

# Managing Moisture in Residential Building Envelopes:

An Overview of the Features and Benefits  
of Moisture Management Solutions and  
Recommendations for Their Specific Use

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## INTRODUCTION

Increasingly, home builders, contractors and architects face the need to incorporate good moisture management solutions when designing and building homes to ward off problems such as mold and mildew damage and to help increase energy efficiency as heating and cooling costs escalate.

The compelling need for these solutions – variously referred to as weather or water resistive barriers, housewraps and rainscreens – is also driven by a series of other important factors, including:

- Preserving the life of exterior cladding, so that it dries optimally both on the inside and the outside of the cladding;
- Managing moisture infiltration – especially in key coastal regions where experts predict more intense weather in future years;
- Averting the potential for callbacks, remediation and/or litigation costs when moisture management is handled improperly, and
- Complying with growing federal requirements such as the 2006 International Residential Code (IRC), which requires the use of a water resistive barrier behind all facades. Wherever the Model Energy Code is in effect, builders also must seal building shells to protect against air infiltration. In Canada, the National Building Code was recently amended to mandate the use of a rainscreen system in areas that exceed a certain moisture threshold, a measure which local provinces are starting to adopt.

## CONFUSION ABOUNDS

But while the need for such solutions is clear, confusion abounds when it comes to how to select the right solution for each job. The starting point for clearing up the confusion lies in the terminology itself. Product names like housewraps, building paper, water or weather resistive barriers and rainscreens are frequently used interchangeably, when in fact they can play distinctly different roles.

To add to the confusion, products such as housewraps and building papers are available in dozens of varieties, making it very difficult to choose the right product for each job. This is further complicated by the fact that there are currently no standards-based methods to evaluate water resistive barriers or rainscreen systems. The International Residential Code mandates the use of water resistive barriers. While most local building codes incorporate IRC guidelines, varying regional practices have led to widespread builder interpretation of the need for such solutions. At the same time, building experts continue to add to the existing body of knowledge in what is a relatively young science, with few existing absolutes.

As a result, only 50% of homes in the U.S. today are constructed with some kind of a housewrap.<sup>1</sup> One thing on which manufacturers, builders, contractors, architects and others concerned with building science can agree, however, is that no one solution is right for every climate. In fact, the location and exterior cladding of the building are central to the decision on which building envelope solution is employed.

So how do builders, contractors, architects and others make sense of the bewildering choice of moisture management solutions available today for residential sidewalls? And, more importantly, how can they understand when and where to use each solution?

Benjamin Obdyke Incorporated, a leading provider of building products, commissioned independent research to help demystify the water resistive barrier and rainscreen system category and provide basic guidelines to assist in determining when, where and how to make the best selections for each job. The study concludes that the three biggest determinants are the amounts of rainfall and wind-driven rain to which the structure will be subjected, as well the choice of siding because each type of cladding responds differently to moisture. Naturally, project budgets and timetables also are key factors. Moreover, the study indicates that more data will be forthcoming as building science continues to add to the existing body of knowledge in this area.

## **WATER RESISTIVE BARRIERS**

Water resistive barriers are part of a building's exterior wall system, designed to prevent air and water from entering the stud wall cavity from the outside. They also allow the free passage of water vapor to the outside of the building so that the framing and wall cavity can dry, reducing the threat of mold and rot. In effect, they perform like a shell for buildings — liquid water that has penetrated the exterior finish does not pass through, yet water vapor from the interior can escape. By keeping building materials dry, a water resistive barrier helps improve building durability, decreases maintenance costs and reduces the risk of moisture-related problems.

In addition, by acting as an air barrier that prevents hot and cold air movement through the wall cavity, water resistive barriers also help reduce utility costs and increase comfort by reducing air infiltration and potential drafts.

Water resistive barriers were originally referred to as weather resistant barriers, and today are called by a variety of other names such as WRBs or water resistant barriers; however, the preferred industry name seems to be water resistive barriers. There are three basic types of water resistive barriers on the market:

### *1. Building Paper*

Building paper has been a staple for years. In fact, most building codes cite so-called Grade D Kraft building paper and/or #15 felt as a standard while allowing for substitutions of other equivalent materials. Building paper is a traditional paper sheet or felt material that is coated or impregnated with asphalt to increase its strength and resistance to water penetration. It's primarily used as a drainage barrier to protect against moisture. Grade D paper ratings are based on the amount of time it takes to wet their opposite side—the most common types are 10, 20, 30 and 60 minute, with the higher rating, the higher the moisture resistance.

The felt variety is made of recycled paper products and sawdust and is frequently used in roofing construction, although many builders also apply it as a water resistive barrier. Grade D Kraft building paper, made of virgin paper fibers, is lighter weight and more breathable than most felt papers.

Felt as a product has evolved over the years. While once designated by weight – the 15-pound variety weighed 15 pounds per square (100 square feet) – modern-day equivalents are differentiated by number, i.e., #15 or #30, but weigh only 7.5 -12.5 pounds (#15) or 16-27 pounds (#30) per square. Because they weigh less, they also are less absorbent than earlier varieties, which may explain why some older felt-wrapped homes have better withstood the ravages of moisture over time.

Both felt and Grade D building paper tend to be less durable than engineered, plastic housewraps (see below). Some building papers are not readily available in all areas of the country – they are widely used in Western states and other areas where stucco cladding is favored, but less so in the Eastern U.S.

## *2. Housewrap*

Housewraps originated in the 1980s to serve as air barriers, and later evolved into moisture barrier products. Today they are becoming increasingly popular for their durability and ability to block water that has penetrated behind the exterior cladding from moving further into the exterior wall assembly. Engineering plastic sheet membrane typically .005-to-0.015 inches thick, housewraps are just that: sheets of varying sizes that are wrapped around a house. They are specifically meant to resist the movement of water in the liquid state while allowing the movement of water in the vapor state.

Housewraps are designed to block water from reaching into the sheathing and framing while allowing the free passage of water vapor so that wall cavities and framing lumber can dry to the outside of the building, reducing the possibility of mold and rot. Acting similar to a GORE-TEX® jacket, housewraps are water resistant on the outside, but also allow water vapor to pass through the building envelope in case moisture problems arise.

It is worth noting that housewraps are not designed to channel the direction of water movement. Since housewraps don't allow the selective passage of water in one direction or the other, moisture will move only in response to concentration or thermal gradients.

Also, as moisture moves through wood and stucco, it extracts surfacants, including detergent, oil, resin, plasticizer and colorant. Because these additives greatly reduce the surface tension of water, a housewrap can eventually lose its repellency and allow water to soak through to underlying sheathing.<sup>2</sup> For wood siding, some manufacturers recommend priming the back of the siding with a water-repellent primer to help combat the problem.

## *3. Drainable Housewraps*

While water resistive barriers keep water off of structural sheathing and framing, water resistive barriers can deteriorate if they remain wet or in contact with certain chemicals for extended periods of time. To avoid rot, water must be permitted to drain away from the sheathing surface.

To solve this problem, beginning in the mid-1990s, builders in wetter and more humid climates began to employ a third type of water resistive barrier, variously referred to as a “textured” housewrap or as a “drainable” or “enhanced” water resistant barrier. The drainable barrier is intended to offer all the features of a housewrap or building paper but with one important addition – a drainage system – all combined in a single product.

Drainable housewraps were developed by benchmarking the performance of felt paper in a stucco assembly, where best practices frequently dictate the use of two layers of building paper or housewrap. Builders noticed that the layer applied closest to the stucco “crinkled” as it dried, in effect creating grooves in the paper that optimized moisture drainage.

Today's drainable housewraps are designed to use this same principle to promote bulk water drainage in wall systems, channeling moisture to the outside through channels or “wrinkles”

engineered into the housewrap sheet, and according to some manufacturers, treated with a special preparation to enhance drainability. Moreover, drainable housewraps are designed to maintain a more constant drain rate than basic water resistive barriers, despite repeated wetting and drying cycles experienced in extremely wet and/or humid climates.

## **RAINSCREENS**

While drainable housewraps are designed to do a better job of draining bulk water than most housewraps or building papers, they may not solve the problem of drying moisture that remains behind cladding even in climates that receive low or average rainfall. Solar-driven, trapped moisture, seeking a drier plane, can seep into interior assemblies, leading to mold and mildew buildup.

Especially in regions of the country prone to wind-driven rain, excessive amounts of rainfall, or high temperature and humidity, a more robust water management solution is often called for – a rainscreen wall system. Originally developed for use in masonry construction, the technology is based on the simple scientific fact that water will infiltrate all exterior cladding over time and therefore a more “forgiving” water management assembly must be deployed in exceptionally wet climates.

A rainscreen is a technique for controlling rain entry in an exterior wall that involves locating a pressure-equalized air space immediately behind exterior cladding<sup>3</sup> in addition to employing a water resistive barrier. The 1/4-to-3/4-inch space between the back of the cladding and the face of the water resistive barrier is designed to neutralize the forces that draw water into the assembly. Thus, a rainscreen not only manages water entry by allowing it to enter and exit, but for bulk water that does seep in behind cladding, also drains it away. At the same time, a rainscreen offers accelerated drying of moisture that accumulates in the interior wall assembly by moving air in a convective fashion throughout the cavity.

The laws of physics demand that the air space be at least 1/8-inch or three-millimeter in depth to provide the necessary capillary break that will prevent water from bridging from the back of the cladding onto the water resistant barrier's drainage plane. Both the top and bottom of the cavity also must be ventilated to allow moisture to escape and help maintain pressure equalization or moderation. Detailed flashings around penetrations also are critical to the success of any rainscreen barrier system.

There are two ways to construct an air space as part of a rainscreen system. The traditional method incorporates nailing wood furring strips – also called strapping – over wall studs after applying a building paper or housewrap. In recent years, building product manufacturers have developed “void space” products that achieve the same effect by using a three-dimensional plastic matrix to create a vented continuous rainscreen. Builders can choose from several different manufactured varieties – a plastic matrix that can be applied directly over a water resistant barrier or special bonded products that combine the plastic matrix with a water resistive barrier for a one-step installation.

The chief advantage of strapping is the savings in material costs – furring strips are much less expensive than manufactured rainscreen systems. However, installing these strips is labor-intensive and therefore strapping is ultimately more costly than using void space products.

Other drawbacks of strapping include the creation of hot spots along stud locations and trapped moisture as a function of wood-to-wood contact, which can lead to reduced air movement and a greater potential for mold buildup. Because manufactured products are applied continuously, the entire surface area of the wall is protected from water infiltration and continuous air movement is optimized. The bonded manufactured systems also are faster to install because they are a unified assembly.

Still, strapping continues to be the preferred method of some builders. Meanwhile, manufactured products, while still in their infancy, are growing in popularity. In Canada, the National Building Code was recently amended to mandate the use of a rainscreen system including a minimum 10-millimeter air space break in all areas that exceed a certain rainfall threshold. While the amended code remains up to provinces to adopt, it appears that certain coastal provinces such as British Columbia and Nova Scotia already are in the process of doing so.

### **SELECTING THE RIGHT PRODUCT FOR THE JOB**

Because building science experts point to rain as the single most important factor to control in order to optimize durability, deciding which building envelope product to use must be predicated on climate conditions to which it will be exposed. A wall assembly that is trouble-free in one area of the country may not perform adequately in another.<sup>4</sup>

Wind-driven rain is an especially powerful foe, forcing its way into small penetrations in cladding materials at joints, laps, settlement cracks, hose-bibs, vents, utility cut-outs, electrical outlets and nail holes. Wind can also blow rain horizontally into cracks and holes in the exterior wall. And wind blowing around a building can create a negative pressure within the wall assembly that literally siphons rainwater up and in to the assembly; “reservoir” style cladding such as stucco is particularly sensitive to this type of phenomenon. Wet wood in turn creates a food source for mold and mildew spores, eventually causing the wall system to rot and leading to potential health hazards. It is estimated that 90% of all mold cases are related to water leaking through exterior finishes.<sup>5</sup>

The main rule, therefore, in selecting a moisture management strategy is that the amount of rain will determine the amount of rain control needed.

In areas like the Southwest that receive low rainfall (less than 20 inches annually), a housewrap or building paper should offer sufficient water resistance protection, according to most building experts. In areas that experience moderate amounts of rainfall (20 to 40 inches annually), protection against rain penetration should include a drainable housewrap. And for extremely wet and/or humid climates, coastal areas and hilltop exposures receiving high (40 to 60 inches annually) or extreme (60 inches or more annually) rainfall, a ventilated rainscreen assembly is recommended; a rainscreen system is also advised for areas that receive high winds in addition to rain. Rainscreen systems are recognized by leading building trade associations for their effectiveness in controlling rain water intrusion into wall assemblies in areas of high and extreme rainfall.<sup>6</sup>

Even in dry, less demanding climates, however, builders seeking optimum drying and drainage capability may wish to install a rainscreen or drainable housewrap as added insurance against moisture problems. The cost of using these methods up front during construction is small in comparison to fixing moisture-related problems later.

As always, budget and schedule will be key factors in builders’ and architects’ ultimate choices. Also, new product alternatives are starting to come on the market – for example, wraps that can be sprayed or painted on sheathing – which bear watching.

**CLADDING IS A FACTOR, TOO**

At the same time, the choice of exterior cladding must be taken into account, as some claddings are more moisture absorbent than others, and thus could benefit from drainable housewraps or rainscreen systems. The following chart offers suggested guidelines from building science experts for selecting a water resistive barrier or rainscreen depending on the type of siding that will be used:

**GUIDELINES FOR BEST BUILDING PRACTICES**

SIDING MATERIAL	BUILDING ENVELOPE PROTECTION OPTION	REASON
Wood cladding	Rainscreen system	All woods are highly susceptible to moisture penetration and absorption and require air space protection
Stucco or stone masonry	Rainscreen system or drainable housewrap	Porous nature of stucco and stone absorbs water and therefore benefit from air space protection. Drainable housewrap may suffice in certain dry climates, but not all enhanced housewraps optimize drying; over time, small cracks will appear in stucco, requiring water drainage behind cladding.
Cement Fiber	Rainscreen system or drainable housewrap	Less susceptible to moisture infiltration and absorption than wood, but can trap water like stucco (see Stucco above)
Vinyl siding	Housewrap or building paper	Non-absorbent, does not trap water, low potential for rot. Good-performing building paper or housewrap is recommended to optimize long-term performance
Brick	Rainscreen system automatically created	Nature of brick construction creates sufficient moisture protection and air movement; however, water seepage is possible if air cavity is not continuously maintained

## CONCLUSION

The application of advances in technology has vastly broadened the range of solutions for builders and architects to incorporate effective moisture management systems in designing and building new residential homes. Those systems today can be tailored to fit the particular circumstances for each new building to help guard against the effects of corrosive water damage over sustained periods of time.

However, selecting the right system remains a complex issue – due in part to a general lack of standards-based methods to evaluate the optimum solution for each home. In addition, factors such as the type of cladding to be used – stucco, wood or vinyl, for example – add another layer in the decision-making process because each responds differently to moisture. Project budgets and timetables are determinants, too.

Ultimately, one of the most crucial deciding factors is the environment. A continuum ranging from the most arid environment to areas where rain and wind are frequent to virtually constant will dictate the level of protection needed. That can range from simple building paper to housewrap along with rainscreen protection. Each of these products should be carefully evaluated before use for their ability to drain bulk water and dry remaining moisture so other building components are not compromised. When in doubt, it is probably better to err on the side of applying a higher level of protection for a small incremental cost, compared to the cost of solving a problem in the future.

With a solid understanding of the differences in the roles and performance characteristics of rainscreen systems and the distinct types of water resistive barriers, making the right product selection can be greatly simplified. As the state of building science progresses, more data will be available to builders and architects to guide them in this decision-making process.

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1. *BUILDERnews Magazine*, April 2006
  2. Fissette, Paul, “Housewraps, Felt Paper and Weather Penetration Barriers,” University of Massachusetts, 2001
  3. *Lstiburek, Joseph W. and Carmody, John, “Moisture Control Handbook: Principles and Practices for Residential and Small Commercial Buildings,”* John Wiley & Sons, New York, NY 1994, pp 1
  4. Cornick S. and Rousseau, M.Z., “*Understanding the Severity of Climate Loads for Moisture-related Design of Walls,*” IRC Building Science Insight 2003 Seminar Series, Toronto, CA Oct. 2003, pp.1.
  5. *Builder Magazine*, May, 2002.
  6. “*To Build a Better Home,*” published by the APA-Engineered Wood Association, 2002.

**FUNCTION COMPARISON OF WATER RESISTIVE BARRIERS AND RAINSCREEN SYSTEMS**

FUNCTION	WATER RESISTIVE BARRIERS		RAINSCREEN WALL SYSTEM
	HOUSEWRAP OR BUILDING PAPER	DRAINABLE HOUSEWRAP	
Water resistive barrier to keep water off structural sheathing and framing	<b>X</b>	<b>X</b>	<b>X</b>
Allows water vapor in framing or insulation to escape, avoiding mold and mildew	<b>X</b>	<b>X</b>	<b>X</b>
Air barrier to stop hot and cold air movement through wall cavity, reducing utility costs	<b>X</b>	<b>X</b>	<b>X</b>
Promotes bulk water drainage in wall systems by channeling moisture through channels, grooves or wrinkles to the outside		<b>X</b>	<b>X</b>
Incorporates air space between the exterior cladding and drainage plane to enhance drainage and promote drying			<b>X</b>

For more information about void space products, such as Benjamin Obdyke's Home Slicker® products, call 800-523-5261 or visit [www.homeslicker.com](http://www.homeslicker.com).