

Chasing Water with Thermal Imaging

Peter Hopkins, Level III Thermographer
SoCal Infrared

ABSTRACT

Chasing water is what I do for a living and I have found thermal imaging to be an excellent tool that compliments any leak detection strategy. With the understanding that water always chooses the “path of least resistance,” we can use thermal imaging to help explain the often mysterious origin of water leaks that may be far from the physical evidence of damage.

Thermal imaging technology has allowed me to expand my business by mapping moisture paths with a completely non-invasive technique. Thermal imaging provides immediate visual results that can reveal the actual sources of leaks. This paper will detail how our company has helped many clients solve their mystery leaks.

INTRODUCTION

People tend to choose the path with the least amount of steps or the fewest obstacles to achieve a goal. Computer navigation systems offer the shortest distance between points A and B or provide a route with least amount of traffic. As defined by wikipedia.org, “The path of least resistance describes the physical or metaphorical pathway that provides the least resistance to forward motion by a given object or entity, among a set of alternative paths. The concept is often used to describe why an object or entity takes a given path.”

Water, of course, is known to follow the path of least resistance. Think of how a river seen from above follows a long, winding, snake-like path. Water, unlike human beings, doesn’t care how long it takes to get to its final destination as long as it travels along the easiest route. This fact is often what confuses people when it comes to understanding where a water leak originates; as they commonly assume the leak must be near the area of visible damage. Having been in the building inspection business for over 15 years, the number of times I’ve encountered individuals frustrated with “mystery leaks” is huge—it’s such a common problem that as a key word search on the Internet, it yields nearly 10 million results.



Figure 1. Aerial views: Left, one segment of a river’s actual course indicated by yellow line measures 14,508 feet; right, the distance between the same starting and end points on the river measures only 5,676 feet when traveled in a straight line.

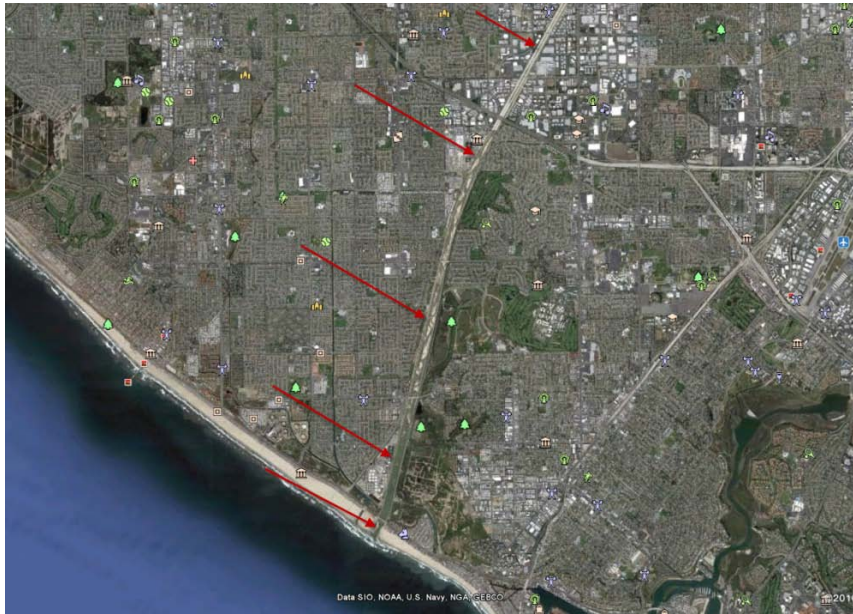


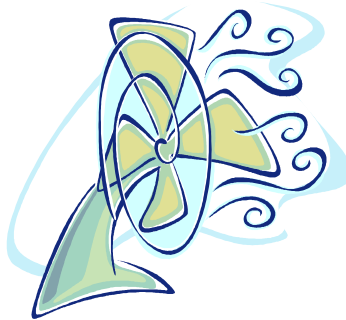
Figure 2. Manmade waterway; notice the straight course.

WHAT'S IN THE BAG

The primary tool in my bag is actually my knowledge and experience. Physical tools are no substitute for effective research, clear communication, utilization of proper investigative techniques, and thorough documentation of problems. A thermal camera along with moisture meters, hygrometers, measuring tapes, and a digital camera can then be utilized to best advantage.

SIMPLE SCIENCE

When objects become wet, due to movement of air, a cooling effect takes place on the object's surface—a process known as evaporation. The infrared camera doesn't "see" water, but rather the effects of water on temperature and environment.



THE CASES

There are all kinds of leaks out there—from plumbing systems to building fenestration leaks to a surprising problem we'll call the “take a leak” syndrome—all of which can be diagnosed with thermal imaging.

Condensation Leak

In this case, we were hired to identify the cause of multiple leaks in a residence, in particular, the cause of moisture in a furnace closet.

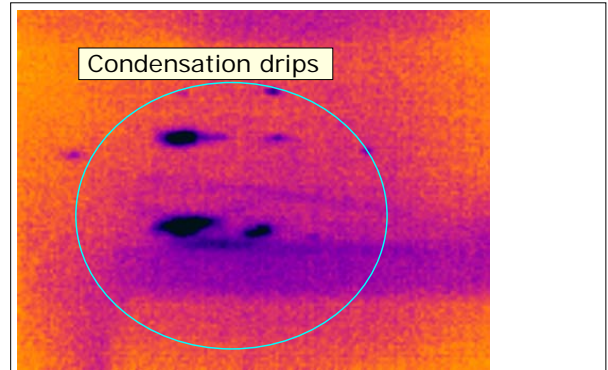


Figure 3. In the images above, water was condensing on and then dripping down from the refrigerant line down into cabinet. Thermal imaging helped map the leak to its source.

The Seven Year Mystery

My company was retained to find the source of an ongoing leak in a downstairs office of a two story home. The owner requested water testing on an exterior window. Recent repairs had been made to the plumbing system, so it didn't seem a likely source of the problem, but thermal imaging proved otherwise.

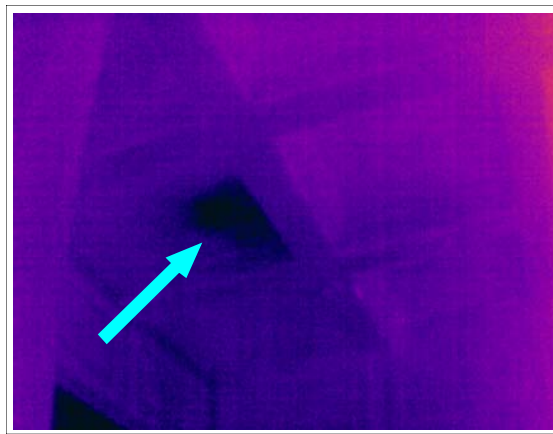


Figure 4. Thermal Imaging quickly identified the location of moisture; now it is up to us find the source of the leak.



Figure 5. The room above the location of moisture damage was quickly viewed with a thermal camera and revealed a colder area at right side of toilet. When read with a moisture meter, this area was found to have 100% moisture. For comparison, the left side of toilet showed high as well, but the center of bathroom showed 0%. Thermal imaging helped to diagnose the leak's source: a failed wax seal and loose bolt on the toilet.

Slab Leak(s)

We are often called upon to identify slab leaks. Usually we recommend a leak-detection company that utilizes ultrasound performed by a licensed plumber, as they obtain good results, sometimes for less than we would have to charge to come out. Occasionally, however, based on the client's situation, we have accepted these jobs and have had great success.

In the case referenced in Figure 6, ultrasound had failed to find the source of the leak, but infrared technology quickly brought the problem area to light.



Figure 6. As you can see in the image, "X" marks the spot

Figures 7 through 10 shows how effective IR technology, when used properly, can be in finding the source of moisture. The client had found us via an Internet search for a solution to his known slab leak. What he didn't know, as the thermal evidence revealed, was the source of the leak was six feet away.



Figure 7. A definite leak is shown at garage floor. The opposite area in lower hallway showed no sign of leakage or damage anywhere.

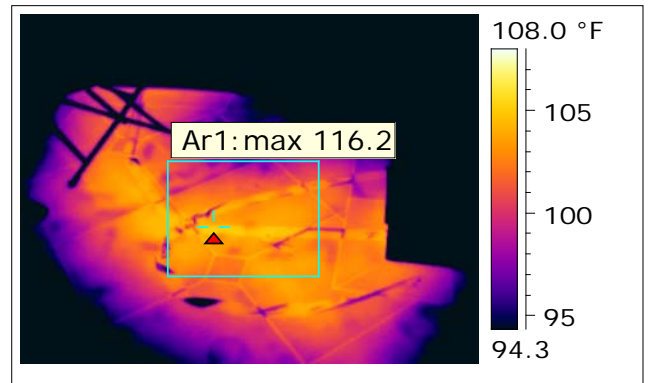
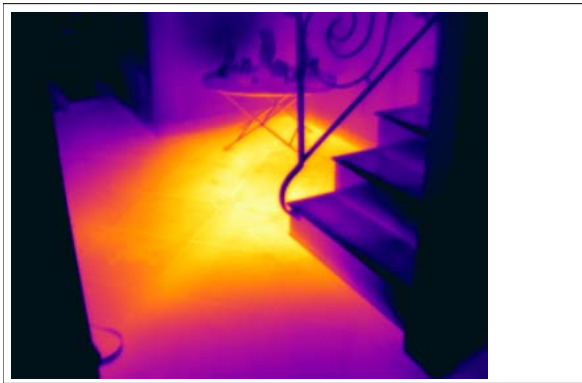


Figure 8. As you can see, a thermal picture is worth a thousand words.

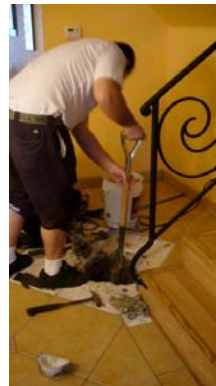


Figure 9. Through the use of thermal technology, we were able to map out a suspected leak location. As you can see in the picture on the right, the plumber is digging right at the "X".



Figure 10. "X" marks the spot; in fact the owner of the home called me the next day to express how upset he was that I was 1" off. (I am being facetious if you didn't get it.) The picture on the right shows the newly repaired pipe back in order.

Toliet or Tub: Which Is It?

A client had contacted our company for additional investigation on an upstairs toilet leak that was supposed to have been repaired by a licensed plumber. Within days of the leak and the downstairs ceiling being repaired, the client found new evidence of leakage which prompted them to engage our services. Through the use of thermal imaging, we were not only able to map the current moisture but, as seen in Figures 11 and 12, were able to prove the leaks came not just from a single source, but from both the toilet AND the tub.

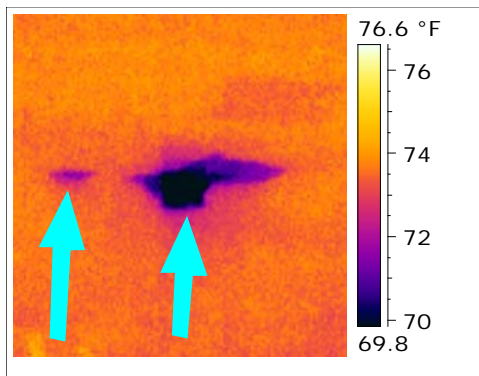


Figure 11. In thermal image on the left, there are two areas of moisture identified, not just one. The visual image to the right shows where client had opened up ceiling and found mold which prompted the call to us.

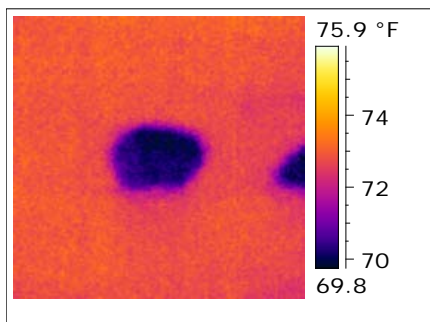


Image.Time 6:56:43 PM

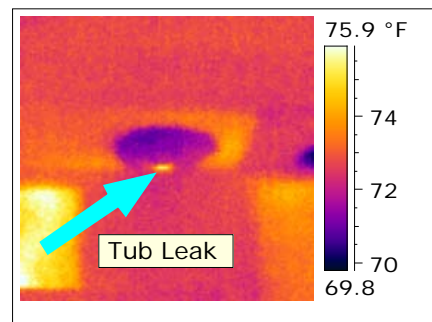


Image.Time 7:08:43 PM

Figure 12. The second spot to left appeared independent of toilet leak (which had not been fixed as you can see). The tub was tested and imaging was done before/after tub was filled with hot water. As you can see in these two images with the time lapse noted under, we were able to confirm two leaks, not just one.

Shower Pan Leaks

A common location for leaks is shower walls and pans.

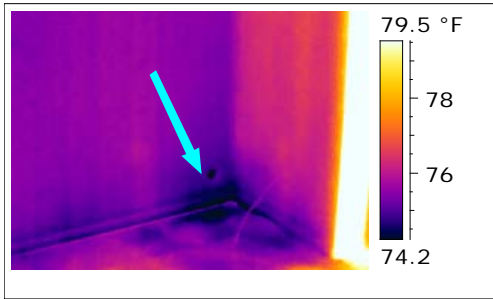


Figure 13. Left, thermal image from bedroom side showing evidence of moisture; right, visible image showing shower which is opposite. The arrow shows same location.

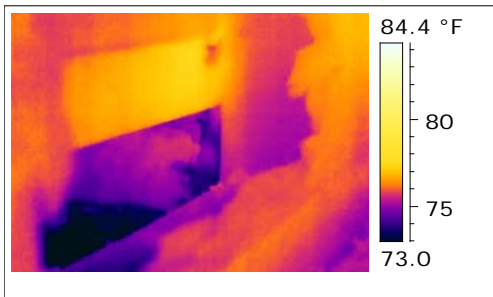


Figure 14. The wall was opened up to confirm the suspected leakage in the shower pan. Note: Dark area was wet at slab.

Deck Leak

The following case shows how the source of a leak can be misidentified. Our company was hired by a contractor who suspected an upstairs bathroom leak, but thermal imaging revealed the problem as a deck flashing leak. We were able to map the moisture and show that just because a stain is in one area, it doesn't necessarily mean the cause is nearby, and how water takes the path of least resistance.

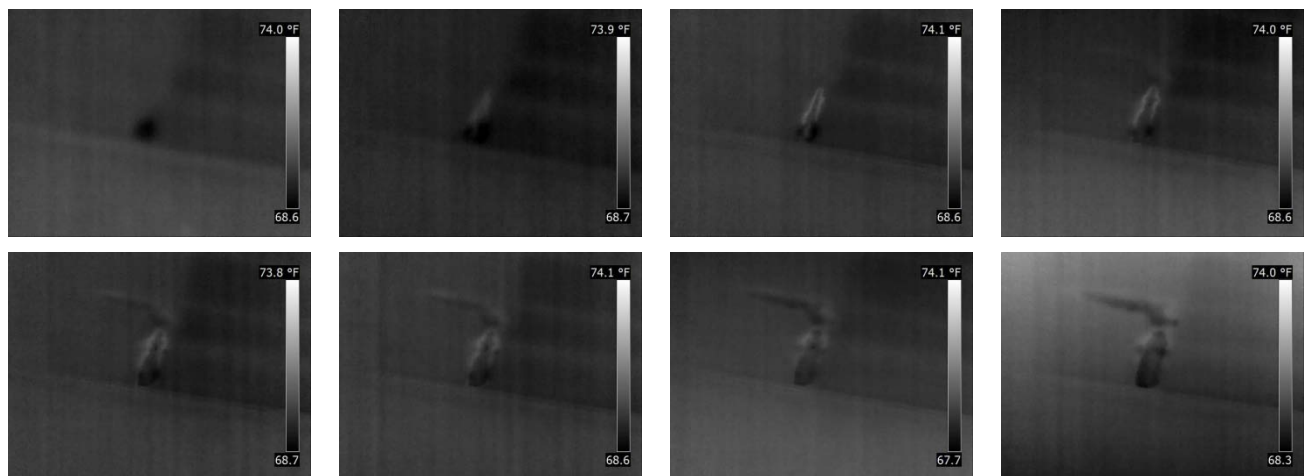


Figure 15. Time lapse thermal photo series over about 30 minutes of water testing.

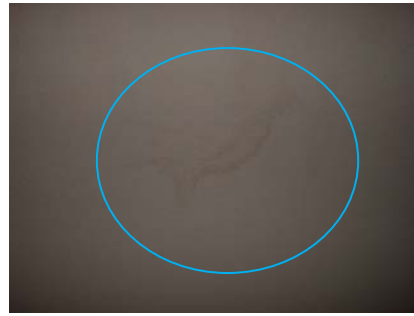


Figure 16. The stain in the image on the right was the final resting place of the water as seen in the last infrared image, but not near source, which was actually several feet away.

Poor Roof Design

The client in this Southern California home was frustrated after having repaired her roof three times for the same problem which was still was not fixed. The roofing contractor suggested replacement of an upper roof to solve the problem. The client was not convinced and called us in for an evaluation.

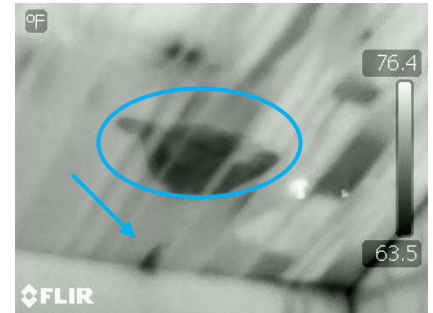


Figure 17. Left, visual image of leak (into blue bowl) centered in passage way between rooms. Center, visual image with circled possible water damage. Right, thermal image reveals wet area in ceiling. The arrow to lower left indicates how the water travels down the ceiling to the header wall directly over the catch basins.



Figure 18. The wet area identified in thermal image was first confirmed with a moisture meter at 100% and then to the source. The roof had a steep slope with an upper roof cascading over, causing water to first hit the structure and bypass the counter flashing therefore leading to moisture entry. The suggested repair on this home involved a new design for a valley flashing versus the suggested roof replacement.

What Do a Kitchen Nook, Master Bedroom, and Living Room Have in Common?

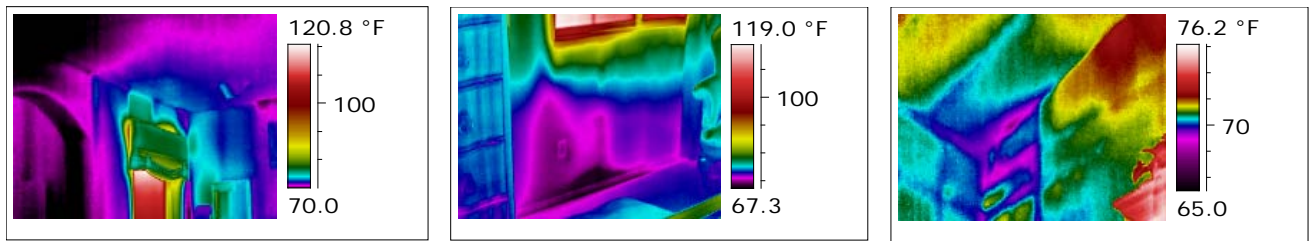


Figure 20. Top: thermal images showing the water damage in each of the rooms shown in visual images in bottom row.



Figure 21. Upon review of the outside, it was found that the downspout from upper roof was directing a large amount of water against the side of the structure, bypassing the counter flashing and leading to water entry.

Large Building Testing

Leaks come in all sizes, and in this case, a large commercial building had a mystery leak that needed to be solved. Our services were engaged in hopes that thermal imaging could give a clue. In this situation, we systematically utilized spray racks to simulate rainfall in order to identify the source.



Figure 22. Leaks were found at three brand new buildings at this complex. The client had complained to builder of many leaks noted at windows.

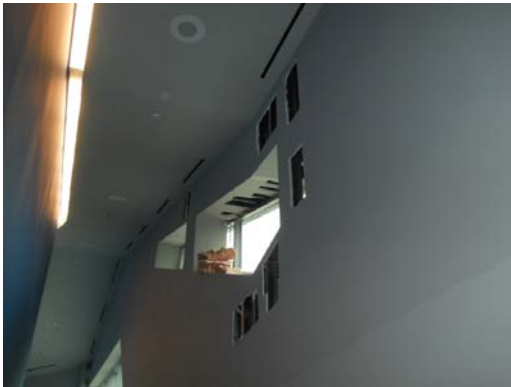


Figure 23. The frustrated builder had cut many holes in the walls in an effort to find the leak (left photo). Through our efforts, we were able to duplicate the leak, and as seen in the photo on right, determine the leakage just under window flashing.

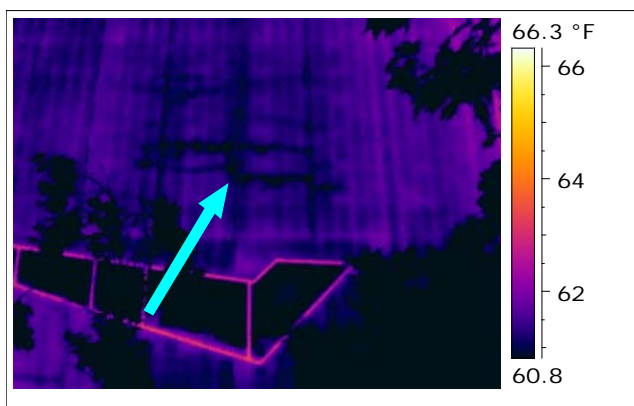


Figure 24. We now needed to locate the source of entry. Thermal imaging of the exterior of building quickly identified an anomaly which captured our attention. Upon closer look, we were able to confirm these anomalies were consistent with cracks in the stucco. As you can see in the photo on the right, the stucco finish was non-absorbent (acrylic finish). These cracks were actually breaks that allowed the point of entry. This collection of water and evaporative cooling are clearly shown in the thermal view. The fact that the finish of the stucco did not allow entry (except at crack) also meant it did not allow the trapped water to escape. Water simply took the path of least resistance and bypassed the window flashing to enter the building. Case solved!

Thought to Be a Planter; Found to Be a Gutter

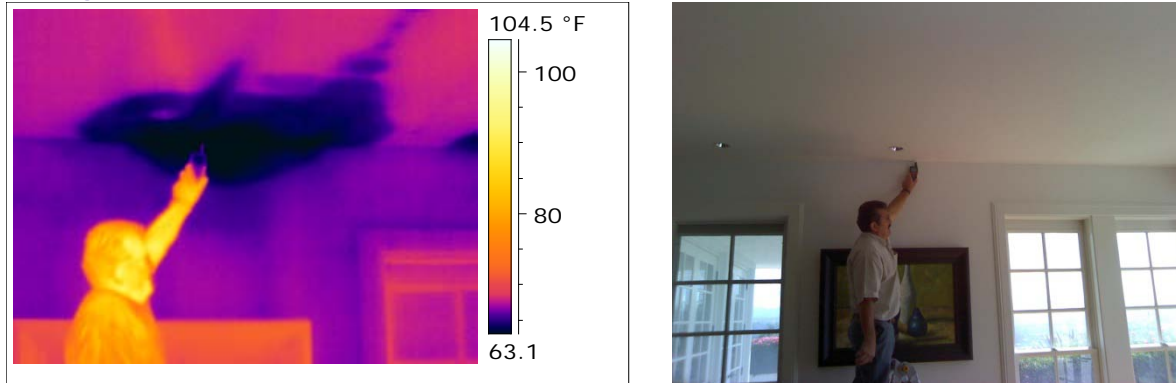


Figure 25. My company was retained after a failed attempt to identify the source of a leak. As seen in the thermal image, the moisture is still there!



Figure 26. The living room of this large custom home showed a leak at the ceiling corresponds to a planter on the exterior of the building as seen in the center image. The right image is the outside view that corresponds to the thermal image in Figure 25 of the gentleman taking a moisture reading. The contractor completely removed and re-waterproofed the planter, believing the moisture was a direct result of the proximity of the planter. The ceilings of living room and adjacent room were all repaired. However, with the next rain, the same leak reappeared.

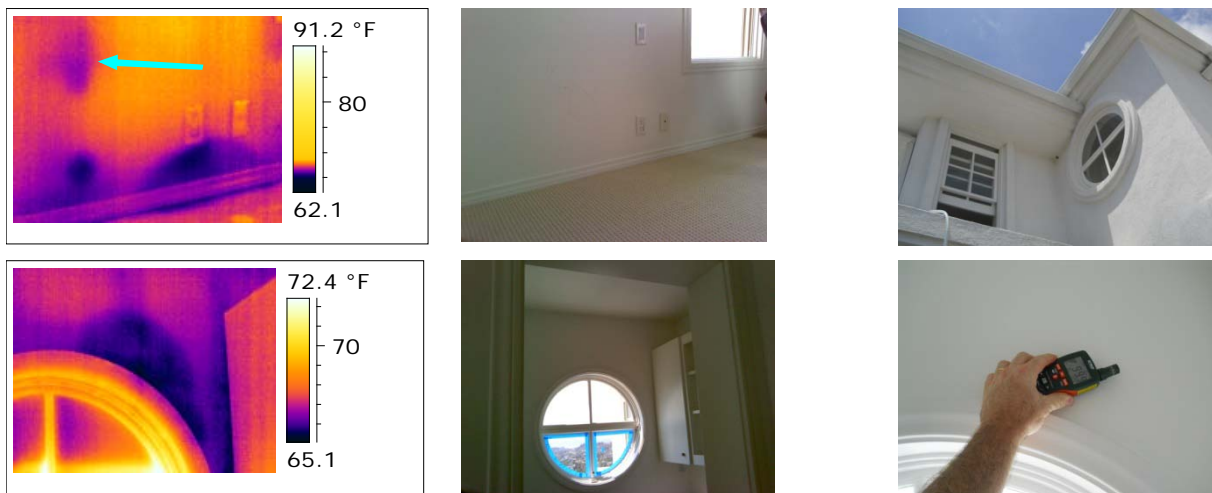


Figure 27. Thermal imaging of the walls showed us the water extended above the planter (top left image, blue arrow and at adjacent bedroom above round window).



Figure 28. Destructive testing confirmed what the thermal imaging had indicated as drenched insulation above planter. Notice the worker wringing out water from insulation taken from wall.



Figure 29. Our attention was now directed toward the roof with water testing. While on the roof and focusing our efforts on upper areas, we identified what appeared to be a new gutter system installation. When the contractor was questioned on this, it was determined that the gutters were installed just weeks before the initial water damage manifested.



Figure 30. It just so happened that the water flowing from roof hit the splash block at gutter, passed back to supporting nail at gutter, and exited around the nail, entering the structure at the soffit.

MARKETING

As stated previously, your brain is always your best tool. The infrared camera, however, can be an excellent marketing tool in addition to its utility in the field. Thermal images are great at getting people interested, especially as public awareness of this technology continues to advance. There are many instances where experience and critical thinking have solved the problem, and the thermal images were merely placeholders in the supporting documentation. However, frequently, it is the thermal image that the client raves about! As the owner of this “magic” tool, I really don’t mind what gets the rave, as long as it brings me more referrals.

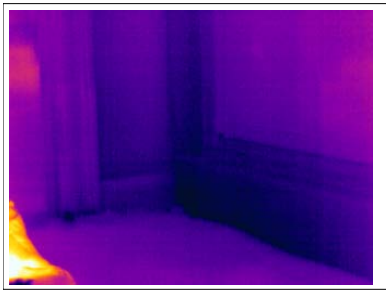


Figure 31. Client's complaint was that the shower leaked, but the shower had not been used in over a year. Thermal imaging in combination with the use of moisture meters confirmed elevated moisture at corner of wall (rather than close to shower as would be suspected).



Figure 32. Well, we finally had to use another meter (our noses) to determine the source of the problem was not what the owner expected. Notice the arrow on left (dog bed) and the guilty party in the right image.

SUMMARY

The title of this paper "Chasing Water with Thermal Imaging" reflects what people are actually hiring us to do. Many times, as shown by the case studies in this paper, thermal imaging has helped us run the source of the problem to the ground. If you are a building professional in search of an excellent diagnostic and marketing tool, an IR camera is a great investment.

I often mentor new and working thermographers, helping them build companies of their own. I advise home inspectors, contractors, or water remediation contractors that any business begins with talent and expertise. Adding a thermal camera can allow them to diversify their businesses by adding building forensics to their repertoire.

REFERENCES

Google Earth: Measurements and Sky View Images
Wikipedia.com: Definition "path of least resistance"

ACKNOWLEDGEMENTS

The author would like to thank FLIR Systems and the Infrared Training Center for allowing me to present a paper true to my heart. I have been in the business of helping people make one of the biggest decisions of their lives with my home inspection company. After adding thermal imaging to my business and helping clients with one of their biggest frustrations (leaks), I now feel honored to help others build their infrared practices.

ABOUT THE AUTHOR

Peter Hopkins has operated a successful home inspection company since 1996 (www.inspecdoc.com) and has personally performed over 7,000 property inspections. His company expanded into infrared in 2005, with the opening of SoCal Infrared (www.socalinfrared.com) specializing in diagnosing moisture conditions found in his property inspections. He is the co-founder of United Infrared (www.UnitedInfrared.com), a national network of contract thermographers which includes application-specific training and business coaching in a multitude of applications related to infrared technology. Peter is a Level III Certified Thermographer, ICC Code Certified Building Inspector, Certified HERS Energy Rater, trained in equine thermography and licensed with the California Horse Racing Board as an Assistant to Veterinarian. Peter lives in Southern California with his wife and two children.