

IN THE MATTER OF

**The Resource Management Act
1991**

AND

IN THE MATTER OF

**A submission by the Director
General of Conservation on the
applications for resource consent
by the Ashburton Community
Water Trust**

**EVIDENCE OF NICHOLAS HEAD
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1. QUALIFICATIONS AND EXPERIENCE

- 1.1 My name is Nicholas John Head. I am currently employed by the Department of Conservation as the plant ecologist for the Canterbury Conservancy where I have worked for the past 12 years. Previously I was employed by Landcare Research as a botanist for the Rabbit and Land Management Programme and Semi-Arid Lands Programme, based out of Alexandra. I have a MSc (Hons) in plant ecology from Lincoln University and a BSc with a double major in plant ecology and physical geography from the University of Canterbury.
- 1.2 I have ecological and botanical responsibilities for the Canterbury Conservancy, with a particular focus on the management and restoration of threatened plant species and rare ecosystems. I am also responsible for providing a wide range of botanical and ecological advice to staff and the public generally.
- 1.3 I have had extensive experience with assessing sites of significant ecological values. For example I have been involved in a number of Protected Natural Area Programme (PNAP) Surveys, including The Plains Ecological Region (ER), the Hundalee Ecological District (ED), and I compiled the Motunau/ Cheviot PNAP report. I have also assessed many sites throughout Canterbury that form the basis of Significant Natural Areas (SNAs) in numerous District Plans.

2. SCOPE OF EVIDENCE

- 2.1 I have been asked to present evidence on the significance of the remaining indigenous vegetation within the construction footprint of the Ashburton Community Water Trust proposal. In doing this I will provide an overview of the Protected Natural Areas Programme (PNAP) and Land Environments of New Zealand (LENZ) as a framework for identifying significant ecological values and assessing environmental effects. I will also consider the adequacy of the applicant's ecological assessment and proposed mitigation.

3. FRAMEWORK FOR ASSESSING ECOLOGICAL SIGNIFICANCE IN NEW ZEALAND

- 3.1 When assessing ecological values and the environmental effects of applications, it is important to use accepted ecological frameworks. These frameworks provide the spatial context for determining the character and importance of indigenous biodiversity in any given area, such as the Canterbury Plains. This context is crucial for ensuring that comparisons are not made between relatively natural areas and highly modified areas. Without this context the importance of remnant indigenous biodiversity in highly modified environments would be under-recognised, or largely dismissed.
- 3.2 In New Zealand, the two main frameworks are Ecological Regions and Ecological Districts (EDs), and more recently, Land Environments of New Zealand (LENZ). The ED framework has its origins in the PNAP and has been the most commonly used and accepted framework to determine sites of ecological significance throughout New Zealand. The PNAP was initiated in 1981 by the National Parks and Reserves Authority in response to concern that New Zealand's protected natural area system did not represent the full range of natural diversity, and that natural areas were continuing to be lost (Kelly & Park 1986). To provide a framework for assessing this natural diversity, the country was subdivided into 268 EDs and 85 ERs by the Biological Resources Centre of DSIR (McEwan 1987). Each ED has a distinctive pattern of climate, geology, landforms and biological features, and adjacent districts with closely related characteristics form Ecological Regions. The ED was considered to be the most appropriate scale for conducting PNAP surveys.
- 3.3 Under PNAP a standardised scientific methodology was developed by the Technical Advisory Group, which was consistent, simple to apply and repeatable. It involved reconnaissance, field survey, local analysis and evaluation. The evaluation of survey data results in the identification of Recommended Areas for Protection (RAP) which best represent natural ecosystems in an ED. They are chosen by applying seven selection criteria that are widely used internationally in evaluating nature conservation values (O'Connor *et al.* 1990). The criteria are:

representativeness, diversity and pattern, rarity and special features, naturalness, size and shape, buffering / surrounding landscape and boundaries, and long-term ecological viability. The explanation of each of the above criteria is set out in appendix 1.

- 3.4 PNAP surveys continue to be undertaken throughout New Zealand by central and local government using the same or similar criteria. These criteria are also used in other ecological surveys, such as those undertaken to identify “Significant Sites” under the Resource Management Act (RMA). For example, similar criteria are used in the Ashburton District Plan for assessing significance for the purposes of Sec 6(c) of the RMA.
- 3.5 In addition to PNAP criteria, in more recent years LENZ has been developed as a tool to identify significant values and protection priorities. LENZ is a national classification of New Zealand environments using climate, landform and soil variables to predict areas of similar ecosystem character (Leathwick 2001; Leathwick *et al.* 2003). In many ways LENZ is a surrogate for the ED framework and is a guide to the likely pre-human pattern of terrestrial ecosystems and biodiversity.
- 3.6 LENZ is used in the Government’s 2007 statement on national priorities for the protection of indigenous vegetation where less than 20% remains within level IV (1:50,000 scale) land environments. The 20% threshold is based on ecological theory which shows a dramatic loss in biodiversity when indigenous ecosystems are reduced to less than 20% of its previous extent (Walker *et al.* 2006). Land environments that contain less than 10% of its original cover are classified as ‘acutely threatened’, and between 10-20% as ‘chronically threatened’.
- 3.7 Protecting representative examples of indigenous vegetation that remain on acutely and chronically threatened land environments is National Priority 1 of the government’s priorities for the protection of indigenous biodiversity on private land (MfE 2007).

4. THE PROPOSAL & DESCRIPTION OF THE ENVIRONMENT

- 4.1 The proposal occurs along the south bank of the Rakaia River where it crosses the Canterbury Plains, spanning the High and Low Plains EDs in The Plains ER. The Canterbury Plains are among the most modified landforms in New Zealand. Consequently, they are almost entirely classified as an acutely threatened land environment, with only the upper terrace risers of the major rivers classified as chronically threatened (Map 1). It is estimated that indigenous cover remaining on the Canterbury Plains is around 0.1%. This is exceptionally low and as a result virtually any remnant indigenous vegetation takes on some importance, as they are some of New Zealand's rarest and most threatened remnant indigenous ecosystems.
- 4.2 The construction footprint of this proposal incorporates a corridor of land along the low terrace and terrace riser from approximately 3km above Highbank to Barrhill. Previous surveys have identified several sites within the construction footprint as having potentially high ecological significance. These sites were identified during the Plains PNAP reconnaissance survey undertaken in 1993 (Steven & Meurk 1996) and are listed in Table 1 (following page) and illustrated in Map 2.
- 4.3 The most important of these sites are those ranked from A-C as they meet the necessary threshold for significance in accordance to Ashburton District Plan assessment criteria and LENZ. These sites are primarily represented by remnant kowhai forest, native shrublands and cabbage trees that occur on low terraces and terrace risers of the Rakaia River. Included within some of these sites are locally rare plant species, such as the shrub *Corokia cotoneaster*, vines (*Rubus schmidelioides*) and native jasmine (*Parsonsia capsularis*), the shrub daisy (*Olearia virgata*), and the sedge (*Carex comans*).
- 4.4 According to Steven and Meurk (1996), sites with an A ranking are of the highest significance. These sites are also the most important to protect as they are the best representative examples of indigenous plant communities remaining within The Plains EDs (and the respective threatened land environments). Whereas E

ranked sites are not considered significant as they typically contain only a few individual plants, although they have some inherent value given the context of extreme loss within the ED.

Table 1: Sites containing remnant indigenous vegetation within or near the construction footprint identified during the Plains PNAP recce survey.

Site ID	Priority	Brief Site Description
154	E	Silver tussock (<i>Poa cita</i>) grassland with scattered native broom (<i>Carmichaelia australis</i>).
155	C	Mixed silver tussock grassland and native shrublands of native broom, kowhai (<i>Sophora microphylla</i>), <i>Coprosma propinqua</i> , bracken (<i>Pteridium esculentum</i>), porcupine shrub (<i>Melicytus aff alpinus</i>), matagouri (<i>Discaria toumatou</i>).
156	E	Native broom.
157	C	Mixed kowhai and native shrubland with exotic Pinus. Native species includes pohuehue (<i>Muehlenbeckia australis</i>), kowhai, cabbage trees (<i>Cordyline australis</i>), bracken, porcupine shrub, <i>Coprosma propinqua</i> , matagouri, <i>Rubus schmidelioides</i> , native jasmine (<i>Parsonsia capsularis</i>), <i>Olearia virgata</i> .
158	C	Dense scrub patches and silver tussock grassland and native shrublands of <i>Coprosma propinqua</i> , matagouri.
1287	C	Small patch of kanuka (<i>Kunzea aff ericoides</i>) with several large trees.
1288	E	Cabbage trees.
1289	E	Cabbage trees.
1290	E	Cabbage trees and native night shade (<i>Solanum laciniatum</i>).
1291	E	Cabbage trees.
1292	E	Cabbage trees.
1293	C	A series of cabbage trees for several km along the terrace crest.
1294	E	Cabbage trees.
1295	E	Cabbage trees.
1296	A	Mixed native shrubland on terrace gully and fan. Kowhai, cabbage trees, <i>Coprosma propinqua</i> , <i>Corokia cotoneaster</i> , <i>Coprosma ciliata</i> (probably <i>C. crassifolia</i>), <i>Coprosma rugosa</i> , <i>Coprosma rotundifolia</i> , native jasmine, porcupine shrub, matagouri, <i>Muehlenbeckia complexa</i> , and the ferns <i>Polysticum vestitum</i> , <i>Pellaea rotundifolia</i> , bracken, necklace fern (<i>Asplenium flabellifolium</i>). Also includes the sedge <i>Carex comans</i> .
1297	A	Extensive kowhai treeland on lower floodplain, with scattered kanuka.
1298	A	Numerous patches of kowhai and diverse native shrublands occur along terrace riser for several kms. Includes <i>Coprosma crassifolia</i> , <i>C. propinqua</i> , porcupine shrubs, <i>Corokia cotoneaster</i> , occasional kanuka, <i>Rubus squarrosus</i> , native jasmine.

- 4.5 A brief inspection of the area below Lowes Cutting during July 2008 confirmed that these sites as identified by Steven and Meurk (1996) (Table 1) were still present.
- 4.6 Para 5.5 of the applicant's statement of ecological evidence notes that DoC had not identified any "sites of natural significance" within the area (referenced as DoC 2003). In contrast, our records clearly identify that sites with values are present, as discussed above and shown in Table 1.
- 4.7 The Plains PNAP survey was, however, only a reconnaissance survey and as a result not all of the proposal area was visited and site descriptions were not necessarily detailed, or mapped to their full extent. Consequently, we lack a full understanding of values present. This is demonstrated by my new find of the very rare shrub (*Medictus aff. flexuosus*) within the construction footprint below Lowes Cutting (Map 2) while visiting the area in July 2008. This species is only known from less than 50 individuals in South Canterbury, and is to be ranked as Acutely Threatened – Nationally Critical (pers. com. Dr Brian Molloy), which is the highest threat ranking awarded by the Dept. of Conservation.
- 4.8 In addition to finding this rare shrub, patches of kowhai forest and shrublands were observed along the terrace within the construction footprint. These sites were not identified during the PNAP survey, but would appear to be significant when considered in their appropriate context.

5 ADEQUACY OF APPLICANT'S ECOLOGICAL ASSESSMENT

- 5.1 The applicant has submitted two ecological reports. The original report titled *Assessment of Potential Impacts to Terrestrial Ecology* (November 2007), has been supplemented by an appended report which includes a proposed planting plan (received 29th of August 2008). Further amendments to the information presented in these reports have been made in the applicant's statement of terrestrial ecology evidence (received 8 Sept 2008).
- 5.2 In my opinion, the applicant's original ecological assessment was incomplete. It relied entirely on the findings of their own limited survey of values within the

proposal area. It did not refer to information gained from previous surveys on ecological values known to be present within the area. Of the limited information they did provide on indigenous biodiversity present, it was not described or assessed using the appropriate ecological framework (as discussed earlier in my evidence). As a result, the importance of the area's indigenous biodiversity was overlooked, undervalued or dismissed. This was despite them identifying relatively rich indigenous plant communities, including their unusual find of a locally rare species (*Coprosma microcarpa*) within the proposal area. Because the applicant failed to adequately identify values present within the construction footprint, their assessment of effects was incomplete and the proposed mitigation was therefore insufficient.

- 5.3 The subsequent appendix to the original assessment of ecological effects has provided more information on indigenous vegetation occurring within the proposal area, which is based on further field surveys. Although it has been useful to have this new information, their second survey for the most part lacks detailed site assessments and “due to time constraints” parts of the construction footprint remain unsurveyed (para 6.9 - terrestrial ecology evidence).
- 5.4 It is standard practise of any field survey to visit known sites to confirm their presence, clarify their condition and obtain further information. However, there remains no acknowledgment or reassessment of ecological values identified from previous surveys within the area, for which information was provided to the applicant (with the exception of recently discovered *Melicytus aff flexuosus* site which was visited by the applicant). There also remains a lack of detailed information of habitat values for indigenous fauna, such as invertebrates and lizards that will almost certainly occur within the proposal area.
- 5.5 Of the indigenous plant communities identified, the applicant has considered their values using ecological criteria in Wellington District Plan. These criteria are similar to those in the Ashburton DP and in my view acceptable to use if applied in the appropriate context. I note, however, that the applicant in his evidence uses the Ashburton District Plan criteria (para. 7). In general I endorse the use of

these criteria as they align with widely accepted criteria for assessing ecological values.

- 5.6 Importantly, the applicant acknowledges the significance of some of the remnants within the area, which I agree with. However, in addition to having incomplete survey data, the applicant's significance assessment remains incomplete as they need to assign a relative weighting to each criteria (as is standard practise), because some criteria are more important than others. This is especially pertinent in highly modified EDs where remnants are typically small, isolated and depleted, and as a result, criteria such as intactness, diversity and pattern, carry less weight because they typically score poorly. For this reason, the Plains PNAP survey considered representativeness and rarity to be the primary (most important) criteria used to identify significant sites, whereas other criteria, such as intactness, diversity and pattern etc, were considered to be secondary and of lesser importance.
- 5.7 It is worth highlighting incorrect information presented in the applicant's addendum report, where the photo shown on pg 7 titled Figure 4: Large Matagouri (*Disaria taumata*)... is in fact a photo of the acutely threatened *Melicytus aff flexuosus*. This nationally threatened plant was only very recently discovered within the proposal area, which is also the northern extent of the known population. This photo suggests that more plants are present within the construction footprint that have yet to be identified and highlights further concerns about our full understanding of values present. This misidentification remains unresolved in the applicant's evidence.
- 5.8 I also note in the applicant's evidence (Sept 2008) that there is a reference to *Coprosma intertexta* (para. 6.5). This plant, if correctly identified, would be a significant find as this species is nationally uncommon (threat rank = sparse) (de Lange et al 2004) and is only known from a few locations on the Canterbury Plains. The significance of this species has not been considered by the applicant.

6 IMPACT OF THE PROPOSAL AND ADEQUACY OF MITIGATION

- 6.1 It is not possible to state with any certainty what the full impact of this proposal will have on ecological values. This is partly because of the inadequacy of information provided, but also because the application lacks specific details of the overall impact of the proposal. For example, although there is an acknowledgement by the applicant that four sites will be lost, (para 8.4 of the applicant's evidence) it appears that other additional losses will occur on the terrace riser and flood plain (which includes the A-ranked site 1297). It is difficult to fully assess the adequacy of mitigation until we have full understanding of values present. Therefore in my opinion a full assessment of values present and effects is required.
- 6.2 The construction of the canal will result in the loss of all native species and plant communities present within its path. Of particular concern is the potential loss of three A-ranked sites identified by Steven and Meurk (1996), as well as the loss of the nationally threatened *Meliccytus aff. flexuosus*, which occur within the construction footprint. Associated with this is the loss of habitat for native fauna, as well as potential seasonal food resources such as those provided to fauna by kowhai. The canal itself will create a physical barrier for wildlife and prevent movement of lizards (and other species generally) between the river floodplain and adjoining terrace riser.
- 6.3 In principle, maintaining existing values, where possible, is important as it is very difficult and expensive to recreate the intrinsic values of natural ecosystems once lost. Given the high significance of some sites and terrestrial plant species present within the construction footprint, the first consideration from an ecological perspective should be given to avoiding these sites where possible with sensitive alignment of the canal. This is especially so for the mature kowhai 'savannah' treeland on the low flood plain immediately below Lowes cutting (Site 1297, Rank A). Although modified, this site is of high significance, being one of best examples of floodplain kowhai forest remaining in the ED. The applicant states that up to 250 trees will be lost, which is most if not all of the site. Currently no mitigation is proposed to compensate for this loss, and is primarily focussed on restoring the terrace riser plant communities and establishing kanuka on the canal

sides. Accordingly, it is my view that the proposed mitigation does not adequately address the full potential impacts on ecological values.

- 6.4 The mitigation proposal to restore 4ha of mixed kowhai and scrub on the terrace riser; the re-establishment of half a hectare of kanuka; and potentially establishing 10 hectares of kanuka by spreading seed along the slopes of the canal, is supported in principle as it has the potential to deliver substantial ecological gains, provided that it can be achieved. The proposal to undertake additional planting of the threatened shrub *Melicytus aff. flexuosus* is also supported.
- 6.5 However, dryland restoration is difficult. It is also very expensive, with conservative estimates at approximately \$100, 000 per hectare (Davis & Meurk 2001). A high degree of failure (seedling death) can be expected unless significant resources are assigned to manage site restoration. In addition to propagation and planting of seedlings, successful management typically requires fencing, ongoing pest (weed and animal) control and follow up maintenance until seedlings are well established.
- 6.6 With respect to the species list included for planting, consideration should also be given to planting other appropriate species, such as *Corkia cotoneaster* and *Coprosma propinqua*, which are an inherent part of the native species assemblages. Introducing locally-sourced broadleaf (*Griselinia littoralis*), narrow-leaved lacebark (*Hoheria angustifolia*) and lowland ribbonwood (*Plagianthus regius*) is also desirable as these species were most likely part of the terrace forests in the past.
- 6.7 Finally, I do not support planting of the exotic Monterey pine (*Pinus radiata*) with appropriate native species as part of the mitigation planting plan at the powerhouse. Given this proposal potentially results in a relatively large amount of loss of native biodiversity, priority should be given to planting appropriate native species wherever possible. Conifers have the potential to spread and could therefore become an even greater weed than they currently are.
- 6.8 Given these concerns, it is my view a fully detailed and budgeted restoration plan should be prepared and committed to before the efficacy of their mitigation can

be evaluated. If the proposal is to proceed, the restoration plan should also be accompanied by a bond to ensure works are successfully undertaken as prescribed.

7 PLANNER'S REPORT

- 7.1 I agree with the findings and recommendations of the planner's report by Dr Keesing pertaining to the ecological review. It provides a comprehensive appraisal of the applicant's assessment of ecological values and effects. I disagree, however, with Dr Keesing's endorsement of the Norton Roper-Lindsay ecological assessment criteria as being more appropriate than those used by the applicant. Norton Roper-Lindsay criteria are not widely accepted by the ecological community or ratified by the Ministry for the Environment.

8 SUMMARY AND CONCLUSIONS

- 8.1 Several remnants of significant indigenous vegetation occur within the construction footprint. These sites were identified during the Plains PNAP survey, which used accepted ecological frameworks to identify significant ecological values.
- 8.2 Some of these sites will be lost with the construction of the canal. Of particular concern is the loss of threatened plants and the A-ranked sites, especially the kowhai floodplain forest for which no mitigation is proposed.
- 8.3 The applicant has identified some ecological values, but their assessment of ecological values and impacts remains incomplete.
- 8.4 Until a full ecological assessment is undertaken it is difficult to evaluate the impacts of this proposal on ecological values and the adequacy of the proposed mitigation.

- 8.5 From an ecological perspective, given the importance of the remnant sites, mitigation should first try and avoid important sites with sensitive alignment of the canal, this especially so for the highest ranked sites and threatened species.
- 8.6 The mitigation proposed does contain some tangible gains in ecological terms, but its success requires a commitment to ongoing management.

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Appendix 1.

CRITERIA FOR IDENTIFYING NATURE CONSERVATION VALUES

Representativeness. This criterion is normally applied in the context of a biogeographical framework. The assessment involves comparing current natural indigenous diversity with that of the past (a specified datum), and focuses on the typical or commonplace, or what is characteristic of an area. A high representative value recognises those ecosystems that were present in the original landscape. In highly modified environments, e.g. lowlands, only some elements of the original ecosystems remain but they can still be rated relatively highly. It is important to ensure representation of the full range of genetic and ecological diversity across all environmental gradients such as climate, altitude and soil sequences. This criterion is complemented by other criteria, as some ecological elements are not well catered for by representativeness e.g. mobile animals, specialised or rare species.

Diversity and pattern. This refers to all kinds of diversity including physical, habitat, biological, genetic and ecological processes. Ecotones are particularly important elements, being transitions between adjacent ecological patterns or communities. They tend to be highly productive, supporting a high species diversity and providing important habitats for species from adjacent communities. In general larger areas contain more diversity, but this is not always the case. Some areas are naturally of low diversity, but support the full range of diversity expected for a particular habitat type or community. This criterion is sometimes referred to as natural diversity.

Rarity and special features. This incorporates rarity in the uncommon sense, and threatened in its classification sense e.g. a nationally endangered species (see de Lange et al 2004). This criterion is applied to biological, physical and ecological features. It identifies non-typical features, and is a safety net for those not identified through representativeness. Rarity can be natural or human-induced. Special features include endemism, relict distributions, type localities, distribution limits and atypical bedrock. 'Distinctiveness' is another term for 'special features'.

Naturalness. Naturalness refers to a lack of human disturbance or modification. Natural ecosystems are valued more as modified ones tend to lose their integrity and their vulnerable species. In reality naturalness is a gradation as there are few, if any, totally natural areas remaining in NZ. While ecosystems may be induced or secondary, they can still be valuable for supporting indigenous flora and fauna. Similarly, highly modified areas can be important for supporting the only remaining indigenous biodiversity in local areas. Naturalness is best assessed within an ED context as it varies greatly between districts.

Size and shape, buffering/ surrounding landscape and boundaries. These two criteria are best applied together as they are very closely related. In general, larger and compact areas are more highly valued because of their greater life supporting or carrying capacity. Larger areas tend to be characterised by greater natural diversity, and compact areas are less influenced by edge effects. Small areas do however, contribute to total genetic diversity and may have an increased collective value e.g. scattered small wetlands used by waterbirds. This is particularly important in highly modified landscapes where small remnants may be all that remain.

Buffers are zones around core areas of ecological value that help to reduce external influences and maintain their values. They are often natural or semi-natural areas, though they can also be highly modified e.g. ungrazed riparian pasture. Activities or threats from surrounding landscapes can have major impacts on the long-term viability of sites, e.g. weed invasion, grazing and nutrient pollution. The ecological processes affecting indigenous ecosystems inevitably extend beyond their obvious physical boundaries e.g. hydrology, pollination and dispersal.

Linkages have important ecological roles between isolated remnants or distant ecosystems. They provide for migration, dispersal and the exchange of genetic material between sites. Linkages encompass all forms of connectivity and are not necessarily linear or continuous. Bennett (1999) reviews linkages and connectivity in considerable depth and provides many case studies, including one from New Zealand. Evidence for the value of linkages includes many documented examples of animals using them for movement such as daily and seasonal movements, dispersal and range expansion. Limited experimental results and predictive models also consistently indicate that high

levels of habitat connectivity are associated with a greater occurrence and persistence of populations in isolated habitats (Bennett 1999). It is important to maximise the width of linkages to minimise edge effects. Wider linkages also increase the potential diversity of habitats, animal and plant assemblages and natural disturbance regimes.

The best option for maintaining connectivity is to retain entire mosaics of natural or semi-natural areas, which is a key consideration for 'significance' in section 4. The primary importance of these types of linkages is for their habitat value, rather than as pathways for channelling movements. Among other things they provide shelter, breeding sites, food resources and maintain continuity of resident populations among patches of sub-optimal habitat (Bennett 1999). The impact of vegetation clearance on invertebrates is dependent on: the condition of the existing vegetation, the size of the area cleared, how well the vegetation is represented in the surrounding landscape, the incidence of weed and pest invasion as well as grazing intensity following clearance. Recovery of the invertebrate fauna will be dependent on the regeneration of the vegetation to pre-clearance condition, the time taken for this to occur, the proximity of similar vegetation and the restoration of suitable abiotic conditions such as microclimate.

Long-term ecological viability. This requires an overview of ecological values and ecosystem functioning. Ideally areas of indigenous biodiversity should inherently be able to retain their ecological health and natural values over time. Park (2000) makes a distinction between integrity and health. Integrity relates to ecosystems in their natural state that are self-maintaining and resilient. Health has a more narrow meaning and applies to altered ecosystems, which despite containing naturalised biota etc., are still stable and resilient. The best way to achieve long-term viability is by maintaining complete ecosystems. This will be difficult in highly modified areas due to ecosystem fragmentation and adjacent land use effects, so that sites will need greater management input. Restoration potential is an integral part of this concept.

Fragility and threat and management input. Fragility refers to a sites inherent vulnerability to environmental change, which is determined by its biological components and its position in the landscape. Threats refer to human or artificial factors which adversely affect the health of a natural area. In highly modified situations where ecosystems are no longer in equilibrium, specific indigenous plants or animals may

function as threats. Management input is a measure of how much effort is required to maintain the health of a particular natural area, e.g. weed control, pest control, fencing or restoration.