VOLUME 4 GEOTECHNICS AND DRAINAGE
SECTION 1 EARTHWORKS

PART 8

HA 120/08

GUIDANCE ON THE TRENCHLESS INSTALLATION OF SERVICES BENEATH MOTORWAYS AND TRUNK ROADS

SUMMARY

This Advice Note provides guidance on the use of trenchless installation techniques for small diameter service tunnels and ducts beneath motorways and trunk roads. It addresses the assessment, review and risk management of such installations.

INSTRUCTIONS FOR USE

1. This documents supersedes HA 120/07.
2. Remove Contents Pages for Volume 4.
3. Insert new Contents Pages for Volume 4 dated August 2008.
4. Remove HA 120/07 from Volume 4, Section 1, Part 8.
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DESIGN MANUAL FOR ROADS AND BRIDGES

HA 120/08
Volume 4, Section 1,
Part 8

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THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Guidance on the Trenchless Installation of Services Beneath Motorways and Trunk Roads

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Contents

1. INTRODUCTION

General

1.1 This Advice Note provides guidance on the assessment, review and risk management of the trenchless installation of small diameter service tunnels and ducts beneath motorways and trunk roads.

1.2 The use of trenchless technology is increasing due to improved techniques and the majority of utility companies now encourage the use of trenchless methods. Although historically only used for motorway crossings their use is currently becoming more common on other trunk road crossings.

1.3 Where an installation needs to cross the width of the carriageway, trenchless methods offer particular advantages over traditional techniques of open trench excavation. These include minimising disruption to the operation of the network and reduction of the requirement for traffic management.

1.4 This Advice Note is issued for the guidance of personnel responsible for the assessment and co-ordination of trenchless construction proposals. It looks at procedures to minimise geotechnical and operational risk to the network. Particular attention is given to the information to be provided by the Installer.

Scope

1.5 It principally covers projects procured by a Statutory Undertaker or other third party, although may also be applied where the Overseeing Organisation is procuring the project.

1.6 The use of trenchless technology is also covered in SD 14 (MCHW 5.8) but this only relates to schemes procured by the Overseeing Organisation.

1.7 This Advice Note covers the installation of new pipes with internal diameters up to and including 2,000 mm. Pipes and conduits in excess of 2,000 mm internal diameter require technical approval, the procedure for which is set out in BD 2/05 (DMRB 1.1).

1.8 The replacement of existing pipes is specifically omitted.

1.9 The guidance is applicable to all Trunk Roads and may also be considered good practice on other trenchless technology projects.

Definitions and Abbreviations

1.10 Definitions relating to this advice note are included in Appendix A.

2. TRENCHLESS TECHNOLOGY METHODS

General

2.1 Trenchless technology covers a range of techniques for constructing crossings beneath motorways and trunk roads without excavation of the carriageway. The methods used must be suitable for creating a stable bore of the required diameter inside which a utility service is placed.

2.2 This advice note aims to provide general guidance on the use and limitations of the various trenchless methods and systems. Since these are constantly improving and developing, it is recommended that reference be made to the United Kingdom Society for Trenchless Technology (UK STT) website **www.ukstt.org.uk** where further guidance and information is freely available.

Pipe Jacking and Microtunnelling

2.3 Pipe jacking is a method by which pipes or sleeves are installed by being pushed through the ground behind a small, steerable, remotely controlled, tunnel boring or ‘micro tunnel’ machine. This technique is called microtunnelling and pipes and sleeves can be installed to very strict tolerances in line and level. This makes them not just suitable for gravity mains, but also minimises any risk from lack of alignment control where close tolerances are needed and expected, such as under trunk roads and motorways.

2.4 Microtunnelling machines generally start in the UK at 600 mm internal diameter although smaller sizes down to 300 mm internal diameter can be obtained from overseas suppliers. The maximum size of what is generally regarded as a microtunnelling machine is approximately 1,500 mm internal diameter. Above this size, tunnelling machines are regarded as Tunnel Boring Machines (TBMs).

2.5 Concrete jacking pipes are supplied in sizes up to 2.55 m internal diameter. Whilst concrete jacking pipes can be supplied in smaller sizes, clay, steel and fibre-reinforced pipes are more often used in these applications. Polymer pipes are becoming increasingly popular for their strength and corrosion resistance properties.

2.6 Minimum diameters are also controlled by safety considerations. BS 6164 *‘Code of practice for safety in tunnelling in the construction industry’* section 7.14.1, states that for small tunnels, the internal size for man-entry should not be less than 1.2 m high by 0.9 m wide. This limits the size of circular man-entry tunnels to 1.2 m internal diameter. Whilst it is recognised that the excavating space at the front of the tunnel may be slightly larger than the internal diameter of the finished tunnel it is generally accepted that the minimum size refers to the whole tunnel consistent with access and egress in emergency situations.

2.7 The use of hand-excavation open pipe-jacking shields is now unacceptable as a trenchless crossing method. This has arisen since the introduction of the Control of Vibration at Work Regulations 2005 (CoVAWRs) which aims to manage the risk to operatives of hand-arm Vibration Syndrome (HAVS) or the more commonly known Vibration White Finger (VWF). In Northern Ireland refer to The Control of Vibration at Work Regulations (Northern Ireland) 2005.

2.8 Commonly used hand controlled equipment used in excavating tunnels have high vibration levels and can only be used for a matter of a few minutes before the operative reaches the maximum daily vibration level of exposure. Consequently, hand excavation using vibrating tools should be reduced and managed or preferably eliminated as a working practice.

2.9 Most micro-tunnels are straight but specialist surveying equipment and short length pipes can be provided to allow some curved tunnels to be excavated and lined.

2.10 There are two types of micro-tunnelling machine, the open-faced auger and the closed-face slurry machine. The open-faced or ‘Decon’ machine uses a front cutting disc, which is driven by a continuous flight auger string from the shaft bottom. As the cutting disc rotates, the cut material is removed along the tunnel by the auger to the shaft bottom for disposal. The ground conditions have to be such that the material can be transported effectively by the screw at a steady rate. Water logged ground unless pre-treated can inundate the face and flood the screw, with consequential ground loss causing major surface settlements. Due to the length of the driving auger the maximum length of this type of micro tunnel is about 100 m but can be much less in very stiff clay with cobbles where the torque on the auger can become excessive.

2.11 The closed-face slurry machine has a sealed bulkhead in the head of the machine through which slurry is pumped at sufficient pressure to stabilise any loose ground and to balance any water pressure. The cutter head is situated in front of the bulkhead and is driven by hydraulic motors in the head. As the ground is cut, the spoil mixes with the slurry and an extraction pump removes the spoil and slurry mixture from behind the bulkhead. It is then pumped down the tunnel to the shaft and then to the surface for separation. Once at the separation plant and separated the spoil can be disposed of to tip and the slurry is returned to the system for reuse. This slurry type system can be used to operate in most ground conditions even rock. The length of the tunnel drives for this type of system depends on ground conditions and the size of the tunnel.

2.12 Drive length is also dependent of the use of intermediate jacking stations. In small tunnels (<900 mm), where stations cannot typically be installed for logistical reasons, except very close to the head of the tunnel, drive lengths characteristically extend to over 120 m and possibly up to 150 m.

2.13 Larger slurry micro-tunnels up to 1,500 mm diameter can be equipped with intermediate jacking stations along the tunnel at regular intervals which can be used to extend the overall length to over 250 m. There is a limit to how many ‘interjacks’ can be used from a logical perspective and generally speaking three is normally accepted as the maximum number.

2.14 Face access is a further consideration in determining the overall possible drive length. Face access is feasible in micro-tunnels above 1,500 mm diameter to facilitate maintenance when back-loading cutters may be changed. On smaller micro-tunnels, worn teeth on the cutter heads cannot be replaced during production and therefore need to be durable enough for the full length of the drive. If ground conditions are particularly bad, access to the face may be assisted by use of compressed air in the tunnel to reduce water flows in the face once the bulkhead is opened.

2.15 Access shaft diameters depend upon the diameter of the tunnel to be driven, the length of the pipes to be used and the ground conditions.

2.16 Shafts can be as small as 2.5 m diameter when using a small diameter micro-tunnelling machine, half-length pipes and where ground conditions are good. Forward headings in front of the machine can be excavated to allow for more space for both machine, pipes and jacking wall construction.

2.17 In poor ground, shafts may need to be larger and 5 m diameter shafts are not uncommon. This size allows for a stronger thicker jacking wall and a sealing bulkhead at the face of the tunnelling machine to prevent loss of ground when the micro-tunnel leaves the shaft. Ground loss may be prevented using ground treatment at the back of the shaft to help resist the jacking loads and also at the exit point of the shield from the shaft.

2.18 Excavation methods for shafts also require pre-planning, particularly in respect of the requirements of CoVAWRs. In small diameter shafts the use of a grab from ground level to excavate the ground will be required in order to minimise the need for hand excavation. Larger diameter shafts, in excess of 4.5 m, may be excavated by grab or be large enough to accommodate a mini-digger, skips and operatives.

Guided Drilling and Directional Drilling

2.19 Guided drilling and directional drilling are techniques in which a steerable boring head is pushed through the ground while being rotated. When the pilot bore is completed it is enlarged to the required diameter by pulling a reamer back towards the drilling machine. When the hole has been opened to the required size the product pipe, duct or cable is pulled into place. Normal practice is for the bore to be supported by a drilling fluid during the works. The fluid also assists in cutting the soil and in removing cuttings from the bore.

2.20 The product pipe or duct pulled into place is normally plastic. Polyethylene (PE) is the most widely used pipe material with either PE or polyvinyl chloride (PVC) being used for ducts. There are several different types and pressure ratings of each material available; selection depends on location and use of the finished pipeline. Any joints in the pipes must be capable of resisting the tension placed on them during installation. This is why automatic butt fusion welded PE is preferred by many Horiztonal Directional Drilling (HDD) installers.

2.21 Guided drilling can be used for crossings with diameters up to 600 mm and lengths up to 200 m.

2.22 Horizontal directional drilling can be used for crossings up to 1,200 mm in diameter and up to 1,800 m long, given good ground conditions.

2.23 Both methods are ideal for pressure pipe or cable installation where a reasonable degree of accuracy is required. Both methods can be used to install pipes and cables on a curved path. Guided drilling can be used where an irregular installation path is required.

2.24 Both methods can be used successfully in a wide range of soils including clays, silts, sands, mudstones and soft rocks. Difficulties may be encountered in loose gravel and cobbles, where creating a stable bore may not be possible. In glacial till, where boulders may cause the drill to deviate, maintaining the alignment can be difficult.

Auger Boring

2.25 Auger boring is a horizontal rotary earth boring process in which a cutter head connected to continuous flight augers is jacked through the ground, usually inside a steel casing. Although it is possible to auger without a casing for small diameters or short bores in cohesive materials this would not be recommended under a road. In suitable ground conditions and properly executed auger boring can be a quick and economic technique.

2.26 The most common application for auger boring is for pressure pipelines that are placed inside the casing. The linings can be metallic, PE or PVC. The advancement of these systems has resulted in guided auger boring. This allows pipes to be installed accurately to line and level and is widely used for installation of gravity sewers where a clay product pipe can be directly installed.

2.27 Crossings up to 80 m in length and diameters up to 1,200 mm can be executed using auger boring.

2.28 Entry and exit pits are required. The entry (working) pit may be very long, as it needs to accommodate the auger sections and casing as well as the drive unit. Newer systems designed for accuracy, now utilise small pits where diameters of 2 m are common. This allows the operation to be undertaken in restricted working areas.

2.29 The technique can be split into two types of system. One system that is essentially unsteered so only a straight drive can be undertaken. The capability to correct deviations is limited and the accuracy is dependent on accurate alignment of the machine prior to starting to bore. Typical alignment accuracy is 1% of the driven length. The other type is the guided system, which is accurately steered through the ground on a straight drive.

2.30 Auger boring may be used in a wide range of soils. Even water bearing ground can now be drilled by the use of systems such as water augers that restrict the ingress of materials.

2.31 However non-cohesive soils can still be problematic as excess material can be pulled into the bore causing surface settlement. Difficulties may also be encountered in glacial tills where boulders may cause the drill path to deviate in an uncontrolled manner. Soft or hard strata that intersect the alignment at shallow angles can also cause the auger to deviate off-line.

Impact Moling and Rod Pushing

2.32 Impact moling is a technique in which a percussive tool, usually driven by compressed air, is driven through the soil, advancing with a hammer action. The soil in front of the mole is displaced. The mole is connected to the launch pit by a pneumatic hose. Moles may be fitted with radio sondes so their position can be tracked from the surface.

2.33 Rod pushing is a similar technique but advancement is by pushing a head on rigid rods from the launch pit with soil being displaced by the driving head.

2.34 The power of the impact moling unit may be used to pull the product pipe, cable or duct into place at the same time as the impact mole advances. With the rod pusher the product pipe, cable or duct is installed by pullback from the target pit.

2.35 Impact moling is generally used for straight crossings although steerable equipment is available. Rod pushing has a limited steering capability but is most often used for straight drives. Both methods require launch and target pits.

2.36 Crossings up to 25 m can be executed with these methods, possibly a little longer with rod pushing in good soil conditions. Diameters range from 45 mm to 200 mm. Because of soil compaction and risk of surface movement (heave) typical minimum cover requirements are 1 metre for every 100 mm of mole diameter.

2.37 Within their limitations, these methods can be quick and cost-effective for short crossings to install small pipes, cables and ducts. Both methods can be used in soils that can be compressed or displaced. Obstacles such as boulders and cobbles can cause deviation of the bore that cannot be corrected.

Pipe Ramming

2.38 Pipe ramming is a technique in which a steel casing, usually open-ended, with a cutter end is driven through the soil by a hammer located in the launch pit. The casing may be in a single section or welded from shorter sections during installation. Soil is removed from inside the casing after driving. The installed casing may itself become part of a product pipe or, more commonly, a product pipe, cable or duct is installed inside it.

2.39 Crossings up to 70 m can be achieved and pipes with diameters up to 2,000 mm have been installed in suitable ground conditions.

2.40 Pipe ramming is unsteerable, so the method is used for straight crossings only; launch and reception pits are required. Directional accuracy is dependent on the accurate alignment of the guide rails on which the casing and hammer are positioned in the launch pit.

2.41 The technique may be used in a wide range of soils above or below the ground water table. The rammed casing is stiff and not easily deviated by cobbles or boulders. However, massive obstructions cannot be penetrated. In very soft soils pipe ramming is less susceptible to deviation than impact moling.

3. MANAGING THE RISKS ASSOCIATED WITH TRENCHLESS METHODS

General

3.1 No project is free of risk, and those employing trenchless methods are no exception. The Overseeing Organisation, who is the risk owner, has a responsibility to develop systems to manage this risk for the following reasons:

- enable delivery of business objectives;
- enable control and stewardship of public assets;
- maintain optimum operation of the road network;
- the need to comply with legal and regulatory requirements.

3.2 To be effective, the risk management should be integrated into the business processes of the Overseeing Organisation. A simple approach to risk management involves three main stages:

a) **risk recognition and identification** – determine what could go wrong;

b) **risk analysis and evaluation** – understand how the risks occur and quantify their possible effects; and

c) **response to risk** – determining resources, prioritising, allocating ownership and responsibility.

Risk Recognition and Identification

Risk of Heave or Settlement

3.3 The principle risk to the highway when a service is installed beneath it using trenchless methods is of either settlement or heave. These ground movements can be avoided by using the most appropriate trenchless installation method, good quality equipment and experienced personnel.

3.4 A good knowledge of the soils to be encountered and appropriate engineering interpretation will further reduce the risks of ground movement. Each of the trenchless techniques applicable to service installation has risks associated with the work.

3.5 The risk and amount of settlement or heave depends upon the depth at which the crossing is made and also the size of the tunnel or sleeve to be provided. Settlement calculations (O'Reilly and New, 1991) should be made taking in to account ground conditions, depth to axis of the sleeve or tunnel from the road surface and the size of the sleeve or tunnel.

3.6 Calculations for heave can be made in a similar manner but heave is generally only temporary and is usually the result of excessive face pressure caused by high jacking forces. Operators should be fully experienced and competent in the use of their equipment and should be aware of the ground conditions along the route.

Method Specific Risks

3.7 Each trenchless technique presents its own particular suite of risks and these are detailed against each method. A summary table showing the level of risk associated with each method is given in Table 3.1.

Microtunnelling

3.8 The principal risks associated with microtunnelling are:

- soil movement – settlement and, to a lesser extent, heave;
- incorrect system operation during installation. This may cause direct damage to the road pavement and affects its traffic-carrying capacity; this can be a short or long-term risk;
- soil settlement or collapse resulting in a depression in the pavement and safety concerns for road-users.

3.9 The British Tunnelling Society and the Association of British Insurers have published *'The Joint Code of Practice for Risk Management of Tunnel Works in the UK'* which is intended as a guide to reducing risk in tunnelling. Whilst aimed at larger tunnels many of the principles advocated in this document are applicable to microtunnelling works.

Directional Drilling

3.10 The principal risks associated with directional drilling are:

- settlement or heave. The risk increases with larger diameters (>300 mm) and is low for small diameter bores;
- soil movements resulting from installation problems;
- 'frac-outs' (blow outs of drilling mud) resulting in drilling mud disrupting the pavement and being a safety issue for road-users.

Auger Boring

3.11 The principal risks associated with auger boring are:

- inappropriate use in poorly graded granular soils or unstable ground conditions. This leads to the creation of voids or direct settlement;
- allowing the auger to rotate/remove soil with no forward movement. This will draw soil into the auger and cause voids/settlement above the bore;
- short-term and long-term settlement;
- damaging existing utilities;
- the unexpected exit from the ground at the road surface is possible. This is due to the fact that auger boring is unsteered but this is a low risk. This can be negated using guided auger boring.

Impact Moling

3.12 The principal risks associated with impact moling are:

- surface heave due to soil displacement or insufficient cover;
- unexpected exit from the ground at the road surface due to the mole being unsteered.

Particular Factors Bringing an Increased Level of Risk

3.13 The following factors have been identified as bringing an increased level of risk to projects where trenchless techniques are being used. These factors are listed in decreasing level of risk:

1. incorrect choice of technique;
2. inadequate site investigation;
3. inadequate skill of the operatives;
4. unforeseen ground conditions (often associated with item 2 above);
5. damage to existing utilities (often associated with items 2 and 3 above);
6. equipment breakdown;
7. inadequate temporary works.

Risk Analysis and Evaluation

3.14 In the previous stage, the typical risks associated with trenchless crossings were identified together with the factors likely to bring these risks about. The subsequent stage of 'risk analysis' looks at the likelihood of these risks occurring along with consequences should these risks be realised.

3.15 The consequences of not adequately managing these risks, in terms of operation of the road network, may include:

- closure of the road network;
- need to implement traffic management;
- damage to highway assets, such as communications cabling, pavement or structures;
- damage to third party assets, for example those owned by utility operators;
- compromise of safety of road users.

3.16 Similarly, the consequences of poor risk management for the geotechnical asset include:

- short-term heave or settlement beneath the pavement;
- long-term settlement beneath the pavement bringing an uneven running surface;
- settlement or slope failure of the highway embankment.

3.17 Table 3.1 assesses each of the trenchless techniques previously discussed and rates the level of risk to the network against what are considered to be the four principal risks.

Risk Response

3.18 Finally, in providing a risk response, it is necessary to allocate ownership of the risk and look at using risk mitigation measures to minimise the consequences and likelihood of the risk.

3.19 Ultimately the owner of all risks is the Overseeing Organisation. However, a risk owner may transfer the management of the risk to another party (with mutual agreement) to be responsible for performing or managing the actions that reduces the impact or likelihood of the risk. It is recommended that the Managing Agent (MA) or equivalent Service Provider appoint a co-ordinator to manage the risks associated with trenchless crossings conducted by a third party (the Installer).

3.20 The Overseeing Organisation needs to maintain a capacity to both manage and monitor the performance of the MA's designated co-ordinator.

3.21 Whilst the MA is accountable for managing the risk, it will be the Installer who has the day to day responsibility for ensuring that decisions are made, procedures upheld and actions are taken to mitigate against creating any unnecessary risk to the Overseeing Organisation.

3.22 In this Advice Note the onus is placed upon the Installer to produce documentary evidence to demonstrate that they are taking all practicable measures to ensure that the risk to the Overseeing Organisation is minimised. It is recommended that the Installer provide the following documentation for submission to the Managing Agent's co-ordinator for approval:

- proposals for demonstrating the effective identification and location of existing utilities;
- method statements demonstrating effective choice of methods, personnel and supervision;
- a risk register to summarise key risks and the methods used in their mitigation;
- emergency procedures for dealing with situations which would require traffic management or compromise the safety of road users;
- a geotechnical report to demonstrate management of geotechnical risk and to support the choice of trenchless technique;
- scope of records to be kept during construction.

3.23 Full details of the documentary requirements are given in subsequent sections of this advice note.

Table 3.1 Risk Summary for Trenchless Installations Below Highways

Technique	Principle Risk			
	Soil Movement Settlement	Soil Movement Heave	Road User Safety	Damage to Existing Utilities
Microtunnelling	Minor	Minor	Negligible	Negligible
Pipe-Jacking	Minor	Minor	Negligible	Negligible
Guided Drilling	Negligible	Negligible	Negligible	Minor
Horizontal Directional Drilling	Minor	Moderate	Negligible	Minor
Auger boring	Moderate	Negligible	Minor	Moderate
Pipe Ramming	Negligible	Moderate	Minor	Moderate
Impact Moling/ Rod Pushing	Negligible	High	Moderate	Moderate
Working Shafts	Minor	N/A	Moderate	Moderate

4. RESPONSIBILITIES UNDER THE NEW ROADS AND STREETWORKS ACT AND TRAFFIC MANAGEMENT ACT

General

4.1 The New Roads and Streetworks Act 1991 (NRSWA) replaced the Public Utilities Streetworks Act 1950 (PUSWA) and came into power in 1993. Part III of the NRSWA repealed and amended parts of the Highways Act 1980 (England and Wales). In addition Part IV of the NRSWA repeals parts of the Roads (Scotland) Act 1984. Various sections of NRSWA were amended by the Traffic Management Act (TMA) 2004. The TMA 2004 does not apply in Scotland.

4.2 In Scotland, where a reference to the NRSWA refers to a non-Scottish section, e.g. Section 59, refer to the Scottish equivalent within NRSWA as amended by Transport (Scotland) Act 2005.

4.3 There are two sections of NRSWA that do contain specific provisions for Highway Works (Works for Road Purposes). These are Section 53, requiring highway authorities (HAs) to register all works and Section 59, requiring highway authorities to co-ordinate works, and protect the structure of the street and the integrity of any apparatus in it.

4.4 The NRSWA Act primarily applies to utility works whether they are carried out in pursuance of a statutory right or of a Section 50 streetworks license.

4.5 The term ‘street’, as defined in NRSWA Section 48, means the whole or part of any highway, road, lane, footway, alley or passage. It, therefore, includes adjacent footways and cycle tracks.

Notification

4.6 Under NRSWA Section 54, undertakers must notify the highway authority in advance before carrying out new/replacement or maintenance works, under the terms of NRSWA (Code of Practice for the Co-ordination of Streetworks and Works for Road Purposes and Related Matters). The exception is urgent repair works and emergencies that may be notified after work has started.

4.7 Notices by undertakers are sent via an electronic process known as Electronic Transfer of Notices (EToN). This searches information on all streets in England (held in the National Street Gazetteer (NSG)) to establish the correct street authority and any restrictions placed on the street.

4.8 Under their statutory powers granted by Acts of Parliament undertakers can install and maintain their apparatus in or under a publicly maintainable highway. An NRSWA Section 50 license gives a non-statutory undertaker similar rights to place and maintain apparatus in the street. In both cases NRSWA controls how those powers may be used.

4.9 Under NRSWA Section 61, any highway or proposed highway that is a ‘special road’, in accordance with Section 16 of the Highways Act, is designated as a ‘protected street’. Motorways have ‘protected street’ designation. Other streets or parts of streets that serve a specific strategic traffic need may also be designated as a ‘protected street’.

4.10 Undertakers need to obtain the written consent from the HA to place or maintain apparatus in protected streets. Currently undesignated trunk roads have no exemption from utilities statutory powers to install apparatus, but can be protected from utility works following new resurfacing/reconstruction, with an NRSWA Section 58 notice served by the Street Authority (Restrictions Following Substantial Road works). Currently this applies only to planned utility works for a period of 12 months but is likely to be considerably extended under the new TMA.

4.11 In addition there are advance NRSWA noticing requirements. Under NRSWA Sections 63 and 64, undertakers are also required to give longer periods of notice and obtain agreement of construction plans when the street has been designated as either a ‘street with special engineering difficulty’ or as ‘traffic sensitive’.

4.12 For example, some bridges, shallow culverts/tunnels, retaining walls and embankments, have this designation. However, unless these designations are entered onto the NSG, they are not considered valid and undertakers will consequently be unaware of them.

4.13 The utility company must notify the Overseeing Organisation (in accordance with the NRSWA Codes of Practice, new TMA or Highways Agency’s road space booking systems where works will involve excavation or affect the flow of traffic. All contact is directed to the Managing Agent (MA).

4.14 Although consents on Motorways and Trunk Roads designated as Protected Streets concentrate on legalities of liability, insurance, road use and general public safety, technical details should be requested in order to review the engineering content.

4.15 The utility company must allow enough time to satisfy any concerns from the Overseeing Organisation and provide details of the proposed trenchless technique in accordance with this advice note, with any additional details that may be requested

4.16 Where Utilities cannot be persuaded to undertake trenchless methods the Agency can (a) give formal directions as to the time and day(s) on which the works must be executed (Section 56) (b) As Traffic authority direct that traffic control in excess of or different to the standards in the NRSWA Code of Practice is required (c) ensure that the requirements in the Reinstatement Code of Practice are strictly adhered to with regards to the new surface which may in some instances negate the use of hand laid materials.

4.17 If utility work is at a junction that spans both trunk road and local authority road then the utility must notify both authorities, with accurate times and measurements appropriate for each individual section.

4.18 The notification period for commencing works may range from one day to one calendar month depending on the category of the works and the traffic sensitive situation. Notification time is likely to be increased under the TMA.

4.19 It is the Utility companies' and their appointed contractors' responsibility to satisfy NRSWA and other legislation to provide a safe design and a properly controlled and executed site operation.

4.20 The MA should inform the Overseeing Organisation of any notification received for works to be carried out on trunk road crossings.

Future Developments in Streetworks

4.21 At the time of production of this Advice Note, the current legislation is going through a period of major change and most of the secondary legislation has yet to be published.

4.22 The TMA 2004 has amended both parts of NRSWA 1991 and the Highways Act. All relevant Acts and associated regulations and codes must be complied with when undertaking any works in or under the highway.

4.23 The TMA has introduced the provision of new powers to HAs for regulating works in the highway. It applies equally to both HA and Utility works.

4.24 The TMA has introduced a permit scheme for all strategic and major roads. All third party works will require permission from the Highway or Bridge Authority before commencing work and fixed penalty fines will be applied for non-compliance.

4.25 HA's own works on strategic/main routes will also require permits, and they will be monitored on their performance. KPI's will be developed to ensure a 'level playing field'.

5. IDENTIFICATION AND LOCATION OF EXISTING UNDERGROUND PLANT AND FACILITIES

General

5.1 Site specific proposals for undertaking the works safely and without damaging any existing underground plant and facilities should be submitted to the Managing Agent's (MA's) co-ordinator for approval. Timescales should be agreed with the MA; notice periods should also comply with the relevant legislation. It is important that the Installer allows sufficient time within the construction programme for this to take place.

5.2 No documentation relating to any working practice or procedure contained within it shall be amended without first seeking approval from the MA in writing.

Types of Utility

5.3 In locations where crossings may be required beneath motorways and trunk roads the following services and facilities may be found:

- foul sewers;
- surface water/storm drains;
- combined sewers;
- water mains;
- gas mains;
- irrigation pipes;
- district heating pipes;
- industrial pipelines;
- oil transmission pipelines;
- electricity cables;
- telephone cables;
- cable TV cables;
- street lighting cables;
- traffic light cables;
- highway information cables;
- wildlife tunnels;
- service tunnels.

5.4 Identification and location of all existing underground infrastructure is necessary prior to commencing any excavation or drilling activity. It should include abandoned and disused services as well as those that are active.

5.5 In all cases the Installer should identify the owners of underground infrastructure likely to be affected by the proposed crossing. All applicable records should be collected and reviewed in detail; drawings developed showing their location and proposals submitted for avoiding damage.

5.6 The level of appropriate investigation for each site should be agreed with the MA and the Installer based on the perceived risk.

5.7 The relevant utility company or owner should be notified before excavating trial holes in order to verify the position of selected services.

6. METHOD STATEMENT AND EMERGENCY PROCEDURES

General

6.1 A site specific Method Statement and Emergency Procedures should be submitted to the Managing Agent's (MA's) co-ordinator for approval. Timescales should be agreed with the MA; notice periods should also comply with the relevant legislation. It is important that the Installer allows sufficient time within the construction programme for this to take place.

6.2 No documentation relating to any working practice or procedure contained within it should be amended without first seeking approval from the MA in writing.

Method Statement

6.3 The Method Statement should outline the procedures involved in the trenchless technology technique and methods of minimising risk. Reference should be made to SD 14 Clause NG 8004 (MCHW 5.8).

6.4 Where the contract requires work on contaminated land, the Installer should contact the relevant authorities before submitting the Method Statement and agree working practices and procedures.

6.5 Personnel should be Confined Space Trained where appropriate. A number of the techniques involve the creation of confined spaces, which include shafts, where gases can collect and pose a hazard to safety unless managed correctly.

6.6 Tunnels of 900 mm diameter and below are accepted as non-man entry and, therefore, deemed to be 'restricted areas'. Emergency repairs may have to be effected in these small tunnels but strict entry procedures must be in place to manage this special situation.

Emergency Procedures

6.7 Emergency procedures should be outlined including the procedures involved in ensuring that the site representatives are sufficiently experienced with the construction design requirements to enable solutions to unexpected or emergency situations to be agreed without delay.

6.8 If excessive heave or settlement occurs emergency situations may arise which could potentially cause an obstruction to the highway or make the road unsafe to the road user. The method statement should outline emergency procedures that are to be taken with details of key members of staff to be contacted.

7. MANAGING GEOTECHNICAL RISK

Managing Geotechnical Risk

7.1 The requirements for Managing Geotechnical Risk are set out in HD 22 (DMRB 4.1.2). The Standard was introduced to ensure that geotechnical risk was properly managed by providing a consistent approach for geotechnical design. Ground conditions are always uncertain and a risk to any project and the risks from these factors should be managed in a positive manner.

7.2 The focal point for the management of geotechnical risk is the Geotechnical Advisor of the Overseeing Organisation. The responsibility for managing the geotechnical risk associated with a trenchless crossing may be delegated to the Managing Agent's Geotechnical Liaison Engineer (MAGLE). This should take place with the prior approval of the Overseeing Organisation and the agreement of the MA. In turn the MAGLE will need to liaise with the streetworks co-ordinator to ensure that proposals submitted by the Installer are appropriate and can subsequently be given approval via Geotechnical Certification.

7.3 It is recommended that the Installer appoints a Geotechnical Specialist as a focal point for all geotechnical aspects of the project. Further information is given in Site Investigation in Construction Series Documents (1993).

7.4 Managing geotechnical risk is also covered by *'The Joint Code of Practice for Risk Management of Tunnel Works in the UK'* published by The British Tunnelling Society and the Association of British Insurers.

Geotechnical Report

7.5 In compiling the Ground Investigation Report, the Installer's Geotechnical Specialist will need to consult sources of existing information, such as geological maps, memoirs and previously completed ground investigations relevant to the site. During this time, temporary 'view-only' access to the Highways Agency Geotechnical Data Management System (HA GMDS) will be granted. The Reports Database of this system contains an inventory and downloadable copies of ground investigation reports previously undertaken on behalf of the Highways Agency.

7.6 The Geotechnical Design Report should be submitted by the Installer to the MAGLE for approval. Timescales for submission should be agreed with the MA; notice periods should also comply with the relevant legislation. It is important that the Installer allows sufficient time within the construction programme for this to take place.

7.7 The general format for the Geotechnical Design Report is given in Appendix E of HD 22. It need only consist of sections that are relevant to the project. Since the specified Geotechnical Design Criteria in the model format apply to highway construction, it is recommended that the following sections be substituted where applicable:

(i) **Open Excavations**

The Geotechnical Design Report should include a discussion of the following points where relevant:

- location and types of materials anticipated;
- any groundwater considerations;
- short-term and long-term stability of the open excavation and support methodology;
- spoil handling and disposal.

(ii) **Trenchless Methods**

The Geotechnical Design Report should include a discussion of the following points where relevant:

- the methodology proposed in relation to ground conditions;
- any restrictions on the proposed excavation method;
- spoil handling and disposal;
- ground water control (including pumping or well pointing) and ground stability issues;
- pipe loadings that have been considered.

(iii) **Instrumentation and Monitoring**

The Geotechnical Design Report should include a discussion of the following points where relevant:

- predicted and critical settlement or heave;
- full details and purpose of all monitoring equipment, installation requirements, restrictions and frequency of reading;
- clearance assumptions to third party property (i.e. existing underground services) and carriageways.

7.8 Simple methods to predict ground displacements caused by trenchless pipelaying operations can be found in Rogers and Chapman (1998) and Chapman (1999).

Approval of the Geotechnical Design Report

7.9 It is recommended that review of the Report should be undertaken by the MAGLE. The Geotechnical Certificate and accompanying Geotechnical Design Report should be sent to the Overseeing Organisation's Geotechnical Advisor for formal approval.

8. MONITORING AND RECORDS TO BE KEPT DURING CONSTRUCTION

Records

8.1 Construction records should be kept to support the procedures outlined in Section 6.

8.2 The records, and their format, to be kept by the Installer and supplied to the Managing Agent's (MA's) co-ordinator should be established and agreed together with the timescale for submission prior to any construction works. The type of records will vary for each method and project (see also SD 14 (MCHW 5.8)), but the details listed in Table 8.1 for each installation method provide guidance on the information to be supplied.

Supervision by a Geotechnical Specialist

8.3 It is recommended that a Geotechnical Specialist inspect the excavations to ensure that the ground conditions reported in the Geotechnical Design Report are consistent with those encountered during site works. Boreholes and trial pits may not reveal the true extent of cobbles or boulders at depth. These may only be seen once the excavation of the shafts or pits has commenced. It should be possible at this stage to review the method and if necessary change it to a more appropriate technique.

Heave and Settlement

8.4 Prior to any trenchless technology works, the Installer may be required to make measurements of existing ground levels.

8.5 The Installer should monitor the levels during construction works and record the values as agreed. Any variation from predicted values should immediately be reported to the MA.

Monitoring Adjacent Structures and Services

8.6 Acceptable levels of damage (if any), movement and levels for noise and vibration at nearby structures should be agreed prior to any construction works.

8.7 All survey information, records, and assessments, should be included in the project Feedback Report.

Table 8.1 Records to be Kept (As indicated by an asterisk)

	Micro Tunnelling[1]	Pipe Jacking	Directional Drilling	Thrust Boring	Auger Boring	Pipe Ramming	Impact Moling
Contract	*	*	*	*	*	*	*
Reference of pipe run	*	*	*	*	*	*	*
Date of work	*	*	*	*	*	*	*
Start time	*	*	*	*	*	*	*
Finish time	*	*	*	*	*	*	*
Details of any stoppages	*	*	*	*	*	*	*
Diameter of bore	*	*	*	*	*	*	*
Pipe material	*	*	*	*	*	*	*
Pipe diameter	*	*	*	*	*	*	*
Joint packing	*	*	*		*		
Length installed	*	*	*	*	*	*	*
Main survey checks	*	*	*	*	*	*	*
Soil conditions	*	*			*		
Ground water level	*	*			*		
Line and level achieved	*	*	*	*	*	*	*
Lubrication	*	*	*				
Support Fluid			*				
Jacking and winch loads, w.r.t. progress	*	*	*	*			
Slurry pressures, viscosity, discharge, flow rate	*	*	*				
Shield role, pitching, steering adjustment	*	*	*				
Thrust rate, cutting torque, soil discharge	*	*	*				

Note: [1] All microtunnelling machines must be equipped with an electronic 'Data-Logger', which should record fully every function of the machine and the back-up equipment, such as the jacking rams and any interjack station installed. These must be available at all times.

9. POST CONSTRUCTION RECORDS

General

9.1 A Feedback Report should be prepared by the Installer and submitted to the Managing Agent's (MA's) co-ordinator within one month of completion of the works. A copy should be supplied to the Overseeing Organisation and will form part of the asset inventory and Health and Safety File.

Feedback Report

9.2 The contents of the Feedback Report should include the following items:

- as-built drawings, including details of the installed conduit, temporary works, permanent structures and back filling;
- post construction structures and level survey;
- construction photographs;
- details of any problems encountered during the works and procedures used to overcome or correct the problems.

10. HEALTH AND SAFETY ASPECTS OF TRENCHLESS CROSSINGS

General

10.1 All trenchless crossings beneath highways should be undertaken with due regard for the health and safety of all site personnel, visitors and road users. Health and safety legislation must be observed, including those requirements concerned with the duties of employers towards both their employees and other persons, including members of the public whose safety may be affected by their works.

10.2 All work undertaken should comply with the Health and Safety at Work etc. Act 1974. Work should also comply with all other relevant regulations such as the Construction (Health, Safety and Welfare) Regulations and the Control of Substances Hazardous to Health Regulations (COSHH). In Northern Ireland refer to the Health and Safety at Work (Northern Ireland) Order 1978.

10.3 The Construction (Design and Management) Regulations 2007 place additional statutory duties upon clients, designers and contractors to ensure that health and safety are taken into account throughout all stages of a construction project. In Northern Ireland refer to The Construction (Design and Management) Regulations (Northern Ireland) 2007.

10.4 The use of hand excavation and vibrating tools is now covered by Control of Vibration at Work Regulations 2005 (CoVAWRs). Working procedures now need to be considered to minimise exposure of operatives to within acceptable vibration levels.

10.5 The British Tunnelling Society has produced *'Guidance for the Management of HAVS in Tunnelling Works'* which is available from their web site (**www.britishtunnelling.org**) which will be of help in managing the HAVS risk.

Risk Assessment

10.6 A Risk Assessment is an essential aspect of the management of health and safety. A suitable risk assessment to meet the requirements of health and safety legislation should be carried out for all relevant activities.

Health and Safety Procedures

10.7 Where specific procedures or recommendations exist concerning particular methods or operations, these procedures should be followed.

Disposal of Waste Materials

10.8 Several of the methods described in this Advice Note use drilling fluids in their operation. These materials, and all excavated materials, must be disposed of in accordance with all relevant legislation and local and national requirements for environmental protection.

11. REFERENCES

1. **Manual of Contract Documents for Highway Works (MCHW)**

SD 14 Implementation Standard for Trenchless Installation of Highway Drainage and Service Ducts

Specification (MCHW 5.8.2)
Notes for Guidance (MCHW 5.8.3)
Method of Measurement (MCHW 5.8.4)

2. **Design Manual for Roads and Bridges (DMRB)**

BD 2 Technical Approval of Highway Structures. (DMRB 1.1.1)

HD 22 Managing Geotechnical Risk. (DMRB 4.1.2)

3. Site Investigation Steering Group (1993) Site Investigation in Construction Series. Pub Thomas Telford.

4. Rogers and Chapman (1998), Analytical Modeling of Ground Movements Associated with Trenchless Pipe Laying Operations, Proceedings of Institute of Civil Engineers, Geotechnical Engineering, 131, pp210-222.

5. Chapman (1999), A Graphical Method for Predicting Ground Movement from Pipe Jacking, Proceedings of Institute of Civil Engineers, Geotechnical Engineering, 137, pp87-96.

6. International Society for Trenchless Technology (ISTT) (1999), Glossary of Terms.

7 O'Reilly and New, (1991) Tunnelling Induced Ground Movements: Predicting their Magnitude and Effects. 4th International Conference on Ground Movements and Structures, Cardiff, pp671-697.

8 'The Joint Code of Practice for Risk Management of Tunnel Works in the UK' – British Tunnelling Society/The Association of British Insurers, 2003.

9 BS 6164 'Code of Practice for Safety in Tunnelling in the Construction Industry' 2001.

10 'Guidance for the Management of Hand-arm Vibration Syndrome (HAVS) in Tunnelling Works' – British Tunnelling Society 2006.

Bibliography

1. NCHRP (1997) Trenchless Installation of Conduits Beneath Roadways' Systems of Highways Practice 242.

2. CIRIA (1998) Trenchless and Minimum Excavation Techniques: Planning and Selection SP147.

12. ENQUIRIES

All technical enquiries or comments on this Advice Note should be sent in writing as appropriate to:

Division Director of Network Services –
Technical Services Division
The Highways Agency
City Tower
Manchester
M1 4BE

D DRYSDALE
Division Director of Network Services –
Technical Services Division

Director, Major Transport Infrastructure Projects
Transport Scotland
8th Floor, Buchanan House
58 Port Dundas Road
Glasgow
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A C McLAUGHLIN
Director, Major Transport Infrastructure
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Chief Highway Engineer
Transport Wales

Director of Engineering
The Department for Regional Development
Roads Service
Clarence Court
10-18 Adelaide Street
Belfast
BT2 8GB

R J M CAIRNS
Director of Engineering

APPENDIX A DEFINITIONS

The trenchless technology terms have been reproduced with permission from the International Society for Trenchless Technology (1999).

Auger Boring: Method for forming a bore, usually from a drive pit, by means of a rotating cutting head. Spoil is removed back to the drive pit by helically wound auger flights rotating in a steel casing. The equipment may have limited steering capability. See also **Guided Auger Boring**.

Back Reamer: Cutting head attached to the leading end of a drill string to enlarge the pilot bore during a pull-back operation to enable the product pipe to be installed.

Bore: Void which is created to receive a pipe, conduit or cable.

Cased Bore: Bore in which a pipe, usually a steel sleeve, is inserted simultaneously with the boring operation. Usually associated with auger boring or pipe jacking.

Casing: Pipe to support a bore. Usually not a product pipe.

Cutting/Cutter Head: Tool or system of tools on a common support that excavates at the face of a bore. Usually applies to mechanical methods of excavation.

Directional Drilling: Steerable method for the installation of pipes, conduits and cables in a shallow arc using a surface launched drilling rig. In particular, the term applies to large scale crossings in which a fluid filled pilot bore is drilled without rotating the drill string, and this is then enlarged by a washover pipe and back reamer to the size required for the product pipe. The required deviation during pilot boring is provided by the positioning of a bent sub.

Drill Bit/Head: Tool which cuts the ground at the head of a drill string, usually by mechanical means.

Drilling Fluid/Mud: Mixture of water and usually bentonite or polymer continuously pumped to the cutting head or drill bit to facilitate the removal of cuttings, stabilise the bore, cool the head and lubricate the passage of the product pipe. In suitable ground conditions water alone may be used.

Drill String/Stem: The total length of drill rods/pipe, bit, swivel joint, etc. in a bore.

Drive/Entry Shaft/Pit: Excavation from which trenchless technology equipment is launched for the installation or renovation of a pipeline, conduit or cable. It may incorporate a thrust wall to spread reaction loads to the ground.

Earth Pressure Balance (EPB) Machine: Type of microtunnelling machine in which mechanical pressure is applied to the material at the face and controlled to provide the correct counter-balance to earth pressure in order to prevent heave or subsidence. The term is usually employed where the pressure originates from the main jacking station in the drive shaft or to systems in which the primary counter-balance to the earth pressures is supplied by pressurised drilling fluid or slurry.

Face Stability: Stability of the excavated face of a tunnel or pipe jack.

Grouting:	Method of filling voids, usually with cementitious grout.
Guided Auger Bore:	Method of auger boring in which the guidance mechanism actuator is sited in the drive shaft. The term may also be applied to those auger boring systems with rudimentary articulation of the casing near the cutting head activated by rods from the drive shaft.
Guided Boring:	See **Guided Drilling**.
Guided Drilling:	Method for the installation of pipes, conduits: and cables using a surface-launched drilling rig. A pilot bore is drilled using a rotating drill string and is then enlarged by a back reamer to the size required for the product pipe. The necessary deviation during the pilot boring is provided by a slanted face to the drill head, an asymmetric drill head, eccentric fluid jets or a combination of these, usually in conjunction with a locator.
Guide Rail:	Device used to support or guide, first the shield and then the pipe within the drive shaft during a pipe jacking operation.
Heaving:	Process in which the ground may be displaced causing a lifting of the ground surface.
Horizontal Directional Drilling (HDD):	See **Directional Drilling**.
Impact Moling:	Method of creating a bore using a pneumatic or hydraulic hammer within a casing, generally of torpedo shape. The term is usually associated with non-steered or limited steering devices without rigid attachment to the launch pit, relying upon the resistance of the ground for forward movement. During the operation the soil is displaced, not removed. An unsupported bore may be formed in suitable ground, or a pipe drawn in, or pushed in, behind the impact moling tool. Cables may also be drawn in.
Impact Ramming:	See **Pipe Ramming**.
Jacking Force:	Force applied to pipes in a pipe jacking operation.
Jacking Pipes:	Pipes designed for use in a pipe jacking operation.
Jacking Shield:	Fabricated steel cylinder from within which excavation is carried out, either manually or by mechanical means. Incorporated within the shield are facilities for controlling line and level.
Launch Pit:	As for drive pit but more usually associated with launching an impact moling or similar tool.
Locator:	An electronic instrument used to determine the position and strength of electro-magnetic signals emitted from a transmitter sonde in the pilot head of a boring system, in an impact moling tool or from existing underground services that have been energised. Sometimes referred to as a **Walkover System**.
Microtunnelling:	Method of steerable remote control pipe jacking to install pipes of internal diameter less than that permissible for man-entry. In North America the term is used to describe remote control continuous pipe jacking in all diameters.

Pilot Bore: First, usually steerable, pass of any boring operation that later requires back-reaming or other enlargement. Most commonly applied to guided drilling, directional drilling and 2-pass microtunnelling systems.

Pipe Jacking: Method for directly installing pipes behind a shield machine by hydraulic or other jacking from a drive shaft such that the pipes form a continuous string in the ground.

Pipe Ramming: Non-steerable method of forming a bore by driving a steel casing, usually open-ended, with a percussive hammer from a drive pit. The soil may be removed by augering, jetting or compressed air. In appropriate ground conditions a closed casing may be used.

Product Pipe: Permanent pipeline for operational use.

Pull-Back: That part of a guided drilling or directional drilling operation in which the drill string is pulled back through the bore to the entry pit or surface rig, usually installing the product pipe at the same time.

Reception/Exit Shaft/Pit: Excavation into which trenchless technology equipment is driven and may be recovered during the installation or renovation of a product pipe, conduit or cable.

Rod Pushing: Method of forming a pilot bore by driving a closed pipe head with rigid attachment from a launch pit into the soil that is displaced. Limited steering and monitoring capability may be provided, usually in conjunction with a locator.

Subsidence: Process in which the ground may be displaced causing a settlement at the surface.

Target Shaft/Pit: See **Reception/Exit Shaft/Pit**.

Thrust Pit: See **Drive Pit**.

Trenchless Technology: Methods for utility and other line installation, rehabilitation, replacement, renovation, repair, inspection, location and leak detection, with minimum excavation from the ground surface.

Uncased Bore: Self-supporting bore without a lining or inserted pipe, whether temporary or permanent.

Walkover System: See **Locator**.