

Flooding Issues: Residential Housing

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Welcome!

University of Nebraska–Lincoln



Flood Disaster in Homes

- Preparedness
- **Response**
 - Safety
 - First Entry
- **Recovery**
 - Clean up
- Mitigation



Water Damage Resources

Sources of portions of information:

■ **North Dakota State Univ.:** K. Hellevang, P.E.

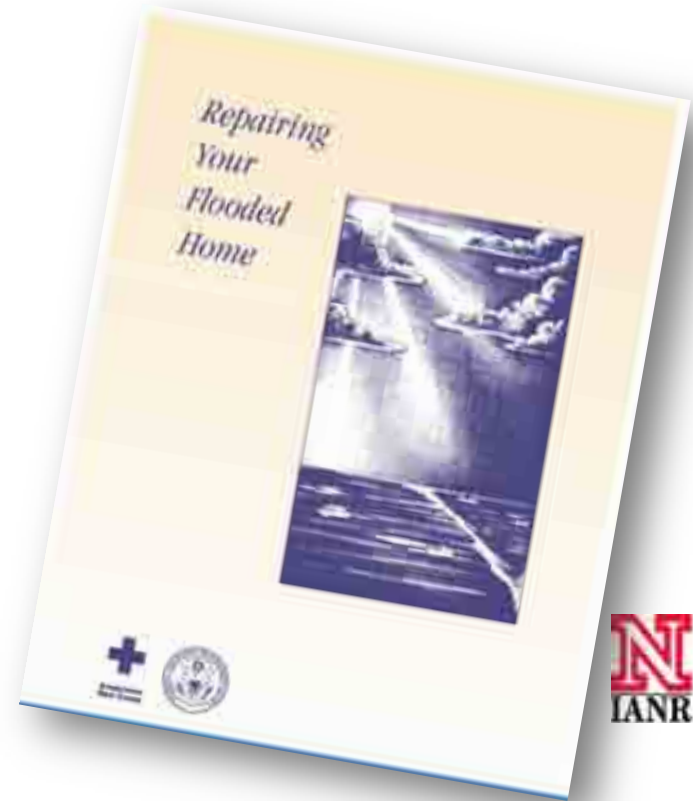
■ **FEMA:**

http://www.floods.org/PDF/FEMA_InitialRestorationFloodBldg.pdf

- Design Manual for Retrofitting Flood-prone Residential Structures FEMA-114
- Answers & Questions About Substantially Damaged Buildings - FEMA - 213
- Repairing Your Flooded Home - FEMA – 234

Water Damage Resources

- **Red Cross *Repairing Your Flooded Home***
 - [http://www.redcross.org/www-files/Documents/pdf/Preparedness/file cont333 lang0 150.pdf](http://www.redcross.org/www-files/Documents/pdf/Preparedness/file_cont333_lang0_150.pdf)



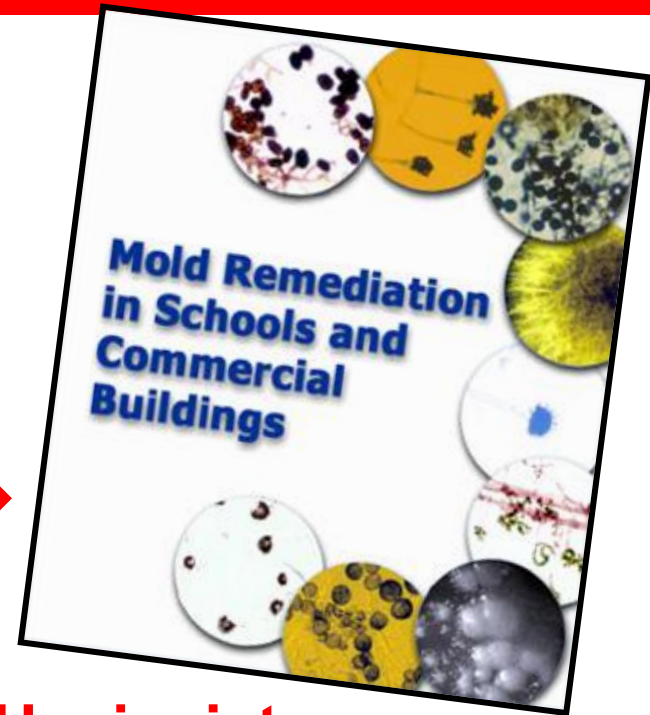
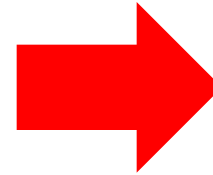
Controlling Molds . . .

- **EPA Guidelines:**

www.epa.gov/mold/index.html

<http://www.epa.gov/mold/moldremediation.html>

800-438-4318



- **Am. Conference of Gov. Industrial Hygienists:**
Bioaerosols: Assessment & Control

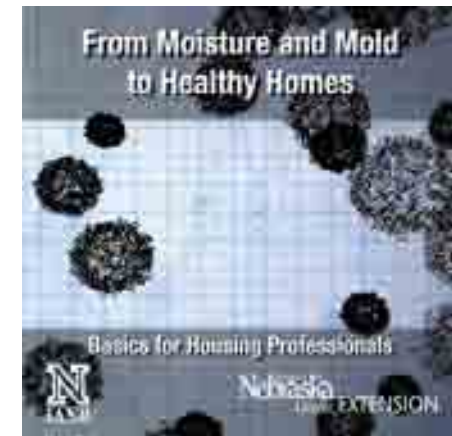
www.acgih.org

513 -742-2020

- ***Disaster Preparedness Notebook*** – each county
No extras left



Resources Order CIT
From Moisture and Mold to Healthy Homes - Basics for Consumers
DVD249 \$9.00



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Agrosecurity and Floods Home

Extension Disaster Education Network Floods

Last Updated: February 10, 2010

- [Protect Your Property](#)
- [Clean-up and Recovery](#)
- [Reduce Future Flood Damage](#)
- [Risk Management](#)

More information
disasters, floods

Have a specific question? [Try asking one of our Experts](#)
Unlike most other resources on the web, we have experts from Universities around the country ready to answer your questions.

This resource area was created by the Extension Disaster Education Network community.

Keep it updated!
Try asking one of our Experts

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Resource Area Feeds

- [Track all new content](#)

In This Resource Area

- [Agrosecurity](#)
- [Asian Influence](#)
- [Floods](#)

Resources

- [Video and Audio files on preparedness and recovery](#)
- [Coastal Hazards assessment in the National Sea Grant Library](#)
- [FloodSmart.gov is the official National Flood Insurance Program Web site. Call flooding](#)

www.extension.org

First Entry of a Flooded Home

What to do:

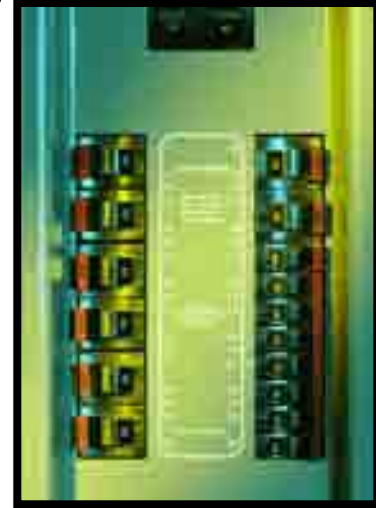
- 1) **Precautions** on First Entry
- 2) Make a **record** of damage & losses.
- 3) To extent you are able, **prevent** further damage to home



Source: FEMA

1. Precautions on First Entry

- Shut off or have shut off
 - **Gas** at gas meter, tank or?
 - **Electricity** shut off at pole or main breaker panel or fuse box
- DO NOT** enter water or stand on wet surfaces to do this!



Inspect Structure for Safety?

- Ridge & eaves straight?
- Walls are vertical & straight?
- Building shifted on foundation, twisted, moved?
 - Water & gas lines, electrical circuits may be damaged
 - May not be safe to enter.
- Consult with building contractor or engineer if damage seen



Inspect Electrical

Have electrician inspect wiring

- Electrical outlets, switches, breaker or fuse boxes may need **replacement**
- Check electrical circuits, insulation for wetness & other water damage (electricity OFF)
- Do not turn on power to flooded structure until
—inspected & determined safe by a qualified person



2. Make Record of Losses & Damage

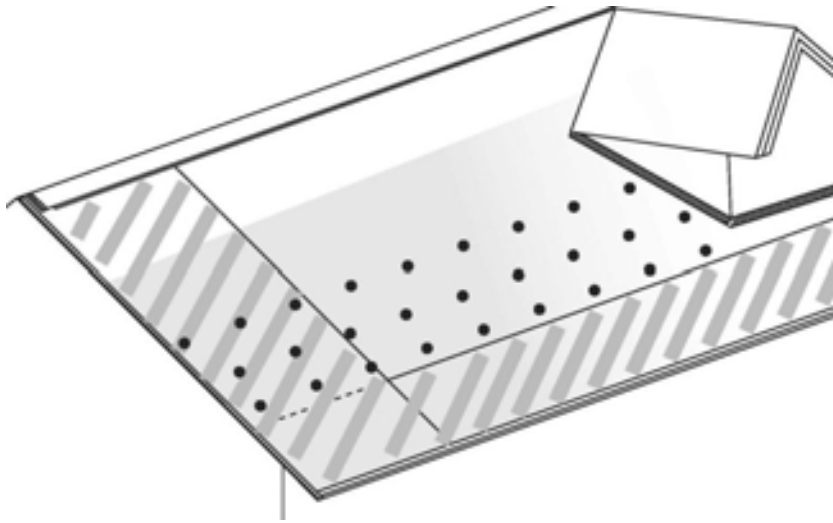
For filing insurance claims & documenting losses for other purposes - tax deductions

- Take photos inside & out
 - Show structural damage,
 - Furnishings, items of value
- Record serial numbers of appliances, equipment, etc. thrown out
- Record damage & items: **Don't haul away unless** record made & insurance adjustor OK to dispose



3. Prevent Further Damage

- If roof or walls have been damaged, temporary or permanent repairs should be arranged as soon as possible.

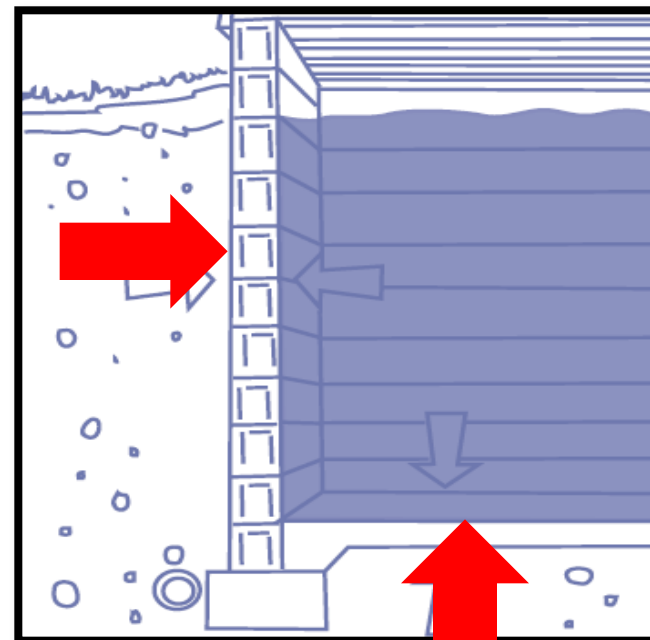


3. Prevent Further Damage

- Remove floodwaters, mud & silt
- Open doors to allow water to exit
- Arrange to have basement pumped out slowly
 - *Only do this when certain that the earth around the building is no longer saturated!*
 - *Water pressure may collapse basement walls as the basement is drained.*

Basement Flooded

- **More than 6 in. of water**
 - Don't be in hurry to pump it out
- **Damage caused by pumping water out too soon**
- **Water inside basement helps brace walls against extra pressure from exterior water & saturated soils**



Water pressure

Photo Source: Red Cross

Basement Flooded

Pumped too soon - floors may push up & walls cave in

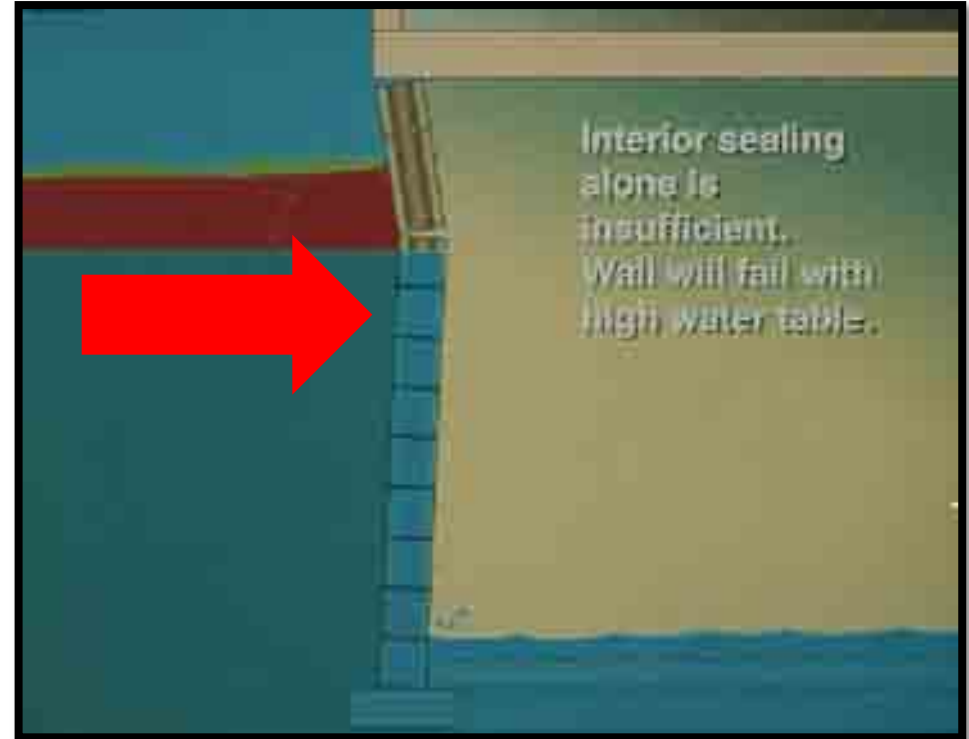


Photo Source: ISU T. Greiner

Basement Flooded

- Don't pump until water around house recedes
- Pump out about 1/3 of water each day
 - Empty well away from house



Basement Flooded

- Use gas powered pump or one connected to outside line, not the house electrical system
- While pumping out dirty water, wash off walls with clean water & remove mud while it is wet

Source:

http://www.ag.ndsu.edu/flood/pdfs/FLOODING_000.pdf

Allow building to dry out

- **Reduce or prevent mold growth**
 - Done quickly, usually in 48 hrs. or less????

- **Wood floors:**
 - Remove a board every few feet to reduce warping, buckle
 - Some warped wood flooring is repairable
 - Plywood/particle board usually separates (de-laminates) from excessive moisture.



Clean Water vs. Contaminated?

Open up wall cavities if walls were/are wet

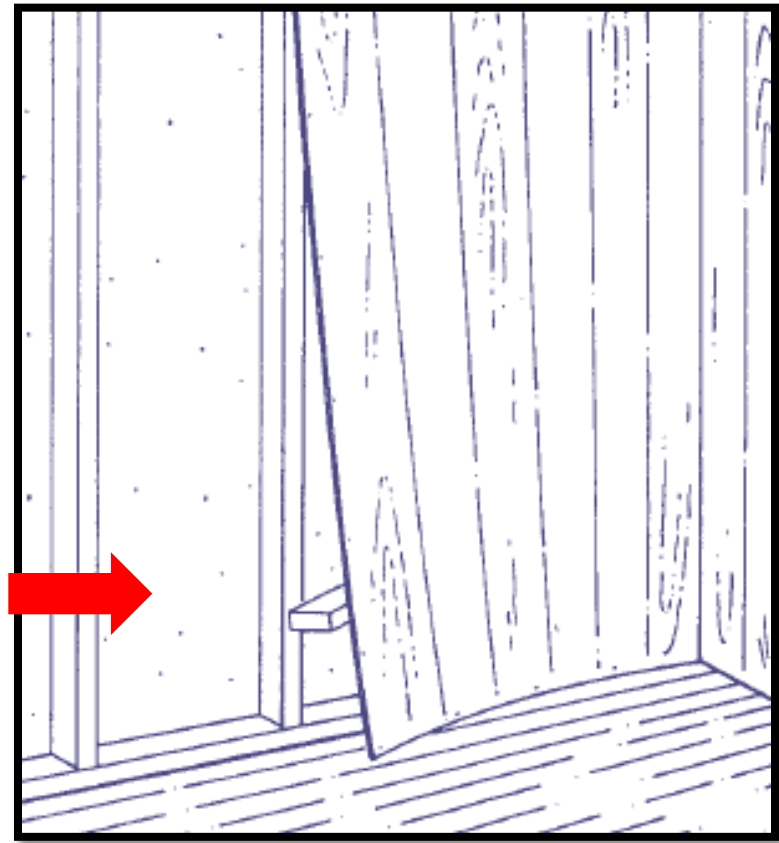
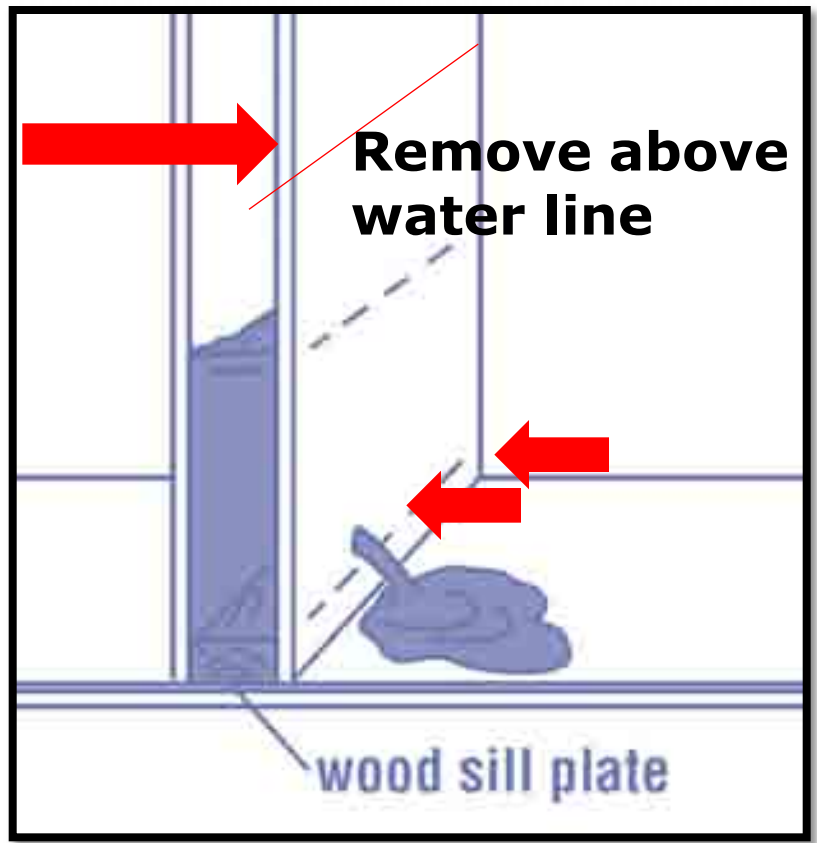


Photo Source: Red Cross

Allow building to dry out

- **In high moisture conditions:**
 - Heat source or some type of mechanical drying equipment will be needed
- **Remove mud & silt**
- **Secure building when not present**
- **Portable valuables removed to a secure location**

Heirlooms & Items of Special Value

- **Specific treatments & procedures**
- **Contact local/area museums or search the Web sites provided below**

American Institute for Conservation of Historic & Artistic Works

**[http://www.conservation-us.org/index.cfm?
fuseaction=Page.viewPage&pageId=597](http://www.conservation-us.org/index.cfm?fuseaction=Page.viewPage&pageId=597)**

Caring for Water-Damaged Family Heirlooms & Other Valuables

Salvaging Water-Damaged Textiles

Saving Photographs After Flood

Salvage Valuable Items First

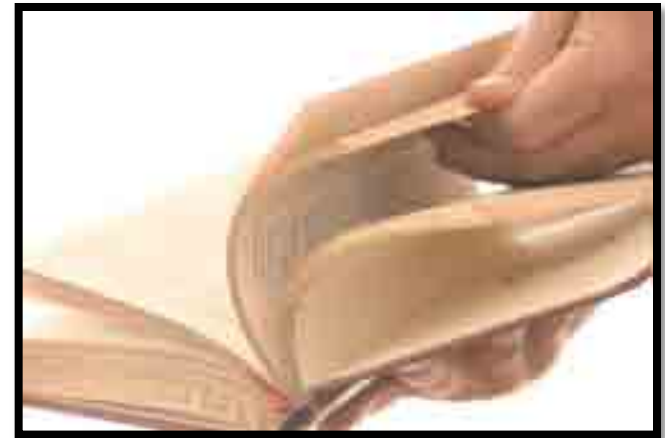
- Important documents & family treasures.



- Clean off mud & allow items to dry in shade or indoors another location
- **Paper records** spread out & air-dried
 - Preferably on blotting paper
 - Frozen in plastic bag?

Salvage Valuables First

- If **photos & books** cannot be immediately dried, clean off mud, place in plastic bags in someone's freezer
 - Separate items - foil, plastic wrap or slick surface between layers
 - These items can be frozen & dried later



Reducing Losses

- **Rapid response**
 - **Microbiological, structural, health issues**
- **Excess water removal**

Loss Assessment & Evaluation

- Materials affected, degree & quantity affected, available ventilation & etc.
- Water migration: Water moves....
 - Lateral
 - Gravity
 - Wicking
 - Intrusion
- Can materials be **decontaminated or** must be **discarded**
 - Porosity, degree of contamination, occupant health, feasibility of cleaning & disinfecting

Evaluating Structural Components

- **Structural wood**
- **Subfloor**
 - OSB, particle board, plywood
- **Flooring**
 - Hardwood, laminate, vinyl, vinyl tile
- **Electrical**



Evaluating Components

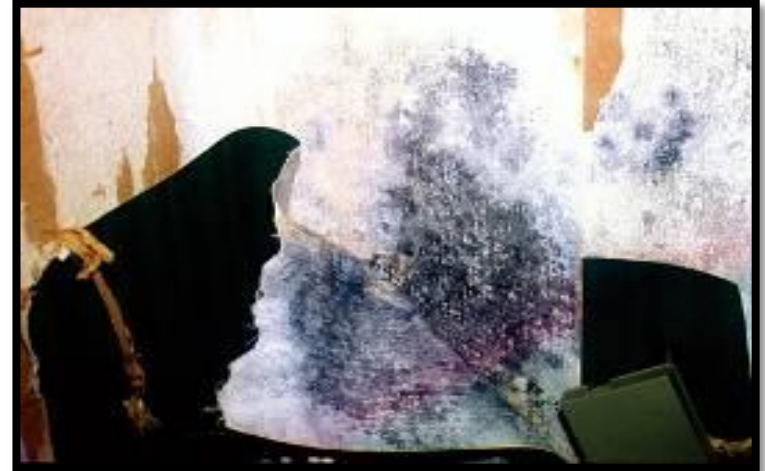
■ Walls

- Plaster or wallboard
- Paneling
- Insulation
 - Glass fiber, cellulose
 - Polystyrene or closed cell rigid

■ Ceilings

■ Crawlspace

■ HVAC



Clean, Salvage or Toss?

- **Hard non-porous materials & building components not damaged can be dried out & salvaged**
 - If mold, cleaning may require more labor than item is worth
- **Flood waters contaminated**
 - **Generally soft, porous or absorbent materials should be discarded**



Reducing Losses

- Rugs or other items that can be laundered or thoroughly cleaned may be salvaged
- Unless absorbent materials dried out within 48 hours, mold growth may make cleaning impossible
 - Longer if temperatures are cool
 - Sooner if temperatures are warm



Categories of Water

- **Clean Water – Category 1**
 - Broken water pipes, rainwater direct entry, etc
- **Gray Water – Category 2**
 - Contains contamination & microorganisms
 - Toilets with urine, sump pump, dishwashers, laundry
- **Black Water – Category 3 (Floods)**
 - Contains pathogenic agents
 - Sewage, surface water flooding, pesticides, run off with chemicals, biologicals, bacteria, etc.

Clean Water Restoration

- **Health & Safety**
 - Do occupants need to be relocated?
 - Nature of contamination & occupants
 - **Children**
- **Water source elimination – stop source**
- **Protect structure & contents**
- **Initial water removal**
 - Pumps, wet-vacuums, scoop, broom, etc.

Clean Water Restoration

- Floor coverings
 - Dry carpet by extracting water, removing, stretching & moving air on both sides (time is important)
 - Use appropriate procedures to dry –
 - Air circulated around carpet



Clean Water Restoration

- Remove wet unsalvageable materials
- Expose all materials needing to dry
- Thoroughly dry all materials
- Use drying resources
 - Heating or AC system, exhaust fans, windows, dehumidifiers, etc



Contaminated Water Restoration

- **Personal Protective Equipment**
 - Respirator with HEPA & organic vapor cartridges
 - Rubber gloves
 - Eye protection
 - Protective clothing
 - Shoes, boots



Protection in inspecting/repair

- **Long gloves**
 - rubber, neoprene, nitrile
- **Goggles** Fit, closed
- **Air Filter - respirator**
 - N-95 or N100 HEPA
 - Half face
 - Full face respirator with HEPA filter
- **Protective clothing & shoes, boots**



Photos: UNL. S
Niemeyer

Evaluation Tools

- **Moisture meter – materials**
 - 4 to check out -TCD Dept.
- **Hygrometer - Humidity gauge or meters**
 - Moisture in air
- **Boroscope**
 - Hard to get at places



Hygrometer

Tools



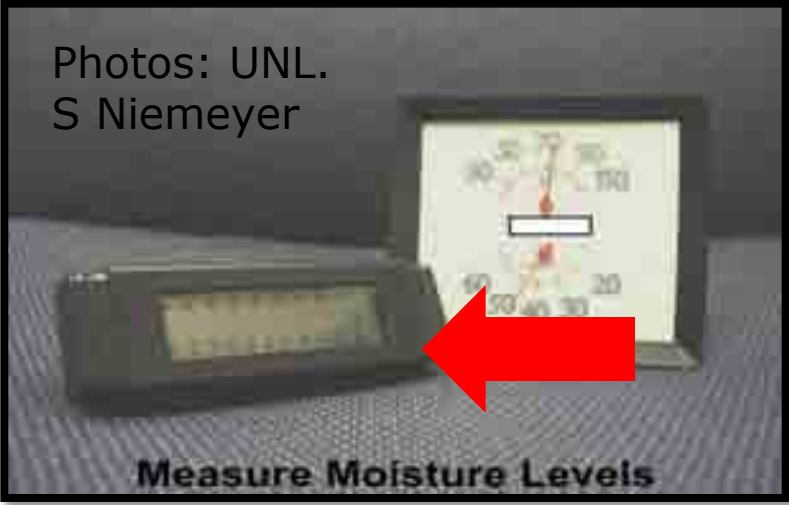
Minimum N-95



HEPA Filter Mask

Moisture Meters
Wood moisture content
should be less than 15-19%

Moisture Meters



Contaminated Water Restoration

- **Isolate contaminated area**
 - **Isolate HVAC system -**
 - **Temporarily turn off and seal ducts**
 - **Polyethylene enclosure**
 - **Negative air pressure**

- **Protect contents**

- **Remove excess water & organic material**

Use negative pressure in work area to avoid spread of mold or contaminants



**Seal off
area?**

Contaminated Water Restoration

■ Dispose

- Carpet cushion
- Absorbent stuffed fabrics
- Saturated absorbent materials
 - Ceiling tile, dry wall, paper, etc.



Contaminated Water Restoration

- Discard carpet & pad saturated with Category 3
—Flood, sewage, run off
- Category 2 water - carpet contamination may be cleaned with hot water extraction & biocide



Remove floor if water reached subflooring

- Subflooring must be cleaned, disinfected, dried or disposed of



Photos: NDSU K. Hellevang

- **While possible to salvage household appliances, heaters, etc.,**
- **Discard in general**
 - **Very difficult to dry & remove mud & silt from inner workings, insulation**
 - **Consult with appliance repair professional or manufacturer.**
 - **Electrician do safety check before starting items that had contact with water**
 - **motors, electronics, wiring etc.**



Before Biocide - Disinfecting

■ **Clean surfaces**

- Household cleaners for materials
- **Borax & water solution according to label or non-phosphate HH detergent**
- **May need multiple cleanings**

Biocide – kill microorganisms

- Must be used according to label (specific application)
 - Label is the law
- Must be applied **to cleaned surface**
- Must have **required exposure time 15 – 30 min.**
- Must use **personal protective equipment & communicate**

Biocide

DON'T MIX !!

- Carefully follow *instructions* on label.
- Use plenty of *fresh air* when applied, & keep people out of area or structure.
- Common biocides
 - **Phenolic** - phenol appears as part of ingredients.
 - **Sodium hypochlorite** (generally 5.25%) - chlorine bleach
 - **Quaternary ammonium compounds**
 - **Pine-oil**
 - **Other:** Iodophors – Iodine, Alcohol, Hydrogen peroxide

Use of Biocides

- Biocides toxic to animals & humans
- Generally provide short term kill of microbe
- Organic matter interferes with some
 - Dirty surfaces - bleach can get 'spent' oxidizing the organics & not get a chance to penetrate mold structure enough to kill it.



Disinfectant - destroys or inhibits microorganisms

- **Bleach recommended per gallon of water varies**
 - Range: **1/4 cup bleach** for a clean surface
 - **1 1/2 cups/gal. of water** for surfaces that could not be thoroughly cleaned.
 - Remain wet for about 15 to 30 minutes to allow to work
 - For hard, non-porous, non-metallic & color-fast items after cleaned

■ **Flush the air.**

- After cleaning and disinfecting, air out building.
- Use fans in windows to pull mold spores to the outdoors.



■ **Dry all wet materials as quickly as possible**

- Air condition or heat, run fans & use a dehumidifier, if possible.
- Some materials may warp or delaminate (wood, etc.)
- If there is **no power**, keep windows open **if lower humidity outside**

Drying Process Consist Of . . .

■ Evaporation

- Circulate air - **Fans**

■ Dehumidification

- Open system: **Ventilation**
- Closed system: **Mechanical dehumidifiers**



■ Temperature Control

- Evaporation, dehumidification, microorganism growth - below 72° F

■ Water Removal

- Extraction units
- Pumps

Structural Drying

- Open enclosed areas
- Reduce indoor relative humidity to (less than) <40%
- Ambient temperature (less than) <72 F
- Circulate air across drying surfaces - fans
- Drying may take **several days or longer – maybe months**
- Monitor with moisture meters
- Monitor relative humidity



Drying Equipment

- **Air Moving Equipment**
 - **Air movers**
 - **Axial fans**
 - **Structural cavity drying equipment**

Wall Dryers



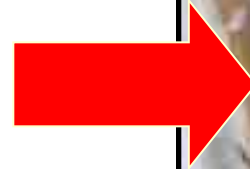
Photo source: NDSU , K. Hellevang

Commercial Dehydrator



Hidden

- Pipe chases – leaks, condensation
- Utility tunnels – leaks, condensation



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Leaks in Interior Walls

Structural Drying

Open up walls & leave open for weeks to several months until DRY.



**Remove baseboard, trim work,
Remove wall board, insulation**
– Increase air circulation

Open up wall cavities



- **Inside wall problems**
 - **Water in interior walls: roof, blown in, structural damage?**



Floors – open up?



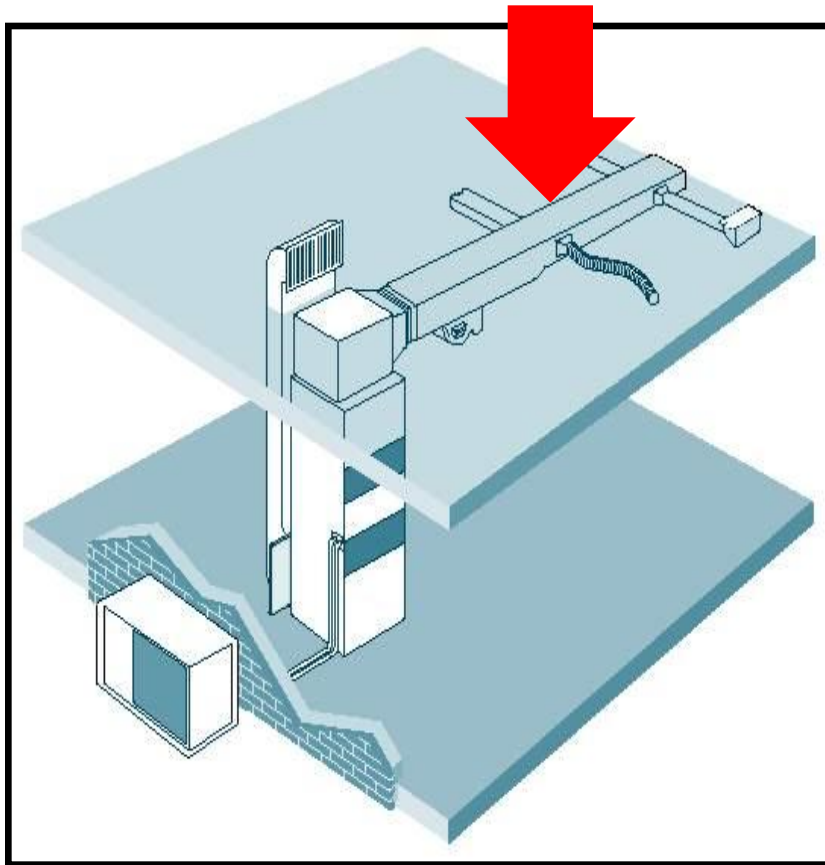
Photo. UNL. S. Niemeyer



Air handling ducts cleaned?

<http://www.epa.gov/iaq/pubs/airduct.html>

- If submerged in water



Strategies Long-Term Prevention

“Any remediation attempt that does not include long-term plans to maintain systems & prevent re-occurrence is short-sighted & destined to fail.” (ACGIH)

- **There is no one-time complete “cure” to microbial contamination.**
- **Continued oversight part of control plan”**
... (ACGIH)

Water Damage Restoration



Conditions for Growth...

- **Nutrients - Molds grow on organic substances**
- **Once living materials**
 - **wood, paper, carpet, wallboard, insulation etc. etc.**
 - **almost anywhere there is soil or films**
- **Moisture**

Problem Solving & Alternatives?

Interior

- **Flooding or leaks? - Open up & dry cavities COMPLETELY. Use Moisture meter.**



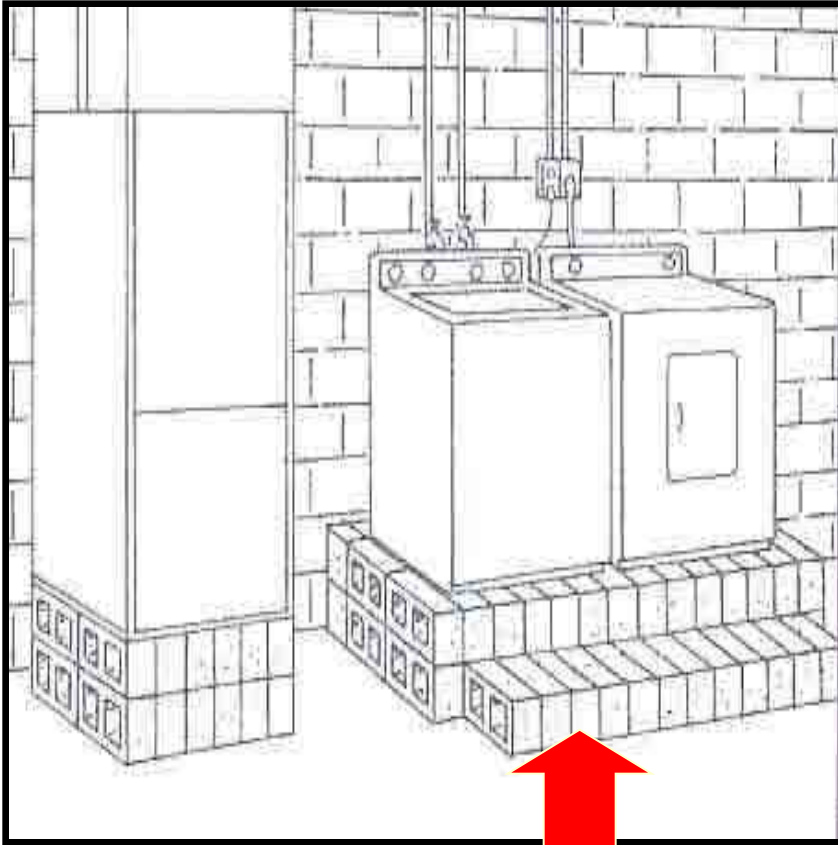
- **Roof materials**
 - **Roof leaks**
 - **Decking, shingles not secure?**
 - **Underlayment?**



■ Basements



Prevention in Basements?



Regular Filters



Electrostatic Precipitator Air Cleaner

University of Nebraska–Lincoln

HEPA Filter



Mold Management

Assess situation:

- Extent – size of area, safety
- Occupants & health priority
- Costs+
- Available professionals
- Insurance

Seal in plastic - Discard



Negative air pressure vented to outside.

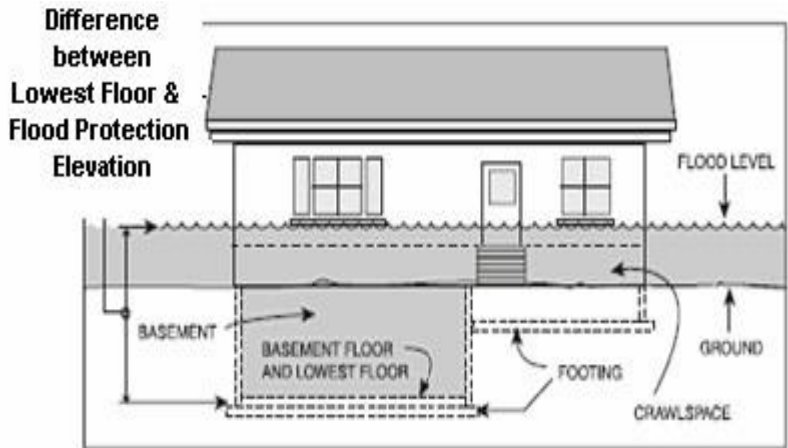


Photo credits:

- **Shirley Niemeyer, University of Nebraska**
- **EPA**
- **Tom Greiner, Iowa State University**
- **Ken Hellevang, North Dakota State University
publication**
- **FEMA**

**An inch of water
on 1,000 square
feet of roof
amounts to about
623 gallons of
water.**





Water Damage Restoration

- **Institute of Inspection Cleaning & Restoration Certification**
 - **IICRC S500 Standard & Reference Guide for Professional Water Damage Restoration Third Edition 2006**

