

Initial Restoration for Flooded Buildings



FEMA

HURRICANE KATRINA RECOVERY ADVISORY

NOTE: This advisory is specifically intended for buildings subject to the effects of long-term flooding and widespread mold growth following Hurricane Katrina. For additional information on more common water leakage and mold situations, refer to the FEMA website (<http://www.fema.gov>) and related links to the Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention (CDC) sites listed at the end of this advisory.

During the initial visit to a flood-damaged building, the situation often appears overwhelming (Figure 1). However, despite the shock that often accompanies an individual's first look at the damage, there are a number of straightforward principles that can be applied to assist with the flood restoration effort. In addition to following the steps outlined below, individuals should review the Hurricane Katrina Recovery Advisory, *The ABC's of Returning to Flooded Buildings*.

1. Air Out

- To promote drying, open all doors and windows whenever you are present and leave as many open when you are not present as security concerns allow. Some styles of windows (double-hung) and patio doors may be able to be left partially open and secured from external opening by inserting a nail in the window frame or using a wooden dowel or stick. Upper floor windows can usually be left open all the time and will also assist in drying the whole house. Try to take advantage of cross-ventilation by opening windows on multiple levels and opposite sides of the building.
- Open interior doors, especially closets and interior rooms, to allow air movement to reach all areas of the building. Take doors off their hinges if necessary to promote air flow.
- Open kitchen cabinet and bathroom vanity doors; remove drawers and stack them to dry.
- Open the attic access, if available, to increase ventilation. Consider the benefits (improved drying) and risks (falling dust, insulation, or other debris) of adding an attic access where none exists.
- When electricity is available, use fans to push moist air outside. However, avoid use of fans if the house is contaminated with sewage as the air movement may spread bacterial contamination.



Figure 1. Typical flood damage to furniture and interior walls (Hurricane Katrina).

2. Move Out

- Remove salvageable contents that were not impacted by the water. If the upper floors are dry, it may be possible to move such items to those areas. When moving items from impacted areas of the building to other locations, consider using protective mats or non-slip drop cloths (e.g., fabric painter cloths) to avoid contamination of unimpacted surfaces.
- Remove saturated porous materials such as mattresses or upholstery, especially those with visible fungal growth. These items should be moved out of the building as soon as possible. Cover contaminated items with plastic drop cloths prior to moving to prevent spread of contaminants. Appropriate personal protective equipment should be utilized to avoid injury from possible exposure to mold and bacteria.

3. Tear Out

- Prior to beginning tear out, install plastic barriers between affected and unaffected areas of the premises (typically between the first and second floors). This will reduce the potential for secondary damage occurring in the unaffected areas.
- Remove wet carpet and padding. Tack strips should also be removed completely when the carpet is taken out to minimize injury during subsequent activities. Since carpet tack strips have protruding nails, wear leather gloves to protect hands from puncture wounds while removing and handling tack strips. Removing wooden baseboards prior to carpet tear out may allow for their later reinstallation.
- Remove any curled vinyl tiles or linoleum over concrete floors, and remove all vinyl tiles or linoleum over wooden sub-floors to allow the wood to dry. Respiratory protection should be worn as many older (pre-1970s) flooring products, such as 9-inch square tiles and adhesives, often contain asbestos.
- Although punching holes in walls for drainage is commonly recommended, this practice does not drain water nor does it cause the wall to dry faster. If holes are not punched in the walls, the drywall (gypsum board) may be able to be easily repaired and restored.
- If drywall or plaster has been saturated by contaminated floodwater, it should be removed. Respiratory protection should be worn when removing drywall as some older drywall joint compound contains asbestos. If the water level was less than 2½ feet, the wall material should be removed to a height of 4 feet to facilitate reinstallation of full sheets of drywall. If the water level was greater than 2½ feet, the wall material should be removed to a height of 8 feet or the ceiling junction, whichever is higher. Electrical outlet and wall switch plates and door and window moldings must be removed prior to the tear out of the wall material.
- Fibrous wall insulation (fiberglass, mineral wool, cellulose, wood fiberboard, etc.) saturated by floodwater should be removed completely. Foam plastic insulation may be left in place and allowed to dry.
- Flooded electrical receptacles should be removed completely after the appropriate circuit breakers or fuses are deactivated.
- Wall paneling should be removed if it is swollen or if saturated drywall is behind the paneling.

4. Clean Out

- Following any necessary tear out, clean up any remaining debris and muck. Squeegees, shovels, and brooms are effective for such cleaning. Personal protective equipment should be utilized. Detailed cleaning and sanitizing of the remaining materials should be conducted. A shop vacuum with dry filters in place and with a solution of clean water and disinfectant in the tank (2-inch depth) to minimize the spread of dust can be used.
- Mold removal. Treatment with commercial mold removers does eliminate visible evidence of mold growth on exposed surfaces and is recommended for restoring flood-damaged homes. Tests have found very little or no evidence of mold growth in the non-exposed (hidden) portions of the walls. Treating the non-exposed portions of the walls for mold control does not appear warranted in most cases. Spraying vertical surfaces using a compression (pump-up) garden sprayer with a commercial mildew remover is recommended.
- Understand the limitations of bleach. While this material is convenient and appropriate as a sanitizer for hard, non-porous items after they have been cleaned, it has distinct drawbacks when cleaning flood-impacted buildings. Application of bleach water can cause corrosion of electrical components and other metal parts of mechanical systems, and can compromise the effectiveness of termite treatments in the soil surrounding the building. Its effectiveness at killing bacteria and mold is significantly reduced when it comes in contact with residual dirt. Moldy surfaces should be cleaned first and then disinfected. Residual mold spores should then be removed, since killing them does not reduce their toxicity.
- Remove mud and gross contamination from floors by shoveling into suitable containers. Reduce soil and



Figure 2. Using a pressure washer to clean contaminated surfaces.

contaminant levels on surfaces by flushing off with clear water. The fastest and most efficient method to clean and decontaminate materials and surfaces is by using a residential-type pressure washer to apply a cleaner-disinfectant solution to the affected areas (Figure 2). Brushes improve decontamination of floors and some walls by scrubbing solution into affected surfaces. Avoid scrubbing drywall and plaster walls at this time because they have become softened by the flooding and moisture and may have their surface damaged by scrubbing. Following the first cleaning, floors and walls should be rinsed with water and the cleaning process redone a second time. Squeegees can be used to control or direct spent solution, and wet vacuums can be used to collect spent solution.

Warning: Failure to allow for adequate drying prior to reconstruction can trap moisture in the building, which can cause structural damage and potential health problems in the future.

5. Dry Out

- Once the clean process is completed, the building and any remaining contents need to dry. Drying is a naturally occurring process. Over time, all wetted building materials will dry. Drying of structural materials will take an extended period of time to dry to pre-flood conditions. Exterior rooms with excellent ventilation can take 2 to 4 weeks to dry, depending on the temperature and humidity outside. Interior rooms, or those with minimal ventilation, can take 4 to 6 weeks or more to dry and are candidates for the use of mechanical drying equipment. The use of fans, dehumidifiers, air conditioners, and/or auxiliary electric heaters will speed drying. Allowing materials to dry naturally will take considerably longer.
- Wood framing. The moisture content of wood framing must be checked professionally or with a commercially available moisture meter before refinishing or recovering so that excessive moisture does not become trapped in the materials and cause future problems (Figures 3a and 3b). Dryness of wood framing materials can be determined quantitatively using the table on the right above. Wetted materials are presumed dry when their moisture content readings are less than or equal to 15 percent when taken with an intrusive/penetrating moisture meter (Figure 3a). If an intrusive/penetrating moisture meter is not available, a non-intrusive/penetrating moisture meter (Figure 3b) may be used; however, keep in mind that the material moisture results measured from non-intrusive meters may be less accurate than intrusive meters.
- Walls, floors, and other building materials. The moisture content of drywall (gypsum board), plywood floors, and other building materials must also be checked professionally or with a commercially available moisture meter before refinishing or recovering so that excessive moisture does not become trapped in the materials and cause future problems (Figures 3a and 3b). Unlike wood framing, the dryness of other building materials must be confirmed qualitatively by comparing readings between like materials in affected areas of the building (at or below flood level) and unaffected areas of the building (a room or upper floor above the flood

Summary of Moisture Reading Results for Wood Framing Materials

Moisture Reading	Results
> 20%	Wet - no good
15 - 20%	Partially dry - caution
< 15%	Dry - OK



Figure 3a. An intrusive/penetrating moisture meter—recommended for final moisture readings.



Figure 3b. A non-intrusive/non-penetrating moisture meter—recommended for initial and interim moisture readings.

level, or inside a nearby building that was not flooded). Wetted materials are presumed dry when their moisture content readings are within 5 percent of those of like materials in unaffected areas of the building when taken with an intrusive/penetrating moisture meter (Figure 3a). If an intrusive/penetrating moisture meter is not available, a non-intrusive/penetrating moisture meter (Figure 3b) may be used; however, keep in mind that the material moisture results measured from non-intrusive meters may be less accurate than intrusive meters.

- Kitchen cabinets, bathroom vanities, and other “built-in” furnishings that were subjected to flood water should be removed from their location to permit drying of the material behind them. Once these “hidden” areas are dried, the furnishings can be reinstalled if they are salvageable.
- When saturated wood, drywall, and/or other structural materials vulnerable to fungal growth are naturally air dried over an extended period (weeks), the application of a disinfectant prior to drying can prevent mold growth. Materials should be closely observed and disinfectant reapplied at the first sight of mold.

General Notes for Drying Foundation Floors

- Crawlspaces. Access to crawlspaces is necessary for decontamination purposes. For crawlspaces that do not have an existing access opening, the simplest method to access the crawlspace is by strategically removing sections of overlying flooring to permit access. When the flooring is not salvageable, removal of the flooring provides the necessary access openings. Once access is obtained, gross (solid) contamination should be removed from the ground underneath the building for health and sanitation purposes. Next, any remaining water should be removed. If there is an existing vapor retarder on the ground, it can be left in place to collect spent water and cleaning solutions. Following remediation and any necessary final cleaning, the vapor retarder can be left in place to facilitate drying. If there is exposed ground within the crawlspace after cleaning, it should be covered with a plastic vapor retarder to minimize potential mold growth and future moisture migration into the house. Plastic vapor retarders can be made watertight by overlapping and sealing them together using either glue or heavy-duty adhesive. Suitable adhesives can be obtained from hardware stores or home improvement centers. After the vapor retarder is placed, the underlying support structure of salvageable wooden floor joists, wood sub-floors, and foundation walls should be cleaned and sanitized. Following cleaning, application of a wood preservative will provide protection against fungi and wood destroying insects.
- Grade slabs. Concrete grade slabs provide a dense barrier between the ground and the interior of the home. Remove mud and gross contamination from slabs by shoveling into suitable containers. Reduce soil and contaminant levels on surfaces by flushing off with clear water. The fastest and most efficient method to clean and decontaminate contaminated grade slabs and adjacent building materials and surfaces is by using a residential type of pressure washer to apply a cleaner-disinfectant solution to affected areas. Brushes improve decontamination of floors and base of walls by scrubbing solution into affected surfaces. Following the first cleaning, floors and base of walls should be rinsed with water and the cleaning process redone a second time. Squeegees can be used to control or direct spent solution, and wet vacuums can be used to collect spent solutions. Following cleaning, the slab should be visually examined for signs of heaving or cracking due to hydrostatic pressure. When in doubt, contact the local building inspector, structural engineer or other appropriate professional.

Additional Resources

- Repairing Your Flooded Home (ARC #4477/FEMA 23)
http://www.redcross.org/services/disaster/0,1082,0_570_,00.html
- Cleaning Flood-Damaged Homes (LSU AgCenter)
http://www.louisianafloods.org/en/family_home/hazards_and_threats/recovery_assistance/cleaning_up/structural_damage/Cleaning+FloodDamaged+Homes.htm
- Mold Fact Sheet (LSU AgCenter)
http://www.louisianafloods.org/en/family_home/home/health_safety/indoor_air_quality_mold/Mold+Fact+Sheet.htm

For additional information on more common water leakage and mold situations:

- Environmental Protection Agency (EPA), <http://www.epa.gov/mold>
- Centers for Disease Control and Prevention (CDC), <http://www.cdc.gov/mold>