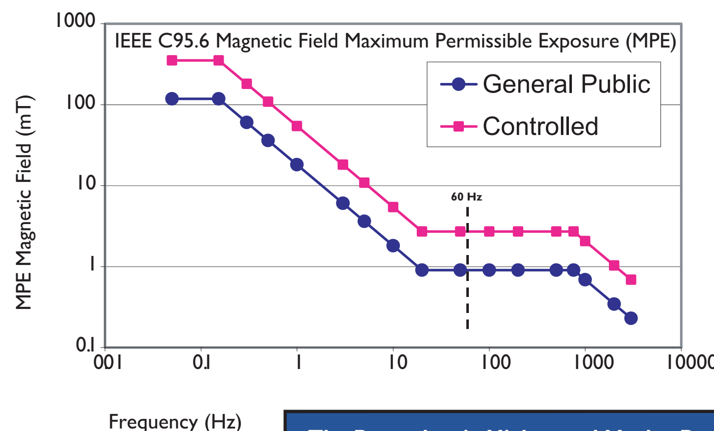
The Pennsylvania High-speed Project
Elevated Guideway
Steel & Concrete Construction
TRO8 Vehicle Magnetic Field Profile
Figure 4.17.1-3

for potential ELF and EMI from moving TR08 vehicles based on distance. The assumed magnetic field threshold for the potential EMI comparison was 10 mG. For the 5-meter (15.4-feet) elevated guideway, the 10 mG EMI threshold is 20 meters (65.6 feet) from the guideway centerline. A symmetrical (bilateral) magnetic emission profile emanates from each side of the moving TR08 car and guideway section. A 10 mG ELF magnetic field strength was used as the EMI threshold for standard CRT computer monitors, unshielded sensitive electronic equipment, and signal cables. Larger high-resolution CRT computer monitors and other equipment are susceptible to EMI at a lower 5 mG magnetic field threshold. Using these criteria, potential ELF magnetic field-induced EMI may occur at distances within approximately 24 meters (79 feet) of the guideway. (It should be noted that the bottom of the guideway for the project is elevated a minimum of 5 meters (16.5 feet) and is 20 meters (65.6 feet) or greater in height in some areas).

It is also necessary to consider the combined effect of the maglev system and background magnetic field levels. Measured background field readings were less than 1 mG at 16 of 20 locations along the currently recommended alignment routes. At these locations, it is not expected that the background magnetic fields will significantly contribute to or alter the potential maglev-induced EMI interference distance profile. However, in four of 20 locations, a maximum magnetic field range of 2.70 to 6.66 mG was recorded. In these locations, the 5 mG magnetic field EMI interference distance profile could extend past 24 meters (79 feet).

Static and ELF magnetic fields have been measured in a variety of other electrified and non-electrified rail transportation systems using similar instrumentation and protocols that were used for the TR08 maglev system. These comparison systems include the Amtrak Northeast Corridor (three lines), New Jersey Transit Long Branch, TGV – Atlantique, and Transrapid TR07 rail systems. No comparisons of very low frequency or low frequency magnetic field levels or ELF and RF electric field levels were made, since no significant field levels of these respective bands were observed on the TR08 system. A comparison of the data shows that the static and ELF magnetic field levels recorded in the TR08 system were in the range of the other rail systems cited above. In addition, the distribution of field levels in the TR08 system was not dramatically different than those recorded in the other rail systems. Copies of the testing facility report and the EMF/EMI working paper (for the data sets and comparative rail system[s] EMF analysis) are contained in the PTSF.

As noted in Section 4.17.1.1, EMF/EMI Background, several organizations have established safety guidelines for human exposure to EMF. Figure 4.17.1-4 provides for reference the maximum human exposure values contained in IEEE C 95.6, *Standards for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0 to 3 kHz*. It should be noted that the referenced IEEE exposure values are greater than those established by the ICNIRP levels. Later in this section, comparisons will be made with ICNIRP human exposure guideline values.



The Pennsylvania High-speed Maglev Project

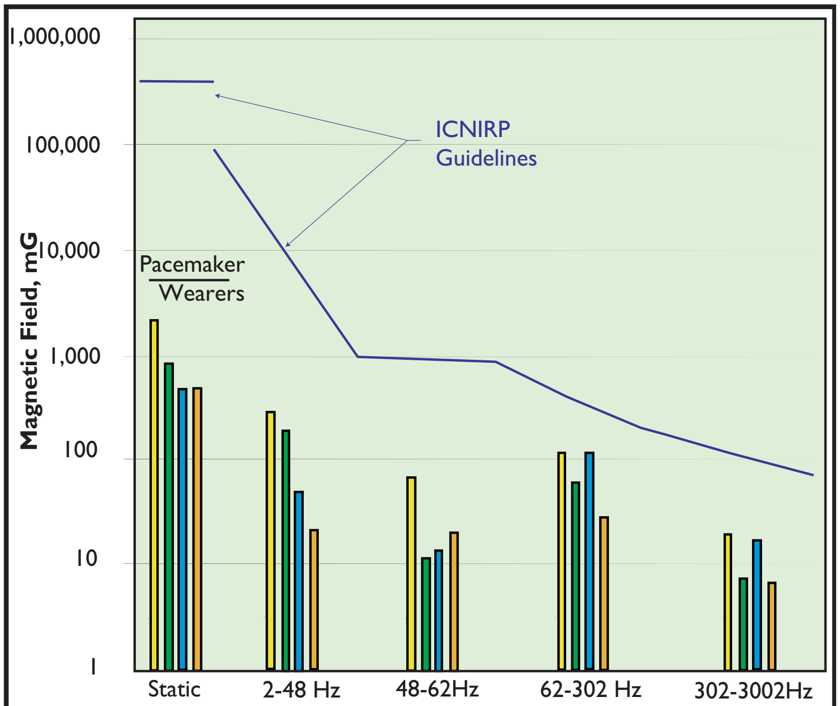
Magnetic Field Exposure Guideline in IEEE C95.6

Figure 4.17.1-4

SOURCE: IEEE, 2002

The observed TR08 magnetic field strengths and those expected to be generated by the maglev system are below all referenced low frequency human exposure EMF guidelines. Figure 4.17.1- 5 provides a comparison between the maximum observed ELF magnetic field levels observed from the TR08 to the ICNIRP guidelines and those recommended for individuals using pacemakers. All observed TR08 system magnetic field values were below both sets of exposure criteria. It should also be noted that meeting the ICNIRP guidelines automatically ensures meeting the higher ACGIH human exposure standards.

The key previously cited RF human exposure magnetic field guidelines are IEEE C 95.1, *Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 Ghz*, the previously listed ICNIRP standard for time–varying



SOURCE: DOT-VNTSC-FRA, May 2002

LEGEND:	The Pennsylvania High-speed Maglev Project
On board Station Guideway Cabinets	**Maximum Static and Time Varying Magnetic Fields (on board TR08)** **Figure 4.17.1-5.**

fields and the FCC's exposure guideline under OET Bulletin 65, Ed. 97-1. The observed TR08 onboard, guideway, and support facilities' magnetic field strengths are below the IEEE, ICNIRP, and FCC RF magnetic field human exposure guidelines.

4.17.1.4 Summary

Given the complexity, types, and varied sources of EMFs that may be encountered with the proposed maglev system, it was necessary to present a large amount of information and data in this EMF assessment. From this information, the following conclusions can be drawn or inferred for the project:

- Background EMF readings were taken at 37 locations along the proposed maglev alignment. Based on the field sampling data and expected maglev vehicle fields, potential maglev-induced electromagnetic interference with computer monitors and other unshielded electrical equipment could occur on a limited basis. Also, magnetic field strengths from the maglev system are comparable to other electrified and non-electrified rail systems.
- All EMFs generated by the maglev system would be in the non-ionizing energy range and do not possess sufficient kinetic energy that is capable of harming human cells and causing direct human health impacts.
- There are no mandatory national standards in the United States for static or ELF magnetic field human exposure limits. Rather these standards were adopted as voluntary

exposure guidelines that are intended to protect human health. However, the EMF levels produced by maglev would be below the EMF exposure guidelines established by the American National Standards Institute, the American Conference of Governmental Industrial Hygienists, the Institute of Electrical and Electronic Engineers, the International Commission on Non–Ionizing Radiation Protection, and the Federal Communications Commission. (It is generally noted that the overwhelming majority of studies dealing with potential EMF-induced human health effects do not show an association between EMF and human health effects).

- Static magnetic fields encountered onboard the maglev vehicles would be on average within 25 percent of the normal ambient level and negligible adjacent to switching cabinets and guideway.
- ELF magnetic fields (2 - 3000 Hz) are the dominant frequency of the spectrum that would be encountered on the maglev system, with the highest field strengths expected at or below the 300 Hz frequency range.
- ELF magnetic fields at the stations and along the proposed guideway would result from the motion of the maglev vehicles and would be of very short duration.
- ELF magnetic fields generated by the switching cabinets would be sinusoidal in relationship to the vehicle motion and related guideway current.
- Power frequency range (60 Hz) magnetic fields would not be a significant component of the ELF magnetic fields expected to be generated.
- Based on available existing maglev system design information, very low frequency (VLF) or low frequency (LF) magnetic fields (3 kHz to 300 kHz) would likely not be encountered with the maglev system. However, it is possible that the final selected electronic control or communications equipment could generate VLF or LF magnetic fields. This would be addressed following project approval as part of the final design of the system.
- Small ELF electrical fields would be detectible at the stations and onboard vehicles but are viewed as negligible.
- Based on available design information, RF electric fields (80 MHz – 40 GHz) would not likely be generated by the maglev system in most locations and in a few isolated instances, where present, would be small. RF electric fields that can be expected to be generated by the maglev system will be well below the above RF exposure guidelines even with a wide margin of variation. The background RF electric fields that are expected to be encountered along the alternative routes are considered insignificant. When these background readings are considered in conjunction with the RF electric fields measured at the testing facility and compared to applicable Federal Communications Commission, International Commission on Non-Ionizing Radiation Protection, and Institute of Electric and Electronics Engineers human exposure standards or guidelines, it was concluded that RF electric fields do not represent an area of concern for the Pennsylvania maglev system. It is noted that the final selected control and communications equipment could generate RF levels significantly different than those encountered at the testing facility. This situation will be evaluated when equipment is selected.

4.17.1.5 Mitigation

Extensive electric and magnetic field data sets were collected for the TR08 at the Emsland, Germany, testing facility in August 2001 and published in the May 2002 *Test Facility Report*. The *Test Facility Report* data collection points included TR08 passenger and operator locations and also station, guideway, and switching cabinet locations. The *Test Facility Report* did not directly identify or suggest electromagnetic compatibility problems or concerns with the

TR08 system and other electrical systems or equipment. However, an EMCCP, in accordance with American Public Transportation Association SS – E – 010-98, *Standard for the Development of an EMCCP*, should be developed after project approval. The EMCCP would incorporate the selected alternative alignment and system final design. It would serve as a guide to EMI and EMC decisions for the design, engineering, procurement, and other related aspects of the project.

The potential maglev-induced EMF/EMI interference is expected to be highly limited and directly influenced by the installation (system equipment and related design) and receptor location (proximity to system sources). As a general rule, EMF/EMI interference is not expected to occur outside of 24 meters (80 feet) from the guideway centerline. In order to determine if mitigation actions are necessary, additional assessment of potential EMF-sensitive electrical equipment, facilities, or buildings adjacent to the alignment will be required. Additional support information and analysis will be developed to augment the existing data. Additional data will be collected at the projected location(s) of specific maglev system components, areas of interest, sensitive field receptors, and at the proper field reading orientation. This expanded information and data set will be used in conjunction with the known testing facility and EMCCP data and analysis to identify and estimate potential specific EMF-induced impacts and develop EMF/EMI mitigation as necessary. Mitigation measures could include shielding sensitive equipment with permeable ferromagnetic alloys (i.e., low carbon steel, silicon-iron steel, nickel-iron, and cobalt iron, etc.), the use of thick, highly conductive materials, or simply moving affected equipment.

4.17.2 Other Public Health and Safety Considerations

The planned maglev system will be subject to FRA's railroad safety jurisdiction, which specifically includes maglev systems. Many of FRA's safety rules will apply to the system in the same way as they do to any other railroad (e.g., alcohol and drug regulations, accident reporting rules, etc.). Once a system has been selected by FRA and funding has been secured, FRA will entertain a request from the perspective system operator for a rule of particular applicability to address the system's unique factors. FRA is already working with the Volpe Center to study the Transrapid system in depth so that FRA can be ready to handle rulemaking once such a petition is received. The explanation of the system's safety features included here describes how the system is intended to function, and does not indicate that FRA has performed a safety analysis of the system as it will be built, or reached any conclusions about the adequacy of the system's safety features. That safety analysis will occur as part of the rulemaking process.

The safety concepts of the Transrapid system and technology to be used by the proposed project include the following elements:

- Automated control and system protection without the need for onboard vehicle operator intervention for safety-critical functions;
- Automatic monitoring and reporting of all system equipment, functions, and status, including automatic dimensional inspection of the guideway;
- Protection of passengers during ingress/egress in stations by a platform separation or gate system;
- Passive protective measures (e.g., barriers, etc.) against the intrusion of obstacles into the vehicle's path;
- Fire protection measures and rescue strategies;

- Vehicle design to minimize hazards associated with collision with unexpected obstacles;
- Elevation of the guideway to ensure there is no opportunity for physical contact with other transportation modes/vehicles;
- Security and monitoring systems for intrusion protection in non-elevated areas or areas where guideway or operating equipment access must be controlled;
- Appropriate Human Machine Interface systems to support vigilant attention by the operating and maintenance personnel and encourage appropriate actions where needed to assure safety of maglev operation;
- Establishment of a Maglev System Safety Plan as the strategic safety process document for the system being deployed;
- Appropriate training and qualification of system operating and maintenance personnel; and
- Pre-revenue operational testing and system qualification testing.

Guideway Safety

Safety is a principal feature of the maglev system. Safety begins with the basic wrap-around guideway design of the vehicle and extends through the fully automatic operation-control system.

Unlike conventional electric powered railroad or transit, there are no plans for exposed high-voltage components such as overhead catenary supply cables/lines. Electronic components are fully insulated and/or enclosed or buried to prevent unauthorized or accidental contact. System safety is also enhanced since only sections of the guideway (motor sections) are powered at any one time as the vehicle physically passes. Other sections are inherently safe with no power supplied to them.

Collisions on the guideway will be prevented by the nature of the propulsion and control system. The safe control of the propulsion system causes the vehicles to travel at the same speed and direction within a propulsion block. Only one vehicle is capable of occupying a propulsion block. Vehicle collisions with other forms of transportation are highly unlikely because there are no at-grade crossings and the vehicles wrap around the guideway, preventing derailment.

In comparison to other conventional transportation systems, the vehicle loads experienced in the system are evenly distributed along the entire length of the vehicle and transferred to the guideway and substructure. This leads to a significant difference in the mechanical strain placed on the guideway versus the point loads of a traditional steel-wheeled train running on steel rails.

As with any elevated transportation system, there is a remote chance that other vehicles could collide with the guideway supports. The use of guide rail or a barrier protection near the column supports would be provided in areas where potential collision is possible.

As the vehicle travels along the guideway, it continually monitors the magnetic air gap that supports the vehicle. This gap is a true indication of the guideway beam location. Using the latest technology, any changes in the guideway or guideway substructure can therefore be accurately monitored and appropriate actions can be taken.

Communication and Control

The design of the long stator propulsion system and the operation control system prevents two maglev vehicle consists from being in the same propulsion block at the same time. Even if this could somehow occur, the system would cause the vehicles to travel at the same speed in the same direction, avoiding a potential collision. The safety features of the automated control system are designed to minimize human error from causing an event that could lead to an emergency situation. The operation control system is designed using failsafe techniques and built with operational redundancy of critical features for system availability. Passenger safety and comfort are the guiding factors in the design of the maglev system.

The primary communication and control of the vehicle is via redundant radio transmission from the operation control system. This is supplemented by normal mobile telephone service.

Vehicle Component Safety

If the system loses power during operation, the vehicle has onboard batteries to maintain power and enable the vehicle to maintain levitation until the vehicle is brought to a safe complete stop. Braking is accomplished through the use of an eddy current braking system powered by the onboard batteries. The vehicle control system is designed to stop the vehicle only at a station or identified auxiliary and safe stopping area at intervals along the guideway. In cases of emergency evacuation, passengers could exit the vehicle safely to the ground via evacuation tubes located at each door. In addition, walkways with stairs are provided along the guideway at the designated safe stopping areas. Specific details addressing issues concerning passenger evacuation, including the elderly or persons with disabilities, will be addressed during final design and as part of the Maglev Safety Program Plan.

The nose of the maglev vehicle is designed to deflect most guideway obstructions and employs a crush zone to absorb larger impacts. These design considerations minimize potential hazards to passengers. The maglev vehicle also employs state-of-the-art protection from indirect and direct lightning strikes. The vehicle is designed to allow a predefined crossover of the lightning current between guidance magnets in the vehicle and the guidance rails on the guideway beams. Each guideway beam is grounded to the guideway substructures, which are grounded to the soil. The vehicle and body are designed as a FARADAY Cage (all vital vehicle operational functions are designed for safe operation while experiencing a lightning strike).

Fire Safety

Maglev vehicles would have similar characteristics relative to fire hazards as conventional electrically powered rail cars. Federal rules for rail passenger equipment cover a wide range of hazards and specify acceptable materials for interior compartments to minimize the likelihood of fire spreading within the passenger compartment, as well as reduce the severity of a fire mainly by limiting the smoke quantity, toxicity, and heat content if a fire should occur. Maglev design will adhere to requirements pertaining to fire safety as specified in the federal passenger equipment rule.

Emergency Preparedness and Evacuation

In most circumstances, the system will operate as intended and passengers will board and disembark through the normal doors at stations. The extensive use of elevated guideway makes evacuation procedures a special concern. The evacuation design depends on evacuation tubes at each vehicle door to provide emergency egress. In locations where tubes are impractical or not considered safe (e.g., over water, swamps, steep terrain, etc.), special structures with stairways will be provided leading to safe areas. Maglev personnel will be responsible for assisting the elderly or passengers with disabilities. Applicable passenger equipment standards require rail systems (and maglev) to complete an emergency plan and specify the number of emergency exits provided, as well as mark them with special lighting and signage. State and local police, as well as local ambulance, fire, and hospital emergency services, will service all maglev passenger stations, guideway, and support and maintenance areas. Existing emergency procedures and routes associated with currently operating transportation systems are sufficient to support the maglev operation. The medical equipment to be carried on the vehicles will be specified through the route operator and U.S. regulations. Related emergency plans, specialized evacuation procedures, and emergency preparedness training will be addressed during the final design stage.

Training

Training will be conducted for all employees in normal and emergency procedures before operations begin. Continual training programs will also be required for all employees.

Maglev Safety Program Plan

A Maglev Safety Program Plan will be developed to cover the following areas: vehicles, maintenance, and inspection; guideway and guideway support structures; guideway equipment; operation control and communications; passenger stations; emergency rules and procedures; training and certification; operating environment; and emergency preparedness. The Maglev Safety Program Plan is the strategic safety process document that describes the design for safety and risk assessment development, implementation, and safety enforcement process for the system to be deployed for the project. The project will be compliant with the processor-based *Regulatory Rule for New and Innovative Technology*, and will meet or exceed the level of safety for existing intercity public transportation systems.

The Maglev Safety Program Plan will include a series of pre-revenue verification and pre-revenue tests. The intent of these tests will be to demonstrate and verify overall system safety before the initiation of revenue service operation.

4.18 Parks and Recreation Areas

4.18.1 Methodology

Parks and recreation areas were identified using a two-phased approach. In the initial phase, field views were performed to identify potential park and recreation areas. During this phase, municipal and county land use plans were also examined along with tax parcel and deed information. In the second phase, interviews were conducted with local and county officials, local parks and recreation representatives, parcel owners, and various recreation groups