



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

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 features of an archaeological site (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  $\pm 2$  degrees in plan, measured from the 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 section on Corduroy, below). Other factors to be considered are the disposition of neighbouring trees, and whether there are high branches that may come down separately in the course of the tree falling.

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 and 26).

#### ***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

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 above the cut of the new stump).



- 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 may be 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.

After trees are felled, consideration should be given to the vegetation succession on the site. Native shrub species, tree ferns, ferns, grasses, 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.

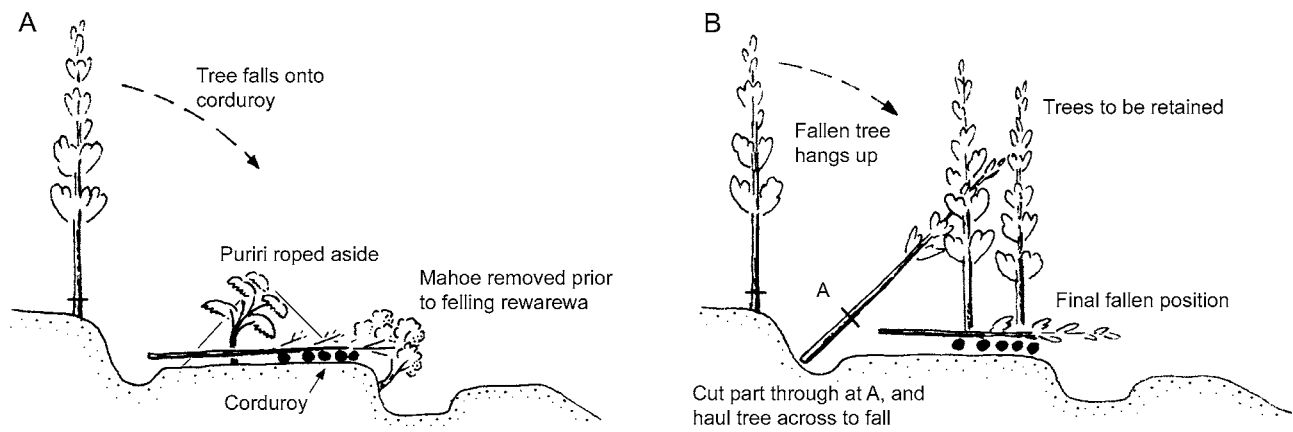


Figure 26. Felling problem trees within the gallery forest of Te Koru Historic Reserve. A and B show two different procedures for successful tree removal without damage to the site. (See also Fig. 25.)

- 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.

Figure 27. A selection of young (c. 20 years) closely spaced Douglas firs has been poisoned on gunfighter pa 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.



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

this method 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 and it is also a cheap method. 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 subsequently 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 ring-barking/poisoning (no later than three months) 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. If they are not to be salvaged for timber, cut logs into smaller sections to make their size more manageable.

When very large trees are removed in amenity areas, the stumps should always be cut at, or 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.

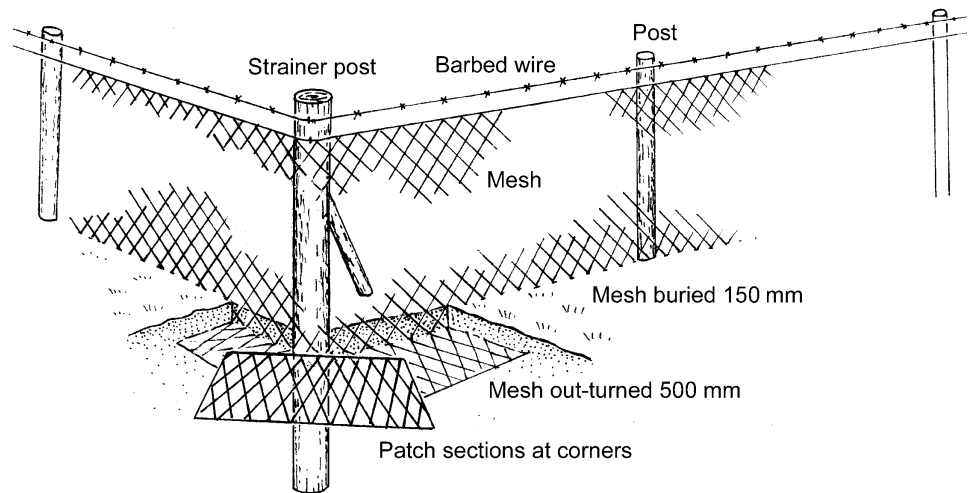
### **2.5.2 Control of burrowing animals, pigs, petrels**

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. Rabbits and cattle can make a destructive combination. 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, to control population movement within manageable areas, followed by gassing, poisoning, ferreting, and night shooting in the site area (see also Jones 1993: 25). Good planning, persisting until the job is done, and making use of the most effective poisons available seem to be the key. Historic Scotland has recently published advice on ridding sites of burrowing animals (Dunwell & Trout 1999). Gassing of warrens is the preferred method there.

Pigs may be kept out by fences (Fig. 28; see also *Avis & 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. Their range is also becoming extended. There is no acceptable means of removing them from such areas. Any decision to re-introduce petrels and other seabirds to areas with archaeological sites needs to be a balanced one, and will be subject to the authority provisions of the Historic Places Act 1993.

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



## 2.6 EARTHWORKS RESTORATION OR RECONSTRUCTION

A conservation plan should determine whether restoration or reconstruction of surface earthworks is warranted. An authority under the Historic Places Act 1993 will be required.

### 2.6.1 Restoration

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 and watering may be needed. Annual ryegrass will establish quickly, but overall it is better to apply a mix of rapidly establishing and perennial grasses. (See Table 1; also Appendix 2, section A2.1, and Appendix 4 for more detail.) In many instances, it will make sense to obtain turfs from a local source. The base of an adjacent ditch may be one source, provided it is well filled with topsoil, and a note or other

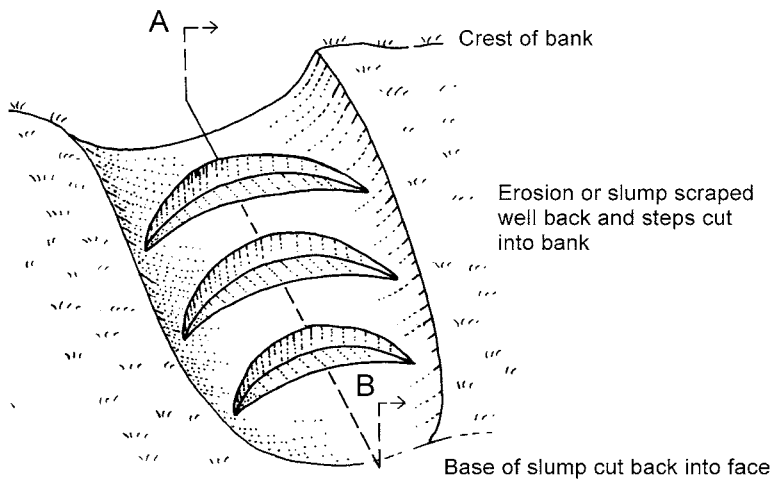
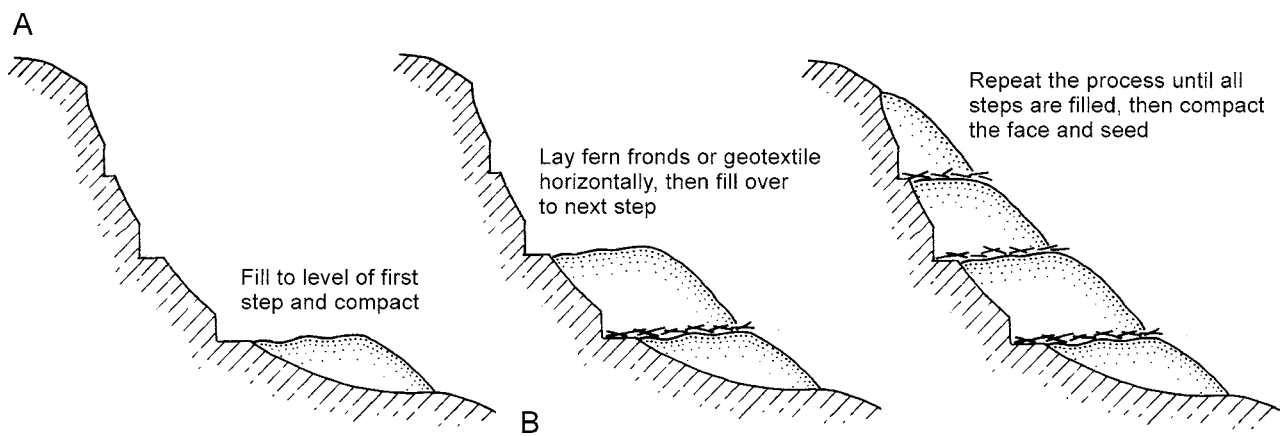


Figure 29. A suggested procedure for restoration of minor breaks or slumps in earthwork banks; successive details of the cross-section A-B are shown below.



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 commercially available turfs 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 turfs 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 turfs. 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 (Ritchie 1995).

## 2.6.2 Reconstruction of archaeological features

There have been a few examples of reconstruction in New Zealand (see Jones 1989). The wish to reconstruct 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. Reconstruction is a particularly difficult subject in heritage conservation. It is doubly difficult with archaeological sites, since the original fabric is much decayed and it may be argued that it is only useful as a source of information.

The fashions and the ethics with respect to reconstruction have changed in recent decades. Something of the problem can be appreciated from the paradox that reconstructions are argued to be more 'authentic' when they are built on the original site—irrevocably destroying that site. Generally, this 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:

- 'Reconstruction is essential to permit understanding of the cultural associations of the park established for that purpose.
- 'Sufficient data exist to permit reconstruction on the original site with minimal conjecture.
- '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 reconstruction 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. The problem may be summed up by the following sequence:

- It is better to stabilise than repair
- It is better to repair than restore
- It is better to restore than reconstruct.

In New Zealand, there are few reconstructions, so the ethical problems relating to authenticity and the destruction of original fabric have not been fully debated. Table 4 (next page) lists some of the advantages and disadvantages of reconstruction of archaeological features.

TABLE 4. RECONSTRUCTION OF ARCHAEOLOGICAL FEATURES.

ADVANTAGES	DISADVANTAGES
<p>Assists with interpretation of a place</p> <p>Gives a tangible result to archaeological research excavations</p> <p>Original fabric may have been destroyed or greatly modified by excavation</p> <p>May be able to incorporate and display elements of the original fabric and offer vantage points</p>	<p>Will almost certainly damage original fabric</p> <p>Will be expensive, require maintenance and may fail</p> <p>Has no patina, appearance of age or the accrual of change that is part of heritage</p>

### 3. Management of sites under reserve, farming, and forestry land

Archaeological sites may be found under most land uses. This part of the guideline gives specific advice to reserves and amenity managers, farmers, and foresters. Its three main sections should be able to be read independently, but the sections read together will provide a guide to practical site conservation.

In almost all cases, specialist advice is needed to determine the existence of archaeological sites, their true extent, and their values. Consulting and following these guidelines is not a substitute for determining whether authorities to modify are required under the Historic Places Act 1993. A starting point will be the Historic Places Trust website ([www.historic.org.nz](http://www.historic.org.nz)). Again, specialist advice will often be needed. Other specialist areas where additional professional advice may be needed on a case-by-case basis include: conservation plans for particular areas, landscape analysis sensitive to archaeological site conservation, engineering issues, local government requirements, statutory land management processes and consents, pasture and grasslands, fire risk, and tree felling and forestry operations.

#### 3.1 AMENITY AREAS OR RESERVE LANDS WITH PUBLIC VISITING

On a small number of selected and accessible sites, land managers may wish to carry out a more intensive form of management which allows for higher numbers of visitors. As few as 20 people per day can create bare patches or informal tracks on a grass sward. As a general rule, any reserve with more than 5000 visitors per annum will need careful planning of visitor tracks and other facilities.

Picnic grounds have destroyed many archaeological sites, since modern-day picnickers like the same sheltered spots that were favoured by Maori and early European settlers. Where an archaeological site is to be presented to the public, it should be assumed that there will be particular parts which will come to have much use by families with small children. Anything which could be dangerous for small children, such as some types of herbicide sprays, or holes concealed by vegetation, will have to be avoided. Even banks of sand or loose pumice, which children may tunnel into while adults are picnicking, can present dangers.

Figure 30 shows typical problems and possible solutions for a large reserve area containing archaeological sites and to which the public has

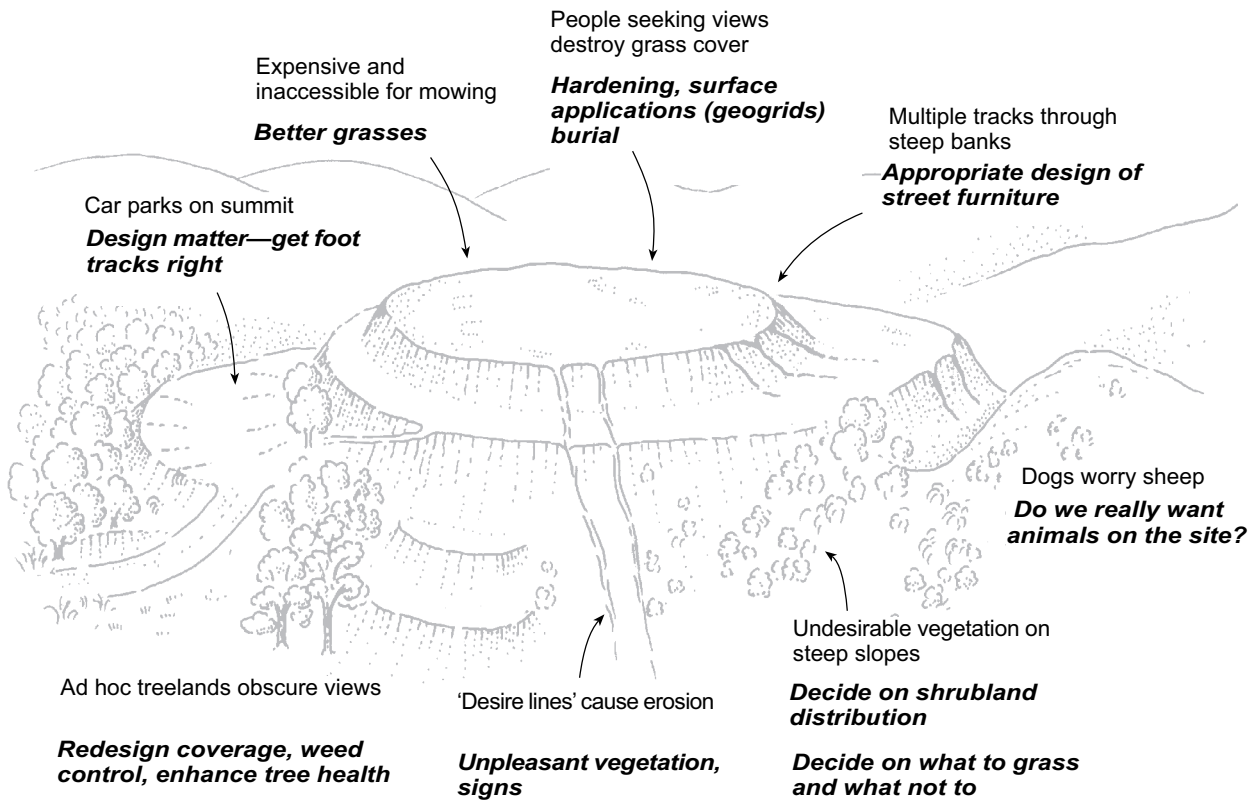


Figure 30. Problems and solutions in the management of a hilltop pa site, at a landscape scale.

access. Besides the need to obtain authorities under the Historic Places Act 1993, important practical issues are:

- Understanding how the public gets access from the road end, and the behaviour and needs of the public in general, while they are on foot on the site
- Maintaining grasslands, shrublands, and treelands, and their role in ensuring site protection
- Designing and utilising signs and other structures, such as boardwalks, viewing areas, and barriers

### 3.1.1 Public access and use

Monitoring and surveys should reveal the use people make of the reserve and how facilities could be improved. Desire lines are a common phenomenon: tracks made by people as they follow what is perceived to be the best or most interesting way around the site. These should be studied quite closely for two reasons: first, to gain an understanding of people's use and intentions, and second, to divert the traffic in a realistic way or to improve the track alignments and construction (Fig. 31).

Any erection of structures will require consents under the Resource Management Act and the Building Act from the territorial authority. Some earthworks (e.g. for tracks and roading) may also require consents under the Resource Management Act from regional councils. The New Zealand handbook: tracks and outdoor visitor structures (see Standards New