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Closing the gap clearinghouse

Constructing and maintaining houses

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Summary

What we know

- There are significant problems with the standard of Indigenous housing in Australia:
 - The percentage of dwellings managed by Indigenous community housing organisations (ICHO) which required major repair or replacement increased from 27% in 2001 to 31% in 2006 (ABS 2007).
 - Data from 1999 to 2011 compiled by Healthabitat showed that a high proportion of Indigenous dwellings did not have fully functioning hardware (such as toilet, electricity, hot water or washing facilities) that supported healthy living practices.
- The poor standard is related to a number of challenges in the design, construction and maintenance of Indigenous housing.

What works

- Designing and constructing housing based on the established standards and accumulated knowledge in the *National Indigenous Housing Guide* (FaHCSIA 2008). This includes a process of consultation with the local community, and designing housing that meets the social and cultural needs of occupants.
- Targeting limited-maintenance budgets for safety and health items to improve the functional performance of the house.
- Using appropriate construction methods and materials, given the particular local environment, especially in rural and remote locations.
- Involving Indigenous communities in planning and implementing programs for construction and maintenance.
- Using local community Indigenous labour to assist with construction and maintenance programs.



- Carefully documenting the performance of Indigenous housing using a set of standard, repeatable tests linked to the principles outlined in the *National Indigenous Housing Guide*.
- Having rigorous inspection programs at handover after completion of building or major upgrade, to ensure that construction complies with the drawings and specifications and that all aspects of the house work properly.

What doesn't work

There is a great deal of evidence about what doesn't work, based on decades of experience. Common characteristics of a number of troubled construction and maintenance programs include the following:

- A one-size-fits-all approach that doesn't allow for particular local cultural, social and environmental circumstances.
- Short-term or piecemeal interventions that are not implemented for long enough to make a significant impact.
- Fixed, short-term deadlines for any construction program.
- Interventions that are adopted without collaborating with Indigenous communities to provide a real opportunity for them to let their views be known.
- Maintenance programs for rural and remote areas based on models that apply in capital cities.
- Programs that are based on 'responsive maintenance' (that is, when repair and other work only occurs when a tenant notifies the landlord), rather than on periodic or cyclical maintenance supplemented with local, ongoing testing of houses.

What we don't know

- While there is a national database on dwellings maintained using the Housing for Health method, there is no equivalent database for new construction detailing individual dwellings. There are therefore no national data available on:
 - the performance of different housing designs and construction methods
 - the long-term cost effectiveness of capital investment and maintenance systems.

Introduction

This resource sheet is about the construction and maintenance of Indigenous housing. It does not cover broader questions such as the total amount of housing required or the best housing management systems, although it touches on these issues. It describes the best approaches to the construction and maintenance of Indigenous housing stock. The basic assumption taken in this document is that, in a resource-constrained environment, it is very important to focus on ensuring that the investment in Indigenous housing generates an improvement in housing function for the residents.

The reason this issue is important is that many of the current approaches to construction and maintenance do not seem to be working. There is evidence, which is described in the next section, of continuing problems with the standard of Indigenous housing. This is particularly disturbing because we know that there is a clear relationship between the quality of Indigenous housing and the health outcomes of the occupants (Bailie 2007). This resource sheet refers to construction and maintenance issues in all geographical areas, although the evidence highlights that some of the greatest challenges lie in remote areas.



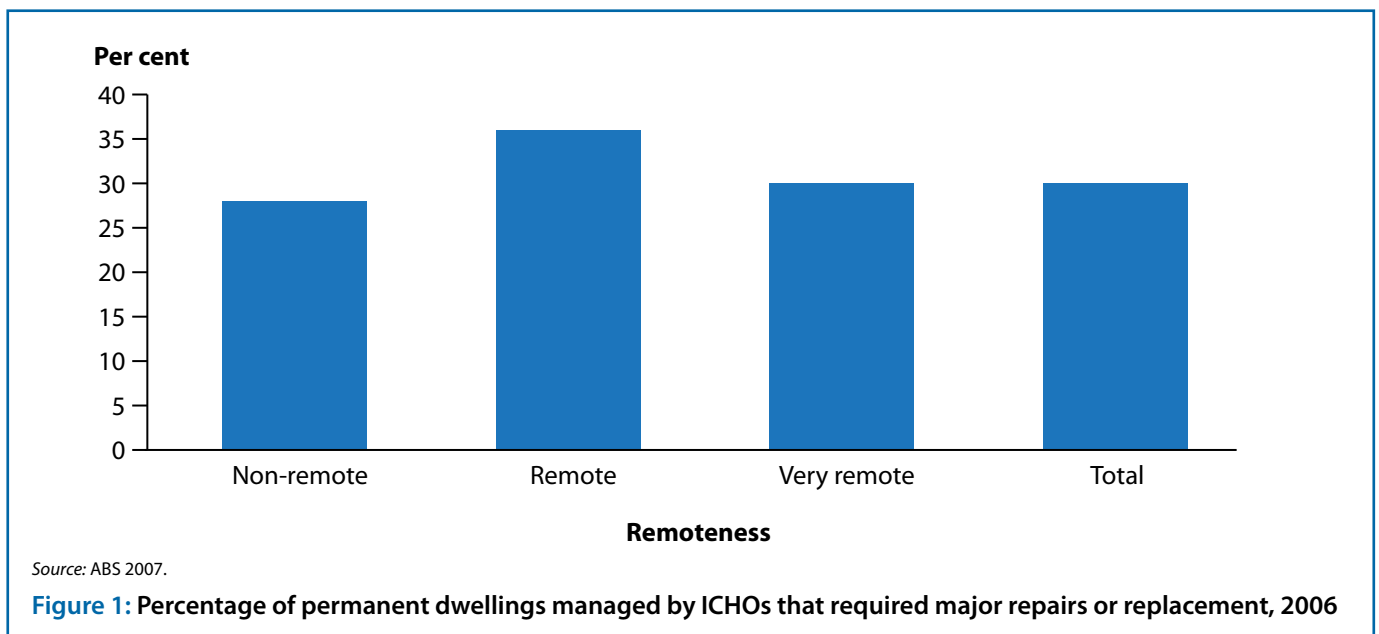
Background

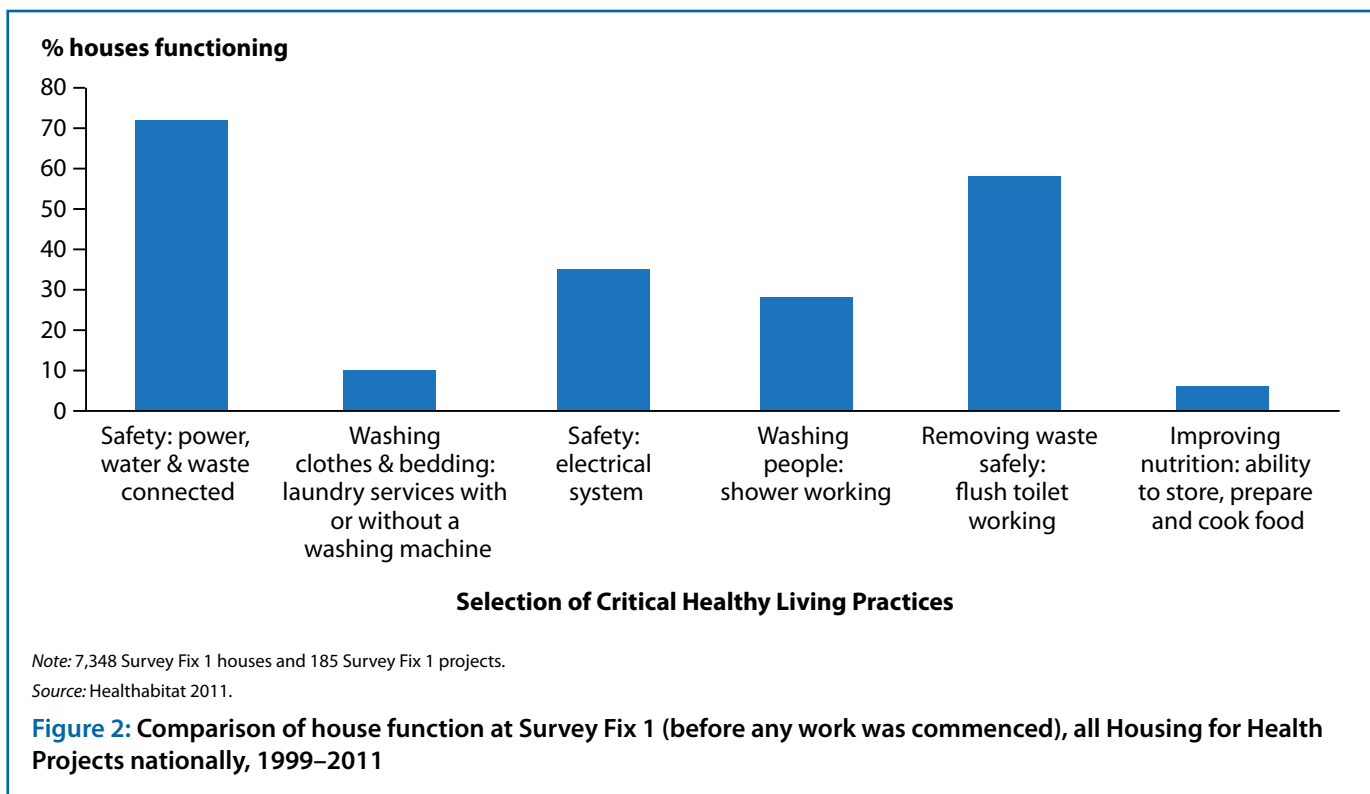
Evidence on the quality of Indigenous housing

ABS National Aboriginal and Torres Strait Islander Social Surveys suggest that the condition of housing for all Indigenous people improved between 2002 and 2008 (ABS 2009). The Survey reported in 2002 that almost four in ten (38%) Indigenous people aged 15 and over lived in dwellings that had major structural problems, compared with three in ten (28%) in 2008. Types of structural problems included: major cracks in walls or floors; major plumbing problems; and wood rot or termite damage. The level of structural problems in dwellings was higher in *Remote* regions where, in 2008, almost four in ten (39%) people living in *Remote* areas experienced structural problems in their housing.

But other ABS data from 2007 suggest that the condition of housing managed by Indigenous community organisations has declined. The percentage of dwellings managed by Indigenous community housing organisations (ICHO) which required major repair or replacement increased from 27% in 2001 to 31% in 2006 (ABS 2007). Major repairs or replacements are defined by an estimated repair cost, with a higher threshold being set in higher cost *Remote* and *Very remote* areas. Although the situation was slightly better in *Non-remote* areas, the issue is not just one of remoteness—even in *Non-remote* areas the percentage of houses requiring major repair or replacement was 28% (see Figure 1).

Data held by Healthabitat (2011) showed that there were problems with health hardware in a high proportion of dwellings. The organisation has adopted a method for maintaining housing, called 'Housing for Health' (Pholeros et al. 1993). Part of this method involves a comprehensive assessment of key elements of house function. Figure 2 shows the performance of Indigenous housing function from 1999–2011, before any fixative work was begun, using nationally accepted standards and repeatable tests.





Recent Government initiatives

While the most recent data indicate significant issues with the quality of Indigenous housing, there have been some recent Government initiatives that seek to improve the quality of Indigenous housing stock and address overcrowding. In 2009 COAG introduced the National Partnership Agreement on Remote Indigenous Housing (NPARIH), and \$5.5 billion was committed over 10 years to 2018 to do the following:

- Reduce overcrowding in remote Indigenous communities.
- Increase the supply of new houses and improve the condition of existing houses in remote Indigenous communities.
- Reform property and tenancy management arrangements to ensure rental houses are maintained and managed to higher standards than previously.

The Agreement has the following elements:

- Consultation with communities on design and build considerations.
- Tenants of new houses receive tenancy support to transition to new tenancy arrangements and to help them understand their rights and responsibilities.
- Prioritisation of refurbishments to address safety and health issues.
- Training/pre-employment support programs to enable Indigenous community members to be employed on associated works.

By 30 April 2012 over 1,219 houses had been constructed and 4,148 existing homes had been refurbished under the Agreement.



Important issues for Indigenous housing

There are a number of important issues to consider when determining the best approaches to constructing and maintaining Indigenous housing. This section reviews these issues.

Remoteness

Much Indigenous housing is situated in *Remote* and *Very remote* parts of Australia. This has a number of effects on construction and maintenance. Firstly, the costs are greater in *Remote* compared with *Non-remote* locations. Industry cost-guides estimate that construction costs in *Very remote* locations are likely to be at least double the costs of *Non-remote* locations (Rawlinsons 2011). Fien & Charlesworth (2012) highlight the reasons for this cost penalty:

- increased cost of materials due to distances from sources of building materials and a lack of competition
- high costs of transporting materials to remote building sites
- shortage of trades people and the high costs of external labour
- poor economies of scale in purchasing
- higher labour costs from having only a 6–7 month construction season due to climate issues in some parts of Australia (see below).

Moreover, poor telecommunications in these areas, combined with long travel distances, make it difficult to implement any *responsive* maintenance system.

Climate

Many areas where Indigenous housing is located, such as the desert regions of central Australia and the tropical regions of northern Australia, experience a harsh climate with very sharp differences between the wet and dry seasons, or extreme temperature variations between the summer and winter months. These climatic extremes can generate considerable stresses on dwellings, which therefore need to be specifically designed and constructed for these conditions—and also to mitigate the impact of the climate on the occupants. The climate also makes it impossible to have either construction or responsive maintenance programs that run throughout the year, since travel is often very problematic in the wet season as many local roads are flooded.

Local environmental conditions

In a number of regions where Indigenous housing is located, there are particular geological and/or hydrological conditions that generate significant stresses on dwellings. For example, in most parts of non-coastal Australia the mineral content of the local water supplies can badly affect the pipework, taps, hot water system and appliances, thus significantly reducing their life and efficiency. Small ants can damage the electrical wiring of houses in some northern areas, and in desert areas dust can lead to increased maintenance of electrical switchboards, light fittings, switches and power points, and also windows. These local problems need to be considered when designing and constructing housing.

Social and cultural factors

Indigenous households are often large, requiring a range of different design and maintenance responses in order to provide for more people. Moreover, particular cultural beliefs (such as avoidance relationships where certain people are required to avoid others in their family or clan) mean that houses need to be designed in a way that responds to a unique Indigenous culture (FaHCSIA 2008). In order for this to occur it is important that construction and maintenance systems are based on close consultation. This requires design, construction



and maintenance staff to have some cross-cultural awareness before they begin working in Indigenous communities. Most importantly, local community members are needed for training and employment, to help with consultation, translation and all aspects of the ongoing construction and maintenance program.

Crowding

A number of studies have highlighted the issue of crowding in Indigenous housing (for example, AIHW 2009). Many of these studies have tended to use density measures such as the number of people per bedroom. A recent review of crowding by Memmott and others (2011) has suggested that the issue of crowding in Indigenous housing is best examined using a stress model rather than a density model. Better design can reduce crowding issues by removing sources of stress. Stress is also often associated with poor performance of the dwelling because of maintenance issues. For example, all the occupants might have to share one tap because the other taps in the house are not functioning.

Whatever measure of crowding is used, for a number of reasons Indigenous housing often has high occupancy levels, often resulting from Indigenous kinship practices:

The sharing of accommodation with certain relatives is a social responsibility and desirable. Visitors will usually stay at a relative's house for anywhere between a single night and a number of months. Indigenous household structures are therefore typically dynamic (Memmott et al. 2011:26).

These high occupancy levels put severe pressures on kitchen, bathroom and laundry facilities, often leading to blocked sewers and drains and failure of other elements in the house (Fien & Charlesworth 2012). In this environment, standard Australian domestic fittings and construction methods are often not appropriate (see 'Further resources' for more information).

Tenure

Tenure and housing system arrangements can have significant effects on construction and maintenance issues. For example, Fien and others (2011) report that in remote areas the rent collected from Indigenous housing is not sufficient to cover routine maintenance. This issue had been highlighted earlier, in an Australian Housing and Urban Research Institute report (Hall & Berry 2006), which indicated that both state owned and managed Indigenous housing and Indigenous Community Housing Organisations were running significant operating deficits. Whatever the tenure arrangements, the owners/operators of the housing need to have at their disposal sufficient financial and technical resources to undertake the complex task of housing construction and maintenance.

Incomes in Indigenous communities

Many Indigenous households have low incomes. This means that it is difficult for many households to support large recurrent energy costs for hot water, cooking, heating and cooling. Hence the operating costs of dwellings need to be important considerations in the detailed design and specification of the house.

Additional risks of Indigenous housing

Davidson and others (2011) highlight a number of risks associated with providing Indigenous housing that do not apply to other housing. The first one is the problem of meeting multiple program objectives, for example, achieving employment and training outcomes within the procurement settings of government. The second problem is the issue of managing and balancing risks that affect project planning and execution—both distant risks (for example, elections, politicians, senior public servants, the media) and local risks, such as community and cultural factors, remote undocumented building sites and climate.

The nature of the construction industry

Indigenous housing and maintenance projects, like any construction project, require appropriate quality control mechanisms. Some construction firms, faced with remote locations, government funding dependent on achieving timelines, and a lack of independent quality control, may end up 'gaming' the system by overcharging and under-delivering on both new housing and upgrades of houses. Although this practice might not be widespread, it will continue to develop unless several levels of quality control are in place.

Other issues

What these issues listed above do not include are some common myths about Indigenous housing such as: *Indigenous housing is in poor condition because Indigenous people wilfully damage houses*. Data collected by Housing for Health Projects on over 168,000 fixed items show that only 9% of items needed repair due to damage or misuse compared with 22% of work required as a result of poor design or initially faulty construction, and 69% required for overdue normal, routine maintenance.

Best practice approaches to construction

Using what we know

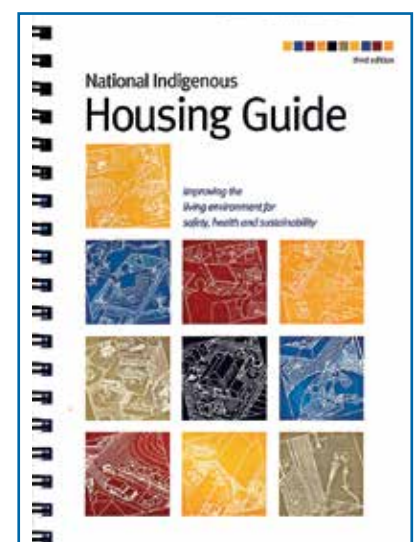
One of the achievements of the recent history of Indigenous housing has been the development of the *National Indigenous Housing Guide*. This guide (FaHCSIA 2008) is now in its third edition. It is a key resource to assist in the design, construction and maintenance of housing for Aboriginal and Torres Strait Islander peoples, with a particular focus on providing and maintaining the health hardware such as toilet, electricity, hot water or washing facilities that supports a safe and healthy living environment.

The guide was conceived as a process to regularly update and document practical information on the design, product selection and installation, construction, renovation and maintenance of housing, and other aspects related to environmental health. Examples covered in the guide include dealing with hot water systems in areas of poor quality water, dust control measures in desert environments, controlling insects in tropical areas, and limiting undesirable contact between dogs and food or water supply points in the house or yard. If used in tandem with local knowledge, the guide can help to improve housing and health outcomes, and community development projects overall.

<<http://www.dss.gov.au/our-responsibilities/indigenous-australians/publications-articles/housing/national-indigenous-housing-guide>>

The guide is meant to be used in conjunction with other building standards including the *Australian Standards* and the *Building Code of Australia*. It also highlights the need to undertake consultation with local Indigenous communities.

Information in the *National Indigenous Housing Guide* is based on the experience of communities, housing design consultants and builders, and is supported by data from housing surveys conducted since the mid-1980s. It provides an opportunity for housing agencies to learn from history about what is appropriate design and construction for Indigenous housing.





Making sure what is designed is what is built

The remote location of much Indigenous housing often means that the building inspection processes commonly used in Australian residential construction do not apply to Indigenous housing. This is not the way to ensure a good quality product. Even though inspection processes will add to the construction costs, there is no alternative. Every building constructed has defects and many of these defects do not become obvious until the building is occupied. Indeed, in areas with great seasonal variations, such as a tropical wet and dry season or the extreme winter and summer temperature differences of the desert, many of these defects will not become apparent until after the building has been occupied for at least 12 months. The *National Indigenous Housing Guide* recommends the following inspection regime in addition to the traditional statutory inspections. At these inspections, the aim is to ensure that the builder has followed all the requirements of the drawings and the specifications. The checks include:

- site/pad preparation and building set-out, in-ground drainage before backfilling, footings/foundation, termite barriers and in-slab drainage before the concrete pour
- wall and roof framing before enclosure, first fix of plumbing and electrical services before concealment
- waterproofing of wet area walls and floors, and that wet area floors fall to drains
- joinery/cabinets before delivery to site, roofing and rainwater system after installation, hot water systems including roof-mounted systems
- operation of all parts of the house, including appliances and fittings, before the final payment to the builder and handing the house over to the housing provider
- a post-occupancy inspection that takes account of seasonal variations.

The procurement process

The application of typical housing procurement methods, which emphasise on-time and on-budget construction, may not be the most appropriate approach to the construction of Indigenous housing since other objectives, such as employment and training, are also important. The recent work of Davidson and others (2011), who undertook a review of Indigenous construction projects across Australia, highlights that the procurement process is arguably just as important as the final housing product itself. These authors suggest that procurement driven by the scenario of maximum numbers of houses on the ground as fast as possible ignores the potential to value-add multiple Aboriginal social and economic capitals.

They suggest that a procurement process needs to:

- be adaptable to both large-scale and small-scale projects
- incorporate a joint venture or partnership structure into its contractual framework, for example, between an Indigenous community, organisation or enterprise and a mainstream building contractor and/or government
- be flexible to allow for major shifts as the program progresses
- offer incentives for mainstream building contractors to participate through risk mitigation
- offer incentives to proprietors to have an open-book scenario for all project costs
- allow time for community-based consultation during both the design and delivery processes
- have flexible delivery timeframes to accommodate remote community politics and social and climatic contexts
- incorporate meaningful training and employment outcomes in the local communities where the program is based
- have a longevity of at least 5 years to enable meaningful training outcomes such as local labourers having an opportunity to gain full certification
- have a long-term exit strategy that incorporates training outcomes and establishes a tenancy and asset management program (Davidson et al. 2011:7–8).



Summary of a best practice approach to construction

Check twice, cut once. Before constructing any new dwelling or undertaking major renovations, ensure that the design is socially and culturally appropriate and complies with the *National Indigenous Housing Guide* and other appropriate standards such as the *Australian Standards* and the *Building Code of Australia*.

Inspect early and often. Note that there is no requirement to make a payment to a builder for work that does not meet the requirements of the drawings and the specifications. There should be a significant final payment available to the builder once all defects identified during the defects period are rectified.

Tailor the procurement process to the particular setting and the objectives of the construction program.

Best practice approaches to maintenance

Best practice approaches to maintenance need to incorporate a range of principles and practices which have been demonstrated to improve housing outcomes for Indigenous Australians. These include:

- utilising the *National Indigenous Housing Guide* to design and construct housing
- targeting limited budgets to prioritise safety and health issues
- using materials and construction techniques which are appropriate to the local physical environment
- consulting with local Indigenous communities on the design, construction and maintenance of housing
- training and utilising local Indigenous labour for construction and maintenance programs
- conducting rigorous inspections at multiple points throughout the construction process to ensure appropriate standards are met.

These principles are detailed in this section.

An example of a maintenance approach which meets these principles and has been evaluated with positive results is the approach developed by Healthhabitat (Pholeros et al. 1993). It is not suggested that this is used as the only approach to maintenance (ANAO 2010). However the approach is a good example of a program that utilises the key principles that are shown to be effective in the maintenance of Indigenous housing.

The Housing for Health method focuses firstly on safety, and identifying and removing life-threatening dangers when maintaining a house. Secondly, the method involves assessing the functionality of health hardware in houses in relation to whether it can support healthy living practices.

Healthy living practices

The Housing for Health approach assesses dwellings in relation to the following nine healthy living practices (HLPs) listed below in order of importance. The first four healthy living practices are described as 'critical healthy living practices' (CHLPs).

1. The ability to wash people, particularly children
2. The ability to wash clothes and bedding
3. Removing waste safely from the house and immediate living environment
4. Improving nutrition: the ability to store, prepare and cook food
5. Reducing the negative effects of crowding



6. Reducing the negative contact between people and animals, insects and vermin
7. Reducing dust
8. Controlling the temperature of the living environment
9. Reducing trauma, or minor injury, by removing hazards.

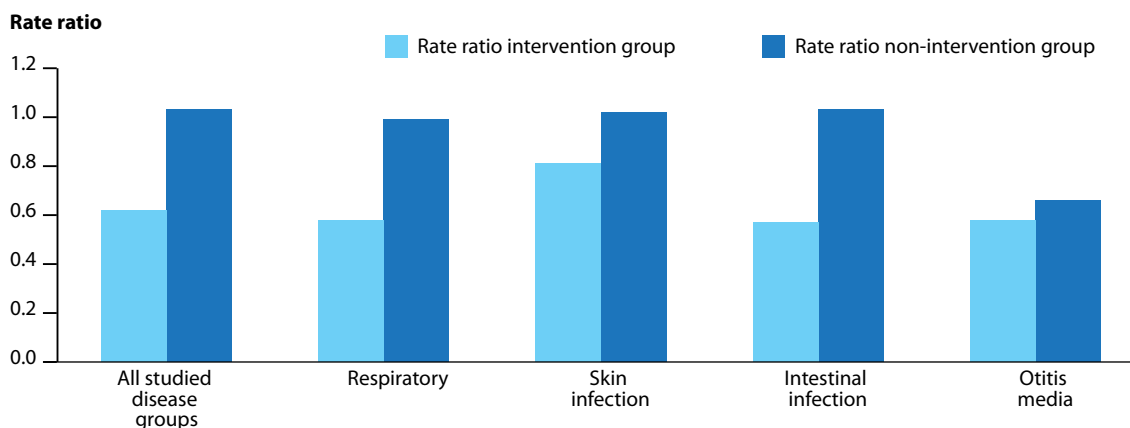
Each CHLP comprises a number of contributing items, each of which is tested and assessed by a yes/no answer—no shades of grey. If any one of the contributing items to the CHLPs fails the test, the house fails. For example, the CHLP involving the ability to wash people has seven contributing items and each one has a prescribed test (Pholeros et al. 1993:42):

- 4.1 Hot water available and flowing
- 4.2 Cold water available and flowing
- 4.3 Hot water temperature greater than 44° C
- 4.4 Hot water tap OK
- 4.5 Cold water tap OK
- 4.6 Shower rose OK
- 4.7 Shower drainage OK.

The Housing for Health Program has a prescribed method for ensuring healthy living practices are maintained. Key features include using:

- a carefully prescribed method comprising over 250 standard repeatable tests with a priority order for testing and checking house safety and health functions (the tests determine the score for the CHLPs and other HLPs)
- simple fixes for immediate improvement to houses on the first day of any project, with any life-threatening safety problems having overarching priority
- an on-site database to capture the results of testing and checking the house's health function
- data from before- and after-fix work surveys to test house function and ensure the improvement of each house
- data generated by Housing for Health Projects to improve the design of new houses
- local Indigenous people employed in all aspects of the work from day one of any project.

The program has been evaluated with positive results by both the Australian Government (SGS 2006) and the New South Wales Government (NSW Health 2010). The New South Wales Government evaluation focused on the health benefits of the model in 71 communities that was used to fix 2,230 houses over the last 10 years. This included fixing over 51,700 individual items critical to health and safety. The evaluation found that the residents of houses where the Housing for Health intervention was implemented (intervention group) had a rate of hospital separation for infectious diseases that was 40% lower than the rest of the rural New South Wales Aboriginal population (non-intervention group).



Note: Disease rate is measured by hospital separations.

Source: NSW Health 2010.

Figure 3: Before and after rate ratios (RR) for disease conditions in populations exposed to Housing for Health (intervention group) versus rural NSW Aboriginal control population (non-intervention group), 2010

Healthabitat has introduced a non-commercial licence, which allows the Housing for Health method to be widely adopted as long as the critical elements of the method are adhered to. Although other approaches to maintenance might be adopted, the important lessons learnt from the Healthabitat program suggest that maintenance programs should:

- be prioritised
- include significant inputs from Indigenous people at the planning and implementation stages
- be carefully documented
- be used to influence the design and construction of dwellings
- include a research and development component to enable the unique issues associated with Indigenous housing to be addressed, and better solutions developed
- be appropriately funded
- be long term in order to gain the trust of Indigenous communities, to allow the programs to be developed and improved, and to enable a range of program participants to develop their skills.

It is also clear that maintenance programs based on responsive maintenance (that is, when repair and other work only occurs when a tenant notifies the landlord) are unlikely to work for a number of reasons. Firstly, communications systems in many remote areas are problematic. Secondly, it is clear that the degree of reporting of housing faults is directly proportional to the level of effective maintenance. In other words, if tenants consider that their maintenance concern is unlikely to be met with an effective response they are unlikely to report it. Thirdly, the travel costs associated with a responsive maintenance program in remote areas is likely to be very high. Instead, a cyclical maintenance program should be undertaken that is focused on ensuring that housing is in good condition before major seasonal changes such as the onset of the wet season or summer and winter seasons.

When considering the geographical location of maintenance programs, local programs are unlikely to be effective because of the problems of scale. For example, there might not be enough work to justify a maintenance program. However, a program based in state capital cities is also unlikely to be effective because of the physical distance between many dwellings and the capital city. In some cases, a lack of knowledge about local cultural and environmental issues also mitigates against effective programs based out of a capital city.

Box 1: Highlighting the need for local Indigenous involvement: the case of Chris the plumber

Chris the plumber turns up with his apprentice in an Indigenous community, having driven 250km from Regionville. He is a bit worried because it has taken him most of the day to get to the community and he hasn't got his tool box out of his truck yet. He eventually finds two houses that he thinks he has bookings for but he finds the houses are empty. A dog bites him at another house so he leaves and, just when he thinks things can't get worse, he gets sworn at by a cranky old bloke who is sitting on the verandah of his second last 'booking'. The man speaks very little English but is obviously not happy about two strangers being on the front steps so Chris bids a hasty retreat. When he finally finds someone home, he decides to replace their toilet rather than replace their damaged washer in order to pay for the trip (and his apprentice's wages). Chris is not having one of his better days. As he finally drives out of the community he makes a note to himself not to come back unless work elsewhere is very short.

Things could have been very different for Chris if he had had the support of a local Indigenous team, let's call them Ben and Brad, who could have bundled up a larger number of maintenance jobs for him so that his ratio of travel costs to plumbing costs was lower. Ben and Brad could have assessed houses, assembled work lists, met Chris at the start of his visit and acted as guides and interpreters during his visit. They could have helped him by doing simple labouring tasks so Chris could have left his apprentice working on other projects back in Regionville. Ben and Brad could have earned a wage and made Chris's day more profitable and productive through getting more work done in their community.

Conclusion

Providing better approaches to the construction and maintenance of Indigenous housing is a hard problem, largely because of the range of complex issues that are involved. However, the problem is fixable, as evidenced by a number of important improvements in recent years.

The *National Indigenous Housing Guide*, agreed to by Commonwealth, state and territory governments, is now in place and is constantly being improved and updated. Moreover, on the maintenance side, a national Housing for Health Program has been developed, which uses a health hardware approach to prioritise maintenance tasks based on a set of healthy living practices. The program has been independently evaluated and has been shown to have positive effects on both dwelling conditions and the health of the occupants.

More progress can be made through a commitment to the adoption of long-term approaches built on the two programs above, as long as the outcomes are carefully documented and evaluated in an ongoing process. Involving Indigenous communities in the planning and implementation of construction and maintenance programs is a crucial element of any successful program.

While Healthabitat maintains a good national database on dwellings that have been maintained through the program, there is no equivalent national database for new construction detailing individual dwellings. Given improvements in technology, especially in the area of geographical information systems, it would be possible to develop such a database and to update this database as systematic maintenance of properties occurs. Such a database would help with measuring and evaluating other things we don't know such as:

- the performance of different designs and construction methods
- the long-term cost effectiveness of capital investment and maintenance systems
- post-occupancy evaluations so that successes and mistakes in design could be established (Fien & Charlesworth 2012), and lessons learnt implemented in the future.

Further resources

Table 1: Information about technology/system type and use, and suitable geographic region

Technology/system type and use		Geographic region in which technology is suitable				
Technology/system	Comments	Reference	Urban	Regional	Remote	Very remote
Composting toilets	Cannot be used for treating greywater Require at least weekly maintenance	Bush Tech Brief no. 15: <i>Choosing the right toilet</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-15.pdf >			✓	✓
Gas fittings	Gas used for heating, cooking, generation of electricity	Bush Tech Brief no. 5: <i>Gas fittings</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-5.pdf >			✓	✓
Gas microturbines and dual-fuel (gas and diesel) generators	Used for electricity generation in remote communities Gas cheaper by litre, but diesel rebate for off-road use makes it cheaper Need trained staff to maintain system	Bush Tech Brief no. 7: <i>Feasibility of gas and dual fuel</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-7.pdf >			✓	✓
Hot water systems	Wood fire system the cheapest to run, but may cause inconvenience due to need to gather wood Solar is expensive to install but cheaper to run. However, supply not reliable, particularly when large numbers of relatives visiting Heat pump systems appear to be the cheapest of the electricity-based systems	Bush Tech Brief no. 1: <i>Hot water</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-1.pdf >		✓	✓	✓

(continued)

Table 1 (continued): Information about technology/system type and use, and suitable geographic region

Technology/system type and use			Geographic region in which technology is suitable			
Technology/system	Comments	Reference	Urban	Regional	Remote	Very remote
Maintenance of doors and windows to prevent heat loss Door saungages to prevent heat loss Insulation Location of houses away from high wind areas Planting of deciduous vines/trees to shade during summer House warming systems Northern orientation		Bush Tech Brief no. 16: <i>House warming</i> < http://www.icasat.org.au/wp-content/uploads/2012/05/bush-tech-16.pdf >	✓ (particularly in colder desert and southern regions)	✓ (particularly in colder desert and southern regions)	✓ (particularly in colder desert and southern regions)	✓ (particularly in colder desert and southern regions)
Mosquito nets and fly screens	Help prevent the spread of vector-borne diseases (e.g. dengue fever, Ross River virus)	Bush Tech Brief no. 49: <i>Protecting your home against dengue outbreaks</i> < http://www.icasat.org.au/wp-content/uploads/2012/05/bush-tech-49.pdf >	✓ (particularly in tropical regions)	✓ (particularly in tropical regions)	✓	✓
Pit toilets	Cheap and easy to build; reliable, but do require some maintenance Not suitable for areas with high water table or where prone to flooding	Bush Tech Brief no. 15: <i>Choosing the right toilet</i> < http://www.icasat.org.au/wp-content/uploads/2012/05/bush-tech-15.pdf >			✓	✓

(continued)

Table 1 (continued): Information about technology/system type and use, and suitable geographic region

Technology/system type and use			Geographic region in which technology is suitable			
Technology/system	Comments	Reference	Urban	Regional	Remote	Very remote
Rainwater tanks	Useful for rainwater harvest, assisting in reliable supply of water Polyethylene tanks are recommended as they are easiest to fix if they leak A range of protections need to be built into system to prevent contamination, e.g. sealed, insect-proof system, interceptors to catch and remove 'first flush' rain, wide self-cleaning guttering	Bush Tech Brief no. 4: <i>Rainwater harvesting</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-4.pdf >	✓	✓	✓	✓
Renewable energy supply (solar systems)	Need systems which can cope with challenging environmental conditions, and which communities can maintain themselves	Bush Tech Brief no. 2: <i>Renewable energy in remote communities</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-2.pdf >		✓	✓	✓
Septic tanks	Require reliable water supply	Bush Tech Brief no. 15: <i>Choosing the right toilet</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-15.pdf >	✓	✓		

(continued)

Table 1 (continued): Information about technology/system type and use, and suitable geographic region

Technology/system type and use		Geographic region in which technology is suitable				
Technology/system	Comments	Reference	Urban	Regional	Remote	Very remote
Septic tanks and absorption trenches	Important for hygiene in settlements not connected to mains sewerage systems	Bush Tech Brief no. 27: <i>Septic tanks and absorption trenches</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-27.pdf >		✓ (useful particularly in areas with loamy soil)	✓ (useful particularly in areas with loamy soil)	✓ (useful particularly in areas with loamy soil)
Solar cookers	Low cost, easy construction and low maintenance Utilise renewable energy to run	Bush Tech Brief no. 45: <i>How to make a solar cooker</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-45.pdf >	✓ (useful in warmer northern and desert areas)	✓ (useful in warmer northern and desert areas)	✓ (useful in warmer northern and desert areas)	✓ (useful in warmer northern and desert areas)
Toilets—anaerobic wastewater treatment systems	Restrictions on where runoff can be used (perhaps not suitable for urban settings then) Require electricity and flush toilet system, as well as needing maintenance by trained technicians	Bush Tech Brief no. 15: <i>Choosing the right toilet</i> < http://www.icat.org.au/wp-content/uploads/2012/05/bush-tech-15.pdf >		✓	✓	

Source: Centre for Appropriate Technology.



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Acknowledgments

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Abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
BPA	best practice approach
CHLP	critical healthy living practices
HLP	healthy living practices
ICHO	Indigenous community housing organisation
FAHCSIA	Department of Families, Community Services and Indigenous Affairs

Terminology

Health hardware: Originally used by Dr Fred Hollows to describe the physical equipment necessary for healthy, hygienic living. The equipment must have design and installation characteristics that allow it to function and to maintain or improve health status. In a water supply system, health hardware includes both the bore and the basin plug, as well as the shower rose, taps and drain.

Indigenous: 'Aboriginal and Torres Strait Islander' and 'Indigenous' are used interchangeably to refer to Australian Aboriginal and/or Torres Strait Islander peoples. The Closing the Gap Clearinghouse uses the term 'Indigenous Australians' to refer to Australia's first people.



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