Optellios, Inc. is a developer and manufacturer of technologically advanced fiber optic based security solutions that are supported by a dedicated commitment to customer service. These products include a full range of fiber optic sensing and communications devices, as well as system integration and alarm management software, all available under the FiberPatrol brand.

The FiberPatrol product line features an application based family of fiber optic intrusion detection and alarm management systems. FiberPatrol intrusion detection systems provide a state-of-the-art solution for perimeter, asset, and infrastructure security by identifying and locating intrusion attempts along site perimeters or infrastructure pathways.

For additional information, contact:
Optellios, Inc.
11 Penns Trail
Suite 300
Newtown, PA 18940
Phone: +1 267.364.5298 | Fax: +1 267.364.5357
info@optellios.com
www.optellios.com

CUT-IMMUNE MULTI-ZONE FIBER OPTIC PERIMETER INTRUSION DETECTION SYSTEM

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY
28 10 00 Electronic Access Control and Intrusion Detection
28 16 00 Intrusion Detection
28 16 43 Perimeter Security Systems

Notes to Specifier:
1. Where several alternative parameters or specifications exist, or where, the specifier has the option of inserting text, such choices are presented in [bold text].

2. Explanatory notes and comments are presented in colored text.
CUT- IMMUNE MULTI-ZONE FIBER OPTIC FENCE INTRUSION DETECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes a multi-zone system to detect intrusion along a perimeter fence employing fiber optic technology.

B. Product - A system consists of fiber optic cable, field termination modules, and central processing equipment which is sensitive to vibration of the fiber optic cable and capable of detecting and indicating the zone in which the disturbance occurs and of being deployed in a closed loop architecture for cut-immune performance.

C. Related Requirements

1. 27 05 08 Vibration and Seismic Controls for Communications Systems
2. 27 06 50 Schedules for Distributed Communications and Monitoring
3. 27 11 00 Communications Equipment Room Fittings
4. 27 13 23 Communications Optical Fiber Backbone Cabling
5. 27 13 23.13 Communications Optical Fiber Splicing and Terminations
6. 27 15 23 Communications Optical Fiber Horizontal Cabling
7. 28 05 13.19 Intrusion Detection Communications Conductors and Cables
8. 28 05 48 Vibration and Seismic Controls for Electronic Safety and Security
9. 28 10 00 Electronic Access Control and Intrusion Detection
10. 28 16 00 Intrusion Detection
11. 28 40 00 Electronic Monitoring and Control
12. 32 31 13 Chain Link Fences and Gates
13. 32 31.13.53 High-Security Chain Link Fences and Gates

1.02 REFERENCES

A. Abbreviations

1. nm - nanometer, a measure of optical wavelength
2. RAMS - Remote Alarm Management System

1.03 SUBMITTALS

A. Product Data

1. Manufacturer’s printed or electronic data sheets
2. Manufacturer’s installation and operation manuals

B. Shop Drawings

1. Fiber optic cable routing
2. Termination points and enclosures

FP1400 CUT- IMMUNE MULTI-ZONE FIBER OPTIC PERIMETER INTRUSION DETECTION SYSTEM

Rev. 20140213 28 16 43 - 2
3. Fiber optic cable fixation method to fence
4. Central processing (head-end) equipment rack elevations

1.04 QUALIFICATIONS
A. Manufacturer of system shall have a minimum of five (5) years of experience in the design, manufacture, and successful implementation of similar systems.
B. Manufacturer’s products shall be manufactured in their entirety within the United States of America.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver the equipment system in the manufacturer’s original, unopened, undamaged container with identification labels intact.
B. Ship and store the system protected from mechanical and environmental conditions as designated by the manufacturer and in a temperature environment as follows:
   1. Head-end equipment: -4°F to +158°F (-20°C and +70°C)
   2. Fiber optic cable: -40°F to +167°F (-40°C and +75°C)

1.06 WARRANTY
A. The Manufacturer shall provide a limited warranty for the system to be free of defects in workmanship and material under normal operating conditions for a period of two years from the date of product shipment.
B. Any parts shown defective in workmanship or material during the warranty period shall be repaired, replaced or adjusted without charge.
C. The system shall be supported with service and replacement parts available for a period of 5 years from the date of product shipment.

- END OF SECTION -
PART 2 PRODUCT

2.01 EQUIPMENT

A. Manufacturer: Optellios, Inc.
   11 Penns Trail
   Suite 300
   Newtown, PA 18940
   Phone: +1 267.364.5298  |  Fax: +1 267.364.5357
   info@optellios.com
   www.optellios.com

B. Model: FP1400

C. Alternates: None

2.02 DESCRIPTION

A. The system shall be sensitive to vibration of the fiber optic cable and capable of locating the point of vibration. By mounting the sensor cable on and in direct contact with a perimeter fence, the motion and/or vibration of the fence is monitored.

B. The system shall be capable of being deployed with multiple intrusion detection zones and shall be expandable as needed.

C. The system shall be capable of being deployed in a cut-immune closed-loop architecture.

D. The system shall consist of field components which perform the sensing function and head-end components which perform signal processing and reporting.

2.03 SYSTEM COMPONENTS

A. Field Components

1. Fiber-optic sensor cable
   a. The sensing element of the system shall be an outdoor-grade fiber-optic cable, be rated for aerial and duct installations according to the accepted industry standards.
   b. The outer jacket of the cable shall be made of black UV-resistant medium-density polyethylene and carry length identification markings.
   c. The internal cable construction shall include water-blocking materials and reinforcement structures such as a strength member.
   d. The fiber-optic sensor cable shall include communication-grade single-mode optical fibers.
      1) The sensor cable shall be a telecom-grade cable of gel-filled loose-tube construction.
         a) At least three (3) fibers in one (1) tube shall be reserved for system operation.
         b) Remaining fibers in the cable may be used as spares for other communication purposes.
2) The optical loss of the individual fibers shall be less than 0.25 dB/km @ 1550 nm wavelength.

e. The sensor cable shall have a nominal lifetime of 20 years and include no conductive elements.

f. The sensor cable shall operate at temperatures between -40°F and +158°F (-40°C and +70°C) without performance degradation.

<table>
<thead>
<tr>
<th>Optionally, the sensor cable may incorporate communication-grade single-mode and/or multi-mode fiber fibers for video and data communication, provided by separate systems.</th>
</tr>
</thead>
</table>

g. The sensor cable shall meet, as a minimum, the following additional parameters:

1) Minimum Bend Radius
   a) Static 10 x Cable Outer Diameter (OD)
   b) Dynamic 20 x OD

2) Tensile Rating
   a) Installation 600 lb-f (2700 N)
   b) Residual 180 lb-f (800 N)

3) Crush Resistance
   a) Short Term 125 lb-f/in (220 N/cm)
   b) Long Term 63 lb-f/in (110 N/cm)

2. Fiber-optic lead cable - The fiber-optic lead cable shall connect the fiber-optic sensor to the head-end equipment and may consist of outdoor and indoor sections as necessary.

a. The outdoor lead cable shall be of the same type as the sensor cable unless otherwise specified.

b. The combined length of the sensor and lead fiber-optic cables shall be less than 8200 ft. (2500 meters).

c. The fiber optic lead cable shall operate in temperatures between -40°F and +167°F (-40°C and +75°C).

d. The optical loss of the individual fibers shall be less than 0.4dB/mi (0.25 dB/km) @ 1550 nm wavelength.

e. The fiber optic lead cable shall meet the same additional parameters, as a minimum, as specified for the fiber optic sensor cable.

3. Sensor termination modules and enclosures.

a. Sensor termination modules shall terminate each end of the fiber-optic sensor cable.
   1) The termination modules shall utilize passive fiber-optic components only and utilize no electrical power.

b. The termination components shall be sealed inside outdoor-rated fiber-optic splice enclosure(s).

c. All fiber connections shall be permanent fusion splice connections.

4. Installation hardware

a. The termination components shall be sealed inside outdoor-rated fiber-optic splice enclosure(s).

5. The system shall require no mechanical, electrical or electronic components or electrical power in the field.
B. Head-end Components

1. The head end components shall be designed for a standard 19" (48.3 cm) wide rack.
   a. Components shall be mounted a minimum of 12" (30.5 cm) above floor level.
   b. Components shall consume no more than 9 RU of vertical rack space, including cable termination and user interface modules.

   Optional modules such as relay I/O may require additional rack space.

2. The head-end components shall include the following:
   a. Sensor controller module - consists of optical components, contained in transmitter and receiver modules.
      1) All optical components shall be either fiber-based or sealed fiber-pigtailed devices.
      2) The sensor controller module shall incorporate a Class 1 infra-red laser, operating at 1550 nm.
      3) The fiber-optic input and output connectors shall be of the FC/APC type.
   b. Data processor module - runs the software to control the system and provides network connectivity.
      1) The data processor module shall be PC-based with the following minimum characteristics:
         a) 1.86 GHz Intel Nehalem CPU
         b) 6.0 GB DDR3-1333 ECC RAM
         c) Two (2) 250 GB 7,200 RPM SATA HDD – Raid 1
         d) DVDRW drive
         e) 550 W redundant universal power supply
      2) The data processor module shall operate under Microsoft Windows 7 Professional 64-bit SP1 operating system or similar.
      3) The data processor module shall provide Ethernet network connectivity with dual 10/100/1000base-T Ethernet RJ-45 interfaces.
   c. Auxiliary components
      1) Fiber optic patch panel/splice tray, capable of supporting a minimum of twelve (12) fiber optic splices
      2) Slide-out LCD / keyboard / touchpad drawer (console)
   
3. The head end equipment shall operate between +50°F and +95°F (+10°C and +35°C) and in relative humidity of 20% to 80%, non-condensing.

4. Head end power requirements:
   a. 100 to 240 Volts AC, 50 / 60 Hz.
   b. Four (4) power outlets.
   c. Capable of sourcing 400 W.
C. System Software

1. The System Software shall run on the data processor module and provide the following functionality:
   a. Modes of Operation - The system software interface shall support the following general modes of operation:
      1) Standalone
      2) Interface to Remote Alarm Management System (RAMS)
         a) The interface to the RAMS, offered by manufacturer or acceptable third party, shall be ASCII text-based input/output.
            i. The interface shall utilize custom XML formatting.
            ii. Standard communication modes shall include
                i. TCP/IP server
                ii. TCP/IP client
                iii. The maximum connection bandwidth requirement shall be 100 Mb/sec.
            iii. The remote interface shall support broadcast and query modes.
   b. Sensor signal processing and analysis
   c. Event detection and alarm generation
   d. Event and alarm logging
   e. Detection zone definition and configuration
   f. Adjustment of detection parameters
   g. Secure System Access
      1) Require a valid password at start-up and shutdown time.
      2) Provide at least three access levels:
         a) Operator level for routine operation
         b) Supervisor level for advanced system monitoring, configuration, and troubleshooting
         c) Installer level for advanced configuration and troubleshooting
   h. Hardware Monitoring and Control
      1) Monitor the operating status of system components.
      2) Alert local and remote operators of any detected system component failure.
   i. Alarms

Note: An uninterrupted power supply (UPS) and/or a stand-by power generator is recommended for continuous system operation.

The alarm data format and communication mode may optionally be customized to fit the requirements of third-party monitoring products, subject to separately defined terms and conditions. Such custom interface capabilities may include hardware input/output, RS-232, relays, network-based input/output, E-mail (SMTP, SOAP) messages, and Instant messaging (SMS).
1) Alarms shall be generated upon the occurrence of a sensed “intrusion event”, determined by the changes in optical signal resulting from minute motion of the optical fibers within the fiber-optic sensor cable.

2) The software shall compute the event’s zone along the sensor cable.

3) Alarm Management
   a) The software shall maintain complete information on all alarms for 24 hours or until the alarm is cleared by a local or remote operator.
   b) If not manually cleared, alarms shall be automatically reset 24 hours after alarm generation.
   c) Until cleared, the alarm information shall be compiled in a scrollable multi-column table and include the following:
      i. unique alarm ID number
      ii. time label
      iii. event duration
      iv. event status
      v. event strength
      vi. event zone
   d) Operator shall be able to
      i. select any of the alarms from the table
      ii. enter text notes regarding the cause of the alarm and the mitigation measures
      iii. clear the alarm
   e) Event Log
      i. The system shall maintain and display an event log, including alarms, system notifications, and user actions.
      ii. Operator notes as well as the alarm clearing event shall be recorded in the event log.
      iii. The logs shall be periodically saved to the hard drive.
      iv. A new set of log files shall be generated every 24 hours.

4) Graphical Alarm Display
   a) Incorporate an image depicting the protected site with a schematic perimeter overlay.
   b) Subject to availability, the site image shall be one of the following:
      i. satellite photo
      ii. aerial photo
      iii. map
      iv. schematic

5) Annunciation of each new alarm shall be via
   a) flashing notification message
   b) zone marker displayed on the site image

---

The site image and alarm zone marker shall be provided for visual reference only.
2.04 PERFORMANCE

A. The system shall be capable of monitoring multiple zones over a single continuous fiber-optic sensor cable deployed in open-loop or closed-loop configurations and detecting the zone(s) in which a breach is attempted.

1. Number of Zones: Between 8 and 28 in increments of 4
2. Minimum Zone Length: 100 ft (30 m)
3. Maximum Zone Length: 7500 ft (2286 m)

B. Detectable Intrusions - The system shall be capable of detecting the following types of intrusions:

1. Direct contact with fence
2. Direct climbing, cutting, spreading, and lifting of the fence or fence fabric

C. Probability of Detection

1. The system shall generate and report an alarm with greater than 95% probability for an isolated breach attempt in quiet environment that involves direct and prolonged contact with the fence structure and results in the intruder’s crossing of the fence line.
2. Such breaches shall include those attempted by direct climbing, cutting, spreading, and lifting of the fence or fence fabric.

D. Time to Detection

1. The system shall be capable of generating an alarm within one second from the onset of an attempted breach that involves an aggressive contact with the fence, such as one attempted by quick climbing.
2. Other detected intrusion attempts shall be reported no later than one second after the fence breach is completed.

The time-to-detection will generally depend on the type and intensity of the intrusion activity and the specific timing and sensitivity settings of the system.

E. Intrusion Location

1. The system shall be capable of identifying the detection zone in which the intrusion attempt occurs.

F. Multiple Simultaneous Intrusions

1. The system shall be capable of detecting and locating up to 28 simultaneous intrusions.
2. The system shall be immune to defeat by an overwhelming disturbance. The system sensitivity at a given zone shall not be impacted by disturbances at any other zone.
G. False Alarms - The false intrusion alarms generated due to occurrences other than sensor
cable motion / vibration shall be limited to less than one such alarm per month of continuous
operation.

H. Nuisance Alarms
   1. The system shall be immune to nuisance alarms and performance degradation
      originating from electromagnetic and radio-frequency interference in the field.
   2. The system shall be intrinsically capable of rejecting nuisance alarms due to moderate
      non-localized environmental disturbances such as wind or rain.
   3. The system shall be capable of rejecting low-level localized or semi-localized
      disturbances such as those created by small animals or nearby vehicle traffic.
   4. The system shall employ adaptive filtering algorithms to minimize the rate of alarms
      induced by environmental factors.

I. Cable Cut
   1. The system shall be capable of detecting and locating a sensor cable cut within a zone.
   2. In the event of a sensor cable cut, the system shall retain detection and location ability in
      the portion(s) of the sensor cable that remain connected to the system head end.
   3. The system shall support cut-immune closed loop sensor deployment architecture.

J. Environmental
   1. The head end equipment shall operate between +50°F and +95°F (+10°C and +35°C).
   2. The head end equipment shall operate in relative humidity of 20% to 80%, non-
      condensing.

2.05 ACCESSORIES

A. Remote Alarm Management System (RAMS)
   1. Manufacturer shall offer a RAMS, which is a network-based software platform for
      enterprise-wide perimeter security integration and alarm management.
   2. The RAMS shall seamlessly integrate the fiber optic intrusion detection system with video
      surveillance and third party sensors and shall provide alarm notifications and automation
      of security policies.

- END OF SECTION -
PART 3  EXECUTION

3.01  INSTALLERS

A. The Contractor’s installers and technicians shall be factory trained and certified to install, service, and maintain the system.

3.02  FIBER OPTIC SENSOR LAYOUT.

A. Maximum total length of the fiber optic sensor cable shall be 8200 ft. (2500 meters).

B. Installations that require zigzagging of the sensor cable will have the maximum effective length of the protected perimeter reduced accordingly.

| A site survey should be considered to determine special recommendations, particularly for more complex perimeter layouts. |
| Shorter sensor length may be specified based upon the considerations of the type and condition of the carrying structure (e.g., fence), the prevailing weather conditions, and the amount of human, animal, and vehicle traffic. Manufacturer should be consulted. |

3.03  SENSOR CABLE INSTALLATION

A. Chain-link Fence Requirements

1. Clearance area shall be at least 10’ (3 m) wide on each side of the fence.

2. Fence signage shall be reduced to the regulated minimum and securely attached to fence posts.

3. Gates shall be secured in closed position so as to eliminate any free movement.

4. Gates remaining open for extended time shall be secured in the open position.

5. Chain-link fence recommended for optimal fiber-optic sensor performance shall have
   b. Bottom rail with fabric twisted ends extending below it.
   c. No top rails.
   d. No intermediate-height rails in run sections.
   e. Reinforcement rails in brace sections installed at ¾ height.
   f. Fabric attached to posts and rails using 9-gauge galvanized steel wire ties at least every 15” (5.1 cm).
   g. 7-gauge hardened galvanized steel tension wire installed 6” to 8” (15.2 - 20.3 cm) below the top of the fabric.
   h. Intermediate-height tension wire(s) recommended.
   i. Fabric attached to tension wire(s) using 12-gauge galvanized steel wires ties at least every 15” (5.1 cm).
   j. No aluminum wire ties and no hog rings.
   k. Welded barb wire outriggers.

6. Chain-link fence shall pass the following fabric tension test
a. Apply 50 lbs (22.7 kg) force pushing on the fence fabric at the mid-point of the section.
b. Apply 50 lbs (22.7 kg) force pulling on the fence fabric at the mid-point of the section.
c. Total range of fabric deflection shall not exceed 4” (10.2 cm).
d. The test shall be repeated for at least 10 representative locations and for all suspect fence sections.

B. Fiber-Optic Sensor Cable Mounting

1. The fiber optic sensor cable shall be installed while the outdoor temperature is in the range of -22°F to +95°F (-30°C to +60°C)

2. Sensor cable positioning
   a. The positioning of the sensor cable on the fence shall depend on the fence type, trim, height, and condition.
   b. Specific recommendations shall be made following the site survey.
   c. Unless otherwise specified, the following shall apply:
      1) The cable shall be mounted along the secure side of the fence.
      2) The cable shall be mounted in a single straight horizontal line.
      3) The height of the cable shall be in the middle of the fence fabric.
      4) A minimum bend radius of 6” (15.2 cm) shall be maintained on all cable turns.
   d. Special cable patterns shall be used around fence corners and brace posts for added sensitivity.

3. Sensor cable attachment
   a. The sensor cable shall be attached directly to the fence fabric.
   b. The cable shall be attached under manual tension.
   c. The cable shall be tied to the fence at wire crossing points.
   d. The cable shall be tied using standard cable ties.
   e. Unless otherwise specified, the cable shall be tied to the fence fabric
      1) At least every 24” (61 cm).
      2) At least 12” (30 cm) away from each fence post, on either side of the post.
      3) At least every 45º on all cable turns.

4. Cable ties
   a. Depending on the prevailing local weather conditions, one of two types of cable ties shall be used for cable attachment:
      1) 3/16” (4.8mm) wide stainless steel cable ties
      2) 3/16” (4.8mm) wide UV-stabilized nylon 6/6 cable ties.

   Stainless steel cable ties are standard and recommended for permanent and maintenance-free cable attachment, usable in all weather conditions. Nylon cable ties are recommended for temporary cable attachment, usable only in moderate climate conditions.

C. Service Loops

1. Fiber-optic cable shall be looped and securely fastened to the fence at least every 1000’ or where specified.
2. Extra cable in service loops shall be for the following purposes:
a. Planned fence maintenance  
b. Planned fiber access points  
c. Cable restoration  

3. Service loops shall  
a. hold approximately 30’ of cable per loop  
b. consist of 5 cable loops per loop,  
c. be arranged in a coil approximately 24” (60 cm) in diameter.  

4. Service loops shall be mounted on the bottom half of the fence, next to a fence post.  

D. Gate Bypass  

1. The sensor cable shall be buried across gates and other openings in the fence.  
2. Overhead structures shall be alternatively used if present and factory approved.  
3. The sensor cable shall be buried in conduit at least 12” (30.5 cm) deep.  
4. Deeper burial shall be recommended for high-traffic or fast-traffic roadways and railroad tracks.  
5. The ground entry points shall be protected by conduit extending at least 12” above ground.  
6. The conduit path shall be offset to the inside of the fence line. The offset distance shall be determined by the following considerations:  
a. extent of underground utilities  
b. extent of gate post foundation  
c. access space requirements for trenching equipment  

Gate Monitoring:  
The sensor cable may be optionally extended onto chain link swing gates. In this option, the sensor cable should be mounted on the swing gate in a loop pattern. Cable crossing point should be encased in a 24”-long open vertical conduit section. This conduit section shall be mounted on the fence next to the gate post and secured to the gate post using at least two stainless steel hose clamps. The sensor cable sections inside the conduit should be encased in protective sleeves and buried across the gate. The sensor extension should be for the purpose of intrusion detection when the gate is in the closed position. The system should not be used as a primary gate sensor for access control purposes because the system may generate alarms when the gate opens and closes.  

7. Split conduit specifications:  
a. Material Schedule 40 PVC  
b. OD 2.375” (6 cm)  
c. Section length 10’ (3 m)  
d. Weight 8.1 lbs (3.7 kg)  
e. 90° elbow dimensions 11.5” x 11.5” (29.2 x 29.2 cm)
f. 90° elbow bend radius  9.5” (24.1 cm)  
g. Coupling sleeve length  6” (15.2 cm)  

E. Building Bypass  
1. In the situations where the fence line is interrupted by a building or other such structure, the sensor cable shall be routed around or through the obstacle in one of the following ways:  
a. Buried at the foot of the structure.  
b. Securely attached to and around the side or over the top of the structure. Subject to factory approval.  
c. Routed through the structure and securely attached inside. Subject to factory approval.  

F. Fiber Optic Sensor Termination  
1. The termination enclosure(s) shall be mounted in a safe location inside the protected area  
2. The termination enclosure(s) shall be mounted next to a fence post and secured to the fence fabric, or buried near the base of the fence.  
3. If mounted on the fence, the bottom of termination enclosure shall be at least 12” (30.5 cm) above ground.  
4. The termination enclosures shall only be opened by factory-trained and certified personnel.  

Unauthorized opening of the termination enclosures shall void any and all product warranties.  

G. Fiber Optic Lead Cable  
1. The lead cable shall be installed inside existing or specially added duct path.  
2. Generally accepted or site-specific requirements pertaining to communication infrastructure shall apply to lead cable installation.  
3. The outdoor end of the lead cable shall be connected to the sensor cable inside the near-end termination enclosure or a separate fiber optic splice enclosure.  
4. The indoor end of the lead cable shall be terminated inside the fiber patch panel installed in proximity to the head end equipment.  

3.04 FIBER OPTIC LEAD CABLE  
A. The lead cable shall be installed according to cable manufacturer’s recommendations.  
B. Generally accepted or site-specific requirements pertaining to communication infrastructure shall apply to the lead cable installation.  
C. The lead cable installation shall be installed while the outdoor temperature is in the range specified by the cable manufacturer.
D. The outdoor end of the lead cable shall be connected to the sensor cable inside the near-end termination enclosure or a separate fiber optic splice enclosure.

E. The indoor end of the lead cable shall be terminated inside the fiber patch panel installed in proximity to the head end equipment.

3.05 HEAD-END EQUIPMENT

A. The head end equipment shall be shipped and stored within temperature range between -4°F and +158°F (-20°C and +70°C) and relative humidity of 5% to 85%, non-condensing.

3.06 SYSTEM SOFTWARE

A. The integration of a site image shall require a detailed mapping of the perimeter, performed at the time of system installation and calibration.

3.07 FIBER OPTIC CABLE STORAGE AND HANDLING

A. The fiber-optic cables shall be shipped and stored within temperature range between -40°F and +167°F (-40°C and +75°C).

General Notes:

1. System performance benchmarks are not fixed and may be influenced by factors related to the fence quality and integrity, fence environment, and sensor installation.

2. The following factors may contribute to elevated rates of nuisance alarms, especially in stormy weather conditions:
   a. Loose fence posts, braces, and trimmings
   b. Loose fence fabric
   c. Improper fence maintenance
   d. Loose signs and other materials on the fence
   e. Loose swing gates
   f. Vegetation around the fence
   g. Ground erosion around the fence
   h. Loose debris around the fence
   i. Loose or improperly installed sensor cable
   j. Other sources of motion and vibration at or around the fence line