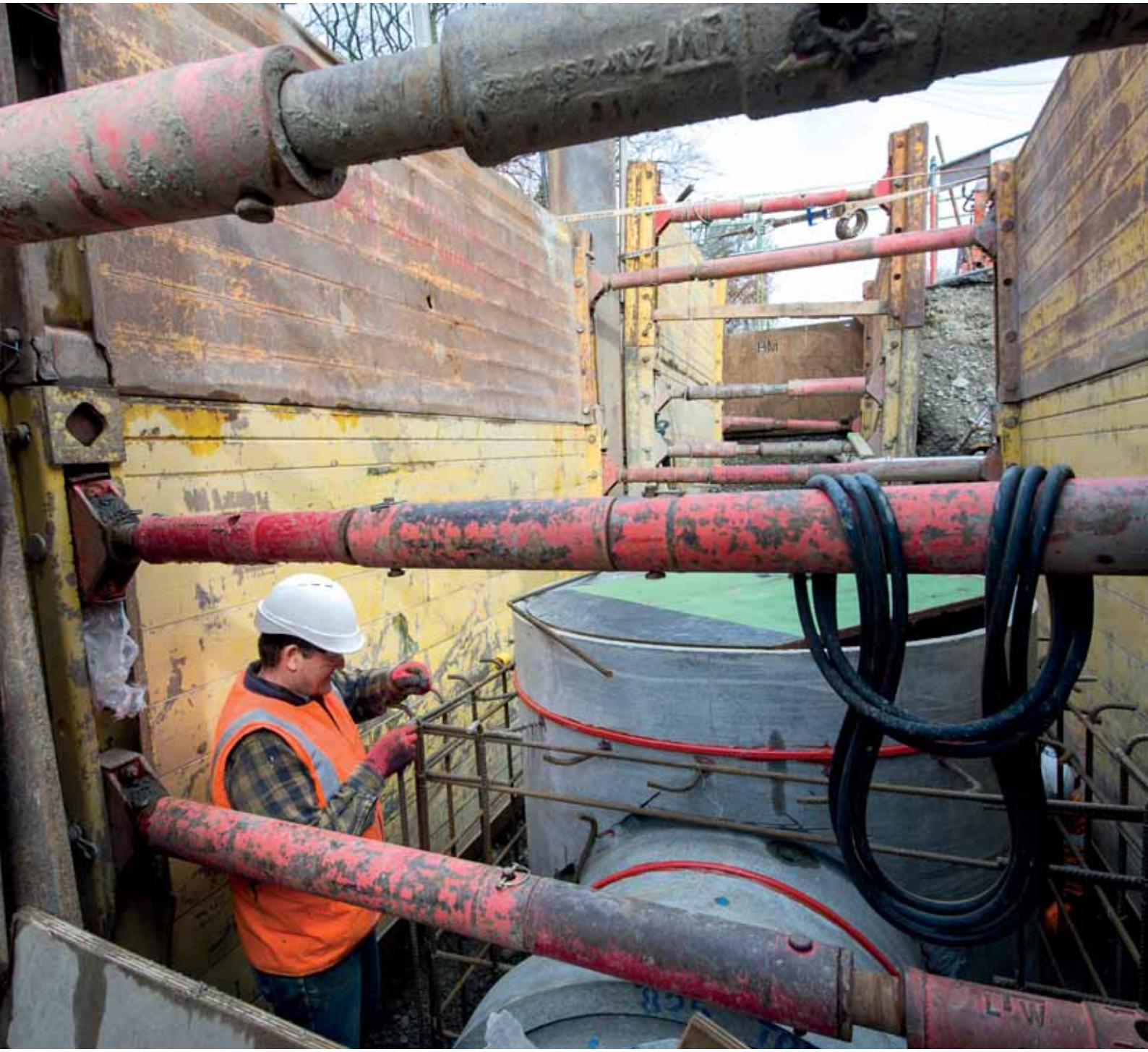
GOOD PRACTICE GUIDELINES

Excavation Safety

JULY 2016



New Zealand Government

WORKSAFE NEW ZEALAND | MAHI HAUMARU AOTEAROA

This guideline provides practical guidance to manage health and safety risks associated with excavation work.

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EXCAVATION SAFETY KEY POINTS:

Avoid underground services and make sure not to undermine nearby structures – use safe digging practice and dig away from them.

Check the excavation each day before starting work and after any event that may affect its stability.

Provide safe access to get in and out.

Prevent collapse – shore, bench, or batter back. Do not assume ground will stand unsupported.

Prevent people and materials falling in – with barriers strong enough not to collapse if someone falls against them.

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INTRODUCTION

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Excavation failures are particularly dangerous because they may occur quickly, limiting the ability of workers (and in some cases others nearby) to escape, especially if the collapse is extensive.

The speed of an excavation collapse increases the risk associated with this type of work. The consequences are significant as the falling earth can bury or crush any person in its path resulting in death by suffocation or internal crush injuries.

1.1 SCOPE AND APPLICATION

This guideline is for persons conducting a business or undertaking (PCBUs), workers, upstream PCBUs, and competent people involved in excavation work.

All work involving excavations must comply with the requirements of the Health and Safety at Work Act 2015 (HSWA) and all relevant regulations, including the Health and Safety in Employment Regulations 1995 (the HSE Regulations) and the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016 (the GRWM Regulations).

This guideline does not apply to shafts associated with mining operations, or tunnelling operations, which are regulated under the Health and Safety at Work (Mining Operations and Quarrying Operations) Regulations 2016 (the MOQO Regulations).

For more information on the specific regulations relating to excavation work, see Appendix A: Legal framework.

Some industries have guidelines that deal with specific problems faced in their working environments, such as the electricity sector or plant and machinery hire. When deciding how to do a job safely, make sure to check any industry specific guidance.

1.2 WHAT IS EXCAVATION WORK?

Excavation work generally means work involving the removal of soil or rock from a site to form an open face, hole or cavity, using tools, machinery or explosives.

Excavation work can occur anywhere, including:

> on construction sites
> on business premises
> in public areas.

Excavation work includes:

> open excavations
> potholing
> pit excavations
> trenches and retaining walls
> shafts and drives.

OPEN EXCAVATIONS

An excavation in open ground is an open excavation and can vary in shape and size.

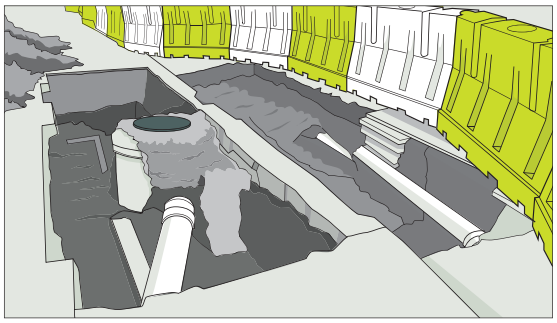

Figure 1: Open excavation

POTHOLING

Potholing is usually a small excavation or inspection hole to find underground services.

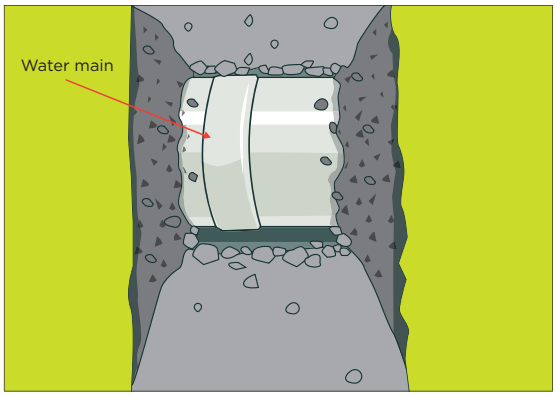

Figure 2: Pot hole

PIT EXCAVATIONS

Pit excavations are usually four-sided and deeper than the narrowest horizontal dimension at the surface.

Pits are generally excavated to install manholes, pump stations, or underground tanks. They are also excavated to construct pile caps and other types of foundations or to access or locate existing services.

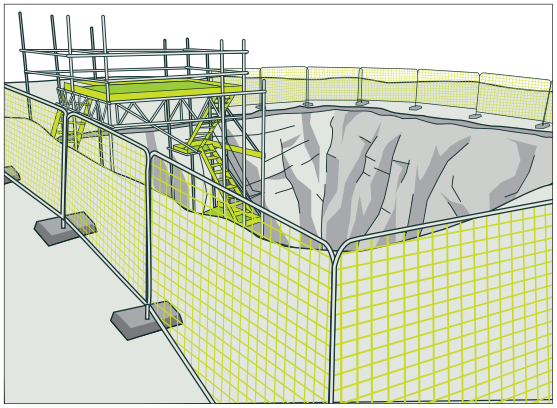

Figure 3: Pit excavation

TRENCHES AND RETAINING WALLS

A trench is a long narrow excavation which is deeper than it is wide, and open to the surface along its length.

Trenches are generally excavated to install or maintain underground services or to investigate what is beneath the surface.

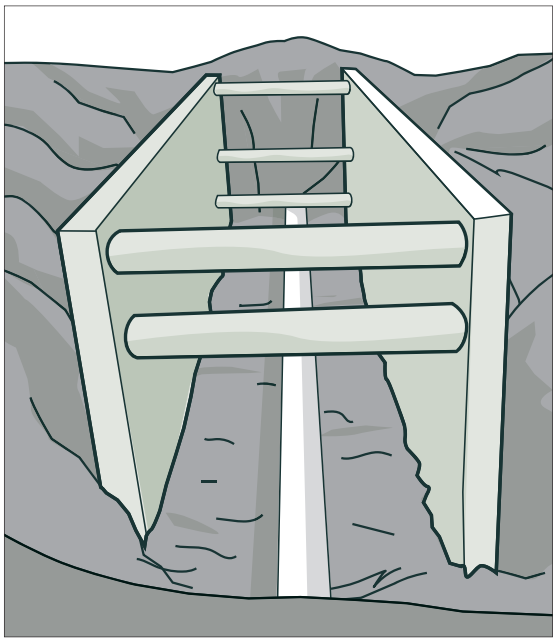

Figure 4: Trench

When a retaining wall is built, an open excavation becomes a trench formed by an excavated face on one side, and a retaining wall on the other. Usually workers need to access this trench to work, for example for waterproofing the retaining wall.

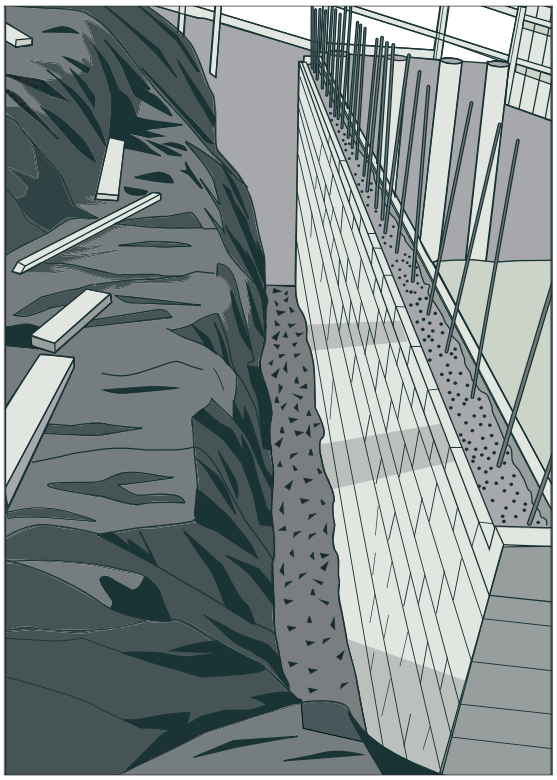

Figure 5: Trench constructed by putting up a retaining wall

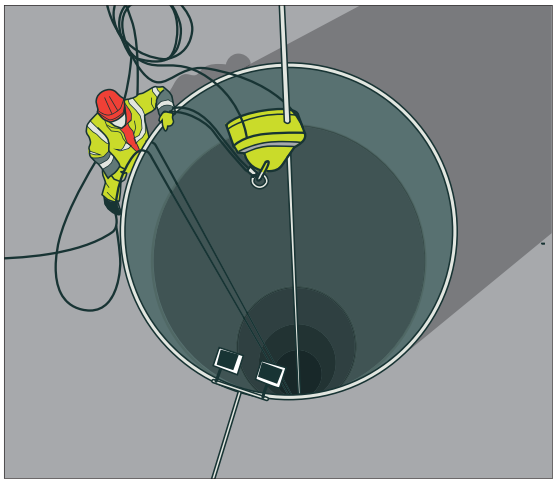

Figure 6: Shaft

SHAFTS AND DRIVES

Sinking a shaft involves constructing a vertical excavation with access and spoil removal from the top.

Drives are small openings cut into the sides of trenches or shafts or elsewhere, for example, under roads. Cutting a drive is particularly hazardous as it introduces the risk of trapping workers with no alternative escape route.

Shafts and drives are often constructed to provide access or ventilation to a tunnel. Shallow shafts can be sunk for investigating or constructing foundations, dewatering, or providing openings to underground facilities.

02/

ROLES AND RESPONSIBILITIES

IN THIS SECTION:

HSWA defines the roles and responsibilities of different duty holders. These include PCBUs, officers, workers and other persons at workplaces.

For more information see WorkSafe's special guide *Introduction to the Health and Safety at Work Act 2015*, available at www.worksafe.govt.nz

2.1 PERSON CONDUCTING A BUSINESS OR UNDERTAKING

While a PCBU may be an individual or an organisation, usually the PCBU will be an organisation, for example a business entity such as a company.

All PCBUs must ensure, so far as is reasonably practicable, the health and safety of workers and other people are not put at risk by their work. This is the **primary duty of care**.

The primary duty of care includes, so far as is reasonably practicable:

- providing and maintaining:
  - a work environment without risks to health and safety
  - safe plant and structures
  - safe systems of work
- ensuring safe use, handling and storage of plant, structures and substances
- providing adequate and accessible welfare facilities for workers
- providing information, training, instruction or supervision necessary to protect all persons from risks to their health and safety from work
- monitoring workers' health and conditions at the workplace to prevent injury or illness.

A PCBU that manages or controls a workplace must ensure, so far as is reasonably practicable, the workplace, the means of entering or exiting the workplace, and anything arising from the workplace are without health and safety risks to any person. For example, before leaving the site unattended for the night, make sure it and any plant and equipment are safe and secure.

PCBUS WITH OVERLAPPING DUTIES

More than one PCBU can have a duty to the same matter. Where this happens the PCBUs have overlapping duties. This might happen in a:

- shared workplace (eg a building site), where more than one PCBU and its workers control and influence the work on site
- contracting chain, where contractors and sub-contractors provide services to a principal contractor and client.

PCBUs that share no contractual relationship may still share overlapping duties, such as when they work on the same site.

PCBUs must discharge their overlapping duties to the extent they have the *ability to influence and control the matter*, and must, so far as is reasonably practicable, co-operate, co-ordinate and consult with others in the workplace. For example:

- Two individual contractors agree to co-ordinate their obligations for providing first aid equipment or personal protective equipment (PPE).
- A utility company agrees to co-operate with the PCBU in locating the underground services before the excavation work starts.

UPSTREAM PCBUs

There are further duties for PCBUs (called upstream PCBUs) who:

- design plant, substances or structures
- manufacture plant, substances or structures
- import plant, substances or structures
- supply plant, substances or structures
- install, construct or commission plant or structures.

Upstream PCBUs influence and sometimes eliminate health and safety risks through, for example, designing or manufacturing products that are safe for the end user. Upstream PCBUs must consider potential health and safety risks of their products that could reasonably be expected to be used at a workplace.

Designers of temporary works or suppliers of plant used by the PCBU are examples of upstream PCBUs in excavation work.

WORKER ENGAGEMENT, PARTICIPATION AND REPRESENTATION

PCBUs can ensure a safe workplace more effectively when everyone involved in the work:

- communicates with each other to identify hazards and risks
- talks about any health and safety concerns
- works together to find solutions.

PCBUs have two main worker engagement duties under HSWA to:

- engage with workers on health and safety matters that affect or are likely to affect them, so far as is reasonably practicable
- have practices that give workers reasonable opportunities to participate effectively in the ongoing improvement of workplace health and safety.

Both duties involve two-way communication in a 'conversation' about health and safety. Everyone involved in health and safety must be able to contribute and have their opinion considered when decisions are made.

Have deliberate, planned ways to engage and support participation. Each PCBU can determine the best way to meet its duties, depending on workers' views and needs, the size of the organisation and the nature of its risks.

2.2 WORKERS

A worker is an individual who carries out work in any capacity for a PCBU and includes employees, contractors, sub-contractors, apprentices and trainees, and volunteer workers.

Workers' responsibilities include:

- taking reasonable care of their own health and safety
- taking reasonable care what they do (or fail to do) does not cause harm to any other person
- co-operating with any reasonable health and safety policy or procedure of the PCBU
- complying, so far as reasonably able, with any reasonable instruction given by the PCBU, so the PCBU can comply with the law
- in relation to PPE:
  - using or wearing PPE in accordance with any information, training or reasonable instruction given by the PCBU
  - not intentionally misusing or damaging the PPE
  - telling the PCBU when they become aware the PPE is damaged or defective, or when it needs to be cleaned or decontaminated.

2.3 OFFICERS

An officer is a person with a specific role in an organisation or a person with the ability to exercise significant influence over the management of the business or undertaking. Organisations can have more than one officer. An officer includes, for example, company directors, and chief executives.

Officers have a duty to exercise due diligence to ensure the PCBU complies with their duties under HSWA. Each officer has a duty – it is not a joint duty.

2.4 OTHER PEOPLE AT THE WORKPLACE

Other people at a workplace must take reasonable care of their own health and safety and that of others. However, PCBU's have the most influence and control over what has created the risk at the workplace, and have the primary duty of care to ensure other people's health and safety is not at risk from the work.

Other people at a workplace potentially at risk from work activities include volunteers, customers, passers-by, visitors, other PCBUs, or workers of another entity.

Think broadly about the work and make sure, so far as is reasonably practicable, other people's health and safety is not put at risk from work being done or from anything else at the workplace.

2.5 COMPETENT PERSON

In this guideline, 'competent person' refers to the temporary works designer, who should be competent to assess and manage the risks relevant to the excavation's depth and have a working knowledge of this guideline. A competent person is a person who has acquired through training, qualification or experience the knowledge and skills to carry out a task.

Table 1 and table 2 set out some recommended competencies for this competent person. The tables show what level of competence is appropriate for increasingly complex excavations.

On sites requiring multiple schemes or different temporary works disciplines, one competent person may not have experience across all the disciplines of temporary works and may require additional technical support on site.

Each excavation has its own unique set of considerations to address during the design process, some of which may not be immediately apparent. Therefore, make an assessment of the appropriate level of competence for each individual excavation.

Experience and competence can be gained via different routes and with lesser qualifications (subject to formal assessment of individual skills) or exemptions made where close supervision/mentoring is provided by others. In some workplaces, the same person could fulfil a number of roles (such as designer and supervisor), depending on their level of competency.

Competency is based on recent knowledge, training, understanding, and experience with a wide variety of considerations, some of which are:

- soil type, weight and strength
- ground water
- sloping ground
- surcharges or vibrations that could destabilise the excavation, such as vehicles, buildings or stockpiled materials
- the potential for the excavation to disturb or damage nearby structures, underground or overhead services
- safe working methods and construction methodologies
- availability and capacity of equipment and temporary works.

Only a competent person should be designing temporary works. Before producing any final design documents and safety report, consider:

- the design of the shoring
- any effects of the excavation on nearby structures
- safe work methods
- controls.

EXCAVATION DEPTH AND TYPE – NORMAL CONDITIONS[1]	RECOMMENDED COMPETENCY
Up to 1.5 m > Shored,[2] benched, and/or battered (eg shored as per table 6)	> Recent experience in carrying out or supervising excavation work
1.5 m – 3 m > Flat, open ground, no surcharge > Shored, [2] benched, and/or battered (eg shored as per table 6)	> Recent experience in carrying out or supervising excavation work at these depths > Technical or trade qualification (eg as a civil engineer or drain layer)
3 m – 6 m > Flat, open ground, no surcharge > Shored, [2] benched, and/or battered (eg shored as per table 6, waler and brace solutions up to 6 m in depth)	> Technical or trade qualification (eg as a civil engineer or drain layer) > Recent experience in carrying out or supervising excavation work in similar ground at these depths > Experienced temporary works designer [3] able to interpret the site's soil information > Monitoring recommended [4]

Table 1: Recommended competencies for excavation work

EXCAVATION DEPTH AND TYPE – COMPLEX CONDITIONS NOT COVERED IN TABLE 1[5]	RECOMMENDED COMPETENCY
Up to 3 m > Shored,[2] with benched and/or battered sides	> Experienced temporary works designer[3] able to judge whether it is safe > Monitoring required[4]
Over 3 m > Requiring detailed analysis of site, significant structural design analysis and sound engineering judgement > Shored,[2] with benched and/or battered sides > All sheet piled excavations (cantilevered, propped, or ground anchored), and excavations shored with H-pile shoring and lagging > Shafts and drives framed with timber or steel with poling boards, lagging or laths. Supported by pre-cast concrete, steel caissons/plates etc	> Experienced temporary works designer[3] able to judge whether it is safe > Monitoring required[4] > Can provide producer statements: PS1-design, and PS4-construction review

Table 2: Recommended competencies for more complex excavation work

[1] Generally flat open ground, with little or no surcharge loading, favourable ground conditions, off set from nearby structures and sensitive infrastructure. Groundwater can be controlled with simple methods, such as a sump pump arrangement.

[2] Shoring that comes with documents stating what depths or soil pressures it can be used to (eg slide-rail shoring). Alternatively, shoring designed to specific soil load profiles (eg trench shields).

[3] Through training, qualifications or experience, has acquired the knowledge and skills to competently excavate to this depth, for example:
> someone who has industry training and expertise, experience, knowledge and skills to excavate to this excavation's depth and type
> a Chartered Professional Engineer with experience designing temporary works, holding formal Engineering qualifi cations (eg Civil, Structural or Geotechnical).

[4] Can verify the design and carry out monitoring, depending on the risks identified in the risk assessment.

[5] The conditions may include very weak or sensitive soils, groundwater that requires specialist dewatering, or locations near structures and sensitive infrastructure. These conditions would result in an elevated risk when constructing the excavation.

03/

MANAGING RISKS

IN THIS SECTION:

Risk management involves thinking more broadly about risk, not just spotting work-related hazards. Think about the root cause of any harmful event, the likelihood it will occur, the consequences if it does and the steps to take to eliminate or minimise the risk.

PCBUs must manage all health and safety risks with excavation work. Remember to consult, co-operate and co-ordinate with other PCBUs and to engage with workers.

To manage risks:

> identify hazards that could reasonably foreseeably create a risk to health and safety
> eliminate the risk so far as is reasonably practicable
> if it is not reasonably practicable to eliminate the risk – minimise the risk so far as is reasonably practicable
> maintain the implemented controls so they remain effective
> review, and if necessary revise controls to maintain, so far as is reasonably practicable, a work environment that does not have risks to health and safety.

Figure 7: Risk management as a continual process

3.1 IDENTIFY HAZARDS

The first step in the risk management process is to identify hazards which could injure or harm anyone. A good hazard identification process is the key to risk management.

Identify hazards and controls before the work starts. It may not be possible to control all hazards before work starts – so identify the controls and implement them when required.

For example, consider the hazards to a person:

> falling into an excavation
> being trapped by the collapse of an excavation
> working in an excavation being struck by a falling object
> working in an excavation being exposed to contaminants that take oxygen from the environment.

To manage the risks, consider all relevant matters including the:

> nature of the excavation
> nature of the excavation work, including the range of possible methods of carrying out the work
> means of entry into and exit from the excavation.

Complete and monitor hazard identification regularly to make sure controls are working and that no new hazards have been introduced.

HAZARD IDENTIFICATION METHODS

Identify hazards by:

- physical inspections:
  - inspect the workplace and assess where someone could get injured by excavation activities
  - consider hazards that may be created by other site users, or if the excavation activities could create hazards for others (eg traffic management)
- task analysis: identify the hazards involved in each task. Some workplaces use job safety analysis (JSA) or task analysis (TA) to do this
- engaging with workers
- process analysis: identify hazards at each stage of the work plan
- consulting guidance and standards
- hazard and operability analysis (HAZOP)
- accident investigation analysis – identify hazards and causes of harm from investigations involving similar types of work.

3.2 ASSESS RISKS

PCBUs must manage risks that could result from work. Risks to health and safety arise from people being exposed to hazards (sources of harm). Carry out a risk assessment when:

- it is uncertain a hazard may cause injury or illness
- a work activity involves diff erent hazards, and the workers involved do not know how those hazards interact to produce new or greater risks
- workplace changes may impact on the effectiveness of controls
- new or different risks are associated with a change in work systems or work location.

PCBUs must eliminate risks so far as is reasonably practicable. If a risk cannot be eliminated, it must be minimised so far as is reasonably practicable.

To decide what is 'reasonably practicable', PCBUs must weigh up all relevant matters. Those matters include, but are not limited to:

- how likely the hazard or risk is to happen
- what degree of harm the hazard or the risk might cause
- how much is known about the hazard or risk and how to eliminate it
- what ways are available to eliminate or minimise the risk
- what ways are suitable to eliminate or minimise the risk.

Only consider cost after assessing the extent of the risk and the available ways of eliminating or minimising the risk.

There are times when certain work risks must be dealt with in a specified way. For example, there are specific requirements in regulations about dealing with the risks arising from carrying out remote or isolated work or work dealing with hazardous substances such as asbestos.

A risk assessment will help to:

- identify which workers or others are at risk
- determine what sources and processes are causing that risk
- determine the severity of the risk
- identify if and what kind of controls should be implemented
- check the effectiveness of existing controls.

3.3 CONTROL RISKS

Some controls are more effective than others. Controls can be ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of controls.

Eliminating a risk is the most effective control. PCBUs must always eliminate a risk if this is reasonably practicable.

If this is not reasonably practicable, PCBUs must minimise the risk by one or a combination of the following:

> Substitution: For example, using an excavator with a rock breaker rather than a manual method.

> Isolation: Isolate means preventing contact or exposure to the risk. For example, using concrete barriers to separate pedestrians and mobile plant.

> Engineering controls: For example benching, battering or shoring the sides of the excavation to reduce the risk of ground collapse.

If risk remains, it must be minimised by implementing administrative controls, so far as is reasonably practicable, for example by installing warning signs near the excavation.

Minimise any remaining risk with suitable PPE, for example hard hats, hearing protectors and high-visibility vests.

Administrative controls and PPE rely on human behaviour and supervision. Used on their own, they tend to be the least effective in minimising risks.

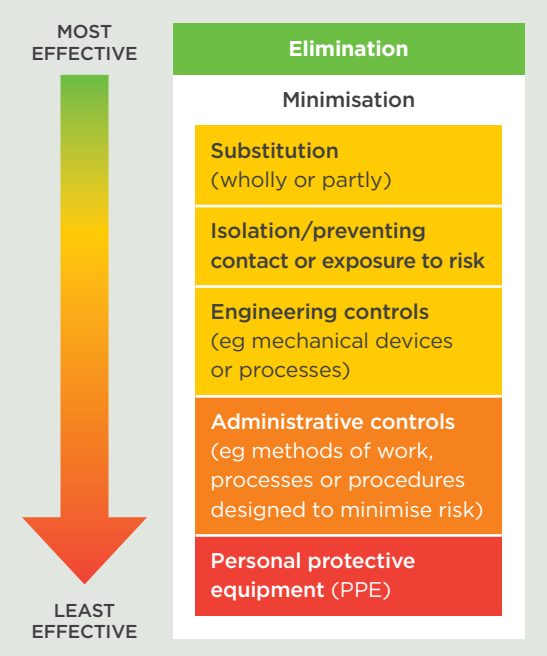

Figure 8: Hierarchy of controls

When choosing suitable controls, consider:

> excavating plant: if quantities are large, it may be effective to use different types of plant for the various materials undergoing excavation

> stockpiling arrangements: another site may need to be found to temporarily stockpile materials

> material placement: evaluate the methods and plant used for excavating, transporting and compacting the material

> dewatering equipment

> transporting the excavated material:
  - type of plant
  - length of haul
  - nature of the haul route
  - tipping or spreading conditions.

3.4 REVIEW CONTROLS

Regularly review controls on site to make sure they are still effective.

Review, and if necessary revise controls:

> when the control is not effective in controlling the risk (eg if there has been an incident or near miss)

> before a change at the workplace that is likely to give rise to a new or different health and safety risk that the control may not effectively control

> if a new hazard or risk is identified

> if the results of consultation indicate that a review is necessary

> if a health and safety representative or committee recommends a review.

Common review methods include workplace inspections, consultation, testing and analysing records and data. When reviewing controls, review the safe system of work or task analysis and revise it if necessary.

If problems are found, go back through the risk management steps, review the information and make further decisions about controls.

04/

PLANNING THE WORK

IN THIS SECTION:

Planning involves identifying the hazards, assessing risks and deciding suitable controls in consultation with everyone involved in the work including other PCBUs, workers, competent people, and mobile plant operators.

Consider the site factors, hazards and the unique characteristics of the site. The nature of the excavation work will affect the selection of an excavation method and a safe system of work. The ground conditions will have a significant impact on what excavation method to select and the controls to use.

Other risks associated with excavation work, including any connected work such as construction, must also be controlled so they do not cause harm to anyone.

4.1 SAFE SYSTEM OF WORK

A safe system of work sets out how a piece of work or a project will be completed safely and in compliance with relevant legislation.

Implement a safe system of work before excavation work starts to make sure the excavation happens in the right location with the right plant and equipment on site and with the right workers with relevant competencies.

Make sure to engage with workers carrying out the excavation work and their representatives, and if you are working with other PCBUs, co-operate, co-ordinate and consult with them so far as is reasonably practicable.

A safe system of work should include:

> assigning responsibilities
> a task analysis
> consulting a competent person regarding any temporary works design
> identifying any health and safety hazards and risks
> carrying out a risk assessment
> describing how you will control any identified risks
> describing how controls will be implemented, monitored and reviewed
> accident investigation and reporting methods
> emergency procedures.

In the event of any reactive excavation work, establish a safe system of work and communicate this to workers.

For more information, see:

> Appendix B: Safe system of work considerations
> Appendix C: Trenching checklist

Table 3 provides some information to consider before starting work. These are the minimum issues to consider.

SITE ISSUES	POSSIBLE FACTORS	MINIMUM CONSIDERATIONS
Ground conditions	> soil types > stability > ground water > other soil and rock properties > contaminated soils > potential for seismic hazards (such as fault rupture, liquefaction and rock fall)	> inspecting to find out what might affect the stability of the excavation (an excavation face can appear stable for 24 hours, but may be unstable) > weather conditions > dewatering plan > confirming if it is a Hazardous Activities and Industries List (HAIL) site > testing soil and water
Site conditions	> surcharges > underground and above ground services > ground slope > adjacent buildings and structures > water courses (including underground) > trees > local weather conditions > environmental conditions > proximity to existing trench lines	> checking with the local authorities whether you are working on a HAIL site > district planning and resource consent requirements > works access permits > consents from service owners > WorkSafe notifications (see Appendix D: Notifications to WorkSafe)
The excavation	> excavation depth > length of time the excavation will be open > ground support > if excavation may be classified as a confined space > the planned height of the excavated face > if there will be other construction activity nearby that may cause vibration	> static and dynamic loads near the excavation > consulting a competent person > deciding on a support solution > identifying all existing overhead and underground services > managing pedestrians and traffic with a traffic management plan (TMP) > securing barriers or fencing to keep members of the public and other site workers away from the excavation site
Work methods	> specialised plant or work methods required (eg ground support) > the method(s) of transport, haul routes and disposal > what exposures might occur, such as noise, ultra-violet rays, falls or hazardous chemicals > workers will need to follow good practice for confined spaces safety > number of workers involved > possibility of unauthorised access to the work area > safe access and egress	> implementing a safe system of work or safety management system > identify hazards, assess and control risks > build in interaction with other trades > adequate facilities > emergency procedures > accident and incident procedures > contractor management > testing and checking for plant, equipment, and materials requirements > inducting and training all workers > exclusion zones where powered mobile plant will operate

Table 3: Planning considerations

4.2 UTILITY SERVICES

Services include gas, water, stormwater, sewerage, telecommunications and electricity supply, chemicals, fuel and refrigerant in pipes or lines. The PCBU must identify and manage hazards and risks associated with underground and overhead services in the planning and design stages. In the first instance, contact the service owner for advice prior to works commencing.

For information on the risks of work around utility service see section 5.7 and WorkSafe's *Guide for Safety with Underground Services* available at www.worksafe.govt.nz

ESTABLISH WHERE THE SERVICES ARE

Before any excavation takes place workers should know what is underground and what is overhead. Consider services present until it is proven they are not there.

- Liaise with all service owners as there are often multiple services and multiple owners.
- Some service owners provide on-site assistance to help identify services; use this assistance where available.
- Make sure plans and relevant locates and mark-outs are available, get plans and mark out the services.
- Accurately trace and mark out underground services. Drawings and service plans may be different from what is underground.
- Keep copies of current services plans on site.
- Use detection equipment that can detect services. There may be a need to use multiple types.
- Knowledge about what energy sources the services actually carry is essential. Service markings and colours can vary from current national standards and the service owner should be able to provide specific information.
- Check service depths as they may vary from the plan (eg the ground cover may have been altered since the service was laid). Pothole to determine service location and depth.
- Make sure mobile plant access and egress is safe by checking the proximity of overhead services and the ground strength for access routes (eg check for underground drainage pipes, service ducts, soak wells, and storage tanks).

HAVE PROCESSES IN PLACE

- Check workers are competent to complete the tasks. This will include giving a briefing and assessing that plant, equipment (including safety and protective equipment), tools, and procedures are fit-for-purpose.
- Workers should be supervised to make sure they carry out the work safely.
- Identify where consents and permits are required for closer work activities. This includes:
  - liaising with service owners
  - sourcing the service owner's web information and resources
  - understanding permit conditions
  - making sure workers understand what they can and cannot do
  - supervising and monitoring conformance.
- Update the service plan arrangements with the service owners.
- Reporting, emergency, and response procedures need to be in place for all identified risks and hazards.
- Put processes in place for reporting incidents, damage, and defects.
- Plan for emergency situations where there is incomplete information about services.
- Develop response plans for workers and others safety in the event of a service strike.

WHAT WORK METHODS WILL YOU USE?

> Is the work in proximity to overhead services?

> Will you expose underground services?

> How will you work with the service owner and get permission? This may be required to approach services using hand-held mechanical tools, or mechanical methods, and to backfill the excavation.

> How will you provide underground service plans and related information to other parties, such as other PCBUs and workers operating mobile plant?

> Will you be backfi lling?

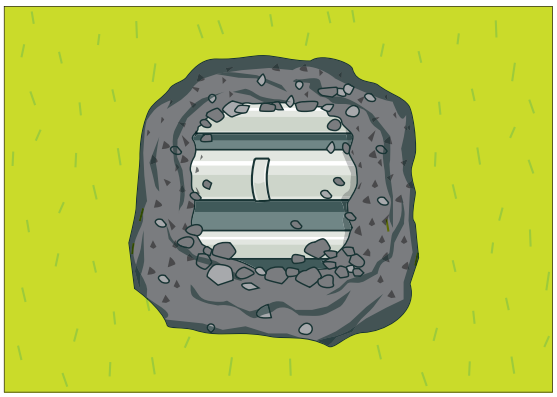

Figure 9: Underground services exposed by 'potholing'

4.3 NEARBY BUILDINGS OR STRUCTURES

Excavation work may seriously affect the stability of any structure near the excavation. This may lead to structural failure, or ground collapse depending on the site's ground conditions.

Consider the excavation's zone of influence on the stability of any nearby structure and make sure the excavation does not remove any nearby structure's ground support.

The zone is normally at an angle from the base of the excavated face to the surface. The zone's angle will depend upon site-specific factors, for example soil strength and density.

Local regulations or resource consent conditions may also stipulate other controls for excavating near existing structures.

A competent person should:

> assess any excavation near or below the footing of any structure, including retaining walls

> determine if any supports to brace the structure are required.

Make sure other structures near the excavation site are not adversely affected by vibration or concussion during the work. If hospitals and other buildings with equipment sensitive to shock and vibration are nearby, consider the need for special precautions.

> The zone of influence's angle will depend upon site-specific factors, for example soil strength and density.

The figures below show examples of nearby structures and services that may restrict the excavation.

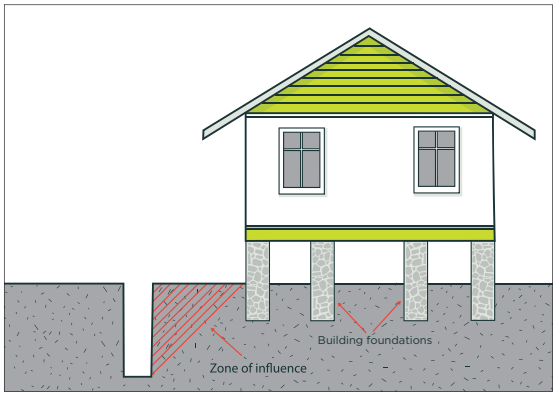

Figure 10: Building line restriction

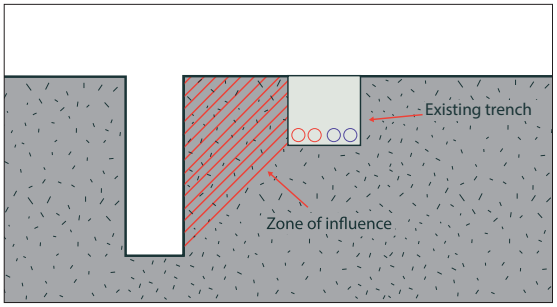

Figure 11: Existing services restriction

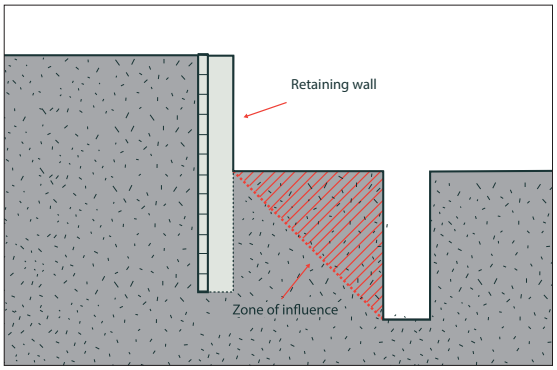

Figure 12: Retaining wall restriction

4.4 SECURING THE WORK AREA

Site security should consider all risks to workers and others. Establish the work activity's boundary before securing the work area. Each work activity may be smaller than the whole workplace, so as each work activity moves its boundary moves with it. As the work boundary moves, so far as is reasonably practicable, minimise risk to workers and others outside the work activity.

Other people near the work have a responsibility to take reasonable care that their actions (or lack of action) do not put themselves or others at risk. They must also comply with any reasonable instruction given by the PCBU, as far as they are reasonably able to.

For example, a long trench line operation secures each work activity's boundary using movable security arrangements as the excavation work progresses.

When organising site security and site access, consider:

- warning or hazard signs
- supervising authorised visitors
- the risk of unauthorised access occurring (consider schools, parks, shops or other public places, or amenities and events nearby)
- pedestrians and other members of public
- other workers and mobile plant on site
- vehicle traffic control within and near the excavation
- delivery points, including vehicle access and egress
- immobilising/locking vehicles
- assessing plant movement to avoid risks to other moving plant or vehicles outside the site's perimeter
- control and storage of any contaminated materials from the excavation
- safe and secure storage of materials (eg hazardous substances)
- control of energy sources (eg temporary mains service boxes, fuel storage)
- suitably designed and constructed physical barriers (eg safety fences, lockable gates, or covers).

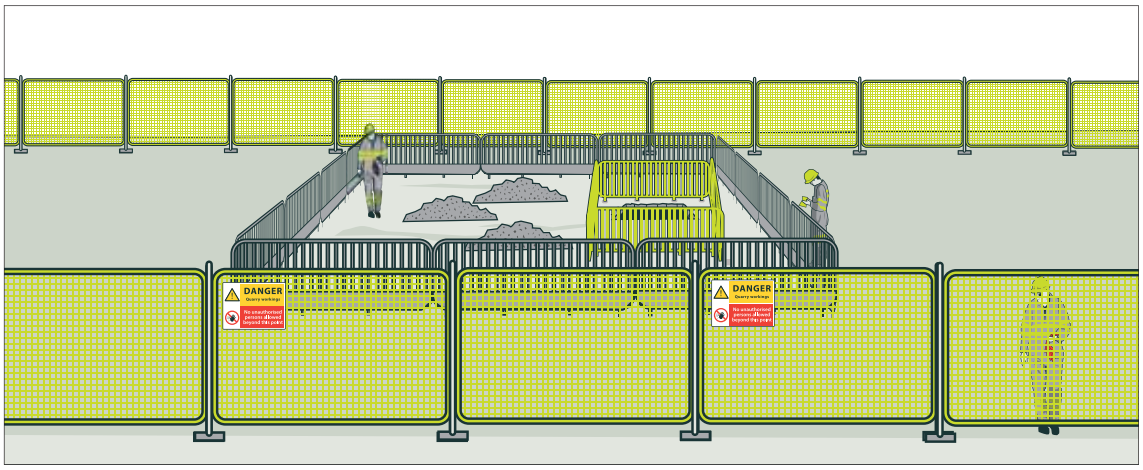

Figure 13: Externally fenced site with internal fences

Safety fences prevent people from gaining access into hazardous areas. Guard any excavations to which the public has or might gain access. Fence off the area even during times when workers are not present on site.

Any safety fence should comply with the minimum requirements of NZTA's *Code of Practice for Temporary Traffic Management* available at www.nzta.govt.nz

HSE Regulation 25 requires any readily accessible excavation likely to collect or retain water to a dangerous depth to be, so far as is reasonably practicable:

> covered or fenced, when no worker is immediately nearby to prevent access; and

> covered, fenced, or filled at the completion of the work.

4.5 MANAGING TRAFFIC

Manage traffic, including all road users while the work takes place with a temporary traffic management plan (TMP). All work on a road or work that affects the normal operating condition of a road must have an approved TMP.

If excavations are to take place on or near a road or transport corridor, obtain approval from the Road Controlling Authority, which is often the local authority or NZTA.

The TMP should show how the excavation will be protected so work can go ahead safely for workers and others. The TMP should show how traffic (including cyclists and pedestrians) will negotiate the site, for example what lanes will be closed by the work, and how.

If the site will be unattended, provide a separate TMP also covering the protection of any excavations by backfilling, plating, or fencing. Where work is located on roads controlled by a local authority, check with the local authority as to what is required for appropriate traffic management.

For more information refer to NZTA's *Code of Practice for Temporary Traffic Management* available at www.nzta.govt.nz

SEPARATING TRAFFIC

Separate the route used for hauling spoil from the one used by workers. If it is not possible to separate the traffic, forbid worker movement while spoil or plant is being moved, and vice versa.

Unless the excavation is so shallow those outside can see and talk easily to those at the face, provide an effective signalling system and interlocks that prevent winding gear from operating while personnel are moving.

When mechanical haulage is used in small drives or manholes, excavate refuges into the side of the drive to provide shelter from passing traffic.

The refuges should be a least 1.2 m deep by 1 m wide by 2 m high (or the height of the drive if it is less than 2 m) and spaced not more than 18 m apart. They should all be on the same side of the drive.

4.6 HAZARDOUS CONDITIONS

Planning considerations should include:

> finding out about the current use and ground history of the work site before assessing any risk

> investigating and testing if a dangerous atmosphere will be present or is likely to be present

> determining if any live services, proximate water courses, or isolation failures could cause sudden flooding of the excavation

> changes in conditions during work (ie disturbing sediment)

> the geology (ie peat soils, methane released from soils).

LOCAL AUTHORITY PLANNING REQUIREMENTS

It is important to obtain the necessary resource consents before work starts. Check your local authority's district plan to find out if resource consents are necessary.

Contact your regional council to check whether you are working on a HAIL[6] site and to make sure you comply with the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES)[7] before excavating. For more information refer to section 5.10.

4.7 CONFINED SPACES

The hazard identification and risk assessment can identify levels of risk that will deem the excavation a confined space under certain conditions.

A confined space is an enclosed or partially enclosed space, not intended or designed primarily for human occupancy, where there is a risk of one or more of the following:

> an oxygen concentration outside the safe oxygen range

> a concentration of airborne contaminant that may cause impairment, loss of consciousness or asphyxiation

> a concentration of flammable airborne contaminant that may cause injury from fire or explosion

> engulfment in a stored free flowing solid or a rising level of liquid that may cause suffocation or drowning.

If the excavation's characteristics meet the defined criteria refer to *AS 2865 Confined spaces* to find out the appropriate work methods, risk management, and emergency planning.

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[6] The Hazardous Industries and Activity List is available at www.mfe.govt.nz

[7] The NES is available at www.mfe.govt.nz

If an excavation is a confined space, undertake pre-entry planning. Make sure:

- workers are trained in confined space entry and enough workers are available
- entry requires a completed permit for entry
- pre-entry tasks are established and understood by all
- the atmosphere is tested before entry and continuously monitored during entry, if necessary
- ventilation is installed and adequate where deemed necessary
- an emergency plan is established, planned and workable
- suitable standby person/s are present, trained and aware of their specific tasks in the event of an emergency
- communication is established with the standby person/s
- all equipment is suitable and operational, within current inspection dates, and used by workers trained in the use of the equipment.

The natural reaction to immediately enter and try to rescue a person often leads to the serious injury or death of the would-be rescuer/s. A suitably trained and competent standby person should be present to communicate and oversee the work being conducted. They will co-ordinate the response to any emergency. Emergency response planning should follow the requirements of AS 2865.

For more information about confined spaces, see WorkSafe's fact sheet *Confined Spaces: Planning Entry and Working Safely in a Confined Space*, available at www.worksafe.govt.nz

4.8 EMERGENCY PLANNING

The PCBU must have an emergency plan for the workplace. It needs to be maintained to remain effective.

The PCBU must make sure the emergency plan deals with unexpected incidents such as ground slips, flooding, gas leaks, and how to rescue workers from an excavation. Planning must determine all the potential emergency conditions. A suitable response must be developed for each credible emergency.

To ensure a co-ordinated response to an emergency, the excavation emergency plan should be incorporated into any broader construction project emergency plan.

GRWM Regulation 14 requires that the PCBU prepare, maintain, and implement an emergency plan.

More information about emergency planning requirements is available on www.worksafe.govt.nz

05/

CONTROLLING EXCAVATION RISKS

IN THIS SECTION:

This section outlines common risks that PCBUs should manage throughout any excavation.

First try and eliminate the risks but if that is not reasonably practicable, then minimise them, so far as is reasonably practicable. A combination of controls may need to be used. Make sure controls prevent anyone being harmed, so far as is reasonably practicable. They must translate into practical standards and expectations, roles, responsibilities, and processes that are relevant for everyone in the supply chain.

Table 4 outlines some excavation hazards and some controls to consider.

CONSIDER	EXAMPLE CONTROLS
Excavation hazards > placement of excavated materials, plant or other loads > influence on any nearby structure > previous disturbance of the ground > external actions causing instability > presence of or possible inrush of water or other liquid > hazardous substances (eg those present in the soil)	> identify safe and secure places for excavated materials, plant and other equipment > geotechnical information and competent person's input for stability and best method for support > processes for dewatering in place > assess hazardous substances and contaminated soil
Falls and falling objects > falls from one level to another > earth or rock falls	> edge protection in place > safe access and egress > catch platforms
Hazardous atmosphere in an excavation	> gas and fumes monitoring > respirators – fitted and maintained correctly
Manual handling tasks	> using lifting devices (eg hiabs, cranes, trolleys) > manual handling training
Natural hazards and weather	> geotechnical site assessment > inspecting to find out what might aff ect the stability of the excavation (an excavation face can appear stable for 24 hours, but may be unstable)
Overhead services	> identification and inclusion in safe system of work > minimum approach distances for mobile plant and work activity from overhead lines > minimum approach distances for excavation and earthworks from towers and support structures > consents or permits > applying required safety measures
Site safety > insufficient natural lighting	> traffic management plan > site security > safety fencing and signage > provide suitable artificial lighting

CONSIDER	EXAMPLE CONTROLS
Underground services > electricity, gas, sewerage, telecommunications, water, services > chemicals, fuel or refrigerant in pipes or lines	> service plans from each service owner > trace and mark out services – detecting and marking actual layout > contingencies for excavations including emergencies – assume services are present until proven otherwise > fit-for-purpose locating devices > consents and permits > exposing and identifying what and where services are > safe digging and excavation practice
Vibration and hazardous noise	> exclusion zones > noise and vibration reduction at source > PPE

Table 4: Typical excavation hazards

Table 5 outlines some shaft specific hazards and some controls to consider.

CONSIDER	EXAMPLE CONTROLS
Airborne contaminants	> install mechanical ventilation to control airborne contaminants and air temperature/humidity
Confined space work	> confined space entry safe procedures (see AS 2865)
Falls and falling objects	> provide appropriate fall protection (eg temporary work platforms)
Fire or explosion/emergency exits	> emergency plan in place > emergency equipment in place > workers trained for emergency procedures
Ground instability and removing spoil	> stabilise the ground at the head of the shaft and remove spoil > continuously line or support the shaft
Hoisting and winching workers, materials, spoil and plant	> guide the working platforms and material
Hoisting equipment > winches, ropes and hooks	> avoid overfilling material kibbles and clean kibbles before lifting > close shaft doors before tipping
Communication systems	> communication systems in place > systems in place that will still work during emergencies
Mobile plant	> isolate access and guard moving parts of plant and equipment
Shaft dimensions limiting work space	> cleaning the spillage off doors, stage and any steelwork

Table 5: Shaft specific hazards

5.1 GROUND COLLAPSE

Ground collapse is one of the main risks of excavation work.

All excavations, no matter what depth, can be risky. Ground collapse can occur quickly and without warning, giving a worker virtually no time to escape, especially if the collapse is extensive. A buried worker is likely to die of suffocation before help arrives (either the head is buried, or the chest is so restricted by the ground's weight the worker cannot breathe).

Some types of ground collapse are:

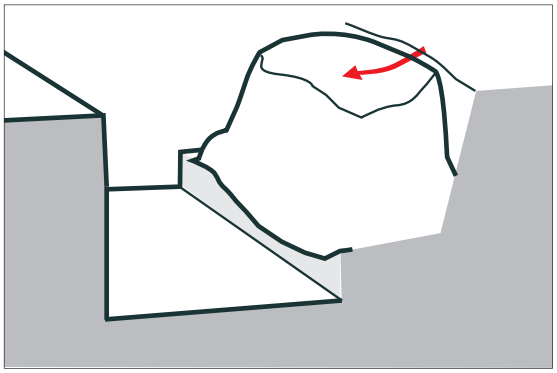

Figure 14: Tension crack

Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the excavation, measured from the top of the vertical face of the excavation.

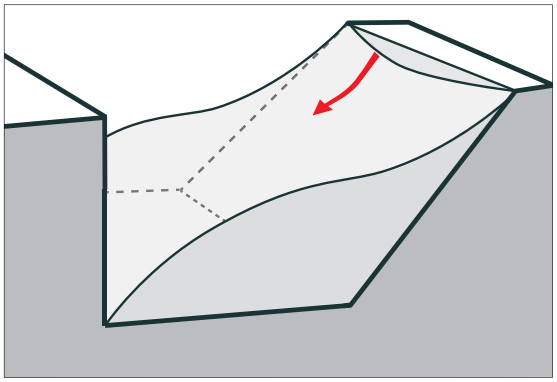

Figure 15: Sliding

Sliding (or sloughing) may occur as a result of tension cracks.

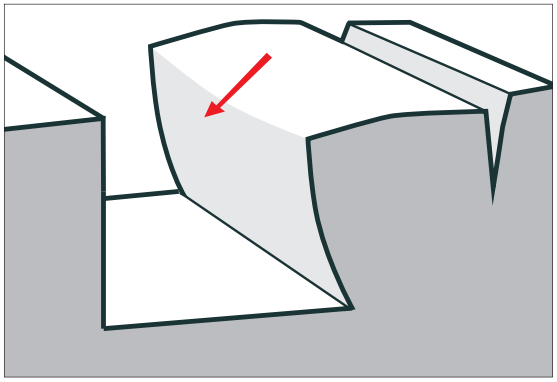

Figure 16: Toppling

In addition to sliding, tension cracks can cause **toppling**. Toppling occurs when a face shears along the tension crack line and topples into the excavation.

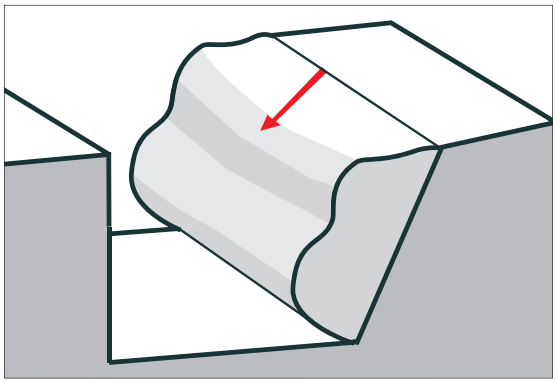

Figure 17: Subsidence and bulging

An unsupported excavation can create an unbalanced stress in the soil which, in turn, causes **subsidence** at the surface and **bulging** of the face. If uncorrected, this condition can cause face failure and trap workers in the excavation.

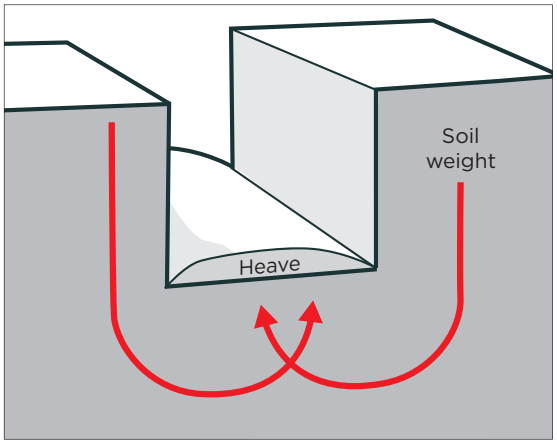

Figure 18: Base heave

Downward pressure created by the adjoining soil's weight causes **base heave**.[8] This pressure causes a bulge in the bottom of the cut. Base heave can occur even when using shoring.

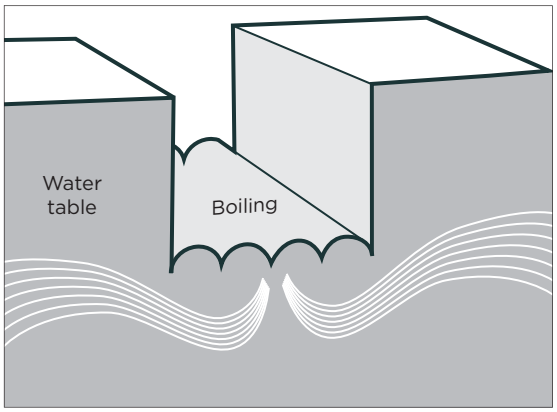

Figure 19: Boiling

Boiling is an upward water flow into the bottom of the excavation. A high water table is one of the causes of boiling. Boiling produces a 'quick' condition in the bottom of the excavation, and can occur even when using shoring.

STABILITY OF AN EXCAVATION

An excavated face's stability depends on the strength of the soil in the face being greater than any stresses. Some situations that increase soil stress in an excavated face and may lead to failure in bad weather, under extra load or vibration are:

> deep cuts and steep slopes, by removing the natural side support of the excavated material

> loads on the ground surface near the top of the face, such as excavated material, digging equipment or other construction plant and material

> shock and vibration, caused by pile-driving, blasting, passing loads or vibration producing plant (eg compacting and drilling plant)

> water pressure from groundwater fl ow, which fills cracks in the soil, increases horizontal stresses and may undermine the excavation

> saturated soil increasing the soil's weight and sometimes the volume

> natural hazards like fl oods or earthquakes (eg earthquakes can cause soil liquefaction).

Some conditions that may reduce soil strength are:

> excess water pressure in sandy soil which may cause boiling and saturate the soil and increase its plasticity

> soil dryness may reduce cohesion in sandy soil and soils with high organic content, which then crumble easily

> prolonged stress, may cause plastic deformity (squeezing or flowing)

> prolonged inactivity at an excavation site; reassess the soil before work begins.

GROUND INVESTIGATIONS

Weak, saturated, or otherwise unfavourable ground can have a significant effect on the construction and performance of an excavation. Consider having ground investigations and geotechnical assessments

[8] Soil weight refers to the weight of one unit of a particular soil. Soil weight varies with type and moisture content. 1 cubic metre of soil can weigh from 1.8 tonnes to 2.2 tonnes or more.

for excavations that are complex or may affect nearby structures or harm workers and others nearby. The ground investigation and geotechnical assessments should include:

> advice on the suitability of diff erent sites or distinct areas of a site for placing structures or services
> suitable and economic design of both temporary and permanent works
> a method to identify and evaluate possible problems in constructing temporary and permanent works
> a process to reduce the risk of unforeseen ground conditions. This will decrease the need for changes in design and construction methods.

5.2 PREVENT GROUND COLLAPSE

If excavation work is planned without shoring, the continuing safety of the excavation will depend on the conditions arising during construction. If the conditions during construction are not as expected, or if conditions change during the course of the work (eg different soils, heavy rain/flooding) take immediate action to protect workers, other people and property.

Excavations shallower than 1.5 m have been known to collapse. If a worker is in the excavation and bending over or crouching down at the time of the collapse, he or she may suffer serious injury. PCBUs must consider the risks associated with these excavations and determine if special precautions or work methods are necessary, for example shoring.

MANAGING THE RISK

There are three main types of controls to prevent ground collapse. Make sure to use one or more of the following controls to support all sides of the excavation:

> **Benching and battering** is the horizontal stepping or sloping of the face, side, or wall of an excavation.
> **Shoring** prevents collapse by maintaining positive pressure on the sides of the excavation, protecting workers.
> **Shields** do not ensure ground stability but protect workers from ground collapse, by preventing the collapsing material falling onto them.

No matter how deep an excavation is, if there is a risk of collapse, put controls in place to prevent this. Involve a competent person when selecting what ground collapse controls to apply.

A combination of controls may be most effective, depending on the work environment and characteristics of the excavated material. In built-up areas or streets the excavation may have to be fully or partly sheeted, or supported to prevent collapse due to localised vehicle movement and vibration.

If shoring is impracticable or unreasonable, make sure a competent person certifies any other safety precautions put in place as adequate. The competent person's advice should state the time period it applies to, and may be subject to a condition that specified natural occurrences may create a risk of collapse.

A report from a competent person can provide information on the stability and safety of an excavation. The report should include:

> details of the soil conditions
> any shoring or excavation support requirements
> dewatering requirements
> any longer term effects on stability and safety of the excavation.

HSE Regulation 24 requires any excavated face more than 1.5 m high to be shored, so far as is reasonably practicable, unless:

- the face is cut back to a safe slope, or
- the material in the face is of proven good standing quality under all reasonably foreseeable conditions of work and weather, or
- by reason of the nature of the work and the position of any worker in the vicinity, there is no danger to any worker, or
- shoring is impracticable or unreasonable and other precautions have been taken to make the face as safe as possible in the circumstances.

REGULAR INSPECTION

The condition of soil surrounding excavations can change quickly when the soil dries out, the water table changes or water saturates the soil. A competent person should frequently check the soil condition and the state of shoring, benching, battering, and excavated faces for signs of earth fretting, slipping, slumping, or ground swelling. If necessary, the PCBU should repair the excavation or strengthen the shoring from above before allowing work below ground to continue.

5.3 BENCHING AND BATTERING

Benching is a method of preventing ground collapse by excavating the sides of an excavation to form one or more horizontal steps with vertical surfaces between levels.

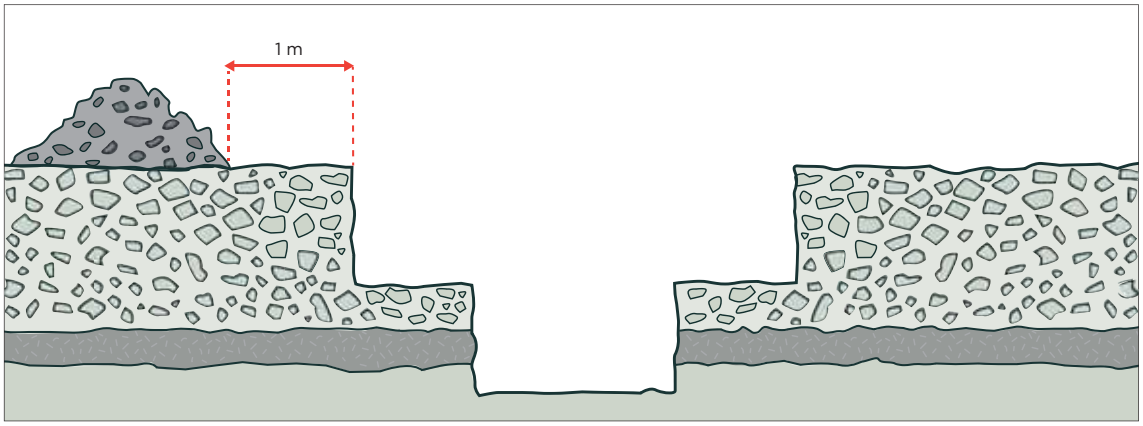

Figure 20: Benching control

Battering is where the wall of an excavation is sloped back to a predetermined angle to ensure stability. Battering reduces the risk of ground collapse by cutting the excavated face back to a safe slope.

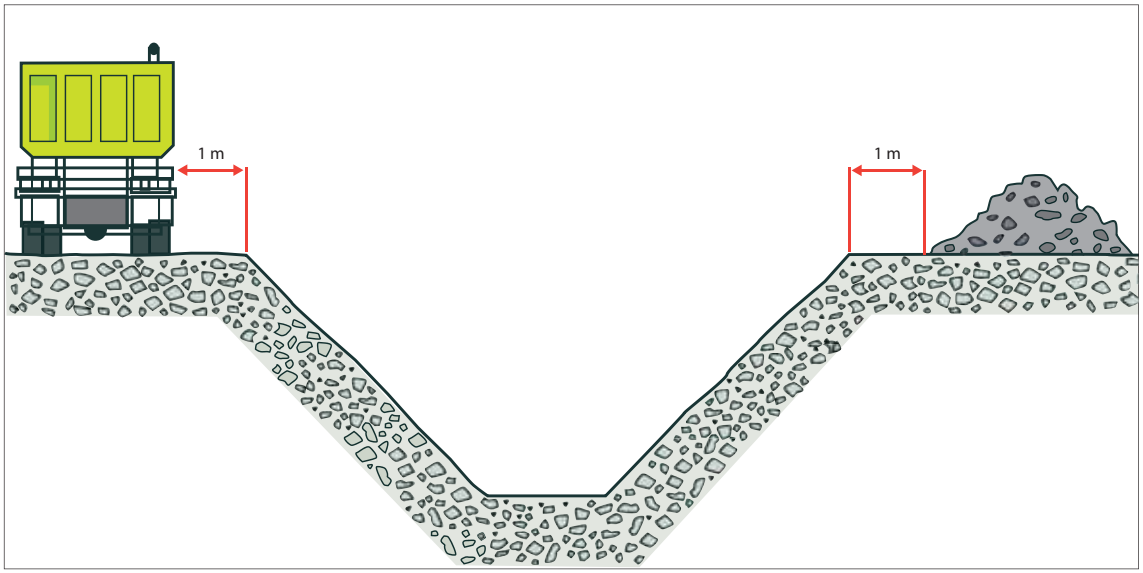

Figure 21: Battering control

Sometimes it may be appropriate to use a combination of benching and battering on an excavation.

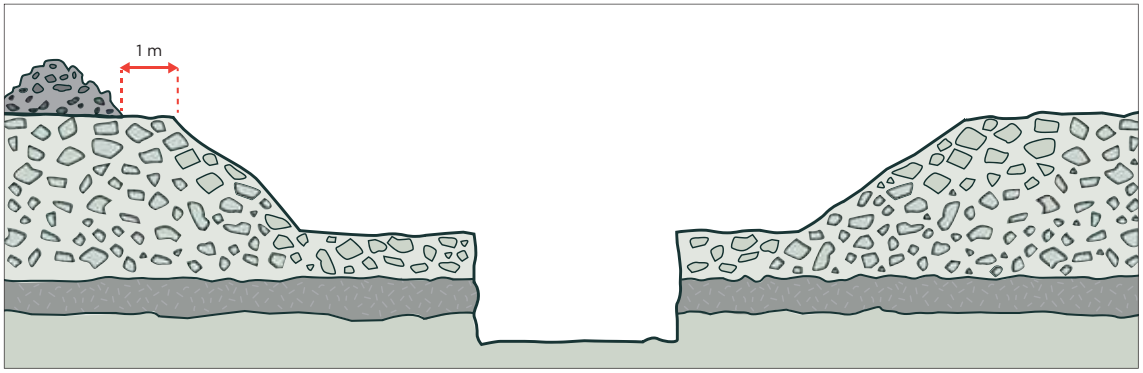

Figure 22: Combination of benching and battering controls

Benching and battering of excavation walls can minimise the risk of soil or rock slipping onto the excavation.

A competent person should design controls considering:

> soil type
> soil moisture content
> planned height of the excavated face
> any surcharge loads acting on the excavated face.

It is not necessary to bench or batter excavated faces which a competent person determines are in stable rock, or has assessed there is no risk of collapse. If benching or battering excavated walls, do not exceed the soil type's angle of repose unless designed by a competent person and certified in writing.

Benches should be wide enough to stabilise the slope to prevent spoil falling into the excavation. They should also be sloped to reduce the possibility of water scouring.

When designing the face, slopes and widths of benches, consider any earthmoving machinery that may be used and any related haul routes.

5.4 SHORING

Shoring provides support to excavated faces to prevent soil moving and ground collapsing. If the ground is not self-supporting, and benching or battering is not suitable, use shoring to manage the risk of a person being buried or trapped during excavation work.

When choosing shoring as a control use certified proprietary or non-proprietary systems, within their rated load capacity limits according to manufacturer or supplier instructions.

Involve a competent person when selecting what shoring to use. This is to make sure the shoring is fit for purpose. Otherwise, a competent person should design the shoring for the specific workplace conditions.

If risks remain for those installing shoring, put other suitable controls in place to ensure the health and safety of workers entering the excavation.

Shore the excavated face as the excavation work progresses. If using mobile plant, assess the risk to find out if any part of the excavation may be left unsupported.

As part of your safe system of work, make sure workers do not enter any unprotected part of the excavation. If the shoring is being progressively installed workers should not work ahead of the shoring.

Shoring should extend above ground level if practicable, or at least to ground level if that is not practicable, for example where covers may need to be placed over the excavation at night. If the shoring does not extend to at least ground level, bench or batter the excavation and make sure the shoring can take the surcharge load.

HSE Regulation 24 requires that any shoring, so far as is reasonably practicable:

> consists of materials that are suitable for the purpose for which they are to be used, of sound quality, and adequate in strength for the particular use
> has bracings, jacks, and struts securely held to prevent accidental displacement, and packings and wedges that are held by nails or spikes
> be placed properly by an experienced person under competent supervision
> not be altered, dismantled, or interfered with except on the instructions of the employer or a representative of the employer.

FLYING SHORING

When using shoring, it may be possible to excavate below the base of the shoring, that is: 'flying shoring'.

To do this, excavate to a maximum depth of 600 mm below the base of the shoring, if:

> the shoring is designed to resist the forces calculated for the full depth of the excavation, and
> there are no indications, while the excavation is open, of instability below the bottom of the shoring.

Control the risk of ground collapse and carefully visually inspect for any effects of:

> bulging
> base heave
> boiling
> surcharge loading
> vibration and other forces.

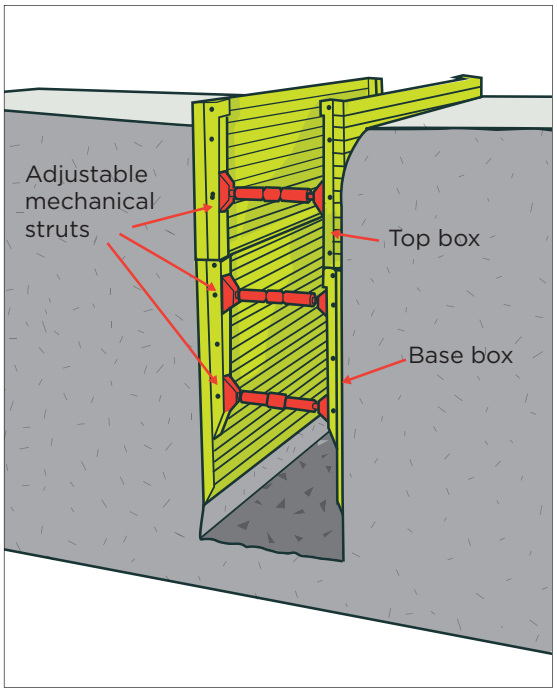

Figure 23: 'Flying' trench-shoring box

SHORING THAT USES SOIL ARCHING

Shoring that slightly compresses soil without allowing the soil to move outward can produce an arching effect in the soil. This is 'soil arching'.

Soil arching allows excavated walls shored with struts to stand even with no sheeting or lagging between the struts, without the soil behind flowing out.

Soil arching does not reduce the total soil load, but distributes it to the shoring and away from the excavated face.

The ability for shoring to use soil arching depends on the consistency of the soil. Both cohesive and non-cohesive soils will experience soil arching to some extent. Generally for soil arching to work there has to be a small amount of soil movement, but soils lacking cohesion are usually not good candidates.

Shoring that uses soil arching is generally only suitable for excavations less than 2 m deep and where each section of the excavation is open for less than one week.

Make sure to follow the manufacturer's or supplier's advice on spacing requirements and recommended preload pressures for shoring; however the closer the shoring is, the better soil arching works.

When using shoring, make sure:

> the soil is good enough for the excavation to stand when excavated
> to install support as soon as practicable
> to achieve at least minimum pressure when pumping out hydraulic support and to maintain it
> to use a minimum of three sets of support with a maximum spacing of 1.5 m
> to minimise the length of time the excavation is open.

Some ravelling, or soil falling off the excavated face between the support may occur but this will not compromise the shoring. Use backing boards or lagging to eliminate or minimise ravelling.

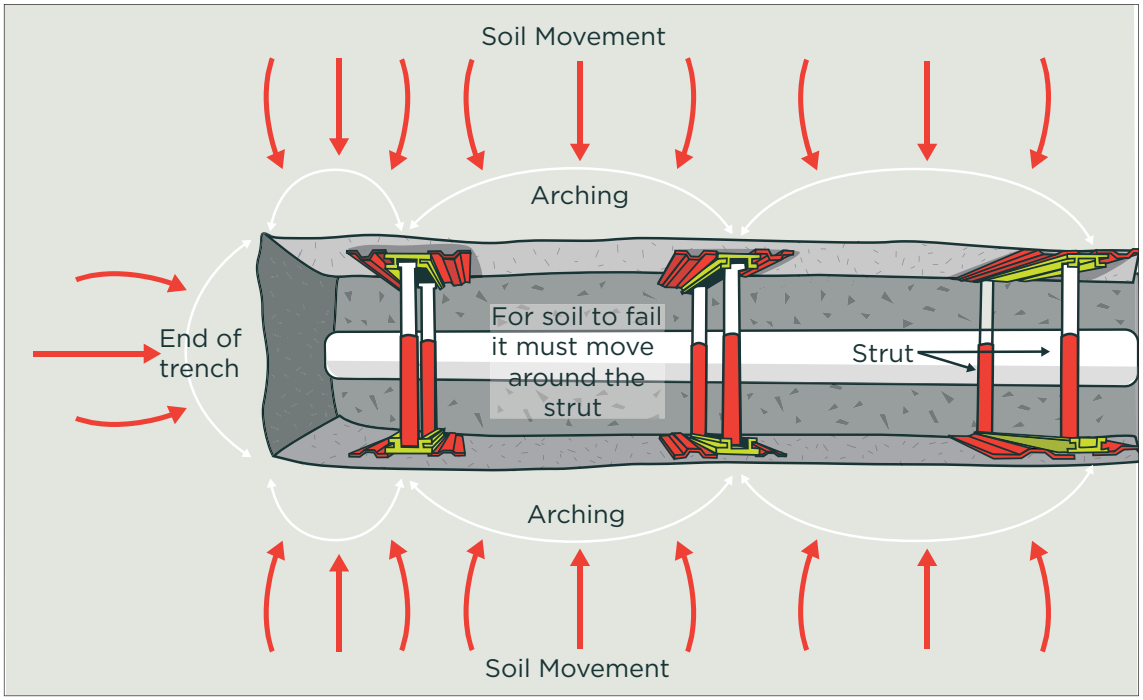

Figure 24: Hydraulic soldier shoring using soil arching

REMOVING SHORING

Remove shoring and all supports in a way that protects workers from ground collapse, structural collapse, or being struck. To keep workers safe, temporary structural members may need to be installed before any removal begins.

When removing shoring, take apart and extract it in reverse order to its installation. Workers should not work outside the protection of the shoring. No part of a shoring system should be removed until the excavation is ready for final backfill and compaction.

TYPES OF SHORING

Trench-shoring boxes, manhole boxes and trench shields

A trench-shoring box is able to withstand the forces imposed by ground, water, or surcharge loads. It will protect workers within it, as well as prevent ground collapse. This is achieved by 'digging and pushing' the box into the ground as the excavation proceeds, maintaining positive pressure on the excavated faces at all times.

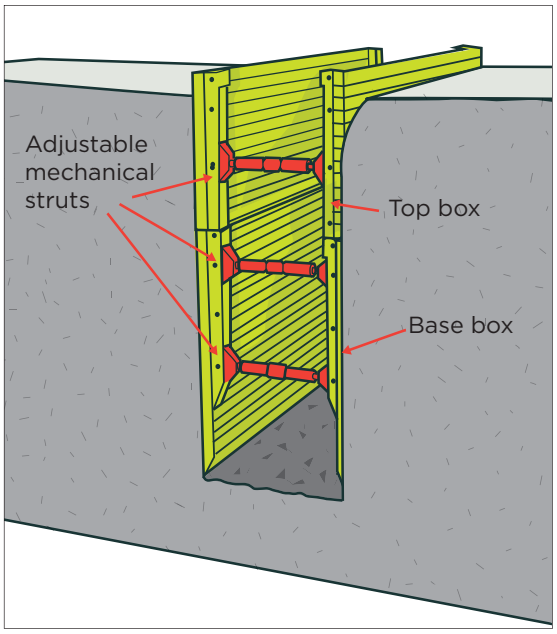

Figure 25: Trench-shoring box

Manhole boxes are a subset of trench-shoring boxes. They are designed and constructed using the same methods and materials as trench-shoring boxes. Most manhole boxes are installed using the 'dig and drop' method. If ground conditions are poor enough that the dig and drop method is not practical, consider digging and pushing manhole box shoring, corner-slide rails or hydraulic brace and sheet systems.

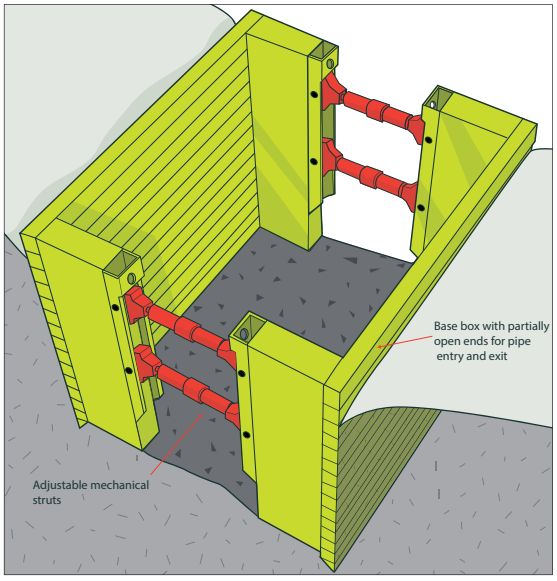

Figure 26: Manhole box

Trench shields are different to trench-shoring boxes as they are only designed to protect workers if a collapse occurs. Trench shields are designed to be installed using the dig and drop method and dragged along as work progresses.

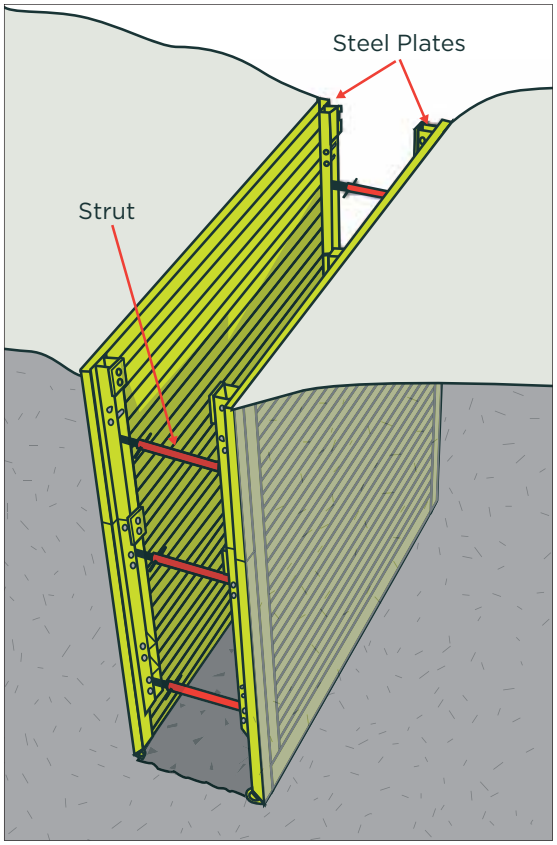

Figure 27: Trench shield

Using trench-shoring boxes and shields correctly makes it safe for workers entering the excavation, while protecting any nearby services or structures. Make sure enough trench-shoring boxes and shields are used to suitably protect workers, as the ends remain open, exposing workers near the ends to falling material. Workers should not work near each end. The length of pipes or services to install usually determines the number of trench-shoring boxes to use.

Use trench-shoring boxes and shields where access is available for an excavator or backhoe to install or extract it from a trench. They are normally not suitable where access is difficult and ground conditions prevent the use of lifting equipment.

Trench-shoring boxes and trench shields should not exceed their maximum designed load. To reduce the load and depth of the excavation, use benching and battering practices.

Suitably maintain trench-shoring boxes and shields or they may fail unexpectedly, particularly if they are damaged. Follow the manufacturer's or supplier's instructions for installing, using, removing, and maintaining them. Regularly inspect them for damage and have a competent person approve any modifications.

Follow the manufacturer's or supplier's instructions when storing or transporting trench-shoring boxes and shields. Heavy-duty equipment may require disassembly for transport.

For more information on trench-shoring boxes, including specific soil and surcharge profiles refer to *AS 4744.1: Steel shoring and trench lining equipment*.

Slide-rail or rolling-strut shoring

Slide-rail shoring is different from trench-shoring boxes and shields, because all parts including posts, panels, and rolling-strut assemblies move during the excavation. Slide-rail shoring features vertical rail posts and panels designed and manufactured to slide relative to each other to dig the shoring into the ground. The rolling-strut allows the struts to move up and down the slide-rail post during installation.

Slide-rail shoring is available in parallel configurations for trenches or rectangular configurations for deep pit excavations.

Slide-rail shoring may be used as an alternative to interlocked sheet-pile and H-pile shoring. Slide-rail shoring is normally effective to depths of up to 9 m.

Evaluate slide-rail shoring alongside other deep shoring systems, especially sheet-pile and H-pile systems. All three systems work best in poor ground conditions such as loose sands, gravels, and soft cohesive clays.

Install slide-rail shoring as the excavation work is progressing. Slide-rail shoring is designed so no void is left in the ground after it is removed. The rail posts and panels can be raised simultaneously with the backfill operation.

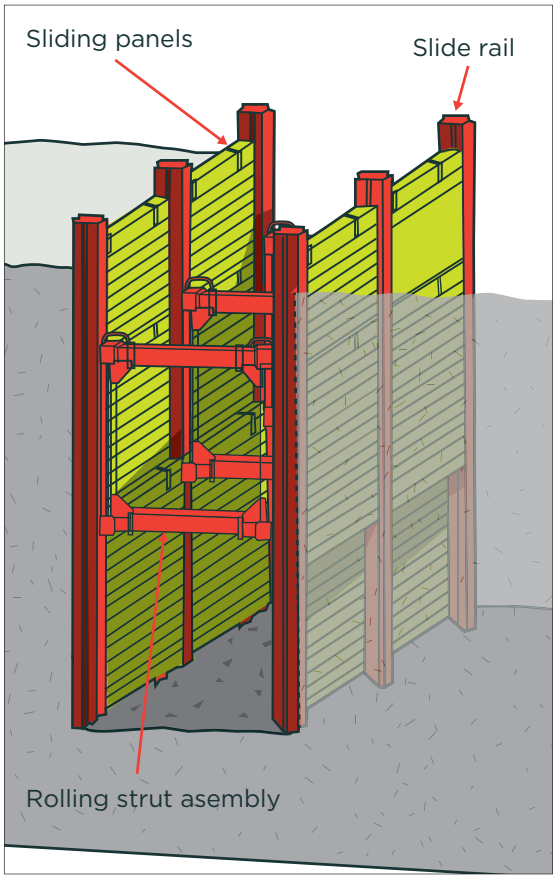

Figure 28: Slide-rail or rolling-strut shoring

Steel sheet piling and steel trench sheeting

Steel sheet piling is normally used on major excavations such as large building foundations, where large embankments need to be held back, or where the excavation is near adjoining buildings. Install sheet piling before any excavation work begins. A competent person should install the sheet piling.

Use sheet piling when the ground is so unstable that sidewall collapse is likely while excavating, for example, in loose and running sand.

Sheet piles are available in various lengths, thicknesses and profiles and interlock to provide a continuous wall.

Sheet piling is usually driven well below the excavation's base. Sheet piling is effective in high groundwater conditions preventing soil escaping behind the excavated walls, and when base heave is a risk because of weak soils.

Normally sheet piles are pre-driven using heavy equipment and vibrating head technology. Minimise noise and vibrations as well as damage to adjacent structures while installing sheet piling.

While installing sheet piling make sure the load does not exceed the piling's designed load capacity. For deep pits this normally requires welded steel frames to be designed and built into the installation. Alternatively, a competent person should design the installation of any proprietary hydraulic frames and struts.

Steel trench sheeting is lighter than sheet piling and overlaps rather than interlocks. It is faster and easier to install but is not capable of being used to the same depths of sheet piling.

It is normally positioned and pneumatically pushed into the final depth as the excavation progresses. Place toms, walings, or hydraulic bracing frames and struts into position as the soil is excavated.

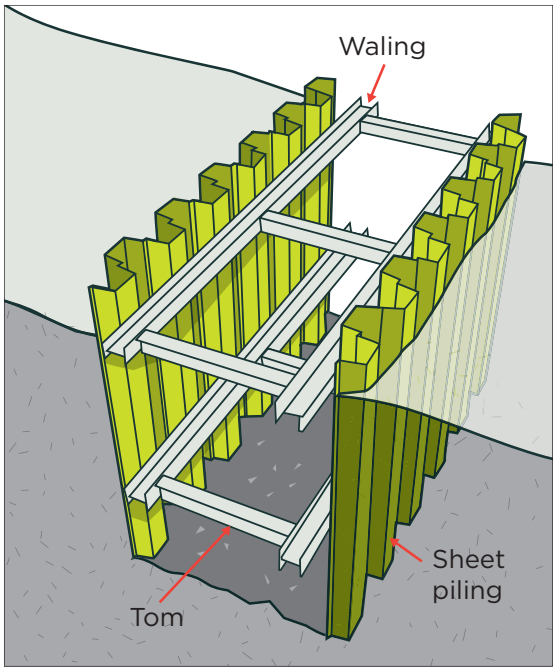

Figure 29: Steel sheet piling with internal waling support

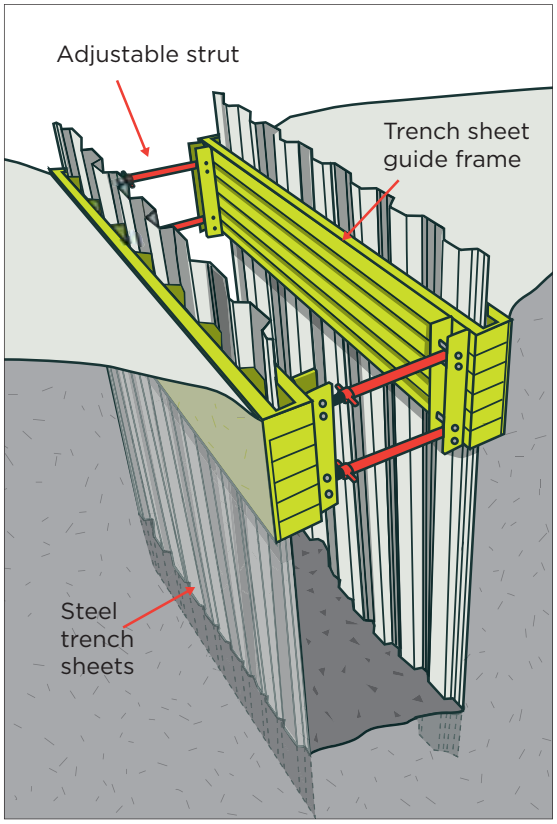

Figure 30: Guide framed steel trench sheeting

Ground anchors

A ground anchor is a structural element installed in soil or rock to transfer a tensile load into the ground. Ground anchors (sometimes referred to as 'tie-backs') alone do not support an excavation, they form part of a larger shoring system, typically with steel sheet piling.

When using ground anchors consider:

> ground conditions
> load cases
> performance criteria
> construction methodology
> construction materials.

Ground anchors may be used:

> in either granular or clay soils
> if the excavation extends through poor ground conditions
> if sensitive structures are nearby.

Install ground anchors in grout filled drill holes.

A competent person should:

> design ground anchors in accordance with commonly accepted standards, for example:
  - *FHWA-IF-99-015 Ground anchors and anchored systems*
  - *BS EN 1537 Execution of special geotechnical works – ground anchors*
  - *BS 8081 Code of practice for grouted anchors*
> perform a series of sustained static load tests on a sample of anchors to confirm they have sufficient load capacity and meet performance criteria
> always approve any soil removal above ground anchors.

Consider having the competent person prepare producer statements:

> PS1 Design
> PS4 Construction review.

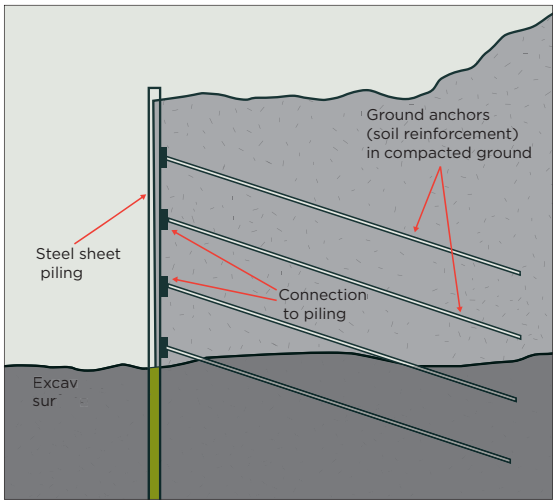

Figure 31: Ground anchors for supporting steel sheet piling

Hydraulic support

Hydraulic support comes in configurations from small, lightweight aluminium, glass-reinforced plastic (GRP) composite or aluminium soldier sets, to large steel hydraulic bracing frames and struts.

Except for small soldier sets, or waler and sheet systems, hydraulic shoring is normally used with steel trench sheeting or sheet piles.

Consider ground pressures before installing hydraulic supports. In complex situations, requiring support other than small soldier sets or waler and sheet systems, a competent person should design hydraulic support in consultation with a geotechnical engineer. The competent person should design hydraulic support to resist the expected ground pressures and potential for collapse.

Properly maintain and use hydraulic support or it may become unreliable. Frequently inspect pressure hoses and rams to detect abrasion, fatigue, or damage such as bent or notched rams.

When the excavation has been fully supported, dismantle the hydraulic support to prevent damage. Inspect, repair if necessary, and store the hydraulic supports so they are not damaged before they are used next.

For more information on hydraulic shoring refer to *AS 5047: Hydraulic shoring and trench lining equipment*.

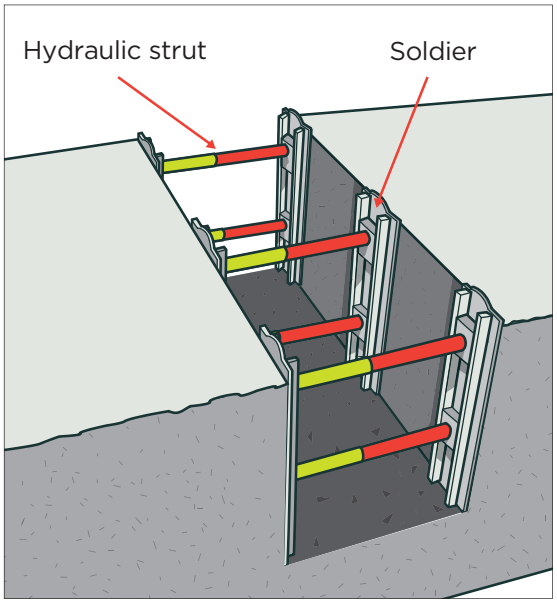

Figure 32: Hydraulic soldier shoring

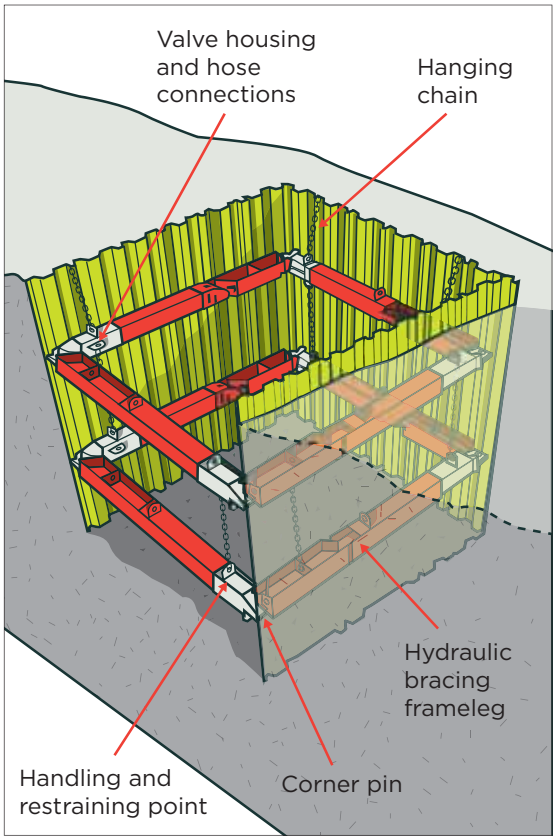

Figure 33: Hydraulic bracing frame with steel trench sheeting

H-pile shoring

H-pile shoring is normally used in large open excavations or pit excavations. Steel H-piles are an advanced form of piling installed by drilling or driving. Timber lagging is normally used between the H-piles every 1.8 to 3 m. Each excavation will require a site-specific design.

Only use H-pile shoring in ground which has enough soil arching potential to permit lagging. The soil should be above the static groundwater level, or have been dewatered. Lagging does not extend below the excavation's base so do not use H-pile shoring and lagging where there is potential for base heave or water and soil flows.

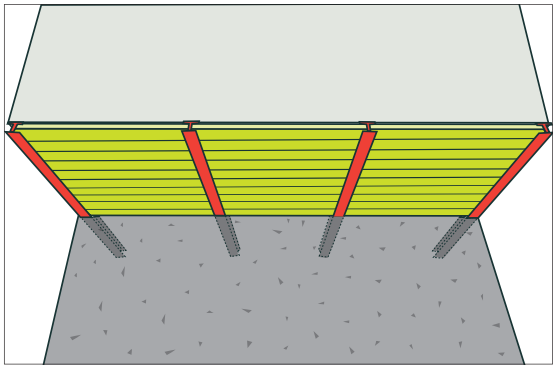

Figure 34: H-pile shoring with timber lagging

Soldier sets

Soldier sets are a simple form of support mostly used in rock, stiff clays and in other soil types with self-supporting properties capable of generating soil arching.

Unlike closed sheeting sets, soldier sets only provide ground support at regular intervals and do not provide positive ground support to the whole excavated face.

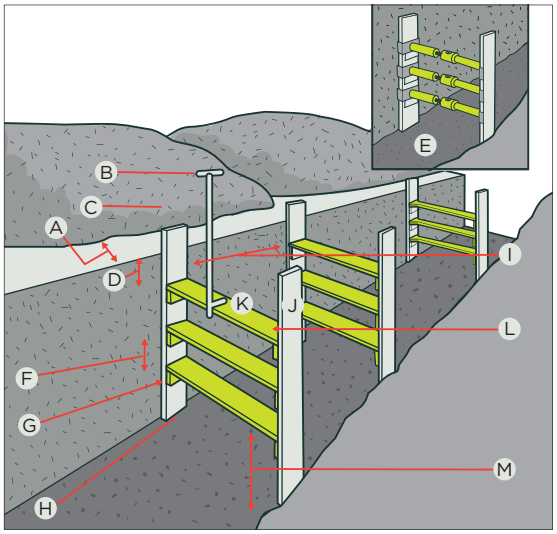

Figure 35: Soldier sets

A. Spoil heap at least 1 m clear
B. Place toms safely from outside the excavation
C. Spoil
D. Top tom 300 mm minimum from the top
E. For added side support, steel struts may replace timber toms
F. 750 mm maximum spacing of toms
G. Securely nail cleats to soldiers before placing soldiers
H. Soldier resting securely on the bottom
I. Maximum spacing between soldier sets 1.5 m
J. Soldier, minimum size 150 x 38 mm
K. Tom, minimum size 150 x 38 mm
L. Tom should be long enough to force soldiers firmly against excavated faces. To prevent soldiers excessively bowing against irregular faces, use wood packing between the face and soldier
M. 600 mm maximum spacing between the bottom tom and excavation floor

Timber shoring

Consider using timber shoring if continuous forms of shoring, or metal shoring cannot be used, for example, where services cross the excavation or need to be worked around.

Timber is used as lagging with H-pile shoring and sometimes for long-term excavations such as pipe drilling pits.

A competent person should design any timber shoring conforming to the timber sizes and grades specified in Table 6.

Timber species and quality have a large effect on strength. Struts, walings, and sheeting sizes should not be less than the minimum sizes and grade prescribed in Table 6.

Timber shoring has some specific safety issues. Installing timber shoring to some extent requires workers to work inside an unshored excavation. Carefully plan any installation procedure as workers must be protected from becoming trapped or engulfed by a cave-in. If required, use temporary intermediate waling and strutting.

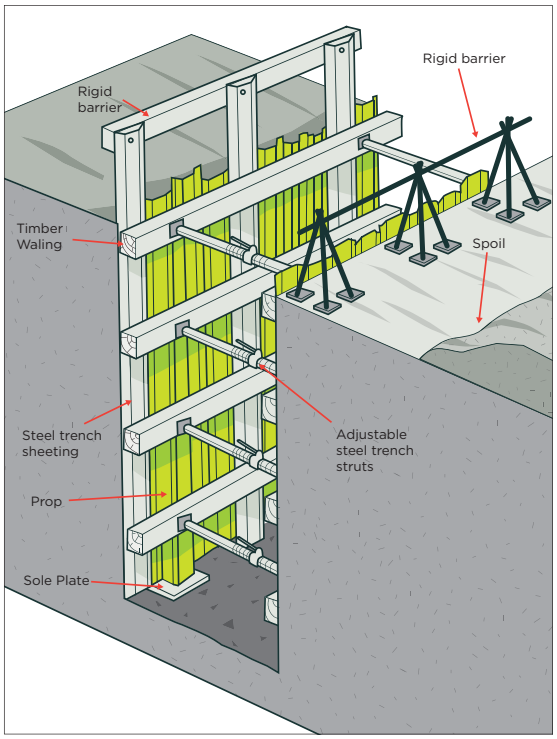

Figure 36: Timber shoring with steel trench sheeting

SOIL CONDITIONS	TRENCH DEPTH (m)	TIMBER SHEETING		TIMBER WALINGS		TIMBER STRUTS					STEEL ADJUSTABLE STRUTS (size no.)				
						Trench width up to			Spacing C to C		Trench width up to			Spacing C to C	
		Min. Dims (mm)	Horizontal spacing (mm)	Min. Dims (mm)	Vertical spacing C to C (mm)	1.0 m (mm)	2.0 m (mm)	2.5 m (mm)	Vertical (mm)	Horizontal (mm)	1.0 m	1.5 m	2.0 m	Vertical (mm)	Horizontal (mm)
Type A Unsaturated ground; soils above ground water table or level	Up to 3.0	150 x 50	1200-300 (a)	150 x 100	1200	100 x 100	150 x 100	150 x 150	1200	1800	No. 2	No. 3	No. 3	1200	1600
	3.0 – 4.5	150 x 50	600 – close (b)	150 x 100	1200	150 x 100	150 x 150	150 x 150	1200	1800	No. 2	No. 3	No. 3	1200	1000
	4.5 – 6.0	200 x 50	300 – close (c)	250 x 100	1200	150 x 100	150 x 150	200 x 150	1200	1800	2/No. 2	2/No. 3	2/No. 3	1200	1600
Type B Saturated ground, soils below ground water table or level	Up to 3.0	150 x 50	close	225 x 150	1200	150 x 100	150 x 150	150 x 150	1200	1800	2/No. 2	2/No. 3	2/No. 3	1200	1600
	3.0 – 4.5	200 x 50	close	250 x 150	1200	150 x 150	200 x 150	200 x 150	1200	1800	2/No. 2	2/No. 3	2/No. 3	1200	1000

Table 6: Timber shoring requirements for trenches

Notes:

1. All timber used for shoring should be sound quality framing grade or structural timber and should conform to *NZS 3603 Timber structures standard*.
2. Timber walings and sheeting made of steel or other material may be used in lieu of timber provided they are equivalent in strength to the sizes prescribed.
3. (a) = 1/8 to 1/2 sheeting

   (b) = 1/4 to full sheeting

   (c) = 1/2 to full sheeting.

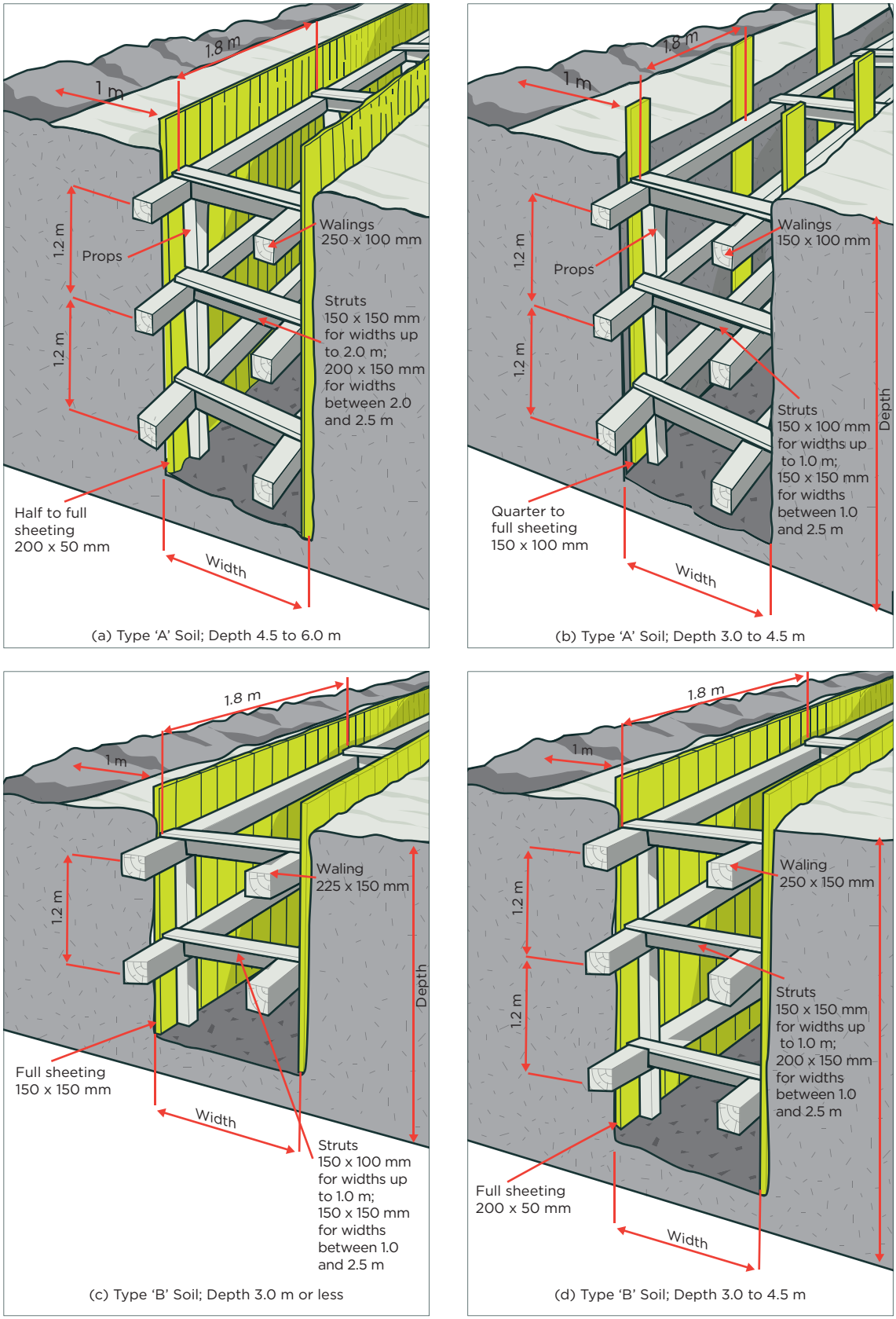

Figure 37: Timber shoring requirements for trenches

5.5 EXCAVATED MATERIAL AND LOADS NEAR EXCAVATIONS

The influence of any loads near the excavation can cause ground collapse. Any excavated material and external actions applying a load to the ground nearby can affect the excavation's stability through the zone of influence. The zone is normally from the base of an excavated face to the surface. The zone's angle will depend on site-specific factors.

Mechanical plant, vehicles, spoil, or heavy loads should not be in the zone of influence plus 1 m from an excavation unless specific design can show it can support the surcharge load.

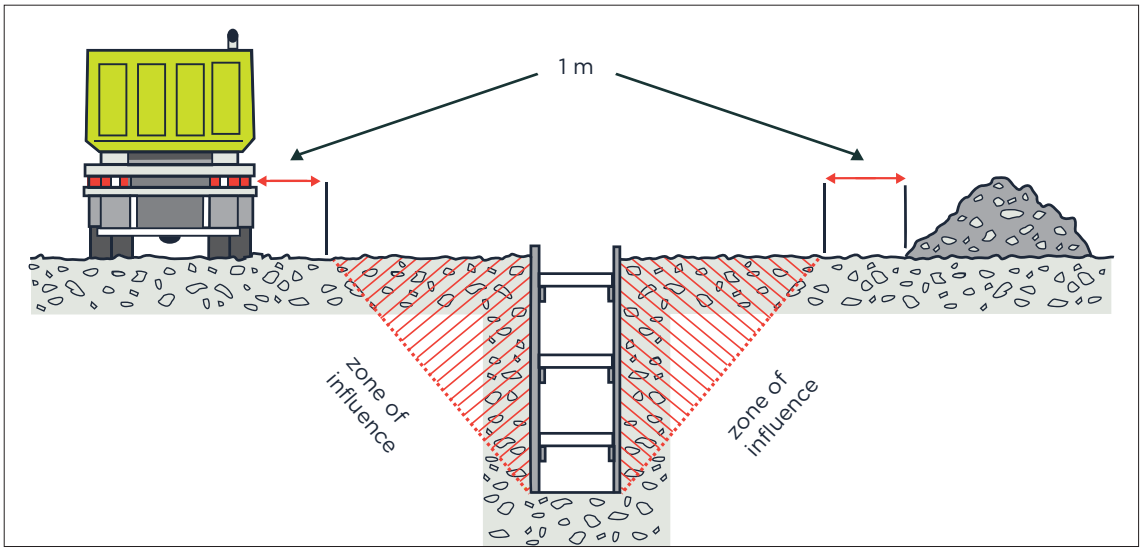

Figure 38: A shored excavation designed to carry soil loads only

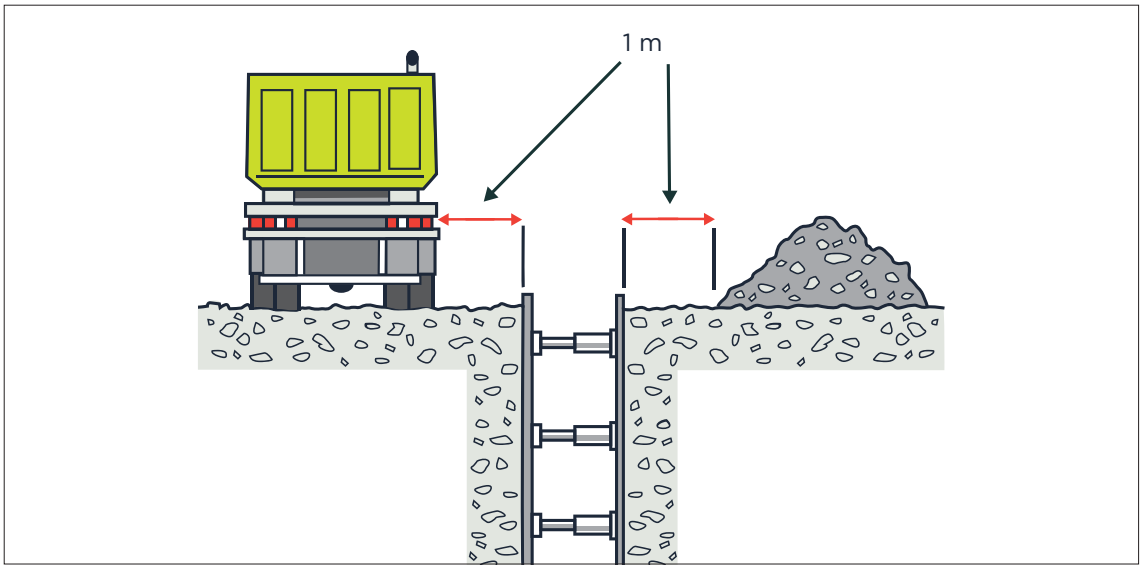

Figure 39: A shored excavation designed to carry soil, vehicle and spoil loads

Placing or stacking spoil near an excavated face puts workers at risk because it adds an extra load where it is placed or stacked. For example, placing spoil near the excavated face may cause it to collapse.

MANAGING THE RISK

Use shoring designed and installed to carry extra loads, including groundwater pressures, saturated soil conditions and saturated spoil. Store spoil away from the excavation's zone of influence plus 1 m.

If spoil is placed close to an excavation due to obstructions like fences, buildings, or trees, the weight of the spoil may overload the excavated faces. In this case, strengthen the ground support system at these locations and provide barriers to prevent the material falling into the excavation.

If excavating beside an old service line, place spoil on the opposite side of it to prevent excessive loading on previously weakened ground.

If excavating in sloping ground decide which side of the excavation to place the excavated material. Consider:

> ground conditions
> access to the excavation
> existing underground services
> needing earthmoving machinery or vehicles to work or move beside the excavation
> service installation and backfilling requirements
> manual work in the excavation.

Placing spoil on the lower side of the excavation will reduce the effective depth of the excavation and the risk of spoil falling into the excavation.

Make sure spoil placed on the high side of the excavation does not increase the risk of ground collapse, flooding, or holding back run-off water. Place spoil so it channels rainwater and other run-off water away from the excavation.

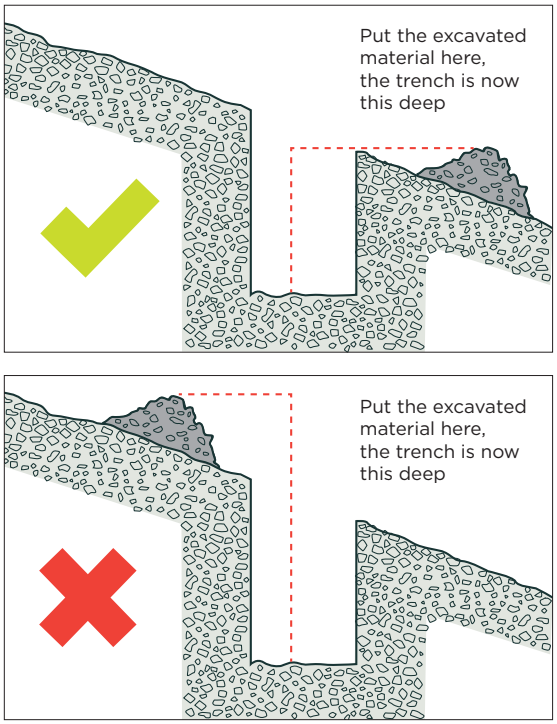

Figure 40: Spoil placement on effective excavation depth

5.6 PREVENT FALLS

Work at height means working in a place where a person could be injured if they fell from one level to another. This can be above or below ground level. First try to eliminate the risk of falling, so far as is reasonably practicable.

MANAGING THE RISK

Use edge protection or fencing able to take the weight of a falling worker. Where shoring extends above 200 mm, toe boards are not required.

Controls to minimise the risk of falling include:

> fall prevention devices (eg temporary work platforms, edge protection and guard rails)

- work positioning systems (eg industrial rope access systems)
- fall arrest systems such as catch platforms
- using shoring itself (eg using trench box extensions or trench sheets taller than the excavation's depth). Where shoring extends above 200 mm toe boards are not required
- installing and securing covers over excavations during non-work times
- installing guard rails and edge protection into the ground immediately around the excavation
- installing landing platforms or scaffold towers inside deep excavations
- securing ladders to shoring
- providing clearly defined pedestrian detours
- providing alternative access and egress points for emergency use
- backfilling the excavation as work progresses.

When installing effective barriers or barricades, or guard rails see WorkSafe's guidelines *Working at Height in New Zealand*, available at www.worksafe.govt.nz

5.7 SAFE ACCESS AND EGRESS

Provide safe access and egress for all workers at all times. Keep the floor of the excavation clear of anything that would impede workers' safe egress in an emergency, including:

- debris
- loose spoil
- timber
- tools.

MANAGING THE RISK

In excavations:

- Up to 1.5 m deep, provide ladder, stairway, or ramp access and egress.
- 1.5 m or more deep, provide ladder or stairway access and egress.

USING LADDERS

Use ladders constructed of suitable materials, conforming to appropriate standards, and maintain them in good condition.

If an excavation is such a small dimension that it is not reasonably practicable to use ladder access or egress, provide other means to allow workers safe access and egress.

For every vertical rise of 6 m, break up ladder runs with intermediate landings. Where ladders meet a landing, offset the ladder below from the ladder above by at least 600 mm.

Unless there are alternative handholds, extend ladders 1 m above the landing or the top of the excavation. Fit landing platforms with guardrails, midrails and/or toe boards.

For more information see WorkSafe's fact sheet *Safe Working with Ladders and Stepladders*, available at www.worksafe.govt.nz

USING STAIRS AND RAMPS

Use temporary stairways in deep excavations as they provide safer access and egress than ladders.

Each flight of stairs should have uniform risers and provide landings of the same width as the stairs for every vertical rise of 6 m.

If using ramps instead of stairs, the maximum slope should not exceed 1 in 6, unless traction cleats are provided at 0.5 m spacing for 1 in 5 slopes, or at 0.4 m spacing for 1 in 4 slopes.

Ramps should not be steeper than 1 in 4.

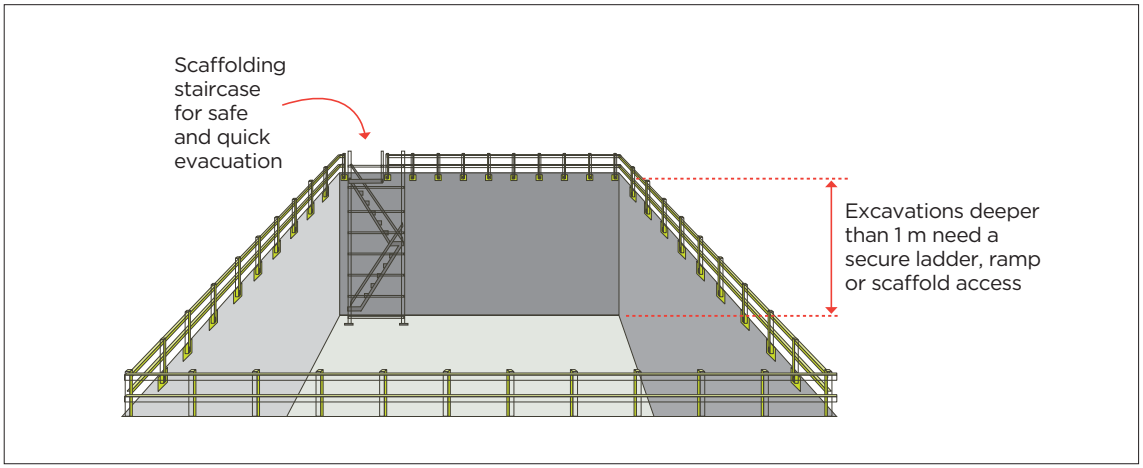

Figure 41: Scaffolding staircase for a safe and quick evacuation

5.8 MANUAL WORK

During excavation work, there will be circumstances that require some form of manual work including:

> hand excavation
> lifting
> working in close proximity to plant and other workers.

Tasks which may lead to manual handling injuries include:

> potholing with sharp hand tools
> spotting/exposing underground services in close proximity to excavator buckets
> frequently accessing trenches around existing services
> installing and removing shoring and fall protection
> placing heavy pipes into the excavation
> using compacting equipment
> using breakers
> using drills.

Manual excavation methods are generally used for small, shallow excavations (eg less than 1.5 m deep) in soft soils.

For some excavations, manual work such as trimming by hand will be required. Trimming can often be accomplished from outside the excavation by shovelling or pushing the material with a long-handled tool or shovel to the bottom of the excavation, where it can be picked up by mobile plant.

Preparatory drilling activity and hand drills may increase the risk of musculoskeletal disorders, including vibration disorders.

MANAGING THE RISK

Controls include:

> creating exclusion zones around mobile plant and ground buckets – disengaging controls when spotters have to get close
> keeping sites tidy and free from trip hazards and loose materials which may lead to slips
> maintaining safe working spaces around workers
> providing safe access and egress
> rotating tasks and making sure workers take breaks
> using correct lifting techniques to ensure solid footing
> using plant to place and position shoring, props and plates, and remove compactors
> wearing correct PPE.

When working close to others, keep workers sufficiently far apart to prevent injury. This applies particularly to work in trenches and small excavations.

For more information on controlling the risks of manual handling, refer to WorkSafe's *Code of Practice for Manual Handling*, available at www.worksafe.govt.nz

5.9 OVERHEAD AND UNDERGROUND SERVICES

Workers and others nearby can be killed or seriously injured by striking services that are overhead or underground.

Avoid striking or undermining services. Good planning and supervision should identify and anticipate all overhead and underground services, which will help decide what activities will be allowed near the excavation work.

Mobile plant operators should:

> know what overhead and underground services are in the vicinity
> identify and mark out underground services
> assume all services are live or in use unless the service owner formally advises in writing there are no risks with the service
> know how far the mobile plant (eg excavator) can reach
> know minimum approach distances (MADs).

SERVICE	DISTANCE AWAY
Cables, gas transmission or high pressure pipelines	2 m or more
Overhead power line	4 m or more
Pole or support stay	5 m or more
Tower	12 m or more

Table 7: MADs to excavate with mobile plant[9]

[9] For more information and any exceptions refer to WorkSafe's *New Zealand Electrical Code of Practice for Electrical Safe Distances* available at www.energysafety.govt.nz

Any plant or excavation activity (including using hand-held tools) closer than the MADs summarised in Table 7 requires a documented permit or consent from the service owner. This should be held on site. Always check with the service owner, as they may have their own specific requirements for work on their service.

Understand the service owner's permit or consent conditions for the work activity and follow these while operating the plant and carrying out the excavation. In some cases this may include following guidance or instructions from a service representative on site.

Always assume there are underground services at the site. Make sure the services are located and confirmed by the service owner. Some service plans are not accurate and the actual position and depth may be quite diferent. There may also be other unmapped services present, and services owned by different parties.

Consider:

> services may be encased in concrete bases, structures, sleeve pipes or coloured ducts
> some cables may not be in any duct or pipe
> services can be at a shallower depth where they cross obstructions such as culverts, or where the ground surface level has changed
> what actions to take in an emergency.

For more information on the risks of work near underground services, refer to WorkSafe's *Guide for Safety with Underground Services* available at www.worksafe.govt.nz

MECHANICAL EXCAVATION

The risk of striking and fracturing a service while excavating increases with the use of mechanical excavation methods.

MANAGING THE RISK

Use plans, mark-outs, locators and safe digging practices when working near buried services.

To minimise risk:

> with the service owner's permission, use water or air vacuum methods to expose congested services
> carefully dig pilot holes progressively towards the services ahead of small-step excavations. Be aware that water under pressure around electric cables with worn sheaths or old joints may cause an electrical hazard
> use one or more spotters to spot obstacles or any signs of services in the excavation. Make sure spotters are a safe distance from any plant movement but still able to see and warn the operator
> excavate as if expecting the unexpected
> excavate alongside the services with suitable side clearance.

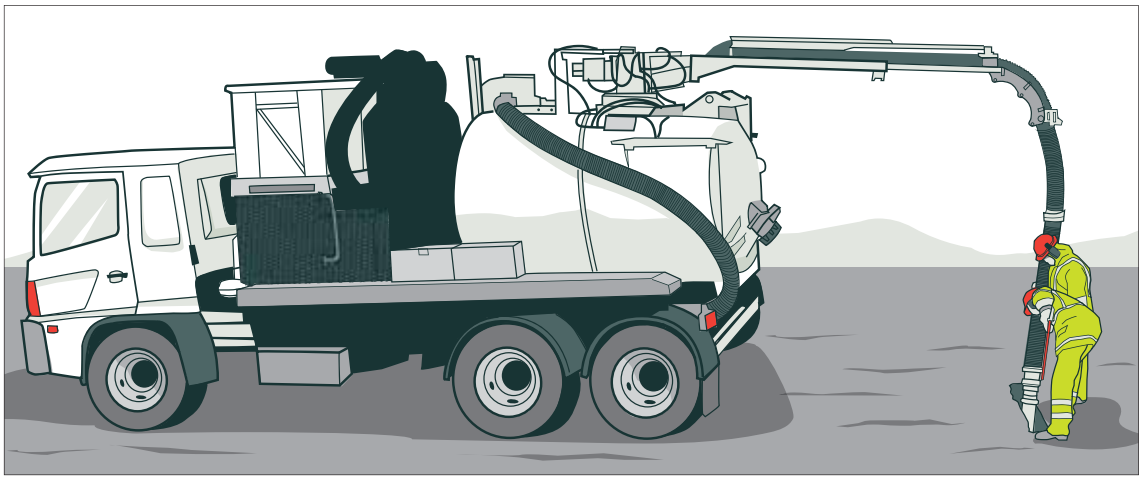

Figure 42: Vacuum truck digging a pilot hole

HAND-HELD TOOLS

Using hand-held tools to approach closer to the point of exposing services can risk fracturing a service if a strike occurs.

MANAGING THE RISK

To minimise risk:

> use detectors to locate services laterally as excavation depth progresses, before working towards and exposing the services
> dig in line with the service, not at right angles
> use hand-held tools suitable for breaking hard surfaces, provided there is adequate substrate keeping the tool ends well separated from the services, including making sure:
  - not to thrust or spike any hand-held tools into the ground in the close vicinity of services
  - hand-held tools (eg shovels and spades) have non-metallic handles and curved edges to ease covering ground away
  - any use of picks, bars or forks is to ease lumps or rocks away. Avoid using metal picks, bars, forks, drills, or hammers near live electrical cables
> use full body cover with arc-resistant or flame-retardant materials when exposing electric cables, including anti-static properties where gas is a potential hazard.

Once services are exposed:

> identify what the exposed services are:
  - service ducts, markings and symbols are in WorkSafe's *Guide for Safety with Underground Services* available at www.worksafe.govt.nz. Old or improperly marked services may vary a lot from the recommended markings
> always treat any uncovered service as electrical or gas until identified
> check with the service owner for their duct and marking colours and identify what the underground services are and their status.

Live electrical work minimum approach distances

For work around live electrical services, use the MADs set out in section 9 of WorkSafe's *New Zealand Electrical Code of Practice for Electrical Safe Distances* (ECP 34). Apply MADs from the hand-held tool to the exposed service.

MADs are available for non-competent persons. Reduced MADs are available where:

> the owner of the live parts gives written permission
> competent employees are working near exposed live parts.

ECP 34 defines a 'competent employee' as an employee who can demonstrate the necessary knowledge, skills and experience to carry out electrical or telecommunications work in the vicinity of overhead electric lines, or exposed live metal, safely and to the standards used by the employer.

BACKFILLING

Consult with the service owner before backfilling. Use appropriate materials to preserve the support and condition of the services. Send information to the services owners so they can update their service plans.

For more information on corridor access requests and corresponding work authority permits refer to the New Zealand Utilities Advisory Group's (NZUAG) *National Code of Practice for Utility Operators' Access to Transport Corridors* available at www.nzuag.org.nz

GAS SERVICE STRIKE

Sparks from striking a gas line can ignite gas and cause a fire or explosion. If a gas line is ruptured, nearby running plant could cause the gas to ignite.

MANAGING THE RISK

To minimise risk:

> Use plastic (resin) intrinsically rated hand-held tools or brass tools around gas services.
> If inside an excavator, turn off the ignition and immediately leave it and the work area and move to a safe distance.
> Turn off any other sources of ignition.

OVERHEAD POWER LINES

Excavating too close to overhead service support structures such as wooden poles can cause these to lean or collapse, putting workers and others at risk. Breaking communications cables can also release laser light that can damage eyesight.

MANAGING THE RISK

To minimise risk:

> carry out operator briefings to:
  - clarify any MADs
  - understand the mobile plant's capability (ie knowing how far the mobile plant can reach)
> put signs or warning labels in the cab about the MADs
> temporarily earth the mobile plant
> use markers and spotters
> shield services
> electrical hazards to mobile plant near overhead power lines and electric cables
> string independently supported fl ag bunting 1.5 m below the span. The operator and spotter can use this as a guide. Consult the service owner to get consent before stringing any bunting.

If the service owner consents to excavating closer than the 4 m MAD:

> Protect operators (including operators of remote controlled plant) from electrical hazards.
> Keep people away from the mobile plant in case of electrical contact.
> Have emergency response procedures in place, if electrical contact does accidently happen.

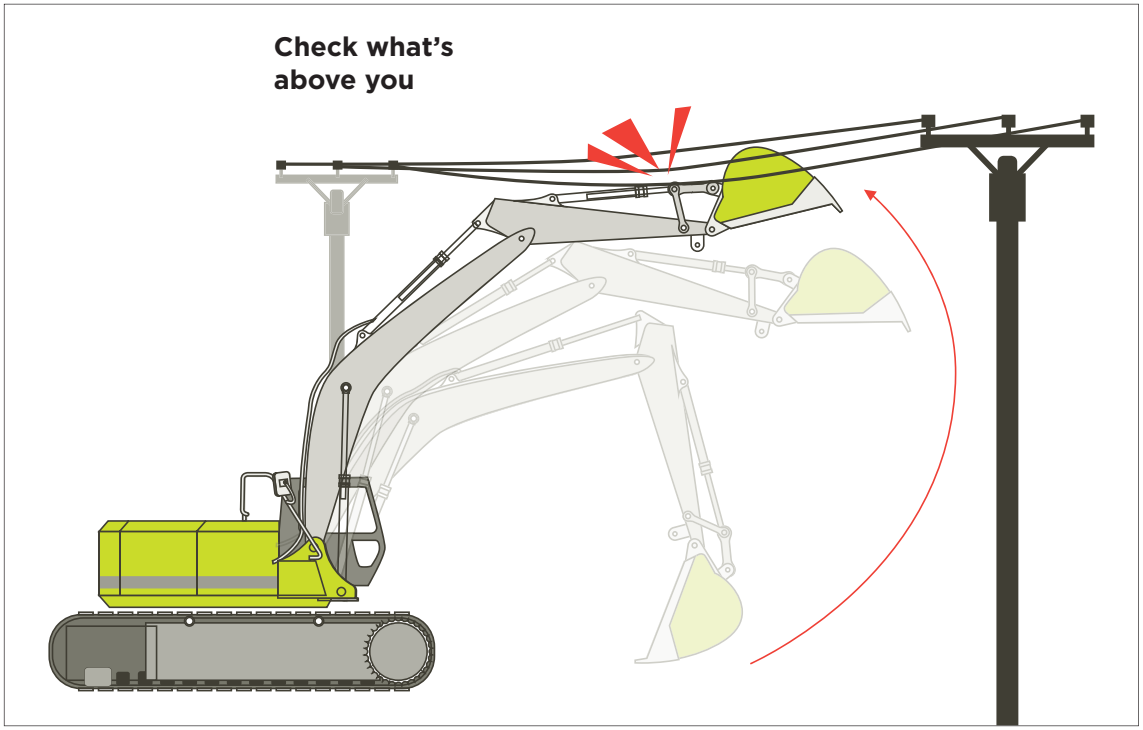

Figure 43: How an excavator can come in contact with live power lines

If there is contact with live power lines, make sure:

> the operator remains inside the excavator unless threatened by fire

> all workers keep well clear of the excavator and anything else in contact with electricity, and shuffle to clear the area

> to call the emergency service

> to initiate an emergency response, including with the service owner to shut down and isolate the affected service

> to restart work only when emergency service authorities and service owners authorise this.

For more safety information about work near power lines and underground electic cables see the Electricty Engineers' Association (EEA) *Guide for Non-Electricity Industry Employees Using Mobile Plant Near Power Lines and Electricity Cables*.

5.10 ATMOSPHERIC CONTAMINANTS

Excavations can have poor natural ventilation. Control the risk of any atmospheric contamination or build-up of gases and fumes.

Dangerous atmospheres can occur in excavations because of a lack of oxygen or the presence of toxic gases, flammable gases, or simple asphyxiates, for example:

> gases (eg hydrogen sulphide)

> engine fumes (eg carbon monoxide and carbon dioxide)

> leakage from:
  - gas bottles
  - fuel tanks
  - sewers
  - drains
  - gas pipes
  - LPG tanks.

GROUND TYPE	ATOMOSPHERIC CONTAMINANTS
Peaty ground	methane, hydrogen sulphide
Filled and made ground	carbon dioxide, hydrogen sulphide
Reclaimed land and tips	methane, carbon dioxide, hydrogen sulphide
Thermal areas	hydrogen sulphide, carbon monoxide, carbon dioxide, sulphur dioxide, methyl mercaptan
City streets	carbon monoxide, natural gas, carbon dioxide
Service stations	petrol and hydrocarbons, kerosene, LPG

Table 8: Other potential sources of harmful gases from types of ground

MANAGING THE RISK

Maintain an atmosphere that is fit to breathe, limiting any contaminants to safe levels, by:

> never using plant with a combustion engine (eg air compressors, electrical generators) in an excavation if workers may potentially enter to work

> using gas monitoring devices

> using ventilation – whether natural, forced, or mechanical to control leaking or seeping toxic gas.

To help determine safe levels, compare the results of air monitoring to workplace exposure standards. For more information, including health-monitoring information, see WorkSafe's *Workplace Exposure Standards and Biological Exposure Indices*, available at www.worksafe.govt.nz

Ventilation systems help to maintain adequate oxygen levels and dilute flammable gases, fumes and certain dusts, such as coal and sulphide. These can ignite if they are present in explosive limits. Mechanical ventilation also reduces dust, fumes and hazardous contaminants, and can control air temperature and humidity.

A competent person should design the ventilation system so it provides plenty of ventilation throughout the excavation. This might include adding localised extraction ventilation to deal with the dust, heat, or fumes from the excavation. The design should allow for installing ventilation equipment or ducting as the excavation progresses to maintain adequate air supply to the working face.

5.11 GROUND AND SURFACE WATER

Workers should not work in excavations where water has collected or is collecting, unless the necessary controls are in place.

Water may collect because of:

> a high groundwater table seeping into the excavation
> nearby storm water drains
> surface run-off after heavy rain
> a nearby swamp, dam, lake, or river.

MANAGING THE RISK

Controls may include:

> shoring
> dewatering techniques (ie water removal), improved by using:
  - cut off walls
  - grouting or an asphalt bund
  - horizontal wells
  - compressed air.

When selecting the most appropriate dewatering technique, consider:

> available space within and around the excavation
> depth to the existing groundwater and the necessary increase in this depth to permit access to the excavation
> soil permeability in and around the excavation; note: this may vary across the site
> structures or underground surfaces near the excavation that may be damaged because of dewatering induced ground settlement
> potential for base heave.

Figure 44 and Figure 45 show two dewatering techniques.

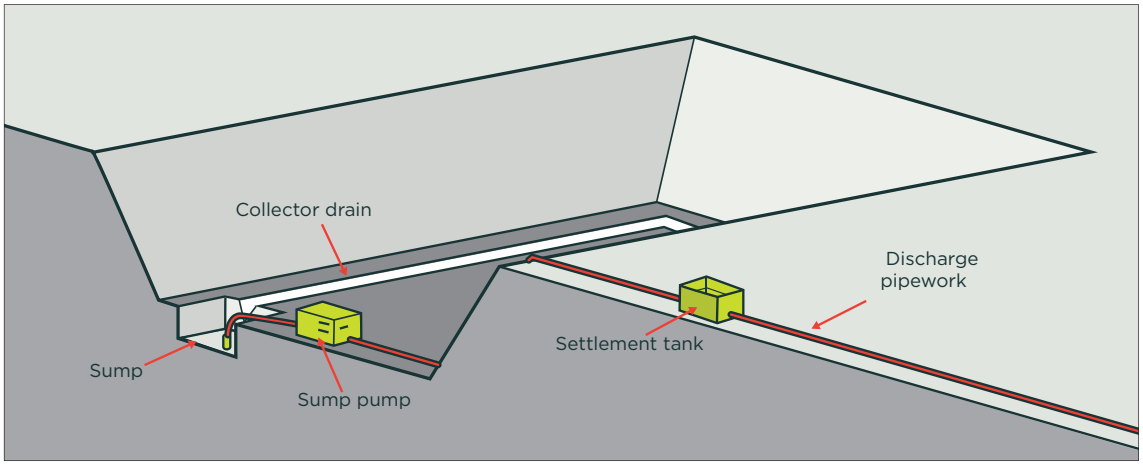

Figure 44: Traditional sump pumps control surface water at the excavation's base

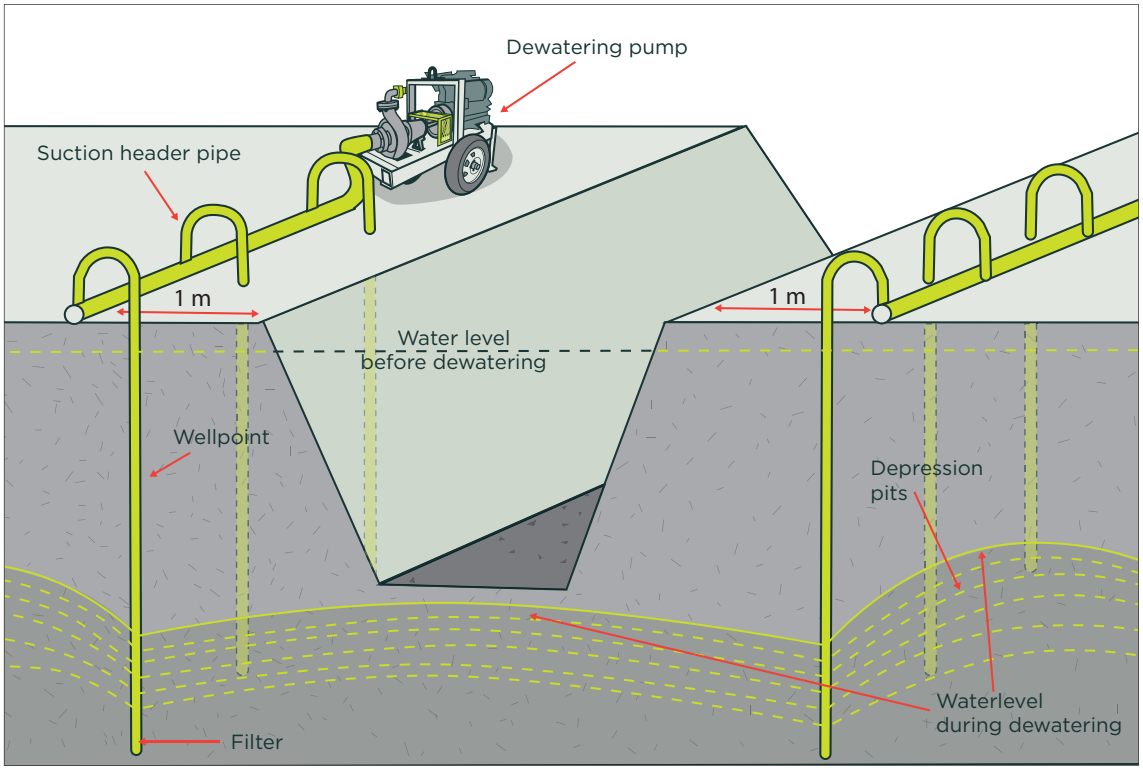

Figure 45: Use well point pumping for lowering groundwater by up to 6 m

5.12 CONTAMINATED SOILS AND GROUNDWATER

Contaminated soils and groundwater can pose a risk to human health through:

> direct contact
> inhaling dust or vapours
> petroleum hydrocarbon contaminated soil
> general landfill
> suspected asbestos containing material (ACM).

Before starting any excavation work, assess the likelihood of encountering contaminated soils or groundwater. If contamination is suspected or discovered, the risk to human health and the environment will require reassessment.

Health monitoring applies to workers if they are at risk of airborne asbestos exposure when carrying out ongoing asbestos-related work or asbestos removal work and are at risk of exposure to airborne asbestos when doing that work.

For more information see WorkSafe's position statement *Managing Occupational Health on Potentially Contaminated Sites*, available at www.worksafe.govt.nz

The Resource Management Act 1991 contains prohibitions against the discharge of contaminants into or onto the land, the water, or the air unless the discharge is expressly allowed by a national environmental standard, a rule in a regional plan or a resource consent.

Contaminated soils and groundwater can also harm the environment through:

> stormwater and groundwater

> dust

> moving or disposing of contaminated soil.

Indicators of potential contamination include, but are not limited to, unusual odours and discoloured or stained water seeps and soils where the land is potentially or actually contaminated.

A land use consent may be required from the local authority to excavate or disturb soils at the site. Seek further advice from a suitably qualified and experienced practitioner.

5.13 USING EXPLOSIVES

Construction work that uses explosives is subject to the Hazardous Substances and New Organisms Act 1996 (HSNO) and regulations. All possession, storage, handling, and use of explosives must be carried out in compliance with this legislation.

The PCBU should consult a competent person in the controlled application of explosives for carrying out the excavation work before deciding whether explosives should be used for the excavation.

Transport explosives in accordance with the Land Transport Act 1998 and regulations and HSNO.

Explosives must only be used by an approved handler who is qualified in explosives safety and has experience in this type of work.

If explosives are used in excavation work, an approved handler should develop the blast management plan and be responsible for all aspects of the use of explosives.

For more information on the use of explosives for excavation work, refer to *AS 2187.2: Explosives – storage and use – use of explosives*.

06/

PLANT AND EQUIPMENT

IN THIS SECTION:

Use suitable plant and equipment maintained in good condition to carry out excavation work safely.

Various plant and equipment can carry out excavation work. Excavators in a range of sizes can:

> extract soil from within an excavation
> lift and move materials
> install and remove shoring.

Make sure to use an appropriate excavator for the excavation work and properly plan and risk assess any lifting operations by the excavator before carrying out the operation.

To use plant safely:

> make sure the plant is operated by a competent operator
> fit suitable guards and protective devices
> display the working load limit and make sure any load measurement devices are operating correctly
> maintain plant in accordance with the manufacturer/supplier's instructions or relevant standards
> fit excavators with an operating weight of seven tonnes or more with hose burst protection valves
> carry out regular planned inspections and maintenance in accordance with the manufacturer's recommendations to make sure the mobile plant works safely, whether leased, hired, or owned
> conduct both mechanical and electrical testing
> carry out the following checks:
  - daily pre-start checks on the general condition and maintenance of the plant
  - regular inspections by a competent person, in accordance with the manufacturer/supplier's specifications or relevant standards.

Plant defects should be reported immediately to the PCBU. If a defect is likely to pose an immediate or imminent risk to health and safety, remove the plant from service until the defect is fixed.

6.1 CHECKING THE PLANT, EQUIPMENT AND MATERIALS

Check plant, equipment, and materials before arriving at the worksite. Make sure the plant and equipment are fit-for-purpose and in good working order.

If applicable, carry out checks before leaving the depot, and report any concerns according to company procedures, for example by tagging unsafe equipment. Do a final check when at the site and look over the area before starting work.

Make sure the materials are suitable for the job and the quantities are correct.

Check that enough material has been ordered, for example geotextiles and metal for backfilling.

Check there is appropriate PPE for the job and it is in good condition. Correct PPE includes:

> high-visibility clothing
> hard hat
> safety footwear
> hearing and eye protection.

6.2 USING PLANT

A wide range of powered mobile plant, including earthmoving machinery can carry out excavation work. To select suitable plant, consider:

> the task
> site access and restrictions
> type and depth of excavation
> ground conditions
> the mobile plant's size and reach
> hazards (eg overhead and underground services)
> the volume of material to be excavated and transported
> where the excavated material is to be located and stored.

A competent operator should use earthmoving machinery for its originally designed purpose. Earthmoving machinery operators must demonstrate they are competent to operate the specific type of plant and any fitted attachments.

USING EARTHMOVING MACHINERY

Bulldozers and scrapers are often used to prepare a work area for further specific excavation.

Bulldozers typically excavate and move large amounts of material short distances. They can be equipped with hydraulically-operated rippers at the back which are capable of loosening the hardest of sedimentary rocks.

Self-propelled rubber-tyred scrapers can excavate and haul very large quantities of material economically over long distances at relatively high speed. Because of the large potential soil output and speeds of modern scrapers, pay careful attention to:

> job layout
> haul roads
> vehicle pathways
> worker movements and overall traffic management.

Temporary haul roads should be well constructed and maintained to let plant operators complete the work safely.

Large earthmoving machinery such as bulldozers should not operate close to an overhang or a deep excavation, as the weight may collapse the excavation.

Excavation work exceeding 1.5 m deep is typically done by excavators or specialised plant such as tunnelling machines and raise-bores. Most of these types of plant have an element of mobility, although tunnelling machines typically have restricted movement.

Other plant used in excavation work includes backhoes, rubber-tyred loaders, skid steer loaders (eg bobcats), trench diggers, graders and tip trucks.

6.3 PLANT AND VEHICLE OPERATION NEAR EXCAVATIONS

Powered mobile plant should not operate or travel near the edge of an excavation unless the shoring can support such loads.

Plant should approach end-on to excavations. If this is not practicable, make sure workers in the excavation get out when the plant is within the excavation's zone of influence or move away and stand further down the excavation.

Workers should never stand under a load being lifted over the excavation.

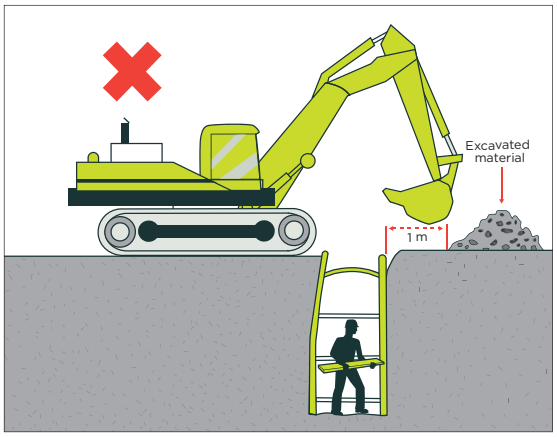

Figure 46: Prevent plant operation near excavations

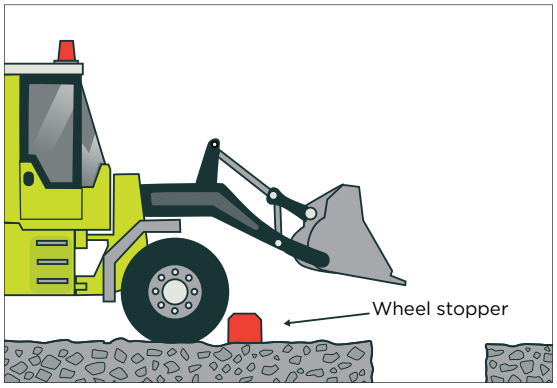

Figure 47: Wheel stopper restricting plant movement

Physical barriers such as wheel stoppers are one way of restricting plant movement near an excavation.

Table 9 outlines some excavation hazards and some controls to consider.

CONSIDER	EXAMPLE CONTROLS
Attachment failure	> use quick hitches to secure attachments > make sure the operator is familiar with and able to implement and manage any quick hitch used > make sure the operator checks any pins
Buried contaminants (eg asbestos)	> conduct a site assessment and carry out any remedial action
Lack of visibility	> make sure operators can see areas where people may be at risk from the operation of the machine > equip excavators with adequate visibility aids or use a spotter/s
Plant instability	> set up as per industry recommendations
Plant striking workers	> keep people away from areas of plant operation. Most excavator related deaths involve a person working in the vicinity of the excavator rather than the driver > use barriers, signage or a spotter

CONSIDER	EXAMPLE CONTROLS
Spoil placement	> safe distance of at least 1 m from edge
Spotter	> use a trained spotter in a safe position to direct excavator operation and any pedestrian movements > make sure the spotter and operator understand the signals they will use and agree on the way to communicate with each other
Strike hazards	> select plant with minimal tail swing if slewing in a confi ned area > maintain over 0.5 m of clearance between any part of the machine, particularly the ballast weight, and the nearest obstruction

Table 9: Typical excavator operation hazards

6.4 BLIND SPOTS

Operators of powered mobile plant can often have severely restricted visibility of ground workers or nearby pedestrians, particularly those close to the plant.

Figure 48 and Figure 49 show some of the blind spots for operators of typical excavation equipment.

In Figure 49 the operator's visibility of the left rear relies on mirrors. Note there will always be a blind spot for the operator in line with the boom. Workers should approach the operator from a point where everyone can clearly see each other.

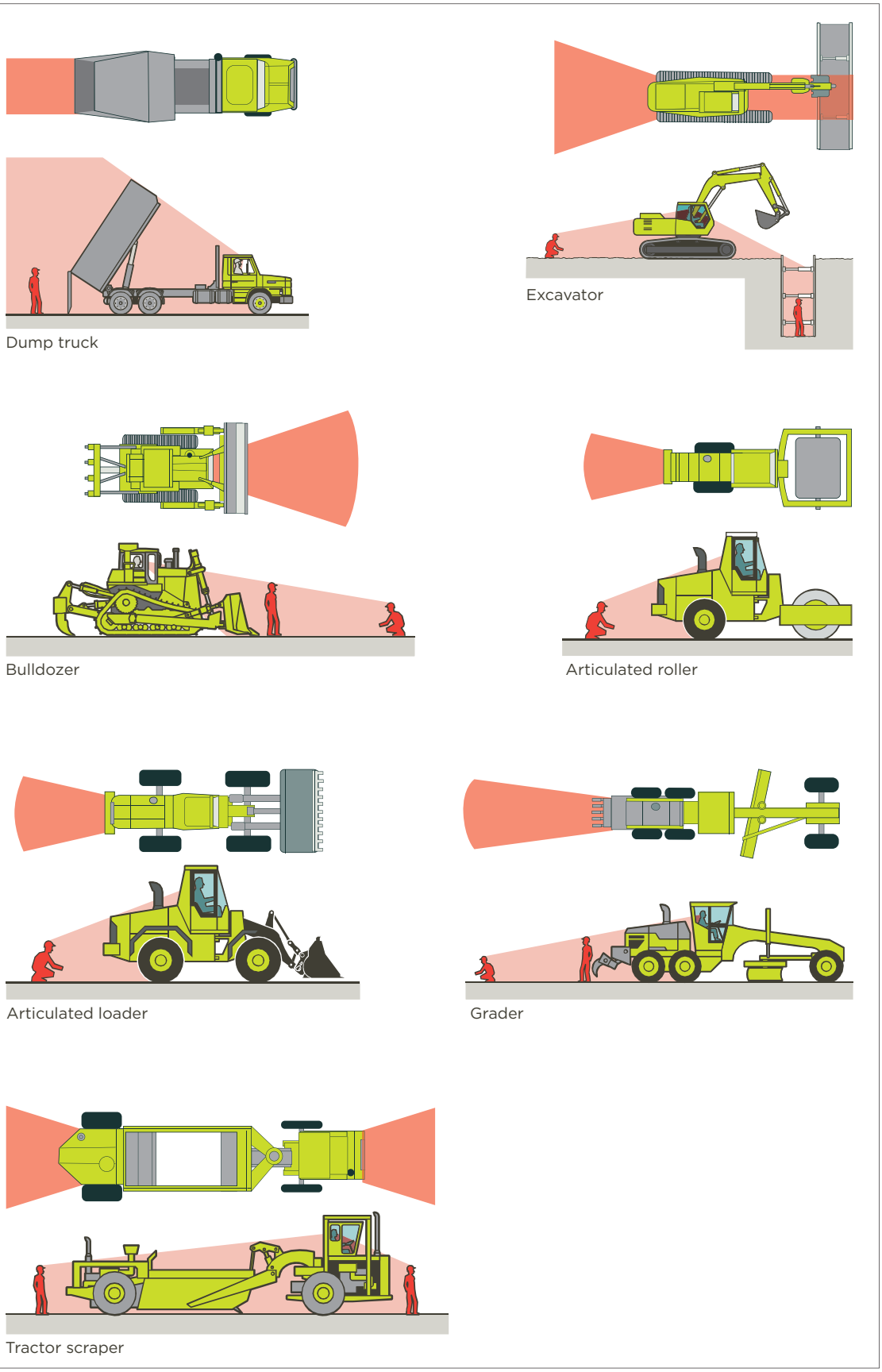

Figure 48: Mobile plant operator blind spots

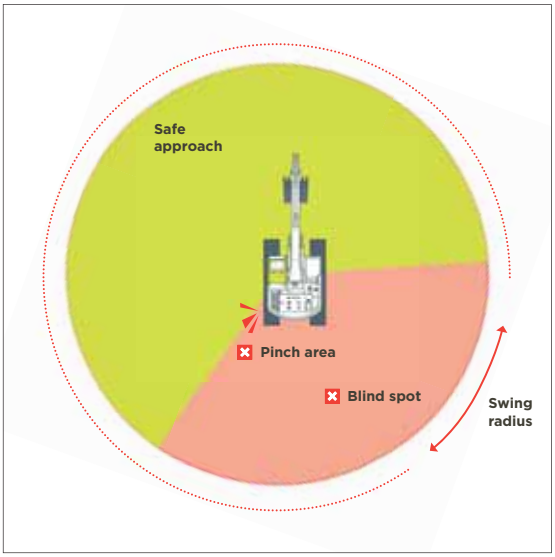

Figure 49: Safe approach zone for an excavator

Equip mobile plant operating near workers or other plant with warning devices (eg a reversing alarm or a revolving light; vehicles can also be fitted with reversing cameras).

Establish an effective system of communication based on two-way acknowledgement between mobile plant operators and ground workers before work starts. Train relevant workers in the procedures before they start work. The system should stop ground workers from approaching mobile plant until the operator has agreed to their request to approach. Similarly, the system should stop operators from moving plant closer than a set distance from ground workers until ground workers have advised the operator that they are aware of the proposed movement.

Mobile plant operators and workers should be familiar with the blind spots of the plant being used. Provide induction-training programs emphasising the dangers of working in close proximity to mobile plant, and provide adequate supervision.

Make sure operators and workers wear high-visibility PPE.

EXCLUSION ZONES AND SPOTTERS

Exclusion zones and separating workers from mobile plant should be the first option for managing this risk. If exclusion is not possible, use spotters to control operations when workers are in the immediate area. A spotter should be in constant contact with the mobile plant operator.

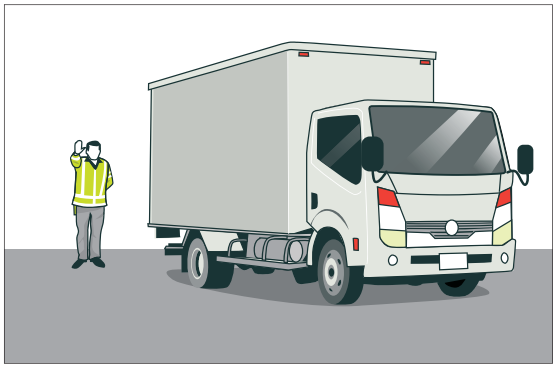

Figure 50: A spotter helping a reversing vehicle

6.5 OPERATOR PROTECTION

Powered mobile plant should be equipped with an appropriate combination of operator protection devices, for example an enclosed cabin and seat belts, to prevent the operator from ejecting from the cab or being struck by falling objects.

Any earthmoving machinery weighing more than 700 kgs, not including attachments, and designed to have a seated operator, should have an appropriate operator protective structure fitted. These are either roll-over protective structures (ROPS), falling object protective structures (FOPS) or both, depending on the application. Self-propelled mechanical mobile plant must, so far as is reasonably practicable, be fitted with roll-over protection and seat belts.

For more information see WorkSafe's *Approved Code of Practice for Operator Protective Structures on Self-Propelled Mobile Mechanical Plant*, available at www.worksafe.govt.nz

6.6 QUICK HITCHES

Quick hitches allow a bucket or other attachment to be quickly and easily connected and disconnected from an excavator or backhoe arm, saving significant time during mobile plant operation.

A pin holds the attachment in place against the quick hitch and insures against accidental release. However, a manual quick hitch may still operate without the retaining pin in place and then suddenly, without warning, swing open or fall completely. If this happens when lifting over or close to a person the result is likely to be fatal.

MANAGING THE RISK

Before operating the mobile plant, make sure the operator:

> checks the attachment is securely attached by the quick hitch

> sets up an exclusion zone around the area where the excavator is operating.

Controls include:

> using a suitable semi or fully automatic system instead of a manually operated quick hitch system

> training excavator operators on the use of quick hitches

> ensuring that excavator operators are competent to use the specific hitch for the machine they use

> operators only using pins designed for this specific use (the manufacturer-specified retaining pin must be available on the machine)

> attachment information clearly displayed or present with the machine identifying:
  - model and serial number
  - manufacturer's name
  - weight and maximum rated capacity
  - each lifting point's capacity

> setting up a system for checking that the pin is in place before starting the work and every time a different attachment is fitted

> conducting random checks to make sure precautions are implemented and followed.

Before operating the mobile plant the operator should:

> check the attachment size is suitable and compatible with the quick hitch

> check the quick hitch is kept in good working order

> physically check the safety pin is securely in place or the automatic system has engaged correctly:
  - before starting work, and
  - when fitting a different attachment

> make sure an exclusion zone is set up when using the excavator and for attachment fitting or removal. If there are other workers on the construction site the exclusion zone applies to them, even if they are not involved in the excavator operation.

For more information on quick hitches see WorkSafe's fact sheet *Using Quick Hitches Safely*, available at www.worksafe.govt.nz

6.7 LOAD-LIFTING

Items of mobile plant (including earthmoving equipment), not originally designed as a crane, and used for load-lifting incidental to their principal function are entirely exempt from the Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999 subject to the following conditions[10] as applicable:

> lifting points and equipment used for rigging loads must be certified by a Chartered Professional Engineer

[10] 'Notice Under the *Health and Safety in Employment (Pressure Equipment, Cranes, and Passenger Ropeways) Regulations 1999*' (24 September 2015) 104 *New Zealand Gazette*. www.gazette.govt.nz/notice/id/2015-go5666

> in the case of new and used hydraulic excavators with an operating weight of seven tonne or more, the following additional conditions apply:
  - the equipment is not to be modified to make it operate as a crane other than the provision of a lifting point
  - the equipment is to have a loading chart available to operators
  - operators and ground support personnel are to be adequately trained
  - operations are to be carried out in accordance with the *Approved Code of Practice for Load-Lifting Rigging*
  - hose burst protection valves are required (except for load-lifting mobile plant used in forestry operations that do not involve the construction of forest roads).

07/

APPENDICES

IN THIS SECTION:

7.1 APPENDIX A: LEGAL FRAMEWORK

All excavation work must comply with HSWA and associated regulations. Table 10 lists the specific duties under the HSE Regulations that apply to excavations in construction work.

Regulation 23 Application of Regulations 24 and 25	(1) In Regulations 24 and 25, the term **employer** means— (a) every employer, in relation to every workplace under the control of that employer in which any construction work is carried out; and (b) every person who controls a workplace in which any construction work is carried out. (2) In Regulations 24 and 25, the term **employee**,— (a) in relation to an employer of the kind described in subclause (1)(a), means an employee of that employer; and (b) in relation to a person of the kind described in subclause (1)(b), means a person working in the workplace.
Regulation 24 Excavations with face more than 1.5 m high	(1) Subject to subclause (2), every employer must, so far as is reasonably practicable, ensure that, where any face of any excavation is more than 1.5 m high, that face is shored. (2) Subclause (1) does not apply where— (a) the face is cut back to a safe slope; or (b) the material in the face is of proven good standing quality under all reasonably foreseeable conditions of work and weather; or (c) by reason of the nature of the work and the position of any employee in the vicinity, there is no danger to any employee; or (d) the provision of shoring is impracticable or unreasonable by reason of the nature of the work and the employer has, so far as is reasonably practicable, taken steps to ensure that other precautions are taken to make the face as safe as possible in the circumstances. (3) Every employer must, so far as is reasonably practicable, ensure that any shoring used in any excavation at the workplace— (a) consists of materials that are suitable for the purpose for which they are to be used, of sound quality, and adequate in strength for the particular use; and (b) has bracings, jacks, and struts that are securely held to prevent accidental displacement, and packings and wedges that are held by nails or spikes; and (c) is placed in a proper manner by an experienced person under competent supervision; and (d) is not altered, dismantled, or interfered with except on the instructions of the employer or a representative of the employer.
Regulation 25 Excavations of hazardous depth	Every employer must, so far as is reasonably practicable, ensure, where any excavation is— (a) readily accessible to any person; and (b) likely to collect or retain water of such a depth as to constitute a danger to any person,— that— (c) any such excavation is covered or fenced, when no employee is in the immediate vicinity to prevent access to it by any person; and (d) any such excavation created in the course of the work is covered, fenced, or filled at the completion of the work.

Table 10: Duties in relation to excavations in the HSE Regulations

TUNNELLING OPERATIONS

Under clause 4 of Schedule 3 of HSWA a tunnelling operation is the extraction of fill to create, extend, or enlarge a tunnel or shaft. Tunnelling operations are subject to Schedule 3 of HSWA and the MOQO Regulations, except operations involving:

> tunnels or shafts of any length where no-one ordinarily works underground
> tunnels or shafts that are or will be 15 m or less, where one or two workers ordinarily work underground at any one time, and:
  - no explosives are used, and
  - methane concentrations will not exceed 0.25% of the air in the tunnel or shaft.

BUILDING LEGISLATION

The Building Act 2004 and Building Regulations 1992 will generally apply if excavations are associated with constructing, altering, demolishing or removing a building. This also includes site work and building-related design work.

For more information on building legislation and controls, refer to the Ministry of Business, Innovation and Employment's website www.building.govt.nz

OTHER REQUIREMENTS

Consider the requirements of any applicable:

> codes of practice
> engineering standards
> laws and regulations and any subsequent amendments
> local authorities, by-laws and district plans.

Relevant legislation to consider may include the following Acts and regulations made under them:

> Building Act 2004
> Electricity Act 1992
> Gas Act 1992
> Land Transport Management Act 2003
> Local Government Act 2000
> Resource Management Act 1991
> Telecommunications Act 2001

7.2 APPENDIX B: SAFE SYSTEM OF WORK CONSIDERATIONS

Planning considerations should include discussions on:

- permits/consents/notifications
- service mark-outs and locations
- site-specific documentation which could include:
  - health and safety policy
  - summary worksite safety plan
  - worksite emergency procedures
  - worksite safety induction card
  - visitor and worksite induction register
  - accident/incident register
  - injury/ill-health/incident reporting
  - hazard identification
  - site-specific risk assessment
  - safe or standard operating procedures
- environmental plan (ie erosion and sediment control)
- quality plan
- overhead services and underground service plans
- construction plans
- nature or condition of the ground, for example:
  - ground water
  - depth of excavation
  - soil conditions
  - confined space and ventilation
- weather conditions (eg time of year, expected conditions etc)
- static and dynamic loads near the excavation
- interaction with other trades
- site access and security
- traffic management and public safety
- type of plant and equipment to be used for excavation work
- the length of time the excavation is to remain open
- provision of adequate facilities.

7.3 APPENDIX C: TRENCHING CHECKLIST

This is a basic checklist for trench work. Add other items as appropriate to a particular site or job.

1. Is the surface clear of plant, spoil heaps and materials for at least 1 m from the edge of the excavation?
2. Are spoil heaps properly controlled and will they stay like this in wet weather?
3. Is the trench clear of workers while the spoil heap is being worked on?
4. Is the space between the trench and the spoil heap clear of pipes, bricks, stones, tools, etc?
5. Is the work properly fenced off and 'signed' during the day. Is the work properly fenced off, 'signed', guarded and lit during the night?
6. Is access adequate without anyone having to jump across? Are footbridges with guard rails available and being used?
7. Are ladders available and being used?
8. Is the supervisor making sure that no-one climbs on the timbering?
9. Is the trench safe from exhaust gases from plant working in the trench or nearby?
10. Does everyone know where the buried services are and are they clearly marked?
11. Are the workers who are excavating and shoring the trench experienced in this sort of work?
12. Are they working at safe distances from each other?
13. Is the ground as the design assumed?
14. Is there any movement or deterioration of the ground that may put adjacent services, roads or structures at risk?
15. Is the area affected by blasting or other heavy vibrations?
16. Is the ground water level as used in the design (ie not higher)?
17. Are proper sumps provided?
18. Does the pumping arrangement avoid drawing material from behind the sheeting?
19. Is the work being done in accordance with the drawings or sketches? If not, is the variation permissible?
20. Are unsheeted faces safe, with no sign of peeling away?
21. Are materials of the correct design size and quality?
22. Are wedges tight?
23. Is timbering free of damage from skips?
24. Are waling and strut spacing within +/-100 mm?
25. Are deflections excessive?
26. Are all struts horizontal and positioned squarely to the walings (within 1 in 40)?
27. Are frames supported against downward movement (by hangers or lip blocks, puncheons and sole plates)?
28. Have correct pins been used in steel trench struts?
29. Is the method of withdrawing sheeting and support for the trench during backfill safe?
30. Is the work area tidy?
31. Are stops provided for mobile plant?
32. Is visibility adequate in the trench?
33. Is PPE available and being used?

7.4 APPENDIX D: NOTIFICATIONS TO WORKSAFE

NOTIFICATION OF PARTICULAR HAZARDOUS WORK

Employers and the person in control of the workplace must notify WorkSafe at least 24 hours' before doing any hazardous work (as defined below).

These notices help WorkSafe plan workplace visits to promote health and safety for everyone in or near a workplace.

Notify WorkSafe by either:

> filing a Notification of Particular Hazardous Work online at www.worksafe.govt.nz

> downloading the notification form and posting or faxing it to WorkSafe.

WORK THAT NEEDS TO BE NOTIFIED TO WORKSAFE

Defined in the HSE regulations as:

> any commercial logging or tree-felling

> any construction work where:

- workers could fall 5 m or more (excluding work on a house up to two-storeys high, a power or telephone line, or carried out from a ladder only, or minor or routine maintenance or repair work)
- scaffolding from which someone could fall 5 m or more while being put up or dismantled
- an appliance (other than a self-propelled mobile crane, excavator or forklift) has to lift weights of half a tonne (500 kg) or more a height of 5 m or more
- people have to work in an excavation that is more than 1.5 m deep and which is deeper than it is wide at the top
- workers need to work in any kind of heading, excavation or drive where there is ground cover overhead
- work in any excavation in which any face has a vertical height of more than 5 m and an average slope steeper than a ratio of 1 horizontal to 2 vertical
- work where explosives are used, or stored for this purpose
- workers need to breathe air that is or has been compressed or breathe a respiratory medium other than air.

NOTIFIABLE EVENTS

A notifiable event is when someone dies or when a notifiable incident, illness or injury occurs as a result of work. WorkSafe must be informed of all notifiable events. Notifiable injuries, illnesses and incidents are specified in HSWA.

NOTIFIABLE INCIDENTS

HSWA requires PCBUs to notify WorkSafe if there is an unplanned or uncontrolled incident at a workplace that exposes a person (worker or otherwise) to a serious risk to their health and safety arising from immediate or imminent exposure to:

- a substance escaping, spilling, or leaking
- an implosion, explosion or fire
- gas or steam escaping
- pressurised substance escaping
- electric shock
- the fall or release from height of any plant, substance or object
- damage to or collapsing, overturning, failing or malfunctioning of any plant that is required to be authorised for use
- the collapse or partial collapse of a structure
- the collapse or failure of an excavation or any shoring supporting an excavation
- the inrush of water, mud, or gas in workings in an underground excavation or tunnel
- the interruption of the main system of ventilation in an underground excavation or tunnel
- a collision between two vessels, a vessel capsize, or the inrush of water into a vessel
- any other incident declared in regulations to be a notifiable incident.

7.5 APPENDIX E: MORE INFORMATION

ENVIRONMENTAL PROTECTION AUTHORITY

For information about how to manage hazardous substances visit the Environmental Protection Authority's website www.epa.govt.nz or call 0800 376 234.

LOCAL COUNCIL

Your council might have additional rules that need to be met. Check with your local council for specific rules that apply in your region.

LOCAL UTILITY OWNERS

Check any local utility owners' websites for additional procedures that may need to be met – look for headings like *safety, working safely* or *public safety*.

NEW ZEALAND LEGISLATION

To access all legislation including Acts and regulations visit the New Zealand Legislation website www.legislation.govt.nz

THE INSTITUTION OF PROFESSIONAL ENGINEERS NEW ZEALAND (IPENZ)

A list of competent engineers can be found on the IPENZ website, under the Chartered Professional Engineers (CPEng) Register available at www.ipenz.nz

WORKSAFE NEW ZEALAND

For information and guidance about health and safety visit WorkSafe's website www.worksafe.govt.nz or call 0800 030 040.

For information and guidance specifically about electrical or gas safety visit WorkSafe's website www.energysafety.govt.nz or call 0800 030 040.

STANDARDS

AS 1657 Fixed platforms, walkways, stairways and ladders – design, construction and installation
AS 2187.2 Explosives – storage and use – use of explosive
AS 2865 Confined spaces
AS 4744.1 Steel shoring and trench lining equipment
AS 5047 Hydraulic shoring and trench lining equipment
AS/NZS 1576 Scaffolding (series)
AS/NZS 1892 Portable ladders (series)
BS EN 13331-1 Trench lining systems. Product specifications
BS EN 13331-2 Trench lining systems. Assessment by calculation or test
BS EN 1537 Execution of special geotechnical works – ground anchors
BS 8081 Code of practice for grouted anchors
FHWA-IF-99-015 Ground anchors and anchored systems
NZS 3603 Timber structures standard

GUIDANCE

Approved Code of Practice for Operator Protective Structures on Self-Propelled Mobile Mechanical Plant
WorkSafe New Zealand www.worksafe.govt.nz

Code of Practice for Temporary Traffic Management: Part 8 of the Traffic Control Devices Manual
New Zealand Transport Agency www.nzta.govt.nz

Excavation Work Code of Practice
Safe Work Australia www.safeworkaustralia.gov.au

Guide for Safety with Underground Services
WorkSafe New Zealand www.worksafe.govt.nz

Health and Safety at Opencast Mines, Alluvial Mines and Quarries
WorkSafe New Zealand www.worksafe.govt.nz

National Code of Practice for Utility Operators' Access to Transport Corridors
New Zealand Utilities Advisory Group (NZUAG) www.nzuag.org.nz

New Zealand Electrical Code of Practice for Electrical Safe Distances (NZECP 34:2001)
WorkSafe New Zealand www.energysafety.govt.nz

Safety around Excavations
WorkSafe New Zealand www.worksafe.govt.nz

Safe Use of Machinery
WorkSafe New Zealand www.worksafe.govt.nz

Using Quick Hitches Safely
WorkSafe New Zealand www.worksafe.govt.nz

Working with Ladders and Stepladders
WorkSafe New Zealand www.worksafe.govt.nz

Workplace Exposure Standards and Biological Exposure Indices
WorkSafe New Zealand www.worksafe.govt.nz

Your Guide to Working Safe on the Road and Staying Alive
New Zealand Utilities Advisory Group (NZUAG) www.powerco.co.nz

7.6 APPENDIX F: GLOSSARY

TERM	BRIEF EXPLANATION
Backfill	Material used for refilling excavations.
Barricade	Any object or structure that creates a barrier obstacle to control, block passage or force the flow of traffic in the desired direction.
Battering	Means to form an angled excavation face, usually less than the natural angle of repose, to prevent ground collapse.
Bench	A horizontal step cut into an excavation face to provide horizontal bearing and sliding resistance.
Benching	The horizontal stepping of an excavation face.
Closed sheeting	A continuous frame with vertical or horizontal sheathing planks placed side by side to form a continuous retaining wall supported by other shoring parts to hold up an excavated face.
Competent person (excavation work)	A person who has competencies for different types of excavations set out in section 2.5.
Competent person (including competent operator)	A person who has acquired through training, qualification, or experience the knowledge and skills to carry out a task.
Drives	Small openings cut into the sides of trenches or shafts or elsewhere, for example, under roads.
Dynamic load	The forces that move or change when acting on a structure.
Exclusion zone	An area from which all persons are excluded during excavation work.
Face	An exposed sloping or vertical surface resulting from excavating material.
Open excavation	An excavation in open ground which can vary in shape and size often defined by adjacent services or buildings.
Permanent works	The parts of a construction project that will be used and remain in position for a long time (eg 60 years). This includes buildings and structures such as bridges, roads, retaining walls, etc.
Person conducting a business or undertaking (PCBU)	Has the meaning provided in HSWA. In general, it means any person (including a legal entity) running a business or undertaking. For example, a limited liability company, partnership, trust, incorporated society, etc.
Pit excavations	Usually four-sided and deeper than the narrowest horizontal dimension at the surface. Generally, beyond a depth of around 10 m, an excavation becomes a shaft. Pits are generally excavated to install manholes, pump stations, underground tanks and the like. They are also excavated to construct pile caps and other types of foundations or to access and/or locate existing services to maintain them.
Risk	Risks arise from people being exposed to a hazard (a source of harm). Risk can be described as the likelihood certain consequences (death, injury, or illness) occur when a person is exposed to a hazard.
Risk assessment	Involves considering what could happen if someone is exposed to a hazard and the likelihood of it happening.
Safe slope	The steepest slope at which an excavated face is stable against slips and slides, having regard to the qualities of the material in the face, the height of the face, the load above the face and the moisture conditions for the time being existing.

TERM	BRIEF EXPLANATION
Shaft	A vertical or inclined way or opening from the surface downwards or from any underground working, the dimensions of which (apart from the perimeter) are less than its depth.
Sheet piling	Vertical, close-spaced, or interlocking planks of steel, reinforced concrete or other structural material driven to form a continuous wall ahead of the excavation and supported either by tie-backs into solid ground structural members from within the excavation as the work proceeds. The use of timber, steel or other structural material to support an excavation in order to prevent collapse so that construction can proceed.
Sheeting	Sheeting is overlapping rather than interlocking, and cannot stand on its own.
Safe system of work	A system of working covering how a piece of work or a project will be completed safely and in compliance with relevant legislation.
Soil arching	Describes an arching effect some types of shoring create by slightly compressing soil in without allowing the soil to move outward.
Soldier	Vertical upright steel or timber element used for supporting a trench wall.
Static load	A static load is the effect of gravity on an object or structure. For example the weight of a bridge.
Structure	A building or other object constructed from several parts.
Strut	Structural member (usually horizontal) in compression resisting thrust or pressure from the face or faces of an excavation.
Temporary works	The parts of a construction project that allow permanent works to be built. Usually they are removed after use (eg access scaffolds and shoring).
Tom	Structural member used to hold soldiers against an excavated face or to press walers apart in a close sheeted excavation.
Trench	A long narrow excavation, deeper than it is wide, and open to the surface along its length. Trenches are generally excavated to install or maintain underground services or to otherwise investigate beneath the ground surface.
Trench shield	A steel or metal structure with two vertical side plates permanently braced apart by cross frames or struts designed to resist the pressure from the walls of a trench and capable of being moved as a unit.
Upstream PCBUs	PCBUs who design, manufacture, import or supply plant, substances or structures, or who install, construct or commission plant or structures.
Waler	A horizontal steel or timber element used for supporting a trench wall.
Water scouring	An erosion process resulting from the action of the flow of water.
Worker	Has the meaning provided in HSWA. In general, it is a person who carries out work in any capacity for a PCBU. It covers almost all working relationships, including employees, contractors, sub-contractors, and volunteers.
Workplace exposure standards (WES)	A WES is the level of a substance in the air that is believed to be safe for nearly all workers repeatedly exposed, day after day, to that substance. The values are usually calculated based on exposure over eight hours, 15 minutes or, in some cases, instantaneous exposure.
Zone of influence	Means the volume of soil around the excavation where actions may influence the excavation's stability (eg vehicles, plant, or spoil) or where the excavation may influence the stability of any nearby structure.

Notes

DISCLAIMER

WorkSafe New Zealand has made every effort to ensure the information contained in this publication is reliable, but makes no guarantee of its completeness. WorkSafe may change the contents of this guide at any time without notice.

This document is a guideline only. It should not be used as a substitute for legislation or legal advice. WorkSafe is not responsible for the results of any action taken on the basis of information in this document, or for any errors or omissions.

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