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The Leader in Perimeter Protection Solutions

GW400K SENSOR CABLE MANUAL FOR PERIMETER FENCE APPLICATIONS

guardwire®

PROVEN PERIMETER PROTECTION

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1.1 GENERAL

The Guardwire system is an advanced perimeter intrusion alarm system based on a microphonic sensor cable. The sensor cable is attached to the perimeter fence and detects intruders attempting to climb over or cut through the fence.

The audio outputs generated by the sensor cable and associated analysers provide valuable additional information to personnel on alarm causes and assist in the discrimination between possible nuisance alarms and types of attempted intrusion.

1.2 PRINCIPLE OF OPERATION

The Guardwire sensor cable detects the vibrations caused by an attempted intrusion as the perimeter fence is either cut through or climbed over and converts them into electrical signals which are processed by either an analyser or an interface. These, in turn, “decide” whether the signals constitute an attempted break-in and, if so, an alarm signal is activated. The relay output is normally connected to some form of annunciator unit which, in turn, operates alarm bells or other indicators.

Care must be taken to ensure that the sensor cable is positioned and fixed correctly to enable it to respond to the vibrations caused by an intrusion. The sensor cable must be fixed to the fence as closely as possible so that the *maximum* amount of signal is generated by the cable in response to the intrusion attempt. The installation notes in this manual are designed to ensure that, as far as possible, the above conditions are satisfied.

Most problems experienced on site stem from a lack of understanding of the principle of operation of the system and consequential installation errors. It is vital that this manual is thoroughly read and understood prior to system installation.

1.3 FUNDAMENTALS OF PERIMETER PROTECTION

The prevention and detection of an intrusion onto a site depends on the installation of an adequate physical barrier in combination with an appropriate sensor system. Together they can alert the operator to the presence of unacceptable levels of perimeter activity and assist in the decision to activate an alarm.

Without a sensor system any barrier is unintelligent and cannot be used to warn when there is an intruder activity; on the other hand the best sensor system cannot provide intruder detection unless it is properly attached to a suitable barrier which can serve as a fundamental component towards giving the system its maximum detection capability.

Perimeter protection should therefore be designed as a ***combination*** of appropriate fence construction and sensor system to achieve the pre-determined expectations for intruder detection.

Guardwire GW400k sensor cable will meet these expectations when correctly installed on any fence constructed so that it causes an intruder to generate a level of vibration or resonance which can be detected by the sensor cable within the standard range of sensitivity settings.

IMPORTANT

The most critical feature of any Guardwire system is the quality of the sensor cable installation.

1.4 CLIMB OVER DETECTION

To achieve climb over detection the vibration of the fence fabric must last for approximately four seconds. Due to this, experience has shown that, generally, climb over detection can only be reliably achieved on fences that are a minimum of 2.4m in height.

On fences lower than this climb over detection can be enhanced by the addition of a barbed wire or razor coil topping. This slows the intruder's progress, thus increasing the duration of the vibrations to such a level that they can be detected by the sensor cable.

1.5 TYPES OF FENCE

Fence types fall into the following broad categories:

1. Plastic-coated or galvanised chain link
2. Weldmesh 358 (UK Home Office type)
3. European Grill type
4. Palisade

IMPORTANT

The specific installation techniques for each type of fence, as described in the following sections, must be carefully observed.

If in ***any*** doubt as to the suitability of a particular fence and sensor cable configuration to provide the required level of intrusion detection please **contact Geoquip Ltd for further advice.**

1.6 PERMISSIBLE ZONE LENGTHS

The optimum installation is a zone length of 100m on a fence of up to 2.4m high but, subject to risk analysis and important factors such as fence type and quality, terrain, camera capability, personnel deployment and alarm response, under suitable conditions zone lengths of up to 300m can be achieved.

1.7 SENSOR CABLE CONFIGURATION GUIDELINES

The following variables in the fence construction will affect the sensor cable performance, the probability of detection of climb over and cut through and the level of interference from extraneous causes:

* Height of fence
* Tension of the fence fabric

* Setting of the fence base in concrete
* Gauge of metal used in fence fabric
* Resonance of the fence
* Additional bracing or supports
* Plastic or galvanised coating
* Method of intrusion

The table below provides guidance on suggested sensor cable configurations on common fence constructions for heights ***up to*** 2.4m.

Type of Fence		Double Run	Single Run
Chain Link:	Light gauge (2mm)	✓	
	Medium gauge (3mm)		✓
	Heavy gauge (4mm+)	✓	
Weldmesh:	50mm x 50mm x 2mm	✓	
	75mm x 25mm x 3mm		✓
Grill type			✓
Palisade fences			✓

1.8 RADIO FREQUENCY INTERFERENCE (RFI)

The GW400k sensor cable and associated analysers have been fully tested to assess their immunity to strong radio frequency fields and each system complies with the requirements of BS6667 Part 3, Level 3, 1985.

2.1 PRE-INSTALLATION CHECKLIST

To ensure that the condition of the fence does not compromise the performance of the GW400k, the following checklist should be studied and any necessary repair work carried out on the fence line prior to commencement of the installation.

1. Ensure that the fabric of the fence is intact and continuous. Areas which have suffered corrosion damage, vandalism, vehicle damage, or other deterioration, must be replaced or repaired.
2. Ensure that the same fabric type is used throughout each zone. Sections of different types of fabric will produce different responses, making it difficult to optimise the system settings.
3. Ensure that posts are firmly fixed in the ground and that the fence fabric is well supported and not liable to sag or chafe against the posts in bad weather.
4. Ensure that there are no overhanging branches of trees in contact with the fence and that the fence line is generally free from vegetation which can muffle vibrations caused by intrusion attempts.
5. Ensure that metalwork fixed to the fence such as signs or outriggers are firmly fixed and do not vibrate or rattle in bad weather conditions.
6. Ensure that gates are secured so that they cannot rattle when closed.

IMPORTANT

In general, any fence movement which can cause metal to metal contact is a potential source of false alarms. Efforts should be directed at eliminating, as far as possible, all such causes.

2.2 CALCULATING CABLE LENGTH

The length of sensor required for each zone can be calculated as follows:

This example assumes a 200m zone.

Length of zone	200m	(A)
Add cable for posts (5% of A)	10m	(B)
7m per corner =		(C)
Double Leaf Gate (4x Gate width) =		(D)
Single Leaf Gate (4x Gate width) =		(E)
Total Sensor Required =	A+B+C+D+E	

2.3 ELECTRICAL INTERFERENCE

When planning the location of sensor cable runs, care must be taken to avoid placing the sensor cable close to sources of electrical interference, particularly any device which may produce alternating magnetic fields. Such devices include motors, contactors, transformers, and power cables carrying large currents.

Normally the sensor cable will reject such stray interference, however, if the interference is sufficiently strong, the audio quality may suffer and in extreme cases, false alarms may be produced. Power cables which are steel wire armoured are sufficiently well screened by the armouring to minimise any interference problem, but it is good practice to allow a separation between the sensor cable and the power cable of at least 1m. Sensor cable running parallel to power cables for distances greater than a few metres must be avoided.

Particularly powerful sources of electrical interference include electrified rail lines and electric fence units, the supply wiring of which tend to radiate broad band electrical interference.

If there is doubt about the suitability of Guardwire sensor cable for use where high levels of electrical interference may exist, contact Geoquip Ltd for advice. A site trial or use of a field strength meter are the usual ways to confirm that there will be no problem and this can usually be carried out by, or under instruction from, Geoquip Ltd.

IMPORTANT

All personnel involved with installation of sensor cable must understand that it is a sensitive vibration detection device and is to be handled accordingly.

3.1 GENERAL HANDLING

1. In general the sensor cable is removed from a reel by placing a pole through the reel and unwinding the cable by rotating of the reel. Failure to do this will allow kinks to form in the cable that will cause internal damage. Figure 1 shows this method of deploying sensor cable prior to fixing to the fence. Ensure that the sensor cable is not subjected to jerking or tugging whilst being wound off the reel. Note that two people will be required when dealing with large reels of sensor cable.

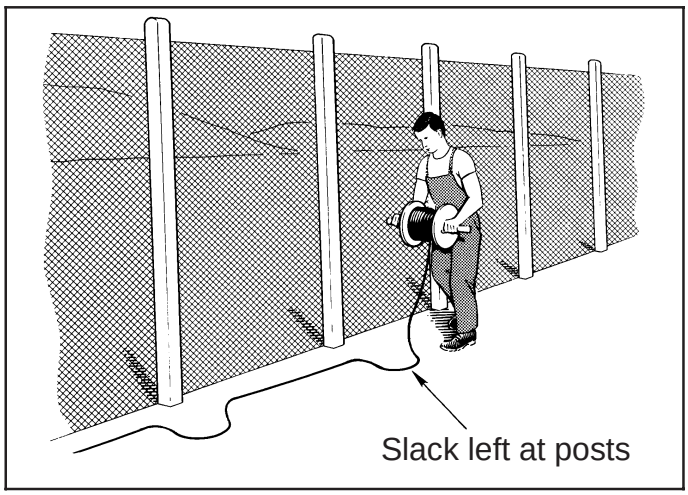

Figure 1

2. Sensor cable deployed and ready for fixing to a fence must be protected from damage by persons walking on the cable or vehicles driving over the cable. Figure 2 illustrates typical maltreatment of sensor cable which must *not* occur. Sensor cable subjected to such treatment will be damaged beyond repair and will prove costly to replace as sensitivity can only be verified after attachment to the fence.

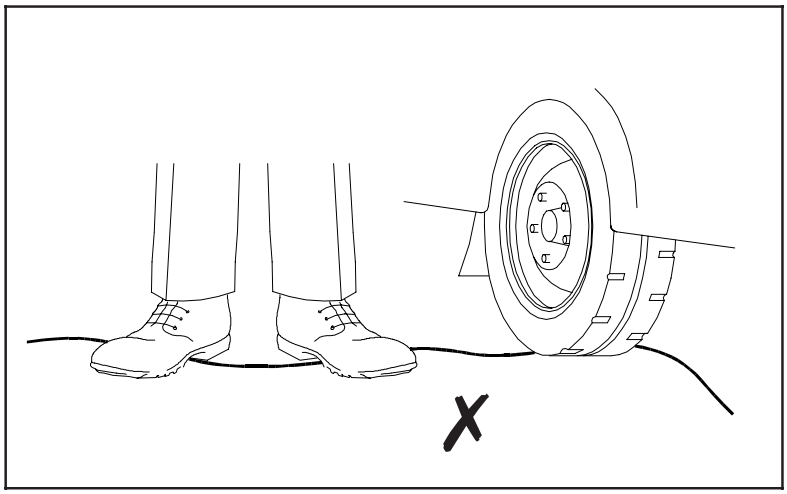

Figure 2

3. When fixing sensor cable to fences, the tightest bend radius of the cable must not be less than 100mm (4"). Note that this applies to the bend radius after installation. Refer to Figure 3.

   When it is necessary to pull the sensor cable round bends during the installation process, the bend radius must be sufficiently large to avoid exceeding the

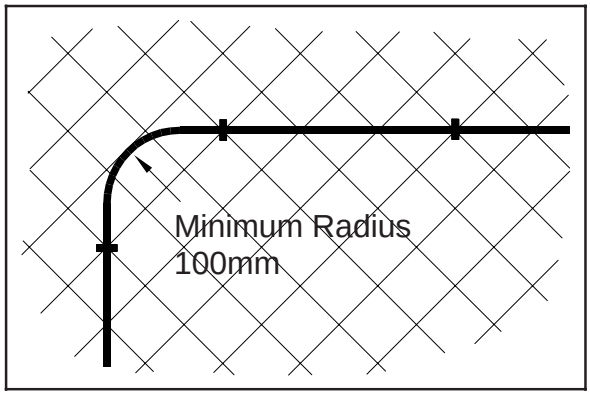

Figure 3

maximum permissible tension as described in the next paragraph.

4. The maximum tension which can be applied to the sensor cable must not exceed 6 kg (13 lb.). Tension in excess of this can cause internal cable damage which may not be obvious from the condition of the outer sheath. Refer to Figure 4.

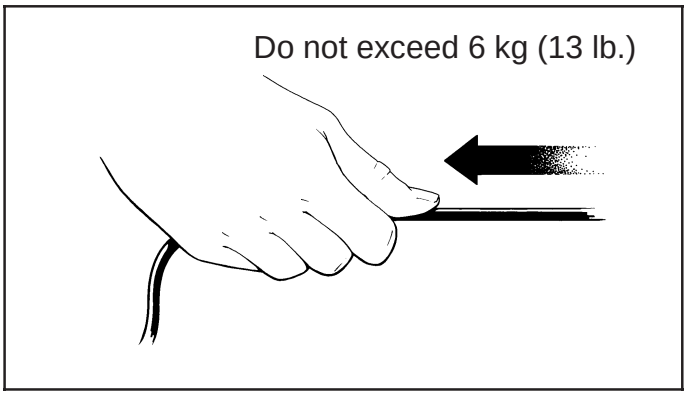

Figure 4

4.1 FENCE SENSOR PLACEMENT

The fence fabric is normally fixed on the outside of the fence post away from the protected area. For fence posts with cranked tops, the crank is designed to face towards the outside of the site, although in some cases it will be found that the reverse is the case.

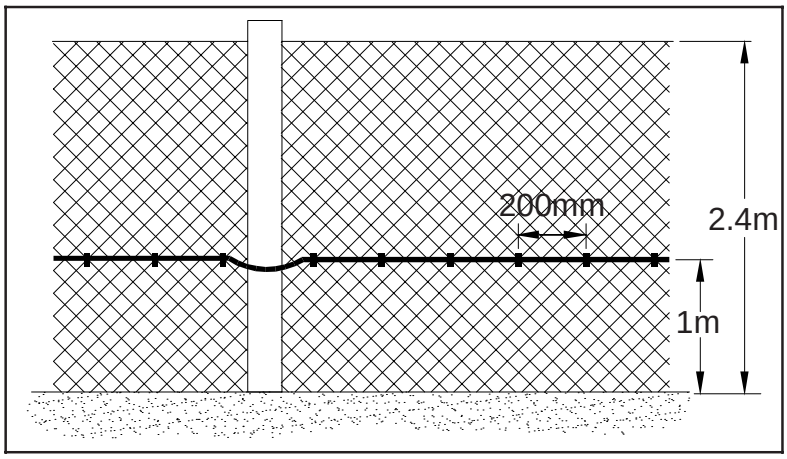

Figure 5

Install the sensor cable to the *inner* face of the fence fabric which offers slightly greater protection against casual vandalism. The sensor cable must be looped around the inner side of each fence post and *not* pulled between the post and the fabric.

If the fence fabric is on the inside face of the posts, the sensor can be installed on the flat face of the fence. However, it should be noted that in this configuration climb over detection is virtually impossible as the posts provide additional insulation from fence fabric contact.

The optimum height for mounting the sensor cable is 1.0 metre above ground level. This offset towards the lower half of the fence provides better detection of cut through intrusion, which is more likely to occur on the lower areas of the fence. See Figure 5.

4.2 FENCE POSTS

When the sensor cable passes around a fence post, it is necessary to leave sufficient slack so that normal movement of the fence fabric does not cause the sensor cable to chafe against the edges of the post. This is particularly important with concrete posts. It is equally important not to leave excessive slack which can be shaken by strong winds and cause false alarms. Figure 6 shows recommended spacings between the cable tie nearest the post and the edge of the post for both concrete and metal posts. For concrete posts, typically 90mm x 100mm in cross-section, dimension ‘A’ should be not less than 100 mm. For metal posts, typically 50mm x 50mm in cross-section, dimension ‘B’ should be not less than 75mm. It is important to allow the sensor cable to form a smooth curve as it passes round the inside of the fence post.

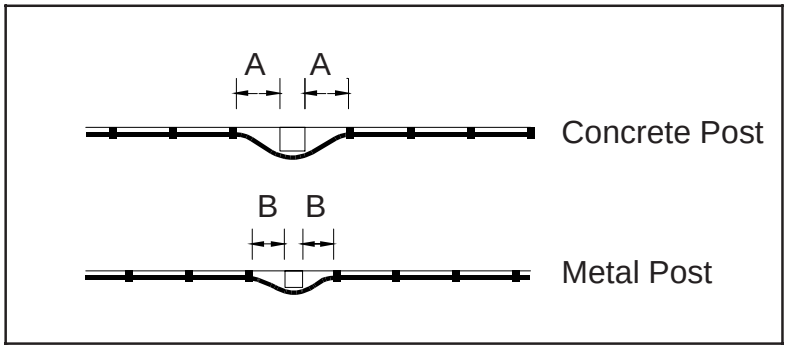

Figure 6

4.3 BI-STEEL POSTS

If 'Bi-Steel' posts are used to support weld-mesh fences, it may be possible to pass the sensor cable through the post assembly and thus avoid the need to form a loop round the post. This is provided that the sensor cable is pulled off the reel using a proprietary de-reeler as shown in Figure 7 and not laid out as shown in Figure 1.

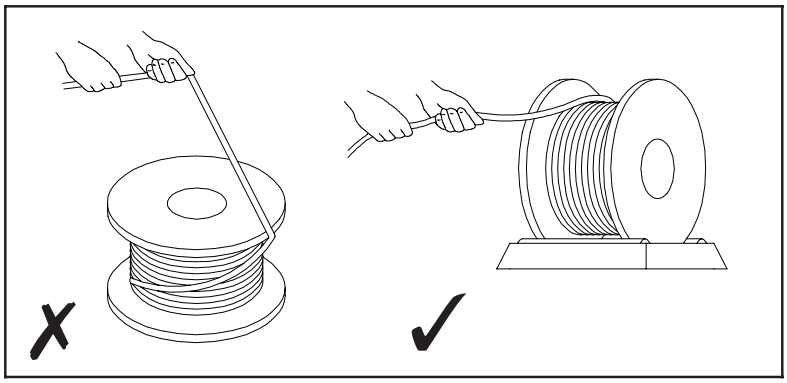

Figure 7

4.4 CORNER POSTS

Corner posts are usually braced with strainer posts making it easier for an intruder to climb over without causing as much vibration as at other points.

Configure the sensor cable as shown in Figure 8. This will improve the probability of detection of intrusion at the corners.

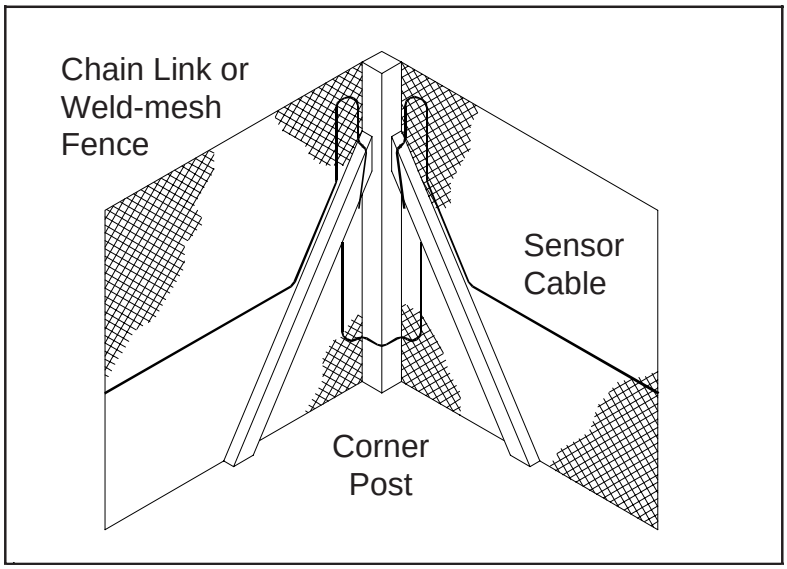

Figure 8

4.5 GROUND LEVEL VARIATION

It will often be found that, because of variations in ground level, the fence panels may be stepped up or down at support posts to eliminate gaps below the fence, or the need to trench out high spots between the posts. When this happens, it is necessary to allow the sensor to follow the steps to maintain the correct average height above the ground level.

Figure 9 shows the line of the sensor cable following the ground contours using smooth bends in the cable at each step.

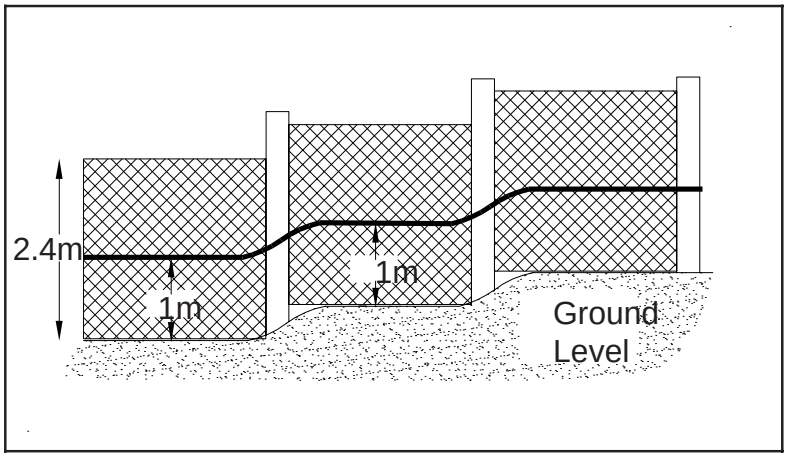

Figure 9

4.6 END OF LINE OVERLAP

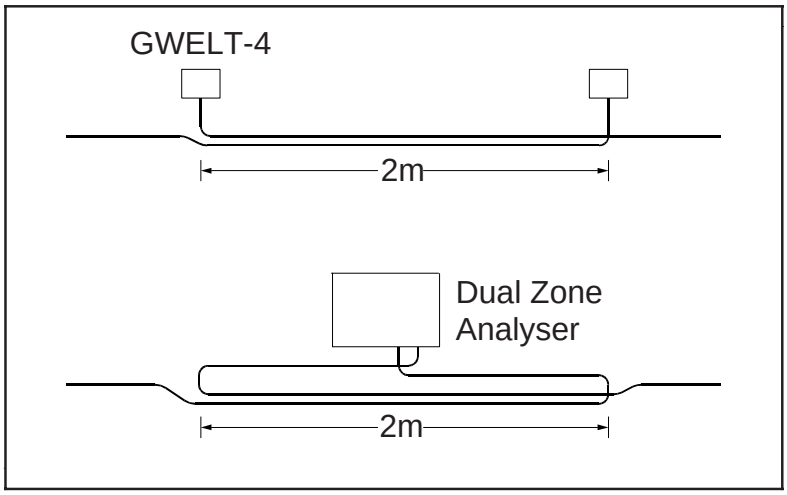

Figure 10

Where the end of line of two adjacent zones meet it is recommended that the sensor cable runs overlap for approximately 2m. This overlap will ensure that the system integrity is not affected by any discontinuity of the sensor cable. Similarly when the sensor cable exits the analyser box it is recommended that the cable is looped horizontally in the opposite direction to the zone for about 1m before returning to continue to the end of line. See Figure 10.

In cases where there is a double run, the sensor cable zones should overlap where the cable is vertical prior to it looping back to begin the return run.

4.7 NON-SENSITIVE SECTIONS

In many cases, there will be areas within a sensor cable zone where, for various reasons, it is not necessary or desirable to provide active sensor cable coverage.

For instance, if, a zone is split by a building or other obstruction, a section of “dead” cable can be inserted in the zone at this point to be re-connected to the sensor cable at the other side of the obstruction. Another application of “dead” cable would be to provide an interconnection between sensor cable on a fence zone and an analyser mounted remotely from the fence, perhaps in a building or other protected area.

The correct “dead” cable is available from Geoquip Ltd, part number GWFC-2. This cable comprises an overall drain wire and two twisted pairs of wires, each with individual foil screens. The cable has a tough black polythene outer sheath making it weather resistant and fully suitable for outdoor use. This cable is ***not*** suitable for direct burial.

The junction between the sensor cable and the “dead” cable is made within a weather-proof GWJB-1 junction box. This junction box provides an integral tamper switch to force a sensor cable tamper condition if the lid is removed.

It is important to ensure that the interconnection of the sensor cable and the “dead” cable conforms to the table below.

GW400k Sensor Cable Conductors		GWFC-2 Dead Cable Conductors
Red Wire	to	Red Wire
Black Wire	to	Green Wire
Green/Yellow Wire	to	Drain Wire
Yellow wire	to	Black Wire
Blue Wire	to	White Wire

Adhere to this schedule at all times when jointing sensor cable to non-sensitive cable. Failure to comply with this will compromise the security of the system. See Figure 11.

Provided that the cables are terminated correctly and moisture is excluded from the joint, almost any number of such sections can be inserted in a zone.

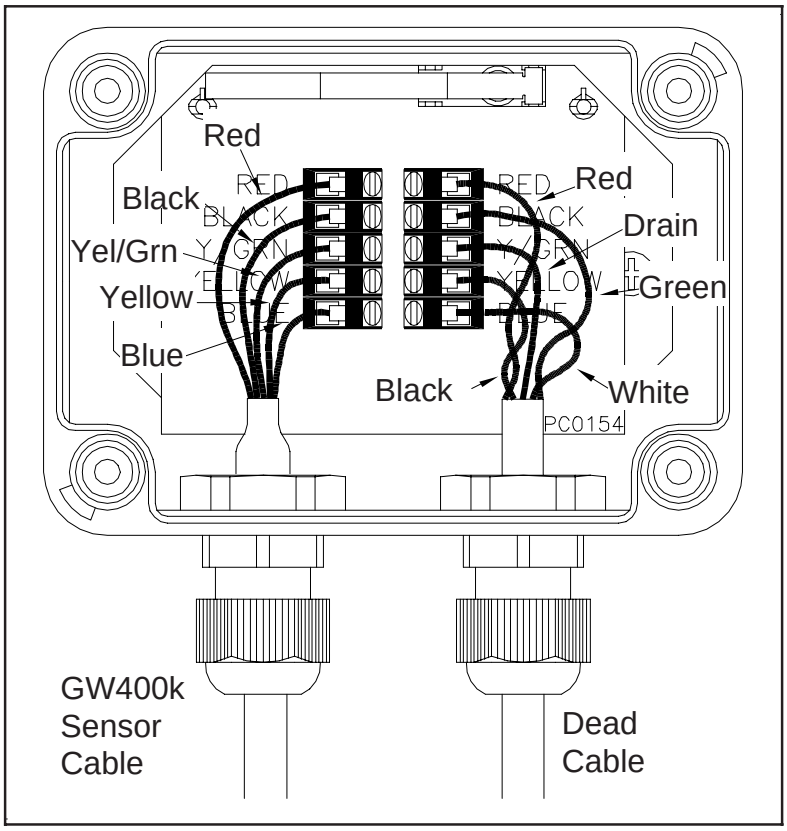

Figure 11

4.8 SENSOR CABLE INSTALLATION

The following general recommendations apply to most types of perimeter fence and must be adhered to when installing Guardwire sensor cable.

IMPORTANT

Sensor cable terminations must only be fitted ***after*** installation of the sensor cable on the fence.
Ensure that cut ends of sensor cable are sealed against moisture until such terminations are fitted. Use the heatshrink boots supplied with each reel of sensor cable.

1. Starting at either the beginning or end of the zone, fix the free end of the sensor cable to the fence. Leave sufficient spare cable at the end of the zone to make the sensor terminations.

2. Place a length of tube or rod through the centre of the cable reel and walk towards the other end of the zone while paying the sensor cable off the reel and allowing it to lie on the ground. Refer to Figure 1. Rotate the drum whilst walking.

3. Ensure that sufficient slack cable is left on the ground to accommodate loops round fence posts, as shown in Figure 1 and corner post configuration, as shown in Figure 8.

4. At the end of the zone, leave the reel and any remaining sensor on the ground until fixing of the sensor to the fence is completed. Do not cut off any remaining sensor as additional cable may be required as fixing progresses.

Once the sensor has been deployed on the ground, it can be fixed to the fence fabric.

5. Starting at the end of the zone that is already fixed to the fence, walk along to each fence post and lift the sensor cable up to the required height. Loosely place a tie wrap round the cable and fence but do not tighten as this stage. Continue to the other end of the zone so that the cable is hanging loosely along the final line to which it will be fixed. Ensure that sufficient slack is left at corners.

6. Return to the fixed end. Work towards the other end of the zone placing intermediate ties every 200mm (8") around the sensor cable and fence and manually tightening them up. Do not use tie wrap guns as these cause the tie wraps to break. Having the sensor cable supported at each post will make the task of placing the sensor cable and tensioning the intermediate ties much easier.

7. Once all the tie wraps are in place cut the excess tail off the tie-wrap using side cutters ensuring that the cable sheath is not damaged. Leave approximately 6mm (1/4") of the tail protruding to allow for any slippage in the tie after tightening.

4.9 COPING WITH CABLE DAMAGE

In the event that damage, whether accidental or intentional, is inflicted on the sensor cable, the damaged section must be replaced with a new short section. This should be inserted using GWJB-1 junction boxes at either end to ensure proper connections. Figure 12 shows the arrangement of the damaged sensor cable replaced with a new section.

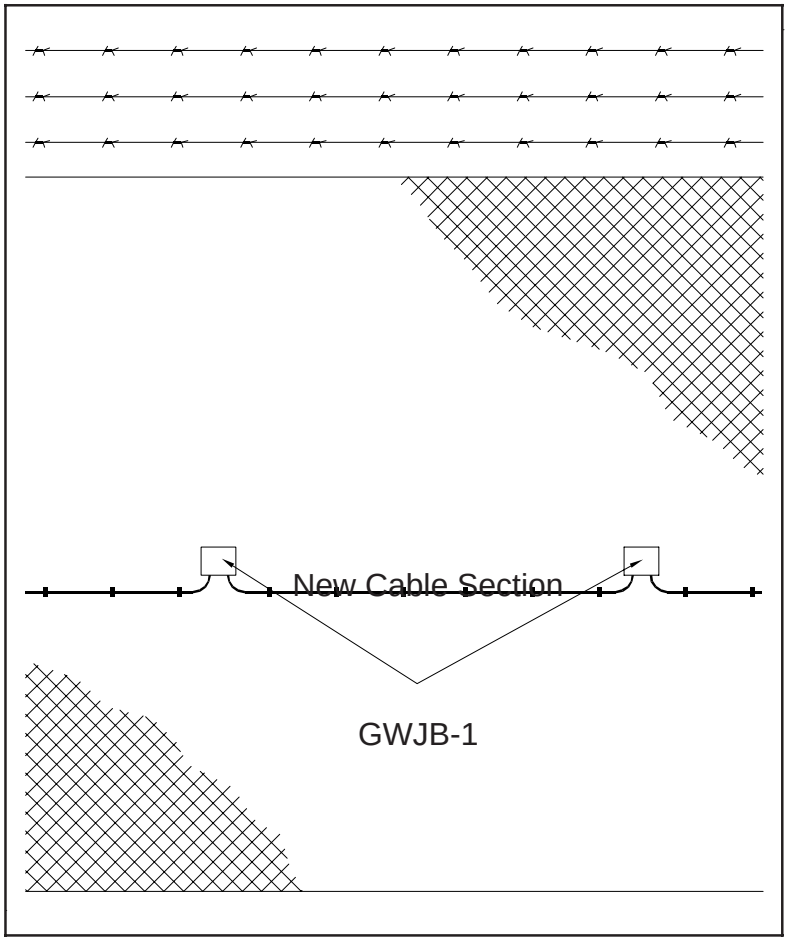

Figure 12

If cable damage has occurred, resulting in exposure of the inner conductors of the sensor to the effects of rain or moisture for a period exceeding a few days, it is advisable to cut out a section of sensor cable at least 5m on either side of the damage to eliminate the effects of moisture penetration due to capillary action.

The new section of cable can be prepared off site using the following method and moved into place when completed.

1. Terminate the ends of a suitable length of sensor cable as described in Section 14.2.

2. Loosen the glands on the junction boxes and pass the cable end into the box so sufficient length is available on the tails to be wired into the terminal blocks. Ensure that the cable is passed through the correct gland to correspond to the position of the terminal block, i.e. through the left gland to connect to the left terminal block at the right hand end of the cable and vice versa at the left end. Tighten the gland by hand so that the rubber sealing ring grips the cable jacket and not the heat-shrink sleeves.

3. Connect the sensor cable tails to the terminal blocks ensuring that the cable tail colours match the screen printing on the PCB. Figure 11 shows sensor cable wired to the left hand terminal block of a junction box.

4. Cut off the damaged section of sensor cable from the fence and terminate the ends of the remaining sensor cable in the same manner as above. To ensure that no moisture enters the open cable ends, this step should only be carried out *immediately* prior to fixing the new section.

5. Position the boxes just above the line of the sensor cable to allow rain water to run away from the cable glands and fix to the fence using the mounting kit provided. Ensure that the new section of sensor cable is at the same height and tension as the original. Do not over tighten the screws on the mounting bars as in extreme circumstances this can cause distortion of the weatherproof seal arrangement.

6. Connect the tails of the fence mounted sensor cable to the junction box terminal blocks, ensuring that the cable tail colours match the screen printing on the PCB.

7. Replace the box lids, taking care not to over-tighten the lid screws and verify that the tamper switch in each box operates by listening for the click of the switch action when the lid is screwed down. Re-test the entire zone to ensure that the sensor cable detects simulated cut and climb attacks.

5.1 GENERAL

Chain-link fences represent the most widely used type of perimeter fence, on both new and existing installations. Since they are so widely used, and in many cases will have been installed before the perimeter intrusion system, the fences may be in less than perfect condition. Therefore it is imperative that the site survey described in Section 2.1 is carried out prior to the sensor cable installation.

5.2 FIXING THE SENSOR CABLE

IMPORTANT

Never fix sensor cable to the strainer wires of chain-link fencing because there is insufficient mechanical contact between the strainer wire and the fence for the sensor to be able to detect vibrations occurring on the fence itself.

When attaching sensor cable place the ties round the natural depression formed by the links of the fence at the points where they fold over each other. By attaching the sensor cable at every third such crossing the fixings will be the recommended 200mm (8") apart, as shown in Figure 13.

For more details on the sensor cable fixing procedure see Section 4.8.

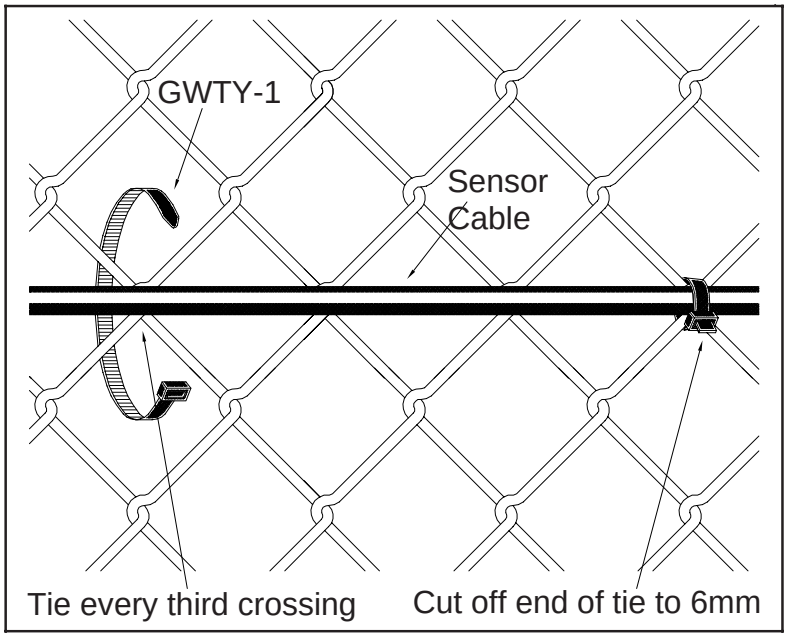

Figure 13

6.1 GENERAL

Welded mesh fences are frequently used on sites requiring a higher degree of protection than can be offered by chain-link fences. Welded mesh fences are generally harder to climb over and require more cuts before a hole sufficiently large enough to permit an intruder to pass through can be made.

Typical welded mesh fence construction comprises 3mm diameter steel wire welded into a grid configuration with a horizontal spacing between the wires of 75mm and a vertical spacing of 25mm. The usual finish is plain galvanised coating. The fencing is produced in panels approximately 2.4m high by 3m wide and is erected on metal posts. All of the following recommendations apply to this type of fence.

IMPORTANT
If a welded mesh fence of radically different construction to that described above is encountered, contact Geoquip Ltd for further advice before installation commences.

As with chain link fences it is imperative that the site survey described in Section 2.1 is carried out prior to the sensor cable installation.

6.2 SENSOR CABLE ALIGNMENT

Study the fixing of the welded mesh panels to the posts and note on which the side of the fence the *horizontal* elements are located. Installation of the sensor cable on the *same* side of the fence as the horizontal wires will result in a much neater arrangement of the sensor and is to be preferred if possible.

If the horizontal wires are on the outer side of the fence, this will mean fixing the sensor cable to the outside of the fence which may not be acceptable to the client. If this is acceptable it is important to position the cable ties as shown in Figure 15.

Figures 14 and 15 show the the ideal configuration whereby the cable is fitted on the same side as the horizontal wires.

Figures 16 or 17 show the alternative arrangement whereby the cable is fitted on the opposite side to the horizontal wires.

For more details on the sensor cable fixing procedure so Section 4.8.

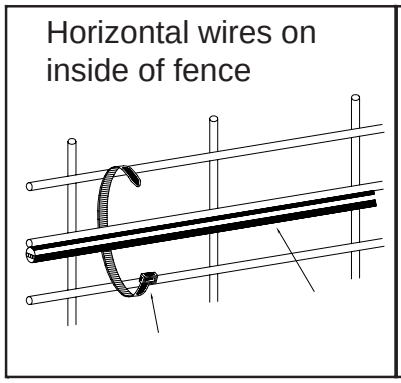

Figure 14

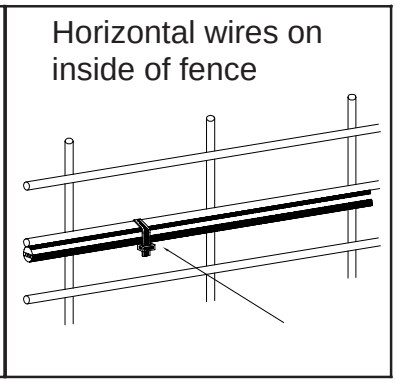

Figure 15

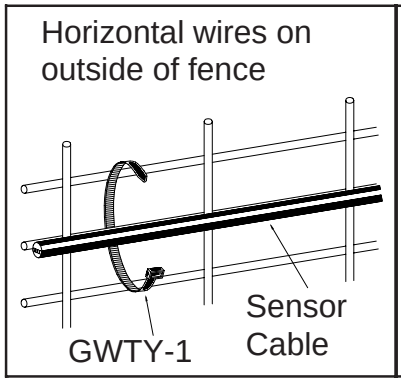

Figure 16

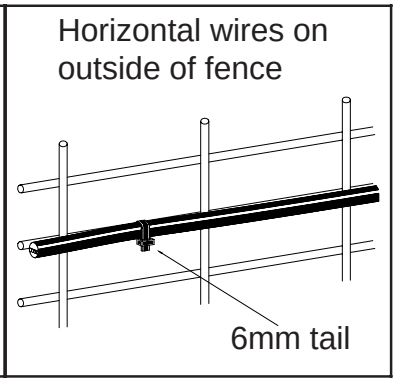

Figure 17

7.1 FENCE AND SENSOR CONFIGURATION

Standard palisade fencing comprises vertical metal palings fixed to horizontal support members referred to as arris rails. The most common arrangement is where the vertical pales are fixed to two arris rails which run along the length of the panel and each panel of fencing is approximately 2.4 metres in length.

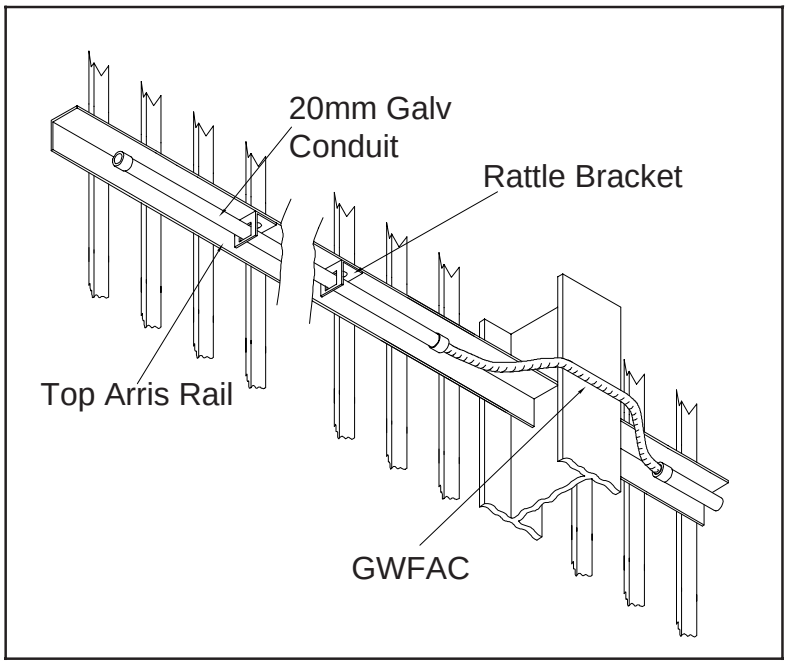

Figure 18

The correct method of installing sensor cable on palisade fencing is by running the sensor cable inside metal conduit which is suspended from the underside of the upper arris rail using a Rattle Bracket, see Figure 18. This bracket assembly amplifies the low frequency vibrational motion caused as an intruder scales the fence into vibrations which can be more easily detected by the analyser circuitry. This gives improved climb over detection, which is the more likely mode of intrusion for this type of fence.

7.2 POSITIONING OF RATTLE BRACKET

It is important that the Rattle Brackets are positioned below the arris rail so that the rigid conduit is balanced and allowed to vibrate freely within them. They should be positioned a quarter of the way in from either end of the arris rail. The length of the conduit should be such that the ends are sufficiently away from the posts to allow the GWFAC to form a smooth loop round the posts.

7.3 FIXING THE SENSOR CABLE

1. Drill each arris rail with two 8mm holes, so that the Rattle Brackets will be positioned as described above.

2. Cut lengths of 20mm diameter galvanised conduit to length so that the flexible conduit passes smoothly round the post as described above.

3. Cut a length of flexible stainless steel conduit to form a smooth loop around the post with sufficient extra to allow a 100mm to be inserted into each conduit end.

4. Insert the bolts, with the thread uppermost, into the holes in the Rattle Brackets and place bracket onto either end of the conduit. Push a female rubber bush onto each end of the conduit. See Figure 19.

5. Place a cable tie around the flexible conduit 30mm from one end and insert it into the rigid conduit so that the 30mm section is protruding.

6. Prepare sufficient lengths of conduit as described above and place each length along the ground to cover the complete zone, orientated so that the flexible conduit is all at the same end .

7. Pull the sensor cable off the reel using a de-reeler as shown in Figure 7 and thread the sensor cable into each section of the conduit in turn, starting at the end with the flexible conduit protruding and working along the zone. Allow a 3m length to protrude beyond the last section.

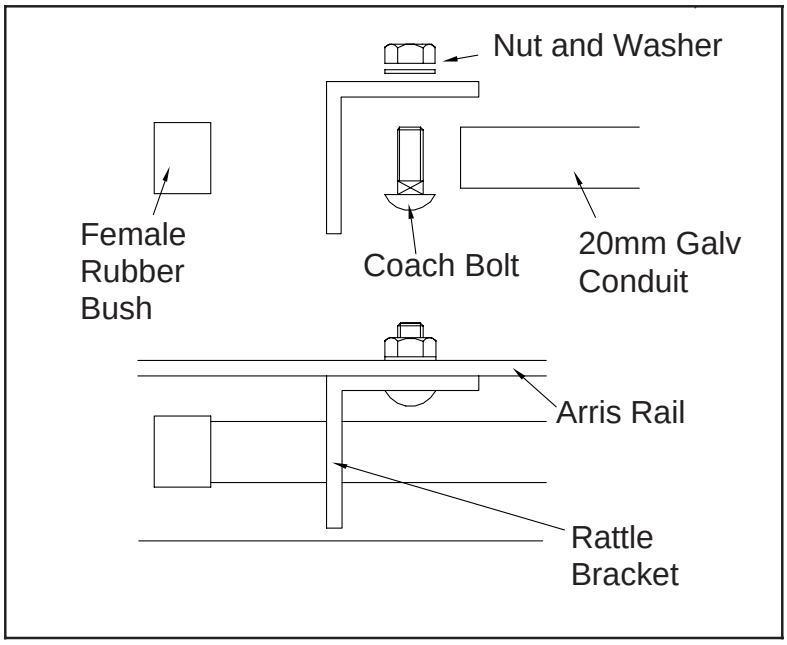

Figure 19

8. Starting at the end of the zone, fix the Rattle Brackets to the arris rail using the holes drilled previously and the stainless steel coach bolts, shakeproof washers, and nuts provided. The coach bolts are to be fitted with washer and nut uppermost. See fixing detail in Figure 19.

9. Lift up the next section of conduit whilst carefully pulling the 3m length of cable through and fix as described above. Repeat until all sections are in place. Leave sufficient sensor cable protruding at the end of the zone to facilitate termination of the cable.

10. Remove the cable ties on the flexible conduit and slide the conduit along the sensor cable until each length is centrally located between the rigid conduit sections. See Figure 20.

11. Ensure that the rigid conduit is balanced between the Rattle Brackets and that it vibrates when the fence is shaken.

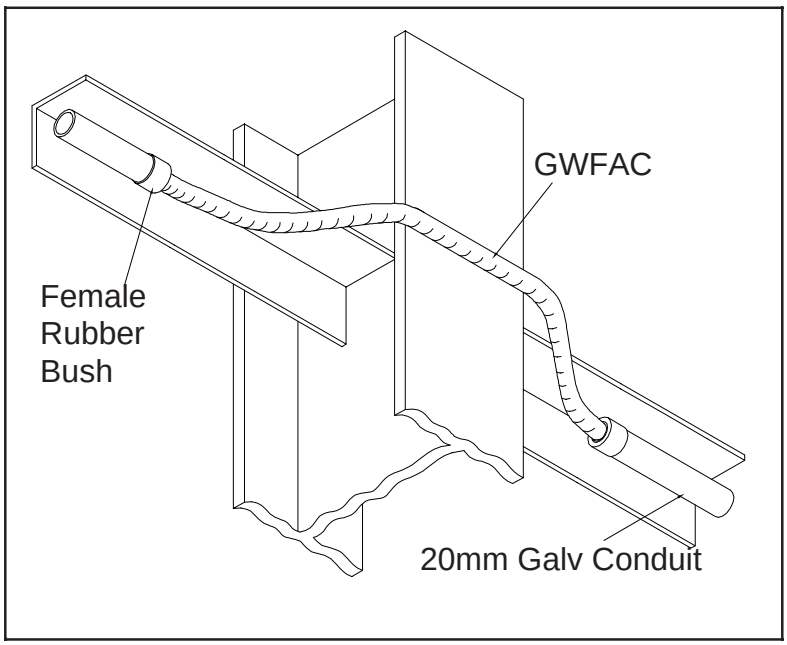

Figure 20

7.4 ALLOWING FOR CABLE DAMAGE

If damage occurs, the damaged section should be removed and a new section inserted using the GWJB-FAC junction box. Since the junction boxes must be fitted on the posts the sensor cable should be cut back to the next post along from the damaged area. See Section 4.9 for details on repairing sensor cable.

The GWJB-FAC junction boxes have special glands to facilitate the flexible conduit and because of these the sensor cable must be inserted into the gland prior to termination. For further details on terminating sensor cable with GWJB-FAC boxes see the Guardwire Accessories Installation Manual supplied with the box.

7.5 CORNER POSTS

As the corners of palisade fences are generally as rigid as the rest of the fence, no special sensor configurations are required when a corner is encountered.

8.1 FENCE AND SENSOR CONFIGURATION

Grill fences comprise of sheets of heavy duty grill made from steel bar, typically 5 - 8mm in diameter, supported by posts at the junction of the sheets. The grill is made from pairs of horizontal bars with vertical bars welded in between them resulting in a mesh size that is typically larger than that on a weldmesh fence. These fences are more common in Continental Europe and are sometimes referred to by their brand name of Wego Fences.

The construction of these fences tends to be rigid and the fence can resonant in high winds. These two factors mean that the system may be subject to nuisance alarms if the sensor cable is attached directly to the fence. Therefore a Rattle Bracket configuration similar to that used on palisade fences is the recommended method.

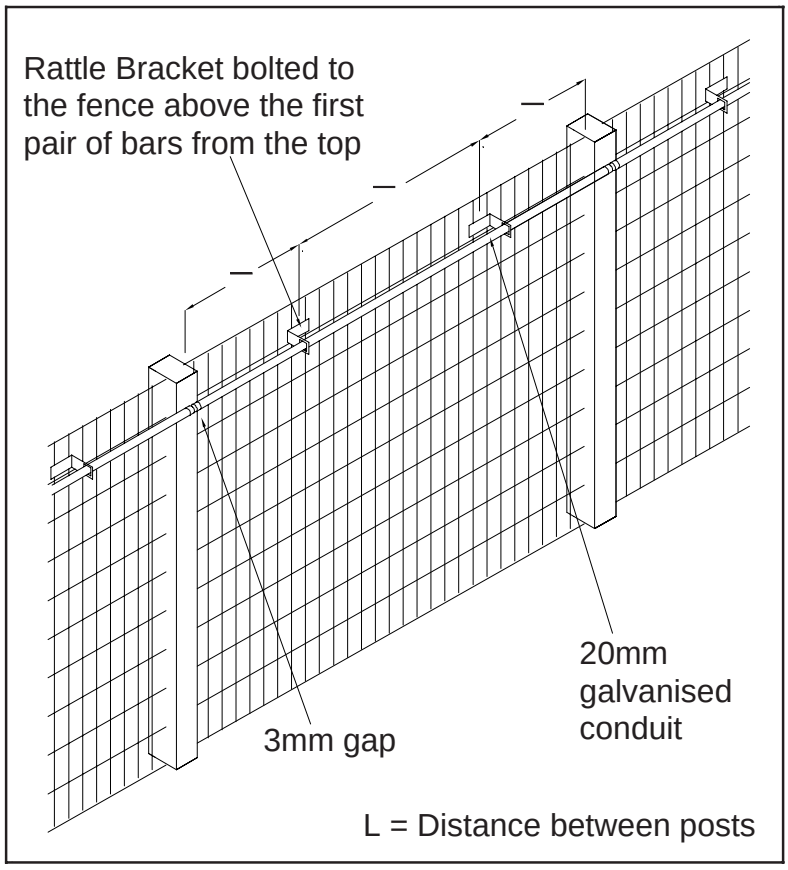

Figure 21

The sensor cable is contained within 20mm galvanised conduit suspended from Rattle Brackets bolted to the side of the fence. These brackets should be positioned on the inside of the fence, above the first pair of horizontal bars from the top and a quarter of the width of the distance between the posts from the end of the sheets. See Figure 21.

It is recommended for both ease of installation and sensor cable repair that a GWJB-FAC junction box is inserted on a post approximately every 50m. Where these occur the the rigid conduit should be cut back by about 150mm and the sensor cable enclosed in GWFAC flexi armoured conduit which is feed back into the rigid conduit. This protects the sensor cable whilst allowing it to be curved upwards into the junction box. Should a section of sensor cable become damaged then a new section can be inserted between the junction boxes.

8.2 FIXING THE SENSOR CABLE

1. Cut lengths of 20mm diameter galvanised conduit approximately equal to the distance between the centres of the posts. The exact length of the conduit should allow a 3mm expansion gap between the female rubber bushes once they have been fitted.

2. Position the backing plate against the outside of the fence so that the bolts face into the site. The bottom edge of the plate should rest against the first pair of horizontal

bars from the top and the plate should be a quarter of the distance between the posts from each end.

3. Place the bracket onto the plate and fix using the nuts provided. Figure 22 shows an exploded view of the bracket, plate and nuts.

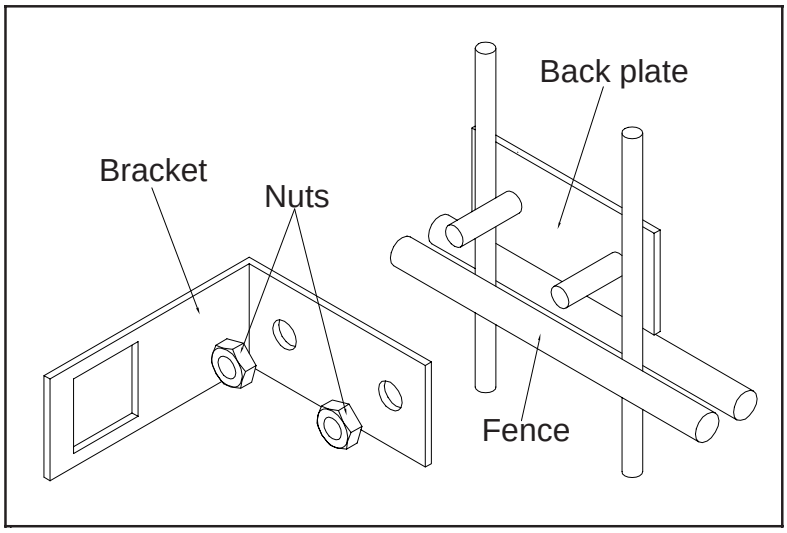

Figure 22

4. Slide the conduit lengths into the brackets so that one length is on one fence panel. The conduit can be inserted by pushing the conduit into one bracket, tilting the conduit downwards and pushing it through halfway and then lifting it up and sliding it into the other bracket.

5. After inserting the conduit into the brackets push a female rubber bush onto both ends.

6. Lay the sensor cable on the ground along the full length of the zone allowing enough cable at either end to make the terminations.

7. Starting at the middle of the zone push the sensor cable through the conduit towards the end of the zone. It is recommended that a maximum of 25m should be pulled through in one go. It may therefore be necessary to move the conduits within the brackets to gain access to the sensor cable. This operation requires at least two people.

8. Once installed to one end of the zone return to the centre and install the sensor cable to the other end of the zone.

9. Return to the centre of the zone and centralise the conduit within the brackets ensuring that the ends of the conduit are in line with the centre of the posts and that there is 3mm gap between the rubber bushes.

10. At the each end of the zone slide a piece of GWFAC flexi armoured conduit over the sensor cable and into the rigid conduit. The flexible conduit should loop below the line of the rigid conduit and then up into either the GWELT-4 or the analyser to prevent rain water flowing into the rigid conduit.

9.1 BREAKTHROUGH DETECTION

Guardwire sensor cable can be used on perimeter walls to detect intruders breaking through the wall. There are two methods of installing the sensor cable, either by using GW400kFAC-HS flexi armoured conduit or by enclosing the sensor cable within 20mm galvanised conduit. The GW400kFAC-HS is a stainless steel flexible conduit containing GW400k sensor cable. In both cases the conduit is saddled/nail clipped directly to the wall surface. See Section 13 for further details on installing sensor cable within conduit.

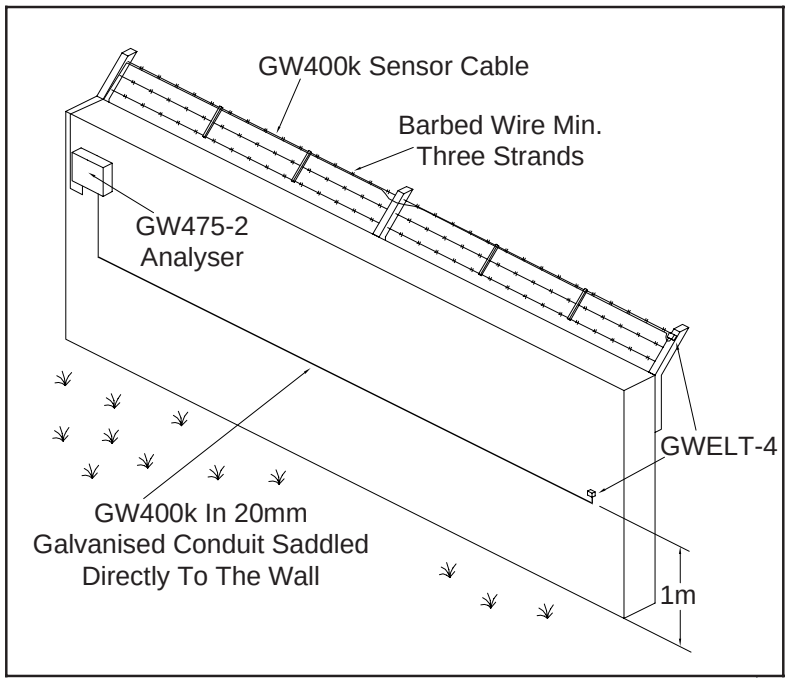

Figure 23

Figure 23 shows a run of sensor cable contained in conduit saddled to a wall. The sensor cable is mounted 1m from ground level since a breakthrough intrusion is more likely to occur nearer the ground. Consideration must be given to the detection level required, particularly on walls greater than 2.5m as this may necessitate double runs being used.

IMPORTANT

If sensor cable is solely attached to the wall surface then only breakthrough detection can be achieved. If climb over detection is also required than additional techniques should be employed.

9.2 CLIMB OVER DETECTION

To achieve climb over detection on perimeter walls then the sensor cable must be attached to an additional wall topping. This topping could be barbed wire attached to outriggers, as shown in Figure 23, weldmesh fitted vertically level with the outside face of the wall, concertina razor coils fitted on top of the wall etc. Regardless of which method is used the sensor cable on the topping must be a separate zone to that attached to the wall since they are different materials and as such will have different sensitivity settings. If a barbed wire topping is used then refer to Section 10 for installation details.

10.1 GENERAL

Many types of perimeter fences include a barbed wire topping on the fence to provide both a physical and visual deterrent to climb over types of intrusion. This topping can be integrated into the perimeter security system by using it as a vehicle for mounting the sensor cable. When installed correctly, a significant improvement in the detection of climb over intrusions can be obtained, *providing there is direct contact between the sensor cable and the barbed wire.*

IMPORTANT

The primary function of using barbed wire topping as a carrier for the sensor cable is to enhance the probability of detection of a climb over attack. Except on the express written advice of Geoquip's personnel do not use sensor cable only on the barbed wire topping.

10.2 CONFIGURATION OF TOPPING

The most commonly encountered type of topping comprises three horizontal strands of barbed wire stretched along the fence line and fixed to the outriggers of concrete or metal posts. For optimum detection the barbed wire mounted sensor cable should be a separate zone from the fence mounted sensor cable, each having its sensitivity correctly adjusted. As a compromise, the barbed wire mounted sensor cable can be an extension of the fence mounted zone although the total zone length must not exceed that specified in Section 1.6.

The following checklist should be studied to ensure the suitability of the topping for use as a vehicle for carrying the sensor cable.

1. The topping must be made up of a minimum of three strands of barbed wire in order to provide an adequate barrier.

2. The strands of barbed wire must be under sufficient tension to prevent movement of the wires during high winds. Loose wire which can swing freely is not acceptable.

3. Each strand of barbed wire must be firmly fixed to each fence post.

4. Bracing wires which tie the three (or more) strands together must be fitted between the posts to prevent the strands being spread apart to allow an intruder to squeeze through. With a spacing between the fence posts of 3m, there should be a minimum of two bracing wires between posts.

10.3 DEPLOYING AND FIXING THE SENSOR

Installation of the sensor cable must be carried out in two stages so that the cable is deployed and fixed to the fence *before* carrying on to deploy and fix the sensor cable to the barbed wire topping. The guidelines set out in Section 3.1 must be adhered to for cable deployment.

The sensor cable is fixed to the *upper* strand of the topping using plastic cable ties (Part No. GWTY-1). Extra care must be taken to ensure that the sheath of the sensor cable is not punctured by the barbs of the barbed wire. As specified for chain-link fencing, the spacing of the cable ties is not to exceed 200mm.

10.4 ALLOWING FOR CABLE DAMAGE

The new section of barbed wire mounted sensor cable should replace a complete length between the fence posts with the GWJB-1 junction boxes mounted on the posts. Refer to Section 4.9 for details of coping with cable damage.

Inevitably, there will be sites where the type of fence or perimeter barrier that is not described in the preceding text. Obtain advice from Geoquip Ltd *before* commencement of any installation work on non-standard perimeter barriers.

12.1 GENERAL

Most configurations of gates can be protected in accordance with the following recommendations **provided that the gate is of a similar construction and material as the fence**. It is important that the gates are in good repair and do not rattle in bad weather otherwise false alarms may be generated.

In general there are two methods of configuring gates.

1. Permanent protection - Here the sensor cable on the gate is constantly monitoring intrusions on the gate fabric. This configuration also gives an indication of when the gate is being opened since its movement will activate an alarm.
2. Switchable protection - Here a Gate Bypass Switch is used to bypass the sensor cable on the gate and adjacent fence sections. This has the advantage that the opening of the gate does not generate an alarm condition. The switches are either locally key operated or remotely 12V dc relay operated.

12.2 SENSOR CABLE CONFIGURATION

The gap between the fence and gate is bridged using a GWGLK-1 Gate Loop Kit. This comprises of two watertight boxes and mounting kits connected by a short length of flexible screened cable. This non-sensitive cable carries the sensor signals to and from the gate and is able to withstand the flexing caused by the gate opening and closing.

The sensor cable on the fence is connected to one of the terminal blocks in the fence mounted box. The sensor cable signal then continues to the gate via the flexible cable. The sensor on the gate is configured in a loop which starts and finishes at the two terminal blocks of the gate mounted box. The sensor cable signal returns back along the flexible cable to the other terminal block in the fence mounted box.

To continue beyond the gate to the end of the zone a length of GWFC-2 feeder cable is buried in a duct under the gate opening. Although this cable has a sheath to ensure suitability for outdoor use, it is not classed as a direct burial cable and as such a cable duct must be provided by the installer.

The following Sections cover the various configurations on single and double swing gates both with and without Gate Bypass Switches. In all cases it recommended that the sensor cable is looped up the side of the gate post to enhance the climb over detection in the area where the fence is more rigid.

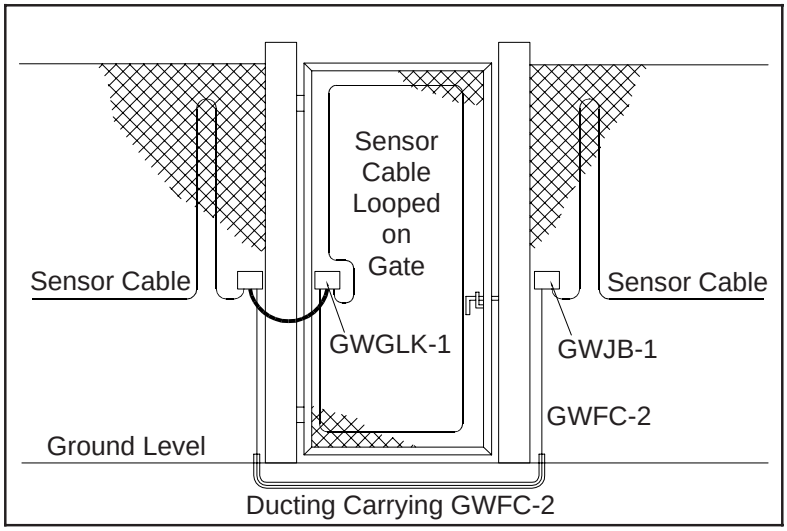

Figure 24

12.3 SINGLE GATE - PERMANENTLY PROTECTED

The GWFC-2 feeder cable that passes under the gate is

reconnected to the fence mounted sensor cable using a GWJB-1 junction box. See Figure 24.

12.4 DOUBLE GATES - PERMANENTLY PROTECTED

In this instance there is a Gate Loop Kit on each gate. Therefore a junction box is not required since the GWFC-2 feeder cable under the gate and the fence mounted sensor cable beyond the gate are connected to the two terminal blocks of the second GWGLK-1. See Figure 25.

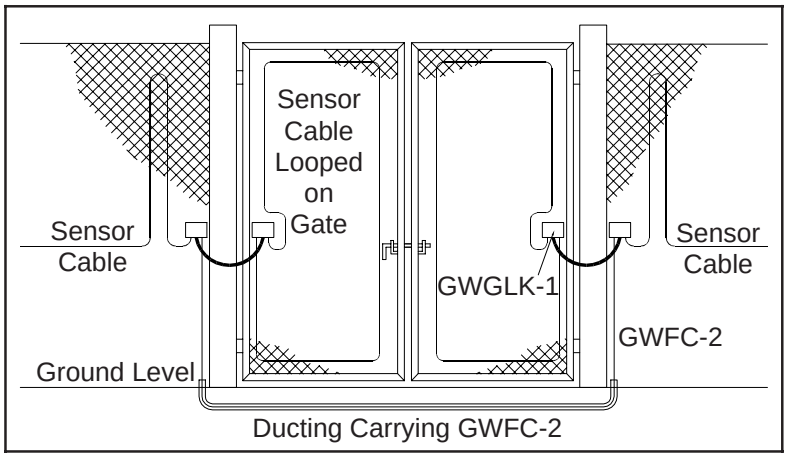

Figure 25

12.5 GATE BY-PASS SWITCHES

When it is required to have the option of disabling the sensor cable on the gates, a Gate By-pass Switch can be fitted. These comprise a switch unit mounted in a watertight housing fitted with cable glands and mounting bars. They are supplied as the GBS400-A locally key operated version or the GBS400-B remotely relay operated version. The relay operated version requires a 12V dc control signal at the unit to operate the internal relay.

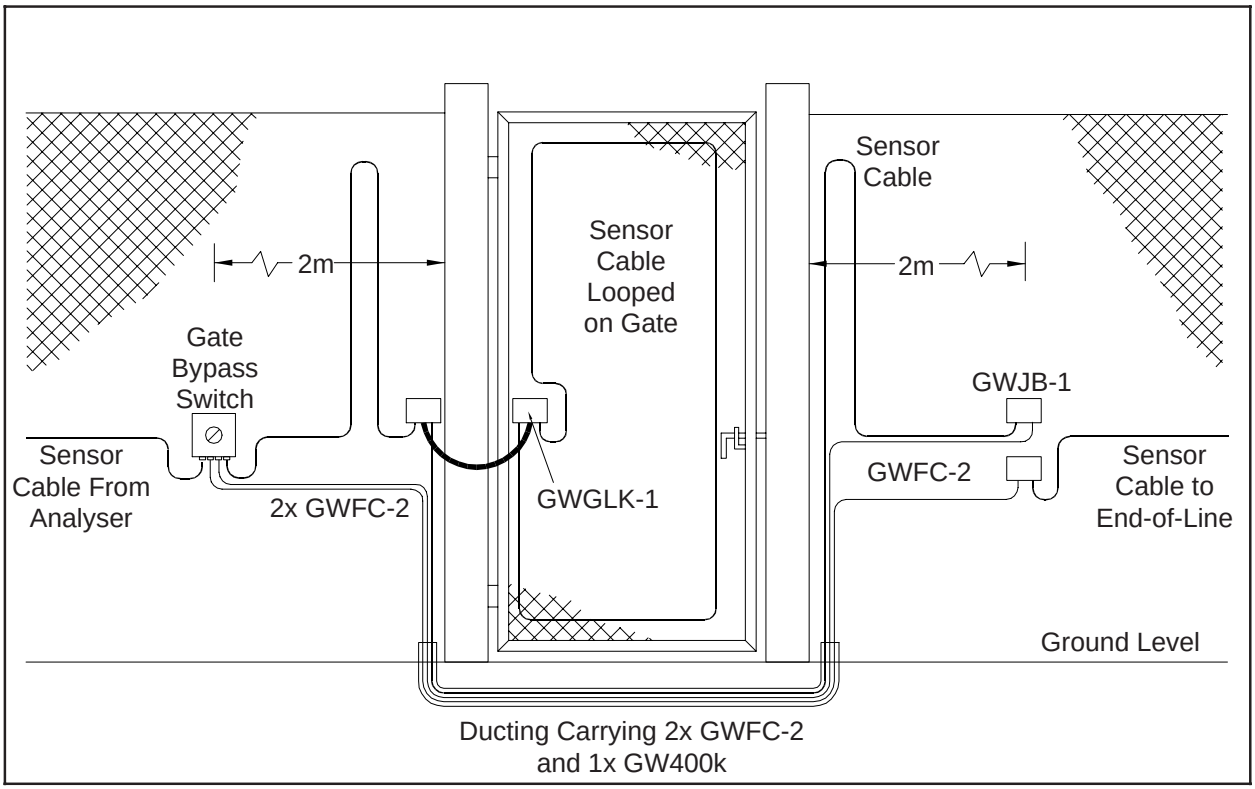

Figure 26

IMPORTANT

Use of the Gate Bypass Switches cause a sudden electrical pulse in the sensor cable which is registered as an 'event' in the analyser circuits. If the 'events' control in the analyser is set to position 1, this pulse will cause the alarm to trigger. This effect must be considered when commissioning the system.

The Gate By-pass Switch should be mounted either two metres or, preferably, one fence panel from the gate-post, thus ensuring that the section of sensor cable fixed to the fence adjacent to the gatepost is also switched off. This ensures that vibrations caused by a slamming gate do not reach the active sensor cable on either side of the gate(s) and cause an alarm.

Figures 26 and 27 show the arrangements required for single and double leaf gates.

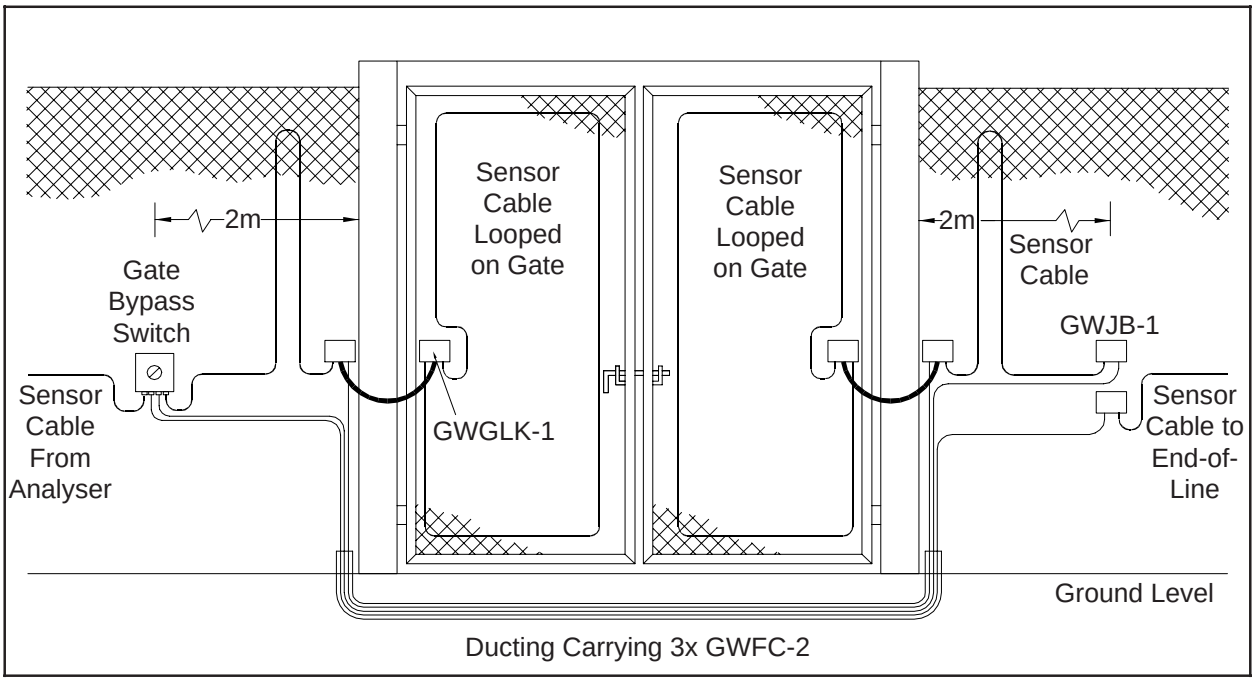

Figure 27

12.6 SLIDING GATES

On sliding gates the gap between the fence and gate is bridged using a GWGLK-3 Gate Loop Kit. This is essentially the same as a GWGLK-1 Gate Loop Kit except that the flexible coiled cable between the boxes is approximately 1.2m long. This cable extends to approximately 6m thus allowing the gate to slide open whilst maintaining the sensor cable signal to and from the gate.

The two Gate Loop Kit boxes should be positioned near the top of the fence and the gate respectively, with the gate mounted box in the middle of the gate. Refer to Figure 28. Positioning the boxes in this way means that the GWGLK-3 can be used on gates up to 10m wide.

To maintain site security it is important that both boxes are positioned on the inside of the fence. Positioning the boxes in this manner necessitates that the coiled cable is passed through the fence fabric to prevent it rubbing against the post when the gate is opened. Since this is the case one of the boxes will have to be dismantled prior to

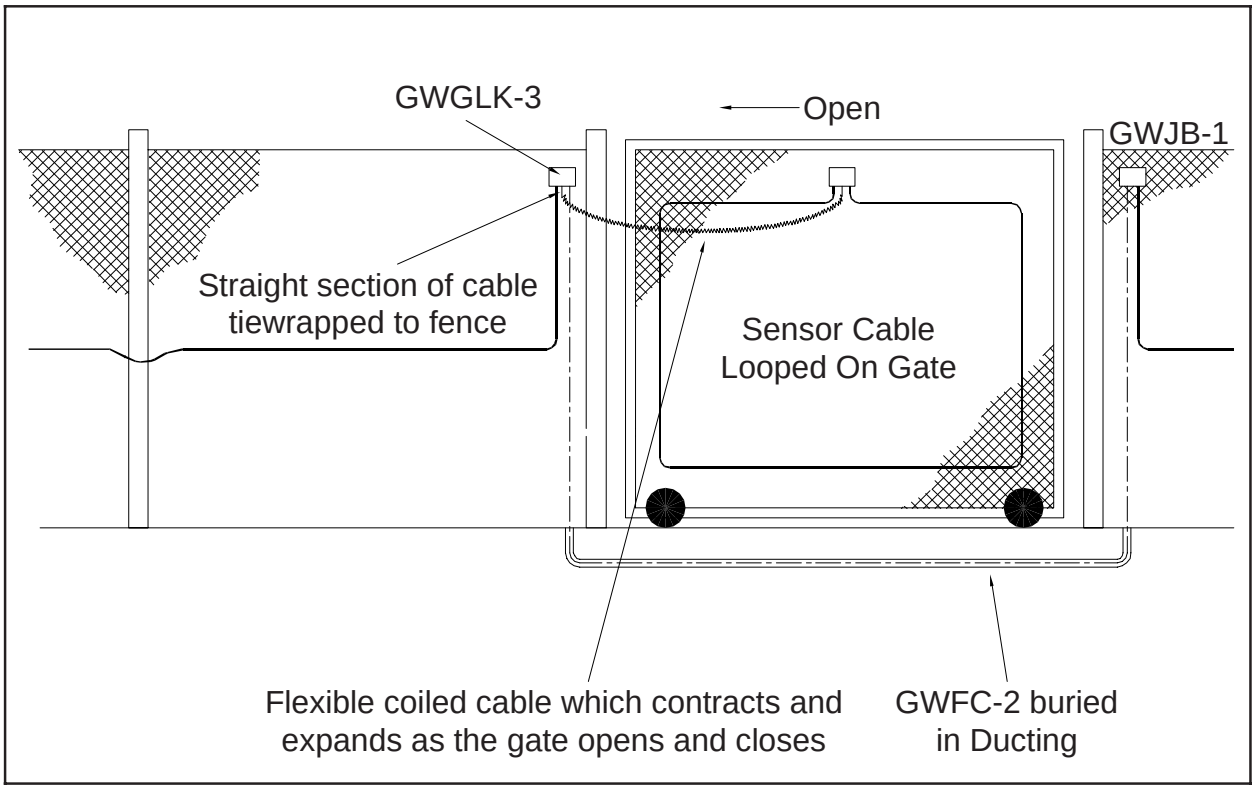

Figure 28

fixing. Dependent on which side of the fence the gate is when fully open determines which box needs to be dismantled, eg if the gate is on the outside of the fence then the fence mounted box will need to be dismantled and vice versa if the gate is on the inside.

To dismantle the box remove the lid, unclip the connector holding the coiled cable to the PCB and remove the PCB by undoing the two fixing screws. Dismantle the cable gland by removing the retaining nut on the inside of the box and sliding the gland down the coiled cable. Thread the cable connector through the retaining nut and the gland hole thereby freeing the box from the coiled cable. Fix the box to the fence or gate, as appropriate, and thread the cable connector through the fence and then back through the gland hole and the retaining nut. Reassemble the box by screwing the cable gland retaining nut back in position, replacing the PCB using the screws removed previously and finally reconnecting the coiled cable's connector.

IMPORTANT

To prevent the coiled cable from pulling out of the cable glands as the gate is opened the short section of straight cable prior to the coils starting should be tie-wrapped to the fence fabric immediately after leaving the cable gland.

In areas where the sensor cable requires additional protection, eg against vandalism or damage from vehicles etc, it can be run inside either flexible or rigid conduit.

In both cases the conduit must be installed over the whole of the zone length to prevent dissimilar responses occurring. If it is considered uneconomical to install conduit over the whole zone length, the zone should be split into two separate zones, each with its own analyser.

13.1 FLEXI-ARMOURED CONDUIT

Flexi-armoured conduit (FAC) is available from Geoquip Ltd in two versions ie GWFAC and GWFAC-HS, both of which can be provided either excluding or including the GW400k sensor cable. They are both made from 316 grade stainless steel and provide protection against the sensor cable being cut whilst being easier to install than rigid conduit. Due to its construction the GWFAC-HS is more rigid and is therefore harder to cut and less flexible than the GWFAC.

In general therefore, the GW400kFAC-HS should be used where long straight sections are required eg on perimeter walls. Conversely the GWFAC should be used to contain the GW400k where short flexible sections are required eg around the posts between sections of rigid conduit mounted on a palisade fence.

Both types of flexi-armoured conduit are available in either 50 or 100m reels. If longer zone lengths are required then sections can be joined using the GWJB-FAC junction box. These junction boxes have special glands to facilitate the flexible conduit and because of these the sensor cable must be inserted into the gland prior to termination. For further details on terminating cable with GWJB-FAC boxes see the Guardwire Accessories Installation Manual supplied with the box.

13.2 INSTALLING THE FAC

When installing FAC on fences it should be fixed using a GWTY-3 stainless steel tie-wrap every 1m with GWTY-1 tie-wraps every 200mm in between.

When installing FAC on walls it should be fixed every 1m with a saddle. Between these it should be fixed every 250mm using either nail clips or saddles depending on the fabric of the wall.

13.3 RIGID CONDUIT

When installing sensor cable in rigid conduit follow the instructions below.

1. The only type of rigid conduit suitable for fence protection is 20mm galvanised steel conduit. Do not use 15mm aluminium security conduit because this suffers severe corrosion damage.

2. All cut ends of conduit must be de-burred prior to installation of sensor cable in the conduit. Wherever possible, brass ferrules or other smooth lead-in components must be used.

3. Pull-through points must be provided at intervals not exceeding 25m (80ft). If the length includes 90° bends, additional pull-through points may be needed.

4. Where bends are required, long, smooth, radius bends must be used to prevent cable damage. Do not use conduit elbows or sharp bends. Such components will cause damage to the sensor cable during installation as the bend radius is less than the recommended minimum radius of 100mm (4"). See Figure 29.

5. The maximum length of sensor cable handled while installing in rigid conduit should not exceed 100m (320ft). Longer zones should be made up by jointing the sensor at appropriate intervals. This will eliminate excessive handling of the sensor when pulling each 25m (80ft) length of sensor into the conduit. No performance degradation will occur by adding joints provided that they are made in accordance with the instructions in Section 4.9.

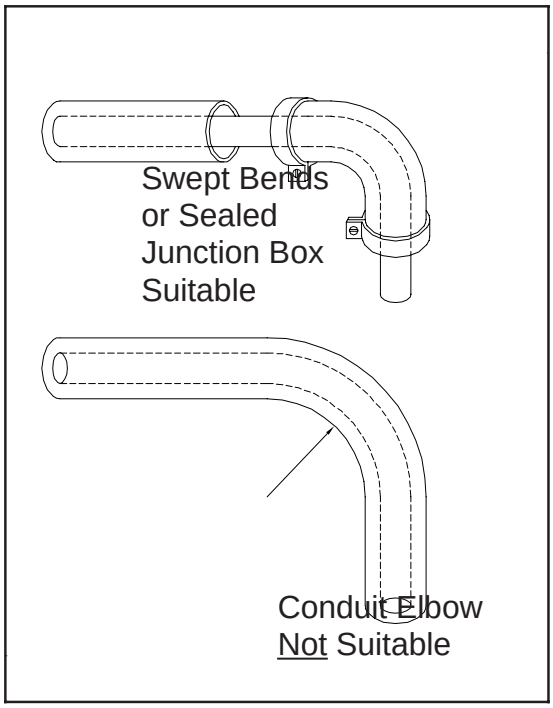

Figure 29

6. When feeding the cable into the conduit, one person must feed the cable into the conduit to prevent the cut end of the conduit from damaging the jacket whilst another person pulls the cable through from the other end. See Figure 30.

7. Conduit can be fastened to the fence by means of GWTY-3 stainless steel wire ties. The spacing of the wire ties should be chosen to ensure that the conduit is held in close physical contact with the fence fabric.

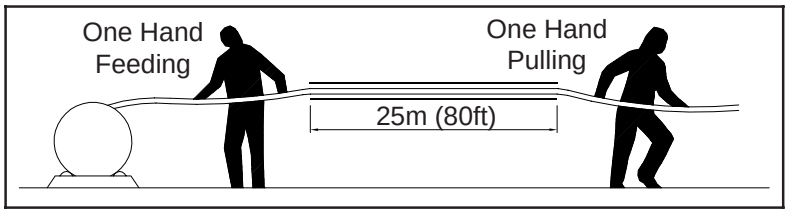

Figure 30

8. When installing rigid conduit on perimeter walls it must be saddled at maximum intervals of 1m (3ft). Where the surface is irregular or uneven, additional saddles will be necessary to ensure close contact with the wall surface.

14.1 GENERAL

Correct termination of the sensor cable with all joints properly sealed to exclude moisture is an essential part of the installation. If moisture penetrates into the sensor cable, it is impossible to remove and will result in poor long-term efficiency. To ensure resistance to moisture penetration at terminations use the adhesive coated heat-shrink sleeving provided for all sensor terminations.

IMPORTANT

To ensure satisfactory long-term performance of the system, it is vital that only termination kits supplied by Geoquip Ltd are used. Terminations should only be fitted on completion of the sensor cable installation.

Use a hot-air gun for all heat-shrink operations specified in the following sections. Do **NOT** use a naked flame to shrink any heat-shrink components.

The following equipment list is recommended to ensure that installation engineers are fully equipped to carry out sensor cable terminations.

1. “Stanley” type craft knife or similar.
2. Gas hot-air gun. (Black and Decker or similar)
3. Small side cutters.
4. The termination kit provided with the Analyser/ GWELT-4/GWJB-1/GWGLK-1

14.2 TERMINATION PROCEDURE

Refer to Figure 31 in conjunction with the following instructions.

1. Carefully cut all the way round the jacket 100mm (4") from the end and then put a longitudinal slit to the end of the cable. Strip back the outer jacket of the sensor cable to expose the drain wire and the underlying aluminium foil screen. It is important not to nick or damage the drain wire or the underlying aluminium screen.
2. Cut off 125mm (5") of green/yellow earth wire from the termination kit provided and strip the insulation 25mm (1") back from one end. Twist and solder the bared end of the earth wire to the drain wire so that the insulation on the earth wire is snug against the point at which the drain wire emerges from the sheath of the cable. Cut off excess wire at the twist to leave 12mm (1/2") of exposed twisted wires. Fold this twist back so it lies along the outer sheath of the sensor.
3. Carefully untwist the aluminium foil screen from the cable without disturbing the underlying layer of clear “Mylar” tape. The lie of tape will determine whether it will be easier to unwind the tape from the cut end of the cable or from the point where the sheath of the cable was cut back to. If it is necessary to unwind the tape from the sheath end, a small pair of side-cutters will help in unpicking the first part. Ensure that the foil tape is removed cleanly at the sheath/core junction.
4. Slide the 40mm (1.5") length of black heatshrink over the junction of the sheath and core of the cable. 20mm of sleeving must cover the sheath and the earth wire

connection while the remainder covers the sensor cable core. Apply heat from the hot-air gun to shrink the sleeving round the core and sheath.

5. Visually inspect the finished shrink to verify that there is a ring of melted adhesive at the ends of the sleeving to provide a good seal between cable and sheath.

6. Cut through the clear “Mylar” tape at the junction of the heatshrink sleeving and the cable core and remove. It may be easier to unwrap from the inner end rather than the cable end.

7. Break off the semi-circular magnetic strips to expose the inner conductors.

8. Identify the bare wire which lies immediately next to the black insulated wire and slide on a piece of red heat-shrink sleeving over it. Ensure that the end of the sleeving is pushed down to where the bare wire emerges from the core. Repeat this step with the other bare wire using a piece of blue heat-shrink sleeving.

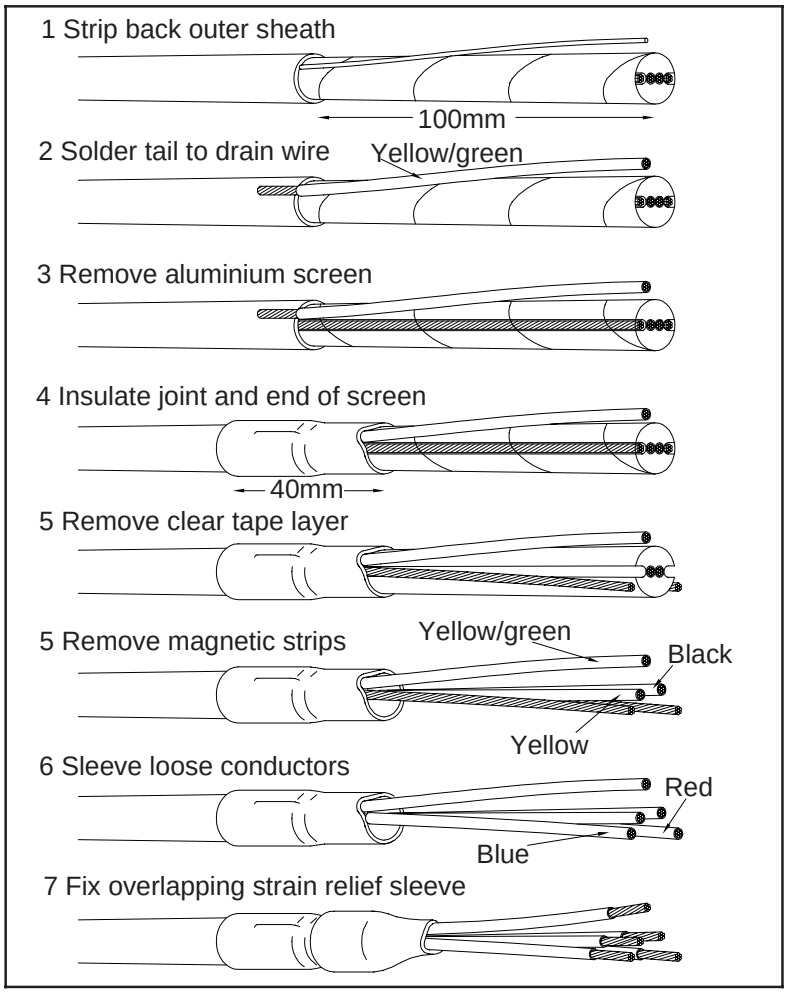

Figure 31

9. Slide the 25mm (1") length of black heatshrink over the junction of the first heatshrink and the insulated cables. The heatshrink should be centrally positioned over this junction. Apply heat from the hot-air gun to shrink the sleeving round the previous sleeving and the insulated wires.

10. Visually inspect the second sleeve to verify that the insulated sleeves are gripped by the outer heat-shrink sleeving and that a melted ring of adhesive is present at both ends of the sleeve.

11. Strip off 12mm (1/2") of the insulation on all of the wires to facilitate connection to the termination blocks.

This completes the termination of the sensor at the analyser end.

15.1 TERMINATION BOXES

Only GWELT-4 termination kits should be used for the end-of-line terminations. These kits comprise of a waterproof box containing a printed circuit board, onto which the sensor cable is connected and a mounting kit. The use of the box and PCB enables easy access to the end of line termination for maintenance, testing and fault finding.

15.2 TERMINATION PROCEDURE

1. Terminate the end of the sensor cable as described in Section 14.2.

2. Loosen the gland on the box and pass the terminated cable end into the box until sufficient length of tails are available to be wired into the terminal blocks. Tighten the gland by hand ensuring the rubber sealing ring grips the cable jacket and not the heatshrink sleeves.

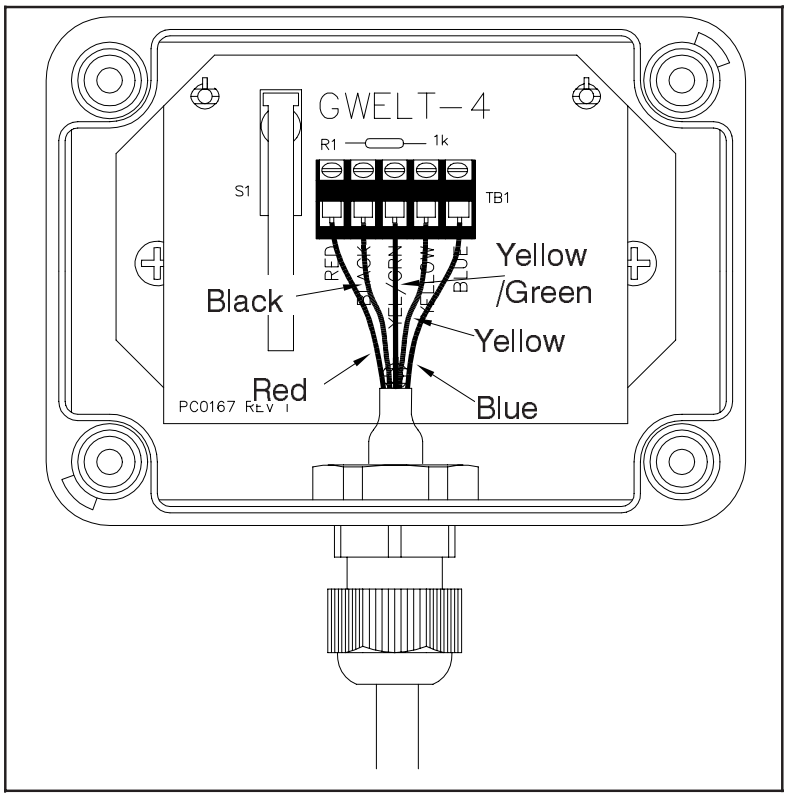

Figure 32

3. Position the box just above the line of the fence mounted cable to allow rain water to run away from the cable gland and clamp the box to the fence using the mounting kit provided. Do not over tighten the screws on the mounting bars as in extreme circumstances this can cause distortion of the weatherproof seal arrangement.

4. Connect the sensor cable tails to the terminal blocks ensuring that the cable tail colours match the screen printing. See Figure 32.

5. Replace the box lid, taking care not to over-tighten the lid screws and verify by listening that the tamper switch operates as the lid is screwed down.

This completes the end- of-line termination.

16.1 GENERAL

After the sensor has been terminated at both ends it must be tested prior to connection to the analyser. Testing the cable will indicate any incorrect terminations or damage which may have been inflicted on the cable during installation.

All lengths of sensor cable dispatched from Geoquip Ltd are fully tested to ensure optimum performance when correctly installed.

IMPORTANT

The sensor cable must be disconnected from the analyser before taking any measurements.

16.2 TEST PROCEDURE

To carry out the following tests, the installation engineer requires a multi-meter capable of reading resistance values up to at least 1MΩ. Refer to Figures 33 and 34.

1. Set the multi-meter to read resistances on the 200Ω range. At the analyser end measure the resistance of the loop formed by the red and yellow wires (M1, Figure 34) and note the value.
2. Again, at the analyser end measure the resistance of the loop formed by the black and blue wires (M2, Figure 34) and note the value.
3. Compare the resistance values obtained from steps 1 and 2 above. In a properly terminated cable the difference between the two readings should be less than 5%.
4. Estimate the cable length from the readings obtained using the formula shown below.

$$\textit{Cable length in metres} = \frac{\textit{Average loop resistance}}{16} \textit{ x } 100 \text{ or}$$

$$\textit{Cable length in feet} = \frac{\textit{Average loop resistance}}{5} \textit{ x } 100$$

NB The Loop Resistance must be entered in Ohms.

5. At the analyser measure the resistance between the red wire and the black wire. (M3, Figure 34) This value should be 1kΩ plus the average loop resistance obtained from steps 1 and 2.
6. Set the meter range to 2000kΩ range and check that the resistance between the green/yellow earth wire and the yellow wire is greater than 1MΩ (M5, Figure 34). Repeat this test to verify no leakage between the blue wire and the earth wire (M4, Figure 34).
7. At the end of line termination box disconnect the red and the yellow/green wires from the terminal block and short together. Set the multimeter to the 200Ω range and check the resistance between the red and the yellow/green wires at the analyser. The resistance obtained should be 21.2Ω for every 100m of cable using

length calculated above. Once this test has been performed reconnect the red and green/yellow wires to the end of line termination block.

If all the above tests are satisfactory, the sensor cable can be connected to the analyser. If a problem is experienced in obtaining the results described above, refer to Section 17 of this manual for guidance on fault-finding.

Schematic representation of sensor cable connections

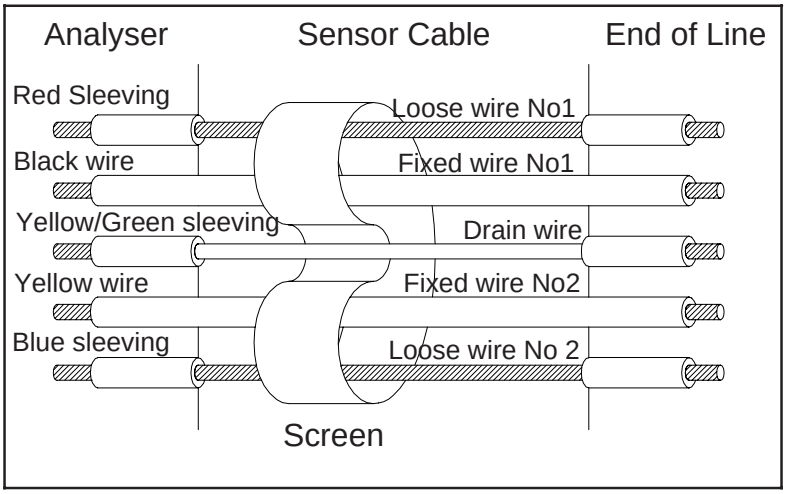

Figure 33

Schematic presentation of meter resistance readings

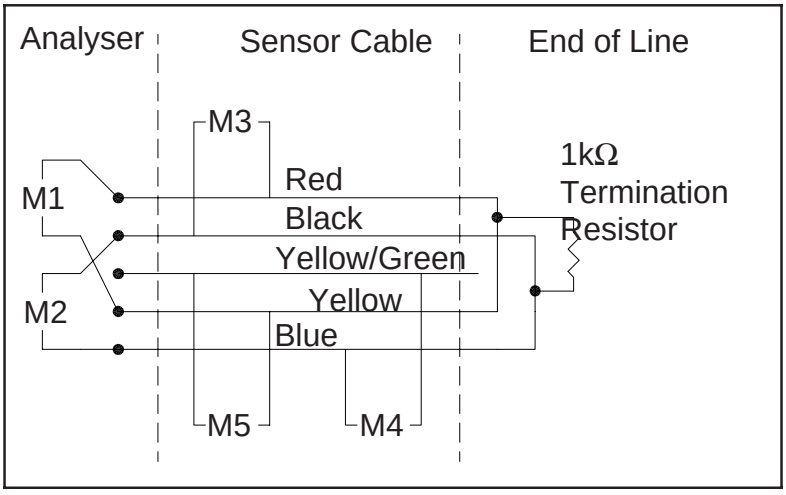

Figure 34

Readings M1 and M2 taken on the 200Ω range.

Reading M3 taken on the 2kΩ range.

Readings M4 and M5 taken on the 2000kΩ range.

The following lists indicate a number of possible problems and methods of overcoming these problems.

Fault finding on Guardwire systems can be separated into two main categories as shown below.

17.1 INSTALLATION RELATED PROBLEMS

SYMPTOM	POSSIBLE CAUSE	REMEDY
Apparent lack of response when testing or commissioning the system.	Inadequate coverage of protected area caused by wide spacing of sensor cable runs.	Increase number of sensor runs to comply with recommended installation requirements.
Excessive audio noise or interference when monitoring audio output.	Sensor cable runs parallel to power cables or other sources of electro- magnetic interference such as transformers, high power cables, etc.	Re-site sensor cables to maintain recommended spacing between sensor cable and sources of interference. Contact Geoquip Ltd for further advice.
Variation in response to test impacts on the same zone.	Sensor cable installed on different types of fabric on the same zone.	Ensure that sensor cable is installed only on one type of fabric per zone.
	Large variation in tension of fence panels.	Tighten up excessively loose panels of fencing.
	Internal damage to sensor cable during installation.	Contact Geoquip Ltd for further advice.
False alarms occur at regular intervals.	Operation of gates at regular times as employees arrive or depart. Animal activity on fence line.	Isolate gates from main protected zones using gate by-pass switches. Investigate fence line for rabbit or fox burrows.
	Transient electrical interference related to regular switching of loads such as street lighting, perimeter lighting etc.	Use audio monitoring to pin-point source of problem. Contact Geoquip Ltd for further advice.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Excessive false alarm rate under bad weather conditions.	Loose or vibrating sections of fence fabric, signs, gates, or outriggers and topping. Vegetation or tree branches brushing against fence line.	Locate problem area using audio monitoring facility. Tighten up loose sections or cut back vegetation and/or tree limbs.

17.2 SENSOR CABLE RELATED PROBLEMS

SYMPTOM	POSSIBLE CAUSE	REMEDY
Analyser indicates tamper fault.	Sensor cable damaged, incorrectly connected to analyser, or incorrectly terminated.	Remove sensor cable from analyser terminal block and insert wire links and 1kΩ resistor as per in Figure 35. If the fault persists, return the analyser for repair. If it clears, reconnect the sensor cable and follow the tests in Section 16.2.

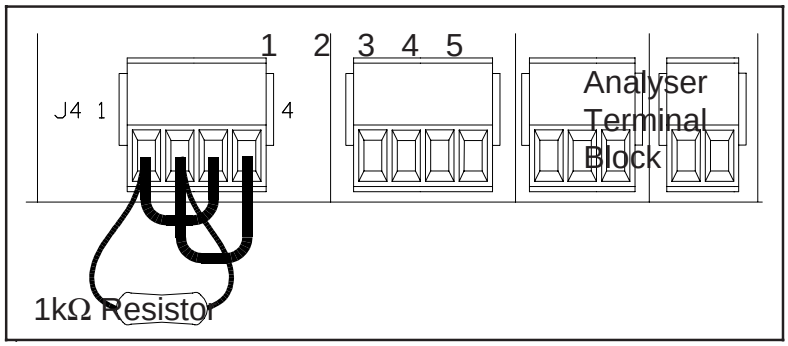

Figure 35

Resistance measurement between red and black conductors less than 1kΩ.	Short-circuit between each loop in sensor cable caused by damage to sensor cable or incorrect connection of sensor cable sections. Incorrect or poorly made end termination.	Locate position of short-circuit using a multimeter to obtain the loop resistance between affected conductor. Distance to short-circuit can be estimated knowing that the resistance of a loop is typically 16Ω per 100m.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Open-circuit measurement found where loop resistance should be indicated.	Broken conductors in cable or incorrect jointing of cable sections. Incorrect junction box or end of line termination.	Inspect terminations and joints to ensure correct termination procedure has been followed. If a broken conductor in the sensor cable is identified, contact Geoquip Ltd for advice on how to locate point of breakage.
Resistance reading less than 1MΩ between earth wire and internal conductors.	Damage to sensor cable, incorrect or poorly made terminations.	Inspect terminations to ensure correct termination procedure has been followed. Inspect cable sheath for damage which may allow moisture into cable. Replace damaged section.

Use only approved parts supplied by Geoquip Ltd in all installations. Use of other items may impair long-term reliability and in some cases may invalidate warranty conditions.

The following accessories and spare parts are available from Geoquip Ltd.

PART NO.	DESCRIPTION	**APPLICATION**
GBS400-A	Key Operated Gate By-pass Switch	For use where it is necessary to isolate a section of sensor cable in a zone. i.e. sections on gates etc.
GBS400-B	Relay operated Gate By-pass Switch	As GBS-400A except that isolation of the sensor cable section is by operation of an internal 12V dc relay.
GW400k	Guardwire Sensor Cable	Microphonic sensor cable used with Geoquip Ltd analysers.
GW400kFAC-HS	High quality flexible stainless steel conduit containing GW400k sensor cable.	Used in high security environments due to high resistance to cutting
GWAMP-1	Audio Amplifier (Battery Powered)	To assist in identifying sources of false alarms.
GWELT-4	Sensor Cable Termination Box	Used to terminate the GW400k sensor cable. It comprises a watertight, tamperproof box containing the end-of-line termination.
GWFAC	Flexible stainless steel conduit (not including sensor cable)	Used to interconnect GWRB-2 Rattle Bracket sections.
GWFC-2	Feeder Cable (External Use)	Used for non-sensitive sections in sensor cable runs or to connect active sensor cable to remotely sited analysers. Not suitable for direct burial.
GWGLK-1	Gate Loop Kit	Comprises two watertight, tamperproof, junction boxes and pre-wired interconnecting cable to simplify installation of sensor cable on hinged gates.

PART NO.	DESCRIPTION	APPLICATION
GWISB-1	Zener Barrier and Housing	For use where sensor cable may be installed in hazardous areas. Provides a safety barrier between sensor cable and analyser. Refer to Geoquip Ltd before specifying.
GWJB-1	Junction Box	Used to connect sections of sensor cable together or sensor cable to non-sensitive cable. Integral tamper monitoring provided.
GWJB-FAC	Flexi Armoured Junction Box	Similar to GWJB-1 except the glands are larger to accept flexible conduit.
GWRB-2	Support Brackets	Used to suspend galvanised conduit containing GW400k from the arris rail of palisade fences.
GWRB-3	Support Brackets	Used to suspend galvanised conduit containing GW400k from grill (Wego) fences.
GWTY-1	Cable Tie-Wraps	For attaching sensor cable to chain-link or weld-mesh fencing. UV resistant for outdoor use. These tie wraps will break when used with tie wrap guns and therefore such guns should **not** be used.
GWTY-3	Stainless Steel Cable Ties	Used where additional security of attachment of sensor cable to fence is required. Cannot be removed by melting. N.B. Care should be exercised when using these to ensure they **not** overtightened as this may cause damage to the sensor cable.

PART NO.	DESCRIPTION	APPLICATION
GWTY-4	Stainless Steel Wire Ties	Used for attaching protective steel conduit containing GW400k sensor cable to fence lines.