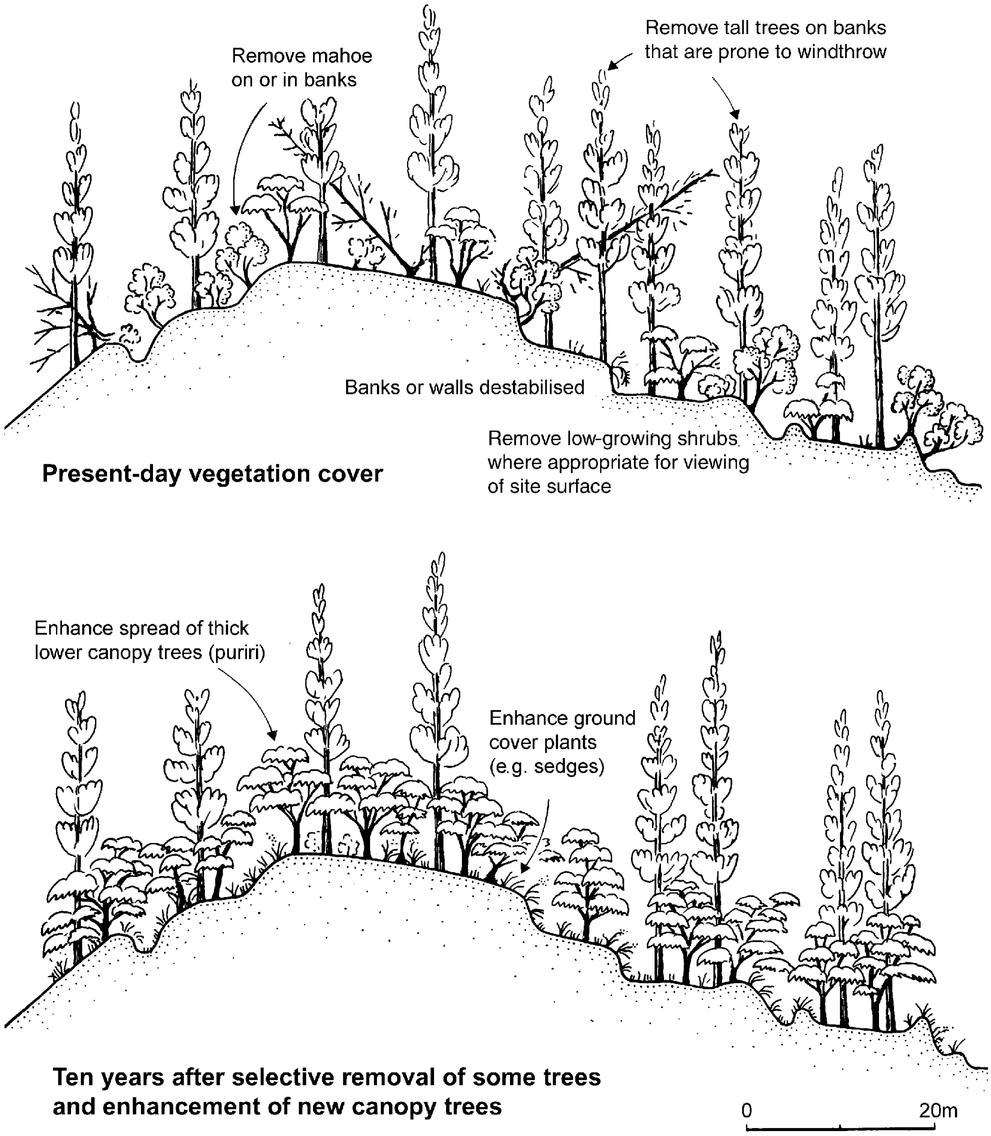
Figure 18. Suggestions for reducing risk from unstable trees (rewarewa), opening out a gallery forest, and enhancing canopy and ground cover at Te Koru.



PRINCIPLES FOR NATIVE SHRUBLANDS AND TREE COVER

- If an earthwork site has a stable tree cover, i.e. coverage of long-lived species, leave it alone: *stable cover equals stable surface earthworks.*
- If trees are potentially unstable, e.g. rewarewa or wattle, they should be removed according to specifications in a conservation plan.
- Allow for replacement canopy by planting in seedlings or allowing the growth of naturally adventive broad-canopied trees such as pūriri or karaka (both culturally appropriate to sites).
- Protect the existing and future canopy trees in any site operations.
- In regenerating forest, remove trees that have the potential to grow bigger than 10 cm d.b.h. Removal should allow for canopy replacement with low density of stems per unit area if long-term forested cover is sought.
- Bare land or cleared land should not be planted in trees or shrubs, but suitable low ground covers should be planted either from seed or container seedlings.

Figure 19. A gallery forest of beech and kamahi at the Lyell graveyard, West Coast. The ground slopes and is vulnerable to erosion because of the high number of vistors who are attracted to this notable commemorative setting.

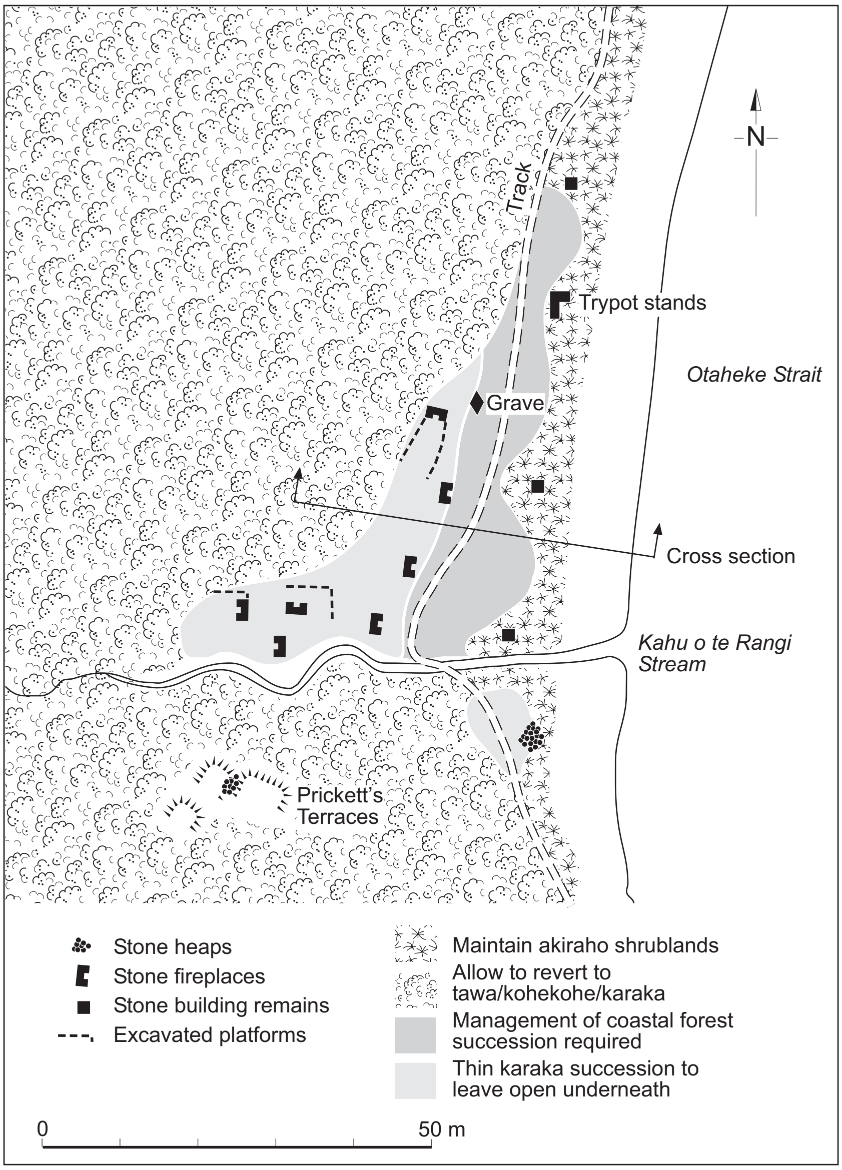
2.2.9 Gallery forest and canopy maintenance

A gallery forest has wide-spaced mature trees with single boles which support a closed canopy. The concept can be seen in natural forests where the forest floor has been immersed in silt or gravel during floods or where goats have destroyed the understorey. The closed canopy reduces light (and hence the potential for weeds) and erosion from rainfall, while the widely spaced single boles allow visibility of the surface features. Figure 19 shows a good example of a beech gallery forest over the cemetery at Lyell. The canopy also suppresses much weedy growth—but not all: privet is a weed that will establish in poor light. Where there are large trees already on a site or reserve, a careful survey is needed as part of the conservation plan to decide whether they can be converted to gallery forest form and the canopy maintained at a density which protects the site from erosion. The following questions need to be answered before determining a plan:

- Are the trees likely to be stable in the long term?
- Do they provide a spreading dense canopy?
- If thinned, will the site be seen amongst the boles of the trees?
- Can fallen trees be easily removed without damage to the site?
- Is the canopy too dense, causing dry erosion of banks and reducing potential growth of desirable ground covers?
- What saplings can be planted to eventually replace the canopy trees that are cut?
- Are there particular trees that are causing a problem, or will cause a problem, to particular archaeological features, e.g. trees at the head of a bank?

If the site is to be kept open for public visiting and viewing, it will be possible to thin out the trees, while still maintaining a canopy to protect the ground surface from erosion and reduce weed growth. Pūriri, mangeao, tawa, karaka (culturally appropriate), kānuka and most tree ferns are the main species that may lend themselves to management as gallery forests. On Te Kahu o Te Rangi, Kapiti Island, the shrublands and trees of a transect from high-water mark to tawa forest

Figure 20. Suggestions for managing an early stage of a coastal forest succession on a site with ruins. On the flat, flax and akiraho should be maintained at the sea's edge. A little further inland, karaka on the flat is thinned to create a gallery forest. Aged kānuka should be felled and removed before they are broken or heaved by the wind.



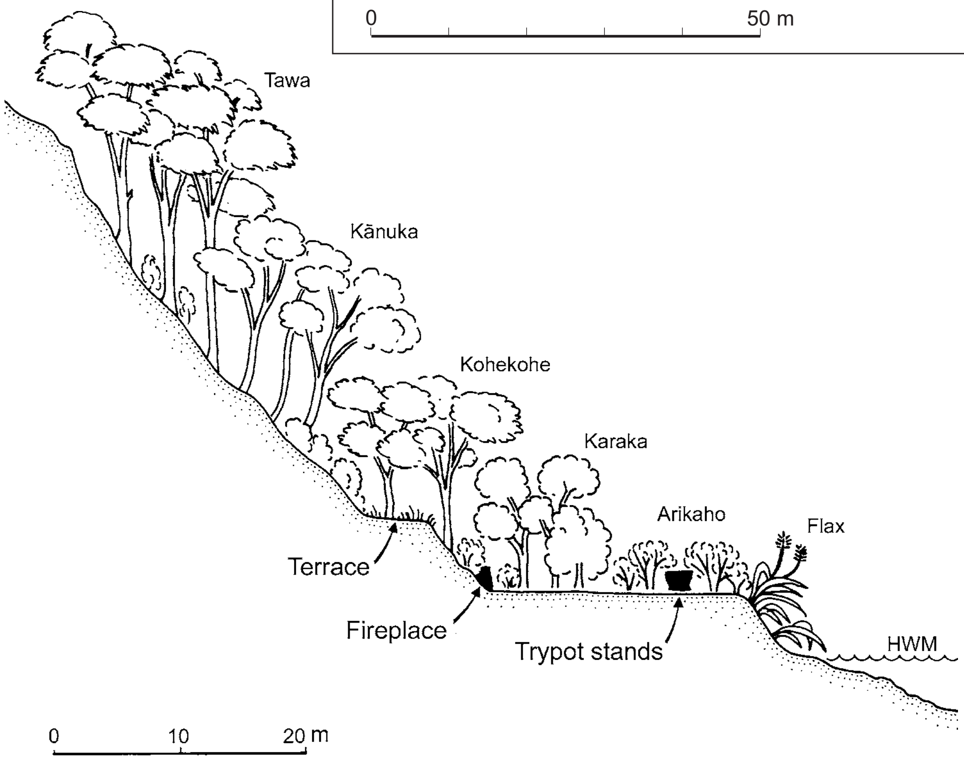


Figure 21. On Te Pari Pari Historic Reserve, following removal of rewarewa, a satisfactory initial cover of broad-leaved poa, sedges and fire weeds has established.

Figure 22. An excellent conservative low cover of five-finger and toetoe on the slopes of a coastal pā at Onemana, Coromandel Peninsula.

(Fig. 20) is maintained to protect stone-faced terraces and archaeological features on the coastal strip. The karaka and kohekohe treeland is managed as a gallery forest so that the archaeological features can be seen.

It seems that pūriri planted and maintained so that it retains a straight bole and spreading canopy at a height above about 6 m is the most suitable species for planting on archaeological sites. Of course this is in warm temperate areas with little frost or where it occurs naturally. Spacing of specimens is a matter for judgement but one sapling per 20 m^2 may be suitable. Thinning could be carried out later. The most desirable trees with the right bole and canopy form will manifest themselves and unsatisfactory specimens can be removed.

In moist areas, kāmahi and tree fern will grow easily. Kānuka is suitable on most harsh sites such as dry ridgelines or exposed coastal headlands where it may form a stable forest. Generally, these are seral species; experimental trials are needed to see whether they can be re-planted to renew cover in cycles of 30–60 years. Where tree growth with the potential to cause deterioration of a site has been removed, care should be taken to retain seedlings/saplings desirable for eventual canopy maintenance, or to plant saplings that will fill this role. On most sites where trees have been removed, the rapidly establishing natural adventives at ground level will provide a good degree of protection from surface erosion—for example, Fig. 21 shows fire weeds and broad-leaved poa on a pā in the Bay of Plenty where potentially unstable rewarewa trees have been removed. Figure 22 shows a satisfactory shrubland cover of five-finger and toetoe on an archaeological site on the Coromandel Peninsula.

For tree removal/felling, see section 2.5.1, p. 49.

2.2.10 Weeds

Many weeds are present on archaeological sites. Weeds provide a reasonable stabilising cover on many sites (see discussion on gorse and blackberry). Some can grow in deep shade (and hence prevent establishment of native seedlings) and can be useful in preventing dry erosion. Weeds may be retained, but only where the species are already present/common and widespread in the locality. The main risk to the site from weeds is that they reduce visibility, and lead to the site's existence being forgotten, with subsequent use of heavy machinery to clear the weeds. Careful consideration is needed to balance weed control imperatives with the need to retain some form of cover. Their historical relevance to the site must also be considered. In many instances they will have been plants brought in by the original inhabitants of the place. The vine *Eleagnus* sp., for example, was once commonly used as an ornamental hedging plant.

Any intervention in archaeological site management (including the removal of grazing animals) risks an increase in weeds. This work contains no particular guidance on weeds since this subject is increasingly well covered by local government and by Department of Conservation weeds specialists and procedures. Data on the distribution, identification, and control of weeds can be found in several sources including the Department of Conservation National Weeds Database, and publications and services from the Forest Research Institute and regional councils.

THINKING ABOUT WEEDS—ARE THEY A PROBLEM?

- Almost all interventions made to protect archaeological sites run the risk of increasing the numbers of weeds present.
- Many historic reserves have small areas, patchy ecology, are adjacent to settled areas and therefore have high numbers of weeds.
- Weeds on archaeological sites should be monitored.
- Weeds should not be removed unless another stabilising vegetative cover is available.
- Long-term natural successions culminating in suitable native shrubland or forest cover will remove many weed problems.
- However, some weed vines and shrubs will prevent or smother succession.
- Heavy machinery must never be used to clear weeds on archaeological sites.

*Gorse (*Ulex europaeus *L. and* U. minor *Roth) and blackberry*

Both gorse and blackberry may provide a practical protective cover and means of erosion control on archaeological sites which are not interpreted or open to the public. Gorse in New Zealand can grow up to 5 m high with proportionately large roots. The roots are highly branched, usually with a deep tap root, and roots of large specimens will destroy stratigraphy. Dwarf gorse (*U. minor*), present in the Tauranga region, may be a better cover there than *U. europaeus*.

Some local authorities forbid planting gorse. In areas already heavily infested with gorse or blackberry, these plants may be tolerated, if not approved of, on archaeological sites. The legality of deliberately maintaining gorse on a site could be problematic. Fire hazard is another potential problem. A stand of gorse used to keep the public off a vulnerable site could be seen as a fire hazard by local land owners. In such instances, in the interest of retaining public goodwill for the protection of archaeological sites, the gorse should be removed.

In general, the most desirable stand form is dense small-stemmed plants, maintained by occasionally removing large bushes to allow dense regeneration of young plants. Periodic burning will, of course, return the gorse to the start of its succession.

Gorse can be a nursery for native shrublands. Gorse seedlings and plants need full sunlight, and they can be eliminated by regenerating or planted native shrublands. If a native shrubland is the desired long-term cover, then the ground beneath the gorse should be checked for native seedlings. They will only be there if native forest or shrubland occurs in the vicinity. Otherwise planting of natives within the gorse may be required.

If maintaining a gorse or blackberry cover is regarded as inefficient, costly, a fire risk, or a source of infestation for surrounding 'clean' land, then a more appropriate and lasting cover should be planned for. The removal of gorse and blackberry from an archaeological site is best achieved by spraying, using one of the proprietary chemicals available. Gorse seed will remain viable in the soil for many years and ongoing control, coupled with alternative shrubland revegetation (in areas of the site specified in a conservation plan) will be necessary.

Bulldozing must never be used to clear gorse or blackberry or any other cover from archaeological sites. Both gorse and blackberry will be present and will provide suitable cover on archaeological sites on farms where there are herds of goats.

2.3 PHYSICAL (NON-VEGETATIVE) METHODS FOR SITE PROTECTION

In some situations on archaeological sites, it is not feasible to have a vegetative cover or any vegetative cover will be ineffective. There is a range of potentially cost-effective physical methods that can be used in place of vegetation. They can be divided into:

- Civil engineering applications, e.g. retaining walls or rip-rapped slopes to prevent large-scale river or coastal erosion—a topic which is covered briefly under general erosion earlier in this part of the guidelines
- Application of synthetic or natural geotextile covers, either exposed on the surface or buried beneath other cover (e.g. soil, shingle, bark)
- Site burial with or without geotextile membranes
- Other technology, including composite vegetation and geotextile management of slope stability
- Applying particular surfaces to paths and viewing areas so as to control behaviour of visitors and reduce any damage caused.

Specialist engineer's or landscape architect's advice and resource consents under the Resource Management Act 1991 may be needed for some non-vegetative methods.

2.3.1 Bunds and underground cut-off walls

Where an area with wet archaeological sites is being drained, lowering the water table may directly threaten buried wooden material which has been preserved in the wet, anaerobic conditions. Further, the shrinkage of organic soils likewise exposed by a lowered water table may change the character of a site and its vegetation. Designing drainage ditches, dams, pumping arrangements and tide gates so that the site or sites is not affected is important.

Building a bank or bund to retain water on the margins of the site may be an effective way of preventing this happening. On some wetland sites in the United Kingdom, an impermeable sheet membrane has been inserted vertically in trenches around the site (and then the trenches were packed with clay) to hold water and maintain anaerobic conditions. Deliberate introduction of water to maintain water table levels may be required.

2.3.2 Geotextiles and geogrids

Geotextiles are synthetic or natural fibres, woven, felted or moulded into sheets, with varying porosities. Geogrids are moulded (as opposed to woven) modules which can lock together to form sheets or moulded porous sheets. They are commonly used in soil conservation and civil engineering applications. In the United States they have been used to protect sites in stream-banks (Thorne 1988, n.d.). They also have potentially wide use for a number of archaeological site conservation problems (see Koerner 1990). Geotextiles can be used in a number of ways—laid on the surface or buried (Fig. 23), or as surfaces in drainage structures.

In applications where geotextiles are buried, they have effect through one of two different mechanisms. One is where the geotextile has small openings which filter soil particles, preventing smaller soil grains migrating into a coarser medium on the other side of the cloth. Puncture resistance is an important feature of filtering cloths because they need to be put onto position without damage to be effective. The other mechanism is the strengthening and reinforcing of weaker soil materials.

For surface applications, some geogrids offer three-dimensional box-like or honeycomb structures made up of many small moulded units that can be locked

Figure 23. Open-pored moulded geogrid provides a base for well bedded angular gravel protecting a midden on this track in the Ōhope Scenic Reserve, Whakatāne.

together on the site. Some geotextiles designed for surface use have biodegradable media as part of their structure so that they prevent weeds (by excluding light) and can be used as a seedbed for grasses. Such textiles have a light steel open weave, sandwiched in or packed around with organic material such as coconut husks. The material can be laid directly on eroded areas and is strong enough to withstand stretching or being pinned down on slopes. The organic surface can be directly planted with grass seed and fertilised. It rots away quickly and the steel weave eventually rusts (Berry & Brown 1994: 34, 47).

Materials designed and sold as weed mats and shade cloths are sometimes represented as geotextiles; their utility outside their specific purpose is limited.

Geotextiles can also be used to reinforce slopes, thus taking the place of gabions, sandbags, or other structural reinforcing devices. Laid on archaeological surfaces, geotextiles can provide erosion control, improve the efficacy of drainage, and protect against root damage by restricting the size of roots that can penetrate the layer. Sites can be protected by covering them with a geotextile topped over with soil brought in from elsewhere (see deliberate site burial in the following section). Where trees or shrubs are planted on such a sacrificial layer of soil, a suitably tough moulded geotextile should assist in preventing penetration of roots into the site.

PROPERTIES AND USES OF GEOTEXTILES AND GEOGRIDS

Surface:

- Protection against the erosive effects of raindrops and runnels
- Reduction in the volume of runoff by retaining moisture on or within the textile
- Reduction of wind-erosion and modification of the microclimate of the soil surface (Coppin and Richards 1990: 84)
- *Geogrids* provide a hard surface for tracks.

Subsurface geotextiles can be used to:

- Separate archaeological layers and excavation surfaces from fill placed to protect them
- Stengthen layers in tension across the plane of the fabric
- Allow water vapour/moisture to percolate so that layers are not sealed in an anerobic state
- Reduce migration of roots into an archaeological site
- Prevent the migration of fine particles into coarse aggregates, e.g. when used in drains or under paths
- Minimise the thickness of fill/aggregate that needs to be applied to surface a buried site or a walking/vehicle track.

A covering layer of soil protects a geotextile from sunlight and surface traffic. When planted over, the geotextile is bound into the soil through the plants' roots. Buried beneath layers of soil as thin as 10 cm, planted-over geotextiles can:

- Reinforce the soil surface layers in a similar way to plant roots

- Create preferential root-growth paths, and improve the lateral continuity of the root network
- Reduce penetration of roots
- Form a soil-root-geotextile composite layer which acts as a surface mat protecting the site beneath
- Reduce the risk of soil compaction
- Absorb part of the impact of foot or even wheeled traffic, thereby reducing compaction in areas of heavy traffic (Coppin and Richards 1990: 84).

For a track or other high-use area (e.g. around an interpretation sign), a filter cloth will minimise the thickness of surface gravel needed. If not used, the fine material (sand and silt) will work its way up into the gravels (and vice versa), and the value of the gravels is soon lost. For almost all applications, joint and edge detailing is most important. Otherwise applications will fail from the edges, even when the textile is performing satisfactorily in the centre of the areas to which it has been applied. Turning the edges of a textile in and down into the ground and covering them with soil is one minimal precaution to take. Geogrids can be left on the surface but again, the treatment of edges is important. They should be well feathered into or slightly buried under the surrounding soil—bearing in mind any potential future erosion there.

Weaknesses of surface-laid geotextiles are:

- They are prone to vandalism or pilfering
- UV degradation, even with UV-resistant compounds, is inevitable
- The geotextile is, by design, permeable to water. When laid on slopes it may trap silt or sand within the lower inside surfaces (facing the bank), leading to stress and failure of the textile.

A good supplier of professional-use geotextiles is Permathene (Auckland).

2.3.3 Deliberate site burial

The objective of deliberate burial is to seal the site from damage such as surface tracking, root growth, ploughing, etc. In New Zealand, a few sites have been buried but without the benefit of an intermediary geotextile membrane. Just how satisfactory the longer-term results will be, is not known. Examples are the midden at Tairua, covered by a carpark; and pits covered at Port Underwood, Marlborough Sounds. In addition, there are many sites that have been buried by natural processes or engineering works, but again no systematic consideration has been given to their condition. The technique has considerable potential in engineering works programmes, and routine domestic house-building. Its utility on steep ridge-top sites seems less secure.

Roots, particularly large tree roots, must be prevented from damaging the stratigraphy of archaeological sites. The introduction of layers of soil or gravel over a site to take up surface wear and root growth may be worthwhile on valuable sites, although the measure is unlikely to be of any use if large vigorous trees are planted. This protective layer should also be considered in the protection of sites from other uses. Sites could be buried under roads, carparks, and under buildings and building yards.

DELIBERATE BURIAL OF ARCHAEOLOGICAL SITES

How deep to bury?

- No more than 60 cm

Positives of burial

- Can provide good protection for underlying features
- Sites are protected from all damage caused by activity on the surface

Negatives of burial

- Can cause changes to the physical, chemical and drainage properties of the site
- Increased pressure on the site
- May break solid foundations or artefacts or displace their position in relation to site stratigraphy
- On steep country, will increase loads at heads of slopes, leading to failure.

Until examples of deliberately buried sites have been excavated, the procedure should be regarded as experimental. As a general rule, no more than 60 cm thickness of soil (estimated to apply a pressure of 5 p.s.i.) should be laid over a site. This will minimise the risk of compression of the site but still give a good protective cover. Consideration should be given to the thickness of the existing topsoil which will have developed since site abandonment. Although it is an integral part of the site, it can be sacrificed and provide some protection for the main layers of the site beneath. A thin layer of added soil (30 cm) will reduce or restrict topsoil formation and incorporate the existing topsoil as part of the protective layer.

If not carried out with care, the process of spreading the cover soil could be very damaging and offset any protection that it may offer. The surfaces and soil should not be wet, and friable soils will need particular care. Wheeled machines should not be allowed onto the surface to be covered. Tracked machines are generally preferable and hydraulic diggers are likely to be the best. They should extend the area covered in one pass, working from the filled area, so that they track over and consolidate the full depth of newly deposited soil. Tracks should not be turned or slewed over the site surface. Trucks bringing material to the site should unload outside the area to be covered and the material then lifted or pushed into place by the digger. If the area to be covered is large, self-propelled scrapers may be acceptable to pass over the uncovered surface but some trials adjacent to the site would be a wise investigatory step to take first.

Unintentional effects of burial (Thorne 1989) may include:

- Physical changes:
  - — Changes in drainage, water table
  - — Compression, especially of softer layers or voids, or creating discontinuities in stratigraphy
  - — Artefacts, solid foundations or delicate floors may be crushed or broken up.
- Chemical changes:
  - — More *acid* conditions will damage shell, bone, iron and other metals

— More *basic* (alkaline) conditions will lead to deterioration of wood, plant remains, some glass and ceramic glazes and metals

— Drier conditions will enhance protection (unless the deposits were previously wet anaerobic)

— Wet anerobic conditions will enhance the preservation of plant remains but, if accompanied by increases in acidity, will damage most other site contents;

— Increased wet conditions will create more plastic stratigraphy.

These effects will be difficult to judge. A rule of thumb would be to exercise caution if burial will:

- Be deeper than the equivalent of one metre thickness of soil cover
- Change drainage factors to create drier or wetter conditions
- Differentially affect soft or plastic parts of stratigraphy
- Lead to greater stresses on hard or longer components (such as solid foundations) which are in more plastic surrounds or stratigraphy
- Increase pressures at slope margins or at the head of scarps, increasing risk of slope failure.

Be careful also where ceramics, glass or other readily broken artefacts are likely to be present at the site.

Protection of a site from activities such as backyard play or gardening will require no more than 30 cm depth of fill. If there is an existing topsoil over the site, the fill could be as thin as 20 cm on level surfaces. Fill other than soil may be used with care. A geotextile and a layer of sand should be in place before using demolition fill. Large boulders (over 60 cm diameter) should not be used in landscape schemes over sites. Gravels laid over geotextiles should be no more than 30 cm thick.

2.4 FIRE

In areas with dry summers where visitors to a site could cause fires, a cover that has a low inflammability is desirable. Uncut, long grass could be disastrous in areas where people might get trapped. Spraying, mowing or grazing may be needed late in spring to make a fire break around a site that is predominantly grassed. Large sites could be segmented with mown strips, the exact position of which should be determined by a fire control management plan. Care should always be taken to avoid creating bare ground that might erode.

Some changes in vegetation cover may be desirable. Fire-resistant species could be planted at key locations such as a carpark, or planted or allowed to grow in areas that provide a key to slowing or stopping the spread of fire. Shrubs or trees with low flammability such as five-finger, taupata, karaka, kawakawa or poroporo can be planted in 'green breaks' (dense bands) to form a moderate fire break where needed. Flax is regarded as a species of moderate flammability. The Forest Research Institute has recently published a pamphlet and a report on the flammability of various species (Fogarty 2001).

On coastal sites, iceplant (the New Zealand native horokaka, *Disphyma australe*) or other succulents such as the native spinach (*Tetragonia* *tetragoides*) may be satisfactory. Near urban areas and where already present, the introduced iceplant *Carpobrotus edulis* may be propagated. Local species will usually be found that can be adapted to protective use.

Managed fire has some potential for maintaining archaeological sites. Continued wild fires have had the effect of maintaining sites in good condition in some areas, e.g. around the margins of the Urewera Ranges (Fig. 9B). The use of fire is under consideration for certain nature conservation purposes also, such as grassland maintenance.

Archaeological conservation objectives where fire might be useful are:

- Where a site needs to be maintained in early successional stages such as grassland or young mānuka
- Where the character of a historic landscape needs to be maintained, e.g. grassed ridges and faces with open treelands in valleys
- Where its low impact on surface profiles, compared with other methods of grass or shrub such as line trimming or grazing, is important.

Factors which may mitigate against use of fire are:

- Community attitudes, public safety factors
- Potential for certain weeds to grow after the fire, especially legumes such as broom, gorse or wattle
- Management costs of a fire, controlled or not, may be high
- Fire may kill some desirable plants such as cabbage trees or flax, or desirable animal species
- Fire will destroy wooden structural remains and possibly metal and glass on nineteenth- and twentieth-century sites
- Fire may alter exposed artefacts such a stone flakes on stone quarries
- Reserve boundaries may not be designed to allow the fire to be easily or effectively managed (some small islands and narrow peninsulas excepted).

FIRE CONTROL MANAGEMENT PLANS FOR HISTORIC RESERVES

- Must have provisions that prevent bulldozing as a fire control measure, even where this may increase the cost or difficulty of putting out the fire.
- Written so that the potential historic conservation benefits can be realised—a greater area could be left to burn to manageable boundaries than for other classes of reserve, if life and property are not at risk from the fire.
- All managed fires require a writen prescribed burn plan and a fire permit approved by a Rural Fire Officer (refer to Department of Conservation Fire Control SOP QD Code: C/1022).

2.5 SPECIFIC SITE MANAGEMENT TECHNIQUES

2.5.1 Problem trees

Some trees pose particular problems for archaeological sites, especially trees that are rapid-growing, that form an intermediate stage in forest succession, or both. Mature rewarewa, for example, is prone to wind throw and can cause damage if growing on an archaeological site. In the last 40 years, before legislative site protection measures were fully in place, a number of archaeological sites were planted in pine forest. Although these trees may have protected the surface features of the site, their roots will have damaged stratigraphy. In addition, their eventual felling, hauling and log staging puts the site at risk of complete destruction. There are, however, methods of removing the trees that minimise the risk of site damage.

One approach is to cut trees down while they are small (perhaps at fence post size). At the other end of the harvesting cycle, it is not an option to leave isolated patches of trees unfelled on the archaeological site area, because they will be prone to wind damage.

The following procedures should only be executed by professional harvest planners and tree felling specialists. They are detailed here so that archaeologists advising on forest harvest have a grasp of the techniques that have potential for use.

When a tree is cut down, its head hits the ground with considerable force and it is worth taking steps to ensure that it does not damage archaeological site features (Fig. 24). It is possible to fell a tree well away from the falling position indicated by its natural lean. Winching the tree, orientation of the scarfing cut, and wedging the back cut—or a combination of all three—can be used to fell a tree quite accurately in a desired direction. The direction of felling can be as precise as an arc measuring ± 2 degrees in plan measured from the stump,

Figure 24. Heavy branches came down with great destructive force on earth works. On the pā Te Rau o Te Huia, Taranaki, (A) corduroy has been laid (the logs forming the corduroy should be longer than those used here) to receive one branch while (B) another smaller branch has come down on corduroy with no damage to the site.

Figure 25. On Te Koru Historic Reserve, a rewarewa growing in an unsatisfactory position at the top of a revetted bank has just been felled. It has caught in some high branches of the other trees and the base has sprung to the right, missing the corduroy (visible just about the cut of the new stump).

particularly for trees of symmetrical form and with vertical trunks. This is sufficient precision to be able to plan to avoid archaeological features or desired canopy replacement species. The ability to fell trees directionally should be used to avoid upstanding earthworks and to get the tree to fall on protective layers (Fig. 24, see also the box on corduroy). Other factors to be considered are the disposition of neighbouring trees and whether there are high branches that may come down in the course of the tree making its passage to the ground.

Generally, the sequence of felling is the key to successful protection of the site. Trees around and outside the site perimeter should be felled first so that trees on the site itself can be felled outwards. When felling trees, care needs to be taken to avoid them hanging up on the neighbouring trees and to avoid problems with rotten trees or branches suspended aloft (Figs 25, 26).

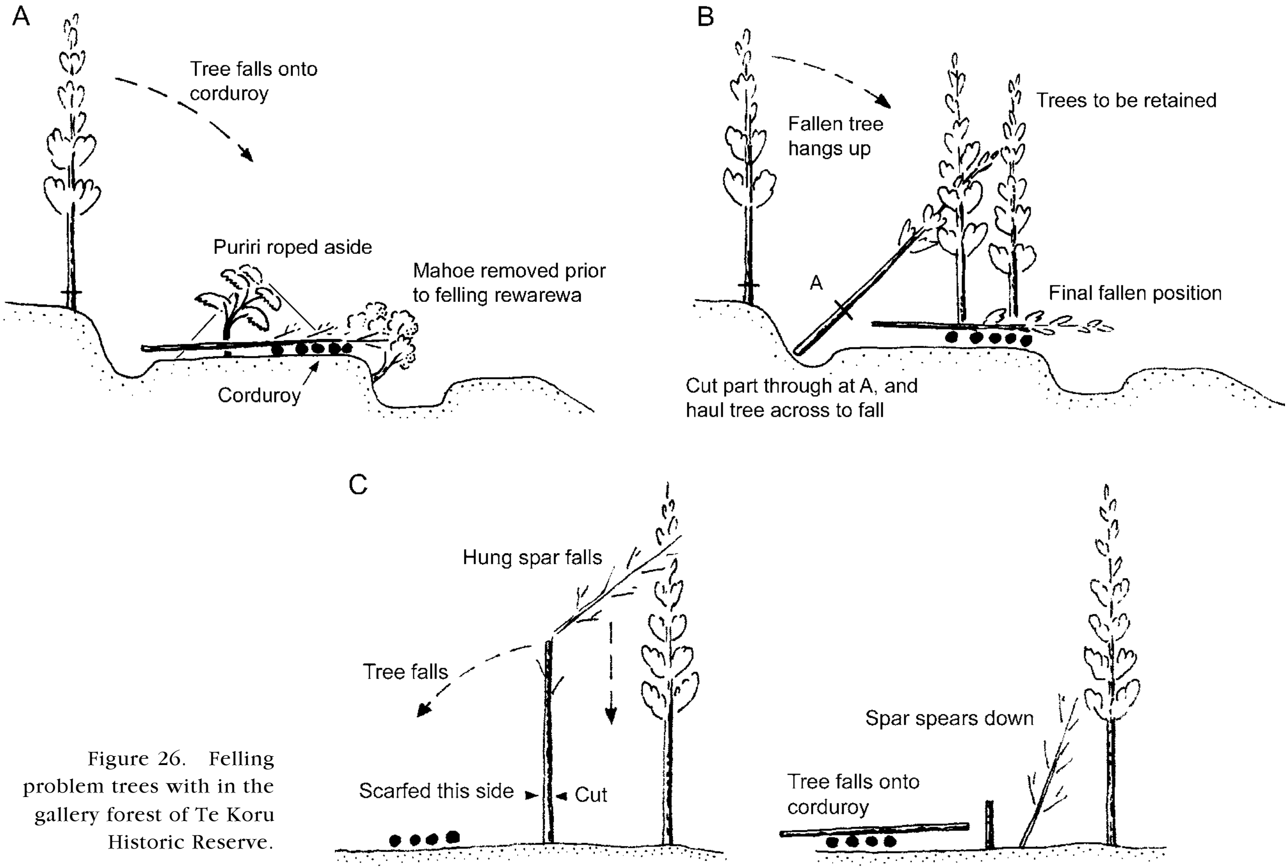


Figure 26. Felling problem trees with in the gallery forest of Te Koru Historic Reserve.

PROCEDURES FOR TREE FELLING ON ARCHAEOLOGICAL SITES

- Direction and sequence of felling is the key to successful protection of the site.
- Safety of personnel is the paramount consideration and should be entirely at the discretion of the logging supervisor.
- Initial cutting of limbs can be carried out to change the natural lean of the tree and reduce its mass.
- Large horizontal limbs which would spear into the site should also be removed before the tree is felled.
- If resources permit, piecemeal cutting and lowering of sections from the top down can reduce damage.
- Branches or small trees may be placed on or near the areas to be protected so as to cushion the impact from felling of large trees.
- 'Sacrificial' felling of small trees to protect archaeological features is best done at the earliest stages of felling.
- Felling along the line of existing features, e.g. ditches and banks, rather than across them will assist to preserve the form of these features.

In some circumstances it will be necessary to decide whether to extract the trees, to poison them or to fell them to waste. Hauling may not be possible or, in the interests of site protection, they are best felled into ground that may be too difficult for recovery—e.g. over a cliff. In other instances, where both archaeological site values and wood values are high, helicopter removal of fallen trees could avoid damage from hauling logs through a site. Slash should generally be moved as little as possible, but cut finely so that it is in contact with the ground and rots quickly.

Because many sites are on friable ground, not only machine and log movement but also unnecessary foot traffic needs to be avoided.

Figure 27. A selection of young (c.20 years) closely spaced Douglas fir has been poisoned on pā Hinamoki I, Whirinaki Valley. Scrub and ferns grow in the improved light coming through holes in the otherwise closed canopy of the Douglas fir trees.

After trees are felled, consideration should be given to the vegetation succession on the site. Native shrub species, tree ferns, ferns, gasses and sedges will also provide useful successional cover after felling. The risk of damaging weeds (e.g. pampas grass, seedling pines) becoming established should be considered. Control must be planned for and indicated in any management plans for the site, including new forest compartment management documents. Weeds and wilding pines will need to be monitored and sprayed with a herbicide or cut down before they become too dominant in the succession.

CORDUROY AND ITS USE

- Corduroy is a protective layer formed from branches/timbers (no less than 10 cm in diameter), up to 2–3 m long. It is placed at right angles to the line of tree fall, particularly where the upper part of the tree is expected to land.
- It is needed at especially vulnerable places such as the edges or tops of banks.
- The head of a felled tree comes down with considerable force and the corduroy should ensure that it does not impact on upstanding earthwork features.
- Old car tyres, tied together, can be used instead of timber.
- The minimum extent of a patch of corduroy should be three logs/ branches placed side by side, with their length spanning an arc of 10–15 degrees in the line of intended fall.
- Corduroy will be difficult to place if the tree to be felled will fall across the line of a bank. Felling of smaller trees along the line of the ditch, to form a tangled mat on which the big trees will fall, may be easier to implement.
- Corduroy may also be used as a temporary track for hauling logs across a site.

An alternative to felling trees is to poison and leave them to die (Fig. 27). Ring-barking is effective on most species provided it is accompanied by application of a poison solution to the cut. The main advantage of these methods is that the dead trees will drop branches gradually and the trunks will be much lighter when they eventually break or fall down. Impact on the site will be minimised. However, ring-barking and poisoning of large trees should not be undertaken lightly. Dead upper branches may fall on visitors, especially during heavy rain or wind. If, for some reason, a dead standing tree is subseqently felled, the upper branches are likely to fall unpredictably.

The best practice would be to close off an area completely for the duration from shortly after (no later than three months) ring-barking/poisoning to the eventual fall of the trees. Poisoning and ring-barking is therefore recommended only for sites not open to the public, where few management operations are needed for the subsequent 3–5 years.

Where large trees have been felled, land owners or managers will be faced with the issue of whether or not to remove the logs. Hauling logs can be very destructive and, if the public are not likely to visit the site, it may be possible to leave logs to rot naturally, or to cut them up on the site and leave them there. Piles of slash, logging debris or logs too difficult to move should be stacked so that they keep contact with the ground. This will assist the material to rot quickly and minimise problems with climbing or scrambling weeds establishing. If logs have to be hauled off a site, an archaeologist should be consulted as to the best route to take. If feasible, corduroy or a causeway of spoil should be built to buffer any destructive effects. Cut logs into smaller sections if they are not to be salvaged for timber and to make their size more manageable.

When very large trees are removed in amenity areas, the stumps should always be cut at, or trimmed close to, ground level. This is cosmetically satisfactory in the short term. Small tree stumps can be easily removed by a stump grinder if access for the machinery is readily available. The temptation will be to leave larger tree stumps. As they rot, they may leave sharp-ended ribs of harder stump wood and cavities—these are extremely dangerous, especially if visibility is obscured by long grass. Before this stage is reached, the partly rotted stumps should be ground or smashed with a sledge hammer to as much as 30 cm below ground surface. The cavities should be filled with a suitable fill marked at its bottom by a geosynthetic cloth. The hole should be overfilled and left with a convex surface so that the soil settles over time. However, if the site is to be mowed, the fill may need to be topped up from time to time as it settles.

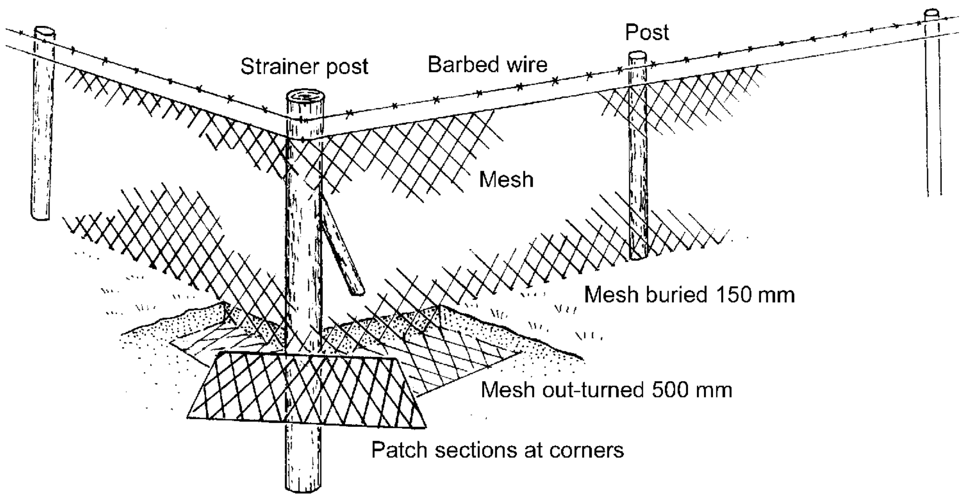
2.5.2 Control of burrowing animals, pigs, petrels

The burrowing animals most likely to affect archaeological sites are rabbits. Well-meaning interventions, such as opening an area in shrubland so that the archaeological features are more visible to visitors, may provide the conditions that pigs and rabbits enjoy—such as warmth and grass and bracken growth. If rabbits are concentrated on the archaeological site itself, then poisoning is likely to be effective. If they are widespread in the district then rabbit-proof fences may be desirable, followed by gassing or poisoning in the site area (see also Jones 1993: 25). Historic Scotland has recently published advice on ridding sites of burrowing animals (Dunwell and Trout 1999). Gassing is the preferred method there.

Pigs may be kept out by fences (Fig. 28, see also Aviss and Roberts, n.d.). The design may be adapted for rabbit control by using smaller mesh sizes, but localised extermination and keeping numbers down in the district will be better.

Petrels burrow in many coastal headlands and offshore islands, and on inland mountain ranges. There is no acceptable means of removing them from such areas. Re-introduction of petrels should not be allowed on archaeological sites.

Figure 28. Concept for pig- or rabbit-proof fencing for archaeological sites.



2.6 EARTHWORKS REPAIR OR RECONSTRUCTION

A conservation plan should determine whether restoration or reconstruction of surface earthworks is warranted. Restoration is most likely to be carried out where there has been recent damage to a bank or infilling of a ditch or both (see Furey 1984). Cuts with faces more than 1 m high will need careful attention to the soil used, drainage at the base, and reinforcement to prevent slippage. Reinforcement could be *temporary*: layers of brush, bracken or hessian laid in or knitted into the horizontal plane; or *permanent:* layers of geotextile or 'bags' made of geotextile (Fig. 29). The brush or bracken layer should be as thin as possible once compacted. Hessian can be doubled over to increase strength. With geotextiles, the layers should be positioned so that the edges of the geotextile are not visible on the surface of the restored bank.

Geotextile or hessian bags are made by laying the geotextile on the surface and filling over it. The geotextile is pulled back up over the fill at the intended line of the face and filling again on that surface, and so on. The face of restoration done in this manner will be unsightly unless hessian, which will rot away rapidly, is used. Jute sacks could also be used.

New earth surfaces on slopes should be well compacted. Grass and lotus seed should be applied before compaction. Rapid grass establishment is desirable.

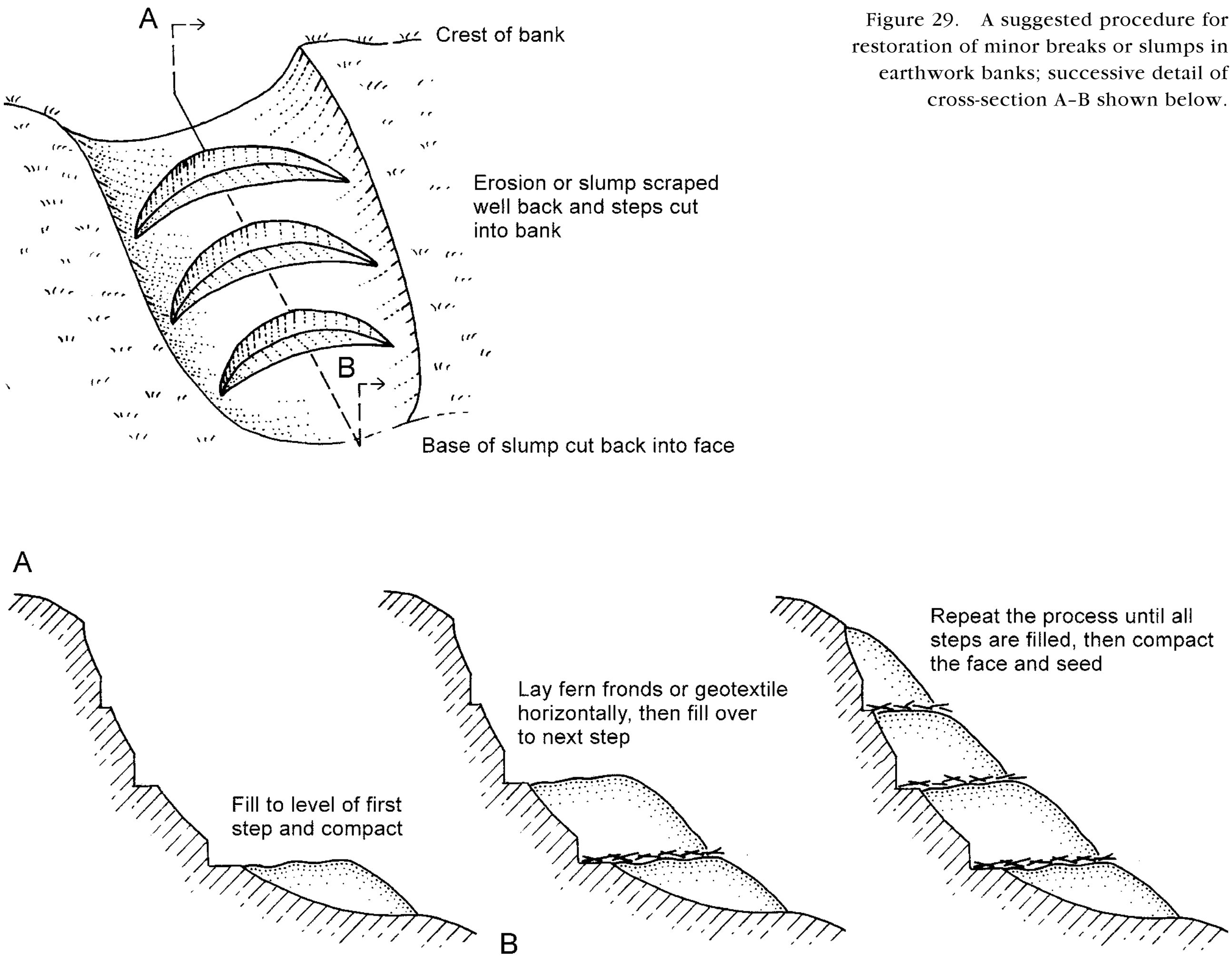


Figure 29. A suggested procedure for restoration of minor breaks or slumps in earthwork banks; successive detail of cross-section A–B shown below.

Annual ryegrass will establish quickly but overall it is better to apply a mix of rapidly establishing and perennial grasses (see box on p. 27; see also Appendix 2, section A2.1 and Appendix 4). In many cases, it will make sense to obtain turves from a local source. The base of an adjacent ditch may be one source, provided it is well filled with topsoils and a note or other record is made of what has been done. The record of management action could be filed with the archaeological site record.

Fill is not always readily available. Moreover, many New Zealand soils are friable and will not compact readily. These techniques therefore need to be supplemented and varied. 'Instant lawn' or any available turves of firm consistency have sufficient strength to enable them to be stacked (flats horizontal) up a steep face (but not a vertical one) in a form of revetting. Sufficient of the outwards-facing live grass will survive to establish a new cover. Rotting of the roots from the buried parts of turf revetments may lead to a loss of strength and to collapse. Soil placed behind the turves may force bulges at the base of the stack and the soil can wash out with rain. Careful compacting is necessary. These are potential applications for the strengthening and filtering properties of geotextiles, used in combination with the turves. Instant lawn is rich in fertiliser and well watered when supplied. It is a potentially good cover where subsoil is exposed in banks or at the crest of banks. It was used successfully in restoration of parts of the standing redoubt at Pirongia.

Small amounts of fill may be added over areas where midden may be exposed, preferably over a geotextile. There should be no risk of further erosion leading to exposure of the geotextile.

2.6.1 Reconstruction of archaeological features

The wish to re-construct the original features of buildings or other structures on their surviving archaeological remains is often expressed, usually when tourist development or interpretation is in prospect. There have been a few examples of such reconstruction in New Zealand (see Jones 1989). The fashions and the ethics with respect to re-construction have changed in recent decades. Generally, the practice is opposed by the ICOMOS charters (e.g. the International Charter on Archaeological Heritage Management, Article 7), and also by other significant sources of published policy such as the US National Park Service. The latter's policy in 1983 was as follows:

'A vanished structure may be reconstructed if:

'1. Reconstruction is essential to permit understanding of the cultural associations of the park established for that purpose.

'2. Sufficient data exist to permit reconstruction on the original site with minimal conjecture.

'3. Significant archaeological resources will be preserved in situ or their research values realised through data recovery.

'A vanished structure will not be reconstructed to appear damaged or ruined. Generalised representations of typical structures will not be attempted.' (United States National Park Service 1983, 44738; also Jones 1993: 111–113).

This policy reflects NPS dissatisfaction with questionable reconstructions which were often designed to present a 'typical' representation and which might not have been on the site originally. A redoubt not sited on its original vantage point on the top of a hill is unlikely to feel correct. A broader ethical problem also arises where the re-construction work is used as the rationale or motivating factor in gaining resources to investigate the archaeological site. The site may not be well investigated, because of time constraints, or for want of close consideration of precise research goals formulated in the light of the most advanced state of knowledge. These are broadly ethical problems. In New Zealand, there are few re-constructions, so the ethical problem relating to authenticity and the destruction of original fabric have not been fully debated.