Conserving Timber Structures

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SUMMARY: The environmental heritage of NSW comprises a broad range of items of cultural and natural heritage value. This includes some outstanding examples of timber buildings and structures. Timber can be subject to deterioration by the main agents of fire, fungal rot, borers and termites. In all cases prevention is better than cure and regular maintenance is an essential requirement. While the general conservation approach as described in the ICOMOS Burra Charter should be adopted in the management of these items, special considerations and needs are required for timber conservation. The golden rule is to do as much as is needed and as little as possible.

Timber bridges are a key heritage group in NSW. These significant engineering structures are now facing a major challenge to their survival. In an environment which is placing greater demands on these important structures to meet current standards of higher load limits how can their heritage values be respected and maintained? The Heritage Office is working closely with state agencies such as the Roads and Traffic Authority (RTA) to find feasible solutions to conserve these landmarks while retaining their ongoing key functions as road or rail bridges. A draft Memorandum of Understanding has been prepared to provide an agreed management strategy between the RTA and the Heritage Office. The fact that these structures were originally constructed from old growth hardwood timber also provides a major challenge for their continuing sympathetic maintenance and conservation.

Figure 1. Walsh Bay, Wharves Precinct, Millers Point

1. GENERAL

Wood is a common and aesthetically pleasing building material in the Australian landscape. It forms the basis of many of our favourite buildings and landmarks.

Timber structures comprise some of the earliest heritage items in NSW and cover a wide range of buildings and works. For example, they range from simple single cottages such as Exeter Farm, Blacktown, managed by the Heritage Office to more elaborate houses characteristic of the North Coast of NSW. Such items also include fences, bridges, wood staved pipes and culverts, shipwrecks, archaeological sites and miscellaneous works.

As expected a large proportion of items listed on the various heritage lists can be classified as timber structures of which about half are in government ownership.

Timber structures are often regarded as high maintenance structures with shorter life cycles than other materials such as masonry structures.

Many timber structures from selected species have shown their durability in favourable environments. There are many English and European examples of structures many hundreds of years old. The ironbark columns in the Crown Street Reservoir, Surry Hills are over 140 years old.

Given that the Australian environment is more demanding, the secret to achieving maximum lifecycle is to undertake regular inspections and undertake annual maintenance.

2. STATUTORY FRAMEWORK

If an item is listed on the State Heritage Register the approval of the Heritage Council is required for any works or development proposals (listed in Section 57 of the Act).

Section 170 of the Heritage act requires all government instrumentalities to identify their heritage assets and list them for public information on a Heritage Conservation Register established under this section of the Act.

A State Heritage Guide (SHG) incorporating the Principles and Guidelines was issued by the Heritage Council and Minister in 2004.

A key deliverable under the Guide is the preparation of a Heritage Asset Management Strategy (HAMS) by each government instrumentality for endorsement of the Heritage...
Council by no later than January 2006 and the finalisation of their Heritage and Conservation Register as part of the HAMS.

In NSW about 8 per cent of identified heritage items listed on Local Environmental Plans (LEPs) relate to railway heritage.

Those items listed on the heritage schedules of LEPs require council approval for any proposed works if they are in private ownership.

Since 1999, owners of items listed on the State Heritage Register including those of timber materials are required to ensure that heritage significance is maintained.

The standards are set out in the Heritage Regulation 1999. The object of this Regulation is to apply minimum standards with respect to the maintenance and repair of buildings, works and relics that are listed on the State Heritage Register or within a precinct that is listed on that Register. (1)

The standards relate to:
(1) · weatherproofing;
(2) · fire protection;
(3) · security; and
(4) · essential maintenance.

Essential maintenance and repair of a building, work or relic means undertaking maintenance and repair necessary to prevent serious or irreparable damage or deterioration.

It includes:
(a) the taking of measures (including inspection) to control pests such as termites, rodents, birds and other vermin, and
(b) the taking of measures to maintain a stable environment for in-situ archaeological relics.

The minimum standards aim to ensure that the heritage significance of a building or work is maintained. They do not require owners to undertake restoration works, but where such works are needed owners may be eligible to apply for financial assistance through the Heritage Incentives Program.

If these standards are not met and the heritage significance of the item is in jeopardy the Heritage Council has the power to order repairs after consultation with the owner.

As a last resort, if negotiations have failed and the owner does not comply with the order, the Heritage Council can arrange for the works to be carried out and charge the expenses to the owner. The Minister may consent to the Heritage Council’s prosecution of the owner for failure to comply with an order under this section of the Act.

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**Figure 2. Timber Slab Cottage, Barden Street, Tempe**

### 3. CHARACTERISTICS OF TIMBER

Trees are either softwoods (gymnosperms or conifers) or hardwoods (angiosperms or flowering plants). Softwoods are not always softer than hardwoods. This general term can be misleading. The Australian native cypress pine (*Callitris*) is a softwood of greater density and hardness than many hardwoods, while balsa (*Ochroma*) is a hardwood.

Commonly used timbers in heritage buildings in NSW include Blackbutt, Blue Gum, White Box, Red Box, Grey Box, Spotted Gum, Ironbark, Stringybark and Red Cedar.

Wood is hydroscopic: its cellulose molecules attract water. When wood is wet, water becomes absorbed within the cell wall structure and the wood swells. Similarly, wood shrinks as it dries. This is an important characteristic in maintaining or repairing timber structures.

Most swelling or shrinkage occurs tangentially (around the circumference of the log), where it can be up to 12 per cent of the original size, compared to up to 6 per cent radially. The amount of swelling or shrinkage also varies between species and with different growth conditions.

Boards cut tangentially (back-sawn or flatsawn) will swell in width up to twice as much as boards cut radially (quarter-sawn). This means quarter-sawn are generally more suitable for use in exposed locations such as weatherboards. Back-sawn timber (tangentially cut) will swell and shrink in response to changes in moisture levels to a much greater degree than the radially cut, quarter-sawn timber.

This characteristic has prompted the need to season timber before use.
4. MAIN CAUSES OF DETERIORATION

There are four main agents of wood deterioration: fire, fungal rot, borers and termites. These are summarised from the NSW Heritage Office Information Sheet on wood preservation (2).

Fire
Surprisingly, wood is not very flammable particularly when it has a degree of size about it. It does not ignite readily, except in small twigs, or when very dry and at high temperatures. Large timbers char slowly and form a layer of charcoal which protects the wood beneath and slows the rate of combustion. Some timber structures may therefore remain serviceable after a fire.

Fungal rot
All rotting of wood is caused by fungal attack. Fungi are minute organisms which live on and within wood and slowly digest the cell wall materials, leading to softening and decay. All forms of fungal rot—including brown rot, white pocket rot, soft rot, the simply named decay, and the confusingly named wet and dry rots—cause severe damage to timber in service and are often not discovered until the decay is well advanced.

Borers
Damage to timber by wood borers is generally minor and rarely needs treating. However, some borers can cause considerable destruction. Most borers are beetles with a four-stage life cycle beginning with eggs, which are laid in the vessels or in cracks in the wood surface. These hatch into the larval or grub stage, which burrow into the wood, producing a network of galleries which may considerably weaken the timber. Adults develop from a pupal stage, burrow out of the wood and fly off to breed. The exit or flight holes of the adult are generally the first signs that borers are present, often with a fine dust (frass) which is borer excrement.

Termites
Unlike borers, termites are a major hazard to wooden building structures and contents. Often incorrectly called white ants, termites are social insects living in colonies numbering more than a million.

Wood-eating termites are classified according to their living and feeding habits: dampwood, tree-dwelling, subterranean and drywood termites.

The last two are the most common types found in buildings.

Subterranean termites
Subterranean termites live largely underground, building their nests in old tree stumps and root systems. From the nests, tunnels or galleries radiate outwards to sources of food, which may be trees, fallen logs, posts, or stumps of timber buildings.

Drywood termites
Unlike subterranean termites, drywood termites do not require continuous contact with the ground, as they can obtain moisture from the wood in which they feed and live. Native drywood termites are found in northern Australia, where the climate and wood are wetter; here they can be a problem for buildings.

Light can also affect the appearance of the timber product. The effect of ultraviolet light is relatively shallow; it degrades exposed surfaces, turning them grey and weakening the surface cells.

While these causes of wood deterioration can be treated with various chemical applications by a specialist, prevention is always better than cure.

Keeping wood in buildings dry will significantly reduce the risk of: swelling and shrinkage cracking, fungal rot attack by termites and some borers. Wooden items need regular maintenance, and should be inspected every six months.

Wood repairs
Sometimes wood is so badly deteriorated that replacement of a section of timber is the only option. It is good conservation practice to replace the minimum necessary, and to do it with the traditional skills of the carpenter, joiner and cabinetmaker. The aim should be to reconstruct the original form of the damaged timber so that the repair does not detract from the appearance of the old work. Preferably, repairs should be done on site so that original fixings and fastenings are not lost. A detailed guide to timber repairs can be found in the NSW Heritage Office Information Sheet on timber repairs (3).

Synthetic repairs
There are occasions when sections of timber need strengthening. This might be because of fungal rot damage to the end of a timber beam, or the need to upgrade the structural capacity of the beam to enable a new use for the conserved building.

An alternative to patching with timber is wood epoxy reinforcement (WER), which uses steel plates or steel or fibreglass rods as reinforcing.

Synthetic resins can also be used to preserve non-structural timbers where the surface survives, such as a termite-damaged architrave with an original grained finish.

This type of work should be undertaken by an experienced conservator.

Structural timber repairs
The complete removal and replacement of a failed timber member should be a last resort. Where the structure is concealed (as in a wall or roof space), a new
member can be inserted beside the old one, or the old member can be patched with timber or strengthened by attaching steel bracing.

Where members are patched with timber, the strength of the joint is critical. The traditional scarf joint will resist most stresses in rafters, posts or beams, while a simpler halved joint can be used in wall plates.

**Joinery repairs**
Firstly, resist the temptation to repair every small knock or dent. Secondly, try to repair joinery on site wherever possible, as the process of removal and refitting inevitably results in further damage.

If decayed timber needs to be removed to form a splice or patch repair, take off just enough timber to allow an effective repair.

Always fit the new material to the profile of the old.

**Repairs using natural wood**
Matching new pieces of wood to existing timber requires considerable skill. Correct species identification (refer to information sheet on Wood Preservation) is only the start. Other issues include: colour and grain matching (for clear-finished joinery); section sizes, especially for larger structural sections; moisture content (see above) and joint design.

**Recycled timber**
Some of these problems may be overcome by using old timber.

When salvaging timber elements from a building or structure, take care to do so in a way which keeps the pieces usable.

**5. CONSERVATION TECHNIQUES**

**5.1 Conservation Principles**
The principles for the conservation of timber structures are similar to the principles adopted for conserving any heritage item. Conservation is based on a respect for the existing fabric, use, associations and meanings.

The Burra Charter advocates a cautious approach to change: do as much as necessary to care for the place and to make it useable, but otherwise change it as little as possible so that its cultural significance is retained.

Based on the Burra Charter the six key conservation principles can be summarised as:

1. investigate the physical and documentary evidence of the place including the fabric;
2. assess the heritage significance of the place including individual building components;
3. develop a conservation and management approach based on the importance of the place;
4. carry out the work;
5. collate a record of what you have done, and
6. use a conservation specialist where necessary.

**Figure 3. Nodule of elements in a roof Truss**

When planning work to heritage items the following approaches should be adopted, as outlined in the NSW Heritage Office Information Sheet on the principles of conservation work on heritage places (4):

**Repair Rather than Replace**
Keep as much of the historic fabric as possible. Heritage items are by definition authentic examples of the architecture and lifestyle of previous generations and should be respected as evidence of our past.

**Make Reversible Alterations**
If alterations must be made to significant building fabric, they should be as reversible as possible. If elements are removed, they should be properly stored nearby for future reinstatement.

**Make a Visual Distinction Between Old and New**
Whilst being sympathetic and respectful to old material, detail of new work should generally be distinguishable from the old. On close inspection, it should be clear what is old and what is new.

**Avoid Precise Imitation of Architectural Detail**
New additions should generally not imitate the precise architectural detail of historic buildings. Additions should not try to look ‘old’—this will only confuse and compromise the integrity of the historic fabric.

**Ensure Alterations are Sympathetic**
Generally, new additions should be sympathetic to the existing building. Additions need to respect the character of the existing building, taking into account the materials, bulk, height, set-back, plan configuration, surface patterns, texture and colours.
Respect the Ageing Process
There is no reason why old buildings, like old people, should not look old. They don’t need to be excessively cleaned or decorated. There may be no reason to repair cracks that are structurally sound or to recoat worn surfaces, where it is not destructive or concealing detail.

Respect Previous Alterations
If there are previous alterations, these may also contribute to the building's significance and should be respected. Emphasis should not be placed on one period of a building's development at the expense of others, unless it is much more significant. Later alterations may be removed if they are much less significant than the earlier fabric.

Discontinue Previous Unsound Practices
Previous unsound practices or details should not be continued, whether in original work or subsequent repairs. Critical failures, such as the absence of a damp course, should be corrected as soon as possible.

Stabilise Problem Areas
The correction of severe structural problems, such as leaning walls, warped beams or uneven floors may cause damage which lessens the authenticity of the building. It is usually better to secure and stabilise the problem area, as this may be sufficient to restore the structural stability of the building.

Respect the Building's Context, Location and Contents
The early context or setting is generally part of the building's significance. If the building is deprived of any of its early context, significance may be lost. New intrusions into the setting should be avoided, or at least be sympathetic and respectful.

The removal of significant contents of a heritage building, such as furniture and furnishings, should be avoided, unless this is the only way they can survive.

A key issue in the conservation of heritage timber structures is the loss of skills base in the techniques and methods of repairing such structures.

The Heritage Office and its partner organisations need to support academically, with the assistance of trades and employers, a plan to maintain and enhance the conservation skills for working on timber structures to conserve fabric rather than wholesale replacement.

6. CONSERVATION MANAGEMENT CASE STUDY: RTA TIMBER BRIDGES
Timber bridges ranging from simple timber beam to complex timber truss road structures and rail bridges are amongst the most significant heritage items in the New South Wales landscape.

They are distinctive components of the built environments and of the scenery in many rural areas of NSW, and are held in high regard by the general community. Their number and significance, as well as their prominence and character have led to New South Wales’ reputation as ‘the timber bridge state’ and contribute significantly to the appeal of scenic touring and rural tourism.

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There are 29 timber bridges currently listed on the State Heritage Register (SHR) of which 14 have been identified as likely to be of national significance. In addition 21 are listed on the RTA Heritage and Conservation Register under Section 170 of the Heritage Act.

From the heritage perspective, the heritage values of the bridge relate to its role in the history of road transport in NSW and its association with key people and events, the aesthetics of the bridge in its setting and its engineering and technological significance.

The desired outcome is to retain the bridge as an operational asset i.e. a road bridge in its original location. For maintenance purposes this means maintaining the existing timber fabric and replacing deteriorated material on the basis of the conservation principles listed in section 5.0.

Responsibility for these important heritage resources is diverse (the Roads and Traffic Authority, State Rail Authority, Rail Infrastructure Corporation, Australian Rail Track Corporation and local councils). However, the RTA manages and/or owns the majority of these items.

Many of these timber bridges were designed to carry loads which in many areas are less than current requirements.
In the current environment there is an increasing conflict between conservation objectives and the demands to meet increasing road traffic standards in an economic and effective manner.

The clear objective is to recognise the legitimate needs of both parties and achieve a beneficial outcome which addresses the conservation requirements and the need to provide safe and durable infrastructure in an economic and efficient manner.

The Heritage Office in discussion with the RTA has prepared a draft Memorandum of Understanding (MOU) between the Heritage Council and RTA on the management of their heritage timber bridges.

In developing the MOU a number of matters have been considered:

- The community expects the heritage values of these structures are given proper consideration in any RTA work proposals and maintenance activities.
- Replacement materials such as old growth hardwood timbers are scarce and hard to get.
- It is recognised that there is a need for state government agencies to account for expenditure of public monies.
- The RTA has a responsibility to ensure that such structures are safe and do not pose a risk in their continuing use as a road bridge.
- It is acknowledged that over time the timber fabric in the bridge will be replaced as it deteriorates and this means that eventually little original fabric will remain.
- Under the Heritage Act the Heritage Council cannot grant approval for the demolition of a whole item listed on the SHR or subject to an Interim Heritage Order.

This last issue is a critical issue in the maintenance of SHR timber bridges. When does the removal of timber fabric and replacement with new material become so extensive that it comprises demolition within the meaning of the Heritage Act?

For example, regardless of the validity of the arguments put forward, can the Heritage Council legally consent to works that involve replacement of 50, 60, 70 or even 80 per cent of the existing bridge fabric or does this equate to demolition?

At the same time it can be understood that the RTA preferred approach is to take the opportunity while at the site to undertake extensive works on the basis that it is a more effective structural and cost efficient solution and will ensure its long term operational use. This may include the complete dismantling and rebuilding of the bridge, replacing ‘like with like’ and retaining the original bridge form.

This issue can be simply described as how to keep ‘grandpa’s axe’. You can replace the handle from time to time and it is still ‘grandpa’s axe’. But is this the case if you replace both the handle and the blade?

**Principles for the Management and Conservation of Timber Bridges**

There are a number of principles that should be adopted in the maintenance and management of timber bridges:

- The heritage values of the timber bridges should be recognised and given due consideration in designing and implementing any works that may affect their significance.
- The preferred conservation option for timber bridges to retain their heritage significance is that they be maintained as fully operational road bridges in their original location.
- It is acknowledged that replacement of deteriorated fabric will be needed over time but such maintenance should be consistent with a minimal approach of replacing as little as possible to maintain the bridge as an operational asset.
- Where more extensive removal of existing fabric is justified then the over-riding consideration is that the technical design and appearance of the bridge in its setting is retained.
- Other techniques such as in situ conservation with load limitations (re-route traffic of inappropriate weight and/or dimensions, use as one way only, etc) should be considered to minimise heritage impacts.
- Decommissioning of a timber bridge reduces the heritage value of the bridge and should only be considered in those rare circumstances, to the satisfaction of both parties, where it can be demonstrated that the bridge cannot be maintained as an operational asset.
- In such circumstances such an orphan asset should be subject to sympathetic adaptive reuse (eg. pedestrian use, market decking, etc) in a way that conserves the heritage values of the bridge and its setting.
- Relocation of a timber bridge should only be undertaken where it has been demonstrated that change of location is the best or only option to conserve a heritage timber bridge.
- The complete dismantling and reconstruction of timber bridges would only be considered in exceptional circumstances.
Demolition of a timber bridge should be seen as a last resort and only be considered where it can be shown, to the satisfaction of both parties, that there is no prudent and feasible alternative available which retains it as an operational asset or allows its adaptive reuse.

All major works proposed to be conducted on timber bridges on the SHR should include advice from an independent heritage engineer.

The setting of the bridge is an important component of the bridge’s heritage significance, history and aesthetic values.

Maintenance of timber bridges should be conducted in accordance to the *State Agency Heritage Guide*, published by the NSW Heritage Office 2005.

On the basis of this agreed approach the Draft MOU proposes that a package of delegations and exemptions be provided to the RTA to enable the continued conservation and maintenance of RTA timber bridges in an effective and efficient manner.

The RTA will provide an annual report on the exercise of delegations and exemption to the Heritage Council.

A key matter associated with the implementation of this strategy is the continued availability of suitable hardwood replacement timber.

The Heritage Office has proposed a short and long term approach to this issue.

In the short term there needs to be agreement with NSW State Forests and the Timber Industry for all suitable hardwood logs to be reserved and stored for timber bridges.

This will need to be supplemented by the use of salvaged or recycled material or by the use of other wood strengthened materials.

In the long term there is a need to establish plantations of suitable species dedicated for use only as aged logs for replacement material for timber bridges.

This initiative will take time but has the potential to attract community and corporate sponsorship e.g., the Joe Brown Monkerai Bridge Plantation.

7. RECOMMENDATIONS AND CONCLUSIONS

To retain the heritage values one first of all has to know what the values are. This is critical in decisions on what to replace or repair in timber, as highlighted in the case of timber bridges.

The key to conservation of all heritage items is maintenance. Regular maintenance assures the good condition and optimum lifecycle of timber structures.

The loss of skills base is a Heritage Office concern with all the conservation trades and the mechanisms available to ensure the skills in conserving heritage timber structures is not lost.

We need to support academically, and in partnerships with the trades and employers, a plan to maintain and enhance the conservation skills for working on timber structures to conserve fabric rather than wholesale replacement.

The availability of quality timber replacements and particular species is becoming a major issue e.g., old growth versus fast grown, the scarcity of some timber species such as red cedar and the trend for fewer lands being available for timber production in native forests as they are included within the parks and reserve system.

Given these issues we need flexible solutions which still retain heritage value and emphasise the need to seek specialist conservation practitioners on major works to timber heritage items.

The Draft MOU on timber bridges provides one template which aims to achieve an acceptable balance between the conservation and operational needs of these important components of the Australian landscape.

8. REFERENCES

(1) NSW Heritage Office 1994 *Heritage Information Series: Minimum standards of maintenance and repair*

(2) NSW Heritage Office 1998 *Information Sheet The Maintenance Series: 5.1 Wood preservation*

(3) NSW Heritage Office 1998 *Information Sheet The Maintenance Series: 5.2 Timber Repairs.*


(5) NSW Heritage Office 2005 *Draft Memorandum of Understanding between the Heritage Office and the RTA: Management of Timber Bridges.*

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Figure 5. Vacy Bridge over Paterson River, Vacy