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# DDAS: Investigating a Metal Detector Reading

Humanitarian Demining Accident and Incident Database  
*AID*

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## **Investigating a metal-detector reading - general**



*The picture above shows the second after getting it wrong during signal investigation (this was a test).*

See [AP blast mine detonation](#) for the entire sequence.

### **Section 4: Investigating a metal-detector reading**

#### **4.1 General**

What follows are basic procedures that you can edit and refine to suit your equipment and working preferences. They presume that deminers operate in a "One-man procedure", with the same deminer performing all tasks during a working shift. When there is not enough equipment for each deminer to be issued with a detector and tools, two-man teams can be deployed. In a two-man team, a one-man procedure is still used. One person works while the other rests, and each individual performs all the tasks required for clearance during his/her shift.

A metal-detector "reading" is sometimes called a "signal" or an "indication". In this

document, all three refer to the same thing. Investigation can only start after the indication closest to the deminer's Base-stick has been pinpointed.

### **4.1.1 Working stance**

When conducting a Hand-tool investigation drill, deminers should work on one knee, two knees or squatting, whichever they find more comfortable and stable. Lying prone to uncover a detector reading is not permitted (for the reasons see [Working prone](#)). Exceptions occur on steep slopes (working uphill) when they may be instructed to lie down to increase their stability. The Supervisor must record all exceptions and the reason for them (usually in the Site Log).

When conducting a combined detector/rake investigation procedure, deminers must always work standing when using the rakes. Shorter tools and the metal-detector can be used in a kneeling or squatting position when required.

### **4.1.2 PPE used when conducting a signal-investigation procedure**

All deminers engaged in a signal-investigation procedure must wear 5mm polycarbonate eye protection and frontal blast-armour that extends onto their thighs. If deminers performing the hand-tool investigation procedure squat rather than kneel (the stance depends on culture and comfort), the frontal blast protection must extend under the groin to protect the genital area.

## **4.2 Signal investigation procedure requirements**

Only persons internally trained and certificated as deminers can be employed to investigate metal-detector readings.

The person who placed the marker indicating the site of a metal-detector reading shall be the same person who investigates that reading. If it is necessary for a second person to investigate a reading, they must check the position of the marker with a metal-detector before starting to investigate the reading.

A formal Risk Assessment (including a Threat Assessment) must have been made and documented for the task. When the Threat Assessment does not identify the anticipated targets and their condition, the most dangerous threats in the region of the Task must be presumed to be present.

**NOTE:** The Risk and Threat Assessment can be varied as work progresses and more knowledge of the actual hazards present is gained. All variations must be documented (usually in the Site Log) with reasons given.

The deminer shall have appropriate tools for the procedure, including a metal-detector that has been set-up appropriately as described in Section 2 [Metal-detector set-up](#).

Depending on the Risk and Threat Assessment, the Supervisor shall decide whether to deploy either:

- 1) hand-tool investigation procedure;

## 4.3 Hand-tool investigation

### 4.3.1 Tools used in the hand-tool investigation procedure

The following may be used during the hand-tool investigation procedure. Ground engaging tools should always be blast-resistant and should be long enough to keep the tip of the tool at least 30cm from the user's hand. Flexible hand-guards on the tools are desirable but not essential.



**A:** A [pick-prod](#) designed to be inserted a small way and twisted to break hard ground. A blade may be substituted for this as long as the blade is 30cm or longer.

**B:** A [thin "needle-prod"](#) with low ground friction ideal for loosening soft ground.

**C:** A [long handled trowel](#) (with or without a magnet attachment).

**D:** [Secateurs](#): long handles and an anvil cutting action are preferred.

**E:** A [long-handled brush](#) with bristles stiff enough to brush clinging earth from a mine casing.

The tools should be kept in a tool-bag but may be carried from the rest area in the plastic bucket that the deminer uses for metal fragmentation and/or contaminated spoil.



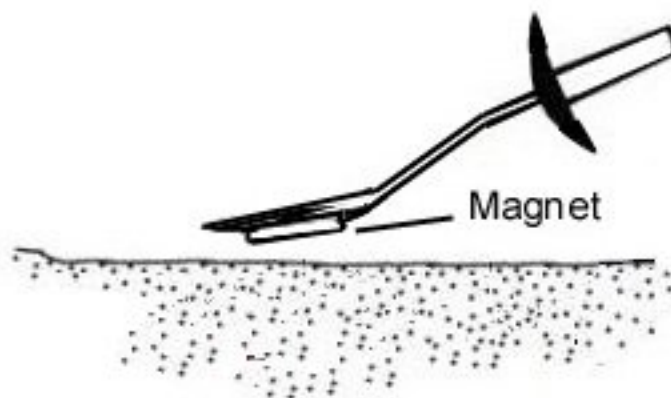
In very hard ground, a two-handed excavator should be used to start the excavation by digging down to the search depth a safe distance back from the signal marker.

### **4.3.2 Hand-tool investigation procedure**

When a detector signal has been pinpointed and a signal marker placed at the nearest part of the reading, the deminer can begin a signal-investigation procedure. If at any point during the procedure the source of the metal-detector indication is located/removed and it was not a mine/device, the deminer should stop the investigation and return to the metal-detector search procedure. If at any point a mine/device is located, the deminer should inform a Supervisor.

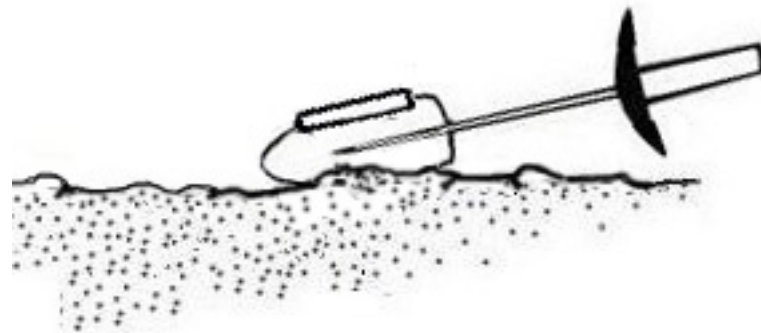
**1)** The deminer must begin by looking closely at the ground surface for sources of the metal-indication. If any metal is found, the deminer should check the position of the original indication with the metal-detector. Throughout this procedure, the deminer should be constantly scanning the ground by eye for the source of the metal-detector signal.

**2)** The deminer should pass a magnet over the ground surface where the detector indicated. The signal marker may be temporarily removed for this.



**3)** On uneven ground, the deminer may lightly scrape the ground surface (applying no downward pressure) with the magnet attached to the trowel. The spoil should then be tipped over the magnet to trap any ferrous fragments present.



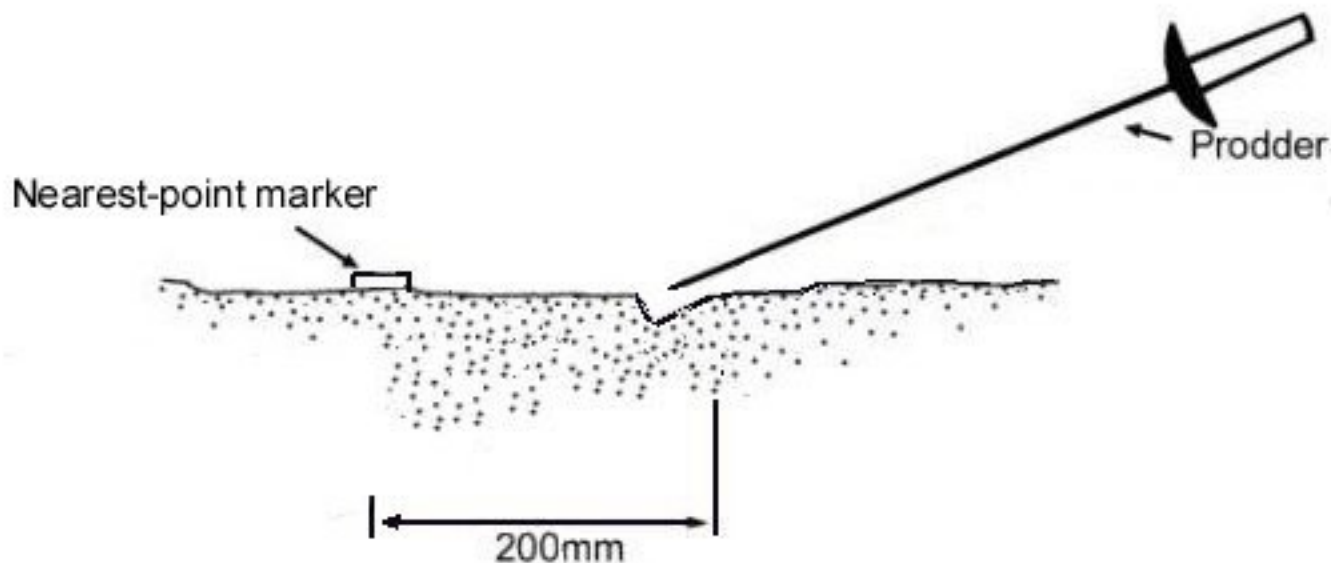


The deminer must check the position of the signal-marker with his metal-detector before continuing whenever the ground surface has been scraped, whether or not fragments have been located.

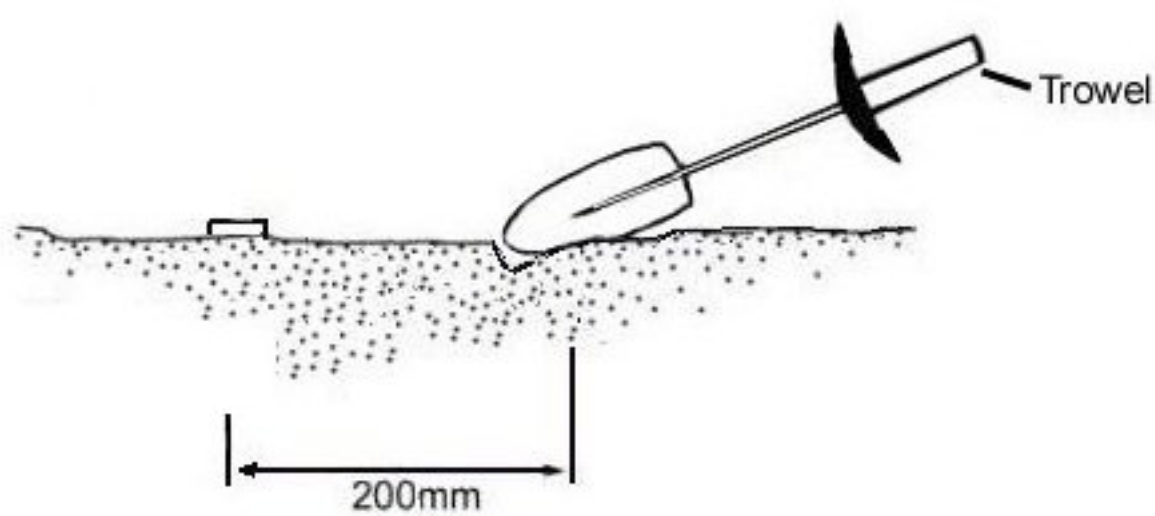
This action should not be permitted when the Threat assessment at the Task indicates the possible presence of particularly sensitive devices.

**4)** An investigation should be started by prodding the ground at least 20cm back from the reading. In most ground, the prod will not penetrate more than a few centimetres. The deminer must not apply excessive pressure to make the prodder go more deeply into the ground. If the needle prodder will not penetrate 3cm, the deminer should use the pick-prod or a two-handed excavator to break the ground surface. Sometimes the ground has a crust with softer spoil underneath. Frequently the ground becomes more compacted as the investigation gets deeper, and the excavator may be required. Both a pick-prod and a two handed-excavator should always be available.

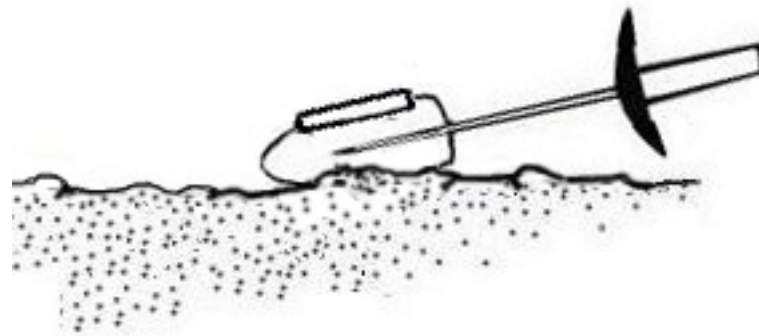
The ground should be prodded or broken-up over a width of excavation equal to the width of the anticipated threats at the site, or 15cm, whichever is greater.



**5)** The ground that has been loosened should then be removed with the trowel. It may be moved to one side onto a cleared area or may be placed in a plastic bucket depending on the kind of metal contamination at the site. When the contamination includes a lot of very small metal fragments, it can be more efficient to remove all the spoil in the bucket.

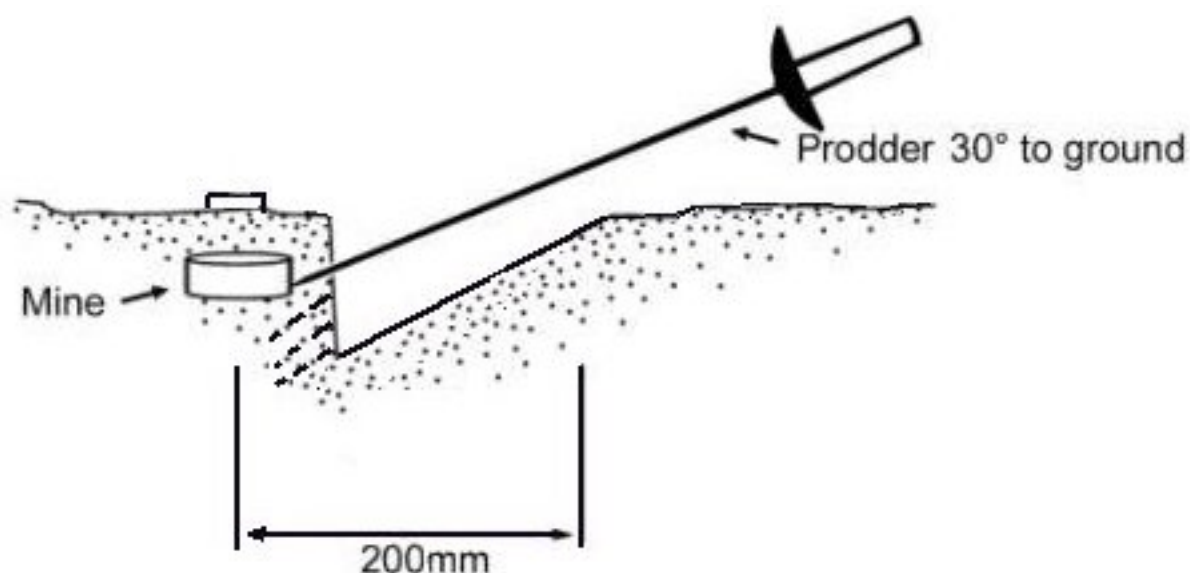


When the contamination consists of ferrous fragments, a magnet can be attached to the trowel and the spoil tipped over the magnet as it is moved aside. This can be very effective at trapping ferrous material that may have made the metal-detector signal.



Whenever metal is found during the excavation - with the magnet or by eye - the deminer should check the position of the original indication with the metal-detector.

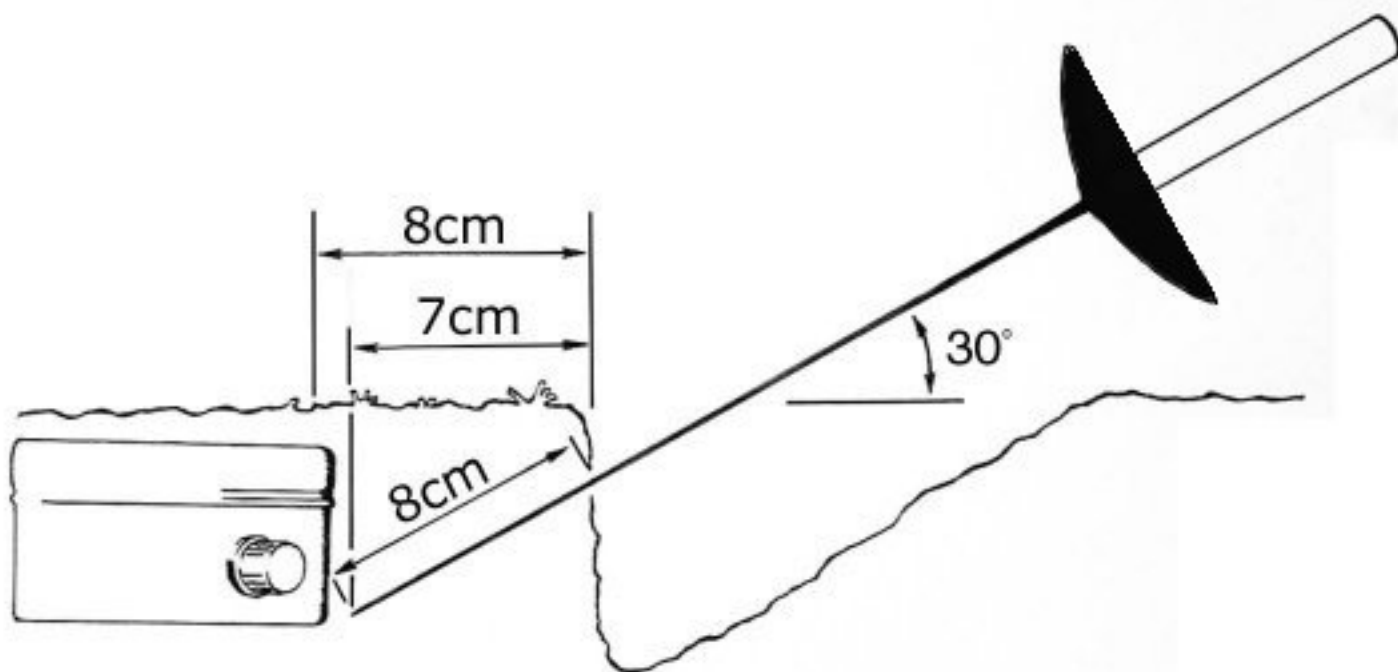
**6)** Steps 4 and 5 should be repeated as many times as necessary to create a sloping hole at least 15 cm wide advancing towards the signal-marker. The depth of the hole should reach the required clearance depth at the site BEFORE the marker is reached.



The side of the excavation closest to the marker is approximately vertical. This must be prodded from the bottom upward at a spacing of 3cm. The prodded earth can then be removed with the trowel. When the prodder meets an obstruction, the prodder should be used to feel for the sides of the obstruction and so estimate its size. The trowel should then be used with extreme caution to expose the

obstruction.

In soft ground, it may be possible to insert the prodder a considerable length into the ground. The prodded ground can then be cut away with the trowel in complete confidence that there is nothing concealed within it. The ground cut away must never be more than the ground interrogated with the prod.



Deminers must remember that the length prodded is NOT the distance ahead of the excavation face that can be safely removed with a trowel. The picture above shows a prodder inserted 8 cms into the ground. Because of the angle of the prodder, the prodder has only reached 7 cms into the unknown ground. In this example, if a deminer were to cut 8cm of soil away with the trowel he/she would press on the extreme edge of a concealed mine as he/she did so.

For safety and to ensure an overlap, the deminer must never cut more away than 75% of the soil that has been prodded. If the prod goes 8 cms into the ground, he/she should only cut away 6cm of soil with the trowel.

After prodding (bottom upwards) the face of the signal-investigation, the deminer should insert the prod a final time and grip the blade to record the depth before withdrawing it. He/she should then estimate three-quarters of the length and mark the ground ahead of the hole lightly with the prodder tip. The ground up to that mark can then be removed with the trowel safely.

Light tapping an obstruction with the prodder can sometimes provide tactile and audio feedback to confirm that the object is a mine. The deminer must expose any obstruction with extreme caution, regardless of the “feedback” from the prodder.

7) If no obstruction is found at the signal-marker, the deminer should check the position of the indication with the metal-detector. When the metal-detector continues to signal over the area, it may be appropriate to dig more deeply. The Supervisor should decide this based on the Task assessment and any pattern of anticipated devices that may be known. Generally, when a mine is missing from an anticipated pattern, a depth of at least 30 cm should be achieved before presuming that the signal is from a benign source.



When searching more deeply, the deminer should start again, further away from the indication and extending the slope of the hole so that any concealed device will still be approached from the side.

8) When a mine/device has been exposed, the deminer should inform a Supervisor and the mine/device should be dealt with in accordance with the approved SOPs.

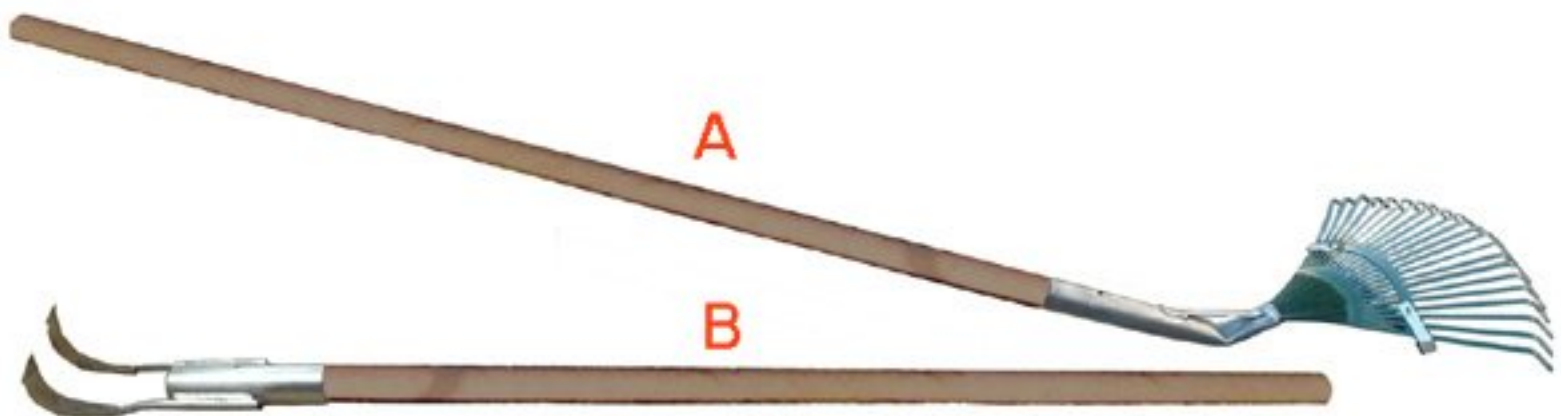
#### 4.4 Combined detector/rake excavation procedure

This is a combination of the use of a metal-detector and the use of rakes to investigate the reading. The procedure can only be used after the Brush rake has been tested. Testing the Brush-rake involves using the rake to expose a test-mine in the ground conditions pertaining at the Task. The test-mine must be an example of the most sensitive anticipated explosive hazard in the Task area. The test-mine is concealed and a deminer wearing visor and frontal protection must attempt to expose the mine with the Brush-rake. If the Brush rake initiates the mechanism in the test-mine, the Brush-rake cannot be used to expose those threats.

##### 4.4.1 Tools used in the combined detector/rake investigation procedure

The combined detector/rake procedure can be very fast when mines are relatively close to the surface (down to 6 cms to the top) or when the source of a detector reading was a ferrous fragment close to the surface. In soft ground, the time saving over a hand-tool investigation can be significant.

The following rakes be used during the combined detector/rake investigation procedure.



**A:** The Brush-rake (with or without a magnetic strip)

**B:** The Harrow rake.

The Harrow-rake head must be made using ductile material that has been welded together firmly and is rigidly attached to its handle. Both rakes must have handles at least 1.6 metres long (longer when average deminer height approaches 2 metres).

The tools used in the Hand-tool investigation drill should also be available.

Before starting the combined detector/rake investigation procedure, an area behind the deminer should be prepared to place the rakes and the metal-detector so that the deminer can change tool rapidly. A small wooden frame may be used to lean the tools against.

#### **4.4.2 Metal-detector/rake investigation procedure**

When a detector signal has been pinpointed, the deminer can begin a signal-investigation procedure with rakes. If at any point during the procedure the source of the metal-detector indication is located/removed and if it was not a mine/device, the deminer should stop the investigation and return to the metal-detector search procedure.

**1)** When the closest metal-detector signal is pinpointed, the signal-marker should be removed and the Brush rake or Magnetic Brush-rake used over the area. The Brush-rake head should be placed beyond the place where the detector signaled and drawn towards the deminer several times. The deminer must hold the handle at least one metre from the rake head and work in a standing position. Leaf-litter, cuttings and spoil collected by the brushing of the rake should be moved back to (or over) the Base-stick.

The area raked will usually extend from 20 cms beyond the metal-detector reading to the Base-stick and be the width of the Brush-rake head. When there are no other metal-detector indications in the area, it may be wider.

**2)** The deminer should look closely for exposed metal. When the Magnetic Brush-rake is used, the magnet may pick up the metal. Exposed metal should be placed in the plastic bucket. If metal is located, the deminer should use the metal-detector to check the position of the indication before using the Brush-rake again. If the indication has gone, the investigation has been completed and the deminer should return to the metal-detector search procedure.

When a mine/device is close to the surface or in loose soil, the Brush-rake will expose the top of the mine/device. When this occurs, the movement of the rake tines over the mine/device makes a noise that can be very different from its movement over soil. When a mine/device is exposed, the deminer should put the rake aside and kneel or squat to use prodder and trowel to expose the device for removal/destruction.



The picture shows an AP blast mine exposed with the Brush-rake.

**3)** When no signal-source is found, the deminer should continue to brush the area with the Brush-rake increasing the depth of the hole. When roots are uncovered, they should be cut with secateurs or saw, as appropriate.

Depending on the ground condition the Brush-rake will eventually become ineffective at removing compacted soil.

**4)** After each use of the Brush-rake, the metal-detector should be used to check the position of the metal-detector indication. If the signal has moved and is now among the spoil that has been drawn back to the Base-stick, the deminer should locate and remove the source. If the source cannot be readily located, the spoil should be trowelled into the bucket until the detector no longer signals the presence of metal. When the indication has gone, the investigation has been completed and the deminer should return to the metal-detector search procedure. The contaminated spoil should be put in the metal-collection pit or a dedicated spoil heap. When the plastic bucket is large, several investigations may be made before the container is emptied.

**5)** When the Brush-rake is ineffective at removing soil, the deminer should use the Harrow-rake. The deminer will have swept the entire area with the metal-detector before starting the investigation so will know approximately where the detector signalled. The tines of the Harrow-rake must always be placed on the ground about 20 cms beyond the signal under investigation and free from other metal signals. The rake head is then drawn towards the deminer without downward pressure. The shape of the tines should make them dig in and break the ground surface. The deminer must hold the handle at least one metre from the rake head and work in a standing position.

**NOTE:** The metal-detector search procedure usually means that an area beyond a signal position has been scanned with the detector. When it has not, the deminer should ensure that the area closest to him is clear, then advance the Base-stick so that he/she can safely sweep the metal-detector beyond the area under investigation before deploying the Harrow-rake. The Harrow-rake tines must not be



placed on the ground directly over a metal-detector indication.

The Harrow-rake should be used to scratch or plough the ground surface (depending on ground hardness) across the width of the signal investigation area. When stones are encountered, the rake tines can be used to flip the stones back towards the deminer's feet. When roots are uncovered, the deminer should cut them with secateurs or saw as appropriate.

In some cases the Harrow-rake will expose or lift a mine/device to the surface. The deminer should then put the rake aside and kneel or squat to use prodder and trowel to fully expose the device for removal/destruction.



The picture shows a mine being lifted out of the ground by the Harrow-rake. When this occurs, the rake should be withdrawn by reversing it and then lifting it away.

**6)** After the Harrow-rake has broken the ground in the investigation area, the Brush-rake should be used to sweep the loosened spoil back towards the deminer's feet, deepening the signal investigation area. At all times the deminer must closely examine the investigation area to look for anything that may have made the metal-detector signal.

**7)** Steps 4-6 must be repeated until the search depth for the Task has been reached. When the metal-detector indication has not moved during the raking process, it may be appropriate to continue excavating to a greater depth. The Supervisor should decide this based on the Task assessment and any pattern of anticipated devices that may be known. Generally, when a mine is missing from an anticipated pattern, a depth of at least 30 cm should be achieved before presuming that the signal is from a benign source.

If the ground becomes very hard as the depth increases, the deminer should use the metal-detector to re-position the signal-marker and start a Hand-tool investigation procedure as described at 4.3.2 above.

Your comment would be appreciated. [email me](#).