Fugro has many years of specialist experience in ground investigation and unexploded ordnance (UXO) detection. Our global expertise and extensive range of probing and drilling rigs combine to offer a rapid solution for all your needs.

**UXO Desk Study**
An unexploded ordnance desk study reports on the bombing history and assesses risk.

**Surface Clearance**
If appropriate, a surface scan of the site is performed to detect any potential UXO targets. This produces an anomaly chart for further investigation. For marine sites a towed magnetometer array can be used.

**UXO Clearance Before Piling or Drilling**
To detect deep unexploded ordnance, we deploy 3D Magcones or 3D Magdrills, which are equipped with UXO magnetometers.

The Magcone penetrates the ground without predrilling and obtains geotechnical and magnetic field data simultaneously in one push.

**UXO Identification and Disposal**
We expose and identify the UXO and manage the disposal.

A WWII bomb explodes.

Damage to a piling rig caused by a WWII bomb.
3D MAGCONE PROBING SYSTEM

UXO Probing System
Fugro’s highly advanced magnetometer probing system can detect buried UXO from several metres away.

It is a very sensitive, accurate magnetometer pushed into the ground using any of our Cone Penetration Testing (CPT) rigs to clear the ground of the threat of UXO.

The probe is compact enough to allow deep penetration of most soil conditions down to 25 metres deep or greater.

The data logging system continuously collects and displays the data from the 3D Magcone in real time, enabling immediate decision making on the presence of UXO.

The primary purpose of the Magcone is to help ensure that there are no unexploded World War 2 air-dropped bombs prior to piling or drilling on construction sites in Europe.

It does this by measuring the strength of the earth’s magnetic field which is distorted if there are any ferrous objects present.

The radius of detection varies depending on the size of bomb, its orientation, its material and the material that it is buried in but a 1 m radius of detection is typical in natural ground for a 50 kg bomb. In order to provide a proposal we normally require a pile layout drawing, a ground investigation report and site plan.

The Magcone can be deployed in a number of formats:
- Standard geotechnical cone combined with magnetometer
- Piezocone combined with magnetometer
- Magnetometer only

This means that geotechnical data is obtainable simultaneously with the magnetometer data, providing valuable information for pile design and for verifying the maximum bomb penetration depth.
THREAT ASSESSMENT
Threat Assessment - Risk Assessment and Desk Study
The risk of UXO can be difficult to manage because of its high potential impact during groundworks. During World War II, many bombs were dropped on Britain. Those that remain unexploded and undiscovered can still represent a considerable risk. As a guideline the depth of risk is over 15 metres in soft sediments or 1-2 m below the interface between soft and competent rock. This is complicated by factors such as the type and size of bomb, geology, type of made ground, change in ground level, extent of cover by buildings and trajectory. German bombs weighing over 1,000 kg were often fitted with a ‘Kopfring’ to prevent them penetrating too far into the ground. In Britain, the most common unexploded bomb (UXB) is the 50 kg SC type.

SURFACE CLEARANCE OF UXO
Shallow Investigation - Appropriate Geophysical Techniques
Fugro has wide experience of all geophysical investigation methods. This means that we can deploy exactly the right method to investigate the threat of unexploded ordnance for any site. Large areas can be investigated rapidly with the latest equipment operated by experienced Fugro geophysicists. The surface geophysical survey produces immediate results in the form of target plots, which are the basis of any necessary explosive ordnance clearance (EOC). These techniques can be used on land, in shallow water and in deepwater environments.

3D MAGDRILL DRILLING SYSTEM
UXO Drilling System For Tough Ground Conditions
Based on the same technology used in the probing system the 3D Magdrill system can be used with any drilling rig. It is fast to use and with its large sphere of detection, it is a cost effective, in situ tool for UXO clearance. The 3D Magdrill system is lowered to the bottom of the drilled hole in stages and looks ahead to clear for the threat of UXO. The Magdrill is then quickly retrieved from the hole and drilling continues to the safe depth, at which point, the 3D Magdrill is lowered again. The system is used to penetrate tough soil conditions such as very dense gravels or made ground containing rubble.
OVER 15 YEARS OF MAGCONE SURVEYS

Examples (yellow dots on map)
2017  Wembley
2016  Nine Elms
2015  Tate Modern
2014  City Island
2013  Greenwich Peninsula
2012  Canning New Town Centre
2011  Olympic Park
2010  Grain LNG
2009  The Shard
2008  Caspian Wharf
2007  Salford Media City
2006  Excel Centre
2005  Wembley
2004  Beckton STW
2003  Royal Docks
2002  Galleons Wharf
2001  Woolwich Arsenal

OTHER SERVICES AVAILABLE

■ Marine UXO survey using magnetometers towed by Fugro vessels
■ Land & marine site investigation
■ Geo-environmental investigation
■ Geophysical investigation
■ Laboratory testing of soil and rock

WORLDWIDE SUPPORT

Wherever you are in the world Fugro is at hand to be your local specialist for geotechnical, survey and instrumentation services. We have the expertise and experience to fully understand the technical, logistical and commercial factors involved, and to offer advice and support as and when appropriate.

Our unrivalled geographical spread means that we can quickly mobilise the people and resources required to meet the specific requirements and challenges of your project.

Marine UXO survey using vessel.
UXO survey using CPT on jack-up barge.
UXO survey using drilling method on jack-up barge.

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