

**DECONTAMINATION OF MOULD-
AFFECTED ENVIRONMENTS:
ADVICE AND EVIDENCE OF
EFFICACY**

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SUMMARY

When building materials become damp, fungal spores and bacteria present in indoor air and dust can colonise the building materials and grow, producing visible contamination, often referred to as mould. Humans may be exposed to fungal spores, fragments and metabolites following establishment of mould, potentially causing allergic reactions, toxic and irritant effects and infections.

Indoor mould growth can be prevented or minimised by actively maintaining, inspecting, and correcting buildings for moisture problems and immediately drying and managing water-damaged materials. However, necessary steps for prevention of mould growth are not always taken and given the potential for adverse human health effects, it is important that mould occurring in the indoor environment be removed and that the cause of the high moisture contents also be addressed.

There is little consistency in the advice provided on biocides for removal and inactivation of fungal material from household items and building materials. Hypochlorite, alcohol, acetic acid and detergent-based biocides have all been suggested for this purpose.

The scientific evidence base from which to formulate advice on mould remediation is very limited. While there is some evidence that a combination of bleach and detergent may be more effective than other biocidal agents, findings are inconsistent and no studies have demonstrated treatments that inactivated fungal spores and mycotoxins and destroyed the allergenicity of fungal residues across the full range of fungal species potentially present in the domestic environment.

On the basis of the available evidence, the advice offered by the USEPA appears to be the most protective of public health; that is, removal of affected material, rather than use of biocides to remediate, wherever possible.

1. INTRODUCTION

1.1 BACKGROUND

When building materials become damp, fungal spores and bacteria present in indoor air and dust can colonise the building materials and grow, producing visible contamination. In the current document, visible fungal and bacterial contamination will be referred to as mould. Humans may be exposed to fungal spores, fragments and metabolites following establishment of mould. The primary route of human exposure is by inhalation (IOM, 2004). Inhalation of fungal material has been associated with allergic reactions, toxic and irritant effects and infections (NYCDHMH, 2008).

Indoor mould growth can be prevented or minimised by actively maintaining, inspecting, and correcting buildings for moisture problems and immediately drying and managing water-damaged materials (NYCDHMH, 2008). However, necessary steps for prevention of mould growth are not always taken and given the potential for adverse human health effects, it is important that mould occurring in the indoor environment be removed and that the cause of the high moisture contents also be addressed.

The current document considers two bodies of information:

- Advice, provided by various organisations, on approaches for the removal of mould
- Evidence for the efficacy of approaches for the removal of mould.

1.2 GENERAL PRINCIPLES AND ASSUMPTIONS

Several general principles should be kept in mind when considering remediation of mould-affected indoor environments:

- The source of the excessive moisture must be identified and corrected or growth of mould will recur. A wide range of fungal species are present in indoor dust and are constantly being introduced from the outdoors.
- The simplest, most expedient remediation that properly and safely removes the mould growth from buildings should be used.
- It is assumed that for each area of visible mould a wider zone of mould contamination will be present.

2. ADVICE ON MOULD REMEDIATION

Appendix A reproduces advice from a range of New Zealand and overseas organisations on remediation of mould damage. A more comprehensive summary of New Zealand advice, carried out by Danielle Servant, Southern District Health Board, is included in Appendix B.

While exact details of mould removal advice vary from source to source, particularly with respect to active substance dilution and contact time, five broad categories of advice for mould removal are given:

- Do not try to remove mould
- Hypochlorite (bleach)
- Organic acid (vinegar)
- Alcohol (methylated spirits/isopropyl alcohol)
- Surfactant (soap/detergent)

Some advice also specifies combinations of decontamination agents.

The use of biocides in remediating mould in buildings is not recommended by the USEPA, as much of the human health concern is due to immunological reactions (allergies) or intoxications, rather than primary infections (USEPA, 2008). While decontamination agents may be effective in inactivating fungal spores, the inactive spore material may still be immunologically active. Similarly, mycotoxins produced by the fungi may or may not be inactivated.

3. SCIENTIFIC EVIDENCE

3.1 SOURCE OF CONTAMINATION

A study was carried out to determine the fungal species present in gypsum wallboard, as manufactured (Andersen *et al.*, 2017). It was confirmed that fungal spores were already present on the wallboard at manufacture. The dominant species was *Neosartorya hiratsukae* (*Aspergillus hiratsukae*), followed by *Chaetium globosum* and *Stachybotrys Chartarum*. Fungi were detected on all wallboard samples analysed, with no major differences between brands. Hyphal growth on wetted wallboard was apparent by day 3, with *A. hiratsukae* visible after 7 days and *S. chartarum* visible after 21 days. *C. globosum* was not visible until 28 days and no new colonies appeared after 42-45 days. The authors speculated that the fungi were associated with the paper outer layer, rather than the gypsum core.

A survey of 160 homes in the United States collected 1330 sticky tape samples from non-porous surfaces (Reynolds *et al.*, 2012). All homes and 73% of samples tested positive for moulds. Windowsills and refrigerator seals were the most frequently positive surfaces (87.5% and 83.3%, respectively). The most frequently identified mould was *Cladosporium* (31% of isolates), followed by *Alternaria* (14% of isolates) and *Helminthosporium* (9% of isolates). *Stachybotrys* was only detected in two homes and represented 0.2% of isolates.

3.2 CONDITIONS FOR SURVIVAL AND GROWTH

Samples of gypsum wallboard were inoculated with *S. chartarum* and placed in controlled environments of specified relative humidity (RH) and with or without direct wetting of the wallboard (Menetrez *et al.*, 2004). *S. chartarum* spores reduced in concentration at RH<97% in the absence of direct wetting. Two levels of wetting were trialled and, at the higher level, *S. chartarum* growth was seen, irrespective of the RH.

3.3 ASSESSMENT OF ADVICE ON MOULD REMEDIATION

A US study (Krause *et al.*, 2006) examined several of the propositions made in guidance material, with respect to water damage and mould formation on gypsum wallboard (NYCDHMH, 2008; USEPA, 2008). The bottom inch of several gypsum wallboard panels was immersed in water and the panels examined and tested over the course of eight weeks. The propositions tested and the results found are summarised in Table 1.

Table 1. Propositions related to water damage and mould formation in gypsum wallboards and experimental findings

Proposition	Findings
Wet wallboard must be dried within 24-48 hours	Mould growth was not detected visually or with tape lifts after one week. Colourless hyphae were detected on some panels after two weeks. Mould was clearly visible after three weeks
Mould growth will be present in gypsum wallboard at least six inches beyond the margin of visible growth (invisible mould)	No mould growth was detected more than six inches beyond the margin of visible mould growth
Cleaning should be carried out using a soap or detergent solution. Disinfectants are seldom needed	Panels were allowed to dry for two weeks, then (1) dry brushed, (2) sprayed with hypochlorite solution and wiped, (3) sprayed with hypochlorite and surfactant and wiped. (2) and (3) produced no fungal

Proposition	Findings
	growth from swabs and only 'normal' trapping with tape. Fungal contamination was still present after dry brushing. Vacuum cleaning produced no additional benefits

Three commercial surface treatments for wallboard were also trialled and produced greater 'lag' times before the appearance of visual mould.

As mould appeared on wallboards, the early colonisers were *Penicillium*, *Cladosporium* and *Acremonium* species, with *Aspergillus*, *Epicoccum*, *Alternaria* and *Unocladium* appearing later. No *Stachybotrys* was detected.

3.4 MOULD REMEDIATION – USE OF BIOCIDES

3.4.1 Moulds in culture

The ability of five biocidal materials (Virkon® - a peroxy acid-based product, Cavicide® - an isopropyl alcohol/quaternary ammonium compound based product, 70% ethanol, 4.0-4.2% acetic acid and tea tree oil) to inhibit the growth of two fungal species associated with the indoor environment (*Aspergillus fumigatus* and *Penicillium chrysogenum*) was assessed using a disc diffusion method (Rogawansamy *et al.*, 2015). The efficacy of each agent was expressed as the size (diameter) of the growth inhibition zone around the applied biocide disc. Tea tree oil (TTO) was the most effective with mean inhibition diameters of 83 and 44 mm against *A. fumigatus* and *P. chrysogenum*, respectively. Virkon 10% had inhibition zone diameters of 19 mm against both species, but was ineffective at lower concentrations. Cavicide 100% (16 mm against both species) and 4% acetic acid (15 mm against *P. chrysogenum*) showed some inhibitory activity, but 70% ethanol and 75% Cavicide were ineffective.

3.4.2 Moulds on household materials

Sections of dry non-sterile gypsum wallboard were inoculated with cultures of *Stachybotrys chartarum* and incubated in vessels at 86% or 92% RH and 22-25°C for up to 12 weeks (Price and Ahearn, 1999). The moisture content of the wallboard increased from 10% to over 35%. Sections were cleaned with:

- Quaternary ammonium compounds (0.036% didecyl dimethyl ammonium chloride (DDAC) and 0.023% *n*-alkyl dimethyl benzyl ammonium chloride)
- 0.72% chlorine dioxide and 0.4% DDAC
- A stabilised, high-oxygen saline solution

Cleaned wallboard was dried and either left as is or treated with an antimicrobial treatment (acrylic or metal primer). All samples were then re-exposed to a moist environment.

S. chartarum was recovered from wallboard after all three sanitisation techniques when no protective treatment was applied. Other fungal species were also recovered. No *S. chartarum* was recovered from samples cleaned with any sanitiser and surface treated, but other fungal species were recovered in all cases.

The use of biocides in remediating mould in buildings is not recommended by the USEPA, as much of the human health concern is due to immunological reactions (allergies) or intoxications, rather than primary infections (USEPA, 2008). In a study with building materials (plywood, drywall and oriented strand board) artificially contaminated with *Aspergillus fumigatus*, surfaces were treated with water, bleach (1:16 dilution in distilled

water) or Tilex (a commercial biocide containing 2.4% sodium hypochlorite) (Martyny *et al.*, 2005). Viability of conidia was assessed by their culturability. With water treatment, culturability decreased by <1 log in most cases, while treatment with dilute bleach or Tilex decreased culturability by at least 2-3 log and, in many cases, decreased the concentration of culturable conidia to below detectable levels. Conidia treated with bleach in solution had reduced antibody reactions in an ELISA assay and resulted in negative skin prick tests on some, but not all, *Aspergillus*-reactive individuals.

S. chartarum was inoculated onto six gypsum wallboard products and incubated until the test material was extensively covered with visible mould (Menetrez *et al.*, 2007). Test materials were cleaned with 13 different cleaning/disinfecting products and regrowth assessed after six months of further incubation. The best performing products were a benzalkonium chloride (BAC, a quaternary ammonium compound) based product, borax and an orange extract-based product. The BAC-based product resulted in no mould regrowth on 5 of 6 wallboard types, while the other two products resulted in no regrowth on 4 of 6 wallboard types.

Samples of gypsum wallboard and pinewood were inoculated with *S. chartarum* and *Aspergillus versicolor*, followed by application of 10 remediation procedures, carried out according to manufacturers' instructions (Peitzsch *et al.*, 2012). Materials were tested immediately before and after treatment, after six weeks drying and after another six weeks of remoistening. None of the remediation treatments was able to completely destroy viable fungi. No noticeable differences in fungal contamination was apparent during the drying period and fungal growth increased rapidly during the re-moistening period. For mycotoxins from *S. chartarum* (satratoxin G and H, verrucal), the verrucal content of building materials decreased after treatment with heat or boron or ammonium-based biocides, while satratoxin levels only decreased after treatment with a boron-based biocide. Levels of the *A. versicolor* toxin, sterigmatocystin, decreased after treatment with heat, and boron, ammonium or hypochlorite-based biocides. None of the remediation treatments removed mycotoxins completely.

Carrier media (glazed or unglazed ceramicware) were inoculated with mould preparations (*Alternaria alternate*, *Aspergillus niger*, *Cladosporium herbarum*, *Mucor bainieri*, *Penicillium chrysogenum*, *Stachybotrys chartarum* and *Trichophyton mentagrophytes*) and after two growth cycles, were treated with 2.4% sodium hypochlorite (Reynolds *et al.*, 2012). Test organisms were inactivated in all cases after five minutes contact on glazed and 10 minutes contact on unglazed ceramicware. Environmentally sampled mould showed similar susceptibility, with a five minute exposure resulting in a 5->6 log₁₀ reduction in mould counts. Hypochlorite treatment also resulted in greater than 90% reduction in allergen elution by *Aspergillus fumigatus*.

Three techniques (gamma irradiation, a detergent/bleach wash and steam cleaning) were used to decontaminate household materials (paper, cloth, wood and carpet) inoculated with fungal spores (*Stachybotrys chartarum*, *Aspergillus niger*, *Penicillium chrysogenum* or *Chaetomium globosum*) or with mycotoxins (rotridin, T-2 toxin or verrucaric acid) (Wilson *et al.*, 2004). Gamma irradiation inactivated fungal spores, but had no impact on mycotoxin concentrations. Washing with detergent/bleach inactivated or removed all fungal spores of all species, except *C. globosum*. For this species spore concentrations were reduced on all materials. Washing removed or inactivated mycotoxins on paper and cloth, but not on carpet or wood. Steam cleaning did not completely eliminate any of the fungal species, but reduced *P. chrysogenum* concentrations on all materials. *C. globosum* concentrations were reduced on wood and carpet, while *S. chartarum* concentrations were reduced on wood. Steam cleaning had no impact on mycotoxin concentrations.

3.5 MOULD REMEDIATION – ENVIRONMENTAL STUDIES

A study was carried out following a major river flooding incident in Brisbane, Australia in 2011 (He *et al.*, 2014). Air particle, fungi and bacteria concentrations were measured in affected and non-affected houses two and six months after the flood. Indoor and outdoor concentrations were also compared. Cleaning with both detergent and bleach resulted in a significantly lower ratio of indoor to outdoor bacterial concentrations than water, detergent and bleach alone. However, no clear indication of the most effective cleaning methods to reduce indoor fungal concentrations were apparent.

4. CONCLUSIONS

There is little consistency in the advice provided on biocides for removal and inactivation of fungal material from household items and building materials. Hypochlorite, alcohol, acetic acid and detergent-based biocides have all been suggested for this purpose.

The scientific evidence base from which to formulate advice on mould remediation is very limited. While there is some evidence that a combination of bleach and detergent may be more effective than other biocidal agents, findings are inconsistent and no studies have demonstrated treatments that inactivated fungal spores and mycotoxins and destroyed the allergenicity of fungal residues across the full range of fungal species potentially present in the domestic environment.

On the basis of the available evidence, the advice offered by the USEPA appears to be the most protective of public health:

“The purpose of mold remediation is to remove the mold to prevent human exposure and damage to building materials and furnishings. It is necessary to clean up mold contamination, not just to kill the mold. Dead mold is still allergenic, and some dead molds are potentially toxic. The use of a biocide, such as chlorine bleach, is not recommended as a routine practice during mold remediation, although there may be instances where professional judgment may indicate its use (for example, when immune-compromised individuals are present).” (USEPA, 2008).

USEPA further note that, while moulds can be effectively removed from hard surfaces, “Mold can grow on or fill in the empty spaces and crevices of porous materials, so the mold may be difficult or impossible to remove completely” (USEPA, 2012). In such cases, the physical removal of the mould-affected material will be the most effective public health measure.

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APPENDIX A: ADVICE ON MOULD REMEDIATION, NEW ZEALAND AND INTERNATIONAL

A.1 NEW ZEALAND

A.1.1 Level/BRANZ

Level is a set of resources developed by the Building Research Association of New Zealand (BRANZ).¹ Level provides information on moulds, including advice on removal and cleaning up procedures:

For toxic moulds:

When toxic mould is found, it usually affects a significant area of the building and employing a specialist contractor to carry out the removal is recommended.

For small areas, the mould may be removed provided the workers undertaking the removal follow these procedures:

- Seal off the space from other parts of the building by taping up all openings.
- Wear a respirator with a P1 filter (minimum protection).
- Wear protective clothing that is disposable or easily washable.
- Remove any materials from which the mould cannot be removed such as wallpaper, timber products, ceiling tiles, gypsum board, carpet, drapes and furniture (carpet that is contaminated may be difficult to clean completely).
- Place removed materials in plastic bags that can be sealed.
- For materials such as glass, plastic and metal from which the mould can be removed completely, clean the affected area using hot water and chlorine bleach, then rinse and allow to dry completely.
- Use a stiff brush on rough or uneven surfaces.
- On completion, thoroughly vacuum all surfaces of the sealed area using a vacuum with a fine particulate (HEPA) filter. Once this is done, the room seals can be removed.

For non-toxic moulds:

Non-toxic moulds can be removed by thoroughly cleaning the surfaces with either a proprietary mould remover or a 25% household bleach/water solution. Surfaces should be allowed to dry thoroughly.

Mould may be removed from fabrics by washing.

A.1.2 Energy Efficiency and Conservation Authority (EECA)

EECA offers the following advice on mould removal:²

How to remove mould:

¹ <http://www.level.org.nz/> Accessed 11 December 2018

² <https://www.energywise.govt.nz/at-home/dampness/mould-removal/> Accessed 11 December 2018

You can remove small patches of surface mould easily yourself, following the steps below. For larger areas of mould and persistently recurring mould, seek advice from a registered or accredited building surveyor.

Things to consider first:

- Keep children, allergy sufferers and people with a weakened immune system out of the room during mould treatment.
- Wear rubber gloves, a dust mask and protective goggles. Shower and wash your clothes afterwards.
- Keep all chemicals well away from children, and open flames or fire.
- Treatment may discolour some materials, so may not be appropriate for all surfaces. Refer to manufacturer for further advice.

Steps to remove mould from walls, ceilings or furniture:

The following steps are for removing superficial mould from wallpaper, plasterboard and wooden surfaces. Where mould has already penetrated deep into the material, cleaning may not be possible - removing the affected material may be necessary.

1. Thoroughly scrub away all visible mould using soapy water and a cloth or scrubbing brush.
2. Rinse well with water and a clean cloth.
3. Let dry completely.
4. Disinfect the affected surface by applying methylated spirits or isopropyl alcohol (available from supermarkets and hardware stores) to the area using a brush or spray bottle. Air the room well during treatment until all fumes have evaporated. Do not smoke or use candles whilst handling methylated spirits or isopropyl alcohol.
5. Let it set for 30 minutes.
6. Re-apply methylated spirits or isopropyl alcohol.
7. Let it set for a further 30 minutes.
8. Wipe with a clean cloth and methylated spirits or isopropyl alcohol.
9. Clean all cloths and brushes well, or throw them in the rubbish when finished, to avoid spreading mould spores.

Bleach, vinegar and commercial mould removers:

We don't recommend bleach or commercial mould removers because they release harmful fumes into your home over a long period of time. We also do not recommend treating mould with vinegar, as any residue left behind may encourage more mould growth in the future.

Removing mould from other materials:

- Mould on smooth surfaces like glass, porcelain or metal can simply be washed away with water and a household cleaner.
- For mould on fabrics such as clothing, bedding, curtains or upholstery, wash and dry, take to the dry cleaners or throw out. Follow manufacturer's cleaning instructions.
- Replace mouldy silicone seals such as those found around your shower, bath, basin or kitchen sink.

A.1.3 Housing New Zealand

Cleaning away mould:

White vinegar is the best way to kill or clean mould. Note it has a bleaching effect so don't use it on surfaces that might discolour. Spray directly onto the mould using a spray bottle or wipe it on using a clean cloth. If necessary, use an old toothbrush to get in to corners.

On painted surfaces, thin down the vinegar half and half with water to avoid damaging the paint. Leave it for a few days to take affect and then wipe off the dead mould with soap and water using a clean cloth. Remember to clean the cloth or throw it away when finished so that the spores don't spread.

4.1.1 Ministry of Business, Innovation & Employment (MBIE) Tenancy Services

MBIE's Tenancy Services provides advice to tenants in rental accommodation.³

How to remove mould:

To protect the health of everyone in your home, remove mould as soon as it appears.

White vinegar is a cheap and effective way to clean mould. On painted surfaces, dilute the vinegar with water (half and half) to avoid damaging the paint. Leave it for a few days then wipe off the dead mould with soap and water using a clean cloth.

You can also use diluted household bleach. Mix one part bleach with three parts water in a bucket of water.

Use a clean sponge or cloth when washing off mould and rinse it often. This reduces the risk of the mould spreading. Wear gloves, eye protection and a safety mask when dealing with cleaning products and mould.

A.2 AUSTRALIA

A.2.1 CHOICE

Choice is a consumer advocacy organisation.⁴

Step 1: Assess the damage

Before starting, work out what kind of surface the mould has attached to:

- If the mould is on something that's **super-porous**, like a textile, clothing or furniture, there's a good chance it can't be completely removed and it may need to be thrown out. Anything like wicker baskets, textiles, paper and cardboard or carpet needs to be chucked away – don't even bother with these surfaces. (And don't just let carpet dry out if there's been water damage, as mould spores will be left behind, buried in the carpet fibres.)
- **Non-porous** surfaces such as hard plastics should be relatively easier to clean.
- **Semi-porous** surfaces will be variable.

Mould in the grout or silicone in your bathroom is worth a separate mention. Once mould gets its grip there, getting rid of it is almost impossible. When mould grows, it develops

³ <https://www.tenancy.govt.nz/maintenance-and-inspections/mould-and-dampness/> Accessed 11 December 2018

⁴ <https://www.choice.com.au/home-and-living/laundry-and-cleaning/surface-cleaners/articles/getting-rid-of-mould> Accessed 11 December 2018

hyphae, or roots, which grow into the grout or silicone. You can clean the surfaces of the grout or silicone, but not deep into it. In those cases you have to replace the silicone or re-grout your bathroom.

Step 2: Vacuum the mould

The next step is to vacuum up the mould, but your vacuum cleaner needs a good HEPA filter, otherwise you could be making the problem worse by spreading the mould around.

Step 3: Remove the mould

Our experts recommend using diluted vinegar, which causes mould to overheat and die.

How to use vinegar to clean mould

- Pour a concentration of 80% vinegar to 20% water into three buckets.
- Grab a microfibre cloth, dip it into the first bucket, then use it for cleaning a patch of mould.
- The same microfibre cloth should then be rinsed in the second bucket, then rinsed again in the third to ensure cross-contamination doesn't occur.
- Microfibre cloths, which reach deep into tiny crevices and have a slight electric charge, can be bought cheaply and washed on a hot cycle in the washing machine with vinegar up to 100 times.
- After using vinegar there may still be streaks or discolouration on surfaces which you should be able to remove with bleach.

Do mould cleaning products work?

Commercially available mould cleaning products may look like they're doing the job, but it's probably an illusion. Most of them use bleach as an active ingredient. Experts we spoke to say there's evidence that bleach can kill fungi, but it needs to be at a 10% concentration to work.

The concentration of bleach in these products marketed as 'mould killers', including Power Force Mould Away, Woolworths Mould Cleaner, Coles Ultra Mould Remover, Selleys Rapid Mould Killer and Exit Mould, is less than five percent. Bleach has a short shelf life and loses potency quickly, and by the end of their shelf life these products may contain just 0.6% bleach. But even at a higher potency, bleach won't penetrate porous materials, so if the mould is growing on plaster, grout or wood, it will kill mould on the surface, but not below it.

Also, several experts told us that bleach can be a masking agent. Bleach takes the colour, or melanin, out of fungi, making it invisible. You can't see it anymore, so you think the bleach has done its job, when that's not necessarily the case.

Strong bleach is also harmful to grout and tiles as it erodes and corrodes the surfaces, making them more porous, which in turn makes them more vulnerable to further fungi growth.

A.2.2 NSW Health

How can I remove mould from my home?⁵

⁵ <https://www.health.nsw.gov.au/environment/factsheets/Pages/mould.aspx> Accessed 11 December 2018

- For routine clean up of mouldy surfaces, use mild detergent or vinegar diluted in water solution (4 parts vinegar to 1 part water).
- If the mould is not readily removed and the item cannot be discarded, use diluted bleach solution (250mls of bleach in 4 litres of water) to clean the surface. When using bleach, protective equipment is recommended: PVC or nitrile rubber gloves; safety glasses; and safety shoes. Make sure the area is well-ventilated while you are cleaning with bleach.
- Ensure the surface is dried completely once cleaned.
- Absorbent materials, such as carpet may need to be professionally cleaned or replaced if they are contaminated with mould.

A.2.3 Queensland Government

Clean mould⁶

Abrasively cleaning mould from a surface, such as with a dry brush, is **not recommended**. This could release spores into the air, which may cause adverse health effects and spread mould to other areas.

There are many effective products for killing and removing mould from walls, floors and other hard surfaces. Household cleaning agents or detergents can do an effective job if used correctly, as can white fermented vinegar cleaning solution.

Using bleach is not recommended because it's not an effective mould killer. However, bleach will help to eliminate other disease-causing organisms that may be present because of contaminated floodwaters. Mixing cleaning agents is **not recommended**. For example, mixing bleach and ammonia can produce toxic fumes.

Items that can be washed, such as stuffed toys and linen, should be washed as usual. If in doubt, take them to a professional cleaner. Otherwise discard the items as advised by your local council.

Non-porous items such as glass-ware and some plastics can be washed in hot water with a bleach solution or with a good quality disinfectant and air dried. If using a dishwasher, clean and disinfect it first. Do the wash using a full cycle and hot water.

Air conditioning and other ventilation units are a good environment for moulds and other bacteria to grow. Using the unit without cleaning it properly first can cause mould spores to become airborne and be inhaled or spread to other areas. It's recommended that you have air conditioners and ventilation units serviced by a qualified technician.

⁶ <https://www.qld.gov.au/community/disasters-emergencies/recovery-after-disaster/cleaning-up/mould>
 Accessed 11 December 2018

A.2.4 Western Australia Department of Health Remediation⁷

Remediation involves removing the mould and mouldy materials, drying all surfaces and fixing the source of the contamination. Remediation should be done in a manner that minimises the release of mould spores. Removing the mould and dampness should be a priority but fixing the source needs to be done at the same time to ensure there is no further contamination.

Removing the mould

- Scrub mould off hard surfaces using soapy water. The physical action of scrubbing is the most important component of removing mould from surfaces as all mould must be physically removed to prevent regrowth. The use of cleaning solutions only form a small part of the remediation process. It is the physical action of the removal of the mould particulates that determines the efficacy of remediation.
- Dry brushing should be avoided as it will break up the fungi in to small fragments and cause the release of fungal spores.
- The area being cleaned should extend 30 to 50 cm beyond the edge of the visible mould contamination to ensure that all mould, including any new growth that is often invisible to the naked eye, is removed.
- Mould residue that may accumulate around the clean-up area as the result of scrubbing needs to be removed using a damp cloth and/or a vacuum cleaner equipped with High Efficiency Particulate Air (HEPA) filtered vacuum. Vacuuming or wiping also needs to extend beyond the area of visible residue to capture spores not visible to the naked eye.
- Remove any standing water and dry damp areas using towels, heaters, dehumidifiers, and fresh air from open windows.

Removing or cleaning mouldy materials

Some materials, particularly porous or absorbent materials (for examples, carpets, clothes and shoes, soft furnishings and tiles) may not be able to be adequately cleaned without professional assistance. If this is the case they should be removed or discarded. Mouldy material that is to be discarded should be placed in a plastic bag to prevent cross-contamination when they are carried through un-contaminated parts of the building. Mould is not considered a 'hazardous waste' and as such can safely be disposed of through normal waste disposal channels. Appendix C provides a list of actions for different materials if they become damp or water damaged.

⁷ <https://healthywa.wa.gov.au/~/-/media/Files/HealthyWA/Original/Mould%20guidelines.ashx> Accessed 11 December 2018

A.2.5 South Australia Department of Health

Removing mould⁸

Mould should be removed as soon as it appears. Completely eliminating mould and its causes can take some persistence.

Small areas of mould can be cleaned by using a bleach mixture (1 part bleach to 3 parts water) or a suitable commercial product (follow the manufacturer's instructions).

Wear rubber gloves, take care not to splash the cleaning solution and make sure the area is well ventilated.

Don't dry-brush the mouldy area as a brush can flick mould spores into the air which may cause health problems.

If mould returns, there may be an underlying problem. If mould contamination is extensive then a professional cleaner should be consulted.

A.2.6 Western Australia Department of Mines, Industry Regulation and Safety

Before starting the cleanup, control the source of the moisture.⁹

Basic mould cleanup for small jobs

For less than 1 m² of affected area:

- close doors and seal air vents where possible to prevent mould spores spreading;
- ensure unprotected people leave the affected area during the cleanup;
- wearing a P2 respirator (mask), gloves and safety glasses, scrub mould off hard surfaces with either:
 - detergent and water; or
 - three parts vinegar with one part water; or
 - three parts alcohol (eg. methylated spirits) and one part water;
- dry the material completely;
- absorbent or porous materials, such as ceiling tiles and carpet, can be dried if the water has been present less than 48 hours. If items have been wet for a longer period, they may have to be thrown away if they become mouldy as their structure makes it very difficult to properly clean them.
- wet vacuums, dehumidifiers and fans assist in drying wet carpets and similar absorbent materials; and
- for valuable items that have been mould affected, seek specialist advice.

Mould cleanup for medium to large jobs

Medium jobs are where the area affected is 1-10 m² and large jobs are where the area affected is more than 10 m².

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<https://www.sahealth.sa.gov.au/wps/wcm/connect/Public+Content/SA+Health+Internet/Protecting+public+health/Living+conditions+and+sanitation/Household+mould/> Accessed 11 December 2018

⁹ <https://www.commerce.wa.gov.au/worksafe/mould-work> Accessed 11 December 2018

For medium to large mould problems, professional advice is recommended. Getting such advice at an early stage can result in the problem being fixed more quickly, provide the tools to find hidden mould, limit further spread of mould, and assist in identifying and resolving the moisture problem.

Additional controls in terms of the containment of the mould and the level of PPE required are likely to be needed for medium to large jobs. Medium to large jobs also require a higher level of consultation with, and provision of, information to stakeholders, including tenants and workers, as building occupants can be quite concerned about the issue and the remediation.

A.3 USA

A.3.1 Environmental Protection Agency (EPA)

Tips and Techniques¹⁰

The tips and techniques presented in this section will help you clean up your mold problem. Professional cleaners or remediators may use methods not covered in this publication. Please note that mold may cause staining and cosmetic damage. It may not be possible to clean an item so that its original appearance is restored.

- **Fix plumbing leaks and other water problems as soon as possible. Dry all items completely.**
- **Scrub mold off hard surfaces with detergent and water, and dry completely.**
- Absorbent or porous materials, such as ceiling tiles and carpet, may have to be thrown away if they become moldy. Mold can grow on or fill in the empty spaces and crevices of porous materials, so the mold may be difficult or impossible to remove completely.
- Avoid exposing yourself or others to mold.
- Do not paint or caulk moldy surfaces. Clean up the mold and dry the surfaces before painting. Paint applied over moldy surfaces is likely to peel.
- If you are unsure about how to clean an item, or if the item is expensive or of sentimental value, you may wish to consult a specialist. Specialists in furniture repair, restoration, painting, art restoration and conservation, carpet and rug cleaning, water damage, and fire or water restoration are commonly listed in phone books. Be sure to ask for and check references. Look for specialists who are affiliated with professional organizations.

A.3.2 Centers for Disease Control and Prevention (CDC)

CDC has developed a poster outlining recommended mould remediation procedures.¹¹ While much of this material has a focus on clean-up following floods or other natural disasters, the information is applicable to incidental mould contamination.

¹⁰ <https://www.epa.gov/mold/mold-cleanup-your-home> Accessed 11 December 2018

¹¹ <https://www.cdc.gov/cpr/infographics/8tipstocleanupmold.htm> Accessed 11 December 2018

8 TIPS TO CLEAN UP MOLD



Protect Yourself

Put on personal protective equipment (gloves, mask, goggles) to protect your eyes, nose, mouth, and skin.



Toss!

Take it out! Anything that was wet with flood water and can't be cleaned and dried completely within 24 to 48 hours should be taken outside. Take photos of discarded items for filing insurance claims.



Air it out

Open all doors and windows when you are working, and leave as many open as you safely can when you leave.



Circulate

When electricity is safe to use, use fans and dehumidifiers to remove moisture.



Don't mix cleaners

If you use cleaning products, do not mix cleaning products together. DO NOT mix bleach and ammonia because it can create toxic vapors.



Scrub surfaces

Clean with water and a detergent. Remove all mold you can see. Dry right away.



Don't cover it, remove it

Painting or caulking over mold will not prevent mold from growing. Fix the water problem completely and clean up all the mold before you paint or caulk.



Dry it up

Dry your home and everything in it as quickly as possible – within 24 to 48 hours if you can.

<http://www.cdc.gov/mold/cleanup.htm>



APPENDIX B: NEW ZEALAND MOULD REMEDIATION ADVICE

Desk-based audit of advice on management of household mould
Collated by Danielle Servant, Southern District Health Board
(Danielle.Servant@southerndhb.govt.nz)

March 2019

This is a working document, so is incomplete: some organisation's information will be internal (so not public) and others have info on platforms not searched (e.g. printed). However, a more comprehensive audit will not change the issue - mould advice is frequently inconsistent, and often completely contradictory.

Summary of Important Points:

- **Hugely inconsistent messaging about mould removal** across and between WHO, Crown agencies, educational facilities and student support, DHBs, Trusts, Consumer magazine, and even the Asthma/Respiratory Foundation
 - One of the most concerning points was that the Asthma/Respiratory Foundation recommends diluted bleach to clean mould. There is evidence that this can actually make the mould and associated symptoms worse
- White vinegar was the most commonly cited mould removal means, with 12 of 21 mentioning it
 - The recommended dilution varied widely from undiluted to a 70-to-30 mix, to half-half;
 - The duration to leave on ranged from:
 - 30 seconds (OUSA)
 - 2-3 minutes (SDHB Healthy Homes Brochure)
 - 10 minutes (Toi Te Ora Public Health)
 - 15minutes – 1 hour (HomeFit, Sustainability Trust, Eco Design Advisor)
 - Until set (EECA Energywise)
 - Few days (Tenancy Services, HNZC, Community and Public Health)
 - Some did not state the time to leave on (Rheumatic Fever Prevention Programme joint venture between MoH, EECA and HPA and DCC – poster)
- Diluted bleach was mentioned by 7 of 21
 - Again, there were different dilutions and durations recommended
- Consumer NZ recommended methylated spirits or isopropyl alcohol... no evidence for this
- WHO recommends soap/detergent and water
- Many agencies were not specific on certain issues e.g. unflued gas heaters (should be encouraging people not to use them at all, rather than guiding on how to use them), curtains (quite a few missed opportunities to mention double-lined, floor-length curtains),

- The University of Otago does not have any information on healthy flatting that I could find, but to their credit OUSA is their student support organisation
- There were wide variations in the recommendations for opening windows/doors to ventilate
- Some of the references are outdated (e.g. the WHO information is from 2009)

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
World Health Organisation (2009)	Prepare a bucket of water and some mild detergent (e.g. washing liquid or soap for hand-washing clothes). Wipe then then dry with a separate rag. Put rags in a plastic bag. After removal, all surfaces in room should be wet wiped.	Ventilate at regular intervals. Open windows in bathroom/kitchen and use fan. To avoid condensation in bedrooms, open windows for 15 minutes each morning. Put lids on pots. Do not leave kettles boiling. Dry washing outside.	Ideal temperature is between 19-22 degrees in living rooms (including kitchen and bathroom) and 16-20 in bedrooms. Don't let temperature drop below 15 when away from home to avoid condensation.		
Southern District Health Board	Spray with a mixture of 70% white vinegar and 30% water, let sit for 2-3 minutes then scrub with cloth. Wipe down condensation on windows every morning.	Ventilate for 3-5 minutes per day in winter by opening windows/doors on opposite site of house. Aim for sunniest part of day but skip it on rainy or foggy days. Dry clothes outside. Use extractor fans or open windows when cooking/showering.	Oil column, convection, micathermic and panel heaters are all good heating choices for bedroom. Look for heaters with a built-in thermostat and a timer. Should be sleeping at 18°C.	Bubble wrap makes inexpensive double glazing when securely attached. Use draught stoppers under bedroom door.	Snug-fitting, two-layer curtains on the windows that fit close to the window with no gaps.
Community and Public Health	Spray with undiluted white vinegar. In a few days clean up the area with soap or detergent and water, and a clean cloth/sponge. Alternatively, use 1 ½ cups household bleach to 4 L cold water. Leave 10 minutes then rinse with hot water.	Use extractor fans in kitchens and bathrooms. Dry clothes outside. Wipe away excessive moisture on windows/doors.	Turn off appliances like unflued gas heaters if you notice moisture on windows/other surfaces. Ensure adequate heating and insulation.	Cover dirt with plastic cover to prevent moisture from the ground. Ensure the crawl space is well ventilated.	Open curtains to allow sunlight in.

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Auckland Regional Public Health Service (ARPHS)	Remove mould using a cloth or sponge and household bleach (1-part bleach to 9-parts water)	Open windows in bathroom and kitchen or use extractor fans. Dry clothes outside. Put lids on pots when cooking. Open windows on fine days to let air through.	Don't use unflued gas heaters.	Insulate your home. Put a moisture barrier under your house if you can. Draught-proof all windows/doors.	Close curtains before it gets dark. Curtains are better than blinds.
Kainga Ora (ADHB HHI)	Wipe water off windows. Clean mould.	Stop cold air. Let steam out by opening windows. Dry washing outside.	Keep your home warm.	Insulate. Sleep top and tail.	Open the curtains.
Toi Te Ora	Spray with undiluted white vinegar or alternatively use 1.5C bleach to 4 L water. Leave for 10 minutes then rinse with hot water. To prevent mould, wipe excessive moisture build-up.	Use extractor fans. Open windows/doors during the day. Dry clothes outside.	Minimum 18°C during the day or 20°C for vulnerable people. Minimum of 16°C in bedroom overnight (WHO recommendations). Avoid unflued gas heaters. Open fires are draughty and inefficient. Match size of heater to space to be heated. Turn off certain appliances (e.g. unflued gas heaters) if you notice moisture on windows/other hard surfaces.	Ensure adequate heating and insulation.	Open curtains to allow sunlight to penetrate.
Asthma Respiratory Foundation NZ	Remove mould using diluted household bleach.	Use extractor fans. Put pot lids on. Open windows/ doors on fine days.		Use draught stoppers under doors and windows.	Close curtains at night to keep heat in.

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Dunedin City Council	<p>Wipe off any moisture from glass/other cold surfaces.</p> <p>Clean mildew with a damp cloth and diluted bleach or white vinegar. Rinse with soap and water and dry thoroughly.</p>	<p>Keep doors to other rooms closed when using the bathroom or kitchen.</p> <p>Clothes driers and extractor fans should be ducted to the outside.</p> <p>Provide ventilation to wardrobes. Avoid drying wet clothes indoors. Limit number of houseplants. Use a dehumidifier in cool/damp areas.</p>	<p>Keep your house warm, generally 5-7°C higher than outside.</p> <p>Unflued gas heaters give off moisture as they provide heat.</p>	<p>Insulate ceiling and wall cavities (if renovating), also "adequately ventilate the basement or underfloor area and insulate with perforated reflective foil".</p> <p>*From the Energywise website: Foil was the most common material used for underfloor insulation in New Zealand. Because of safety concerns, retrofitting foil insulation and repairing foil insulation in residential buildings is now banned under section 26 of the Building Act 2004.</p>	<p>Use heavy curtains that cover the window completely.</p>
Otago University Students Association	<p>Spray mould with solution of 30% water 70% vinegar leave for 30 seconds and wipe away with cloth.</p>	<p>Ventilate well every day.</p> <p>Open the house right up for 15 minutes.</p> <p>Bathroom and kitchen should have an extractor fan and windows open.</p> <p>Avoid drying clothes indoors.</p> <p>Cover pots with lids.</p>	<p>Heat the whole room rather than use an electric blanket. Refers to Energy Wise website for heater choices.</p>	<p>Use door sausages.</p>	

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Eco Design Advisor Network (Council Based scheme where experts provide free advice to rate payers)	<p>Wipe down condensation from windows as soon as you see it.</p> <p>Regularly check for mould, when you find it scrub with soapy water, rinse and dry.</p>	<p>Use extractor fan and pot lids when cooking/extractor fan while showering.</p> <p>Ensure dryers are vented outside.</p> <p>Leave wardrobe doors open to allow ventilation.</p> <p>Flush your home for 10-20 minutes each day by opening windows and doors. Do not air washing indoors.</p> <p>Ensure adequate drainage around your home. Limit house plants and cover fish tanks.</p> <p>Check gutters/downpipes for leaks.</p> <p>Run a dehumidifier as needed.</p>	<p>Before even considering type of heater, consider insulation, draught-proofing, and curtains.</p> <p>Heat house to WHO minimums</p> <p>Don't use unflued gas heaters (release moisture and poisonous gases)</p>	<p>Install a ground vapour barrier if appropriate house.</p> <p>Target south facing walls with insulation.</p> <p>Draughts – seal up openings such as unused cat doors and open fireplaces, get draught sausages to lie against bottom of door, fit self-adhesive weather strips around windows and strips/draught excluders around and under external doors.</p>	<p>Make sure the bottom of the curtain rests on the floor. Use a minimum of 2 layers of fabric – the thicker the material the better. 2-layer roman blinds can be as effective as double-layer curtains, provided they are snug all round. Close off the top with a fitted pelmet.</p>

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Home Performance Advisor Training Programme and Beacon Pathway	Manage mould by <ul style="list-style-type: none"> • drying house • remove any mould as soon as seen. Physically with hot soapy water, rinse and dry. • Get help if material is infested and must be replaced 	Duct all driers and extractor fan to outside Air the house 10-15min (at least once a day) to swap damp inside air for drier outside air. Dry clothes outside Use extractor fans in wet areas (kitchen, laundry, bathroom) Fix drains and leaks, broken gutters Install ground vapour barrier in sub-floor	Heat living rooms and bedrooms to WHO minimums (18°C or 20°C if elderly unwell or children present) Don't use unflued gas heaters (release moisture and poisonous gases)	Ceiling and underfloor as minimum. Insulate above building code if can. Stop all draughts in door/windows Maintain home so no holes in fabric of buildings	Curtains should be on every window in the house. Good curtains have multiple layers, they puddle on the floor and are hung on a railing which seals curtain against the window frame at the top. Open curtains during the day, close before temperature drops in evening.
Building NZ	Commercial mould cleaner or bleach (1.5 cups to 4 L water) for 10 minutes before rinsing and drying.				
MoH/EECA/HPA Partnership (RFPP)	Use white vinegar to remove mould from ceilings and walls.	Let steam out in kitchen and bathroom. Wipe off any water that has collected on walls/inside of windows. Dry washing outside or in garage/carport.	Check you have the best heating option for your home.	Stop draughts around doors, windows and fireplaces. Find out if your home is insulated.	Open curtains during the day and close at night.

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
EECA Energywise	<p>Spray with white vinegar, let set, then wipe (in brochure).</p> <p>Scrub the area with soapy water, rinse well with water, let dry completely, and then disinfect the surface with methylated spirits or isopropyl alcohol and air room until all fumes have evaporated. Let sit for 30 minutes. Re-apply methylated spirits or isopropyl alcohol. Let sit for another 30 minutes. Wipe with a clean cloth and methylated spirits or isopropyl alcohol. We don't recommend bleach or commercial mould removals and we don't recommend using vinegar as residue left behind may encourage future growth (on website).</p> <p>.</p>	<p>Use extractor fans to remove moisture.</p> <p>Open windows regularly to remove moisture and prevent damp and mould.</p> <p>Air your house a few times a day with wide open doors and windows to create a cross-draught, even in winter.</p> <p>Ventilate your bedroom overnight – keep windows open a finger width.</p> <p>Dry your clothes outside.</p> <p>Install shower dome, use lids on pots, use range hoods/extractor fans.</p> <p>Check for leaking downpipes/gutters, check vents on all sides of house in the subfloor walls</p>	<p>Unflued gas heaters are bad for health, never use in bedroom. A cheap portable electric heater costs less and won't make your home damp.</p> <p>Avoid unflued gas heaters.</p> <p>During cold winter nights use an electric heater on a low thermostat setting.</p>	<p>Draughts – tighten hinges, catches and latches to stop heat loss. Use draught stoppers.</p> <p>Keep your roof leak free as wet insulation is less effective.</p> <p>Install ground vapour barrier.</p>	<p>Curtains should be floor-length and touch the floor or have pelmets above them – should fit tightly against the wall or window frame. They should also be double layered.</p>
Ministry of Social Development		<p>Block up unused chimneys and stop draughts around windows/doors.</p> <p>Open window when showering and cooking.</p> <p>Dry clothes outside.</p> <p>Use pot lids.</p>	<p>Keep temperature between 18 and 21 degrees.</p> <p>Make sure bedroom warm enough.</p> <p>If you use an unflued gas heater make sure you use it safely.</p>		<p>Open windows/curtains on sunny days and close when sun goes down.</p>

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Housing NZ	White vinegar sprayed directly onto mould. Leave for few days then wipe with soap/water and clean cloth.	<p>Open windows slightly 1-2 hours a day (longer on sunny days).</p> <p>Open a window/use extractor fan.</p> <p>Wipe condensation off windows/walls.</p> <p>Avoid splashing in the kitchen and bathroom, and dry the areas with splashes.</p> <p>Keep pot lids on.</p> <p>Hang washing outside to dry.</p>	Use thermostats/timers on heaters.	Use a door snake to stop cold air coming through.	Open curtains in morning and close just before dark.
Tenancy Services	White vinegar diluted with water (half/half), leave for few days then wipe with soap/water. Can also use diluted household bleach (1 part bleach with 3 parts water).	<p>Keep lids on pots.</p> <p>Wipe condensation off windows and walls.</p> <p>Hang washing outside.</p> <p>Leave wardrobes a bit open</p> <p>Keep the shower curtain hanging inside the shower/bath.</p> <p>Keep only a few plants inside.</p>			

Source	What are they saying?				
	Mould	Moisture management	Heating	Insulation/Draughts	Curtains
Sustainability Trust, Wellington	Put white vinegar in a spray bottle, spray the mould and leave for 30min-1 hour before wiping clean with water and a cloth/brush.	Open the windows for about 30 minutes even on cold days. Cook with pot lids on, close bathroom door when using, wipe condensation in morning.	Do heat children's bedrooms (no less than 16°C at night). Don't use an unflued gas heater.	If your insulation was installed 10 years ago or more, get it checked. Old foil should be replaced with bulk insulation because it loses reflective properties/thermal value over time (and is now banned). A ground vapour barrier is recommended.	Open curtains at day, close as sun starts to set. Lined curtains are better.
HomeFit	Spray with mixture of 70mL white vinegar, 30mL water, leave for up to an hour then wipe off with a clean damp cloth.	Extractor fans in bathroom and kitchen that can hold up a piece of A4 paper.		Ground vapour barrier recommended.	Full-length, double-lined curtains or (if this is impractical) multi-layered honeycomb or roman blinds – fitted and closed at the top (pelmet).
Consumer NZ	Wipe condensation off windows and walls. Remove surface mould using methylated spirits or isopropyl alcohol in a spray bottle, or a 1:4 bleach/water solution. You can use white vinegar but it doesn't kill all mould and residue can encourage more mould growth.	Use extractor fans. Install a shower dome. Close doors to contain steam/condensation. Air the home with cross draught once or twice a day. Leave windows closed on damp days. Ill-fitting or broken cat/dog doors can let in cold air. Dry clothes outside or use an externally vented dryer. Use pot lids when cooking.	Do not use unflued gas heaters. Heat pumps cheapest to run. Think about what heater best suits the space you're in.		Floor length curtains are more effective than windowsill length curtains, which are not much better than no curtains at all. Pelmets help decrease heat loss but won't stop it completely.



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