



# Detailing for Durability

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# Discussion

- Moisture Transport Mechanisms
- Relative Threats
- Primary Actions
- Prevention and Control



# Why We Care

- Human Comfort
- Energy Consumption
- Occupant Health
- Maintenance
- Durability



# Four Moisture Transport Mechanisms

- Vapor Diffusion (lowest threat)
- Air Transport
- Capillarity
- Bulk Transport (highest threat)

# Vapor Diffusion



- Primary Action
  - moves in or out
- Requirements
  - permeance
  - driving force
  - time
  - surface area
  - source



# Diffusion Control

- Easiest to control permeance of materials
- Examples of vapor barriers
  - foil
  - polyethylene
  - Kraft facing
  - vapor barrier paint
- Install on warm side

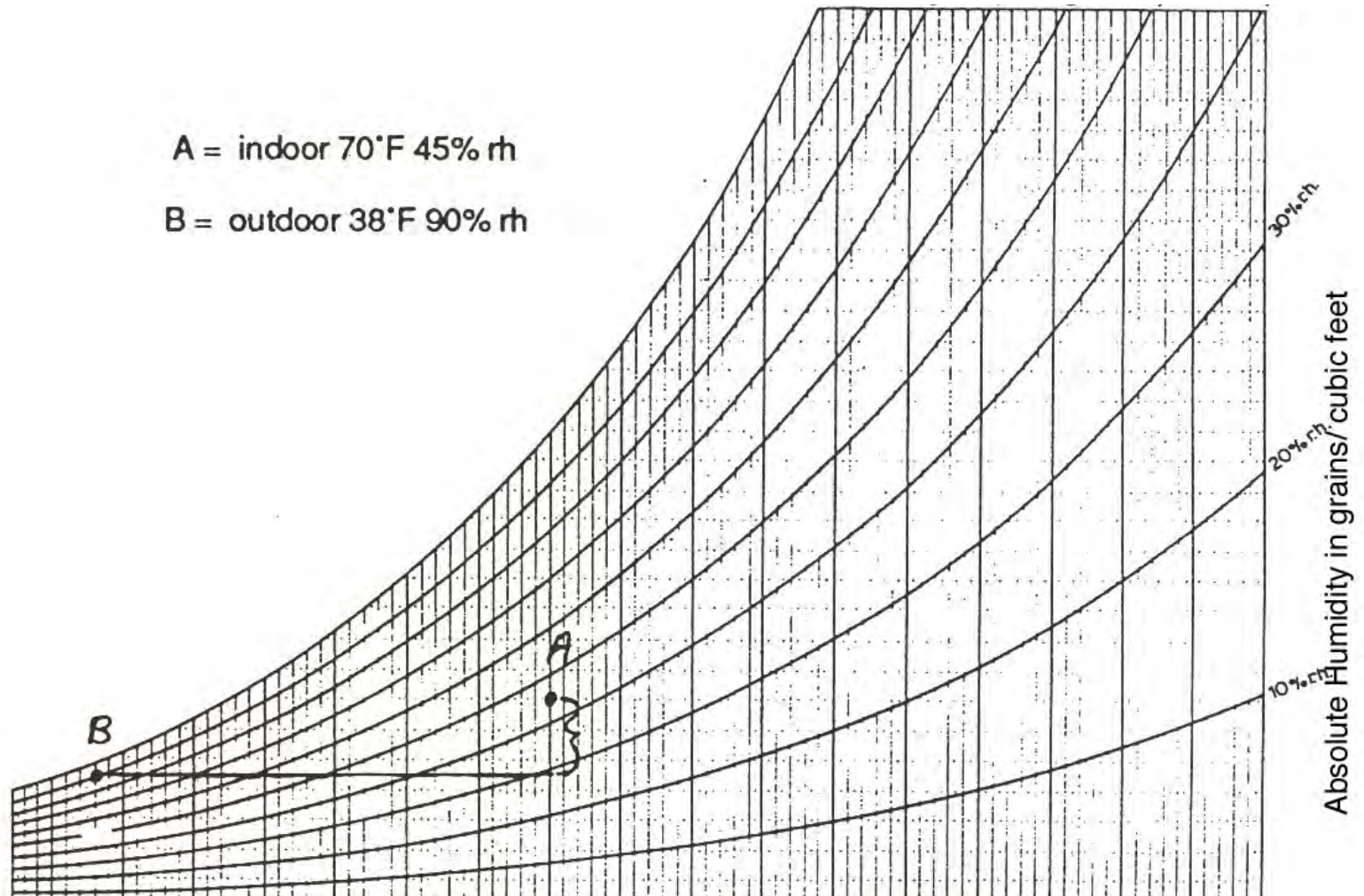
# Perm Ratings of Common Building Materials (Source:ASHRAE)

- Built up Roofing.....0.00
- 0.35-mil Aluminum Foil.....0.05
- 6-mil Polyethylene.....0.06
- 1/2-inch Exterior Plywood.....0.35
- 3 Coats of Oil-based Paint.....0.65
- Kraft Paper.....1.0
- 1-inch Expanded Polyurethane.....1.0
- 15-lb asphalt felt.....1.0
- 1-inch Extruded Polystyrene.....1.2
- 1-inch Molded Expanded Polystyrene.....3.9
- 3/8-inch Gypsum Wallboard .....50

# Vapor Pressure vs.. Temperature

A = indoor 70°F 45% rh

B = outdoor 38°F 90% rh





# Vapor & Capillary Control

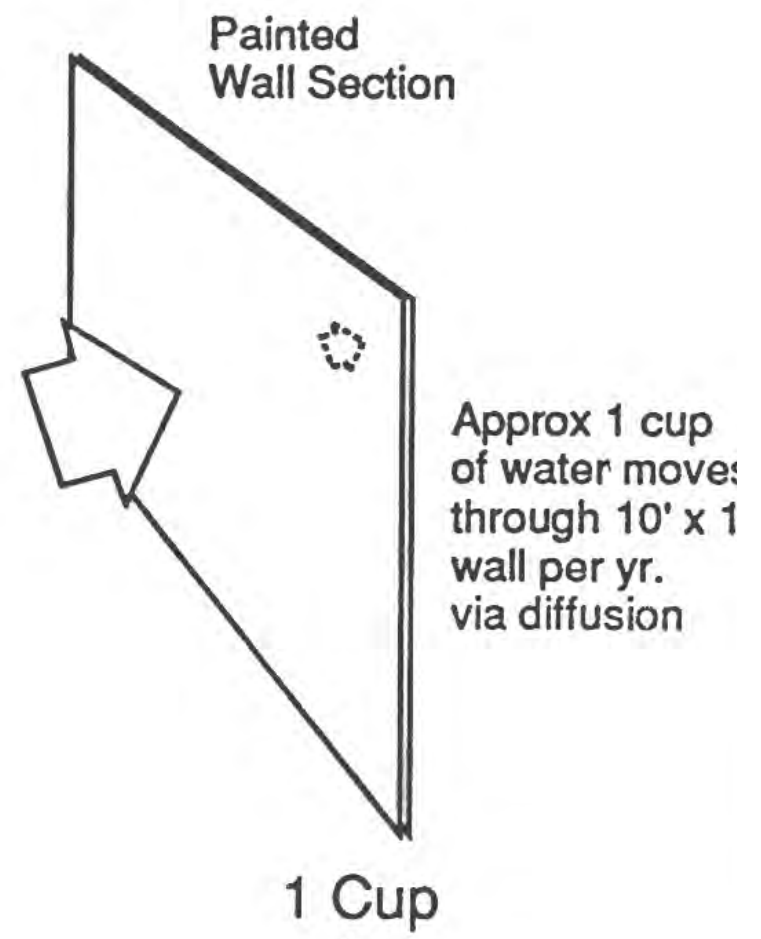
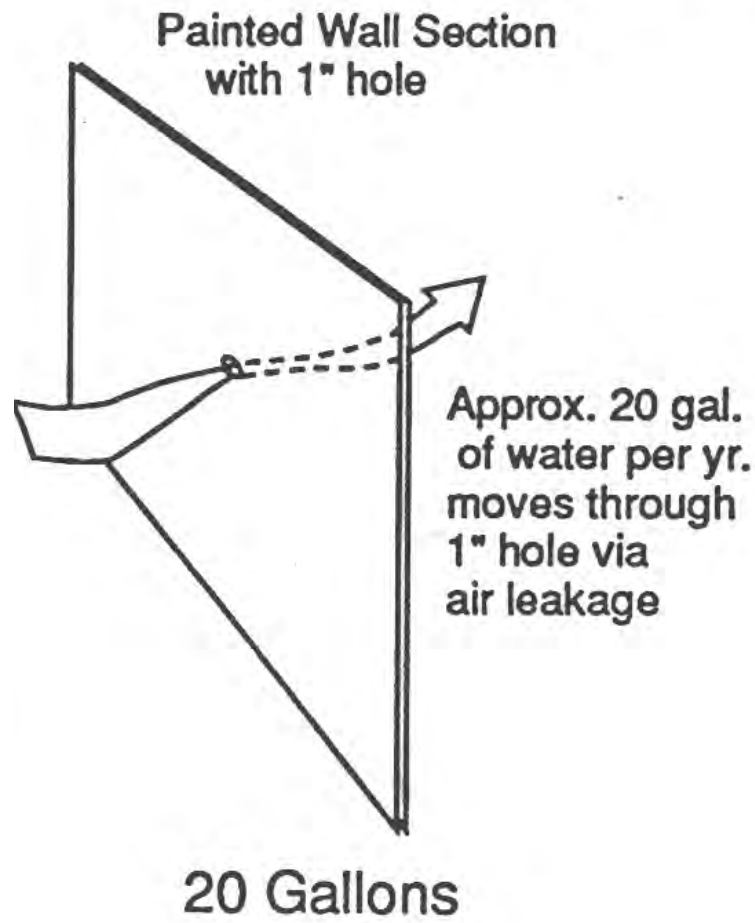




# Air Transport

- Primary Action
  - moves moisture in or out as vapor
  - second most dominant force ~ capillary drive
- Requirements
  - source of moisture
  - holes or pathway
  - pressure differential

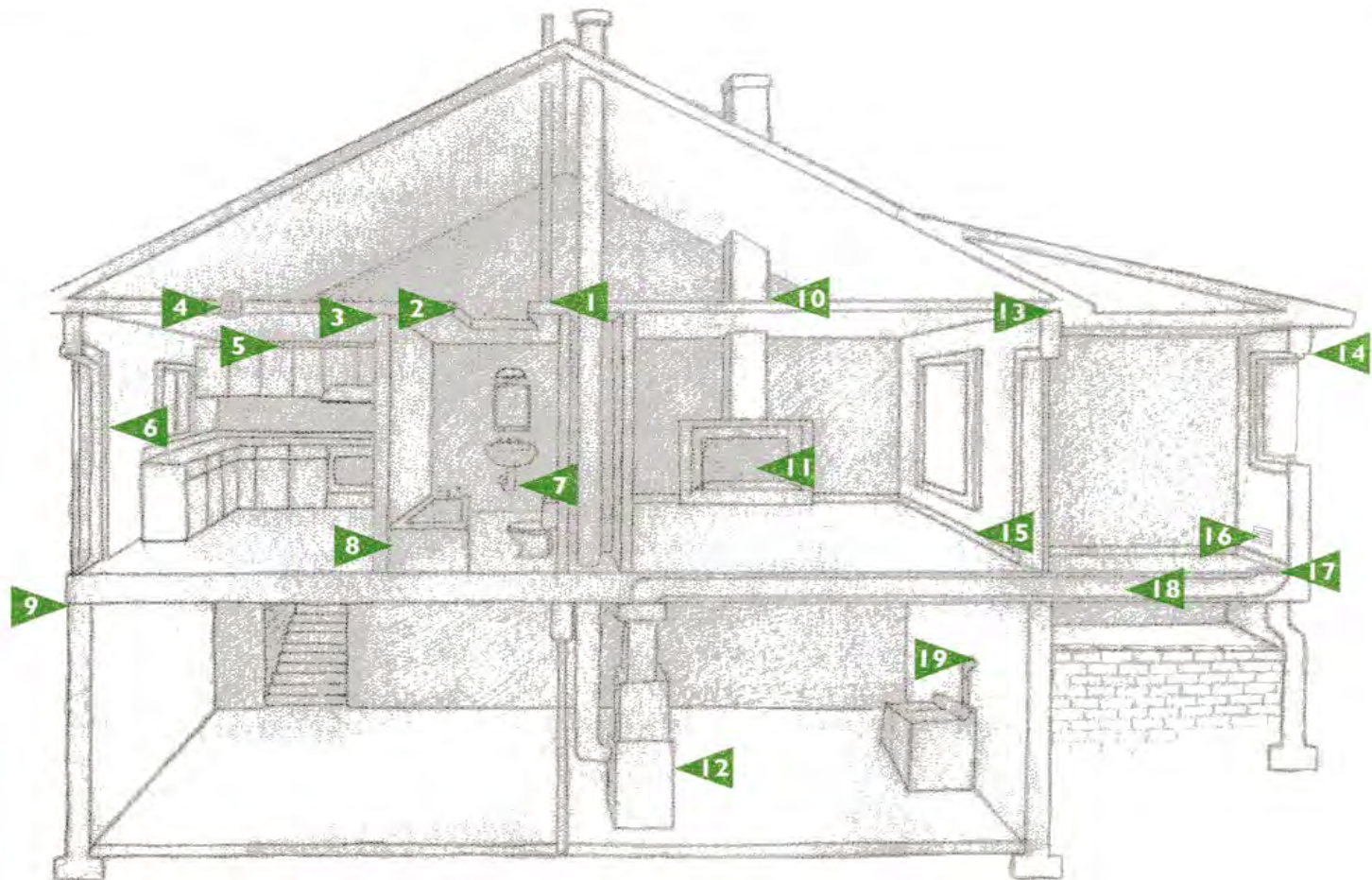
# Significance Air vs. Diffusion





# Air Transport Control

- Control each - I at a time or all together
- Easiest to control source or pressure
- Control temperature vs. dew point



**1** Around plumbing vent stack

**2** Attic hatch

**3** Tops of interior walls

**4** Recessed light

**5** Behind built-in cabinets

**6** Around door

**7** Plumbing penetrations

**8** Around bathtub

**9** Sill plate

**10** Around chimneys and flues

**11** Fireplace damper

**12** Furnace or air conditioner air handler box

**13** Where additions join house

**14** Around window

**15** Behind baseboards

**16** Around electrical sockets

**17** Around duct boot and register

**18** Ducts

**19** Around dryer vent

*Common air leakage sites in a home*

# Air & Bulk Moisture Control





# Methods of Control

- Dehumidification
- Dilution - air changes in heating climates
- Depressurization in heating climates
- Controlled ventilation
- Point source ventilation
- Raise surface temperatures
- Control of #holes very difficult

# Heat Recovery Ventilation





# Air, Diffusion and Surface Temp





# Capillary Movement

## Second Most Serious Threat

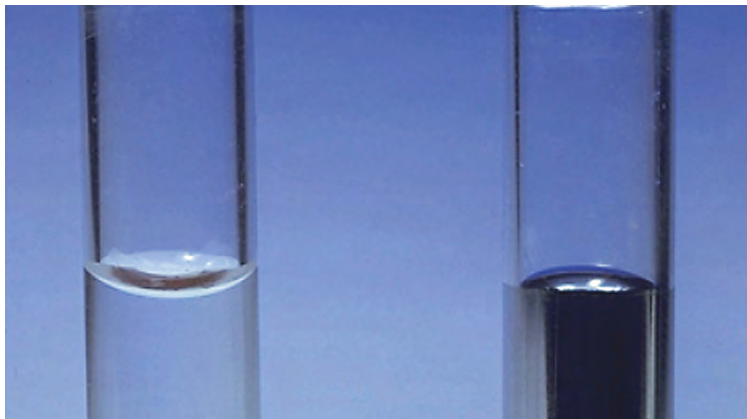
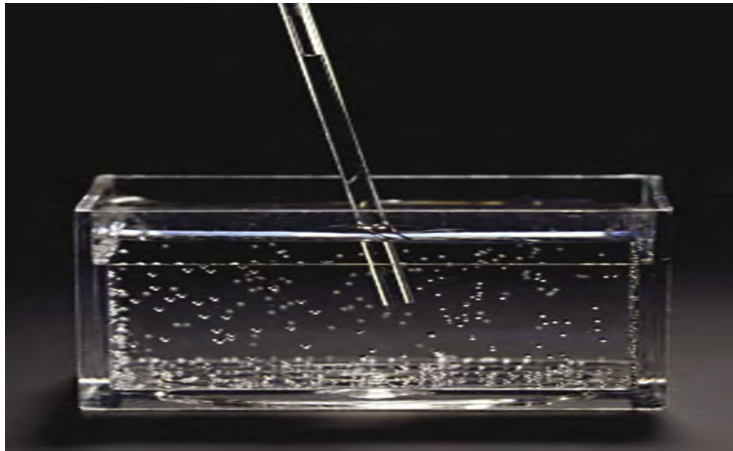
- **Primary Action**
  - Moves moisture from outside into envelope
- **Requirements**
  - Surface tension
  - Pore size
  - Source of moisture

# Surface Tension



- Water spreads into thin film on clean glass left.
- Water beads (cohesion of water-to-water) on oil-coated surface on right.

# Capillary Rise



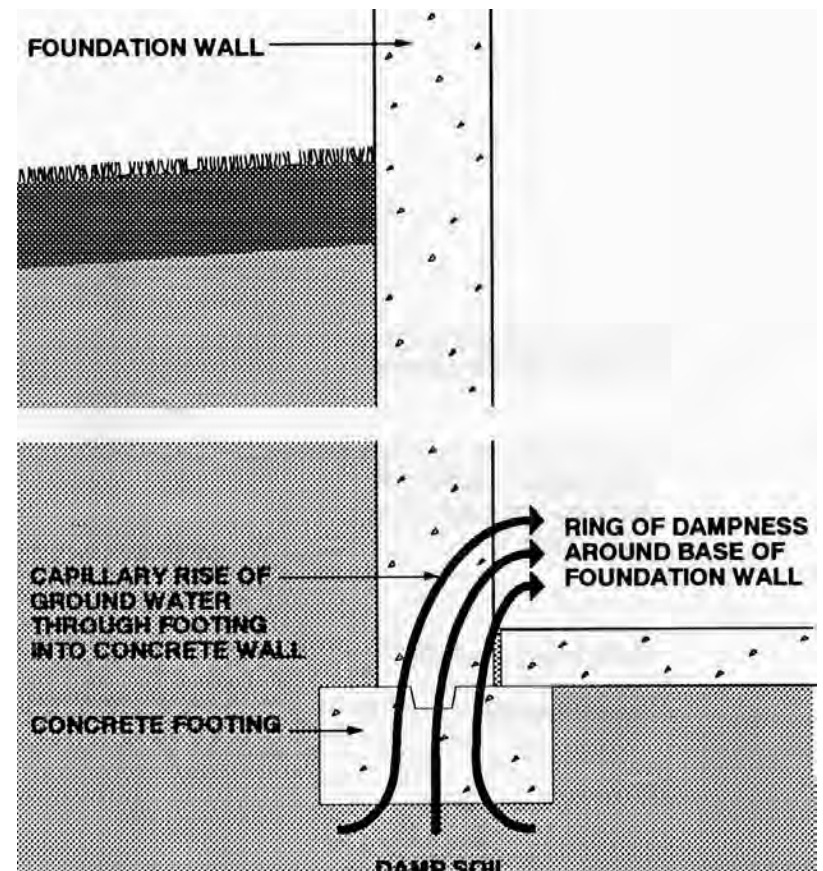
- Examples
  - blotter paper
  - solder in plumbing
  - wood siding
- Water wets glass (left) concave meniscus.
- Mercury doesn't wet glass convex meniscus.

# Capillary Control

Pore Size: = 0 or  $> 1/4''$

## Below Grade

- Stone base
- Polyethylene (sealed)
- Drainage mats
- Parging/coatings
- Good drainage

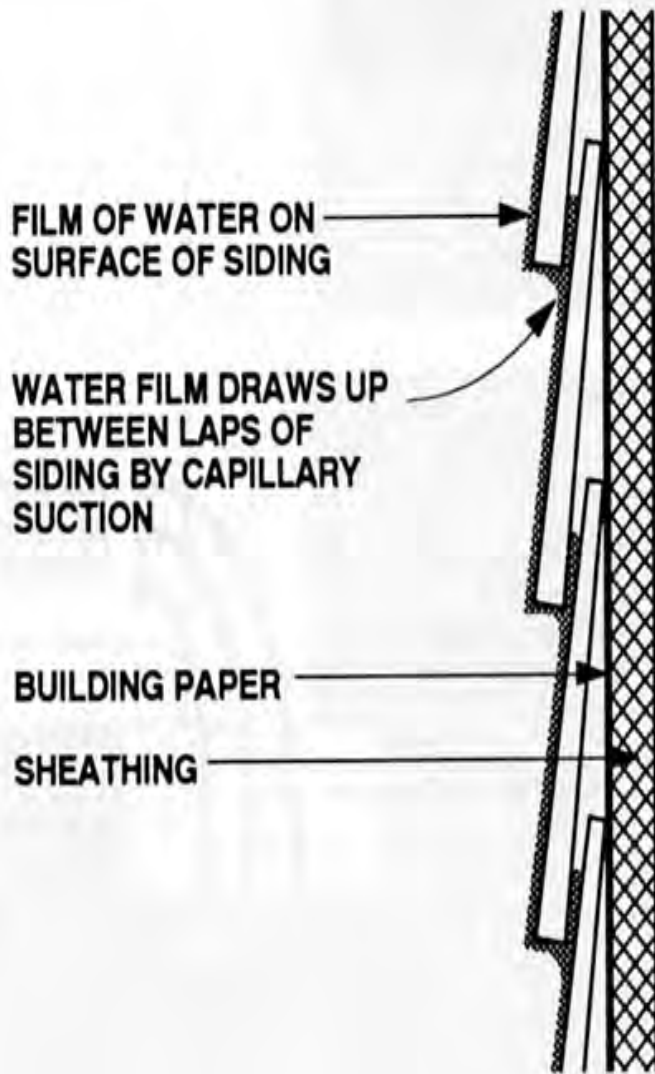




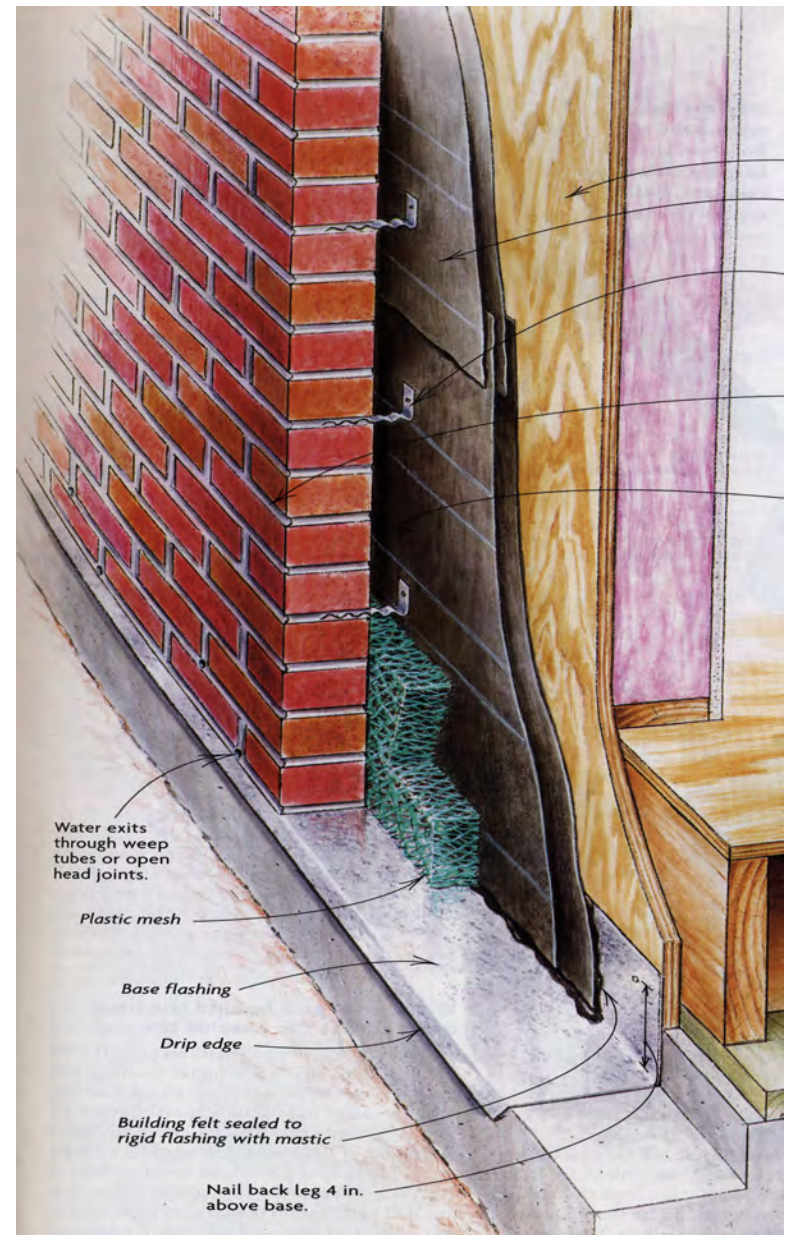
# Capillary Control

## Above Grade

- Paint
- Small joints = pores
- Space joined materials
- Good drainage
- Rain Screen



**Figure 2-15: Capillary Rise in Wood Siding**





# Bulk Movement Most Significant Threat

- Primary Action

- Moves from outside into envelope
- Snow, rain, and ground water most significant
- Moves most moisture in the least time

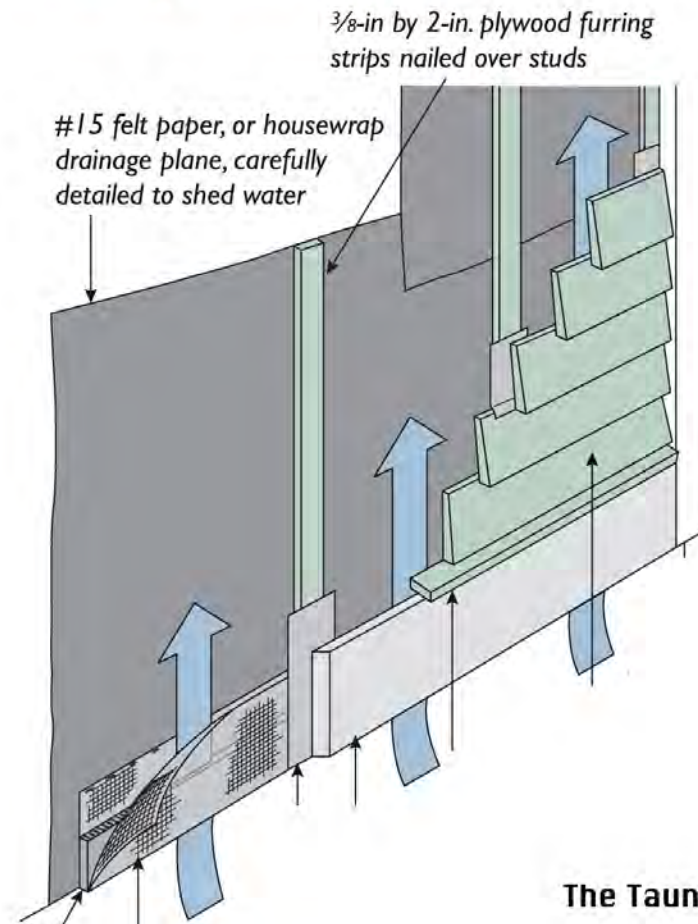
- Needed to Control

- Bulk moisture (source)
- Hole (pathway)
- Driving force (pressure, gravity, etc.)



# Above Grade Control

- Sheltered Location
- Rain Screen
- Caulking
- Flashing
- Redundancy
- Channel/Redirect



# Above Grade Control



# Below Grade Control



# Below Grade Control



# Structural Damage

- Peeling Paint
- Rotting Wood - 21% MC or 90% RH
- Mold -  $RH > 70\%$
- Condensation - cosmetic, health, & energy
- Corrosion
- Insects